Alliance for
Internet of Things
Innovation

# IG Distributed Ledger Technologies Presentation of the Report on DLT-IoT Technological Convergence

Online • 6 July 2022

# Agenda

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# Agenda

15:00h **Opening and Welcome**

Damir Filipovic, AIOTI Secretary General

**Introduction of the AIOTI DLT Group**

Tom De Block, AIOTI IG DLT Chair

15.05h **Presentation of the Report on DLT-IoT Technological Convergence**

**Introduction and overview of the report** (20 min)

Alfredo Favenza, AIOTI IG DLT Co-Chair, Fondazione LINKS

# Agenda

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|---|---|
| Cont. | **Use Case presentation Examples (45 min)** |
| | Tasos Charisis, Nydor System Technologies |
| | Tom De Block, Nearcom |
| | Jaikrishnan Radhakrishnan, BovLabs |
| | Milenko Tosic, VizLore Labs |
| | Tom De Block, Nearcom |
| | George Suciu, BEIA Consult |
| | **Questions and open discussions** (20 min) |
| 16.25h | **Wrap-up and end of Webinar** |
| | Tom De Block, AIOTI IG DLT Chair |

# IG Distributed Ledger Technologies

**Chair**
Tom De Block
Nearcom

**Co-Chair**
Alfredo Favenza
Fondazione LINKS

**Vision:** To represent the DLT aka 'Blockchain' enabling technology. Opening new business models that will allow IoT infrastructures to become trustful and sustainable

**Scope:** To bring knowledge and awareness, starting with AIOTI verticals. To assist members to work towards deployments

# Highlights

**Relevant facts**

**62** member organisations

**77** participants

**Main achievements**

1. Development of the convergence document (DLT/IoT)
2. Contribution to AIOTI Testbeds Catalogue (11 DLT testbeds)

# Priorities 2022

| Deliverable |
| --- |
| IG DLT welcome package (ToR + main milestones/deliverables) |
| IG DLT member profiles (for matchmaking) |
| Vision on Common EU Data Space |
| IG DLT-specific aspects in AIOTI SRIA |
| Opportunities for IG DLT members cooperation in HEU and DEP work programmes |
| Role of DLT in addressing targets for<br>a) the Green Deal<br>b) Farm to Fork<br>c) EU data spaces |
| Blogs on Convergence with other enabling technologies |
| Blogs on Convergence with legacy |

# Introduction and Overview of the Report

Alfredo Favenza, AIOTI IG DLT Co-Chair, Fondazione LINKS

AIOTI

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The IoT promises many benefits for how we live and our environment, but there are numerous challenges, from monitoring and controlling millions (if not billions) of heterogenous devices, to helping them to communicate and transact securely.

As the IoT continues to grow, the centralized approaches to these challenges that are in use today are reaching their limits. Blockchain can help by offering a decentralized alternative for IoT platforms, providing scalability and interoperability via a trusted, common communication layer and bringing automation and other efficiencies to large sensors platforms.

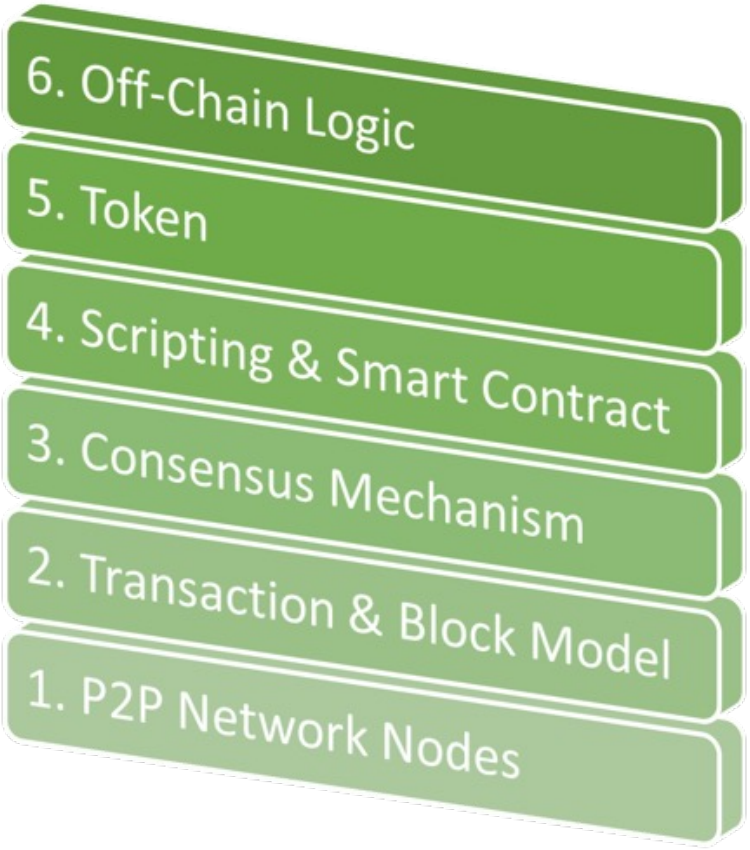
“Convergence of Blockchain, AI and IoT”, European Union Blockchain Observatory & Forum, 21 April 2020

# Objectives

- Explore opportunities lying at the intersection of DLT and IoT by connecting the different layers of the two technological stack
- Discover promising areas and topics of convergence where DLT and IoT can help solving respective challenges
- Connect the areas and topics of convergence to the relevant use cases in the AIOTI community (DLT Testbeds)
- Provide the AIOTI vision on the future of DLT-IoT convergence

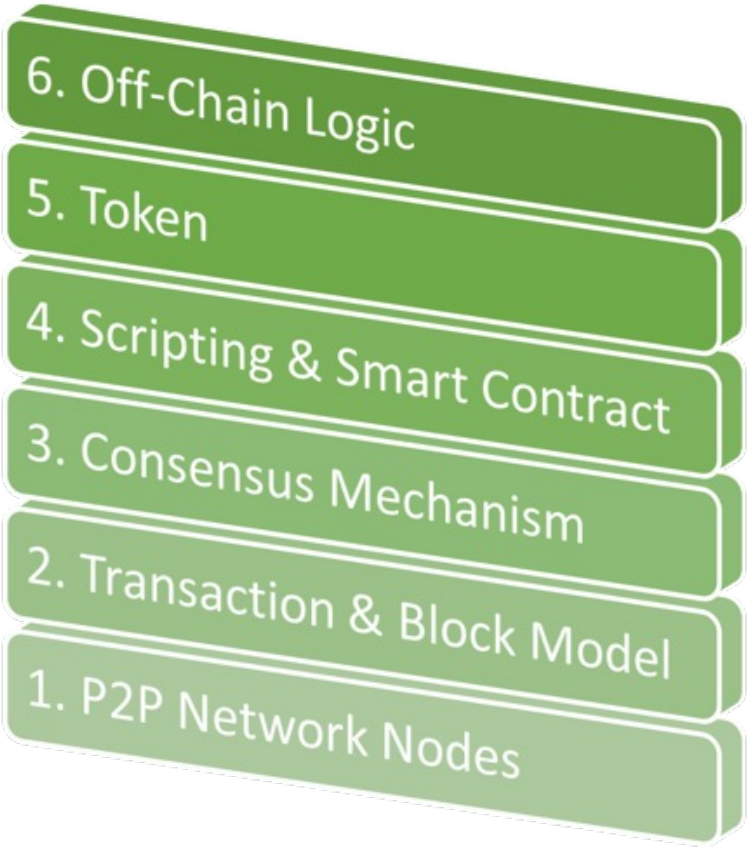
# DLT technology stack

- **P2P Network of Nodes**. A network of physical or virtual machines (peers) maintaining a local copy of the ledger communicating over the internet (TCP/IP protocol). Peers are equally privileged, equipotent participants in the application. They share resources without a centralized administrative system or control in an untrusted environment.
- **Transaction & Block Models**. The representation of the distributed ledger data replicated across nodes on the P2P network, usually a cryptographically secure linked list of blocks where each block contains an ordered list of transactions.



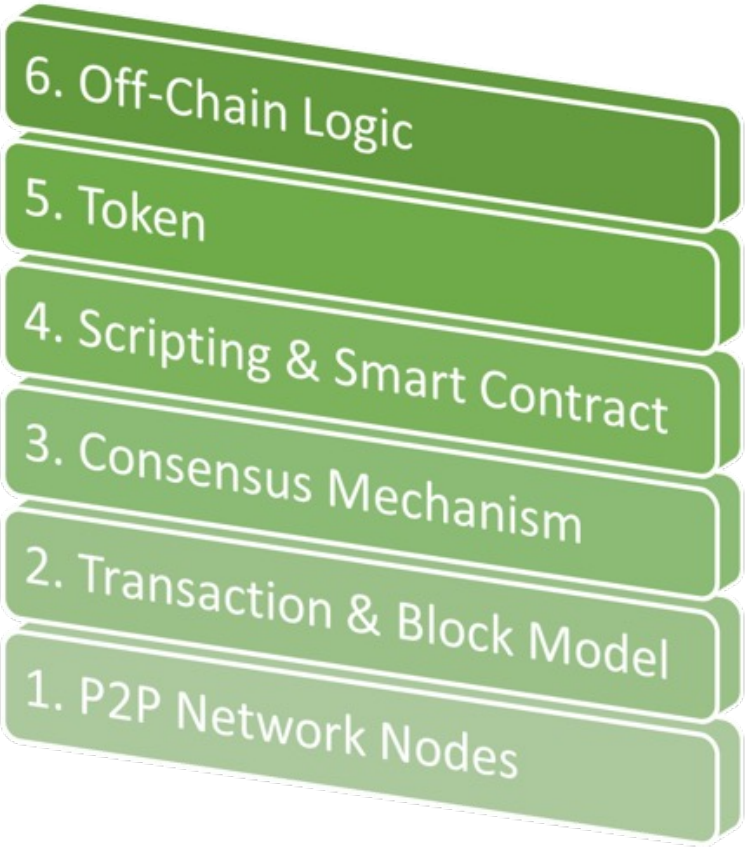
# DLT technology stack

- **Consensus Mechanism.** A network protocol that defines rights, responsibilities, and means of communication, verification, validation, and consensus across the nodes in the network. This layer includes ensuring authorization and authentication of new transactions and incentive mechanisms (if needed).
- **Scripting & Smart Contract (On-chain Logic).** Scripts (code) deployed as data in the ledger and executed throughout sending transactions to the network. Smart contracts can hold and transfer digital assets managed by the DLT and can invoke other smart contracts. Smart contract code is deterministic and immutable once deployed.



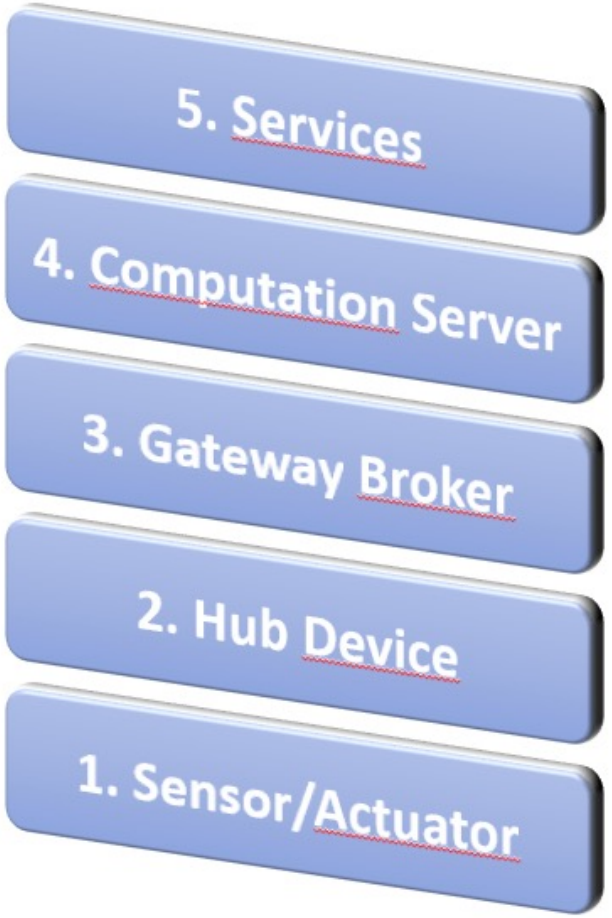
# DLT technology stack

- **Token.** Tokens allow to digitalize (tokenize) fungible (i.e., money) and non-fungible (i.e., work of arts) assets. Tokens can represent shares in a company, the right to benefit from future earnings, grant voice power for voting systems, etc. Tokens can be created and exchanged, usually using smart contracts.
- **Off-chain Logic.** Includes all parts of the data, and computation kept off-chain. As for the data, usual practices are to store large or private sets of data off-chain (e.g., replicated databases, sidechain, cloud) and to keep hashes, metadata, and small-sized public data on-chain. For logic, due to the "closed-world" logic of smart contracts (i.e., SC can usually only examine state stored on the ledger), oracles are invoked to interact with the external world and to bring the external knowledge into the ledger.



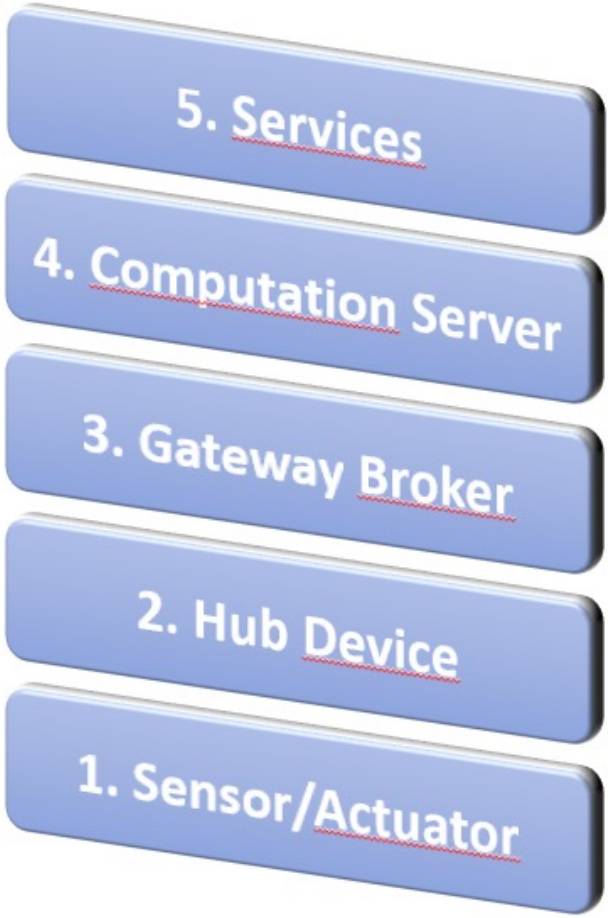
# IoT technology stack

- **Sensors and Actuators.** Devices exposing either an analog or a digital interface. Most sensors are coupled with an embedded hub device in which case an internal bus technology is used to link both systems, such as I2C, RS232, RS485, SPI, SDI 12, 20mA etc.
- **Hub Device.** Enables the collection of data from sensors through a multitude of standards and configurations. It creates a bridge between the IoT Gateway and the sensors and actuators. The Hub device presents two Communication Interfaces (both bidirectional): one towards sensors and a second wireless one towards the IoT Gateway. The goal of this devices is to group several sensors/actuators in a first level of processing power.



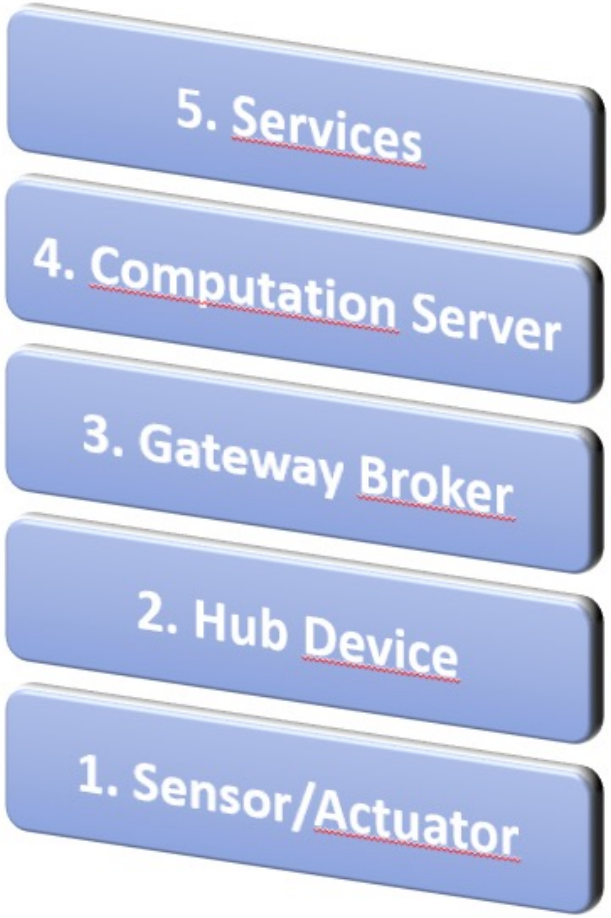
# IoT technology stack

- **Gateway.** Provides the means to bridge the gap between devices in the field (factory floor, home, etc.), the (enterprise) Cloud where data is collected, stored and manipulated by enterprise applications, and the user equipment (smart phones, tablets etc.). The IoT Gateway, provides a communication link between the field and the network and can also offer local processing and storage capabilities to provide offline services and if required.
- **Computation servers.** These types of system are designed to deal with Big Data and provide complex computations on them, like Machine Learning algorithms. The amount of processing power expected at this level corresponds to CPD clustering systems or more frequently Cloud platforms. Communications between the gateway and the computation server is usually done through TCP/IP protocols.



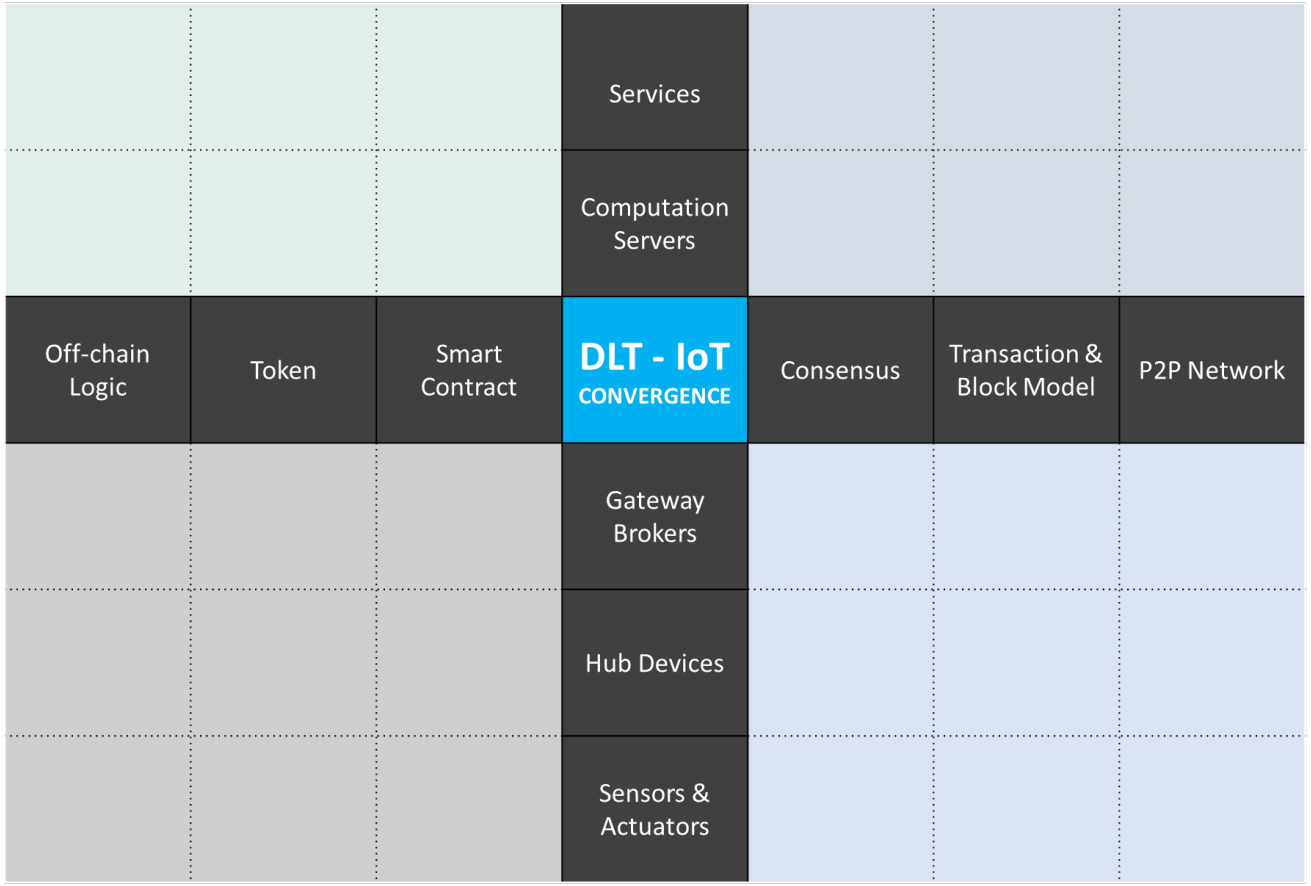
# IoT technology stack

- **Services.** This level covers the interaction between servers and users, representing man-machine interface technologies. Services provide a virtual/direct link between people and data, using infrastructure as a transparent tunnel. The exploitation of information can be based on web technologies, or visualization on mobile devices. Quality of service is a key concept here in the sense of access to processed data, but also taking into account their temporal validity.



# The Convergence Matrix

Highlights the possible **areas and topics of convergence** lying at the **intersection of the building blocks** of the DLT and the IoT stacks.



# Areas and topics of convergence

- Decentralization
- Interoperability
- Scalability
- Secure Data Exchange
- IoT network security and Identity management
- Autonomous M2M interaction
- Data monetization
- Micro-payments
- Voting & Negotiation

| | | | | | | |
|---|---|---|---|---|---|---|
| | Data Monetization | | Services | | Micro-payments | |
| | | | Computation Servers | | | Decentralization |
| **Off-chain Logic** | **Token** | **Smart Contract** | **DLT - IoT CONVERGENCE** | **Consensus** | **Transactions & block model** | **P2P Network** |
| | Securing Access management with access token | IoT Network Management | **Gateway Brokers** | | | |
| | | Securing IoT with fingerprinting | | | | |
| Scalability | Autonomous identity | IoT network Management | **Hub Devices** | Decentralization | Scalability | Scalability |
| Interoperability | | Autonomous Identity Management | | Interoperability | | Decentralization |
| | Voting & Negotiation | Autonomous M2M interaction | | Voting & Negotiation | | |
| | | Securing IoT with fingerprinting | | | | |
| | Voting & Negotiation | Automated and Secure Firmware update | **Sensors & Actuators** | Voting & Negotiation | Automated and secure Firmware update | Decentralization |

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# Convergence Topics (1 of 4)

## Decentralization

- DLT can help to **decentralize the management of computation and storage resources** across billions od IoT devices that form the IoT network.
- A decentralized approach will help **reducing IoT costs** associated with installing and maintaining large and centralized data centers, **improving security**, and enabling **efficient control of resources**.

## Interoperability

- Blockchain can help increasing IoT interoperability providing a **common, trusted communications layer** between devices of different types and manufacture.
- **Reduce fragmentation and lack of interoperability** among different IoT platforms in terms of underlying communication protocols, data formats, and technologies from different devices vendors.

# Convergence Topics (2 of 4)

## Scalability

- DLTs, in particular layer 2 scalable solutions (e.g., Lightning Network), can enable **fast processing of transactions and coordination** among billions of IoT devices connected devices.
- **IoT edge devices can improve the scalability of blockchain** in a distributed and efficient manner by delivering computing and cache resources to the blockchain-enabled IoT systems.

## Secure Data Exchange

- DLTs **can maintain an immutable, auditable, and single-version-of-truth data** and provide **a secure mechanism for data sharing** among IoT devices so that visibility, privacy, interoperability, and protection of data are accountable along the entire data exchange process.
- Differently from the cloud-based data exchange services, a decentralized approaches can help to **reduce the probability of adversary access to the data**, promoting an efficient use of valuable data in the IoT ecosystem.

# Convergence Topics (3 of 4)

## IoT network security and identity management

- A decentralize P2P network is **more resilient to cyber attacks or single points of failure**. Any attempts attack a decentralized network would require penetration of a majority of connected nodes, making it virtually impossible.
- Blockchain can also provide mechanisms for IoT devices **identity authentication based on Self-Sovereign Identity (SSI).**

## Autonomous M2M interaction

- Blockchain technology could facilitate **autonomous machine-to-machine transactions**, avoiding the proliferation of vendor-based machine-to-machine (M2M) communication protocols.
- **Smart contracts** can be exploited to deploy **autonomous services** that allow machines to hold funds, make decisions based on complex business logic and carry out transactions autonomously.

# Convergence Topics (4 of 4)

## Micro-payments & Data Monetization

- DLTs, and, in particular layer 2 solutions (e.g., Lightning Network) can be suitable as a **micropayment p2p solution** for having a devices autonomously pay another device for a service.
- DLTs can act as a **trusted broker to monetize IoT's data trading**. DLT enables the creation of **data marketplaces** based on automated, reliable, and transparent monetization system, **allowing IoT data users to exercise fine-grained control on shared data**.

## Voting & Negotiation

- DLTs, through consensus and tokenization mechanisms, can enable IoT networks to **autonomously negotiate and reach a common agreement through a voting process**.
- The system can perform a **simple majority voting, or a more complex voting process** by exploiting the specific characteristics of the different consensus protocols and tokenization mechanism

# Presentation of the Use-Cases

# Use-Case: Development of Aquacolture (POAY in Greece)

- **Domain:** Rural development
- **Scope:** POAYs are organized supervisory bodies for industrial activities that extend on land and sea and relate to existing or to be established, without environmental and spatial problems, aquaculture infrastructures (fish farms, packaging, fish food production etc). POAYs have been instituted by EU legislation and are compulsory for member states that include coastal lines at which industrial/commercial activities are established. For Greece a total of 23 such establishments are planned and expected to become operational in 2021. Their main role is the monitoring of environmental impact of aquaculture activities at the respective areas, in order to ensure that the foreseen sea activity planning progresses according to the national and EU policies. This involves measurements at frequent intervals of both sea water and air quality, proven validation and authenticity of these measurements, and final analysis to be delivered periodically to the central government. The above requirements can only be achieved if a robust IoT infrastructure combined with a proven DLT framework is provided to the POAYs and the respective organisations of other EU member states
- **Area/topic of convergence:** IoT network security and management
- **Role of IoT:** IoT Infrastructure
- **Role of DLT:** secure data collection, notarization and monitoring

# Use-Case: VERSES DLT HSTP Spatial Web

- **Domain:** Transversal
- **Scope:** demonstrate the Hyper Spatial Modelling Language (HSML) and Hyperspace Transaction Protocol (HSTP) using COSM (Spatial Operating system) that enables interoperable, semantically compatible connections between connected software and hardware and includes specifications for: 1) a spatial range query format and response language for requesting data about objects within a dimensional range (spatial, temperature, pressure, motion) and their content; 2) a semantic data ontology schema for describing objects, relations, and actions in a standardized way; 3) a verifiable credentialing and certification method for permissioned create, retrieve, update, and delete (CRUD) access to devices, locations, users, and data; and 4) a human and machine-readable contracting language that enables the expression and automated execution of legal, financial and physical activities
- **Area/topic of convergence:** verifiable credentialing and certification method for permissioned create, retrieve, update, and delete (CRUD) access to devices
- **Role of IoT:** Autonomous drones, sensors, smart devices, and robots
- **Role of DLT:** Certification methods for permissioned CRUD operations, access to devices data, human and machine-readable smart contracts for automated execution of legal, financial and physical activities

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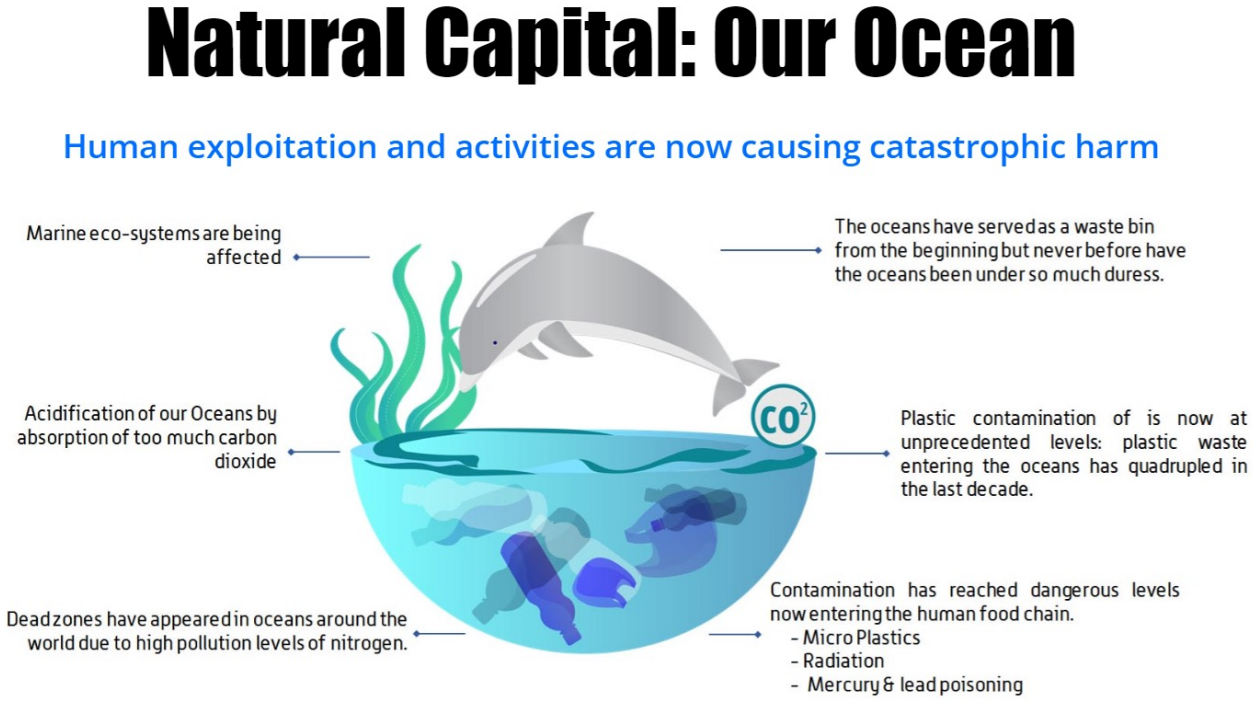
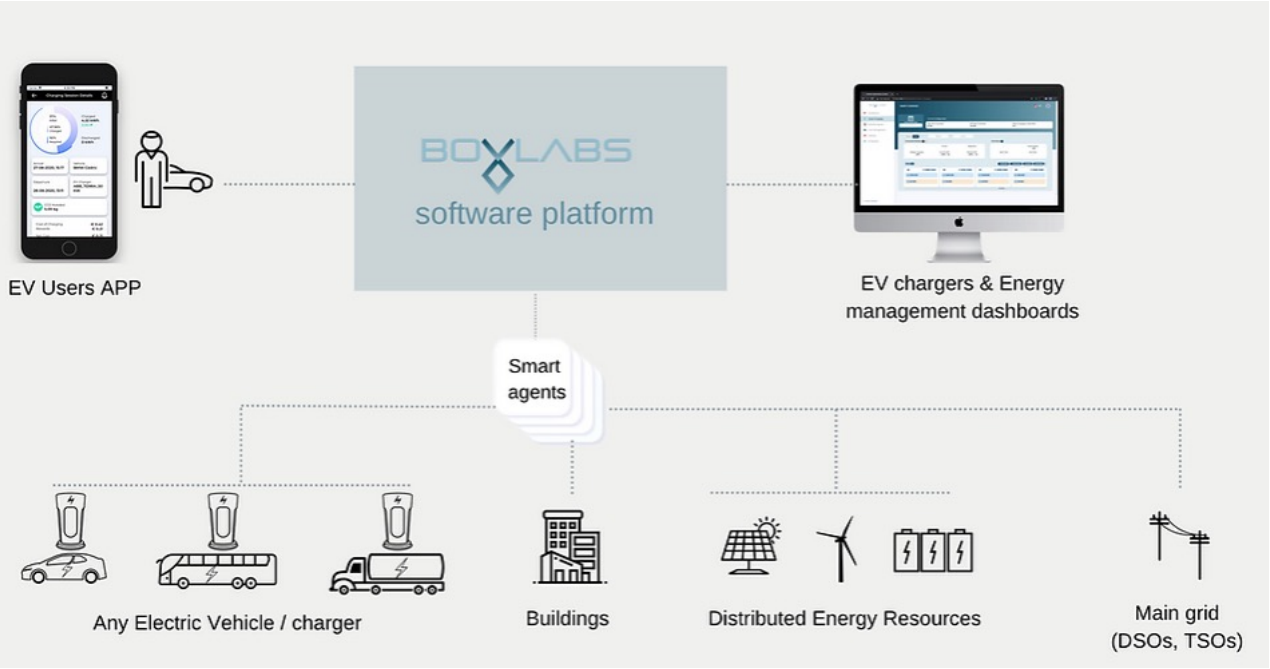
# Use-Case: Blue Future Organization DAO

- **Domain:** Farm-to-Fork, Farm-to-Finance, Climate action
- **Scope:** demonstrate how Distributed Ledger Technologies enables "Farm-to-Fork" in aquaculture as a foundation to enable financial instruments and investments for acceleration into the blue economy. BFO is set to provide insights into the technical layers allowing observers to properly understand how the DLT is applied into the IT stack. BFO also demonstrates the autonomous reporting mechanism with XBRL as facilitator for financial and non-financial information.
- **Area of convergence**: Secure data exchange, interoperability, data monetization, new business models
- **Role of IoT**: Water quality sensors, data collect, surveillance
- **Role of DLT**: DAO, Voting, Certification



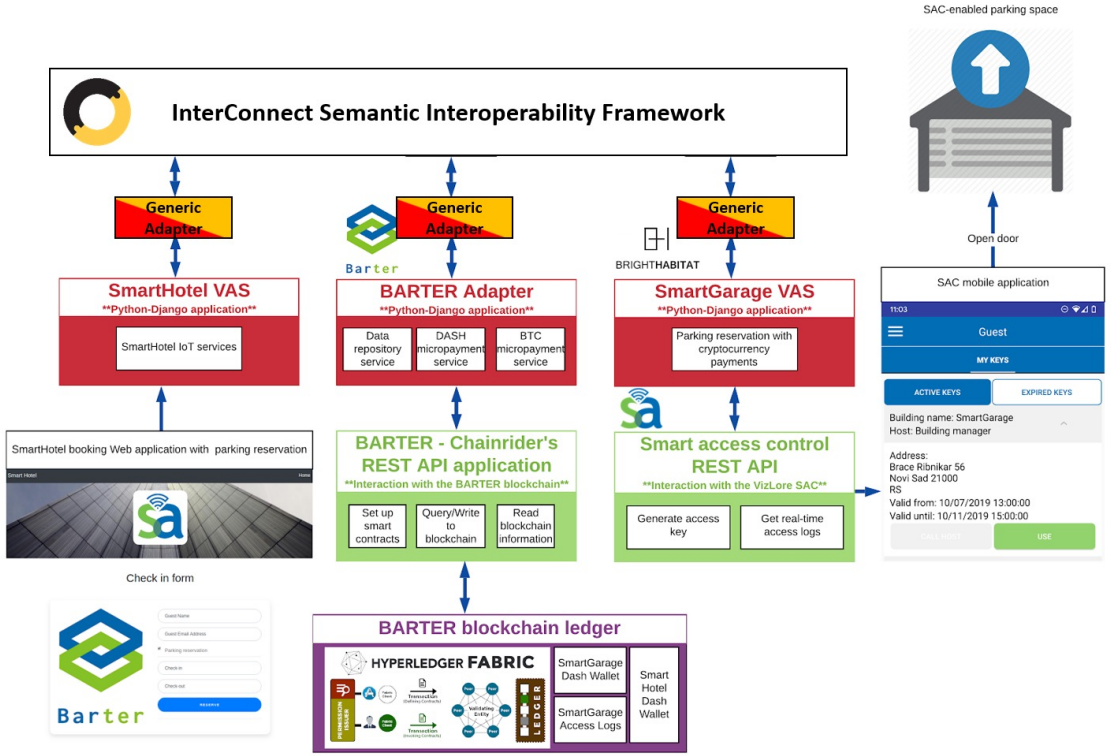
# Use-Case: Bovlabs DLT PoC

- **Domain**: Energy, mobility
- **Description:** platform to manage and control EV chargers. Our goal is to maximize utility for operators and EV owners. In doing so, charging cycles are optimized based on energy price, demand chargers, demand response programmers, along with driver inputs (for example, parking duration). Bovlabs developed an innovative system for SNCF G&C responsible for the management of EV charging stations at passenger train stations. Bovlabs PoC is set to demonstrate Ethereum Blockchain. Proof of Authority Based Consensus; 3 million transactions recorded in the first project; 450 transactions per second are supported; Smart agents uses light nodes to transact energy transactions; Smart contracts used for trade and execution (written using Solidity); ERC 20 Tokens used for transacting energy peer to peer.
- **Area/topic of convergence:** decentralization, scalability, micropayments, new business models.
- **Role of IoT:** Smart agents integrate with any DERs (like solar, battery storage, EVSE) to record secure P2P energy transactions within the blockchain node embedded within the agent. This creates a distributed, decentralized dataset and with distributed intelligence at edges (ML) creates Virtual Power Plant
- **Role of DLT:** Proof-of-authority consensus, smart contracts, tokens



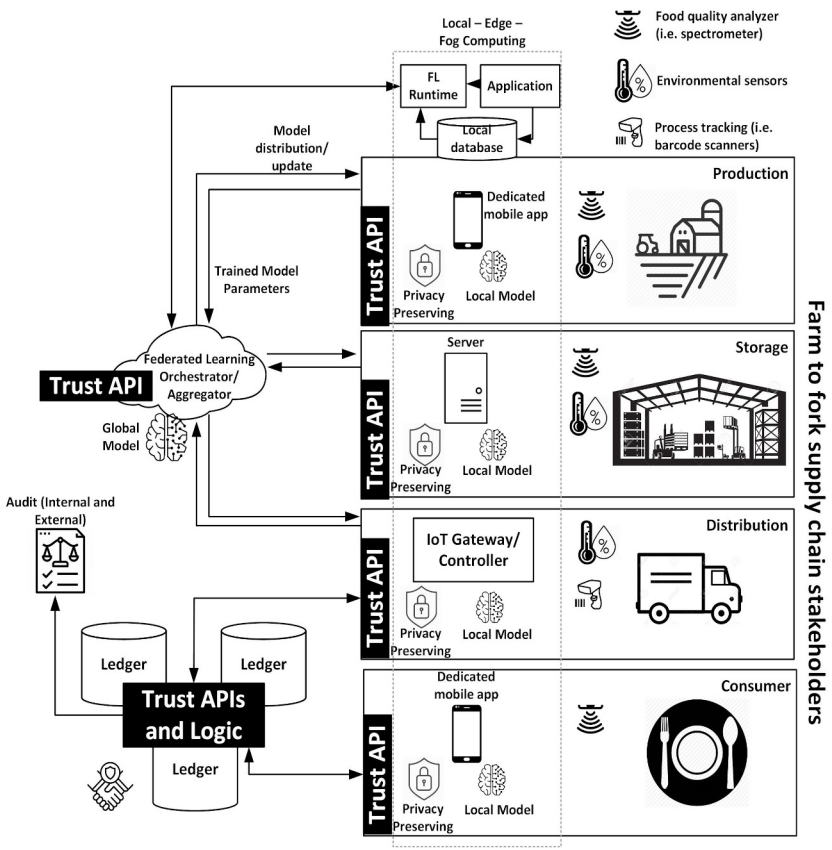
# Use-Case: VizLore DLT Labs - BARTER Testbed

- **Domain**: Smart city, smart buildings, e-mobility
- **Scope**: Testbed is set to demonstrate a blockchain framework built on top of Hyperledger Fabric, Dash, Bitcoin and VizLore's ChainRider service. It is a micro-payment enabler service that can be exploited to support a range of use-cases that need a secure and scalable M2M micro-payment solution, specifically designed for the IoT. The testbed includes parking reservation emulation and IoT system for access control. The testbed utilizes semantic interoperability framework of the InterConnect project for interconnecting different services.
- **Area of convergence**: Autonomous M2M interaction, micropayments, interoperability.
- **Role of IoT**: M2M IoT Systems, smart sensing and actuation.
- **Role of DLT**: Automated micro-payments and data storage. Smart contracts for regulations, ethics and business rules compliancy.



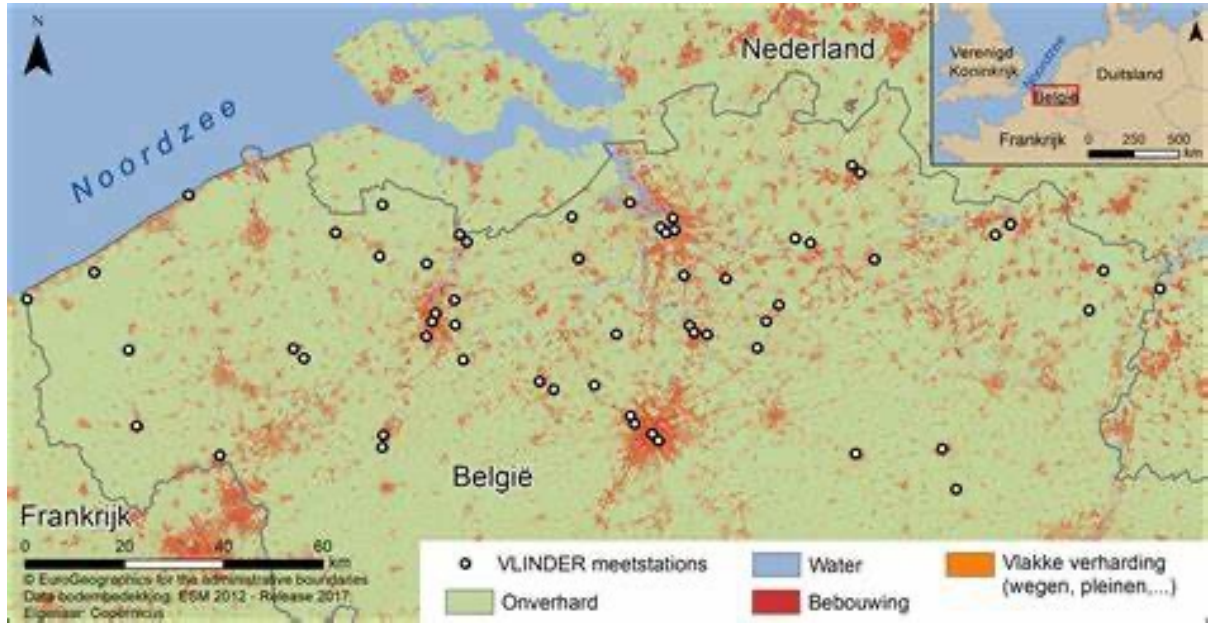
# Use-Case: VizLore DLT Labs - FT-Chain Testbed

- **Domain**: Food supply chains
- **Scope**: FT-Chain combines IoT system for food quality measurements (spectrometry methods), IOT system for environmental sensing, Hyperledger Fabric based ledger for trusted data sharing between parties and federated learning framework for high performance data analysis and decision making. The goal is to emulate complex processes and dependencies in food supply chains that might result in food quality degradation and contamination.
- **Area of convergence**: decentralization, trust management.
- **Role of IoT**: environmental sensing, field spectrometry, smart actuation.
- **Role of DLT**: smart contracts for supply chain process automation, trusted federated learning and local/global ML model alignment, auditing and reporting.



# Use-Case: AIRQ DAO

- **Domain:** Smart city, Climate action
- **Description:** demonstrates the convergence of IoT and DLT into an autonomous system based on the AIOTI High Level Architecture (HLA) for data markets. Co-creation, micropayments and (smart contract) revenue-splits enable a 'self-sustaining' and financially autonomous IoT sensor network. Each air quality sensor integrates with the DLT network via a dedicated wallet. Local engaged citizens subscribe to notification services via micropayments. The sensor receives monthly payments, and an automated revenue split rewards the data aggregator, service providers and the AIRQ DAO foundation. If the sensor can earn its own value after two years, a smart contract orders his replacement. As such, only valuable sensors are maintained, and the network becomes (financially) self-sustainable
- **Area/topic of convergence:** Decentralization, scalability, data monetisation, new business models.
- **Role of IoT:** Air quality monitoring stations, solar cells
- **Role of DLT:** Automated micro-payments, smart contracts



# Use-Case: BEIA PimeoAI

- **Domain:** AI, Unmanned Surface Vehicle, water pollution
- **Scope:** An artificial intelligence (AI) powered unmanned surface vehicle (USV) capable of performing a full range of water quality tests in all types of sensitive aquatic ecosystems is developed and tested in several representative situations. The PIMEO AI USV that results will be a cutting-edge advanced analysis tool for analysing fragile ecosystems, identifying pollution sources, and mapping their environmental impact. It will meet a critical market demand for complete water quality USVs, which are currently scarce and mostly used in hydrology research.
- **Area of convergence:** IoT Network Security & Identity Management, Autonomous M2M interaction
- **Role of IoT:** The USVs will be integrated with water quality sensors that will measure different water parameters (Temperature, Conductivity, pH, Turbidity, Chlorophyll) and record GPS coordinates.
- **Role of DLT:** The blockchain technology will be utilized to provide trust and traceability, such as securely handling sensor data information and stakeholders' identities. Implementing reliable, secure data transfer and access will enable GDPR compliance in terms of security and privacy.

# Use-Case: FarmSustainaBL

- **Domain:** Smart Farming, GHG emissions reduction
- **Scope:** The project's major goal is to use a holistic strategy to reduce GHG emissions associated with intensive livestock farming by optimizing livestock production. The collaboration will accomplish so by keeping an eye on the animal diet, animal behaviour and traits, and a stable environment. A web-based platform will be established to collect and analyse all of the above data in order to provide suggestions to livestock farming stakeholders (farmers, consultants, etc.) so that management decisions may be made to reduce GHG emissions.
- **Area of convergence:** decentralization, IoT Network Security & Identity Management
- **Role of IoT:** IoT devices will be installed in the farm for monitoring key parameters of the animal (motion sensor, accelerometer, weight sensor etc.), the stable environment (gas sensors (CH4, NH3, NOx, COx and others), humidity, temperature) and the feed (weight sensor, humidity sensor, flow sensor, etc.).
- **Role of DLT:** The platform will employ Blockchain Technology to provide features like data protection, data privacy, data sharing, traceability, and smart contracts among livestock farming players. The platform's smart contracts functionality, in particular, will assist livestock farming players in obtaining contracts with better prices due to lower GHG emissions.

# Use-Case: SMARDY Open Science

- **Domain:** Data Exchange, Data Security, Blockchain
- **Scope:** Smardy is developing a research data marketplace for technology transfer based on software and data carpentry (i.e., developing and teaching workshops on the core data skills required to conduct research) where academia, industry, and government can share datasets, technology, and curated tools to promote economic and social development. A marketplace like this puts together data producers and data consumers to support the implementation of cross-cutting solutions based on an open innovation approach.
- **Area of convergence:** interoperability, Secure Data Exchange
- **Role of DLT:** One of the main objectives of the SMARDY project is data security and data protection in the online environment. Smardy integrates blockchain technology to meet this objective. The exposure of data to customers for use in various research must guarantee its authenticity in a secure, decentralized and uneditable environment. These features are the characteristics with which blockchain technology has entered the technology market. For the exchanging actions, the guarantee of data exposure security is achieved by Ethereum, one of the most popular and secure blockchain environments.

SMARDY

# Thank you for listening

Any questions?

You can find us at @AIOTI_EU or email sg@aioti.eu

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