

Blockchain ICT platform for assets and transactions management



Agenda

- **Introduction - Ethereum & Smart Contract**
- **Innovation and Blockchain - Our vision**
- **Blockchain in the Energy Domain**
- **ChainPRO** - A blockchain based platform for assets and transactions management
- **Other Business Cases**

01

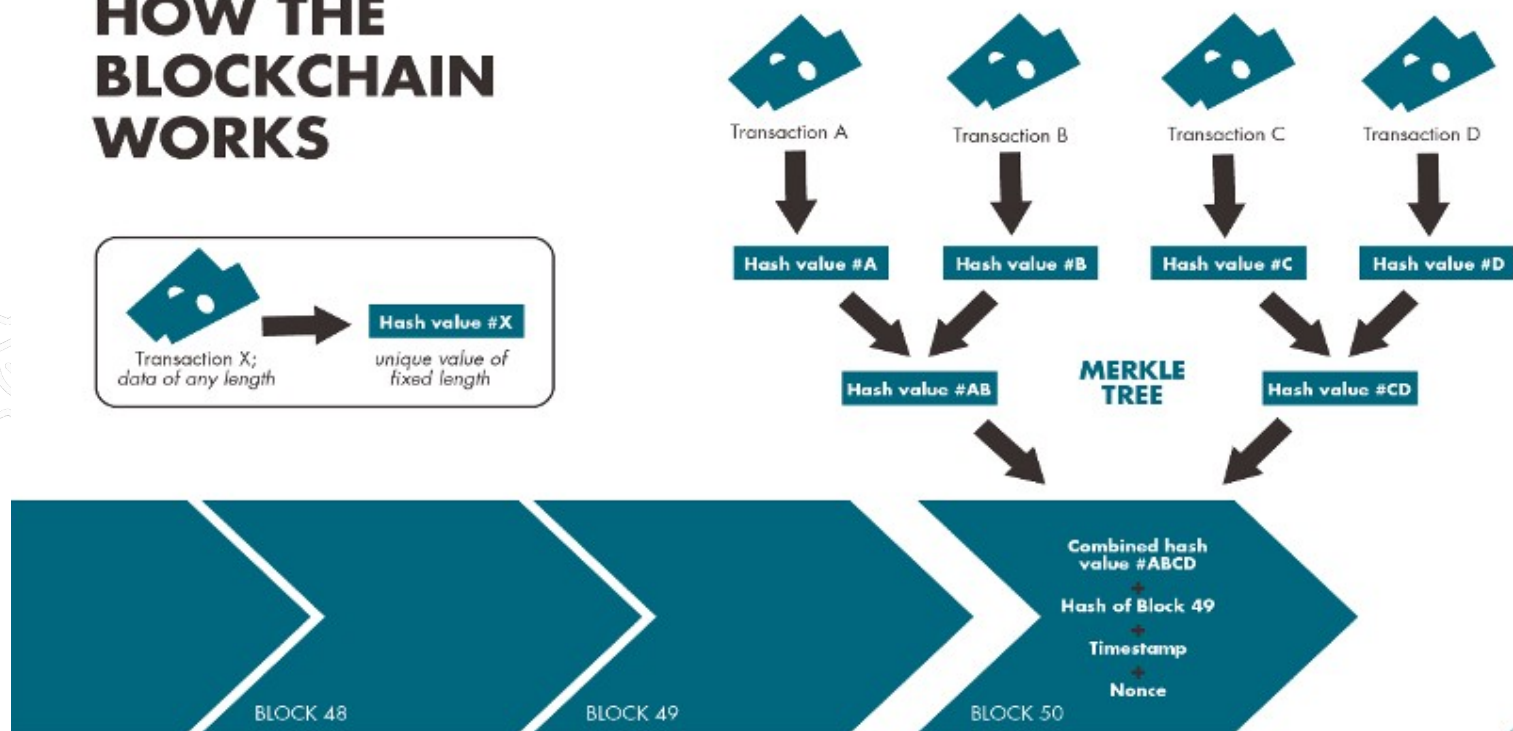
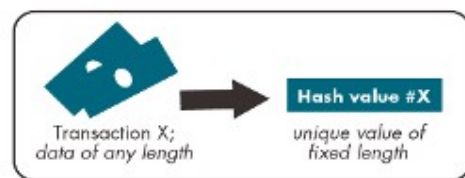
Introduction - Ethereum & Smart contracts

What is a Blockchain?

A blockchain is a data structure that links together a list of records – “**blocks**” - using the cryptographic hash of the previous block.

Usually a blockchain is managed by a P2P network of nodes, following specific rules for communication and validation, becoming a public **distributed ledger**.

HOW THE BLOCKCHAIN WORKS



Reproduction of an original figure in "The Great Chain of Being Sure About Things" by the Economist

About Ethereum

Ethereum is a blockchain platform that allows the execution of **Turing-complete** smart contracts and **decentralised applications** which can be run without downtime or third-party interferences.

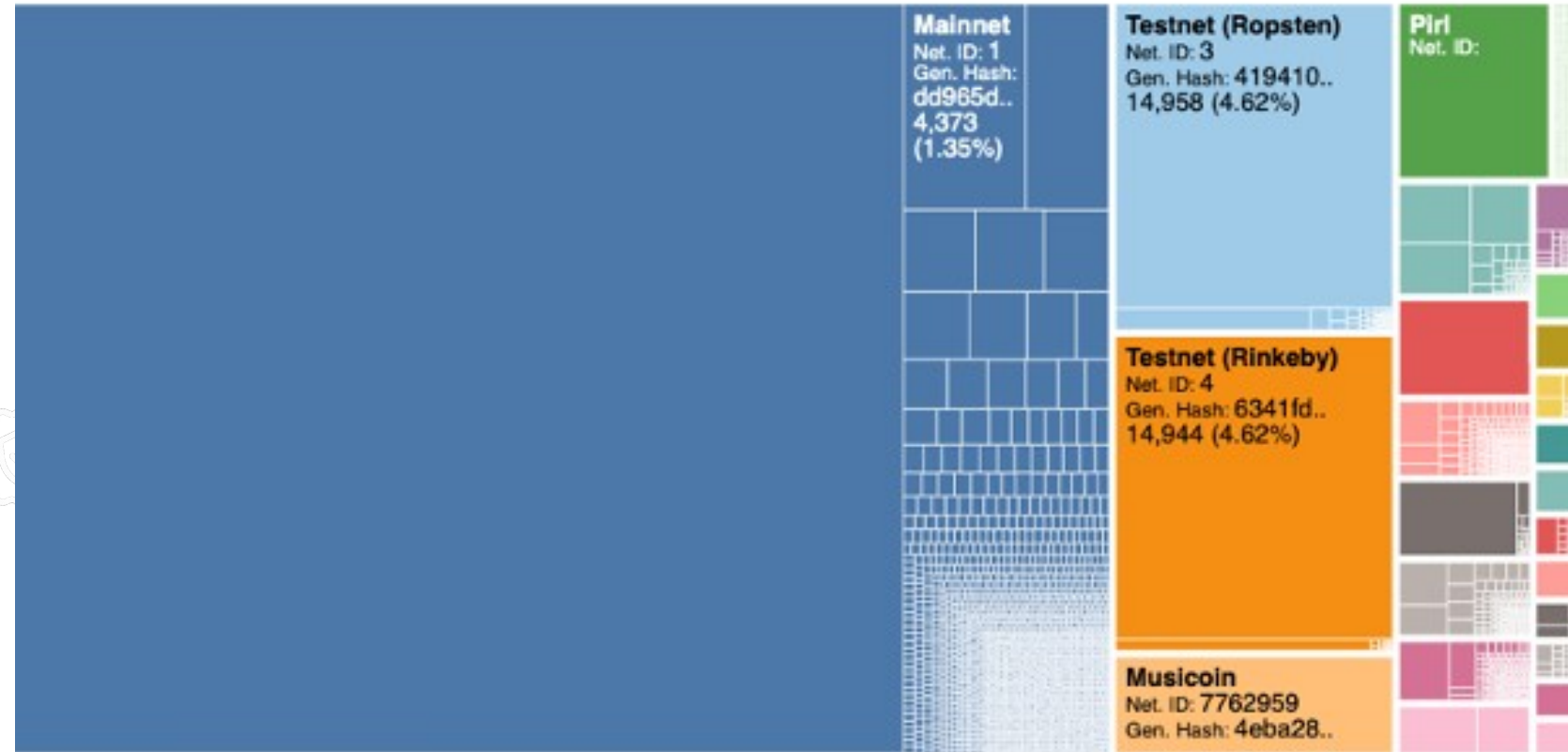
A "smart contract" is a program that runs on the Ethereum blockchain. It includes its functions and data and it is accessible at a specific address on the Ethereum blockchain.

Ethereum Network

Ethereum is more a series of peer-to-peer networks than a single network.

In addition to the "official" network, **Mainnet**, there are several test networks, **Testnet**, as well as a whole series of networks using Ethereum nodes with custom configurations.

A **private network** is a series of Ethereum nodes configured to connect to each other and not to the main public network.



Each network applies the same basic rules and they can run the same type of applications by executing the same smart contracts.

Decentralised Applications

Decentralised Applications are digital applications operating on a P2P network incorporating some common features



02

Innovation and Blockchain - Our vision

DIGITAL TRANSFORMATION

Digital Transformation is a process driven by the strategy of transformation, integration and connection of processes within an organization to enable **new digital paradigms** that produce **new values and new business opportunities**.



Research

Research is the first and fundamental phase of ***Digital Transformation***, which allows us to explore ***innovative methodologies*** and ***emerging technologies*** that will constitute the solutions of tomorrow.

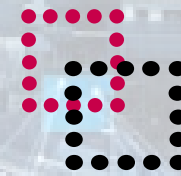
Research...



Founded in **1987**



+300 successfully
projects



+70
Ongoing projects



5 Labs

Roma, Palermo, Trento, Padova, Napoli

450

Researchers



40M Euro yearly investment

... & Innovation

*Innovation is the process that
generates value starting from
ideas*

11 Innovation Areas

Augmented City

Smart City Platform

Digital Finance

Instant Digital Payments

Smart Transportation

Urban Transit Tracking System

Smart Energy & Utilities

Field Service Management via Virtual Reality

Smart Agriculture

Internet of Things (IoT) on the Vineyard

E-Health

Electronic Medical Record

Digital Industry

Predictive Maintenance in the Factory

Digital Media & Communication

Cloud Gaming

Digital Retail & Fashion

Virtual Showroom

Smart Government

Digital Citizenship

Digital Defence, Aerospace & Homeland Security

Marine Safety Systems

Emerging Technologies



AI & Advanced
Analytics



RPA



Internet
of Things



AR/MR/VR



Blockchain



Digital Twin



Cloud



Cybersecurity

*The **Digital Transformation** revolution starts with the use of **emerging and cutting-edge technologies***



Smart Energy & Utilities

Enegan

Business Challenge

Enegan, one of the largest electricity and gas supply companies in Italy, was looking for a solution to optimize the use and exchange of energy, building the foundations for a future key role in the "distributed generation" of energy.

Solution

The solution is called "Energy Bank", a system of Blockchain transactions that allows private users of the energy network to optimize the production, accumulation, use and exchange of energy from renewable sources. Leveraging Blockchain technology the solution improves the amount of exchanged flows and information reliability.

PlatOne

Business Challenge

Energy transition requires innovative tools: the increasing adoption of renewable energy, characterized by an unforeseeable energy generation and in combination with less predictable consumption, requires a better monitoring and network flexibility.

Solution

In response to this challenge, Engineering participates to the PlatOne project leading the design and development of a Blockchain based Marketplace platform to guarantee energy flexibility and a safe monitoring of consumption, putting the user at the heart of the network. This platform will enable innovative services, such as the Peer to Peer energy exchange between users, will lower traditional market access barriers and will allow all the players in the network to trust on more reliable measures.

Smart Transportation

Blockchain for Digital Airports

Business Challenge

One of the challenges daily faced by every airport is that of safety: it is increasingly necessary to adopt solutions that guarantee an effective and accurate monitoring of the passengers' flow, but that, at the same time, are not time-consuming for travelers.

Solution

Our solution is an app for frequent flyers where it is possible to register all the personal information, travel information, passports and documents, which are encrypted, inserted in the Blockchain network and make available through a QR code. Travelers scan the code at the check-in steps and just take a selfie to confirm their identity. In this way, passengers are monitored rapidly and safely.

Blockchain for Ticket Refunding

Business Challenge

Tickets refund process is usually very slow, it requires various documents and worsens the customer experience. Moreover, transport companies often receive fines from consumer protection authorities linked to errors in the refund process.

Solution

Using Blockchain technology, it is possible to provide travelers with an app that verifies their need for refund on company's servers, if it is confirmed, it delivers the amount directly via app and allows the customer to book a new means of transport, even from other companies. It is possible since the Blockchain network is shared between different companies, that now can trust on reliable data about their passengers.





Digital Media & Communication

Blockchain for Creative Industry

Business Challenge

In the Digital Media and Creative industries copyright enforcement is difficult to be managed and the online world has made it harder. Copyrights on creative contents (music, movies, pictures) are often ignored or infringed, being shared or showed without authorization.

Solution

Using Blockchain it is possible to manage and track the complete media contents value-chain: creation, rights management and distribution of media contents. The solution we propose is based upon Ethereum Blockchain infrastructure and permits to archive the full set of data related to the media contents. In this way, having a reliable and univocal proof of the content and its owner, copyright enforcement could be more effective.

USE CASE

Blockchain for B2B Interactions

Business Challenge

For companies that manage projects and activities with many partners, often in different ways and through undocumented ways (e.g. by phone), it could be difficult to provide documentary evidence, as in the case of telecommunications companies. The risk is that customers may not trust these interactions.

Solution

Leveraging Blockchain technology it is possible to record the origin of the communications and the resulting documentation by sharing all the information with the interlocutors, who compose the nodes of the network. In this way the documentation is notarized by the Blockchain, it is available for all the users and can also be used in case of disputes.

USE CASE

Augmented City

Blockchain for E-mobility

Business Challenge

E-mobility and distributed renewable energy sources will be part of our future. However, the latter are characterized by intermittent and non-programmable energy. This aspect, combined with high demand loads, reduces the balancing of the Energy network and limits the possibility to optimally integrate car charging stations and renewable energy sources.

Solution

Blockchain could solve this issue, supporting the management and the balancing of demand and supply peaks of energy. Engineering is working on this field, coordinating eDREAM: an international project in the Smart Energy field, that creates a platform for Demand Response, allowing Distribution System Operators to leverage various third-party energy resources. Blockchain ensures safe data handling, market-based microgrid control and near real time Demand Response verification, improving the monitoring and allowing fair transactions.

Blockchain for management of collection

Business Challenge

La gestione delle riscossioni per gli Enti Pubblici ha come suo passaggio determinante la possibilità di operare degli sgravi sugli importi che il cittadino deve versare. Questa attività si basa sulla discrezionalità nella concessione degli sgravi ed è in capo all'operatore di sportello.

Solution

We have created a platform for the complete management of monitoring activities related to collections. It allows a clear and structured data analysis process with the certification of information on the Blockchain. Through the notarization of the data, each tax relief made has the certain date, the operator code and the certainty that the archived data cannot be changed.



Smart Government

CAPE: compliance with GDPR

Business Challenge

GDPR has revolutionized the field of personal data protection. Indeed, while the usage of data can generate multiple social and economic benefits, at the same time it is necessary to ensure regulatory compliance for the collection, storage and transmission of personal data.

Solution

Engineering faces this challenge by combining two proprietary assets, CaPe and Value-Chain, to create a solution that supports the end-to-end process of consent management by providing data subjects the natural need of data ownership and leveraging the benefits of Blockchain to automatize the "notarization" (certification of authenticity) of their consent. In this way, people can track and monitor the usage of their personal information and data processors can exploit it for the declared and certified business purposes, being safe of the compliance to the GDPR.

Blockchain for reducing bureaucracy

Business Challenge

In order to proceed with a contractual agreement with municipalities, people, professionals (e.g. constructors) and organizations usually request a Letter of Guarantee (LoG) to the Governmental Services, which indicates that the involved parties are eligible and financially secured. However, this procedure is time-consuming and costly.

Solution

Governmental Services could issue a digital certificate of authenticity leveraging Blockchain technology, which permits to archive all the applicant's data (financial amount of the transaction, timeframe, etc.). Then, the certificate is sent online to municipal authorities that cross-check its validity. In case of information update, members of the chain are automatically updated. This solution permits information flows via online, reducing costs related to paper and transportation, permits digital certificate to be crosschecked by multiple public bodies and makes them reliable and not modifiable.



Digital Defense, Aerospace & Homeland Security

Protect ID

Business Challenge

Web permits everyone to use Digital Identities for accessing to many services, often critical (bank accounts, health services, etc.). From this perspective, privacy and identity management are central themes today and side effects of violations can include crimes such as defamation, cyberstalking, economic damage, etc.

Solution

ProtectID deals with these topics and provides a set of models and tools to manage threats related to potential violations of digital identity. It adopts Blockchain, used as a public ledger where stakeholders (data subjects and data controllers/processors) can track the entire lifecycle of a digital identity, from the negotiation of a privacy policy to the erasure of all the related data ("right to be forgotten").

Blockchain for Antiterrorism

Business Challenge

In big cities, crowded spaces such as malls, train stations, etc. are "soft targets" for terrorist attacks. The availability of large quantities of data in smart cities can make urban systems more responsive against these threats. However, it is necessary to establish a new collaborative approach between national, regional, local institutions.

Solution

Blockchain technology can enhance the collaboration between institutions without requiring any new agency, just a private peer-to-peer network and a distributed ledger paradigm, used as an information bus for members. They can post alerts related to events of interest, which are a digitally signed (i.e. sealed and non-refutable) record. Inside the record there is a link to a separate document stored on a dedicated and safe facility, containing highly sensible data in encrypted form.



Research Projects

Blockchain Technology applied in Research and Innovation Projects



DLS OCS (Distributed Ledger Services for Online Contract Settlement) (completed December 2017)

SOFIE (2018-2020) Open and Secure way to establish new IoT Platforms for business (completed December 2020)

eDREAM (2018-2021) Demand Response ecosystem, blockchain based, for cooperate in a market framework (**active**)

CoordiNet (2019-2022) TSO-DSO coordination to procure grid services in the most reliable and efficient way (**active**)

PlatOne (2019-2023) PLATform for Operation of distribution Networks (**active**)

Bright (2020-2023) Boosting DR through increased community-level consumer engaGement by combining Data-driven and blockcHain technology Tools with social science approaches and multivalue service design (**active**)

IANOS (2020-2023) Integrated Solution for the Decarbonization and Smartification of Islands (**active**)

MATRYCS (2020-2023) Modular Big Data Applications for Holistic Energy Services in Buildings (**active**)

BD4NRG (2020-2023) Big Data for Next Generation Energy (**active**)

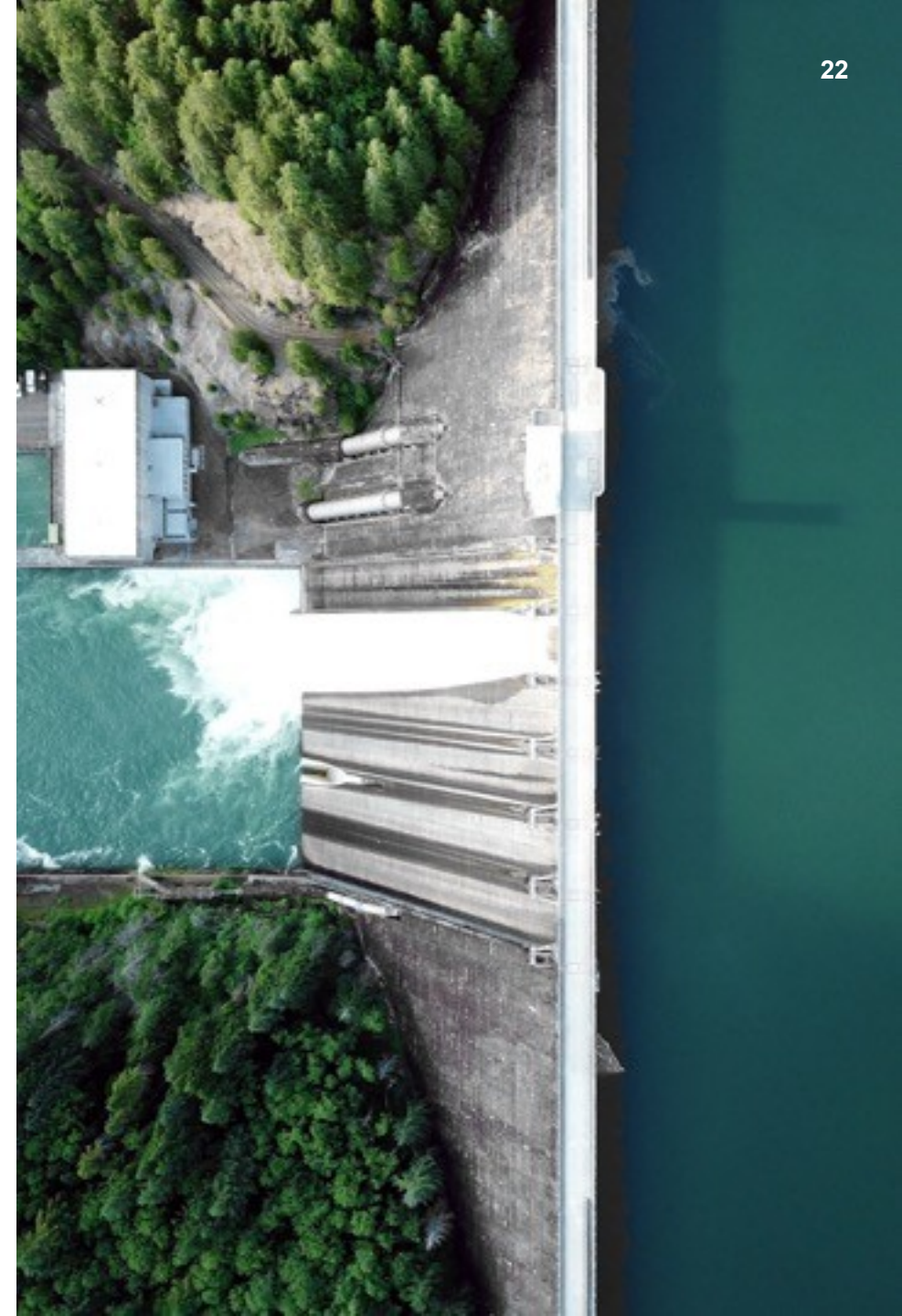
CENET (2020-2023) One Network for Europe (**active**)

03

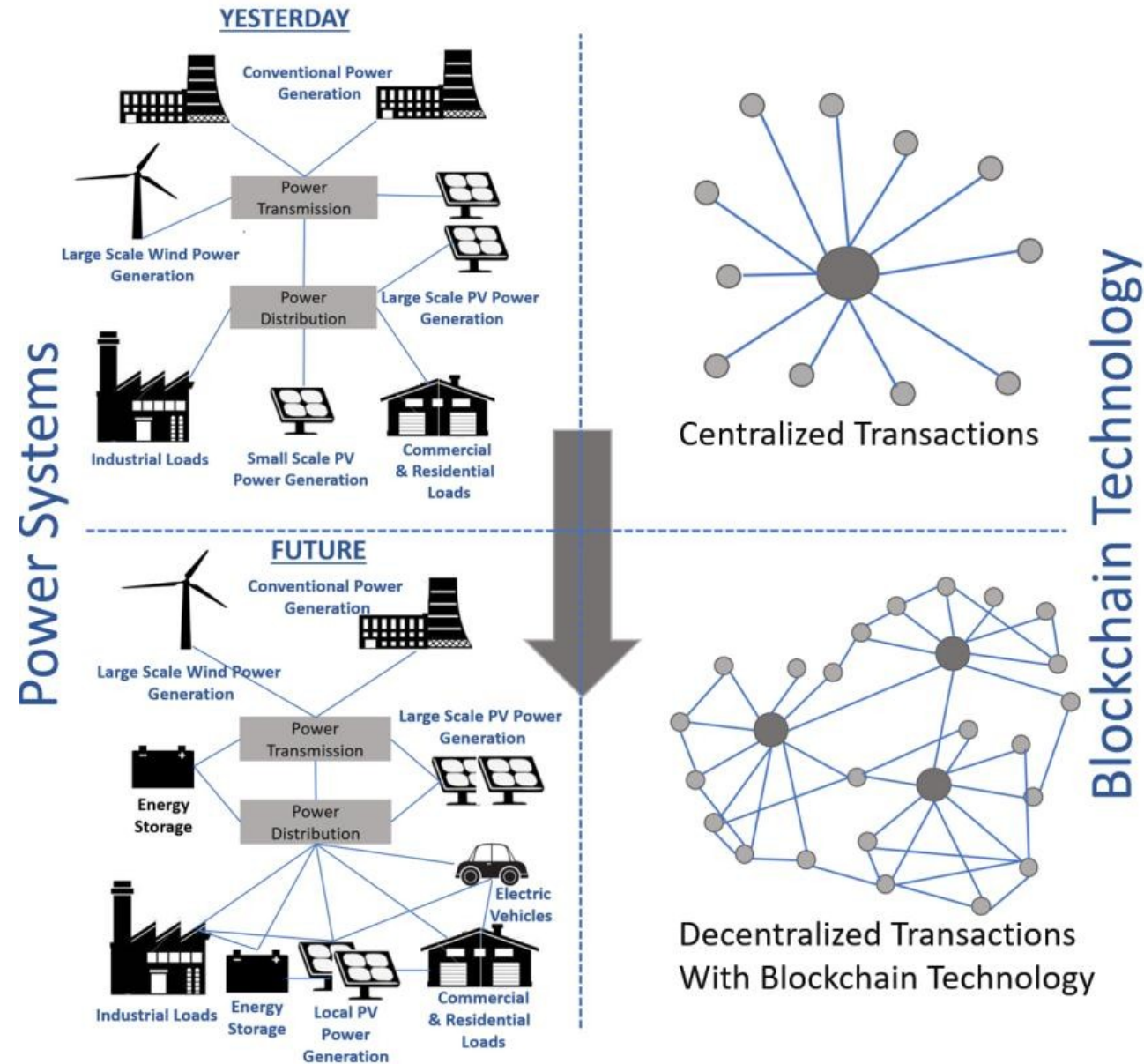
Blockchain in the Energy Domain

2020 Report on European Electricity Markets (Q2)

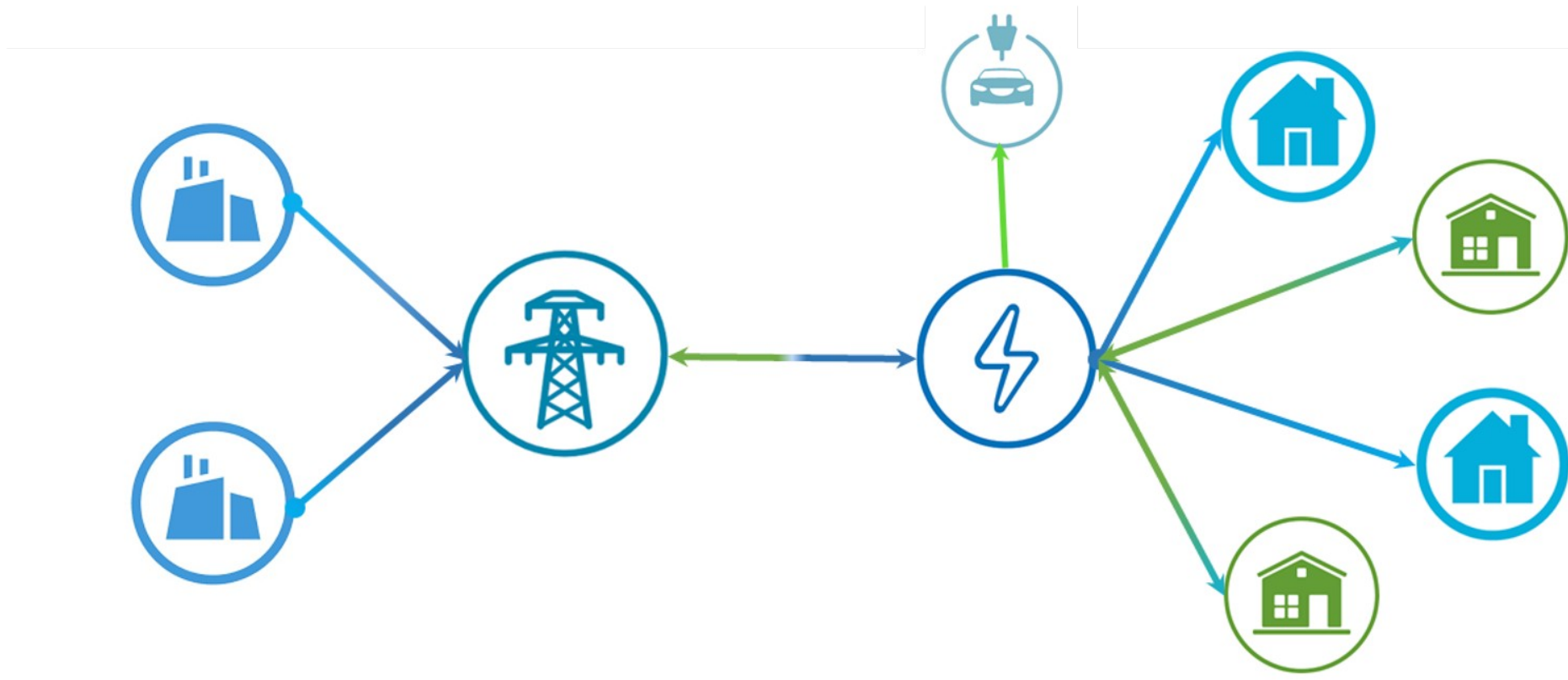
- The share of renewables jumped from 37% to 43%
- More than 129,000 new EVs registered (+53%)
- EVs market share to record 7.2%
- Grid operators managed increased volumes of intermittent RES
- Search for market instruments putting value on storage and flexibility intensified



From Centralized Systems to Decentralization



Optimized EVs Charging Helps Stabilizing the Distribution Grid



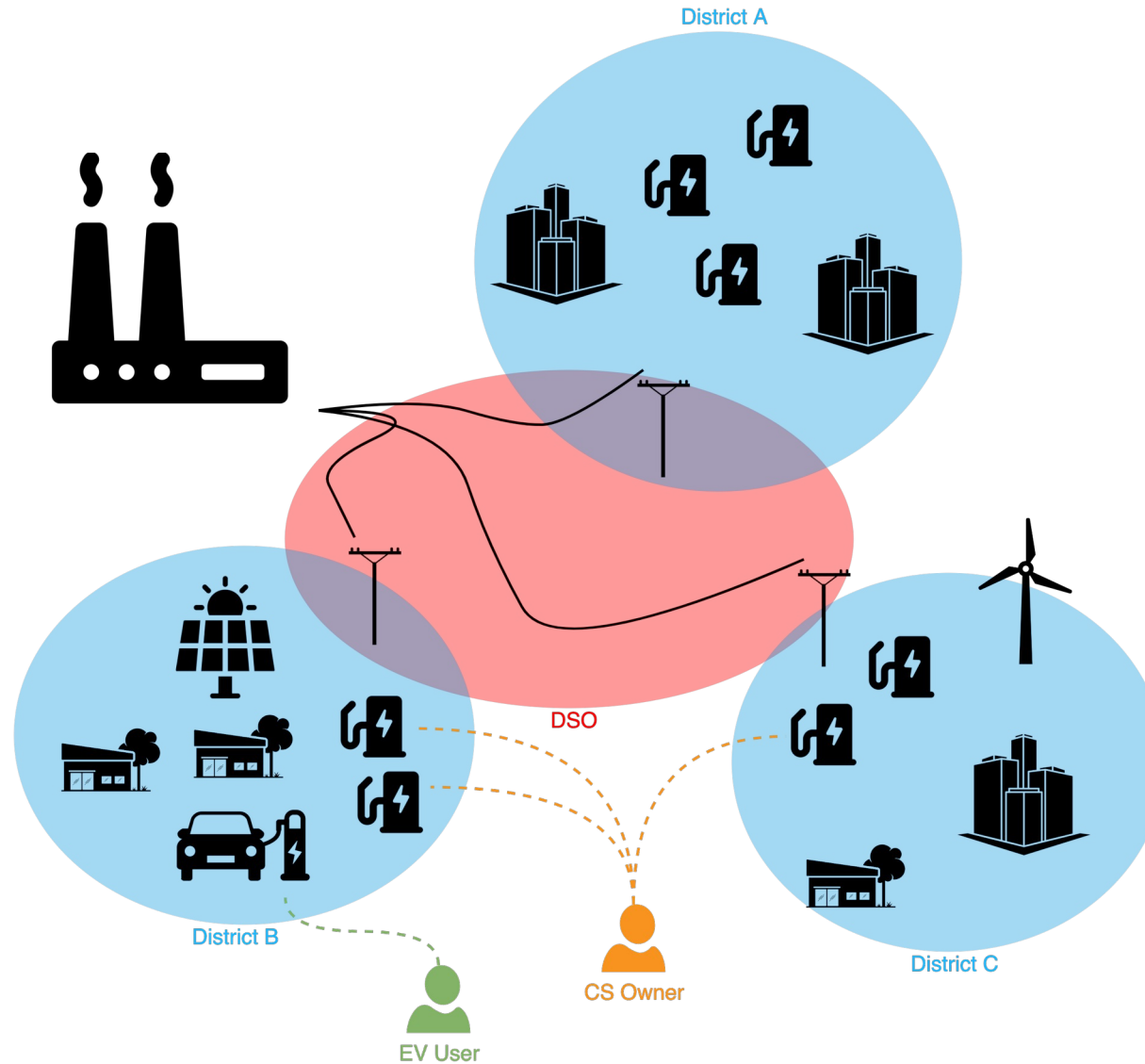
The Need for Energy Flexibility Markets

DSOs need to dramatically increase their hosting capacity to face RES and EV penetration

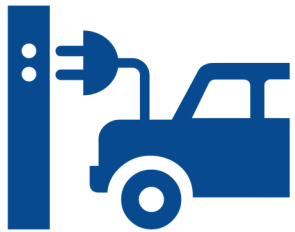
Flexibility helps reducing the costs on infrastructure, shaving peaks of PV and Charging Stations

Fleet Managers may reduce the operational costs by participating in flexibility markets

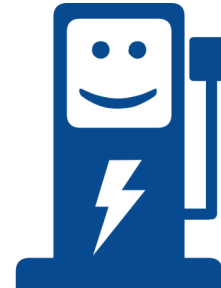
SOFIE - Decentralized Energy Flexibility Marketplace pilot



SOFIE - Decentralized Energy Flexibility Marketplace pilot



EV users can charge their electric vehicles in multiple locations at will



CS are managed by different operators within the same municipality



DSO offers incentives to charge EVs in certain periods of time or location, balancing the load on the electrical grid



Finally, thanks to the marketplace, the most favourable energy retailer can be selected any time a recharge is needed

SOFIE: DSO

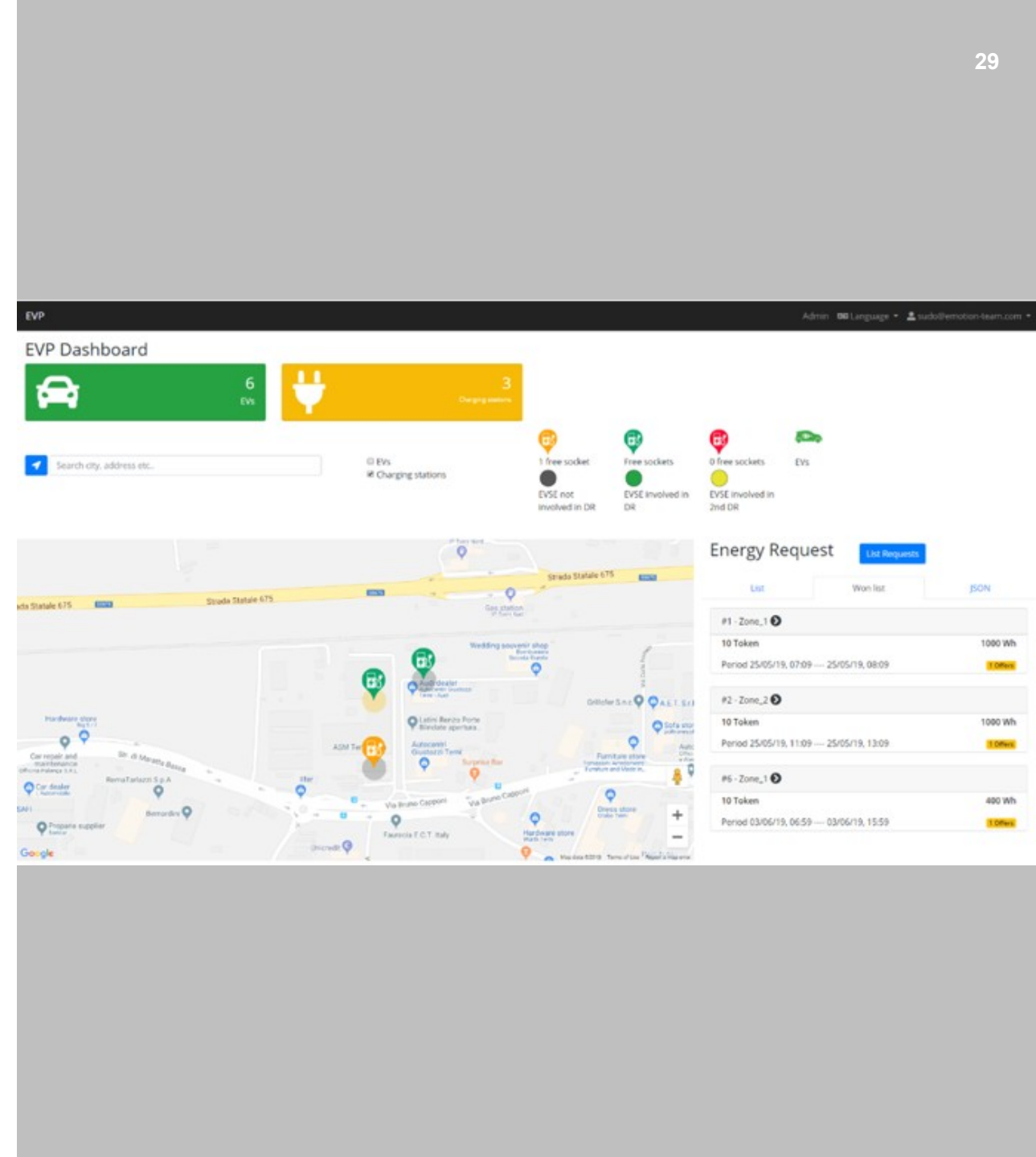
- IoT smart meters enable accurate forecasts helping to reduce the reverse power flow
- Decentralized ledgers and smart contracts enable a **secure** and **transparent** mechanism to time-shift and modulate the end users' consumption according to the need of the network (Demand Response)



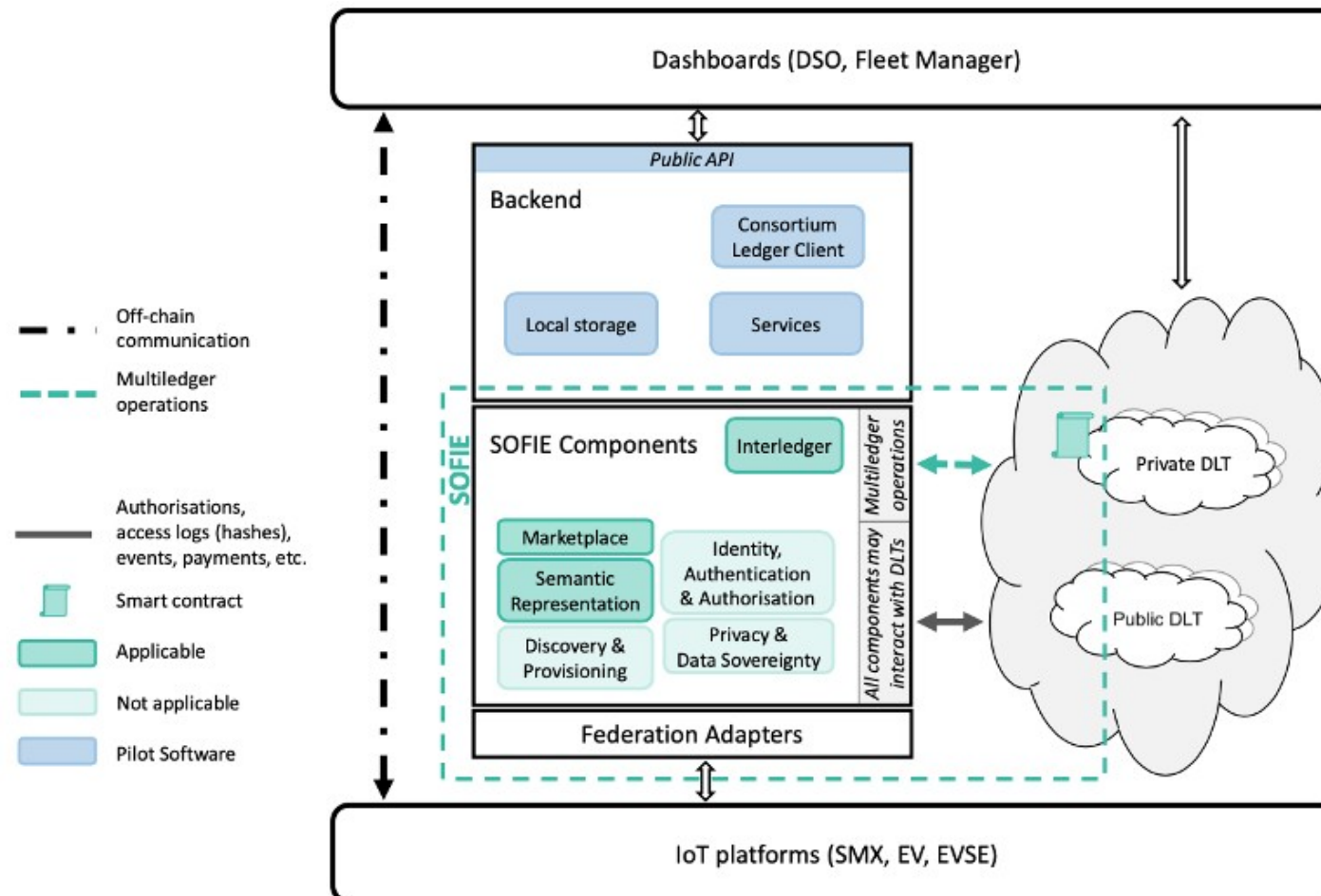
The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 778884.

SOFIE: Fleet Manager

- On board IoT and smart charging stations support fleet managers in route planning and charging schedule
- Incentives from flexibility campaigns and Energy Retailers marketplace help reducing the operational costs



SOFIE - Decentralised Energy Flexibility Marketplace



SOFIE - Blockchain-based marketplace for DSOs and EV users

DSO WALLET

966 ST

0x5A7604dbe012C19F1131d10A5E16923048E67017

INTERLEDGER

Request	Offer	Token	Status
1	2	34	\$

#	Author	Status	Winning Offer	Paid	Info
1	ds0: 0x5A7604dbe012C19F1131d10A5E16923048E67017	decided	# 2	ⓧ	ⓧ

Details

Delivery Interval: 23/11/2020 11:52 - 23/11/2020 12:52

Zone: Zone_1

Quantity: 1000 Wh

Max Price: 50

Deadline: 2020-11-23 10:52:00

Get Winning Offer
Unlock Payment

Offers

#	Author	Price
1	fm: 0xBAFAB60f35FcBB82C806026D4E0D03eb3c9e5FB2	45
2	fm: 0xBAFAB60f35FcBB82C806026D4E0D03eb3c9e5FB2	34
3	fm: 0xBAFAB60f35FcBB82C806026D4E0D03eb3c9e5FB2	40

Request 1 is paid now.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 779984.

Request info

Request ID	2
Author	0x5A7604dbe012C19F1131d10A5E16923048E67017
Status	open
Type	Zone_1
Max Price	50 Token
Quantity	1000 Wh
Quantity charged	<div style="width: 50%; background-color: #ccc; height: 10px;"></div>
Deadline	10/02/2021 17:48
Period	10/02/2021 17:48 ---- 10/02/2021 18:48
	<input style="width: 80%;" type="text" value="10"/> Add Offer

Offers

Offer ID 4 - Price: 30
Author: 0xBAFAB60f35FcBB82C806026D4E0D03eb3c9e5FB2

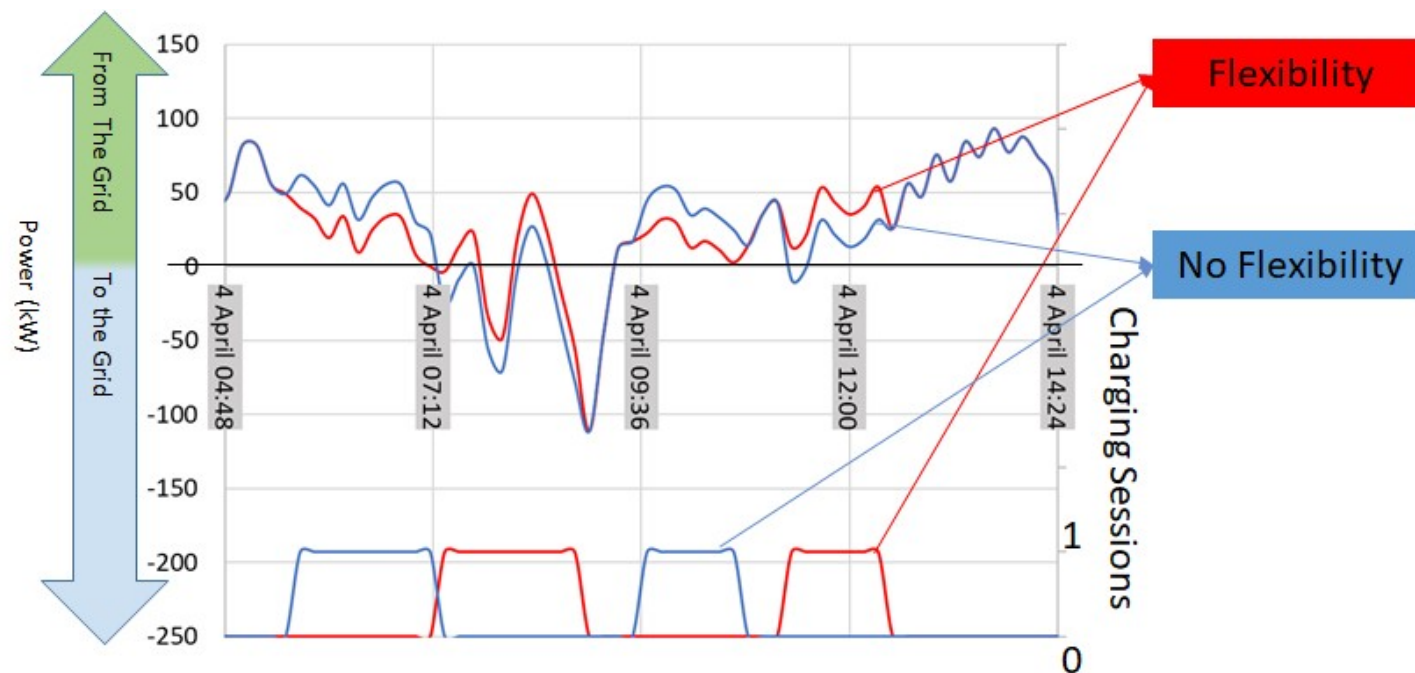
Offer ID 5 - Price: 30
Author: 0xBAFAB60f35FcBB82C806026D4E0D03eb3c9e5FB2

Offer ID 6 - Price: 20
Author: 0xBAFAB60f35FcBB82C806026D4E0D03eb3c9e5FB2

Offer ID 7 - Price: 20
Author: 0xBAFAB60f35FcBB82C806026D4E0D03eb3c9e5FB2

SOFIE - Exploiting EV flexibility in a district

- In the Terni district, scheduling of the charging sessions can increase the contribution to Reverse Power Flow reduction
- Contribution from EV to reducing RPF could be 3,5 times higher during a year.
- Money savings for the district manager are drawn from the increased self-consumption



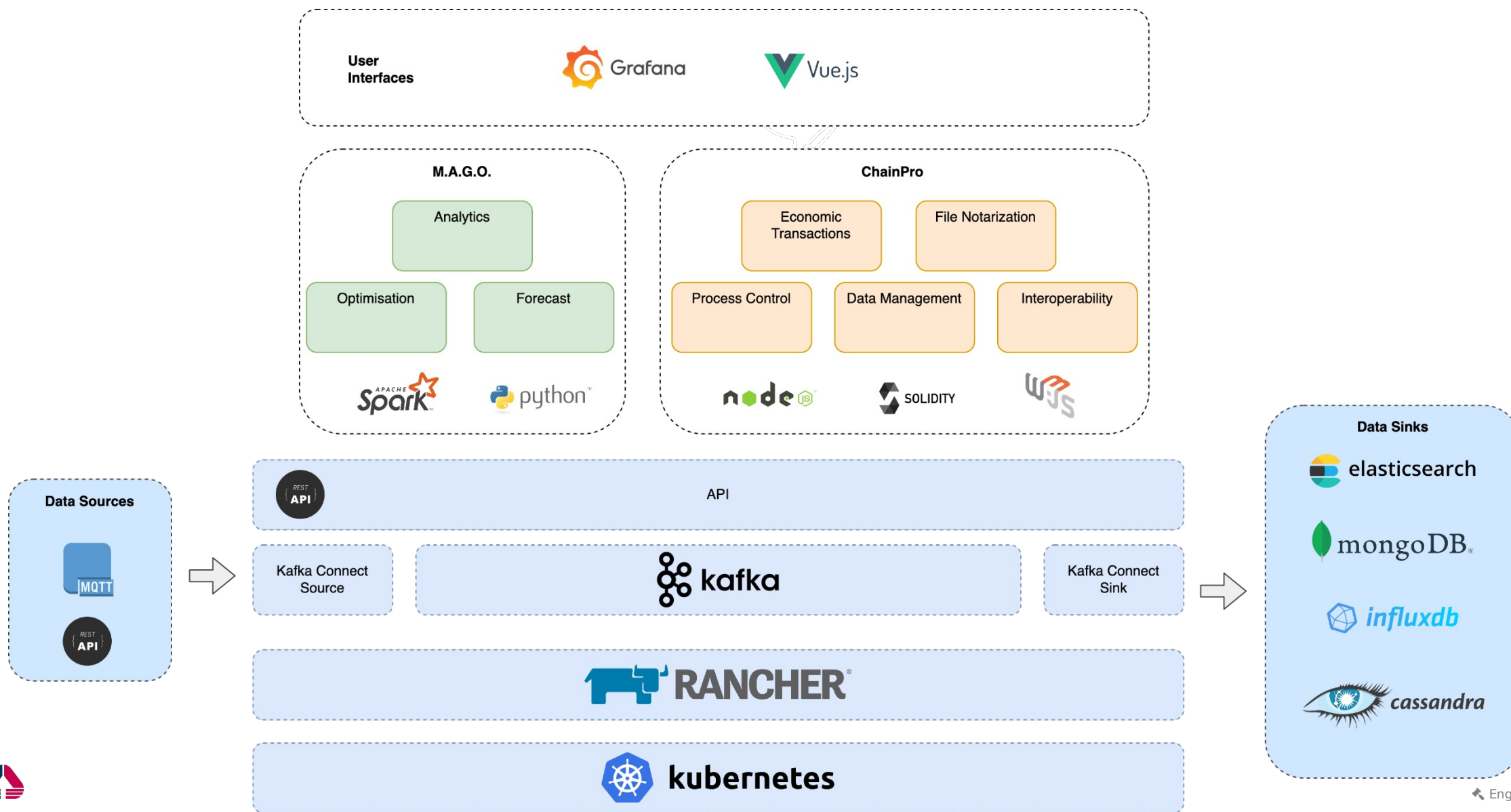
Yearly evaluation of benefits	Ex-ante	SOFIE
Scheduled charging sessions / charging sessions	0 / 401	190 / 401
Energy from PV for EVSE / Energy for EVSE (MWh)	0,7 / 5	3,9 / 5

04

ChainPRO

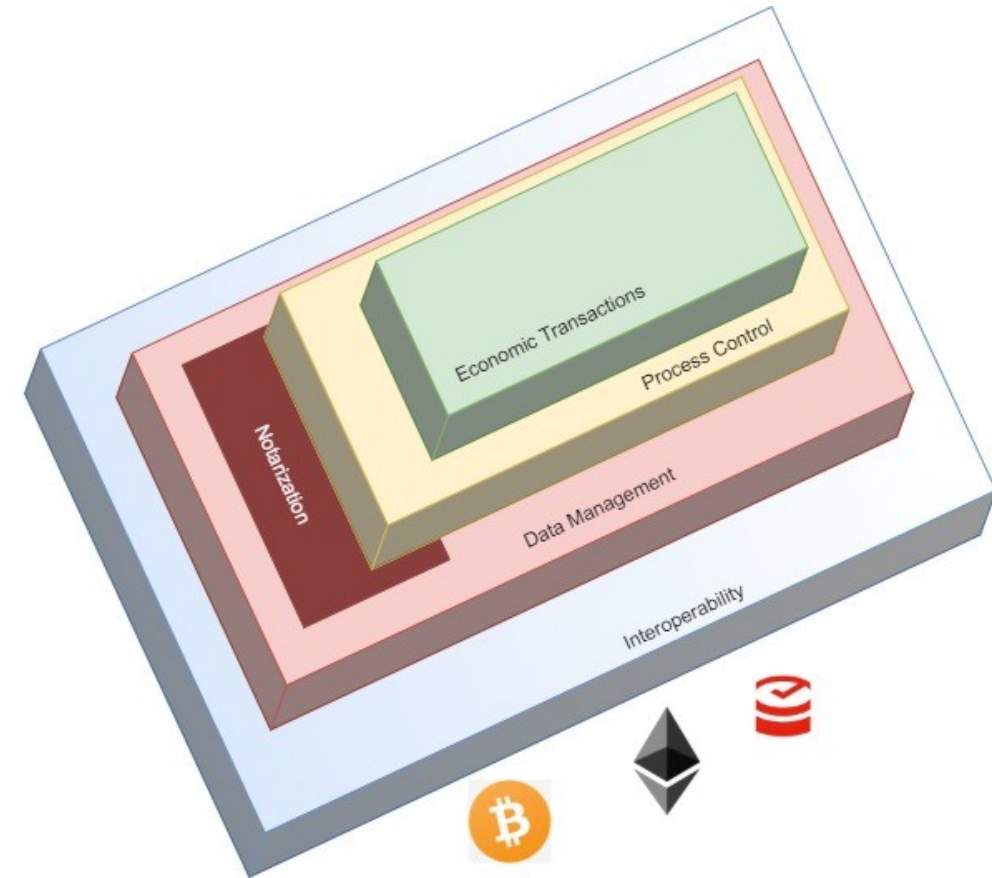
A blockchain based platform for assets
and transactions management

Blockchain-based machine Learning IoT Platform (BLIP)



ChainPro

A blockchain based ICT platform for assets and transactions management



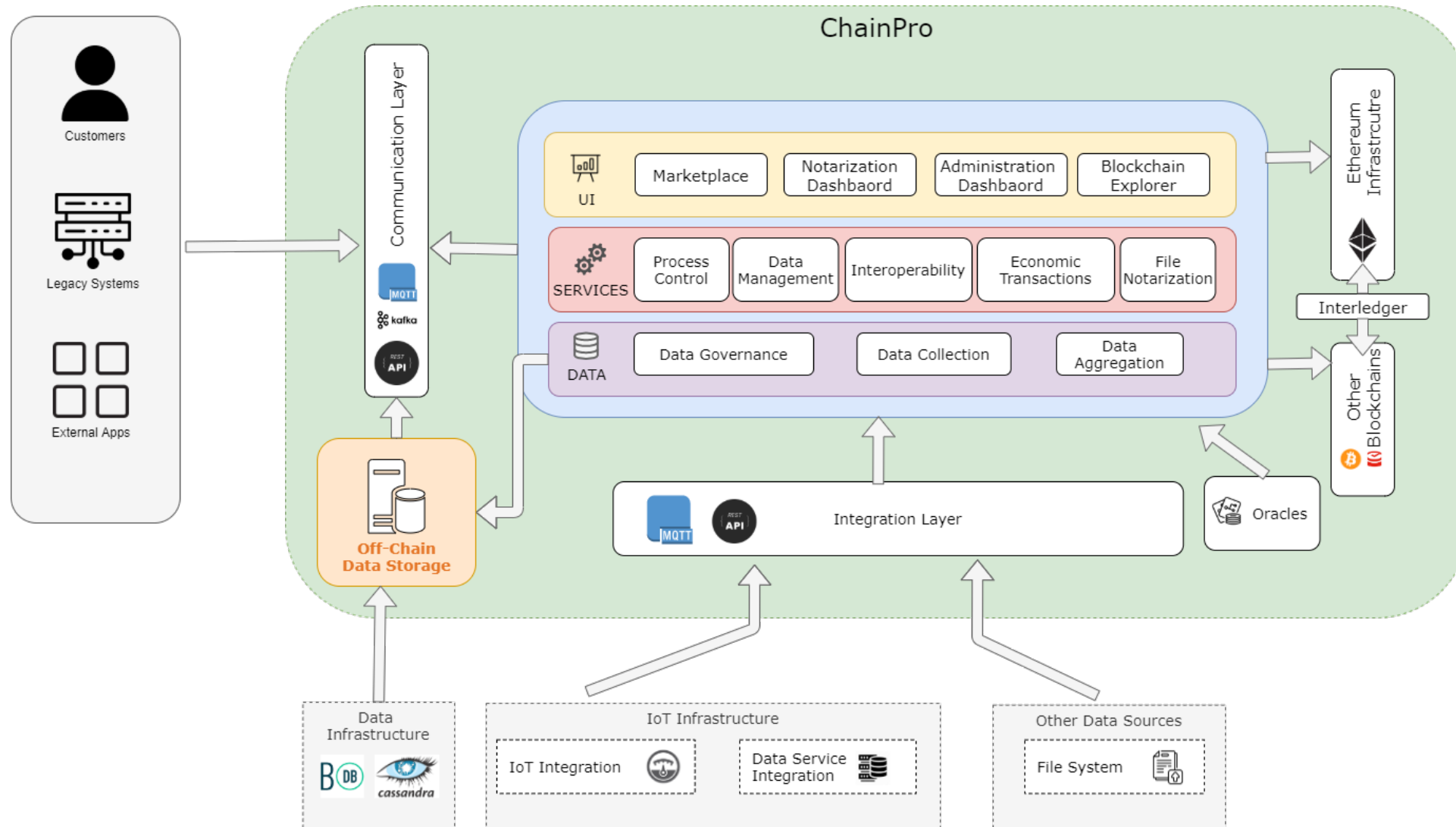
Economic Transaction: Blockchain Smart contracts for payments between two (or more) actors. Token as digital representation of a value for assets, used to reward (or penalise) users. (e.g., incentivisation of actors involved in DR programs according to their behaviour).

Process Control: Blockchain smart contracts used to manage inter-processes activities (e.g., the control DR flexibility services and energy transactions, thanks to the application of smart contracts to prosumers' flexibility aggregation and local peer-to-peer energy trading, making the transactions trackable and tamper-proof).

Data Management : Blockchain Hybrid approaches for data storage minimise the costs and assure the necessary scaling up. Distributed databases and off-chain storage improve the storage capabilities of the system, without losing the advantages provided by a distributed system.

Interoperability: Interledger Protocols used to reduce the entry barrier for new players, leading to a more competitive environment of products and services. Integration with any type of ledger with a variety of higher-level protocols, maintaining the advantages provided by the distributed ledgers of transparency, security and trust.

ChainPro - Architecture



ChainPro - Main Characteristics

Data Agnostic Interoperability Mechanisms



Integration of different data sources in a seamless way and hybrid approaches

Modular and extensible Blockchain- based tool



All the benefits of the blockchain technology in a configurable service tool

Flexible, scalable and integrable in already existing systems






Open, flexible and interoperable architecture exploitable in many different contexts

Blockchain for everyone



ChainPro - Use Cases

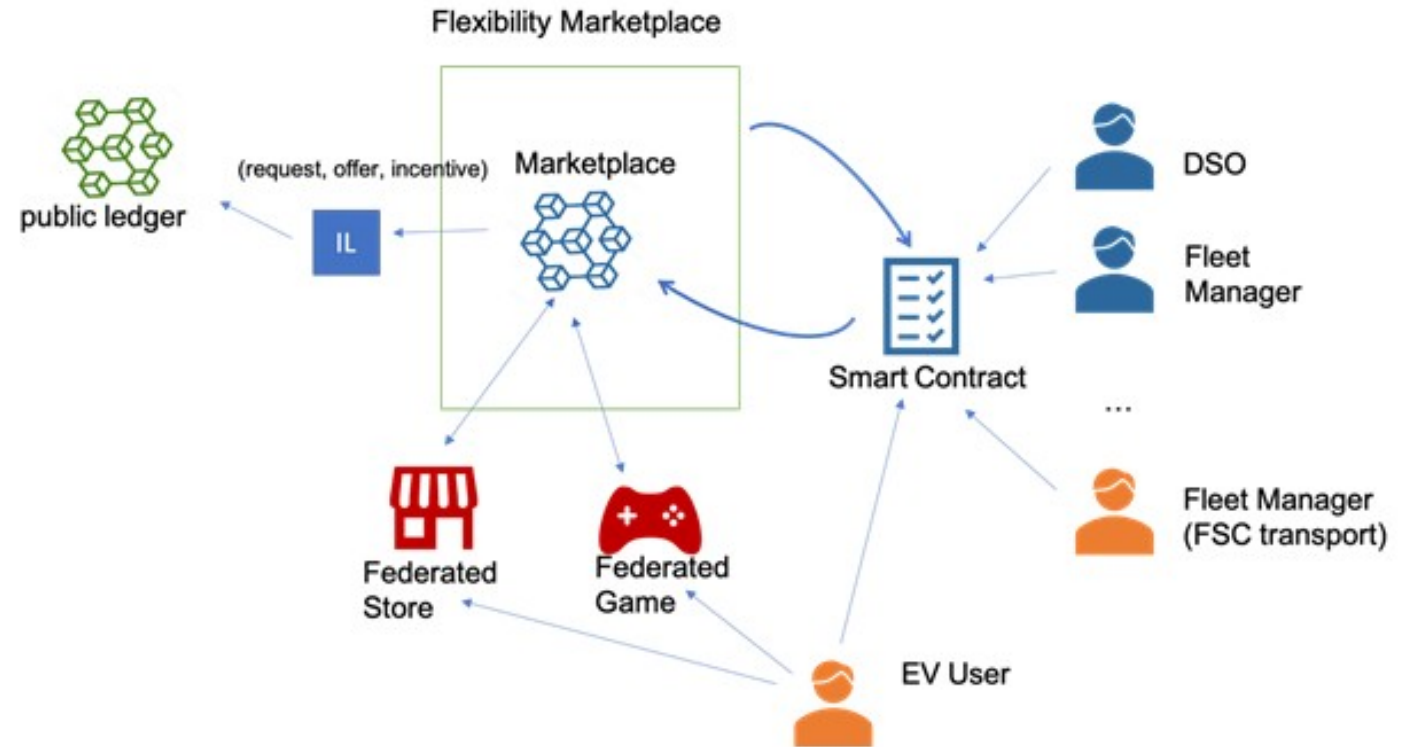
Ecosystems:

- ▶ **Dynamic coalitions** of prosumers
 - ▶ Virtual Power Plants for flexibility provisioning 
 - ▶ Energy Trading
 - ▶ Profit Optimization
- ▶ Community **cross-domain services**
 - ▶ Energy
 - ▶ Social
 - ▶ Loyalty circuits **tokenized rewarding** 
- ▶ Extensible decentralized **marketplace** smart-contracts
 - ▶ The smart contract define the business logic for a marketplace platform, customisable by different applications.
 - ▶ e.g. energy and flexibility markets, IoT lockers rental 
- ▶ Financial
 - ▶ Self-liquidating **loans** for renewable energy sources

ChainPro - Cross-domain use cases: reward exchange

Focus on the added value for the end users derived from the ability to spend their token in different contexts

- ▶ a unique environment
 - ▶ same actor participates to different scenarios at once
 - ▶ with different roles
- ▶ cross-scenario reward exchange
 - ▶ enabled by a unique ERC-20 based smart contract
- ▶ interledger functionality maintains token balance consistency even across different ledgers



the principle behind this **cross-pilot scenario** is a direct network effect: an increase in usage leads to an increase in value for other users (as in social networks, online games, telephone systems, etc)

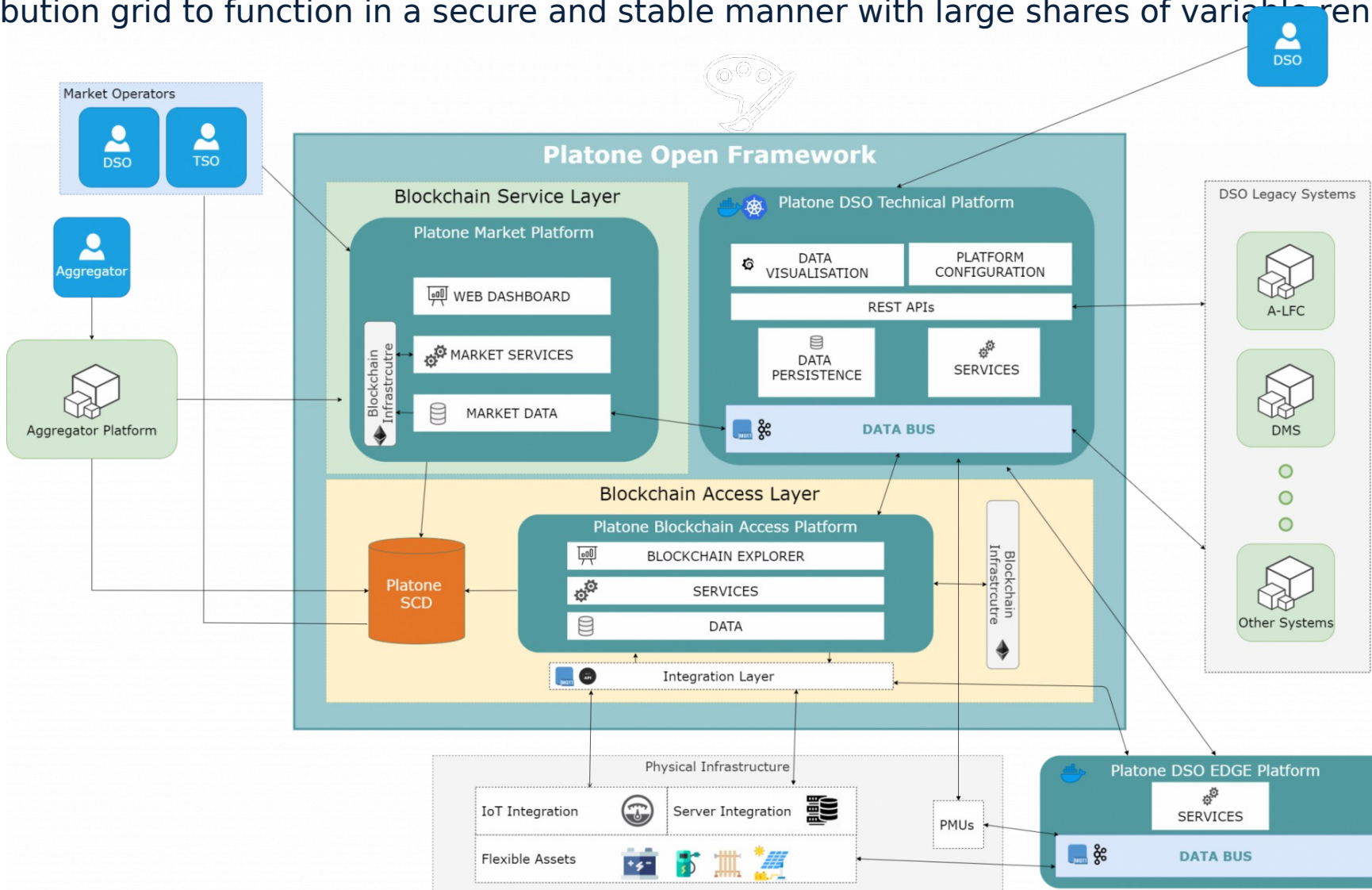
05

Other Business Cases

Projects and Services

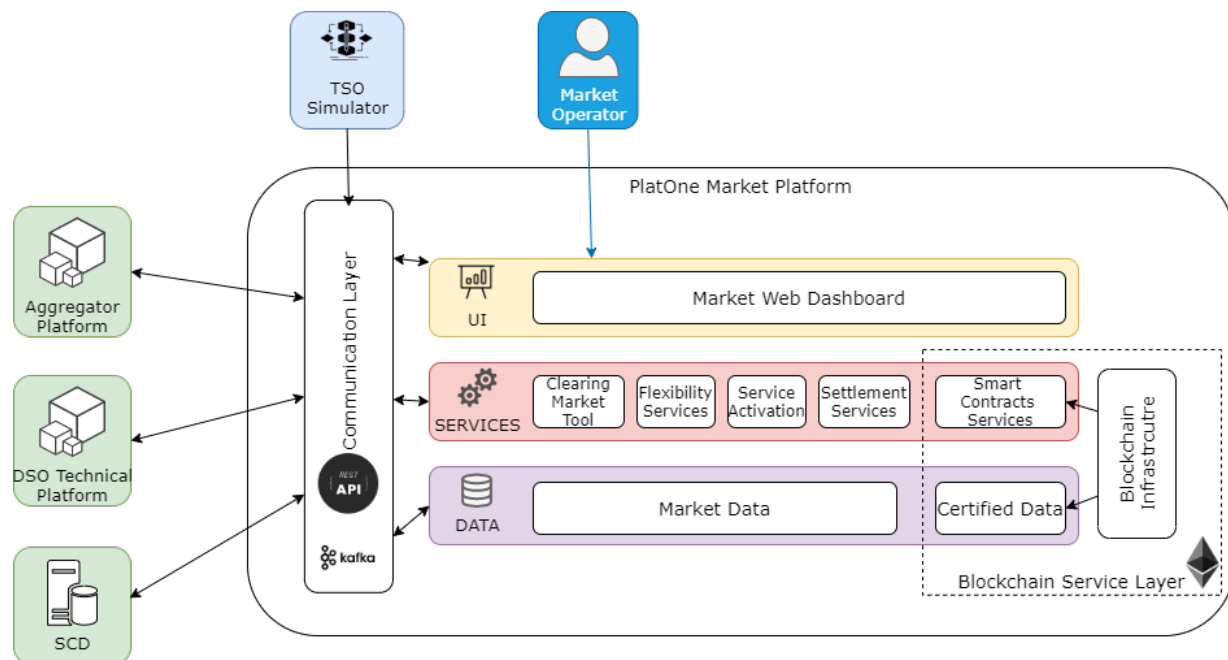
Platone - The interoperable Platone Open Framework

Platone implements a **two-layer blockchain-based framework for distribution network operation and market operation**, creating a seamless integration of local prosumers in an open market structure, allowing the distribution grid to function in a secure and stable manner with large shares of variable renewables.

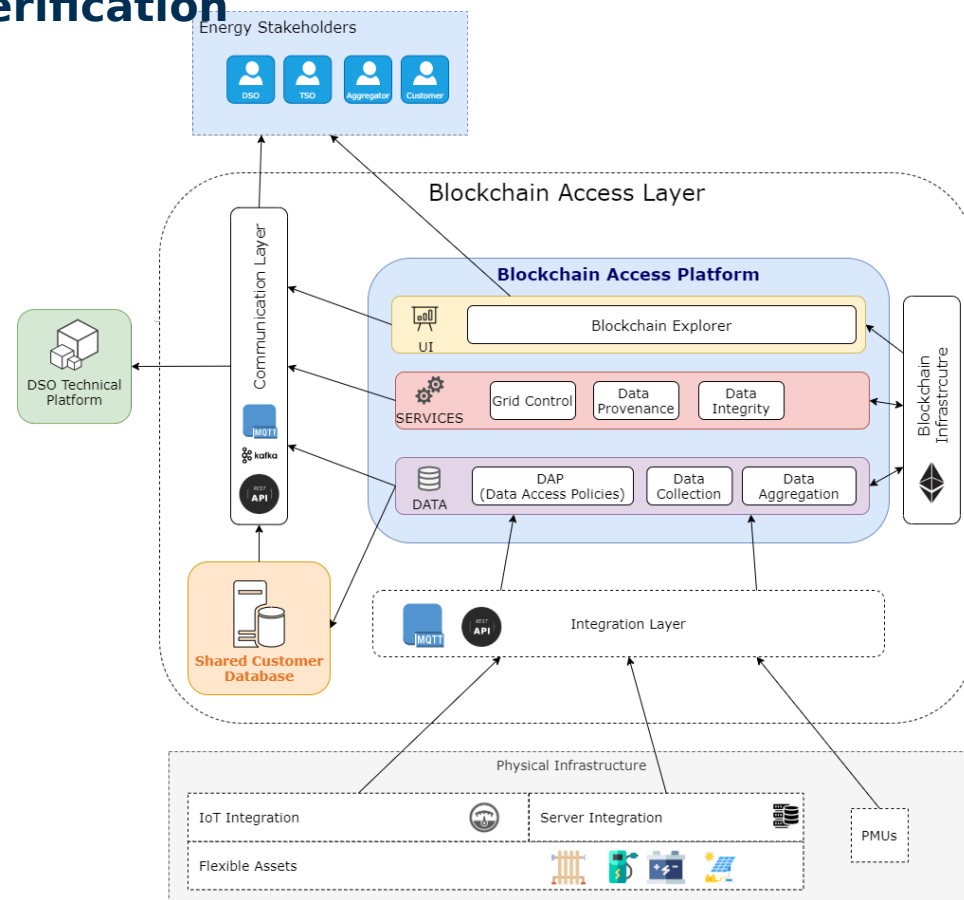


Platone - Blockchain-based Platforms

Market Platform for Flexibility Services Management, including based on blockchain technology and smart contract services for **Market Data Certification** and **Token-Based Customer Incentivization**



Blockchain Access Layer implements a secure **IoT Data Integration Layer** with standard communication protocols and data models enabling **measurements certification and verification**



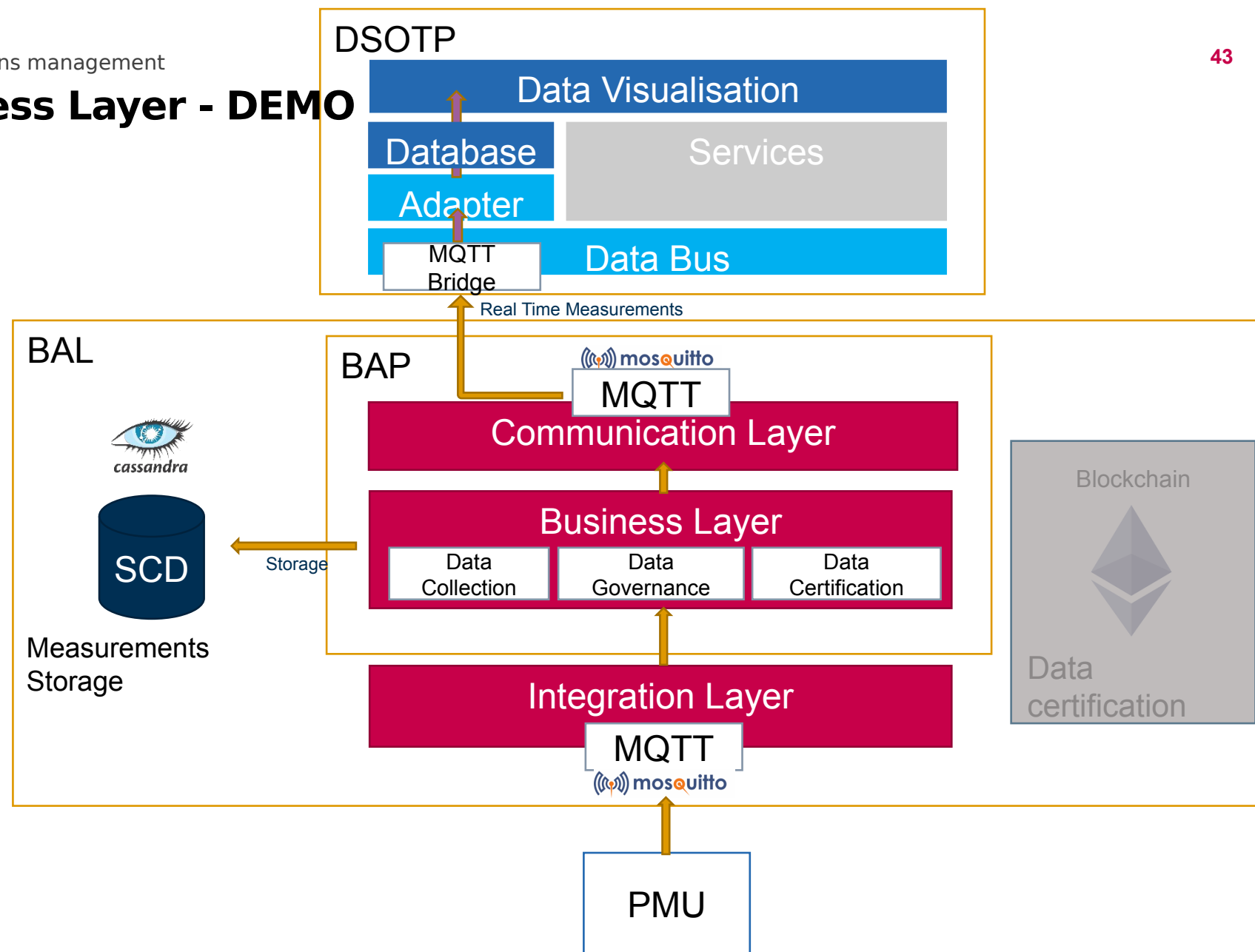
Platone Blockchain Access Layer - DEMO

Step1 – PMU Data collection, storage and provisioning

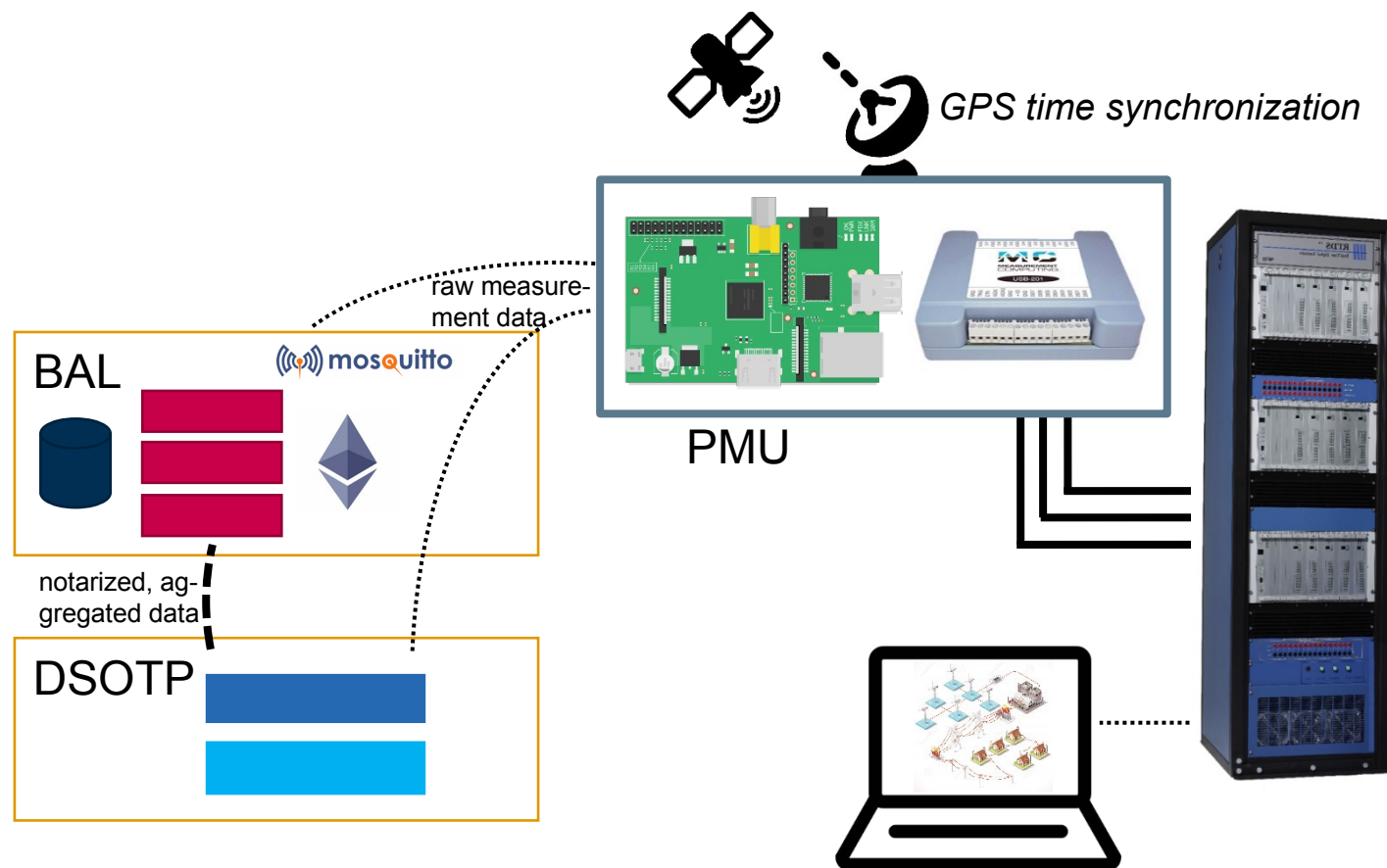
1. MQTT Broker of the BAL receives data from PMU, in authenticated way and under TLS connection every seconds. **Every device can only write in its dedicated topic**
2. BAP stores data into SCD
3. BAL provides data to DSOTP via MQTT bridging. DSOTP has its credentials for authenticating on MQTT. It has to request the access to the specific dataset.
4. DSOTP makes selected topics available on its internal message broker for processing by services;
5. Within DSOTP, PMU data are stored in a timeseries database and visualized in customizable dashboards;

Step2 – Periodic PMU Data certification

7. BAP periodically request aggregated Data to SCD
8. SCD send aggregated data to BAP for data certification
9. BAP certify data. It creates a hash of the aggregated data and registers it on the blockchain infrastructure



Platone Blockchain Access Layer - DEMO



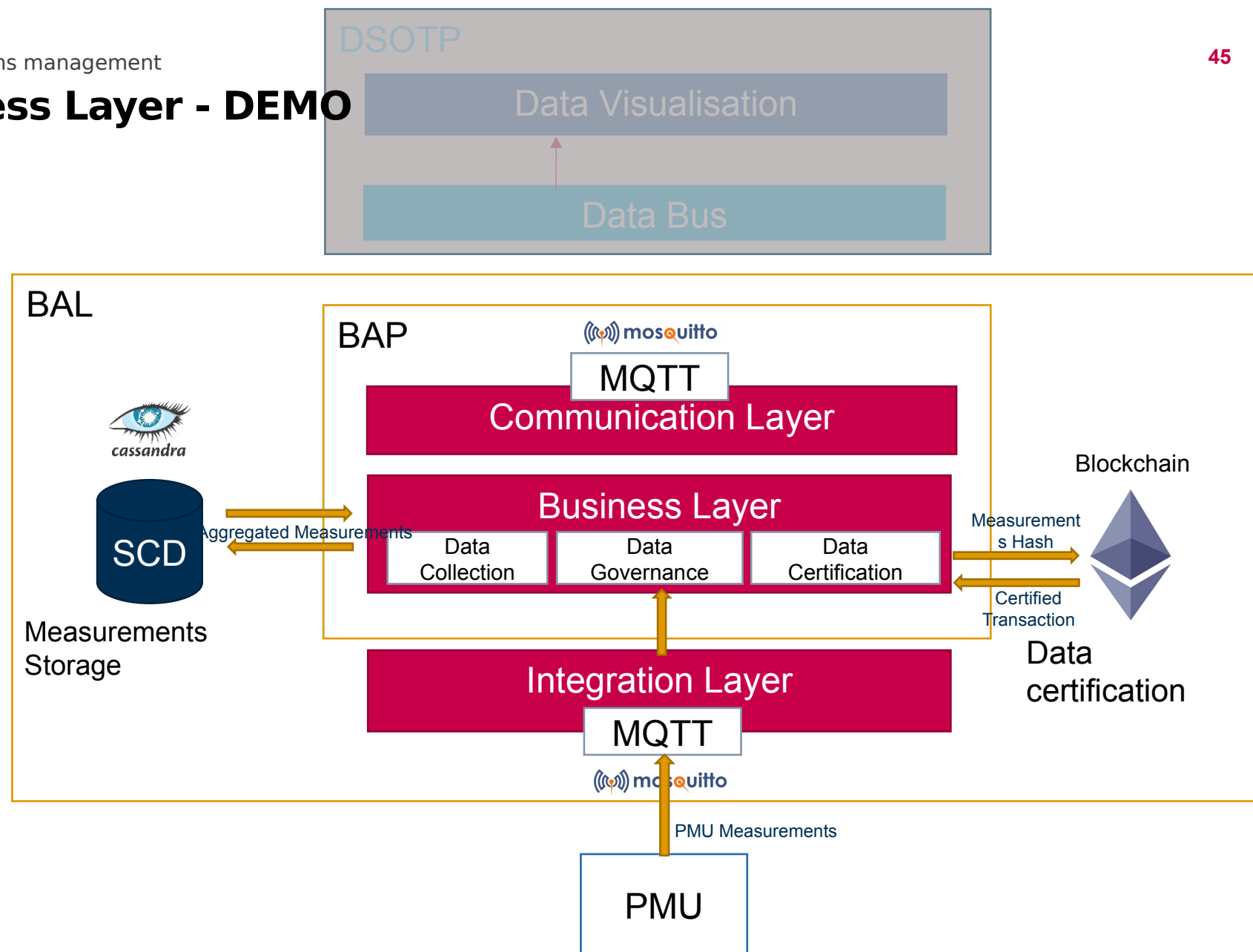
Platone Blockchain Access Layer - DEMO

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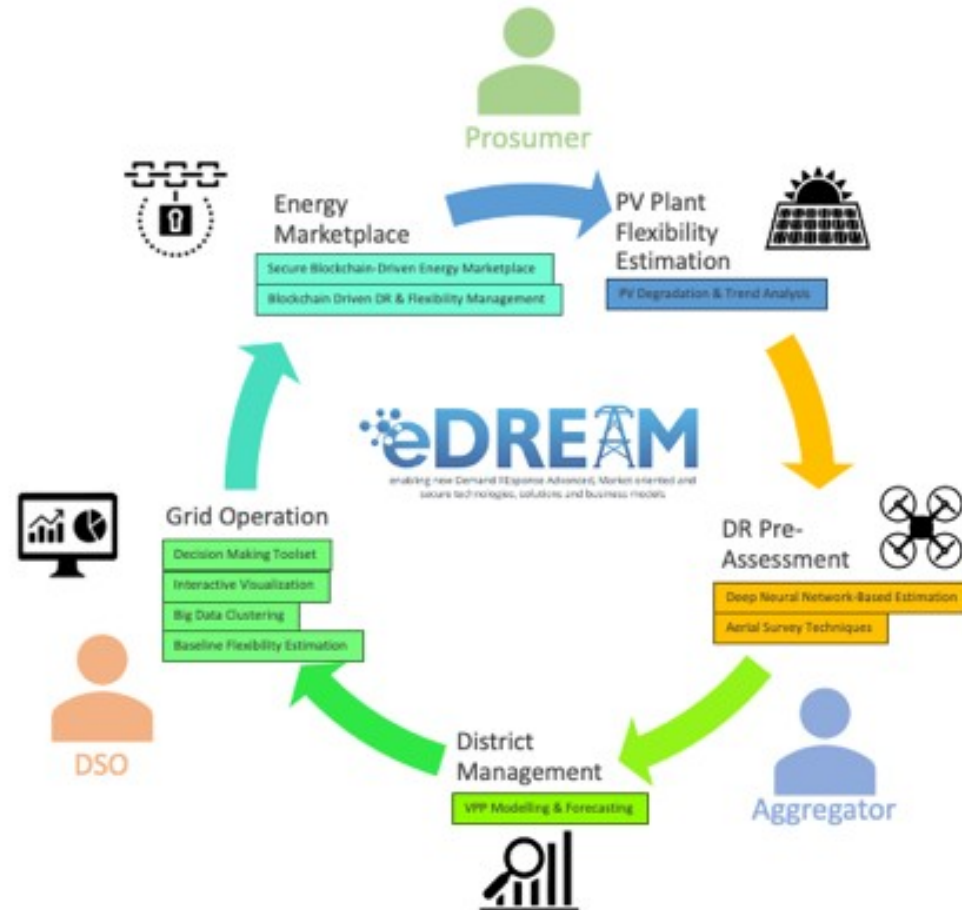
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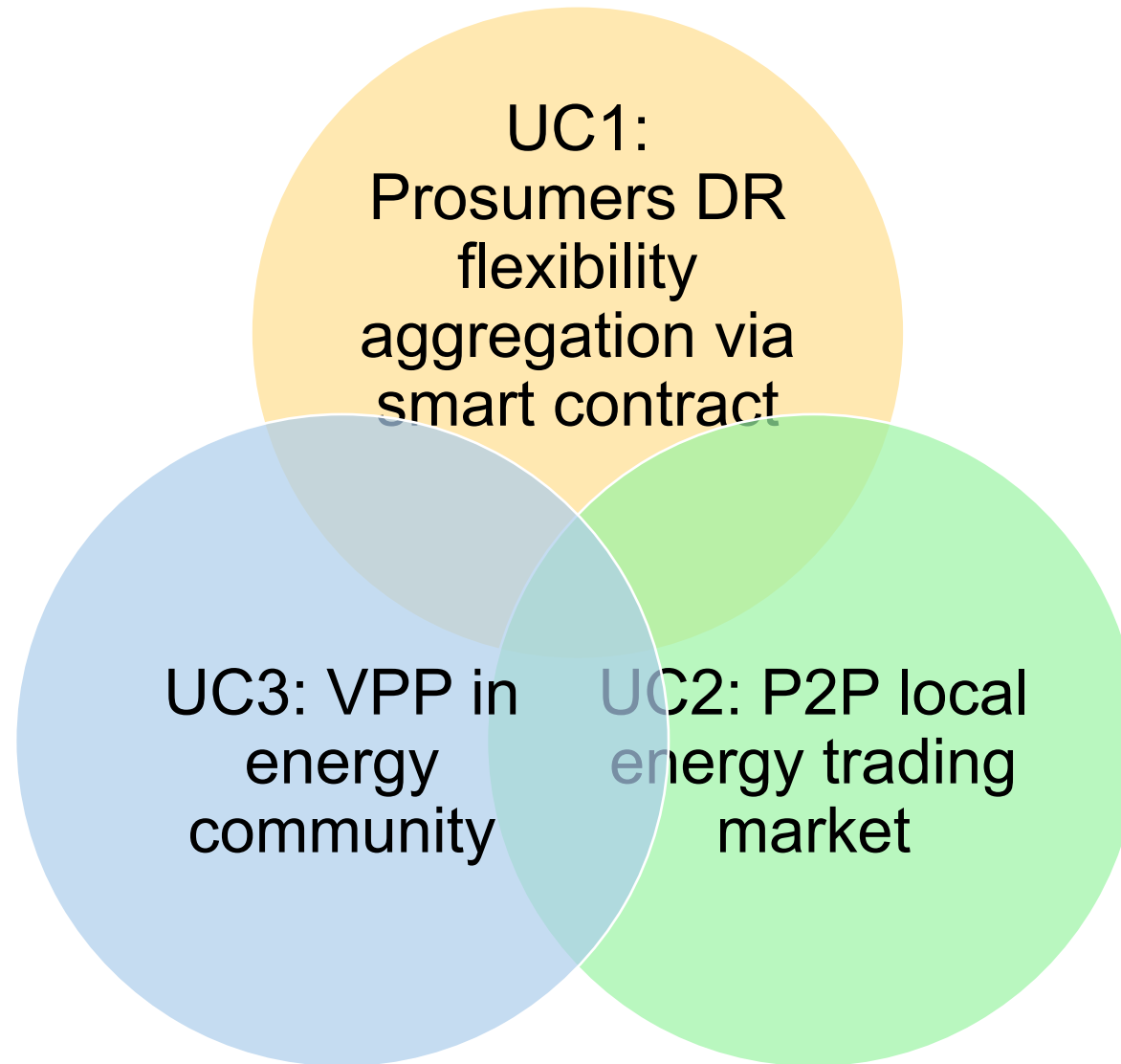
eDream - New DR Technologies and Services



Key principles of blockchain application:

- ▶ Validation and Financial Settlement
- ▶ Decentralized Smart Contracts
- ▶ Secure Data Storage

eDream - Use Cases



eDream - Value Proposition

A blockchain-based Demand Response decentralized ecosystem, aimed at:

- ❑ Alleviating local network constraints caused by the imbalances in the power grid
- ❑ Optimising nearby energy management

The eDREAM offering is available through three main project's assets:



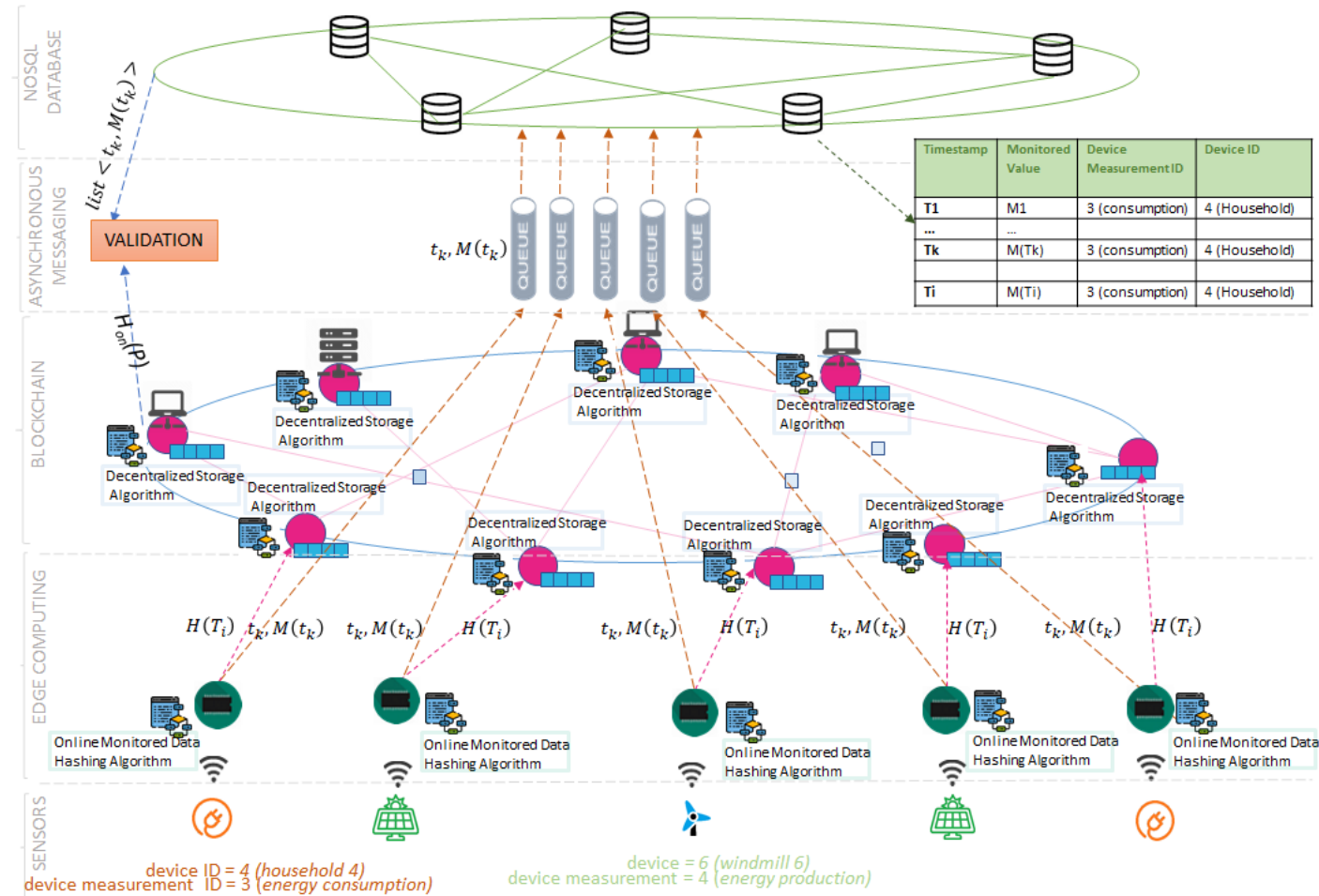
eDream - 2nd Tier Energy Data Storage

Combines:

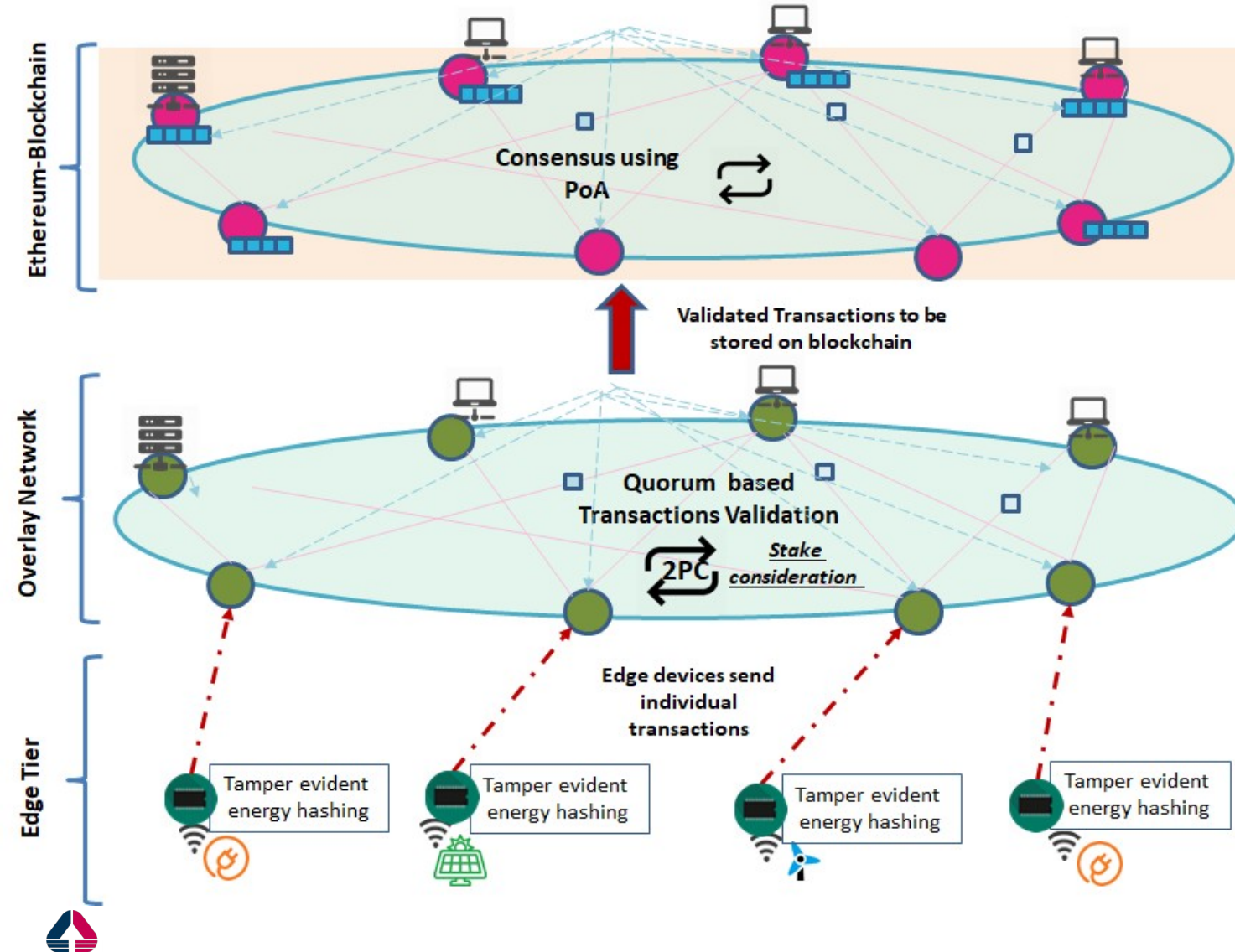
- Blockchain Ledger
- Distributed Queuing Systems
- NoSQL Database

Takes advantage of:

- High scalability of NoSQL database (off-chain storage)
- Tamper-proof, provenance tracking, self-enforcing smart contracts benefits brought by the blockchain



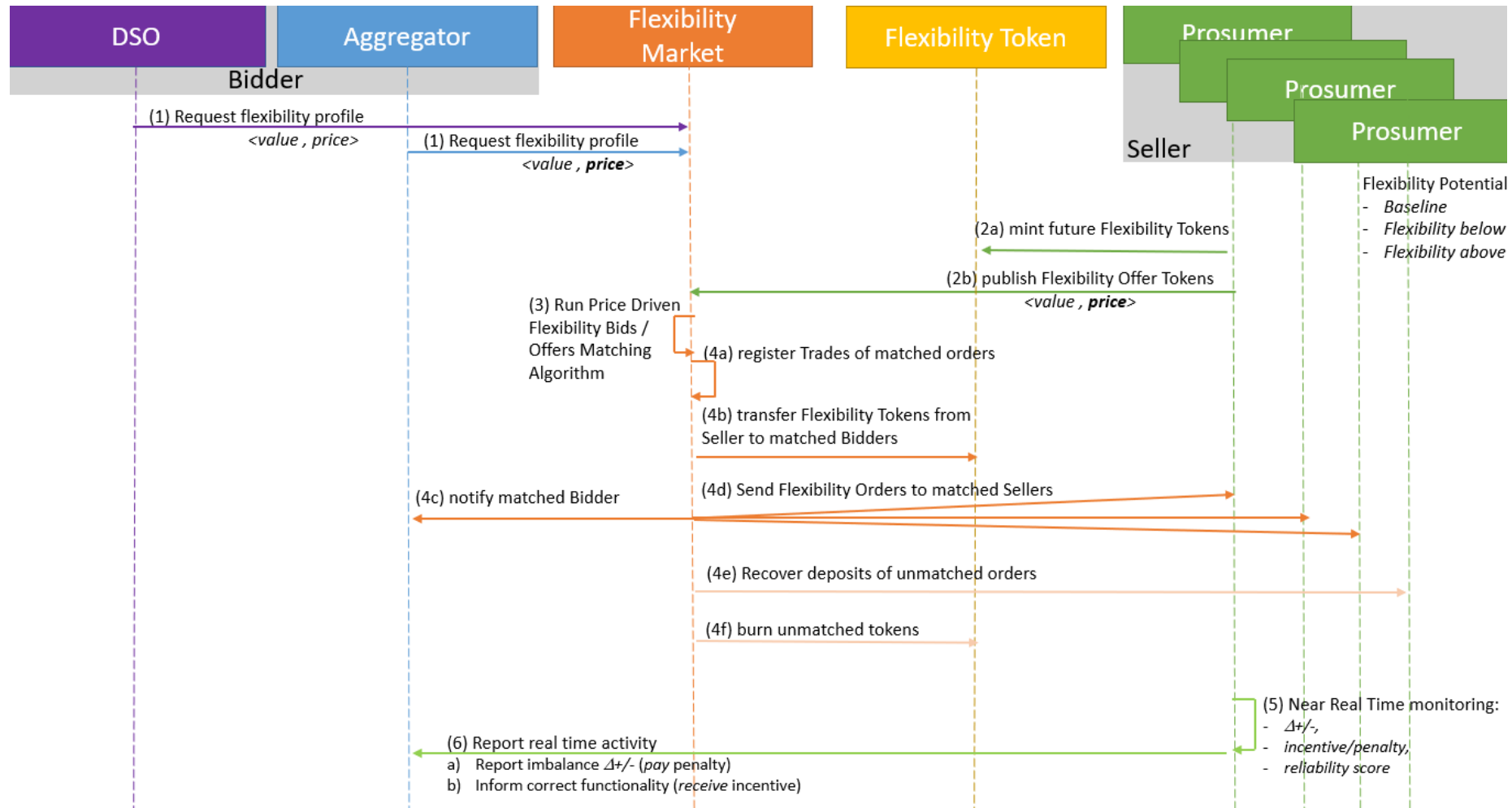
eDream - P2P Consensus for Energy Transactions Validation



Two-stage consensus based on a Peer-to-Peer overlay network that validates energy registration transactions:

- Receives transactions from Edge Devices
- Validates the transactions using a Weighted Voting Scheme based on the Stakes of each energy prosumer involved in the transactions and historical data from NoSQL DB
- Uses Cryptographic Sortition based on Verifiable Random Functions (VRFs) for selecting the Validator
- Consensus algorithm derived from 2-Phase Commit to validate transactions and propagate to network for block creation

eDream - Price Driven Flexibility Marketplace



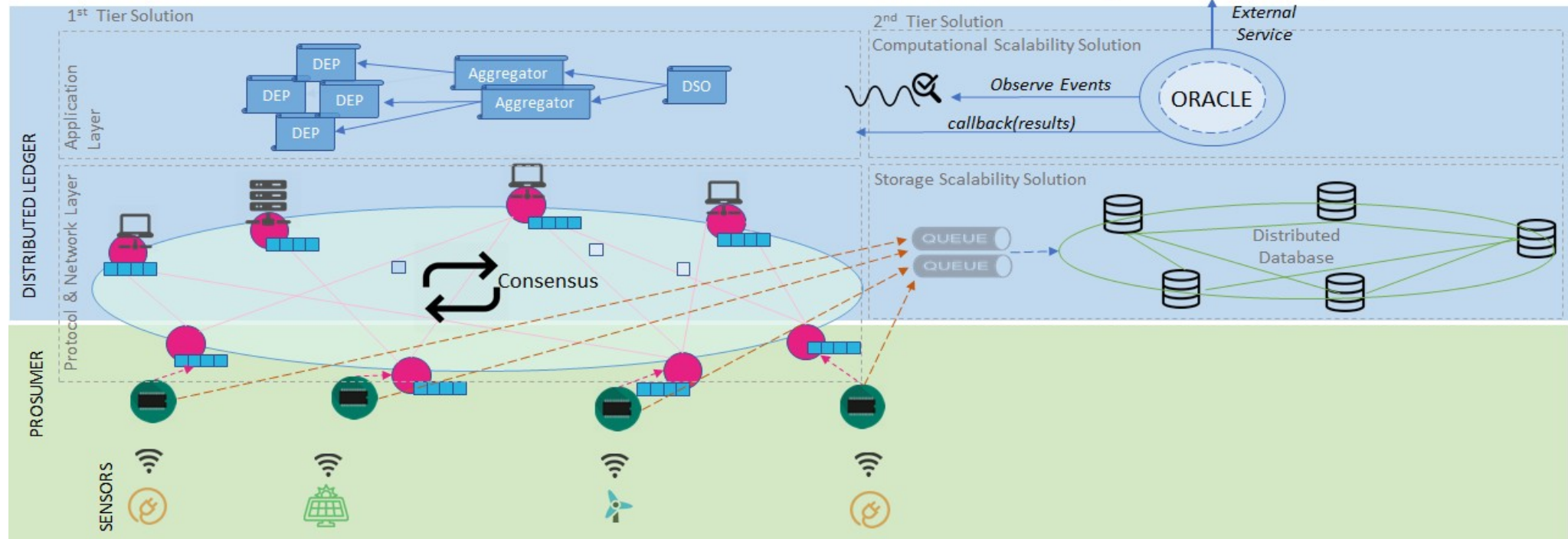
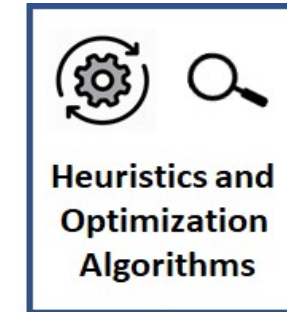
eDream - Advanced Heuristics for P2P Demand/Offer Matching

P2P Energy Trading

- Energy Bids/offers matching algorithm considering technical capabilities constraints

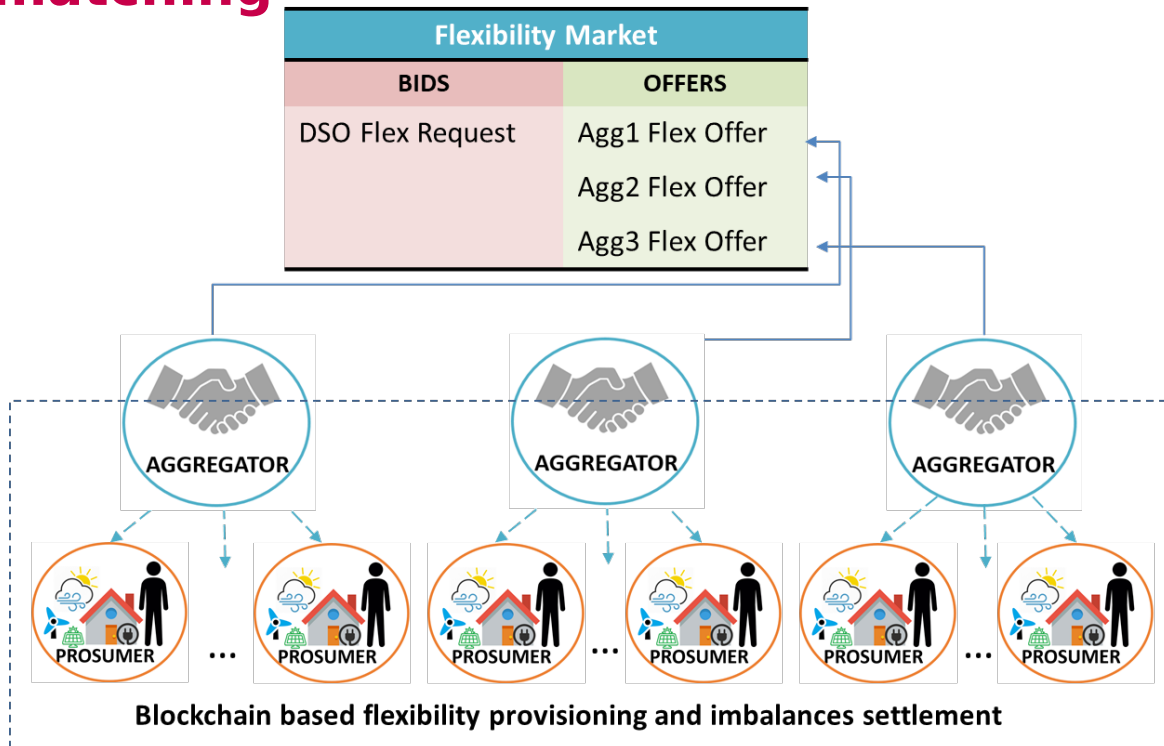
P2P Flexibility Trading

- Flexibility Request Disaggregation
- Price Driven Flexibility Bids / Offers Matching

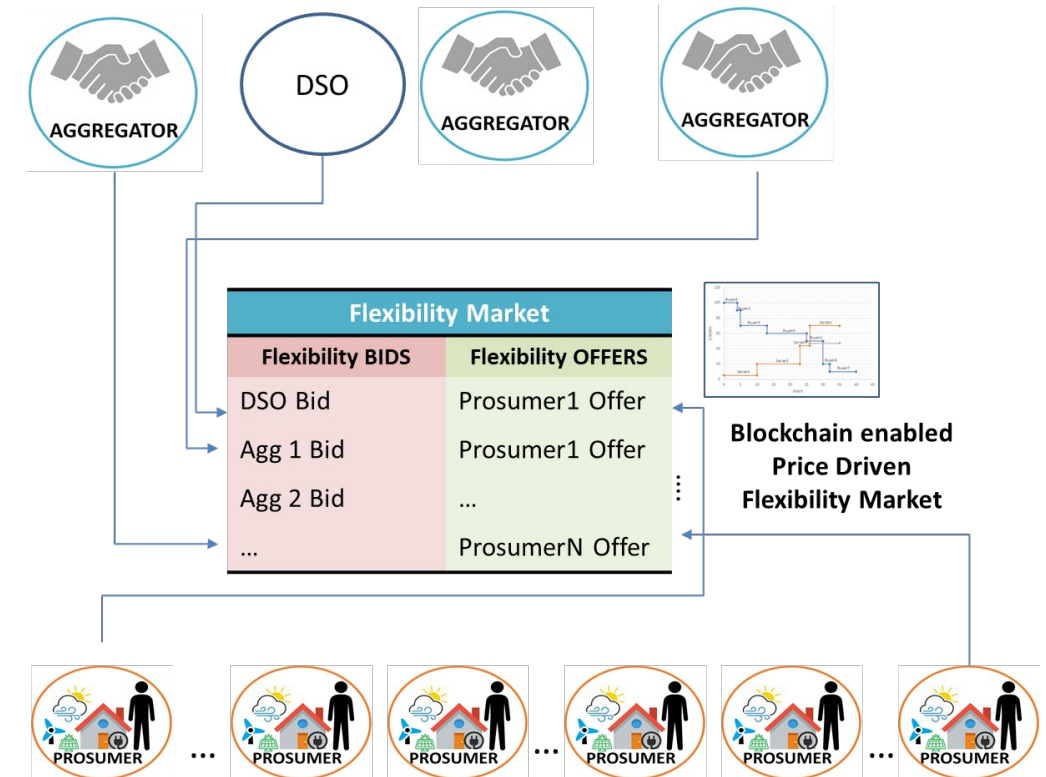


eDream - Bids/Offers Matching

Flexibility request of aggregator disaggregation and prosumer flexibility matching



Price driven flexibility matching

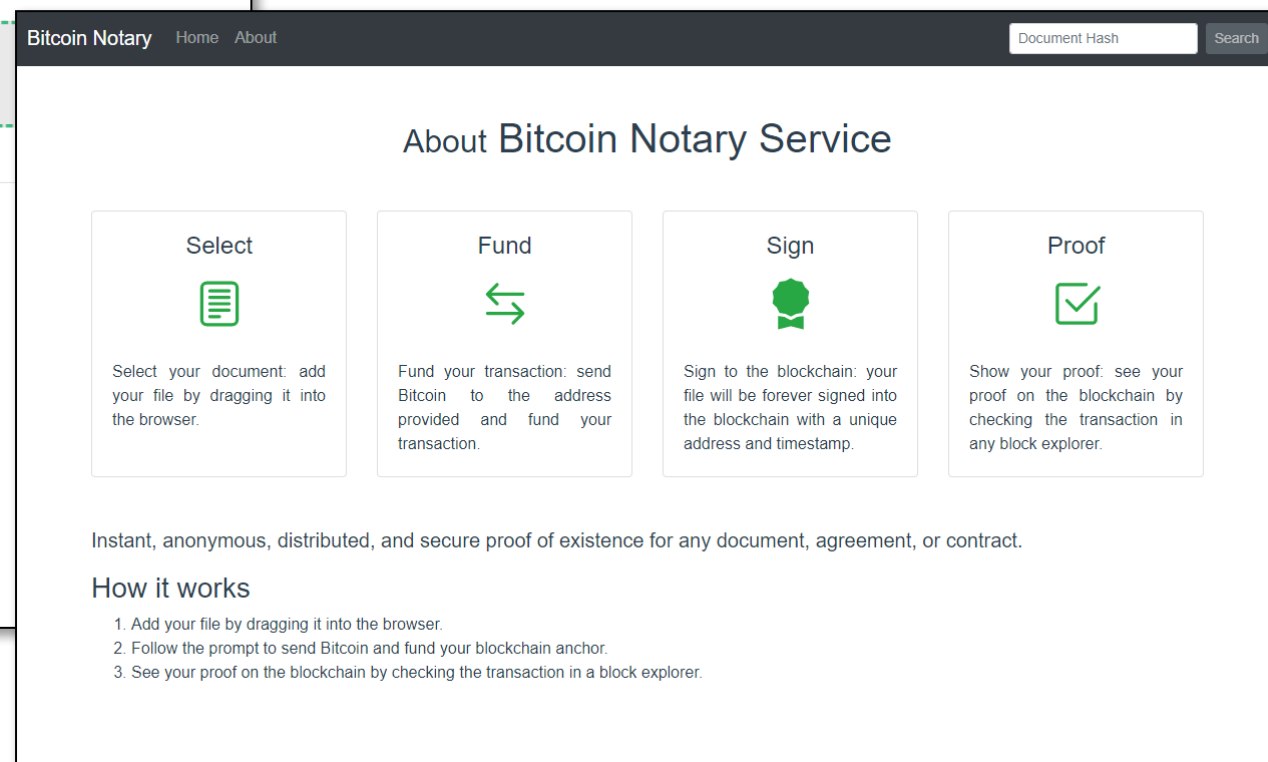
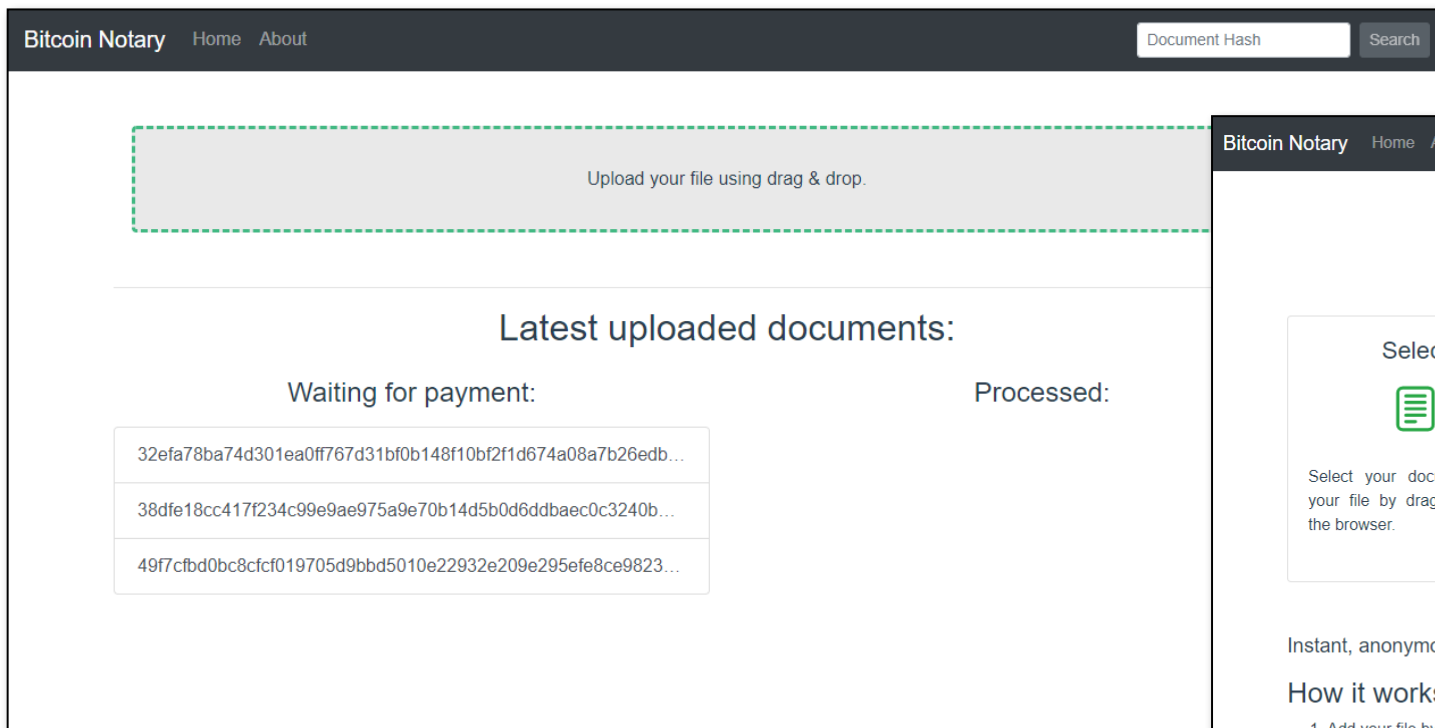


- NP-complete Optimization Problem solved using **Genetic Heuristics**
- Computation performed outside the blockchain using **Oracles**

Other Services - Bitcoin Notary Service

Exploits Bitcoin blockchain for the Notarization of User files

- ▶ File are signed with a unique reference and timestamp
- ▶ Block explorer can be used in order to proof the file existence



Thank you!



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