PROSUME / NGI

ECP - The Energy Commons Protocol

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ECP Whitepaper

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Introduction

The aim of this document is to present a vision and a possible path to a "*General Purpose Tech Platform*", a **Smart Decentralized Information, Energy and Logistic Network** for Resilient Communities in the age of the **IoT**, where a new society of Prosumers will be able to use data to easily program their own algorithms to increase productivity and efficiency by reducing the *marginal costs* almost to zero [7].[1]

PROSUME srl Company after successfully experimenting the Blockchain Technology applied in a Use Case in Austria for the Utility Energie Steiermark, in a Use Case in Italy with the Aggregator EVOLVERE, in a Use Case with the italian Gas TSO SNAM to provide a trading platform, and within the LEDGER Program where it developed the **ECP** Project, it is bringing the technology a further step by leveraging the "on the field" experiences and completing the development of what should be the "*Platform*" composed of various software tools, like a **Toolkit**.

The idea is to build a modularized system composed of:

1. software binaries to install on the meter devices, sub-meter, IoT, routers, etc. to provide flexibility and integration on the infrastructure layers
2. softwares modules like ECP and Zenroom to build the business logics in human understandable self programmable language, and to maintain interoperability
3. Self Sovereign Identity and privacy modules, to build awareness and reduce the risk of algorithmic black holes

Energy Infrastructure is following the same path that Telecommunication Infrastructure has taken in the last 20 year, with the main difference that Telecommunication became mobile while Energy Provisioning is fixed, but end users are in search of a flexible and portable management of their Energy **Service Level**.
To achieve these transformation objectives we have to align front/middle/back-office operations, separate the **Identity** and **Privacy** layers from the **Smart Contract** modules while providing strong cryptographic procedures and interoperability, so to be able to improve customer experience and margin from the bottom-line profit. This process would allow to establish a framework for every industry partner and participant making it easy to contract distributed resources, exactly the same way the wholesale markets work today.

[1] "*The Zero Marginal Cost Society*",Jeremy Rifkin's new book (2014).

P2P Energy sharing coupled with "Local Energy Communities"[2], EV Charging, Storage and Management of the Micro-Grid system can be an excellent marriage between **Decentralized Governance** and Community Aggregation, while providing sustainability and resiliency[8].

The goal is to be aligned with the European Digital Single Market (DSI) strategy, the proposed Sustainable Development Goals (SDG) and to bind to European Directives and regulation. While realizing our system architecture for the **LEDGER** MVP test, we came to the conclusion that integration with upcoming standards and existing Digital Identity Systems is very important to provide interoperability both with legacy infrastructure and, at a policy level, European regulations like eIDAS.

Social digital innovation is lead by new paradigms of immaterial value transfer, but when dealing with energy transition scenarios is clear that we still live in a reality of **physical authenticated systems**. Parties have to share private information while participating to a public service and/or public infrastructure. Innovative research in **cryptography** has converged in our development thanks to **LEDGER** and has helped to solve problems and envision even more opportunities for developments ahead. Algorithms for Zero-Knowledge proofs (**ZKP**) and Multi-Party Computation (**MPC**) are the building blocks of **ECP** and its evolution as a protocol.

Interoperability is a key factor, not only to avoid specific lock-in effects commonly caused by the oligopolies of Service Providers, but also to re-use legacy infrastructure. It is fundamental to support existing hardware which does not always provide a Linux Operating System, and therefore develop sensor components that can be retro-fitted to legacy infrastructure.

[2] Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources

Chapter 2

Functionalities

2.1 Order Processing

By adopting the **ECP protocol**, **Prosume** offers to participants the freedom to choose how their energy is managed and sourced. For example participants can opt to buy only locally produced renewable energy, or **trade their excess power** directly with their neighbors. Participants can also benefit from **flexibility management** of energy production and accumulation, for instance by deciding to store excess energy and place it on the market for additional revenues according to custom conditions defined by smart contracts.

We have to build an *online distributed marketplace* where "Smart Contracts" manage offers and bids, automatically matched by the platform based on participant's preferences. Members of a certain area have complete transparency to monitor with whom, when, and at what price their energy was traded: transparency is contextual to local environments as defined by "Community Bindings" (PRESETS contracts).

Following standard Order Management Systems we provide participants with the possibility to establish **market** and **limit orders**, further recording **booked orders** and **exchanges** as immutable records in the Distributed Ledger. To establish a sort of "digital single market" the execution of Smart Contracts takes place in the distributed system based on given specific attributes:

1. UID: type of asset and name, status and trade date/time
2. BUY/SELL: value, price, quantity
3. Seller: Sales, Shipper, Provider
4. Counterparty: UID/name/address/date/payment/settlement/delivery_type (as for the Seller it requires specific Attributes)

Given the specific Attributes, it is important to have the Order Booking logic separated from the DLT system and the Accounting systems who might inherit attributes from other systems.

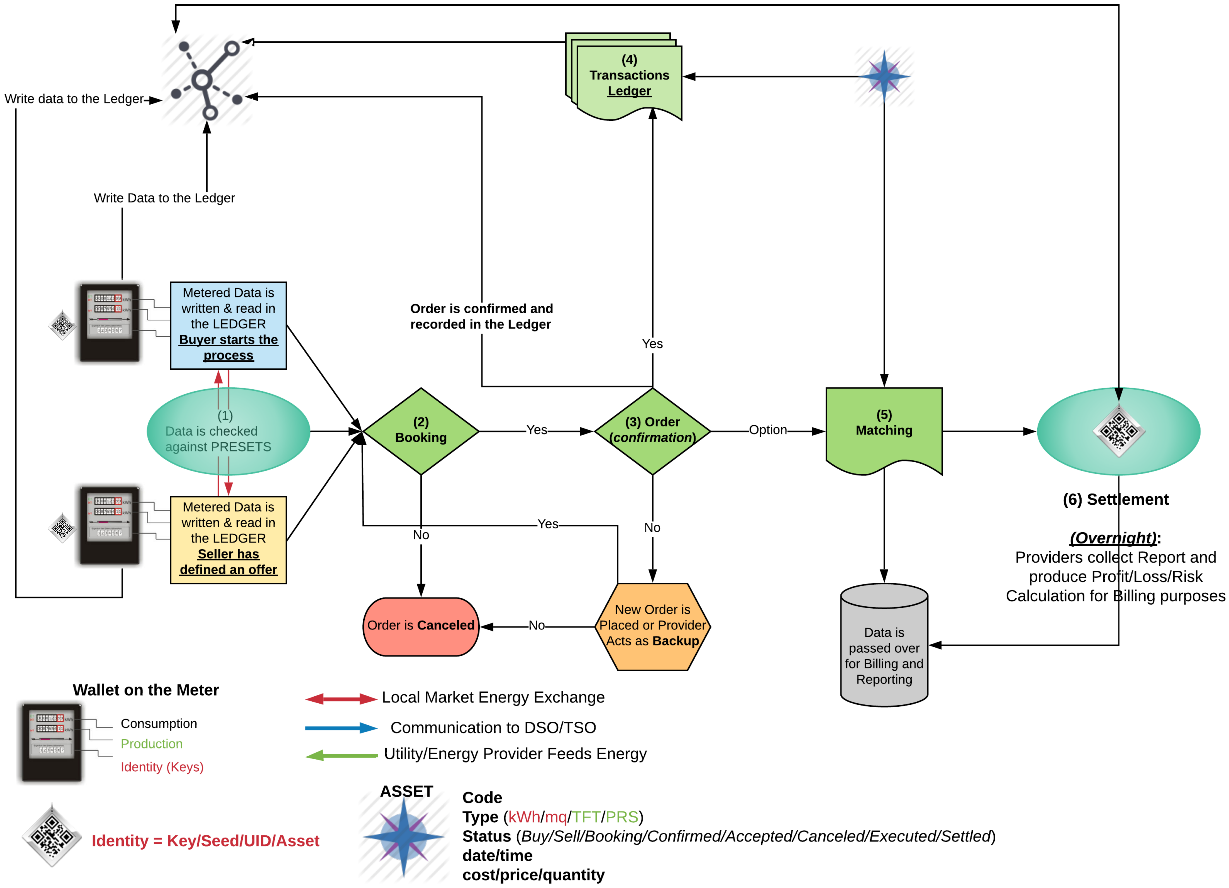

Figure 2.1: Order processing following the 6 steps of a settlement life-cycle.

1. Given that the Seller or Buyer have Proper ID, Credit (enough Asset), and a Specific Service Level, there can be an offer to buy or sell. This is the **Pre-Execution** step where data are checked against **Attributes** and <u>metered data values</u> which are registered in the Ledger by metering devices
2. **Booking**: Both parties agree on the characteristics and assets. Only then there can be an order between them
3. **Order** (*Confirmation*): Once agreed, there must be an Order Confirmation and at this step the order becomes a transaction and is written into the Ledger
4. **Transaction**: happening on the Ledger. Orders are matched and values are exchanged
5. **Matching**: after the transaction has happened, given that specific exchanges happened and values transacted, those values are registered as confirmed and settled for the Billing procedure (*real invoice*). In case something goes wrong they have to be canceled
6. **Settlement**: at this step all the orders are registered on the Ledger and on the systems managing operations and providing then the reports generated for **Overnight** profit/loss calculation, risk and billing procedures and any different type of document might be requested by the accountant offices (*this is necessary not only for the Trading offices but also for a possible p2p marketplace*)

This type of development would help us provide a flexible solution to relevant stakeholders' co-design enabling a greater autonomy in building new sets of business logic smart-contracts with high societal impact.

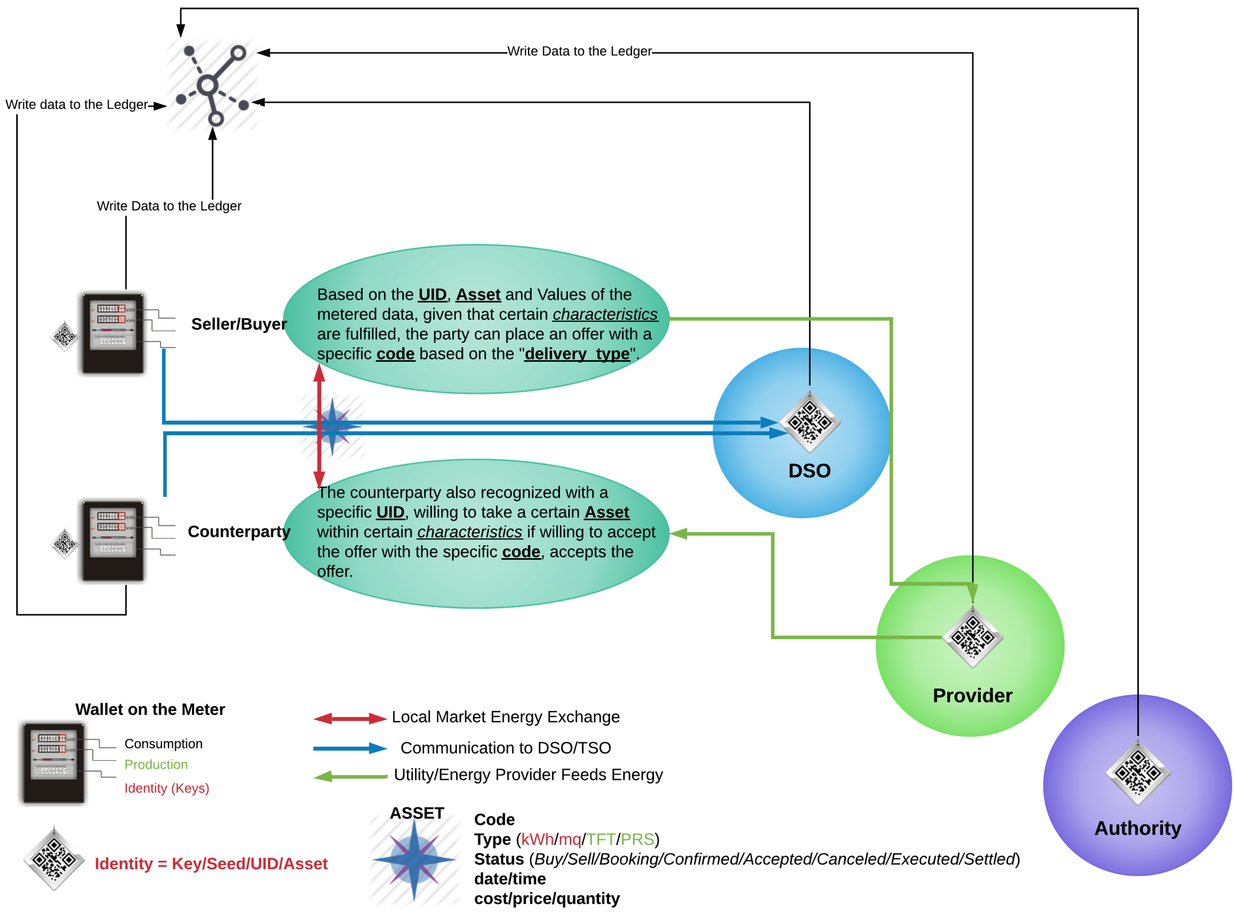

Figure 2.2: Access map of stakeholders for booking orders and trading operations.

IoT is especially relevant to the Smart Grid since it provides systems to gather and act on energy and power-related information in an automated fashion with the goal to improve the efficiency, reliability, economics, and sustainability of the production and distribution of electricity.

Chapter 3

System Architecture

3.1 Tools for the Energy Networks

As the rollout of the IoT becomes widespread, connecting everyone and everything in a neural network raises **privacy issues** and could seriously compromise any personal or corporate **information associated with Internet connected devices**. This is a an important aspect with which we are willing to engage by providing distributed autonomous internet and energy solutions for a **TIR** society. Fostering the adoption of the distributed model with standard protocols, by providing tools that simplify the process of upgrade of actual infrastructures and enable implementation of Automation and Distribution Systems.

In the IoT age, individuals have to set their privacy policies for every daily activity. These policies correspond with their counterpart in the distributed network of databases but also within the Community they belong to, and linked to national and at least european wide Indentity Systems. Providing a granular level of privacy and a modular approach to authentication and access, like for example allowing to build credentials based on defined attributes, would simplify the process for the user who could be less constrained in providing her entire identity in order to offer or receive services for a particular activity. As citizens generate the data, they also decide who to sell it to in order to enrich it with, lately they can also decide to keep it private. This can only be achieved with a decentralized model based on **distributed p2p networks and smart energy meters within a decentralized data governance**, while preserving different **levels of privacies** and providing higher standards of security.

To build such a Platform we need to provide an enabler allowing us a to modularize service provisioning so to be able to gain revenues from specific services following customer's requests and needs, the stakeholder's participation and the infrastructure resiliency, rather than a simple "company profit model". Service levels defined by providers can be multiple and, although being normally in a fixed location, the users might be belonging to different Communities, Nationalities, or simply "Residency", as it often happens when home owners have multiple properties (consider also the Electric Vehicle they might use).

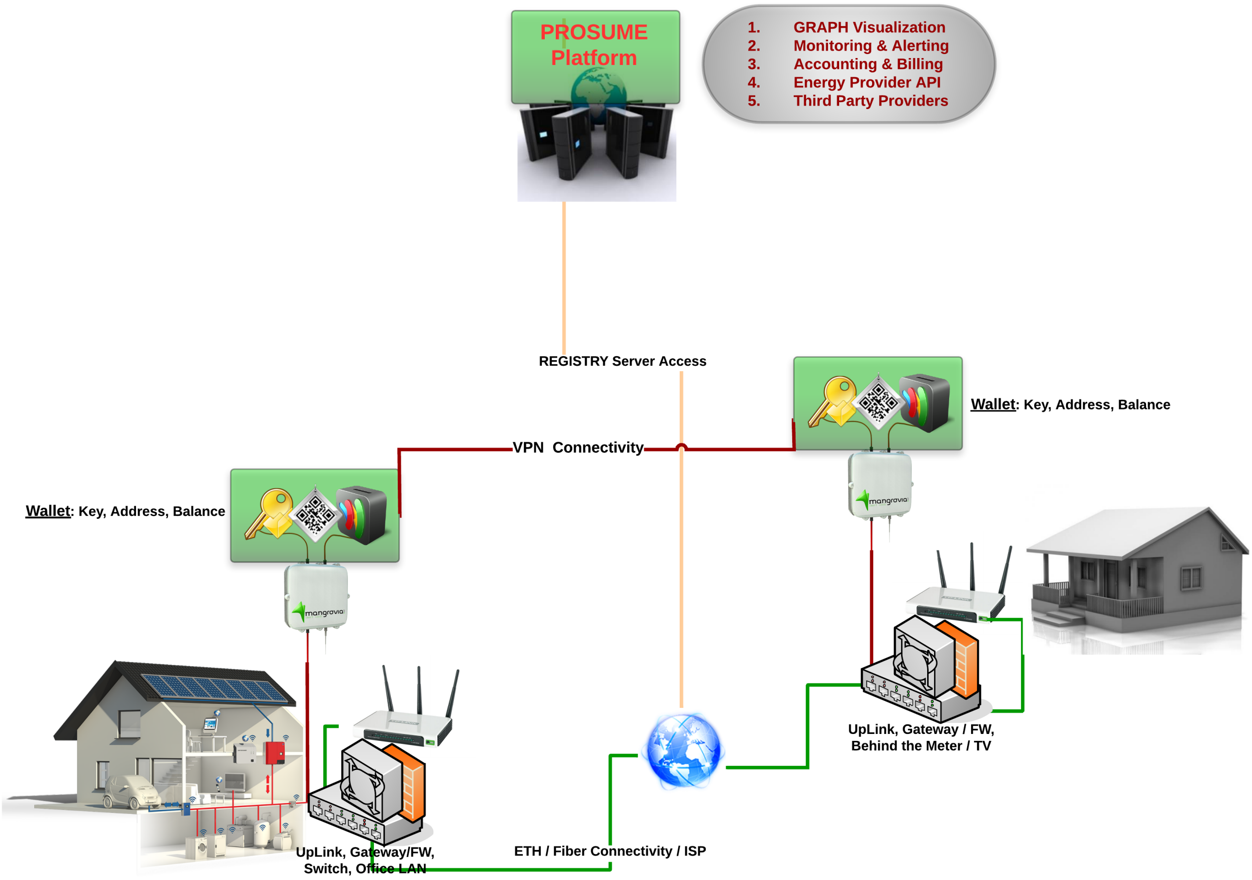

Figure 3.1: Access to Services through one Account

For this feature to work, **ESO** (Energy Service Operator, like AXPO spa) but also **DSO** (Distribution System Operator) and **TSO** (Transmission System Operator) need a configurable system where the contracting step happens before the booking and transaction steps. Only transaction processes are recorder on the ledger (**DLT**) while other steps of the settlement procedures are checked only for computational integrity, but kept off-the-record to provide privacy and enhanced flexibility. Because of the nature of blockchain technologies, when adopting DLT solutions to provide transparency of transactions for all participants, one still needs to preserve their privacy.

To plan the system architecture is important to know what information goes on the DLT. We have to apply a fine-grained strategy for data-disclosure: to enable greater flexibility to the overall system, but also ease the process of interoperability and integration with legacy systems, important to allow a faster energy transition from industrial infrastructure.

3.2 Solution

The modularized architecture can help us easily maintain modules of the solution following the evolution of DLT and Metering technologies and swapping services depending on customer's needs and market dynamics:

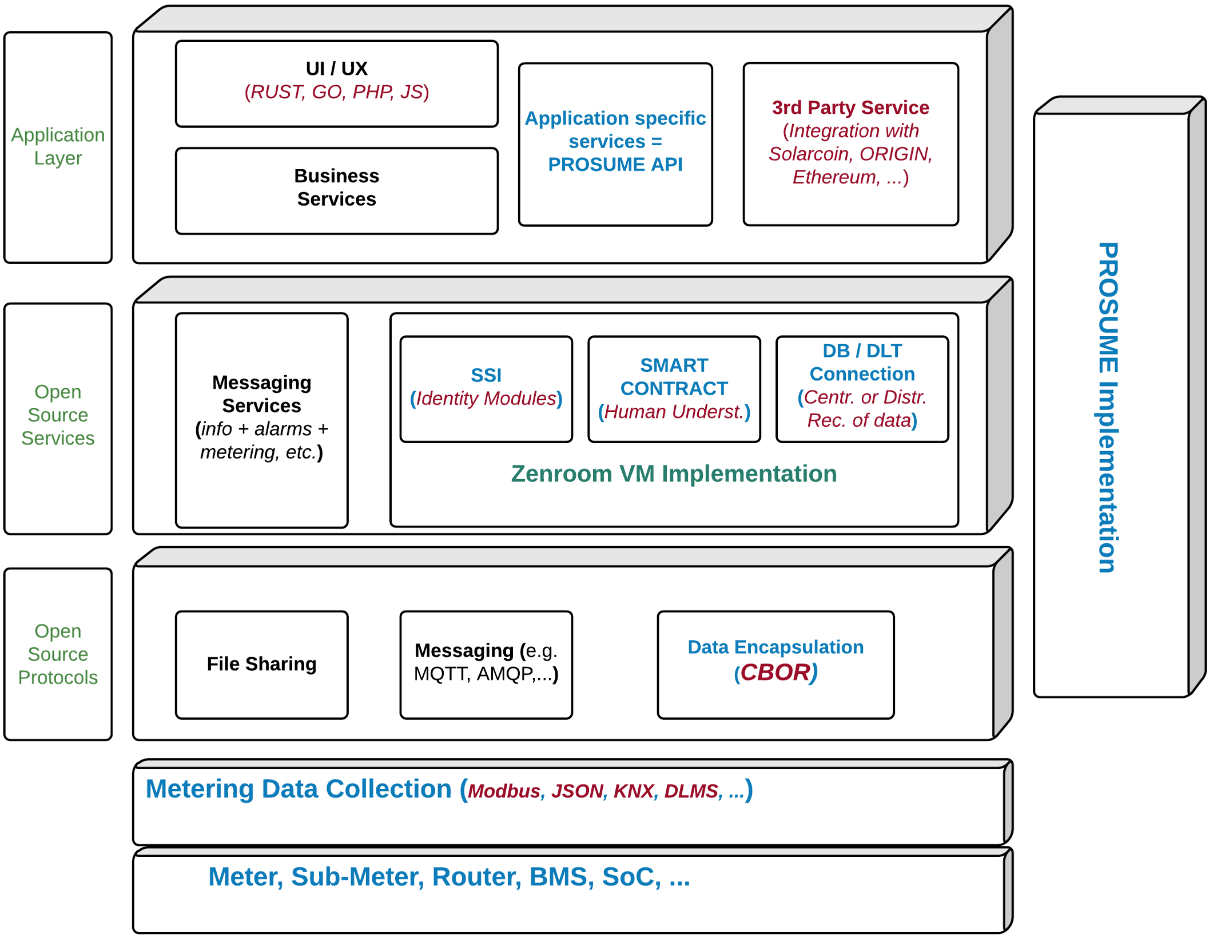

Figure 3.2: PROSUME Software Stack model

In a local Micro-Grid model the devices could be reachable to each other through VPN Connectivity and communicate with the Registry Server where the PROSUME Platform resides. In an enclosed environment instead, they would push notifications through gateways to external nodes, as for example in situations where we would have meters communicating over LoRa protocols to LoRaWan gateways forwarding traffic, or through a Mobile APP.

When access to the Micro-Grid layer is available Participant nodes are "cold wallets" consisting of sensor and cryptographic technology installed on real fiscal meters, capable of operating DLT based communication. The cold wallets collect data from the meters and send them over to the full node registering the meter measures and executing payments from the nodes consuming energy paid to the local provider (*that could be an Aggregator, an ESO or the Municipality, in our case represented by GridAbility*).

The Linux hardened meter devices installed at home by customers directly in their "*electrical boxes*" can be the enabler, bypassing the standard meter and opening the possibility to provide anyway various value added services. This process implies installing hardware at home which might be not so convenient for customers and for providers too. That is why we have to keep in mind that accessibility plays a fundamental role for the scalability of the project, so we should be open to different type of solutions enabling customers to take advantage of the modularity of our solutions.

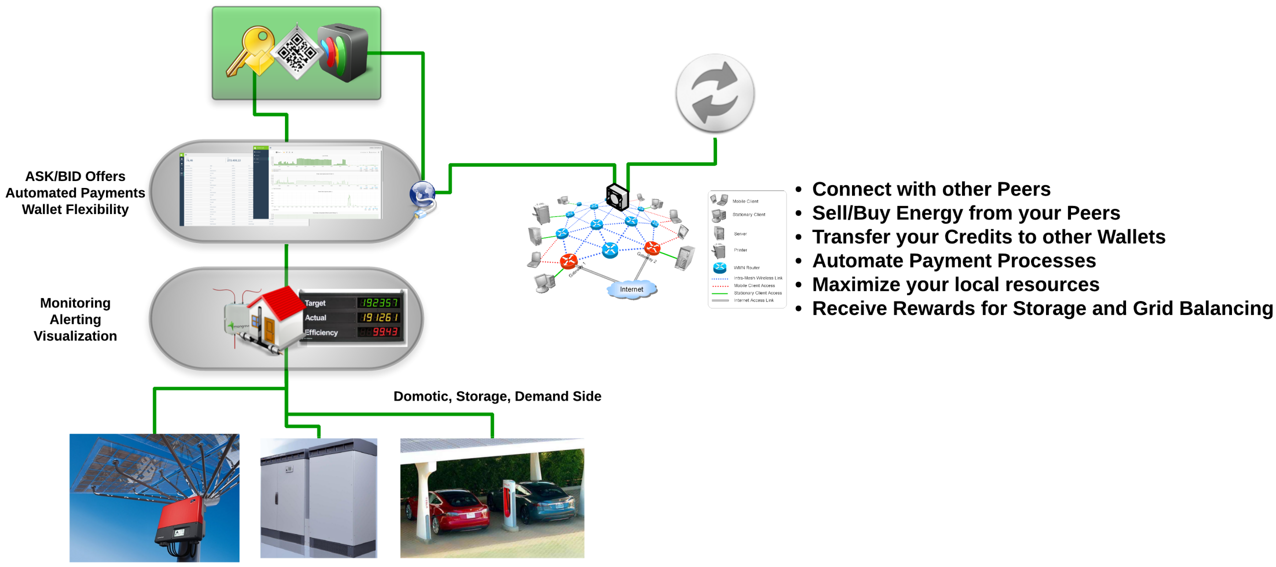

Figure 3.3: PROSUME, graph of single ECP participant

Each meter/router device does not only collect metering data of Energy Production, Consumption, Storage, Exchange but it becomes an **HUB** for the home and a real **Gateway** enabling PROSUME to provide Third Party Services (*any competitor can install its own application and provide their own services to customers. The provider would pay to PROSUME a fee for gaining access over our customer*).

Online distributed environments (self-hosted, but also cloud based) run full nodes consisting of infrastructure capable of running heavier computations and that operates a semi-permissioned DLT granting the integrity of stored information. Yet the coupling of IoT devices and broadband help us take advantage of a fully decentralized architecture and service offering without intermediaries.

The semi-permissioned nature of the **LEDGER** is a transitional state to allow adjustments during the testing and piloting phases under close monitoring for the development of the **MVP**. The MVP is engineered to exchange energy/accounting relevant information in between the different stakeholders of the energy marketplace (*DSO/TSO/ESO/ESCo/Aggregators/Municipalities*). The system communicates over a **common and standard protocol** which is free and open source and easy to adapt and implement for any type of IoT device or metering system, also with constrained system resources. A data structure and specification is released. For this purpose we have found that the CBOR Protocol pretty well has all these defined characteristics and can be the perfect choice for interoperability in complex architectures like the ones of the "energy stakeholders infrastructures". For compatibility reasons and to allow faster debugging and modifications, we developed a standard JSON data structure model to include common metering parameters used in most of the metering devices and future parameters that will be relevant when adoption of storage systems will grow.

Chapter 4

Acknowledgments

After many years of experience matured in the fields of *Networking* & *Routing* and *Energy*, following the happenings around the **Community Networks**[12] projects developed in different European Countries, and the collaboration with the activists from the **CETRI-TIRES** no-profit Organization, in year 2014 Alex (acme) D'Elia has written the document which was originally conceived as the Toolkit solution.
This Whitepaper is the result of the work done in the last years and specifically within the LEDGER Program. This was possible unless with the work done by Mattia De Vecchi, Massimo Ferronato, Pierluigi (newmark) Maori, Denis (jaromil) Roio, Marco (radium) Sachy, Francesco Visconti, Puria Nafisi Azizi, Ivan (parazyd) Jelincic, Marta Arniani, Omar Caboni and all the people involved in **LEDGER**. Also, and specially this was possible thanks to the support of my broader family, my daughter, and all the friends who supported us.

4.1 License of this document

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