Research Documentation Report

Introduction

This document serves to complement the "State-of-the-Art Analysis of Blockchain Standards for Circular Supply Chains" report (D1). Its purpose is to provide a structured compilation of the research documentation underpinning the analysis presented in D1. This includes a categorized list of pertinent standards and frameworks, databases of relevant EU-funded projects focusing on blockchain applications in the agricultural and healthcare sectors (linking them explicitly to relevant standards where applicable), and a bibliography of the sources consulted during the research phase of D1.

The information is organized to provide a clear overview of the landscape of EU blockchain innovation in the target circular sectors and the evolving standardization efforts relevant to blockchain and circular supply chains. Where applicable, cross-references ([D1 Ref: X]) are provided to link standards and sources back to their corresponding entry number in the reference list of the State-of-the-Art Analysis report, facilitating easy navigation between the two reports. This compilation aims to be a valuable resource for BlockStand stakeholders seeking detailed information on specific projects, standards, or sources relevant to the program's objectives.

Table of Content

Section 1: Relevant Standards & Frameworks

1.1 Introduction

Standardization is crucial for enabling interoperability, security, trust, and regulatory compliance in blockchain and DLT applications, particularly within complex and regulated domains like circular supply chains in agriculture and healthcare. This section provides a structured overview of key standards, specifications, and frameworks identified as relevant during the research for Deliverable 1 (D1). These are categorized by the issuing body or type, including international standards organizations (ISO, IEEE, ASTM, W3C, GS1, UNECE), regional bodies (CEN-CENELEC), national specifications (DIN), and significant enabling frameworks (e.g., European Blockchain Services Infrastructure [EBSI], Next Generation Internet [NGI]).

The research underpinning D1 was based on extensive desk research, including the analysis of project documentation (e.g., CORDIS, EIC, NGI), publications from major standardization bodies, and a broad review of academic literature and industry reports. While direct engagement with stakeholders through interviews or workshops was not part of the methodology for D1, the selection of projects and standards reflects the key actors and priorities shaping the European blockchain ecosystem in the context of circular supply chains. To build upon these findings and move from mapping the current landscape to enabling practical progress, a targeted stakeholder engagement strategy has been also developed in part of this report to structure the subsequent phase for translating the insights of D1 into actionable recommendations and fostering effective adoption of blockchain standards in support of circular economy objectives.

1.2 International Standards

1.2.1 ISO (International Organization for Standardization)

- **ISO/TC 307 (Blockchain and DLT):** The primary committee developing foundational blockchain standards. [D1 Ref: 49]
    - **ISO 22739:2020**: Vocabulary. [D1 Ref: 39]
    - **ISO 23257:2022**: Reference Architecture. [D1 Ref: 41]
    - **ISO/TR 3242:2022**: Use Cases.
    - **ISO/TR 6277:2024**: Data Flow Models. [D1 Ref: 44]
    - Other relevant work areas: Security, Privacy, Identity, Governance, Smart Contracts, Interoperability.
- **ISO/TC 323 (Circular Economy):** Develops standards defining circular economy concepts and practices.
    - **ISO 59004:2024**: Vocabulary, Principles, Implementation Guidance. [D1 Ref: 61]
    - **ISO 59010:2024**: Guidance on Business Model & Value Network Transition. [D1 Ref: 61]
    - **ISO 59020:2024**: Measuring and Assessing Circularity Performance. [D1 Ref: 46, 61]

    - **ISO/AWI 59040**: Product Circularity Data Sheet (PCDS). [D1 Ref: 29]

- **ISO/TR 16340:2023:** Application of blockchain-based traceability platform for cold chain food (principles adaptable).
- **ISO/IEC TR 30176:2021:** Internet of Things (IoT) — Integration of IoT and DLT/blockchain: Use cases.
- **ISO/IEC 20889:** Privacy enhancing data de-identification techniques.
- **ISO 50001:** Energy management systems.
- **ISO/IEC 15408 (Common Criteria):** Evaluation criteria for IT security (referenced by TS 17880).
- **ISO 10377:** Consumer products — Safety related guidelines for suppliers *(Referenced in PCDS context)*.
- **ISO 14067:** Greenhouse gases — Carbon footprint of products *(Referenced in Lifecycle Accountability context)*.
- **ISO/TC 207:** Environmental management *(Relevant to sustainability)*.
- **ISO/TC 331:** Biodiversity *(Relevant to sustainability)*.
- **ISO 13485:** Medical devices — Quality management systems *(Referenced by MDOT)*.
- **ISO 27001:** Information security management *(Referenced by PANACEA)*.

1.2.2 IEEE (Institute of Electrical and Electronics Engineers)

- **IEEE 2418.7-2021:** Standard for the Use of Blockchain in Supply Chain Finance. [D1 Ref: 1]
- **IEEE P2418.1:** Standard for the Framework of Blockchain Use in Internet of Things (IoT). [D1 Ref: 76]
- **IEEE 1149.1:** Standard Test Access Port and Boundary-Scan Architecture (JTAG) *(Referenced by TS 17880)*.

1.2.3 ASTM International

- **ASTM D8558-2024:** Standard Guide for Verification of a Certificate of Authentication Used to Track Products through Their Supply Chain by Utilizing Blockchain Technology. [D1 Ref: 53]
- **ASTM E3225-20:** Standard Practice for Verification of Material Origin and Chain of Custody Claims in Metal Additive Manufacturing *(Referenced in PCDS context)*.

1.2.4 W3C (World Wide Web Consortium)

- Decentralized Identifiers (DIDs) v1.0.
- Verifiable Credentials (VCs) Data Model v1.1.
- *(These are crucial for SSI solutions frequently mentioned in NGI projects and BlockStand recommendations)*.

1.2.5 GS1

- Global Traceability Standard (GTS).
- Electronic Product Code Information Services (EPCIS). [D1 Ref: 45]
- GS1 Digital Link.
- *(GS1 identifiers (GTIN, etc.) are foundational for linking physical items to blockchain records)*.

1.2.6 UNECE (United Nations Economic Commission for Europe)

- Traceability standards for sustainable garments and footwear. [D1 Ref: 85]
- Framework for Blockchain in Trade Facilitation.

1.2.7 ITU-T (International Telecommunication Union - Telecom Standardization Sector)

- Focus Group on Application of DLT (FG DLT) - Produced several relevant technical specifications and reports (referenced in source documents).
    - FG DLT D1.1: DLT terms and definitions. [D1 Ref: 40]
    - FG DLT D2.1: DLT use cases.
    - FG DLT D3.1: DLT reference architecture.
    - FG DLT D3.3: Assessment criteria for DLT platforms.
    - FG DLT D4.1: DLT regulatory framework.

1.3 Regional/National Standards & Specifications

1.3.1 CEN-CENELEC (European Committee for Standardization / European Committee for Electrotechnical Standardization)

- **CEN/CLC/TS 17880:2022:** Protection Profile for Smart Meter - Minimum Security requirements (Crucial for trusted blockchain data input and creation of blockchain trust infrastructure).
- **CLC/EN 45557:2020:** General method for assessing the proportion of recycled material content in energy-related products. [D1 Ref: 47]
- CEN-CENELEC/JTC 19: Blockchain and DLT committee (European counterpart to ISO/TC 307).
    - CEN-CENELEC/JTC 19/WG 2: Focused on Sustainability aspects of DLT.

1.3.2 DIN (German Institute for Standardization)

- **DIN SPEC 32790:2022-11:** Reference architecture for blockchain applications to create transparency in supply chains. [D1 Ref: 42]
- **DIN SPEC 16597:** Terminology for blockchains.

- **DIN SPEC 9012:** Digital Certificate of Conformity (e-CoC) for Aerospace (example of digital certification).

1.3.3 ETSI (European Telecommunications Standards Institute)

- **ETSI ISG PDL (Permissioned Distributed Ledgers):** Focuses on standards for permissioned DLTs relevant for enterprise/government use.
- **CEN/CLC/ETSI TR 50571:** Smart meter Functional reference architecture (Referenced by TS 17880).

1.4 Key Frameworks & Initiatives

These are not formal standards but represent important ecosystems, infrastructures, or policy initiatives influencing blockchain deployment and standardization.

- **EBSI (European Blockchain Services Infrastructure):** EU initiative deploying pan-European public service blockchain infrastructure, focusing on use cases like diplomas, ESSIF (SSI framework), and notarization. BlockStand alignment is key. SSITIZEN project leverages EBSI ID. [D1 Ref: 35]
- **NGI (Next Generation Internet) Initiative:** EU program funding research and innovation for a human-centric internet, including Cascade Funding projects under ONTOCHAIN and TrustChain that heavily explored blockchain, SSI, PETs. [D1 Ref: 36]
- **BlockStand (EU Project GA: 101102757):** Coordination and Support Action focused on monitoring, supporting, and contributing to EU blockchain standardization efforts, linking research, industry, SDOs, and policy. [D1 Ref: 31]
- **eIDAS 2 Regulation (Proposal):** Revised EU regulation establishing framework for European Digital Identity Wallet (EUDIW) and new trust services (electronic attestations of attributes, electronic ledgers), significantly impacting blockchain identity solutions.
- **EU Data Strategy (inc. Data Act, GDPR):** Policy framework influencing data governance, data sharing agreements (smart contracts mentioned in Data Act), and privacy requirements (GDPR) impacting blockchain design. [D1 Ref: 34, 48]
- **EU Green Deal & Circular Economy Action Plan (CEAP):** Policy drivers for sustainability and circularity, promoting applications like DPPs and resource tracking where blockchain is an enabler.
- **Financial Regulations (MiCA, DORA):** Regulations impacting crypto-assets and operational resilience, influencing standards related to tokenization and DLT security in financial contexts.
- **W3C (World Wide Web Consortium):** Develops foundational web standards including DID Core and VC Data Model, widely adopted in blockchain identity projects.
- **GS1:** Global standards organization for identification and data sharing in supply chains, whose standards (GTIN, EPCIS, Digital Link) are complementary to blockchain traceability solutions.
- **AIM (Agricultural Information Model - DEMETER Project):** Attempt to create a standard semantic model for interoperability in smart farming.

- **Catena-X Automotive Network:** Industry initiative creating a data ecosystem for the automotive value chain, potentially using blockchain principles or integration points.

Section 2: EU-Funded Blockchain Projects (Agriculture & Healthcare Focus)

2.1 Introduction

This section provides a repository of European Union-funded projects reviewed during the preparation of Deliverable D1. These projects utilized blockchain/DLT or related concepts within the agricultural sciences (including food systems) and healthcare sectors. The projects were identified through searches of CORDIS, the EIC Accelerator database, and relevant Cascade Funding programs (primarily under the Next Generation Internet - NGI initiative, such as ONTOCHAIN and TrustChain). The lists below categorize projects by sector and primary funding mechanism, offering a snapshot of EU investment priorities and innovation activities in these key areas. **Where applicable, connections to relevant standards (from Section 1) are highlighted.** Further details on the specific technical implementations and objectives can often be found via the provided Grant Agreement (GA) numbers or project acronyms on the respective EU funding portals.

2.2 Agricultural Sciences & Food System Projects

This subsection lists projects focused on applying blockchain/DLT to agriculture, food production, supply chains, sustainability, and related areas.

2.2.1 CORDIS Consortium Projects (RIA/IA)

This group includes larger, multi-partner projects often focused on integrating various technologies, including blockchain, to address complex systemic challenges.

CORDIS Consortium Projects

1. **i4Q (GA: 958205) [P49]** Fact Sheet

This project developed the IoT-based Reliable Industrial Data Services (RIDS) suite for smart manufacturing quality control. It focused on managing large volumes of industrial data, ensuring reliability across sensing, communication, computing, storage, and analysis. The technical architecture utilized Distributed Ledger Technology, demonstrated with Hyperledger Orion Server, to guarantee data accuracy, traceability, and time-stamped integrity, supporting zero-defect manufacturing through simulation and optimization tools.

Standards Relevance: Aligns with concepts in **ISO 23257** (Reference Architecture) for modular systems and **ISO/TR 6277** (Data Flow Models) for DLT-external system interaction (IoT). Implicitly addresses data integrity needs relevant to **ISO 59020** (Circularity Measurement) if applied to resource/waste tracking.

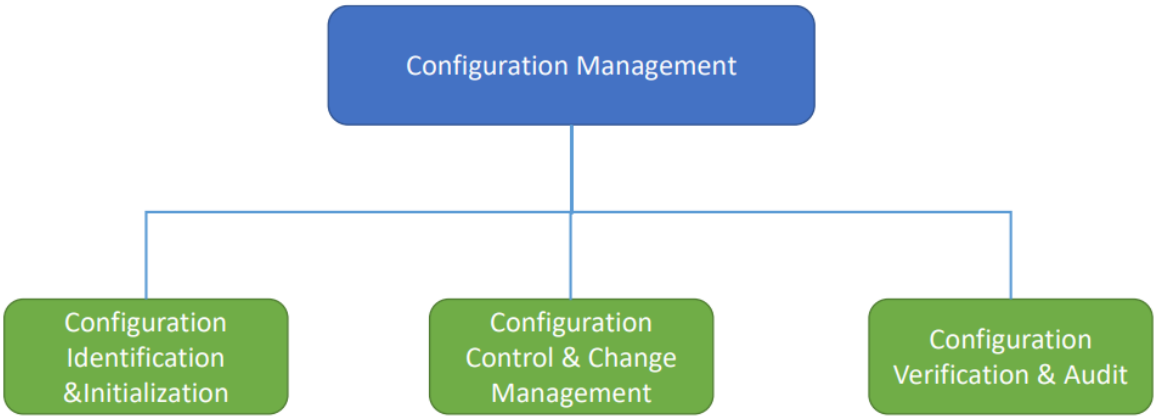


Figure 1. Three main elements of configuration management in the i4Q^{BC} Solution

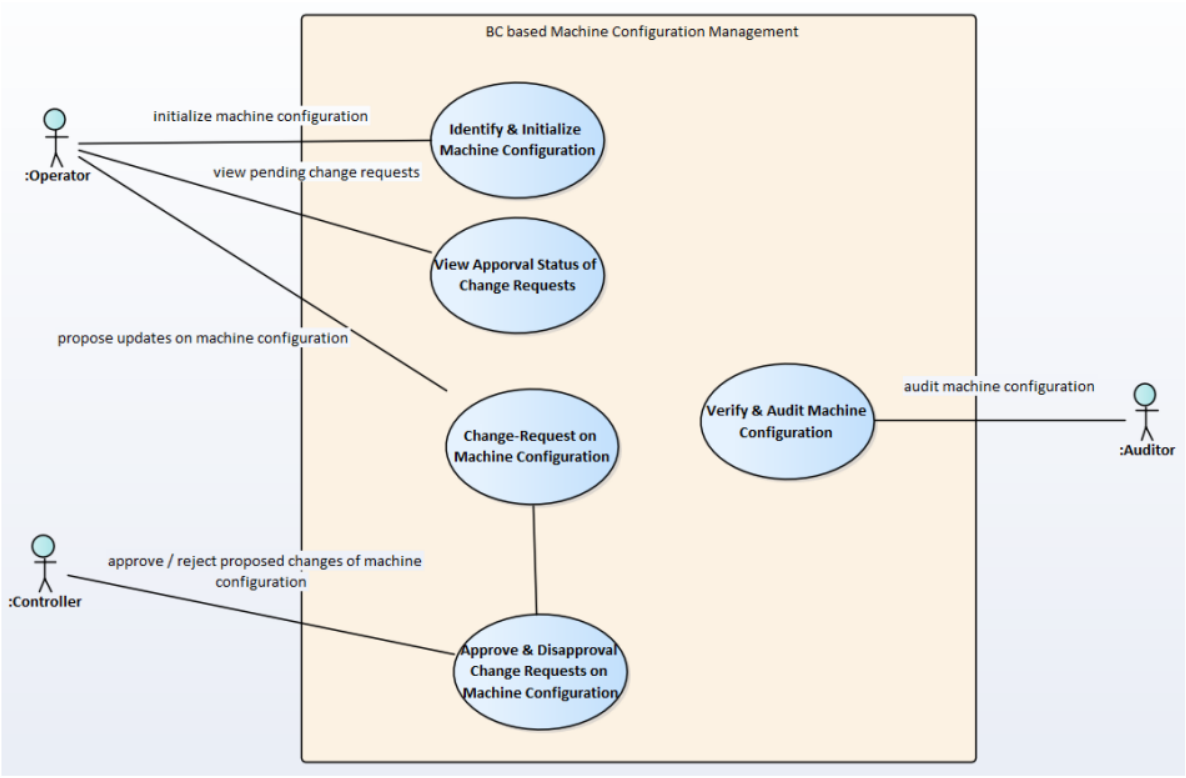


Figure 3. Use Case Diagram - i4Q^{BC} Machine Configuration Management

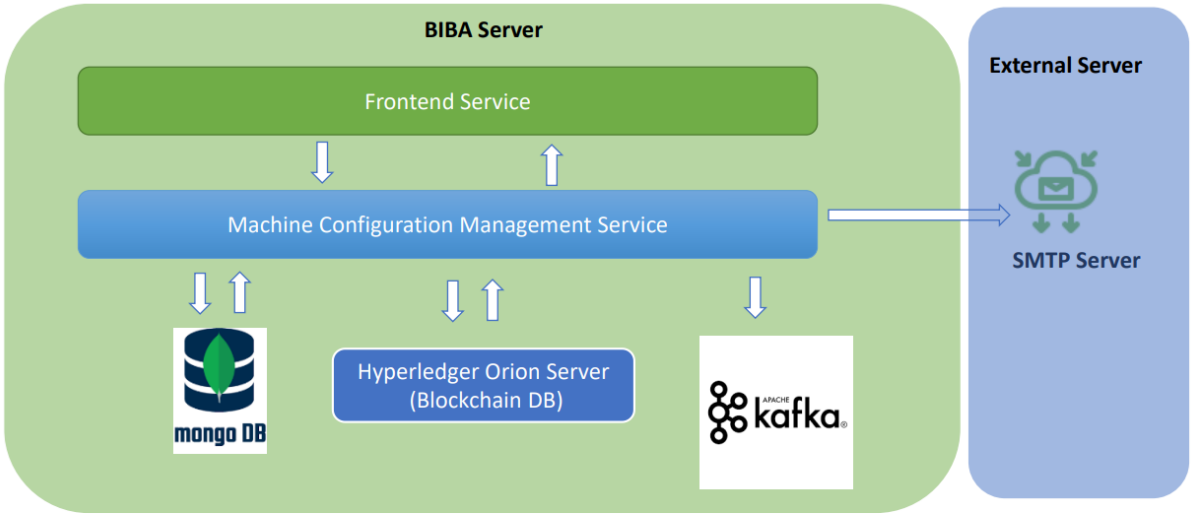


Figure 8. Sample deployment - i4Q[BC] Machine Configuration Management

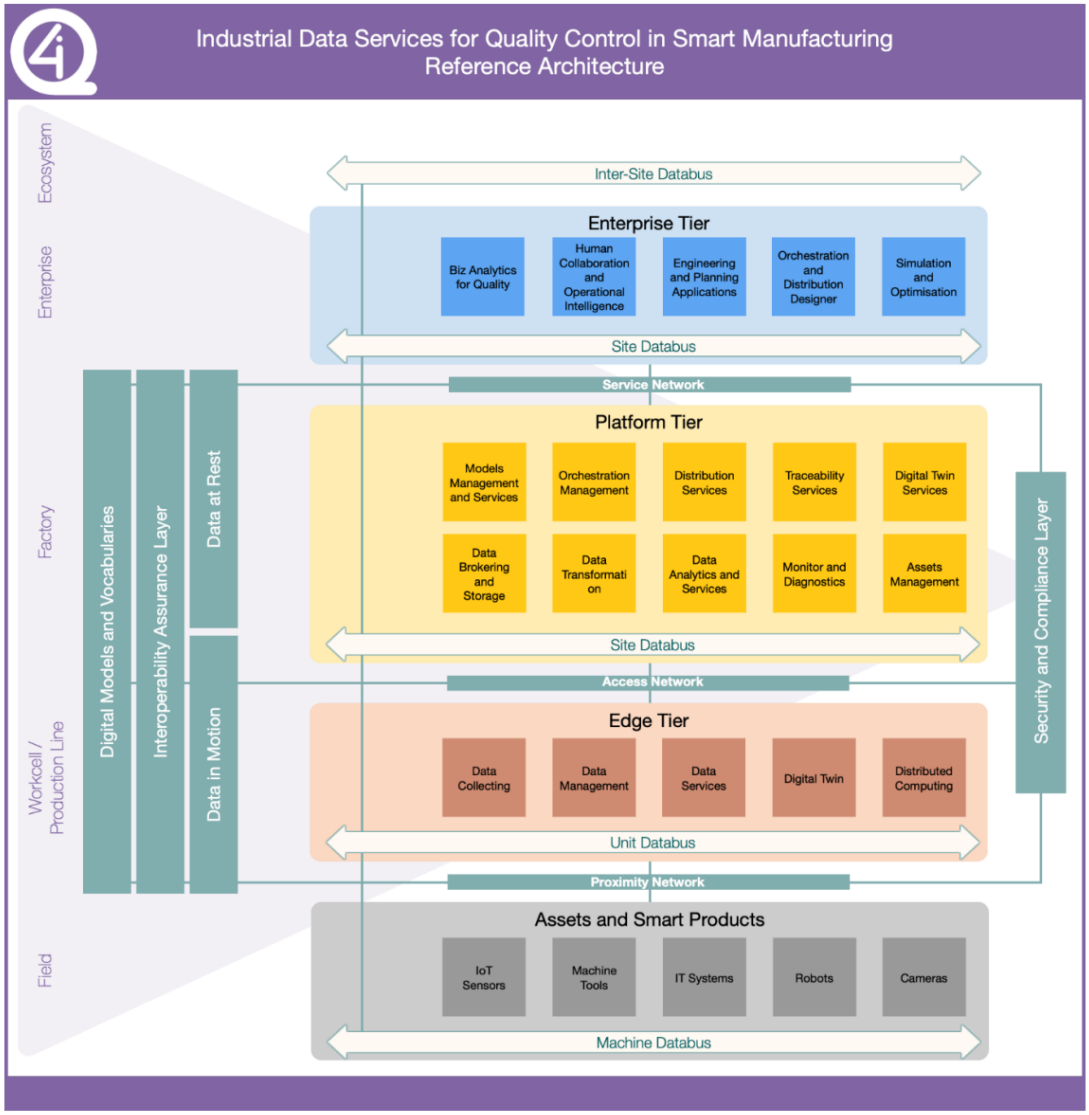


Figure 9. i4Q[RA] mapping with i4Q[BC]

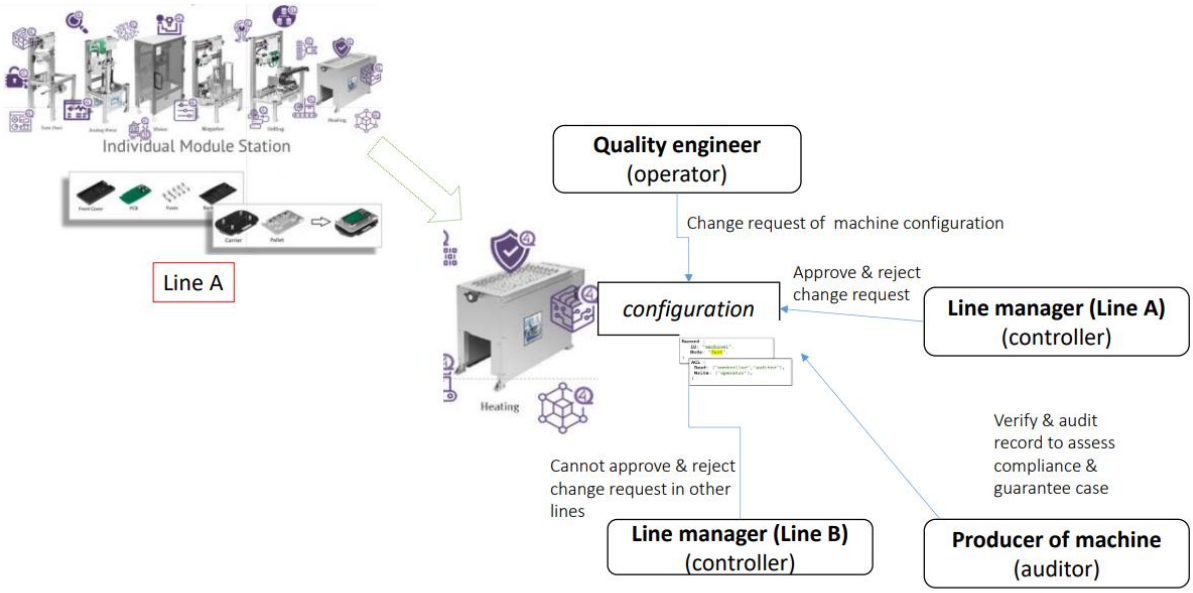


Figure 19. Sample Scenario for managing machine configurations

2. **CATTLECHAIN 4.0 (GA: 853864) [P21]** Fact Sheet

Aiming to improve efficiency and transparency in the EU livestock sector, this project integrated IoT wearables, AI algorithms, FIWARE, satellite imagery, and blockchain technologies. Its technical solution involved a blockchain-based cloud platform connected to the Alastria network. This provided farmers with AI-driven decision support based on sensor data and offered consumers/authorities immutable traceability and verification of animal welfare standards.

Standards Relevance: Leverages IoT integration (**IEEE P2418.1**, **ISO/IEC TR 30176**) and potentially **GS1** identifiers for animal tracking. Aims to provide verifiable claims relevant to **ISO 59004** principles (transparency) and potentially **ISO 59020** (if welfare metrics are tracked).

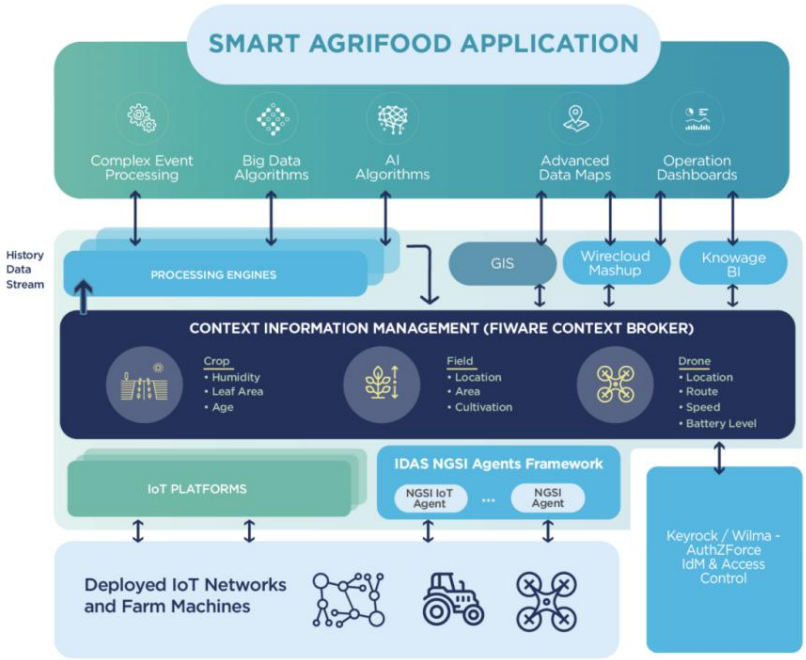
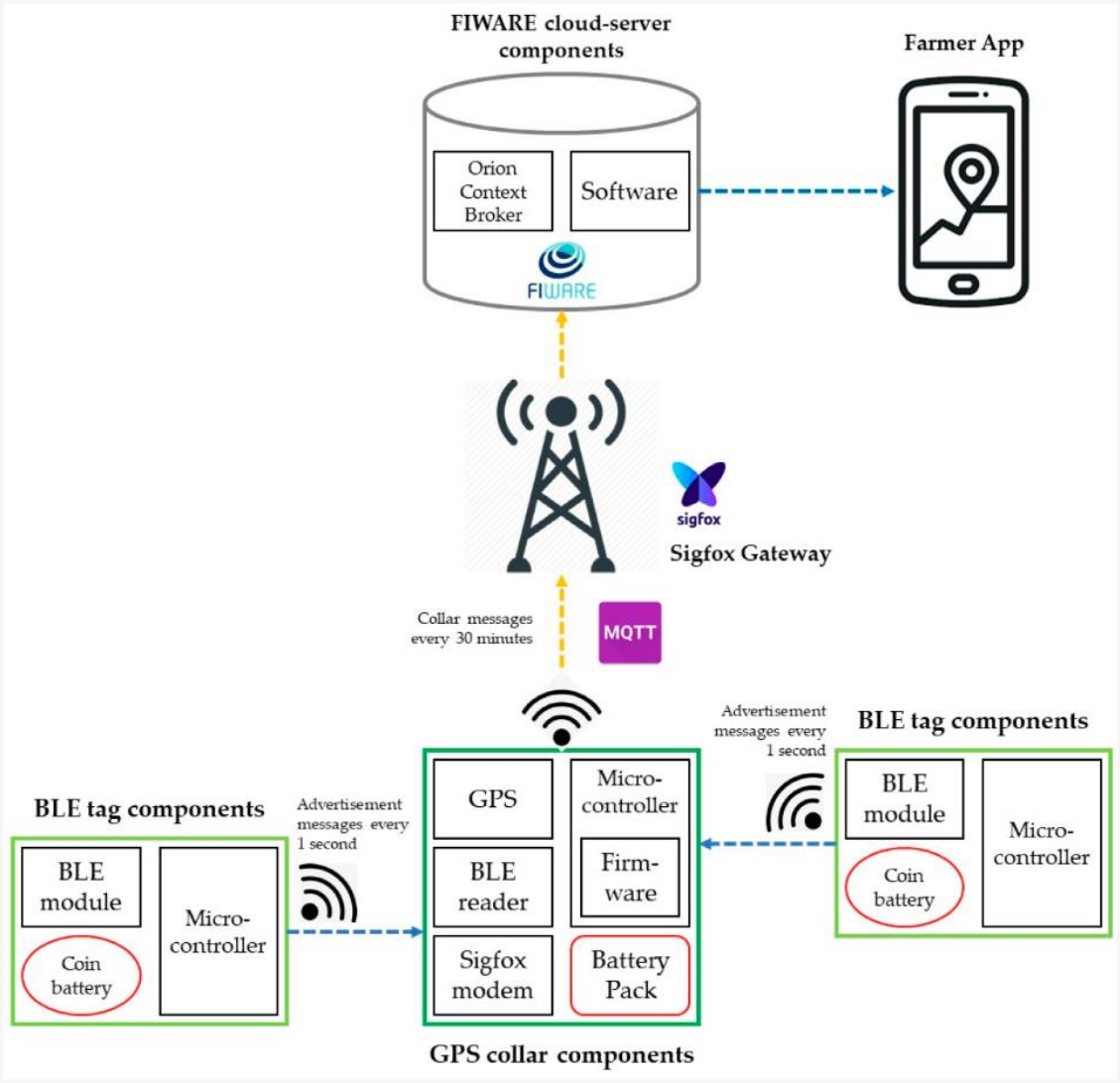


Figure 1. General diagram of the Livestock platform developed

Figure 1. Architecture diagram of the proposed solution.



3. **TRACEWINDU (GA: 101007979) [P14]** Fact Sheet

This project targets wine traceability and authentication by integrating isotopic fingerprinting and sensory analysis with smart tags and blockchain technology. It implements a decentralized blockchain-based traceability system utilizing cryptographic schemes. Unique identifiers (QR codes) on bottles link to blockchain records containing provenance and quality data, updated immutably throughout the supply chain to combat fraud and ensure authenticity.

Standards Relevance: Implements traceability concepts aligned with **GS1 Digital Link** (QR codes) and **GS1 EPCIS** (event tracking). Creates verifiable certificates of authenticity relevant to **ASTM D8558**.

4. **SPACE4GREEN (GA: 101082630) [P15]** Fact Sheet

This project developed a trusted platform for automated certification of location and time without human intermediaries, validated in agri-food and fishing. The technical core integrates secure Galileo OS-NMA signals with Blockchain via smart devices. The blockchain acts as the immutable distributed ledger, storing cryptographically verified spatio-temporal proofs derived from authenticated GNSS data, ensuring trustworthy traceability records.

Standards Relevance: Focuses on trusted data input, conceptually similar to the goals of **CEN/CLC/TS 17880** but for location/time. Provides verifiable provenance data.

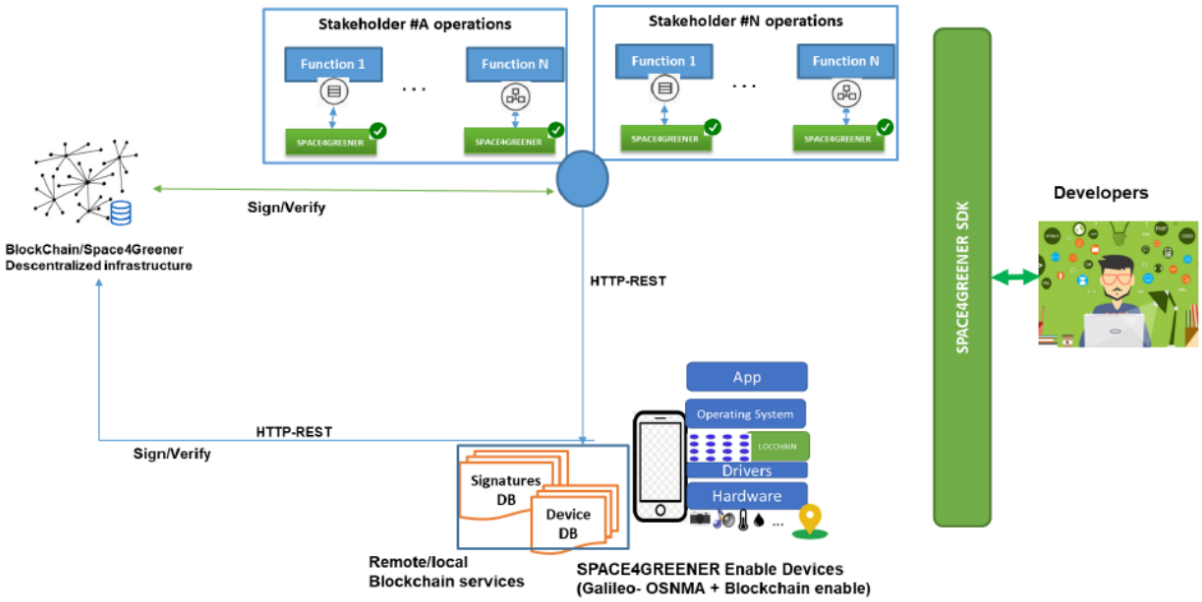


Figure 1. High level architecture as shown in the project proposal

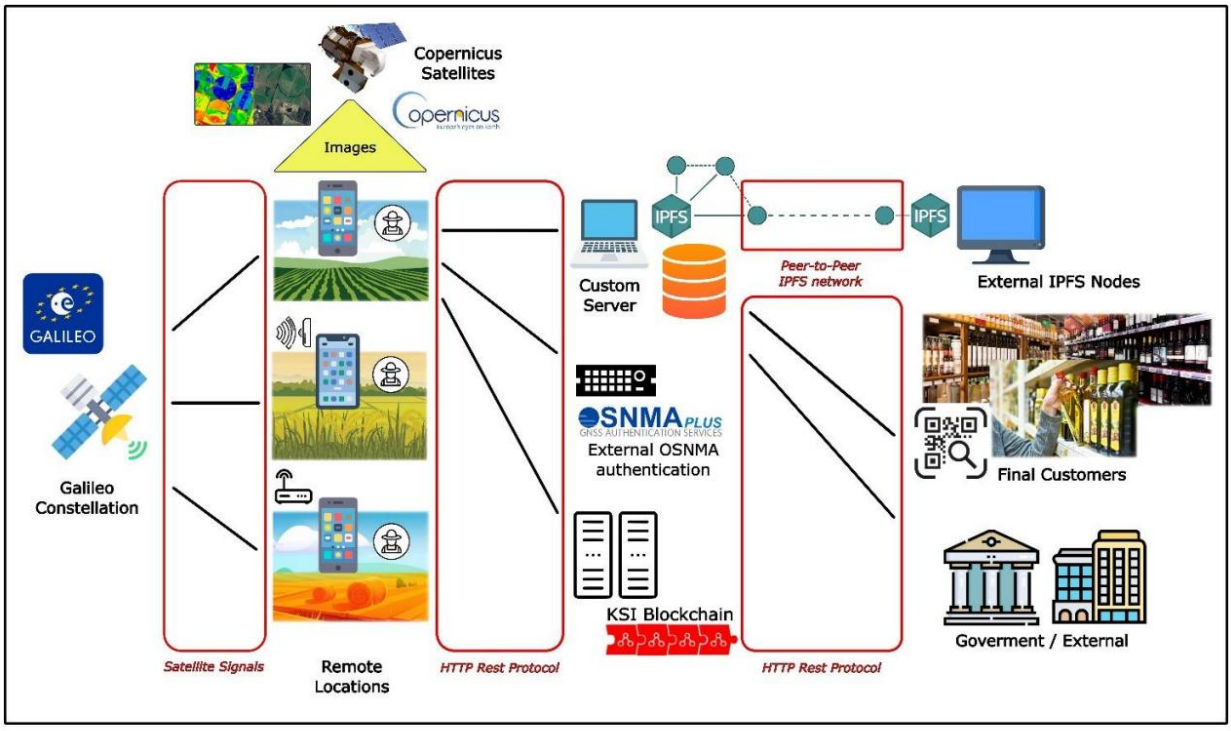


Figure 2 Elements involved in Space4Green architecture

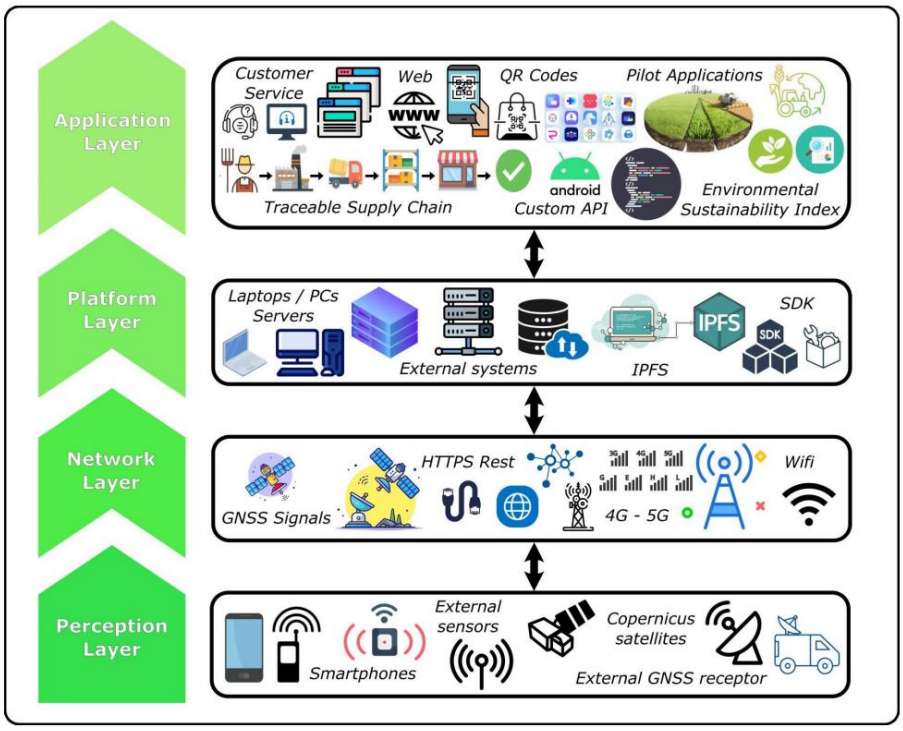


Figure 6. Layered overview of Space4Green architecture

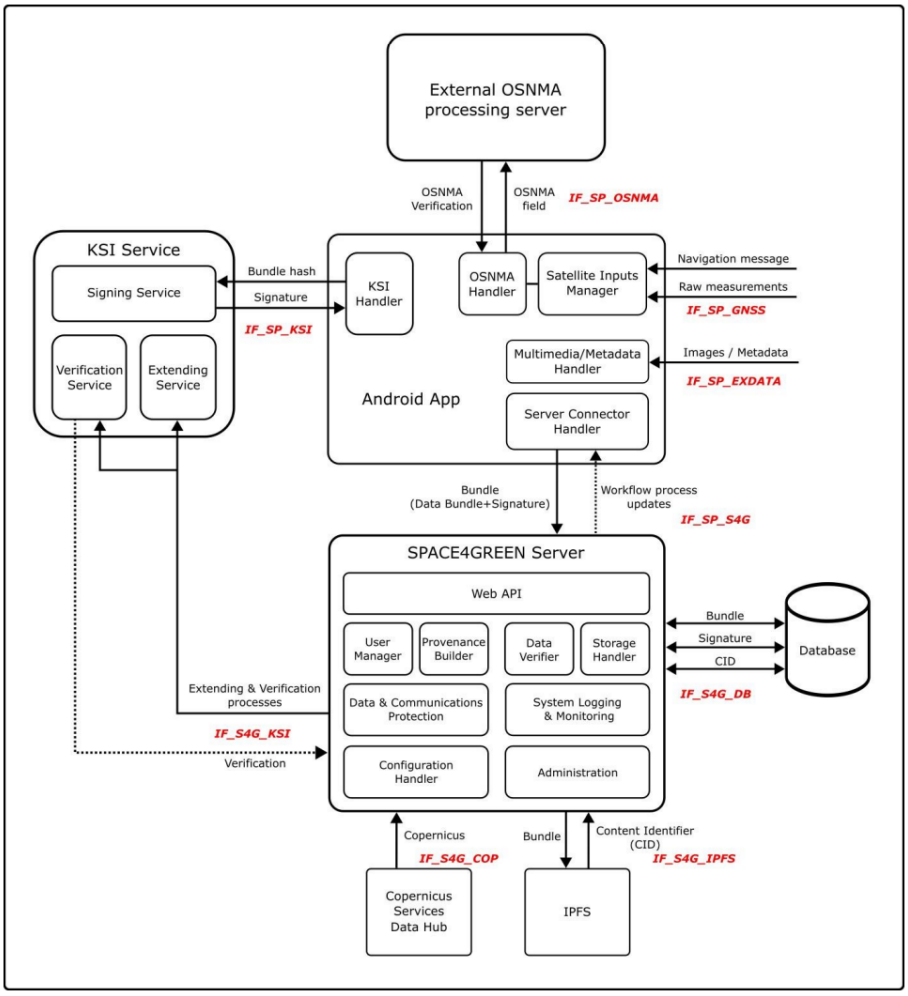


Figure 7. High-level overview of components and interfaces of Space4Green's architecture

5. **BEACON (GA: 821964) [P32]** Fact Sheet

Developed a commercial service toolbox for the Agricultural Insurance (AgI) sector, combining Earth Observation data and weather intelligence with ICT, including blockchain technology. Its technical blockchain application was a smart contract service designed to automate insurance payouts securely and transparently, based on trigger conditions verified by objective EO and weather data.

Standards Relevance: Demonstrates smart contract use cases (**ISO/TC 307** work area) relying on trusted external data (oracles), relevant to **ISO/TR 3242** (Use Cases).

6. **ReSeed (GA: 101118063) [P50]** Fact Sheet

This ERC project utilizes blockchain technology to create a digital farmers' market focused on indigenous seeds and associated know-how (ISK). The blockchain serves as a decentralized, transparent, and immutable system to track the flow of ISK, facilitate equitable transfers, incentivize honest reporting of downstream use, and integrate with regulatory frameworks for *in situ* conservation.

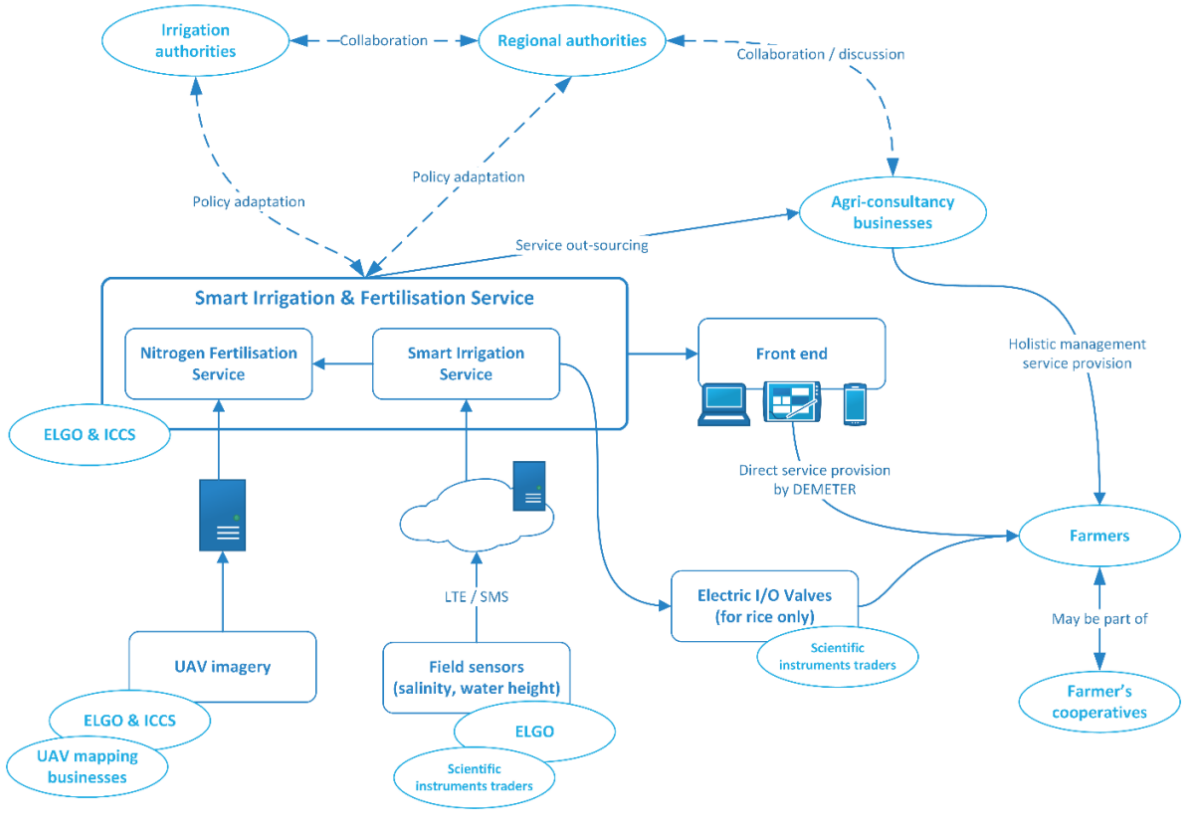
Standards Relevance: Explores tokenization (**IEEE 2418.7**) for incentivization and potentially **GS1** standards for seed identification/tracking. Addresses **ISO 59004** principles (value sharing, resource management).

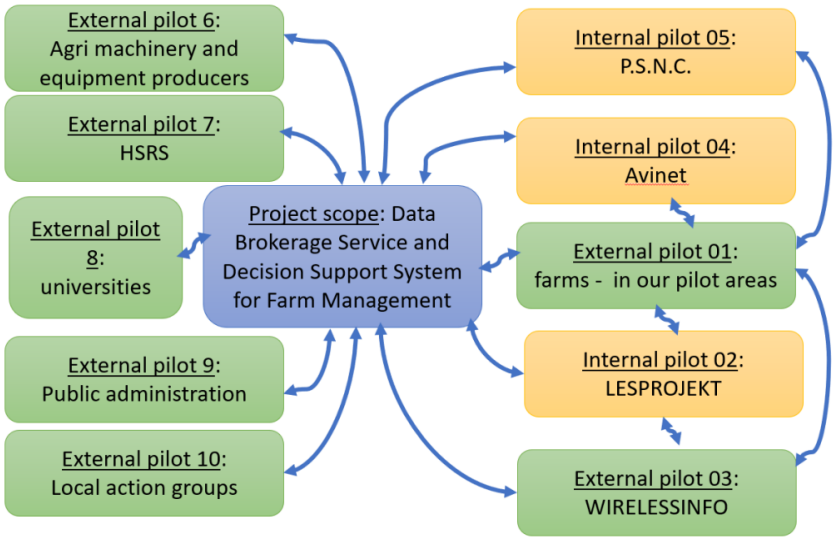
7. **DEMETER (GA: 857202) [P35]** Fact Sheet

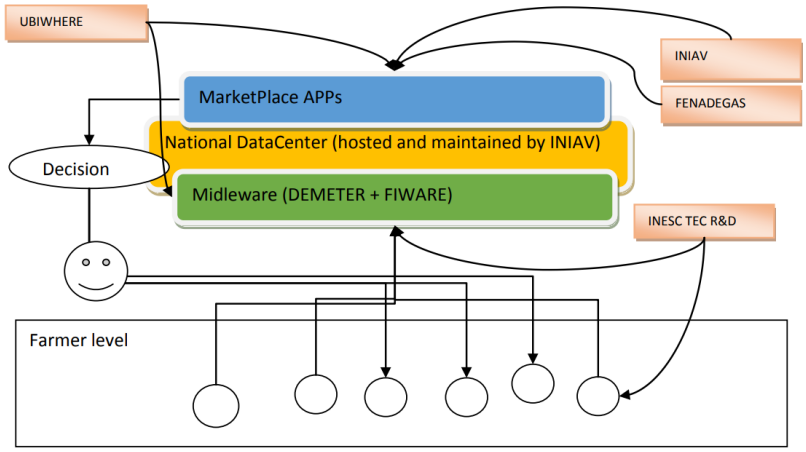
Deployed large-scale, interoperable smart farming IoT platforms across 20 pilots in 18 countries. The core technical innovation was the development and promotion of a common Agricultural Information Model (AIM) based on extending existing standards for semantic interoperability across systems and data sources (IoT, legacy, satellite). It aimed for secure, private data handling but emphasized AIM over a specific blockchain framework.

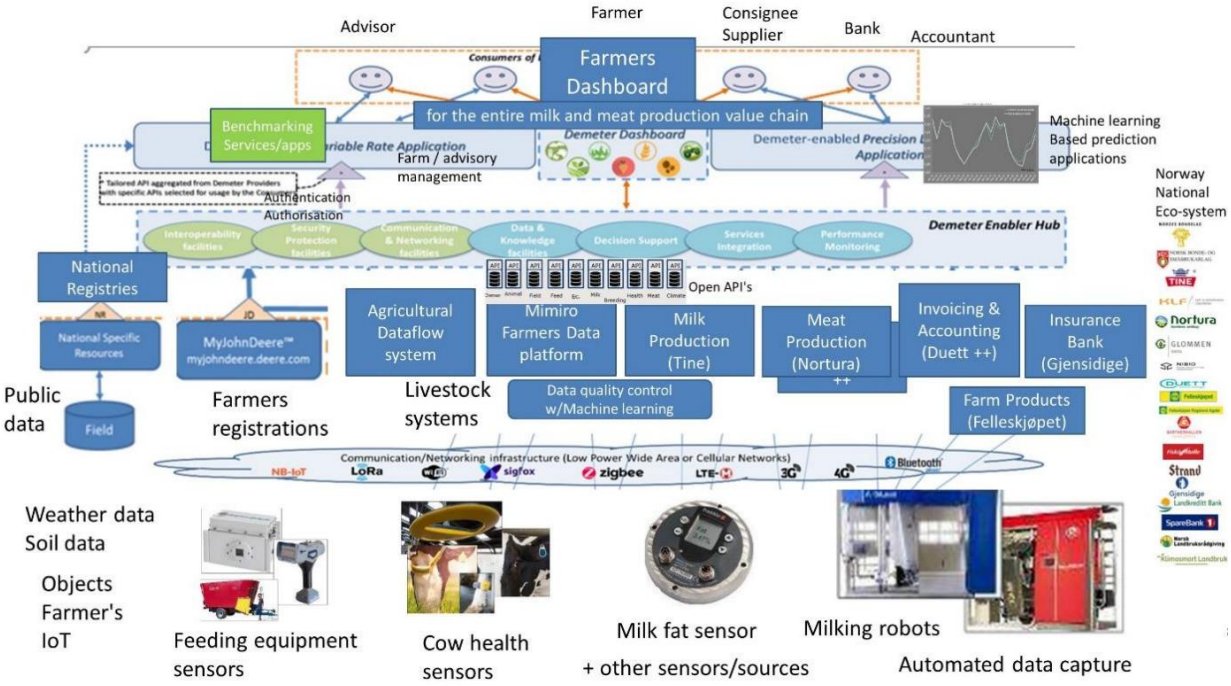
Standards Relevance: Primarily focused on semantic interoperability (data models) rather than blockchain itself, but highlights the need for standardized data formats (**GS1**, potentially **ISO 59040** structure) for any DLT integration in agriculture.

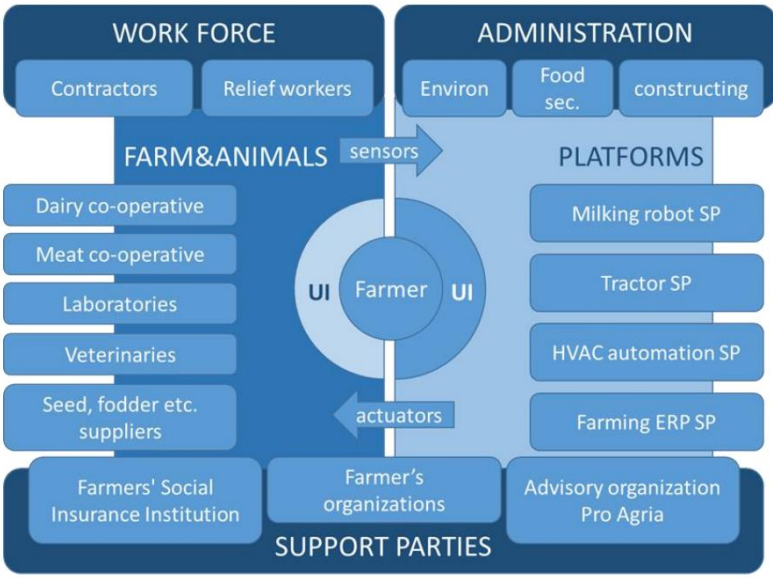
The relationships between the stakeholders are shown in the following diagram:






UBIWHERE
INIAV
FENADEGAS
MarketPlace APPs
National DataCenter (hosted and maintained by INIAV)
Decision
Midleware (DEMETER + FIWARE)
INESC TEC R&D
Farmer level


Advisor
Farmer
Consignee
Supplier
Bank
Accountant
Farmers Dashboard
for the entire milk and meat production value chain
Benchmarking Services/apps
Demeter Dashboard
Machine learning Based prediction applications
Farm / advisory management
Authentication
Authorisation
Demeter Enabler Hub
Norway National Eco-system
National Registries
Open API's
Agricultural Dataflow system
Mimiro Farmers Data platform
Milk Production (Tine)
Meat Production (Nortura)
Invoicing & Accounting (Duett ++)
Insurance Bank (Gjensidige)
Public data
Field
Farmers registrations
Livestock systems
Data quality control w/Machine learning
Farm Products (Felleskjøpet)
Communication/Networking infrastructure (Low Power Wide Area or Cellular Networks)
Weather data
Soil data
Objects
Farmer's
IoT
Feeding equipment sensors
Cow health sensors
Milk fat sensor
+ other sensors/sources
Milking robots
Automated data capture


WORK FORCE
ADMINISTRATION
Contractors
Relief workers
Environ
Food sec.
constructing
FARM&ANIMALS
sensors
PLATFORMS
Dairy co-operative
Meat co-operative
Laboratories
Veterinaries
Seed, fodder etc. suppliers
UI
Farmer
UI
actuators
Milking robot SP
Tractor SP
HVAC automation SP
Farming ERP SP
Farmers' Social Insurance Institution
Farmer's organizations
Advisory organization Pro Agria
SUPPORT PARTIES

8. **DiTECT (GA: 861915) [P10]** Fact Sheet

Developed an EU-China integrated framework for real-time food safety monitoring, incorporating blockchain processes. The project built a standards-based, modular, Big Data-enabled platform using microbial/spectroscopic fingerprinting and sensor data. Blockchain technology was integrated to ensure the traceability, transparency, and integrity of food safety data collected throughout the supply chain (crop, storage, livestock, food supply).

Standards Relevance: Implements traceability (**GS1 EPCIS**) and requires secure IoT integration (**IEEE P2418.1**). Addresses **ISO 59004** (transparency).

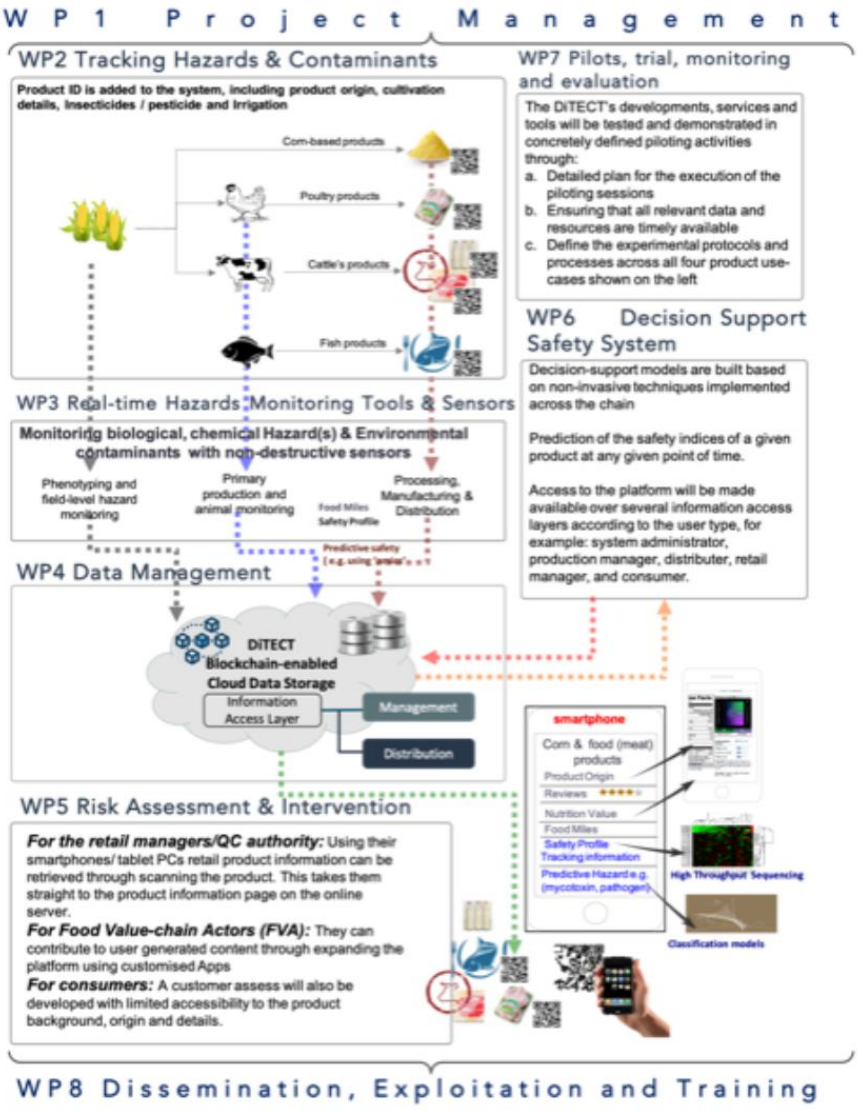


Fig.1 DiTECT conceptual and Work Packages Overview

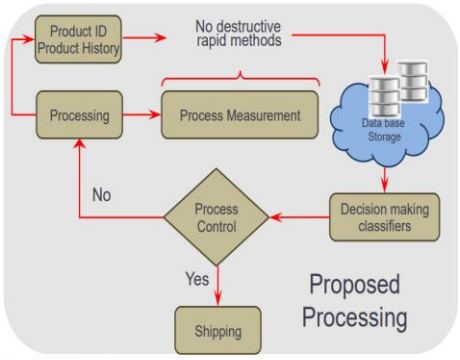


Figure 2 DiTECT Approach

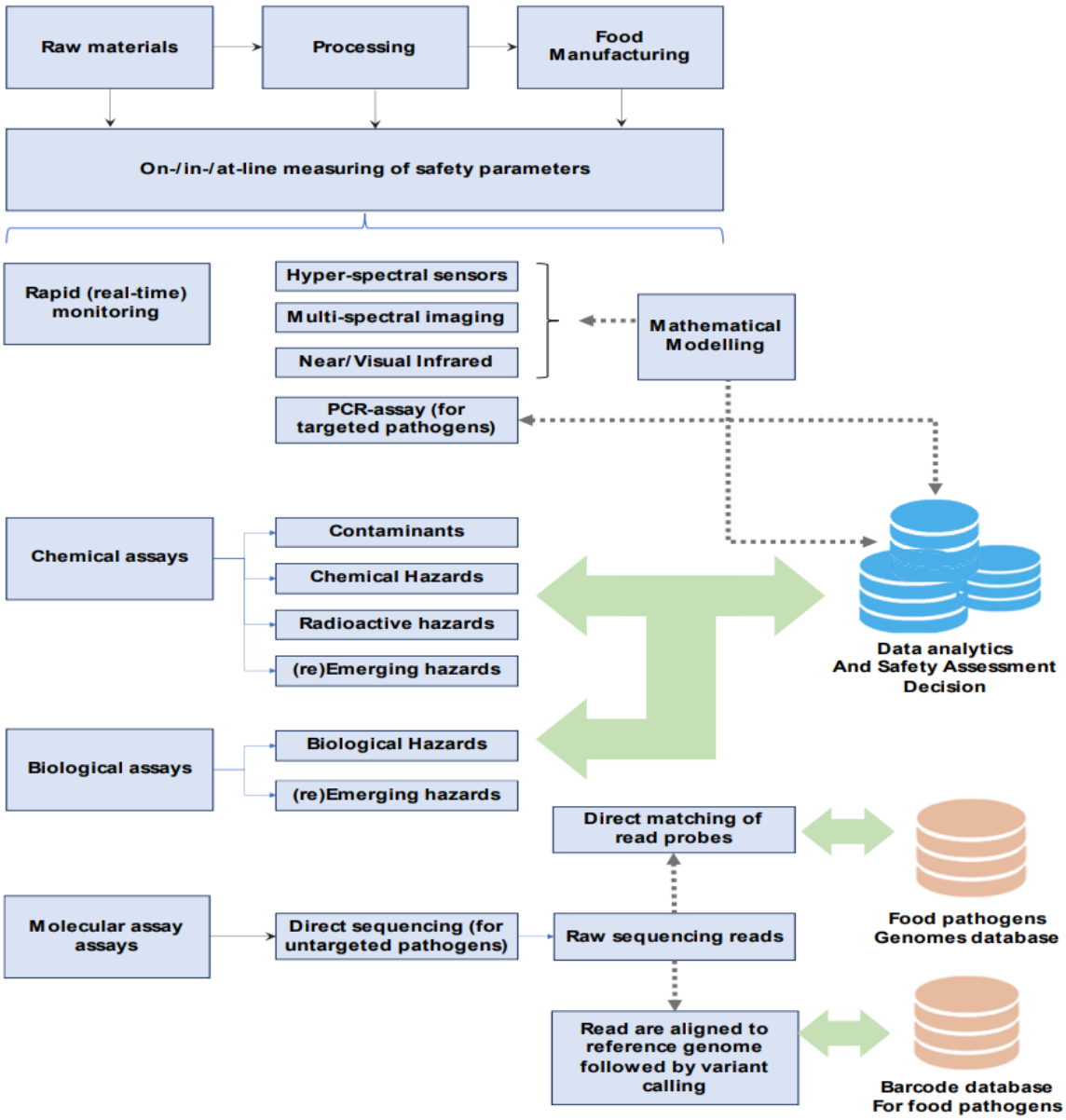


Figure 4 Collection data from farm to fork - DiTECT's greatest plan to secure food quality and safety.

9. **PestNu (GA: 101037128) [P19]** Fact Sheet

Focused on reducing pesticide/nutrient use through digital technologies (AI robotic traps, robots, EO data via Copernicus, nutrient analysers) and agro-ecological practices. Its technical architecture interconnected these tools with a cloud Farm Management System featuring a Decision Support System integrated with a blockchain-based system using the IOTA DLT framework, smart contracts, and APIs for data evidence, integrity, and AI model verification.

Standards Relevance: Leverages IoT (**IEEE P2418.1**, **ISO/IEC TR 30176**) and aims to provide verifiable sustainability claims relevant to **ISO 59020**. Uses a DAG-based DLT (IOTA).

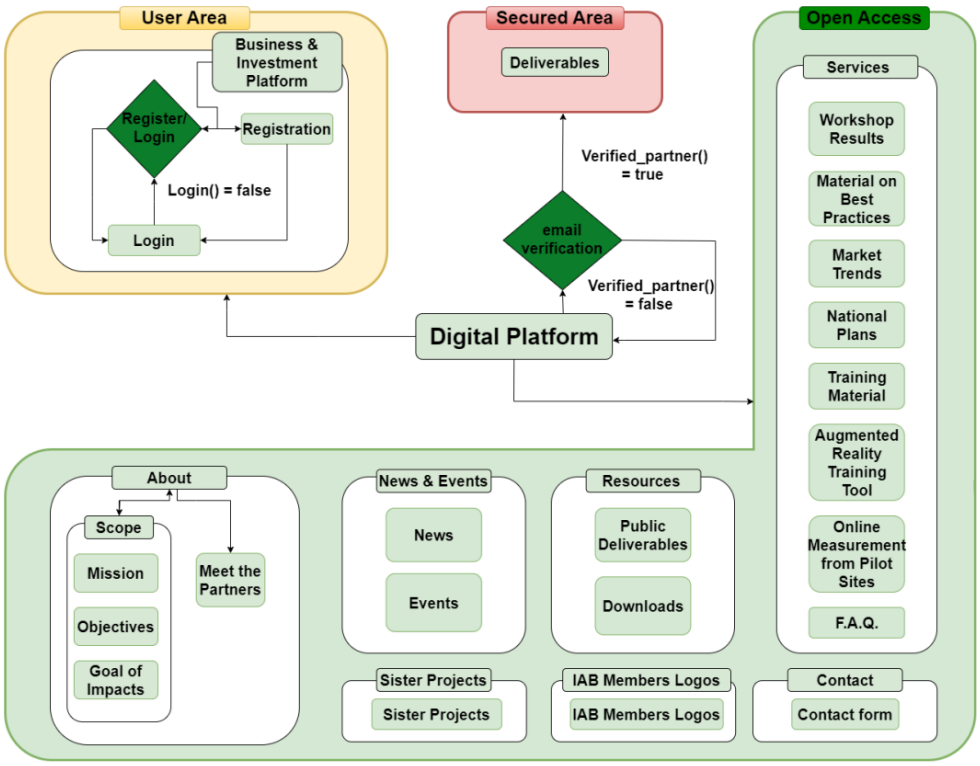


Figure 1: Digital Platform's Architecture View

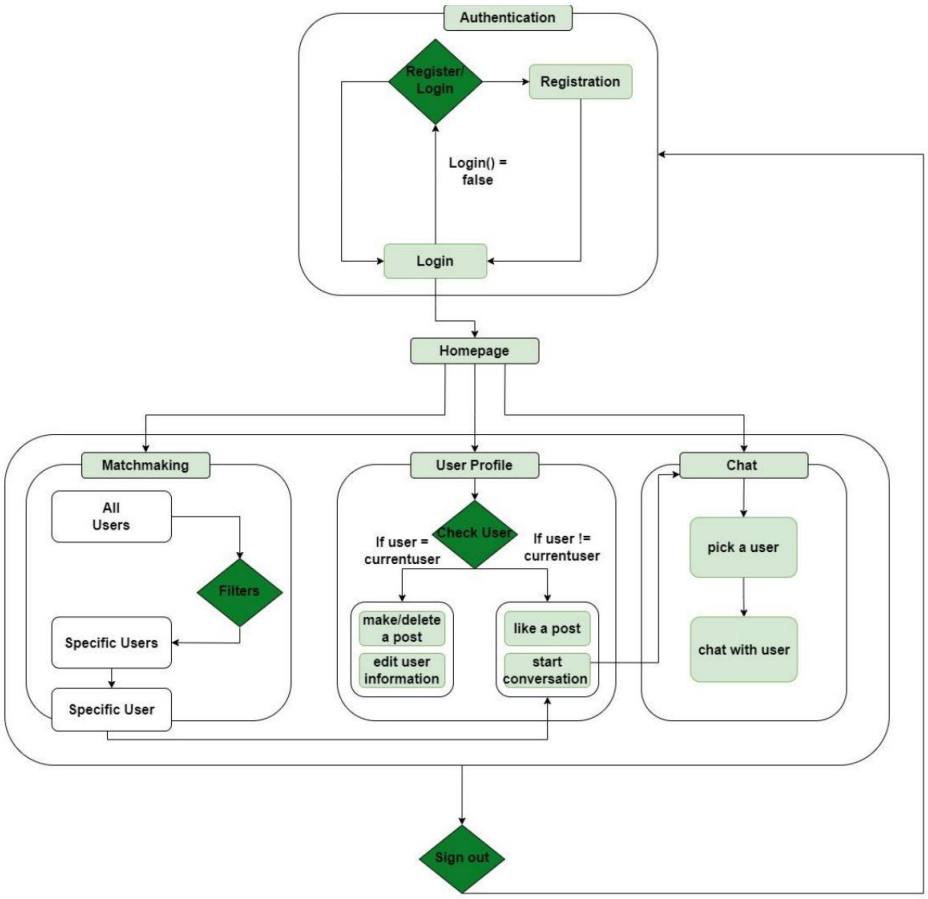


Figure 13: Business and Investment Opportunities Tool Architecture View

10. **BBTWINS (GA: 101023334) [P6]** Fact Sheet

Develops innovative digital twins for optimizing agri-food value chains (meat, fruit) and biomass valorisation. The platform integrates AI, IoT, software analytics, logistics solutions, and blockchain. The blockchain component provides verifiable traceability of products and derived bio-streams (from waste valorisation) throughout the processing chain, ensuring data integrity and transparency within the digital twin.

Standards Relevance: Combines digital twins (relevant to ISO 23247 series) with blockchain traceability (**GS1**, **ISO 23257**). Addresses tracking for circularity (bio-streams).

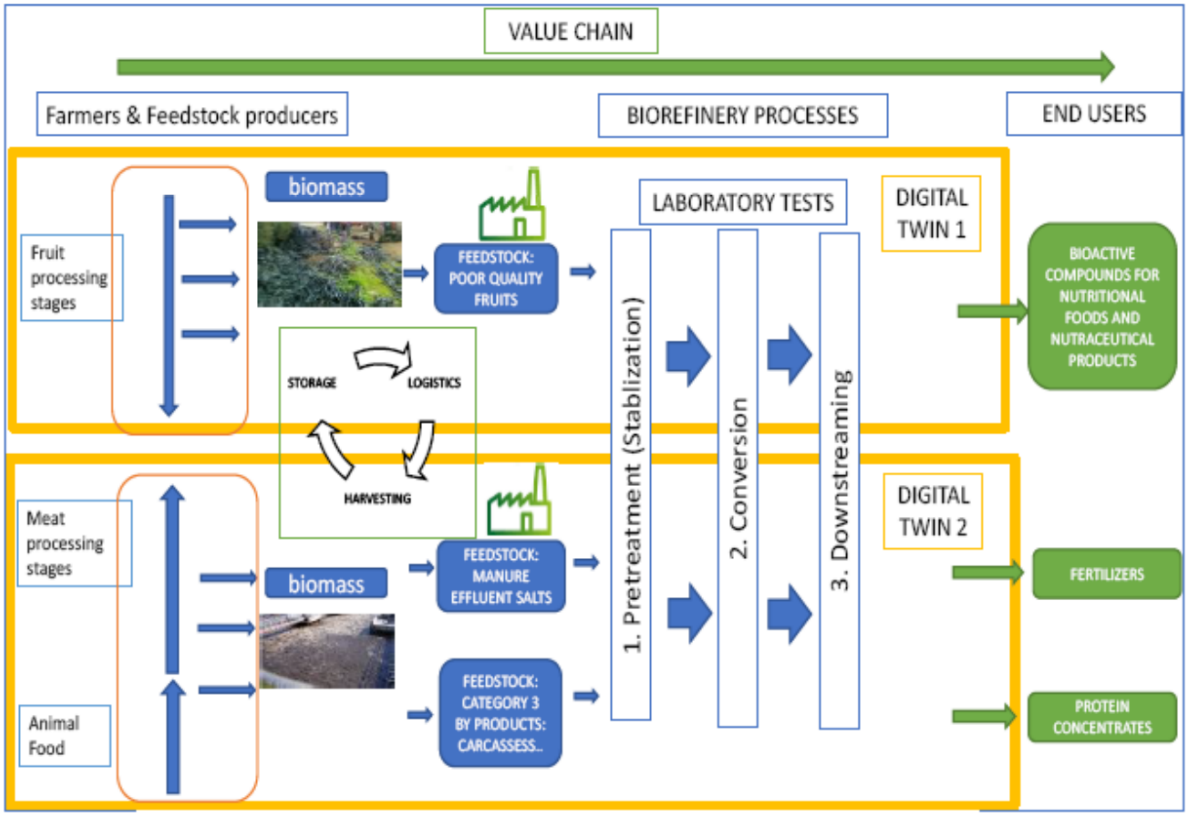


Figure 5.3.1: BBTWINS' Value Chain Coverage.

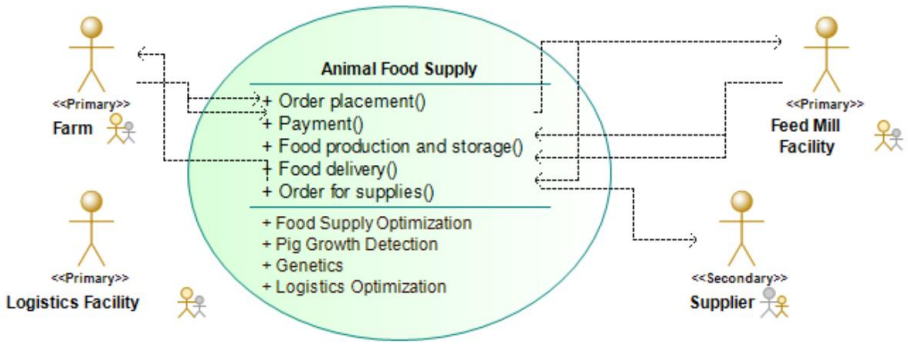


Figure 6.1.1: Animal food production optimization.

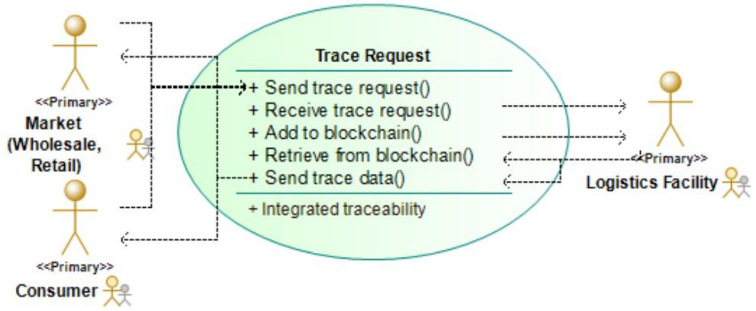


Figure 6.1.3: Product traceability – meat sector.

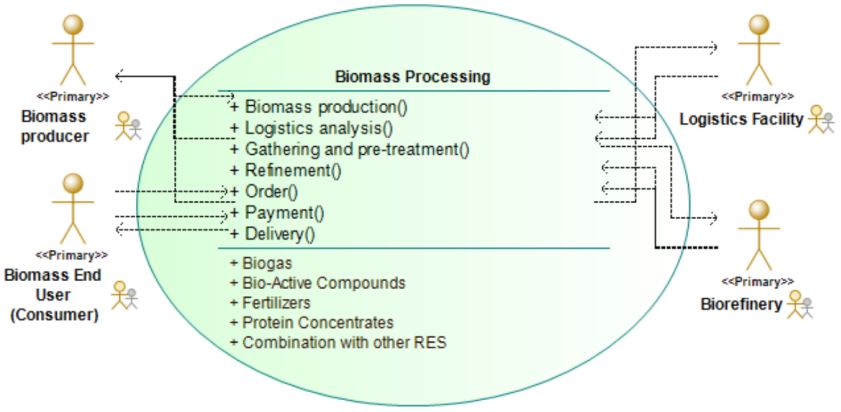


Figure 6.1.4: Waste management for biomass valorization – meat sector.

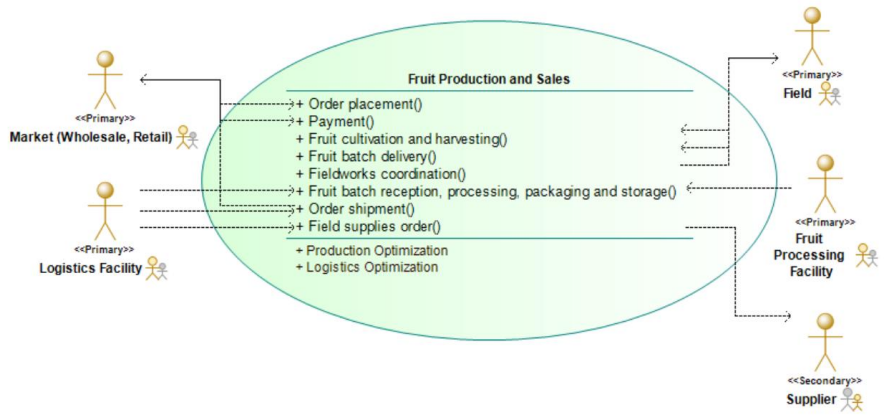
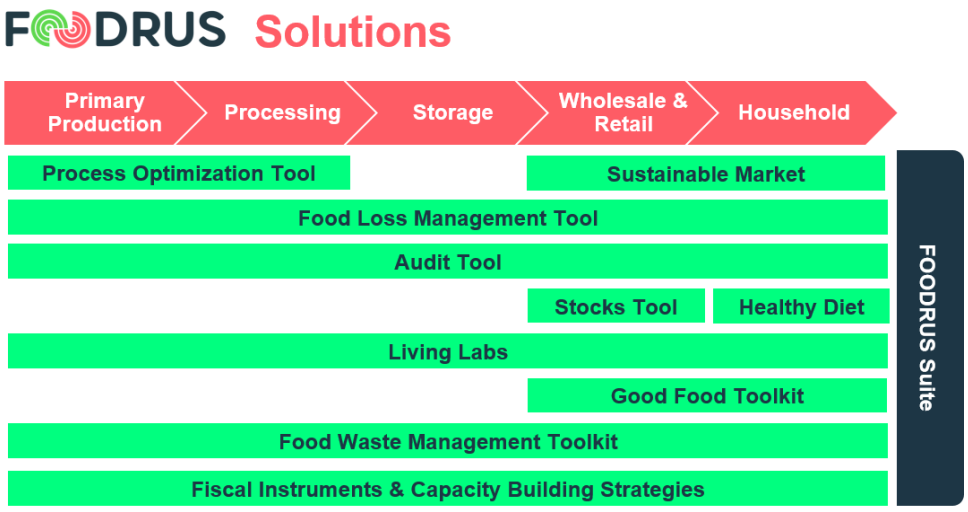


Figure 6.2.1: Fruit Production Optimization

11. **FOODRUS (GA: 101000617) [P20]** Fact Sheet

Aimed to reduce food loss and waste (FLW) through 23 technological, social, and organizational solutions. Blockchain technology was specifically implemented for an FLW prevention certification process and a product traceability tool to enhance transparency. A municipal Pay-As-You-Throw (PAYT) model, potentially powered by blockchain, was also introduced for immutable waste tracking.

Standards Relevance: Provides verifiable claims relevant to **ISO 59020** (waste reduction metrics) and **ASTM D8558** (certification). Implements traceability aligned with **GS1** concepts.



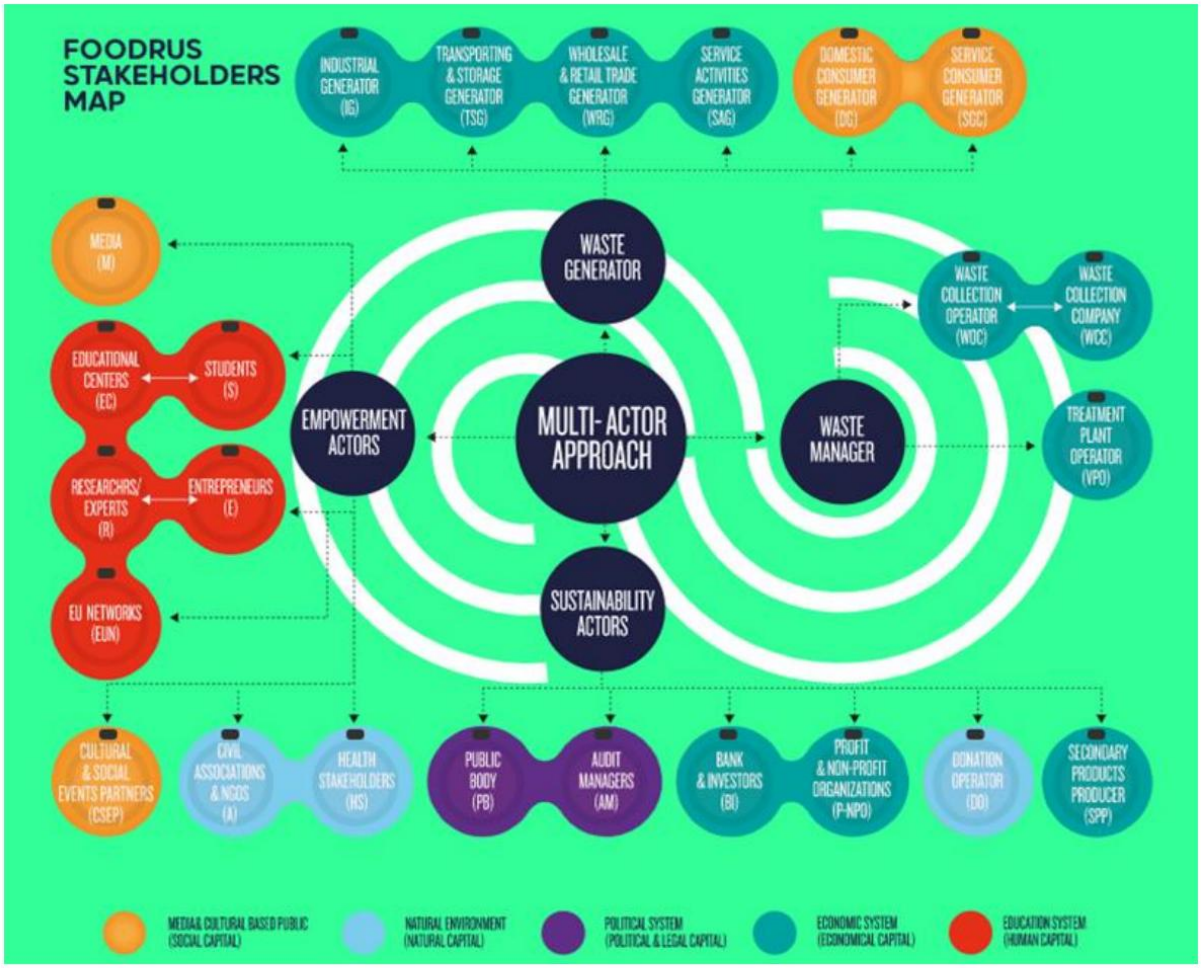


Figure 2. Stakeholder mapping in FOODRUS project (source www.foodrus.eu)

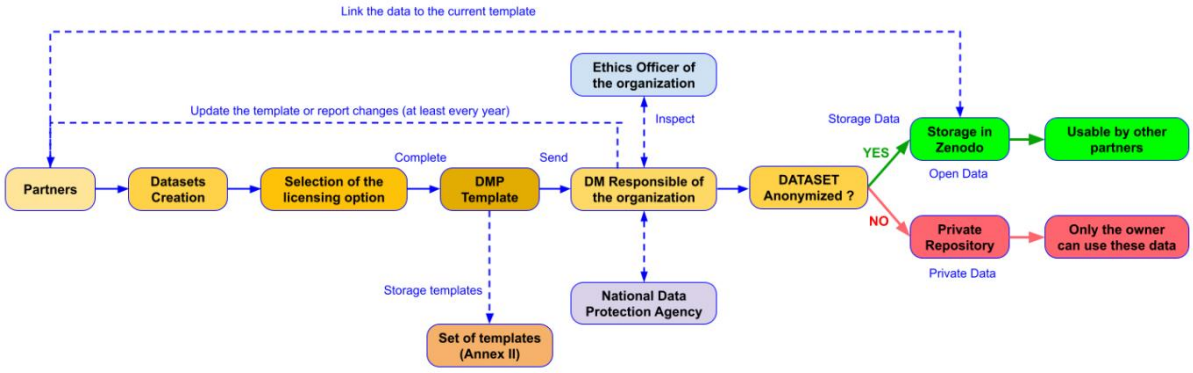


Figure 2. DMP Procedure. Source: Own elaboration.

12. **DigInTraCE (GA: 101091801) [P2]** Fact Sheet

Develops a "transparent and interoperable **Decentralised Traceability platform**" using "**blockchain**" technology for process industries (including pulp/paper derived from forestry) to enhance circularity and secondary raw material use. Key technical components include dynamically updated Digital Product Passports (DPPs), AI-based optimization, advanced sensing/sorting, and "**blockchain contracts**" for secure, real-time data access and exchange.

Standards Relevance: Directly addresses DPPs (**ISO 59040**), traceability (**GS1 EPCIS**), smart contracts (**ISO/TC 307**), and circularity data (**ISO 59020**, **EN 45557**). Utilizes reference architecture concepts (**ISO 23257**, **DIN SPEC 32790**).

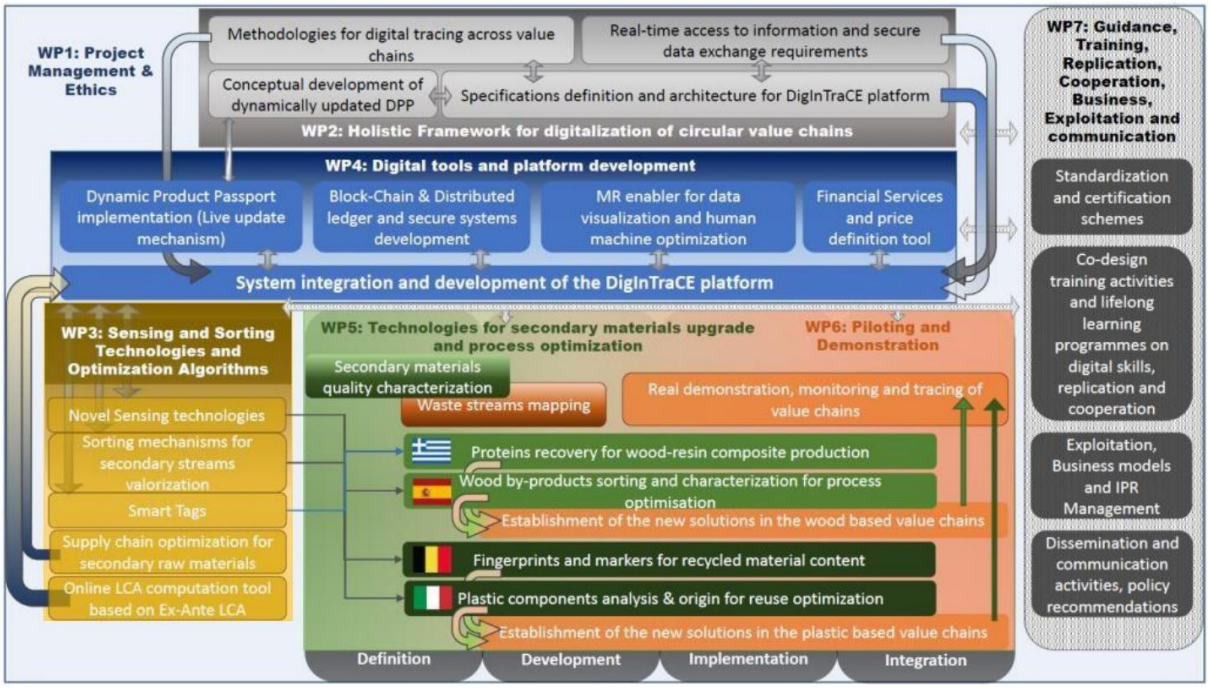


Figure 1: PERT Chart DIGINTRACE Project

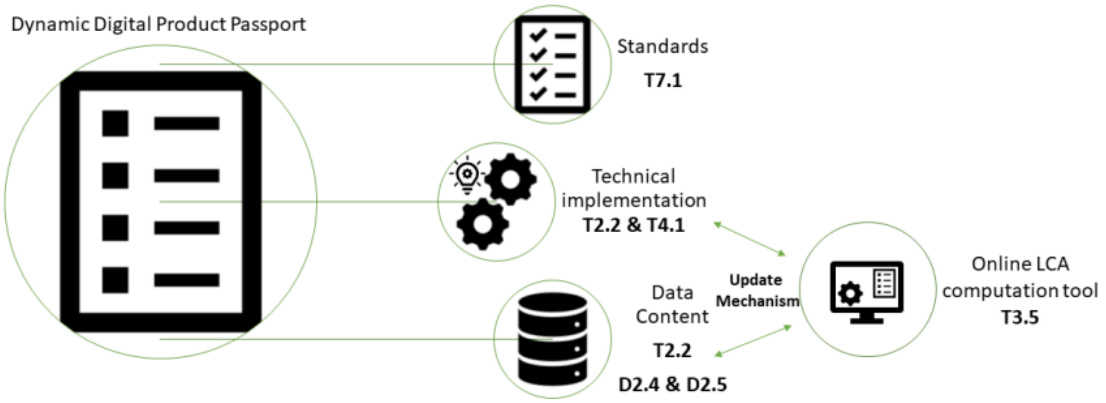


Figure 1. D2.4 relation to other tasks dealing with critical aspects in the DPP development.

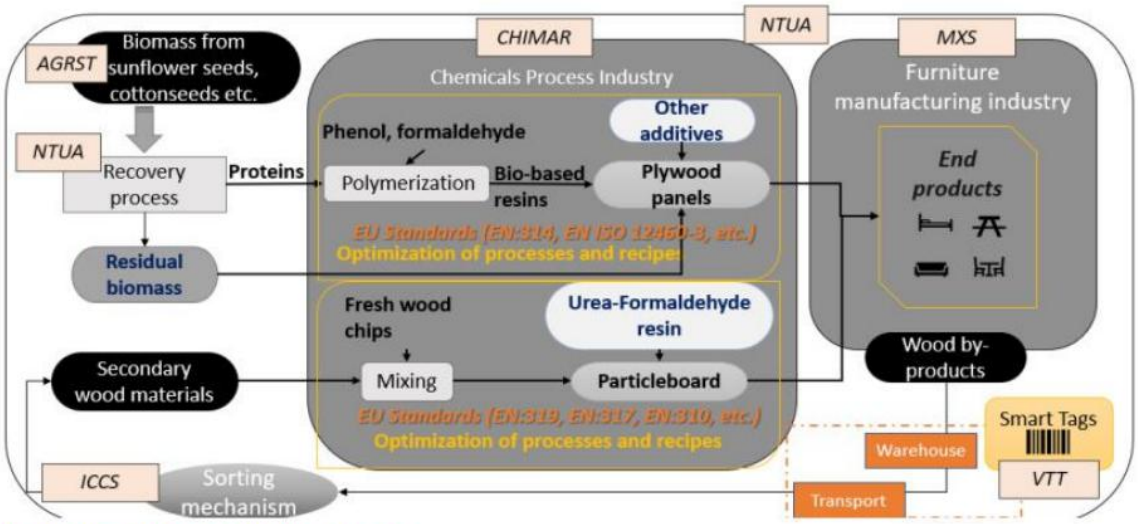


Figure 3 Greek demonstrator scheme

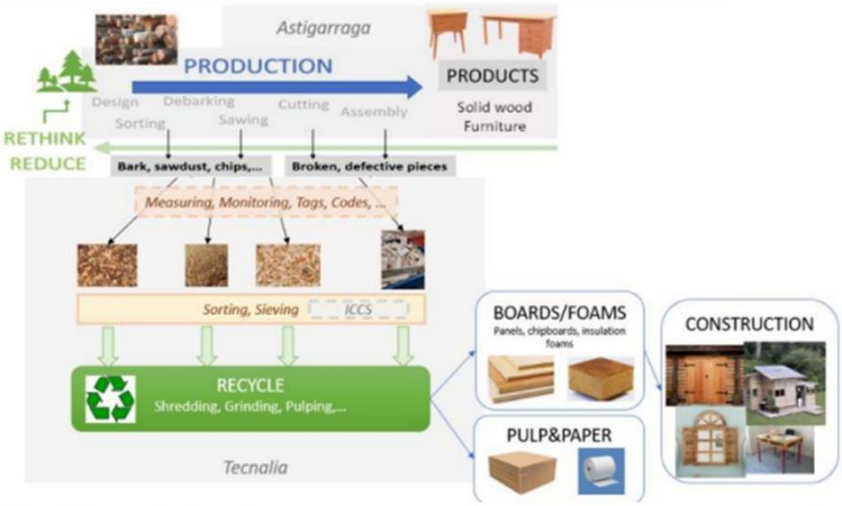


Figure 4 Spanish demonstrator scheme

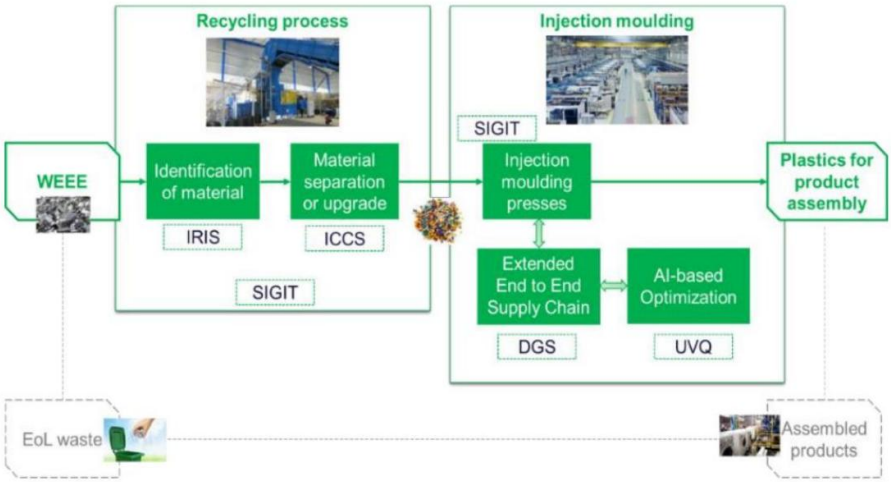


Figure 6 Italian demonstrator scheme

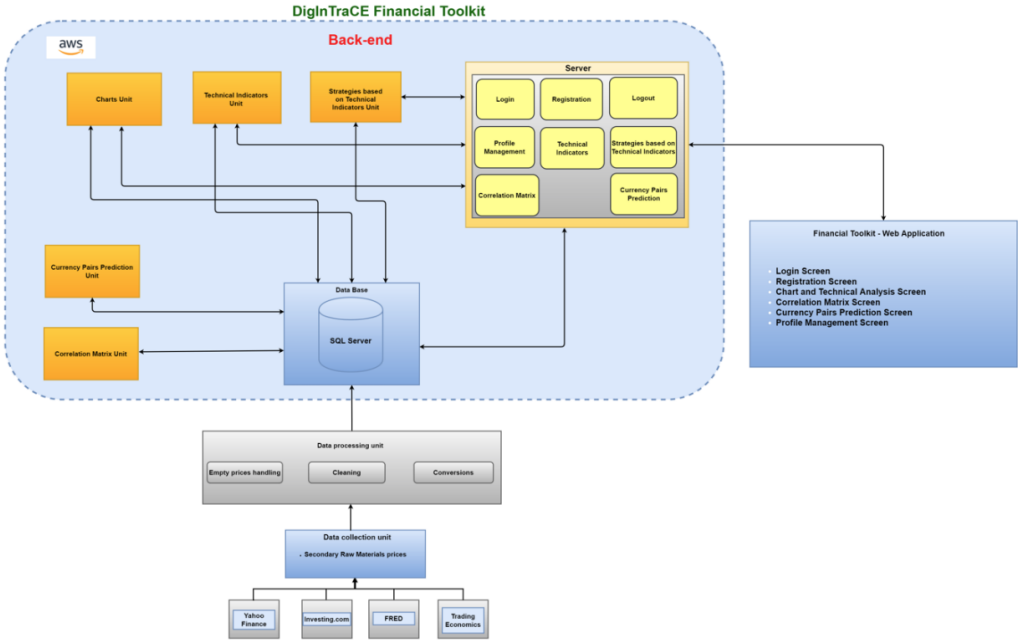


Figure 1 Financial Toolkit Architecture

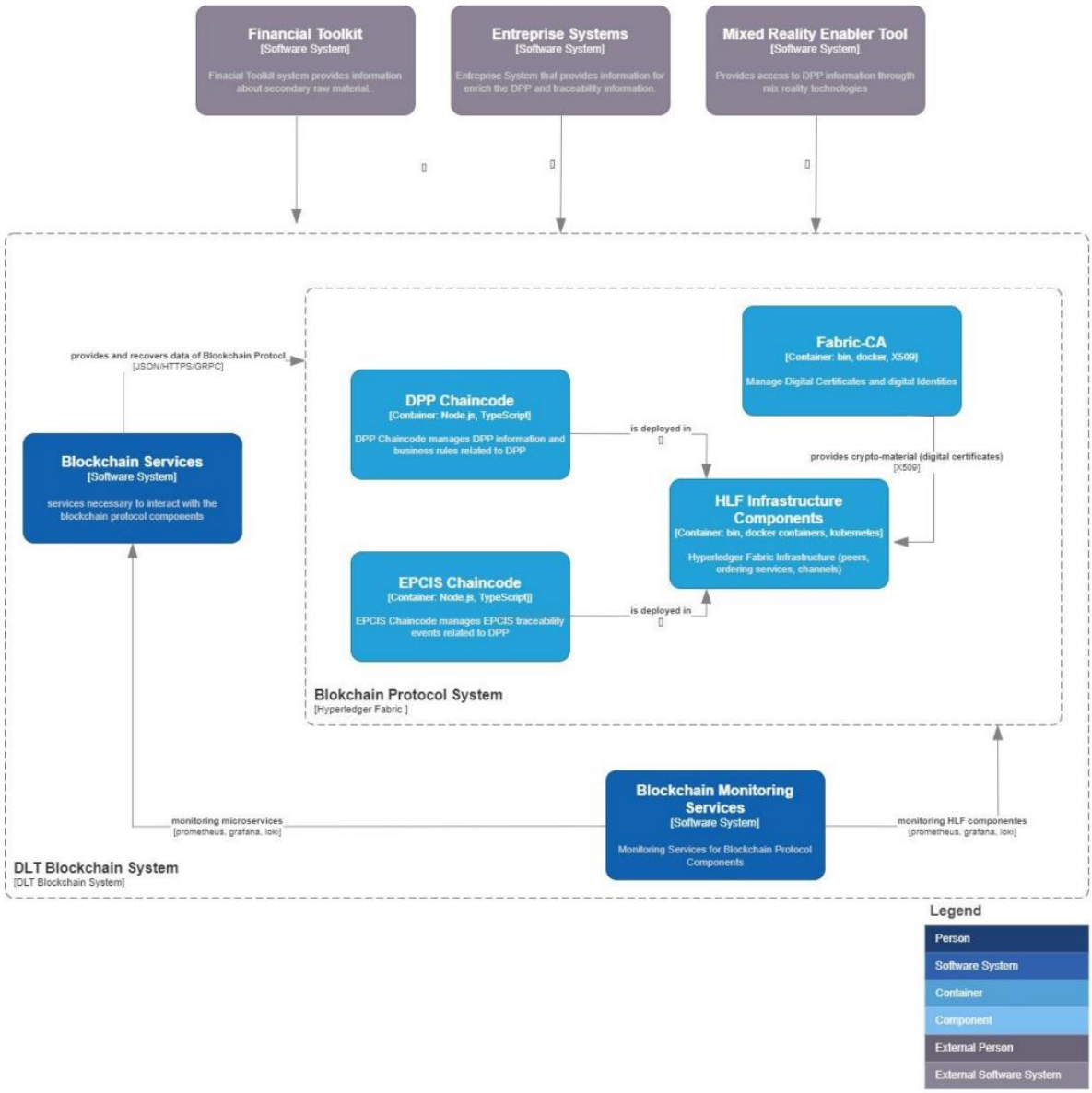


Figure 16 C4 Blockchain Protocol Diagram

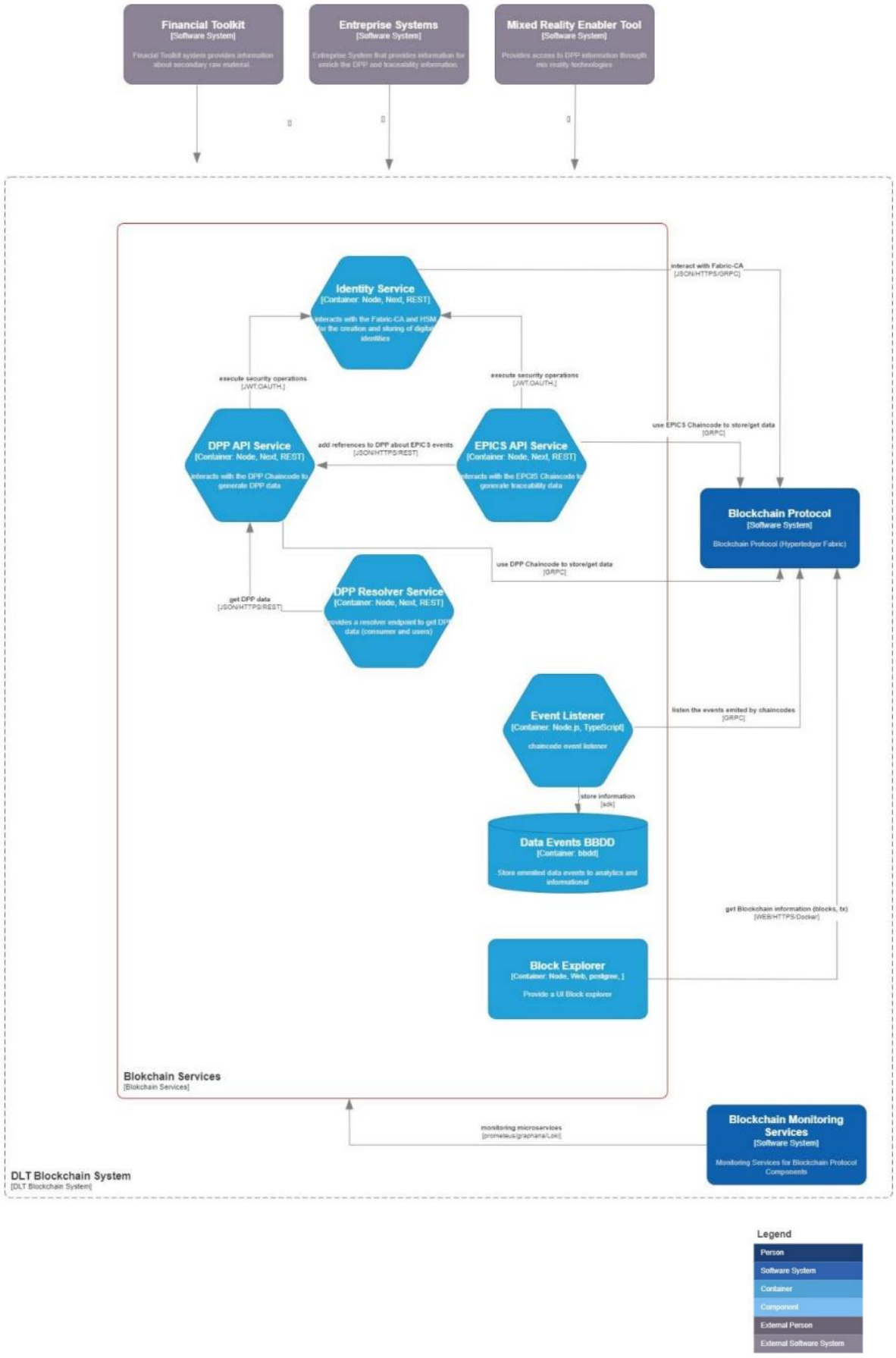


Figure 17 C4 Blockchain Services Diagram

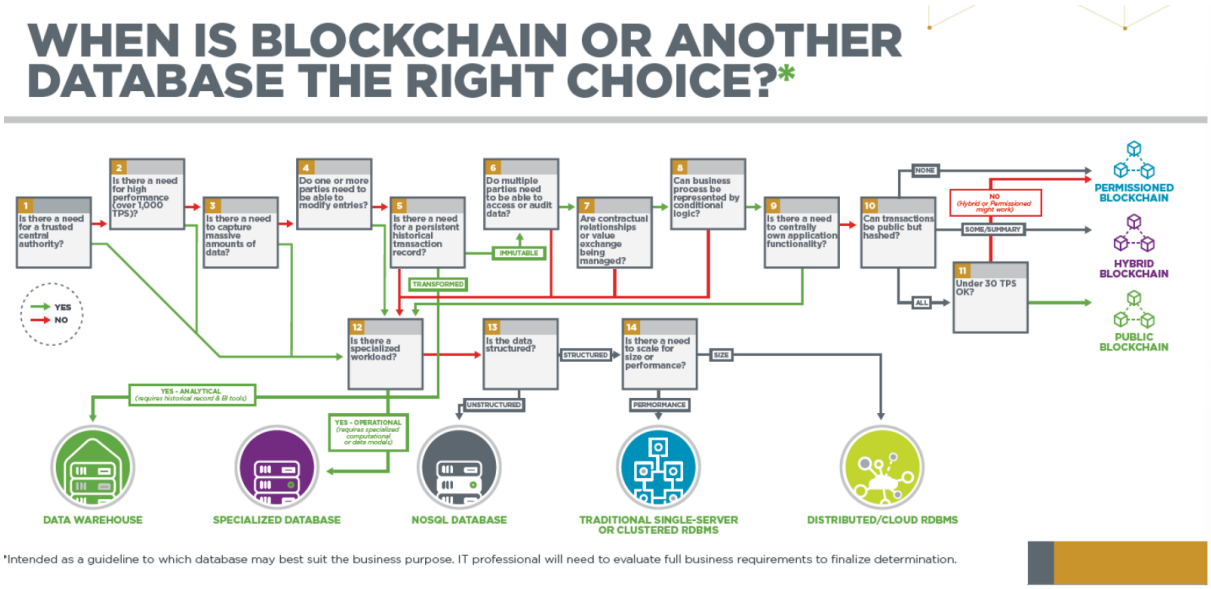


Figure 23 Blockchain-decision-tree

13. **mEATquality (GA: 101000344) [P11]** Fact Sheet

Investigated links between extensive husbandry practices and meat quality (pork, broiler), evaluating "**blockchain technology**" alongside fingerprinting techniques for product authentication. The technical objective involved assessing blockchain as a tool to combat food fraud by creating immutable, verifiable records linking meat products to their specific production system and quality attributes.

Standards Relevance: Focuses on verifying product claims/authenticity, relevant to **ASTM D8558**.

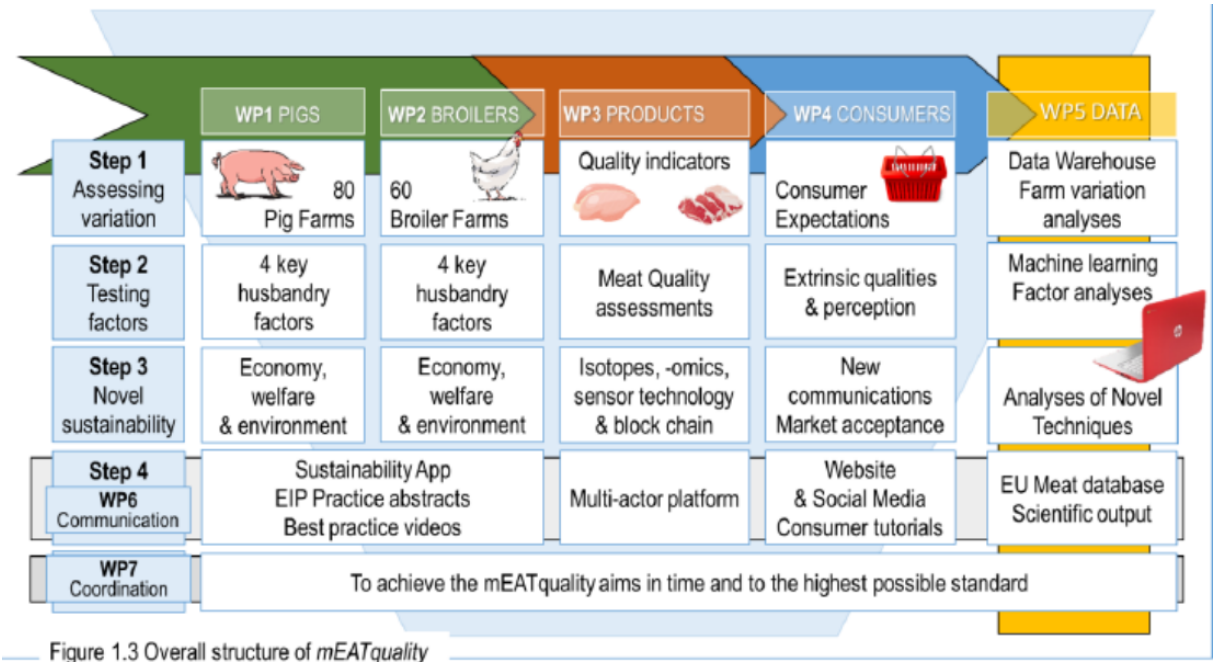


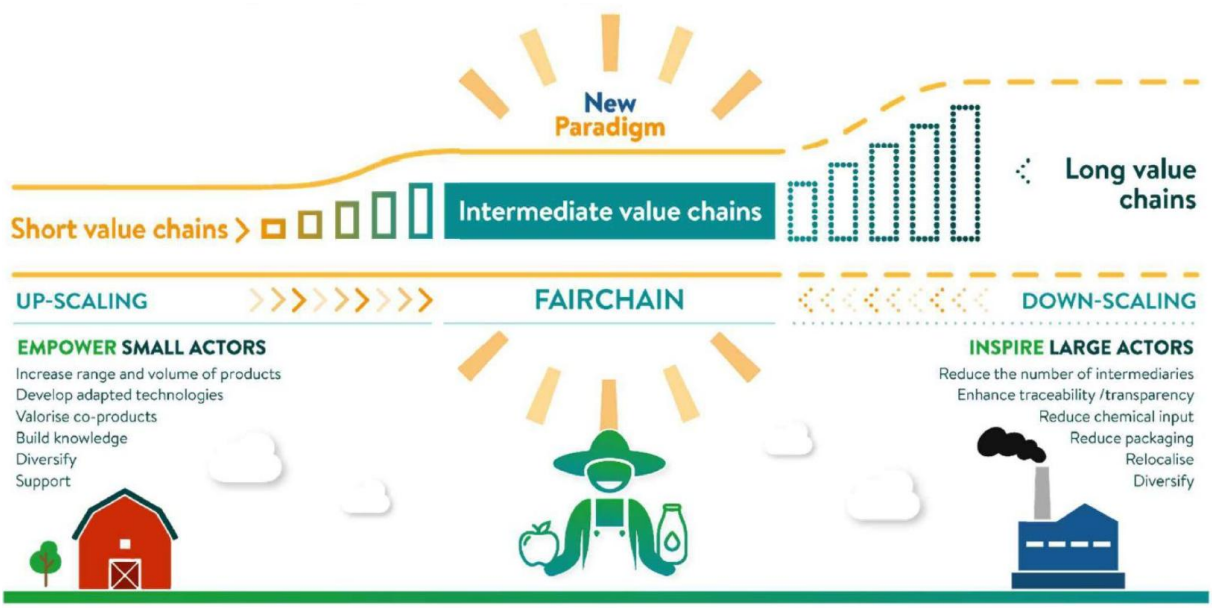
Figure 1.3 Overall structure of *mEATquality*

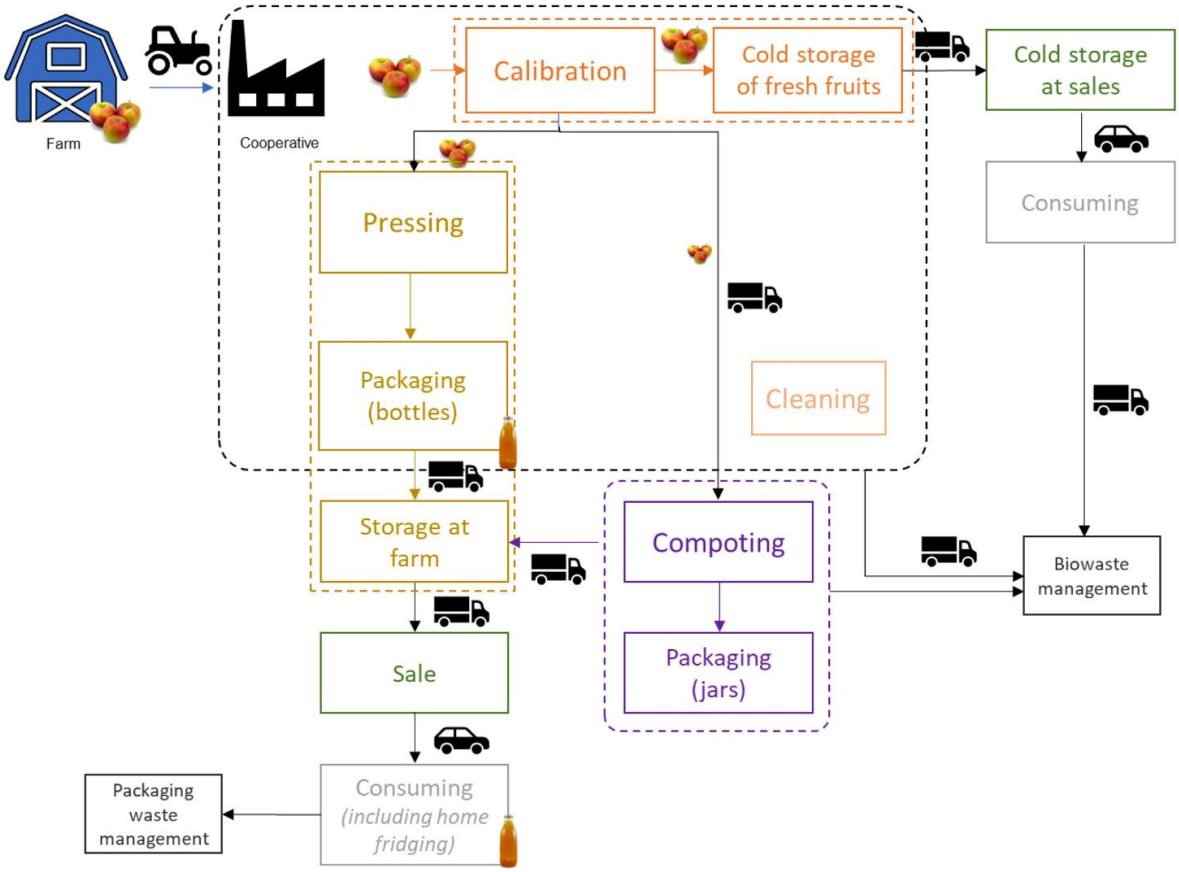
14. **FAIRCHAIN (GA: 101000723) [P12]** Fact Sheet

Focused on developing fairer intermediate food value chains (dairy, fruit/vegetables). A key technical output developed was a "**Blockchain-based solution**". This DLT application was designed to standardize

information flow management, enhance traceability and transparency for consumers, and thereby strengthen the position of small/mid-sized actors.

Standards Relevance: Addresses data flow (**ISO/TR 6277**) and traceability (**GS1 EPCIS**) to improve transparency (**ISO 59004**).





2.2.2 EIC Accelerator Projects

These projects are typically SME-led initiatives aiming to scale up disruptive innovations, often using blockchain as a core technology enabler.

1. **I Go Slow (FOB SOLUTIONS OU / VOVERE IR RIESUTAS, MB, GA: 868842) [P52]** *(Phase 1 Feasibility)* **Direct link**

This project explored a platform integrating internet, e-commerce, cloud, and distributed ledger technologies. The goal was to connect small gourmet food producers directly with consumers, promoting Slow Food ideas and family farming. A native Slow Token ecosystem, underpinned by immutable ledger technology, was envisioned to manage interactions like sales and visits, thereby enhancing trust and authenticity while disintermediating the supply chain.

Relation to Agriculture: Direct market access and traceability for small gourmet/family farms.

Standards Relevance: Explores tokenization (**IEEE 2418.7**) and disintermediation concepts.

2. **TNT (GUARDTIME OU, GA: H2020-SMEInst-2018-2020-2) [P51]** **Direct link**

Developed TrueTrail (TT), a log security solution utilizing Guardtime's proprietary hash-based cryptography and production-grade distributed ledger implementation. This technology functioned as a decentralized trust anchor, enabling large-scale, automated, independent verification of log data immutability. It provided real-time integrity checks and aimed to detect previously hidden log manipulations, bolstering cybersecurity monitoring.

Relation to Agriculture: Applicable to securing IT systems used in agriculture, ensuring data integrity for farm management software or supply chain platforms.

Standards Relevance: Focuses on data integrity, a foundational security aspect relevant to any secure DLT system ([ISO/TC 307** Security work area).

3. **SMark2.0 (SMARK TECHNOLOGY ZARTKORUEN MUKODO RESZVENYTARSASAG, GA: H2020-SMEInst-2018-2020-1) [P53]** *(Phase 1 Feasibility)* **Direct link**

Proposed a multi-layer product authentication and track-and-trace system. The technical approach involved linking a physical nanotechnology-based label (SMark NanoLabel) with a decentralized secure network described as a Blockchain Framework. This framework would serve as the immutable ledger recording product identity and tracking its supply chain journey for B2B, B2C, and B2G anti-counterfeiting purposes.

Relation to Agriculture: Anti-counterfeiting and traceability for high-value agricultural products (e.g., wine, spirits, specialty foods).

Standards Relevance: Combines physical marking with blockchain verification, relevant to **ASTM D8558** concepts.

4. **EKOFOLIO (EKOFOLIO SARL, GA: 876676) [P47]** *(Phase 1 Feasibility)* **Direct link**

This FinTech project proposed a platform using distributed ledger technology to tokenize large forestry assets into small, tradable Tree Tokens. The blockchain would provide the decentralized infrastructure

for issuing tokens, tracking ownership securely and transparently via user wallets, and facilitating peer-to-peer trading, thereby aiming to add liquidity and accessibility to forestry investments.

Relation to Agriculture: While focused on forestry, the tokenization model could be applied to agricultural land, carbon credits from farming, or other farm-related assets.

Standards Relevance: Direct application of tokenization standards/concepts (**IEEE 2418.7**, potentially ERC standards like **ERC-1155**).

5. **CirculariseSource (CIRCULARISE BV, GA: H2020-EIC-SMEInst-2018-2020-3) [P1]** Direct link

Developed a distributed ledger-based transparency solution, initially exploring Ethereum, using decentralized, encrypted data and potentially chemical tracers. This system tracked material characteristics (like recycled content) through supply chains without disclosing sensitive partner information. The technical approach aimed to provide verifiable proof of circularity and sustainability practices.

Relation to Agriculture: Tracking recycled content in agricultural packaging or verifying the origin of bio-based materials derived from agriculture.

Standards Relevance: Directly addresses tracking for circularity (**ISO 59020**, **EN 45557**) using privacy-preserving techniques (relevant to **ISO/IEC 20889**).

6. **tilkal (TILKAL, GA: HORIZON-EIC-2022-ACCELERATOR-01) [P45]** Direct link

Built a distributed ledger-based supply chain traceability and transparency platform. It provides a real-time digital representation of supply chains, utilizing DLT to create a secured and provable B2B data sharing network. This technical foundation, combined with real-time analysis algorithms, aimed to improve control, compliance, and fraud detection in sectors including agrifood.

Relation to Agriculture: Directly applicable for end-to-end traceability and transparency in various agrifood supply chains.

Standards Relevance: Implements core traceability (**GS1 EPCIS**) and transparency (**ISO 59004**) principles using DLT architecture (**ISO 23257**).

7. **DIGI-TRUSTY (CONNECTING FOOD, GA: HORIZON-EIC-2022-ACCELERATOROPEN) [P7]** Direct link

Created a digital platform for continuous food traceability and auditing, secured by distributed ledger technology. The core technical innovation involved generating product digital twins by ingesting, standardizing, auditing (using blockchain immutability), and enabling interoperability of data from diverse sources along the farm-to-store journey.

Relation to Agriculture: Provides detailed, verifiable traceability for food products, enhancing food safety and consumer trust.

Standards Relevance: Combines digital twins (ISO 23247 concepts) with blockchain traceability (**GS1**) and auditing capabilities.

8. **STOPTHEFRAUDINOLIVEO (HASHED BLOCKTAC SL, GA: H2020-SMEInst-2018-2020-1) [P8]** *(Phase 1 Feasibility)* Direct link

Developed a working, deep-tech, distributed ledger-based digital seal product to combat olive oil counterfeiting. This technical solution immutably linked physical bottles (via seal/QR code) to verified origin and batch information on the blockchain, allowing consumer verification and batch identification.

Relation to Agriculture: Combating counterfeiting specifically for high-value agricultural products like olive oil.

Standards Relevance: Application of verifiable digital seals/certificates (**ASTM D8558**).

9. **COOL-SENS (ANSERLOG S.A., GA: H2020-SMEInst-2018-2020-1) [P48]** *(Phase 1 Feasibility)* **Direct link**

Developed an advanced cold chain monitoring solution leveraging IoT sensors, Artificial Intelligence, and Distributed Ledger Technology. The DLT component aimed to guarantee full transparency by providing an immutable, verifiable record of real-time sensor data (e.g., temperature) throughout the transportation process.

Relation to Agriculture: Ensuring safety and quality for temperature-sensitive agricultural products (fresh produce, meat, dairy) during logistics.

Standards Relevance: Integrates IoT (**IEEE P2418.1**, **ISO/IEC TR 30176**) with blockchain for verifiable cold chain traceability (relevant to **ISO/TR 16340** principles).

10. **SOLARFARM (Qualifying Photovoltics S.L. / ELA, INGENIERIA Y MEDIO AMBIENTE SL, GA: 817096) [P30]** *(Phase 1 Feasibility)* **Direct link**

Explored technical and financial solutions for Photovoltaic Irrigation (PVI), including testing distributed ledger-based smart contracts. A pilot smart contract Power Purchase Agreement (PPA) was used to assess blockchain's potential for streamlining the validation of PVI assets as collateral in green financing.

Relation to Agriculture: Facilitating investment in solar energy for sustainable irrigation practices on farms.

Standards Relevance: Explores smart contracts (**ISO/TC 307**) for financial applications (**IEEE 2418.7**).

11. **FOrLedger (OPEN CANARIAS SL, GA: H2020-SMEInst-2018-2020-1) [P42]** *(Phase 1 Feasibility)* **Direct link**

Developed a low-code, as-a-service platform enabling the rapid creation of distributed ledger-based software for agri-food traceability and certification. It utilized DLT and Smart Contracts, combined with model-driven techniques, to provide a decentralized, immutable ledger for supply chain data management.

Relation to Agriculture: Providing tools for easier development of blockchain-based traceability solutions for the agri-food sector.

Standards Relevance: Aims to simplify implementation based on underlying standards (**ISO 23257**, **GS1**).

12. **SeafoodTrace (SKYNJAR TECHNOLOGIES EHF, GA: H2020-SMEInst-2018-2020-1) [P9]** *(Phase 1 Feasibility)* **Direct link**

Created an Intelligent Traceability Platform for the seafood industry. Its technical architecture combined anti-tamper smart labels (with temperature sensors) with an innovative, distributed ledger-enabled IoT platform. The blockchain provided the secure, transparent, end-to-end immutable ledger for recording sensor data.

Relation to Agriculture: Specific traceability and quality control for the aquaculture and fisheries sector.

Standards Relevance: Integrates IoT (**IEEE P2418.1**) and secure tagging with blockchain traceability (**GS1**).

13. **INSPECTO (inspecto solutions, GA: 808038) [P41]** *(Phase 1 Feasibility)* **Direct link**

Developed a portable device for detecting food contaminants using RAMAN-SERS spectroscopy. While the core technology is spectroscopic, the project description noted potential integration with third-party systems such as Blockchain for immutable recording and verification of test results, enhancing data integrity.

Relation to Agriculture: Enhancing food safety by enabling verifiable, potentially on-chain recording of contaminant testing results for agricultural produce.

Standards Relevance: Potential application for creating verifiable records (**ASTM D8558**) based on trusted (sensor) input.

2.2.3 Cascade Funding Projects (NGI)

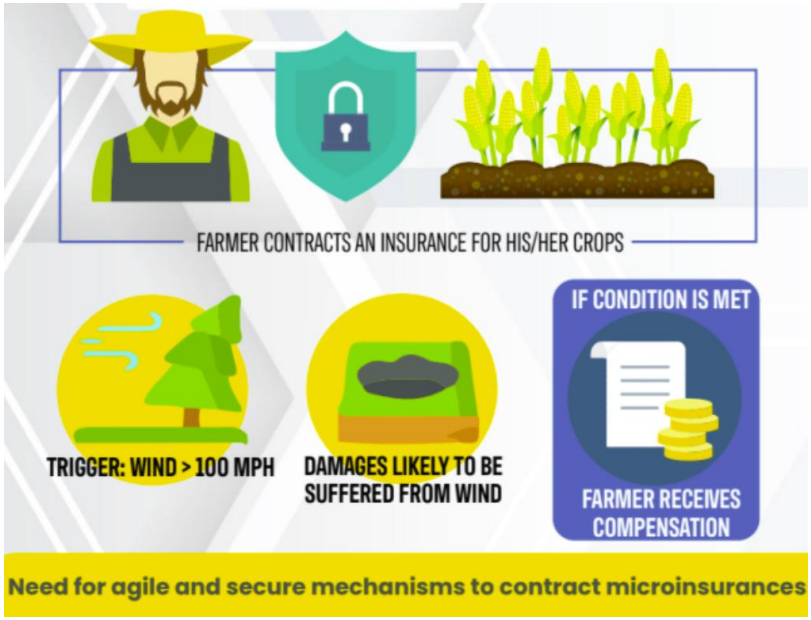
These projects contribute specialized components or applications within larger NGI or specific Horizon Europe program ecosystems.

1. **CARECHAIN (ONTOCHAIN OC#1) [P29]** **Direct link**

Developed by BISITE (USAL) and Eurostar Mediagroup, researched **DLTs (blockchain and DAGs/tangles)** to build a **Smart Contract** execution environment using **Oracles** for parametric microinsurance in agriculture. Implemented using **Ethereum Smart Contracts** (specifically ERC735 Claim Holder and ERC930 Eternal Storage proxy patterns).

Relation to Agriculture: Demonstrated specifically for agricultural insurance (storm damage), automating payouts based on verified sensor data.

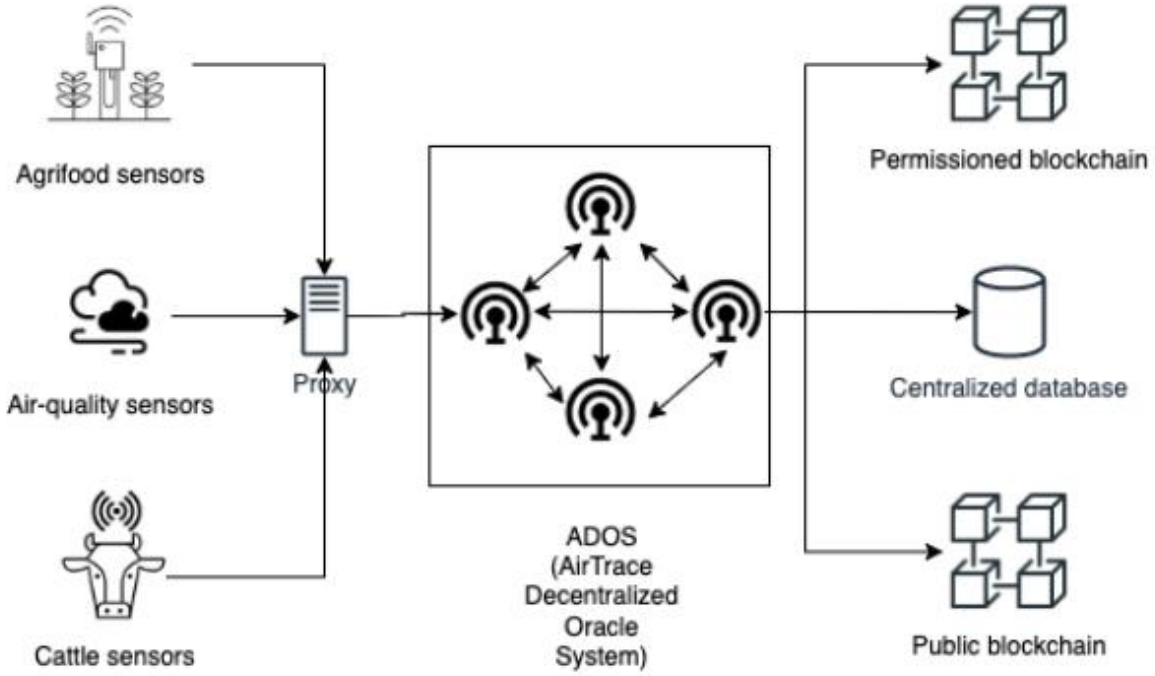
Standards Relevance: Explores smart contracts (**ISO/TC 307**) and oracle integration for specific financial applications (**IEEE 2418.7**).



2. **ADOS (ONTOCHAIN OC#1) [P39]** Direct link

AI-based decentralized oracle system using anomaly detection and TEEs to assess IoT data integrity before blockchain recording. ADOS aims at developing an advanced solution for a distributed system of oracles in IoT scenarios. IoT sensors present some promising options to improve security, reliability, and authenticity of the information provided by oracles, that we want to explore via cutting-edge technologies like Artificial Intelligence thanks to anomaly detection, for instance, and the application of advanced identity verification procedures for each particular IoT device.

Standards Relevance: Addresses the oracle problem for trusted IoT data input (**IEEE P2418.1**).

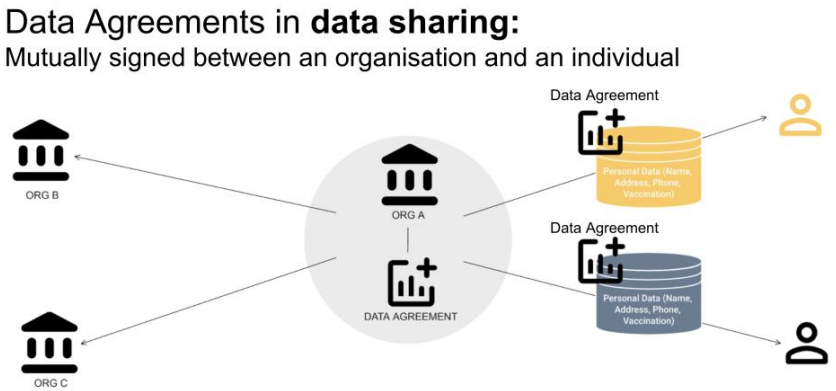


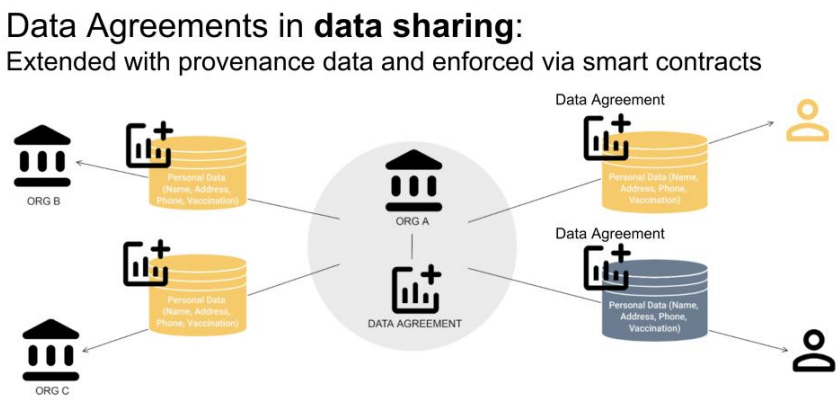
3. **PS-SDA (ONTOCHAIN OC#2) [P24]** [Direct link]

Developed by LCubed AB et al., extended the W3C DID:mydata based Data Agreement protocol, storing provenance metadata "**in a chain**" (implying blockchain). It utilizes **smart contracts** to facilitate and enforce GDPR compliance during B2B personal data exchanges, ensuring individual sign-off and creating an immutable audit trail.

Relation to Agriculture: Relevant for managing consent and tracing usage of personal data in agricultural data sharing platforms (e.g., farmer or consumer data).

Standards Relevance: Implements **W3C DID** concepts and addresses GDPR compliance via smart contracts.



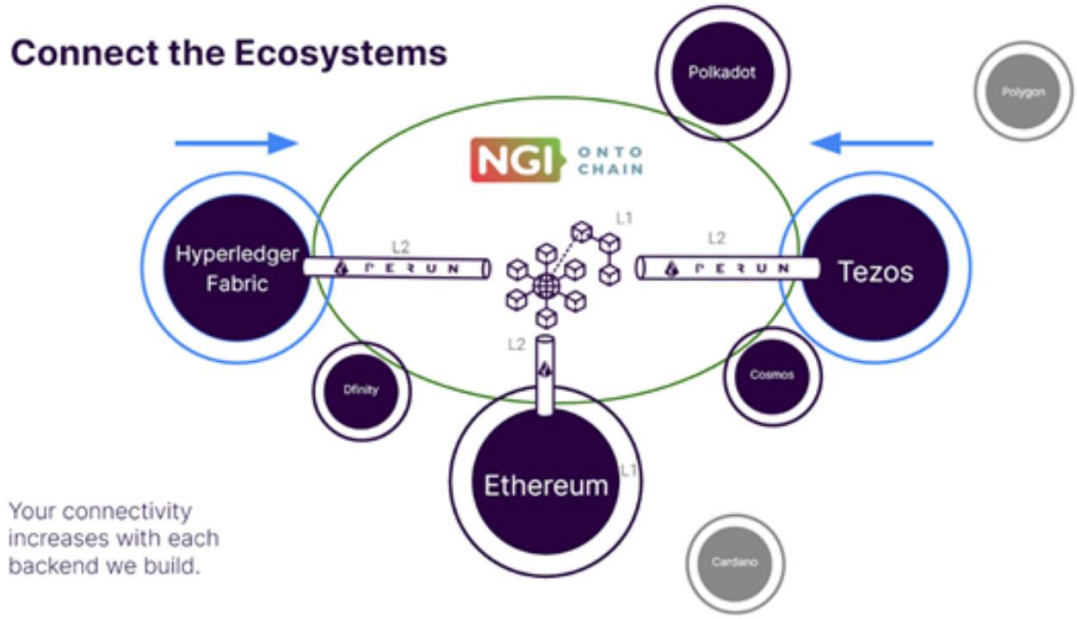


4. **Perun-X (ONTOCHAIN OC#2) [P36]** [Direct link]

Developed an efficient cross-chain infrastructure using a decentralized network of state channels. The framework allows for arbitrary logic execution within channels, enabling trustless and low-cost transfers and potential cross-chain smart contracts between heterogeneous blockchain ecosystems. It provides an SDK for application integration.

Relation to Agriculture: Provides foundational interoperability technology that could connect different agricultural blockchain platforms or enable the transfer of agricultural assets/data (e.g., traceability records, tokens) between otherwise isolated systems.

Standards Relevance: Directly addresses interoperability challenges (**ISO 23257**, **ISO/TR 6277**).



5. **TokEngine (TrustChain OC#4) [P37]** Direct link

Developed by Convex, created a token exchange hub built on the energy-efficient **Convex DLT** (using Convergent Proof of Stake). Employed **smart contracts** and wrapped tokens to demonstrate interoperability, enabling low-cost exchange between different NGI ecosystems and **EVM compatible chains** like Tezos and Alastria.

Relation to Agriculture: This is applicable for managing and exchanging tokens related to agricultural activities, such as renewable energy certificates from farms or carbon credits.

Standards Relevance: Focuses on token standards (**ERC-1155** concepts) and cross-chain interoperability.

6. **NeWG (TrustChain OC#4) [P38]** Direct link

Developed by capillar IT, created a **multi-chain** supporting data space (FIWARE/Gaia-X) for fresh food logistics. Used an "**EBSI-compatible**... approach for storing logs on... data transactions on **blockchain networks**" and integrated decentralized identity management based on **W3C and OIDC standards for verifiable credentials (VCs)**.

Relation to Agriculture: The project directly improves traceability, data sharing, and potentially AI-driven optimization in fresh food distribution from wholesale markets.

Standards Relevance: Integrates data spaces with **EBSI**-compatible logging and **W3C DID/VC** standards for identity. Addresses interoperability (**ISO 23257**).

7. **TAC! (TrustChain OC#2) [P13]** Direct link

Developed by Enismaro S.r.l., provided an end-to-end food traceability solution using a "**Blockchain ledger**" and IoT sensors. It employed legally valid "**Smart Contracts**" registered on the blockchain, linked to KPIs and quality conditions captured by sensors, to enforce transparency.

Relation to Agriculture: The project offers a direct technical solution for enhancing transparency in agrifood supply chains.

Standards Relevance: Implements traceability (**GS1**) with IoT integration (**IEEE P2418.1**) and smart contracts (**ISO/TC 307**).

8. **Value4All (TrustChain OC#2) [P46]** Direct link

Developed by Arsys, created a data aggregation platform using reward "**tokens**" to incentivize customer data sharing. This implies a DLT/blockchain system for secure token issuance, management, and redemption, facilitating the creation of Gaia-X/IDSA compliant datasets.

Relation to Agriculture: The solution is relevant for agricultural retail or food service businesses seeking to gather verifiable customer feedback or purchasing data.

Standards Relevance: Uses tokenization (**IEEE 2418.7**) for data sharing incentives.

9. **AI-MetaBloQ (TrustChain OC#1) [P28]** Direct link

Developed by Metabio, created a "**DLT-Marketplace**" applying **Blockchain technologies** for exchanging human biospecimen data. It featured AI for quality assessment, regulatory compliance, and utilized **Distributed Digital Identity** along with privacy-preserving techniques.

Relation to Agriculture: While originally focused on human biosamples, the technical model for a secure, traceable marketplace is potentially adaptable for agricultural biomaterials, genetic samples, or organic certifications.

Standards Relevance: Combines DLT marketplace concepts with **W3C DID/VC** and privacy techniques (**ISO/IEC 20889**).

10. **MultiPass (TrustChain OC#4) [P43]** Direct link

Developed by StreamOwl, provides a "**multi-ledger**" bridge allowing verifiable Digital Product Passport (DPP) data to be stored across multiple locations. It uses a TUF-inspired trust framework and **blockchain** to manage custody and data pointers securely, ensuring DPP data portability and interoperability.

Relation to Agriculture: MultiPass ensures DPP data can be securely managed across different storage systems or blockchains, important for complex agricultural products with long lifecycles or sustainability attributes needing verification.

Standards Relevance: Directly addresses DPP implementation (**ISO 59040**) and multi-ledger interoperability (**ISO 23257**, **ISO/TR 6277**).

11. **SSITIZEN (TrustChain OC#1) [P57]** Direct link

Developed by Izertis, integrated Self-Sovereign Identity (SSI) solutions (compatible with **EBSI/Alastria ID**) with "**blockchain-based e-money tokens**" managed via DLT. This technical setup enables secure authentication and transparent disbursement/redemption of social aid tokens.

Relation to Agriculture: In this way the project provides a relevant approach for administering agricultural subsidies or targeted support payments to farmers or rural communities transparently and efficiently.

Standards Relevance: Implements **W3C DID/VC** aligned with **EBSI** and tokenization (**IEEE 2418.7**).

12. **Trade on Chain (TrustChain OC#3) [P31]** Direct link

Developed by Intrade4you, created an open-source "**blockchain platform**" utilizing Self-Sovereign Identity (SSI), Verifiable Credentials (VCs), and "**Smart contracts**". This decentralized technical environment digitizes and automates international trade contracts securely and transparently.

Relation to Agriculture: Trade on Chain is directly applicable to improving efficiency, trust, and reducing costs in the cross-border trade of agricultural commodities.

Standards Relevance: Leverages **W3C DID/VC** and smart contracts (**ISO/TC 307**) for trade automation (relevant to **UNECE** frameworks).

13. **CHECKS (TrustChain OC#3) [P44]** Direct link

Developed by Identinet GmbH, provided an e-commerce Verification Service using "**TrustChain's blockchain and SSI technologies**". It employed **DIF Linked Verifiable Presentations** and compatible **DID methods (did:alas, did:ebsi)** allowing businesses to publish verifiable credentials decentrally for consumer verification.

Relation to Agriculture: It is applicable for authenticating online sellers of farm products, organic foods, or agricultural supplies.

Standards Relevance: Implements **W3C DID/VC** and DIF standards for business verification, compatible with **EBSI**.

2.3 Healthcare Projects

This subsection lists projects applying blockchain/DLT within healthcare, pharma, medical devices, and health data management.

2.3.1 CORDIS Consortium Projects (RIA/IA)

The following list provides summaries for the identified blockchain CORDIS projects, focusing on their objectives and technical approaches within the healthcare and related medical sciences field. Specific details regarding blockchain or DLT implementation are included where mentioned in the source material.

1. **MH-MD (GA: 732907) [P5]** Fact Sheet

MyHealth-MyData aimed to revolutionize biomedical data exchange by implementing a distributed, peer-to-peer architecture centered on patient control, moving away from isolated hospital repositories. Technically, it utilized a blockchain infrastructure (diagrams suggest Hyperledger Fabric) orchestrated by smart contracts to manage a GDPR-compliant access control layer and a novel dynamic consent framework. The system integrated advanced privacy-enhancing technologies, including homomorphic encryption (HE) and secure multi-party computation (SMPC), allowing secure data analysis (algorithms visiting data) without exposing raw sensitive information. It also explored synthetic data generation for AI training within this secure environment.

Standards Relevance: Implements **ISO 23257** concepts (architecture), uses smart contracts for access control (**ISO/TC 307**), integrates PETs (**ISO/IEC 20889**), and aligns with GDPR.

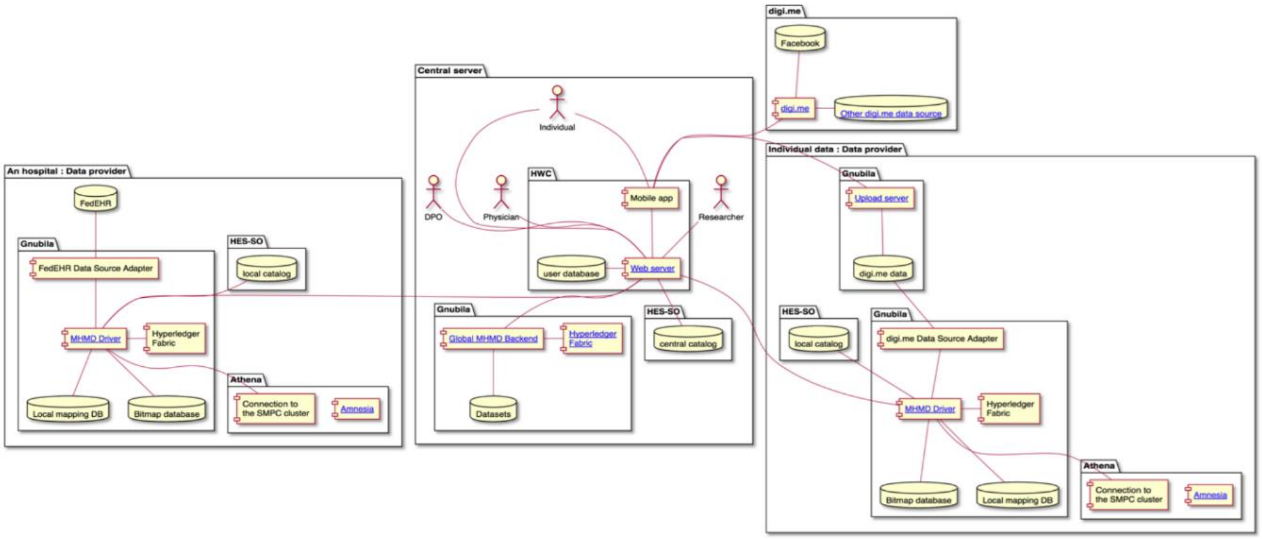


Figure 3: The architecture of the MHMD system (updated to Sept 4, 2018)[3]

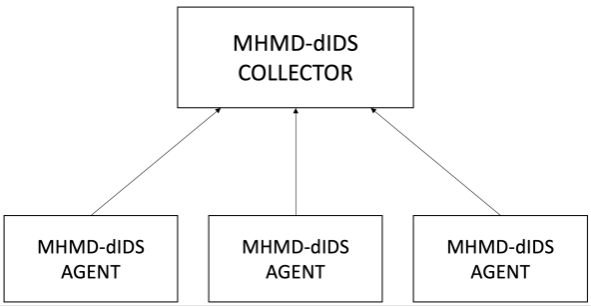


Figure 4: The high-level architecture of the MHMD-dIDS

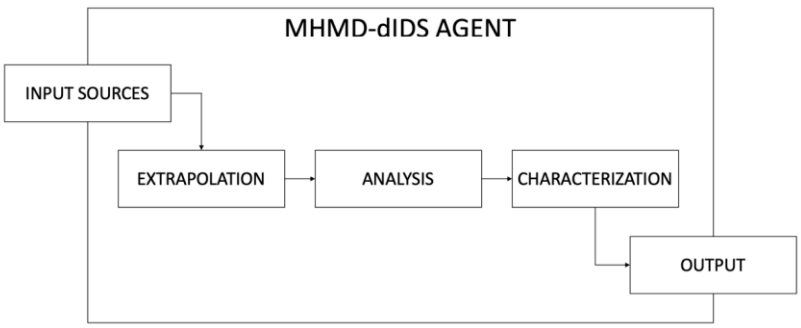
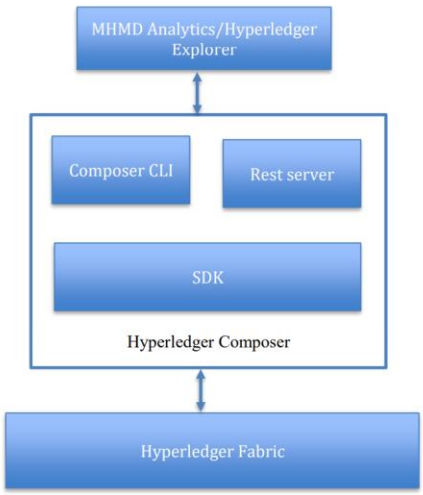


Figure 5: The high-level architecture of the MHMD-dIDS Agent

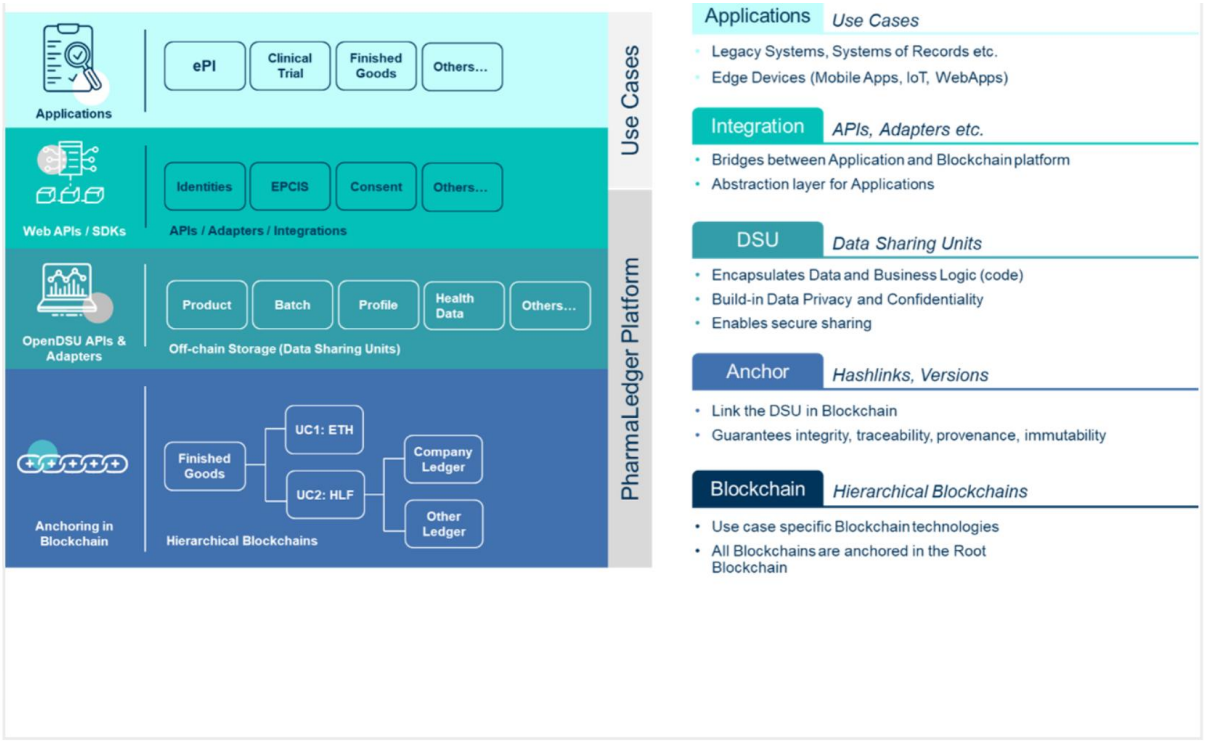


5.3 MHMD Hyperledger Explorer

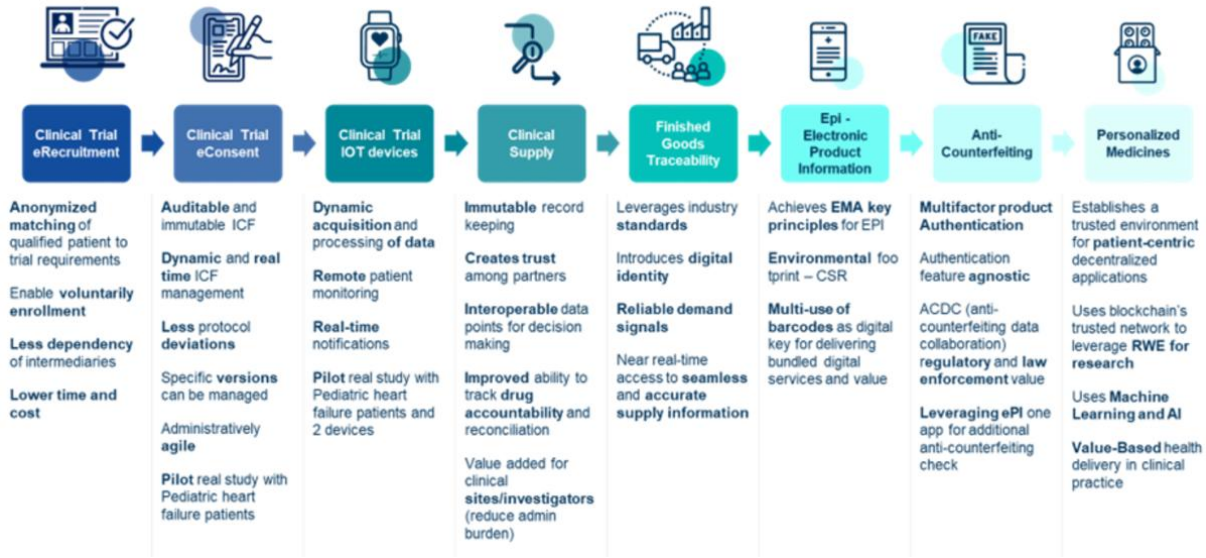
2. **PharmaLedger (GA: 853992) [P16]** Fact Sheet

PharmaLedger developed a blockchain-enabled platform tailored for the pharmaceutical industry, aiming to enhance trust and efficiency across various use cases like supply chain integrity, anti-counterfeiting, clinical trials (recruitment, eConsent, IoT data), and potentially personalized medicine data marketplaces. Its core technical innovation is the OpenDSU (Data Sharing Units) architecture, which stores data and related code off-chain in user-controlled, cryptographically secured containers. These DSUs are anchored immutably on-chain via hashlinks, ensuring integrity and traceability while preserving confidentiality. The platform was designed to be blockchain-agnostic, supporting various DLTs underneath the OpenDSU layer.

Standards Relevance: Addresses traceability (**GS1 EPCIS**), authenticity (**ASTM D8558** concepts), and uses a specific architecture pattern relevant to **ISO 23257**.



PharmaLedger Architecture



PharmaLedger Use Cases in healthcare value chain

3. **LEAP (GA: 101071724) [P59]** Fact Sheet

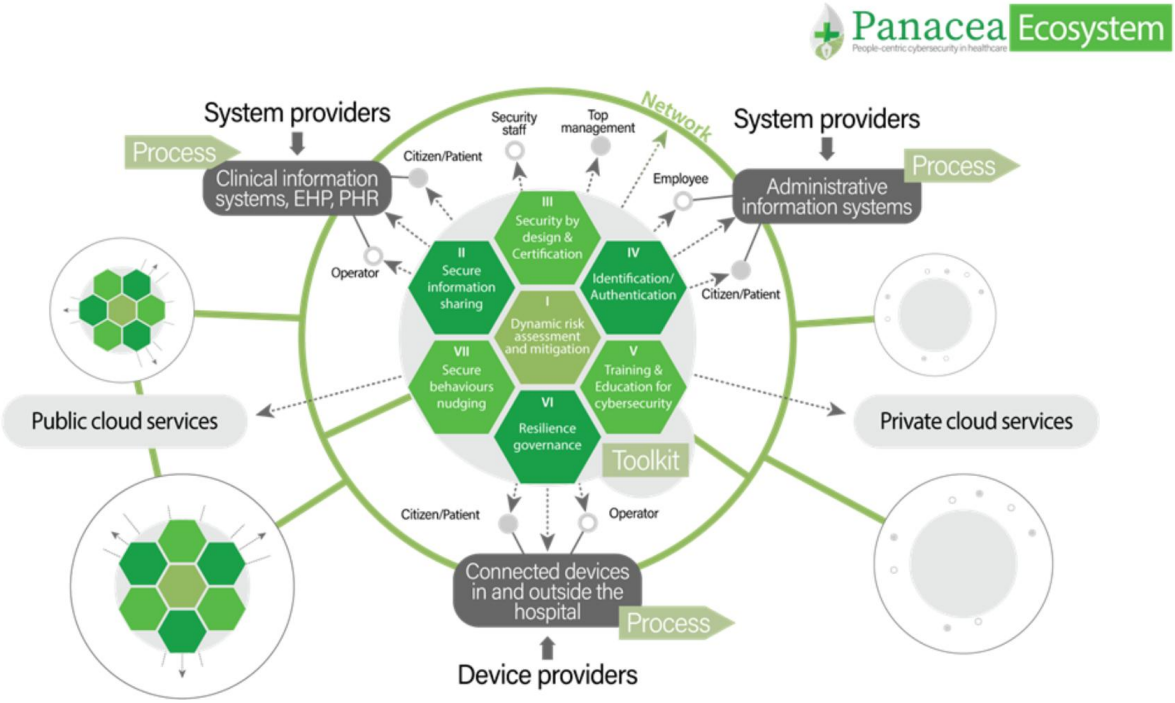
Linksight ExplainAble Privacy enhancing technologies (LEAP) focused on enabling secure data analytics on distributed datasets without sharing sensitive raw data, particularly targeting the healthcare domain for validating value-based healthcare interventions. The core technology combines advanced cryptography, specifically Secure Multi-Party Computation (MPC), with blockchain. While MPC allows joint computations on encrypted data held by different parties (e.g., hospitals, insurers), the blockchain component likely provides the trust anchor, coordination mechanism, or auditable log for these secure computations, ensuring compliance and transparency in collaborative data analysis while preserving privacy according to GDPR.

Standards Relevance: Integrates PETs (**ISO/IEC 20889**) with blockchain governance/auditing (**ISO/TC 307**).

4. **PANACEA (GA: 826293) [P27]** Fact Sheet

PANACEA developed a people-centric cybersecurity toolkit for healthcare organizations. One of its technical tools, the Secure Information Sharing Platform (SISP), utilized blockchain concepts. SISP enabled GDPR-compliant, peer-to-peer exchange of data (including heavy images) between HCOs using a ticketing approach. It featured a reliable and decentralized deployment model with selective sharing controls, likely leveraging DLT for managing permissions, ensuring data flow integrity, or providing an audit trail for shared security information or clinical data between trusted healthcare partners.

Standards Relevance: Leverages DLT for secure data sharing and auditing, relevant to **ISO/TR 6277** (data flows) and security standards.



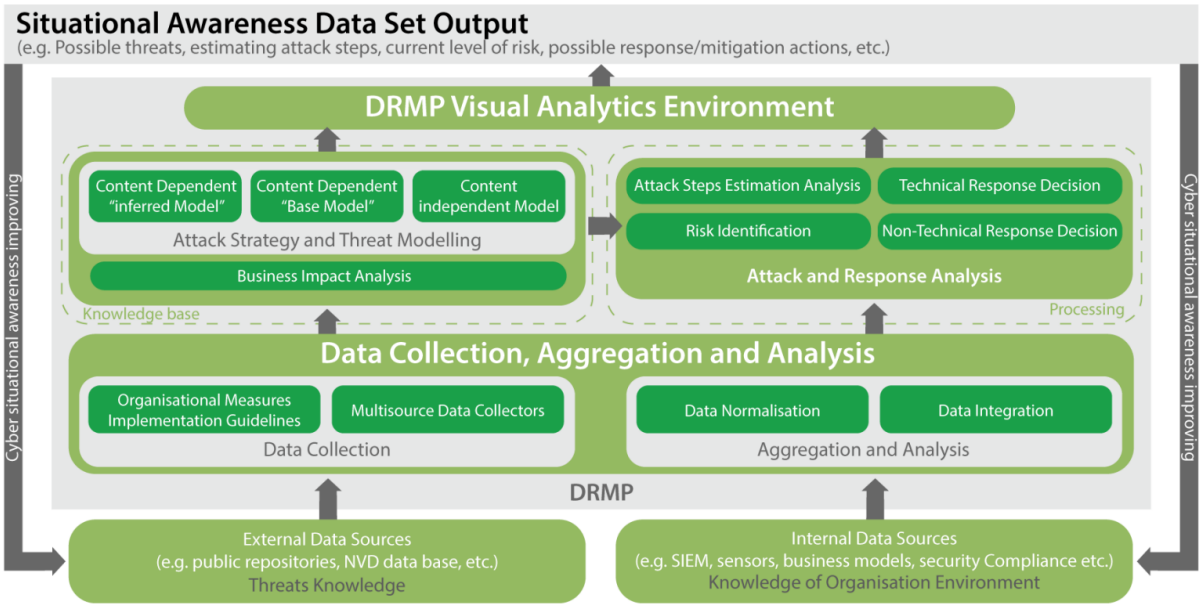


Figure 2: PANACEA DRMP Concept Design

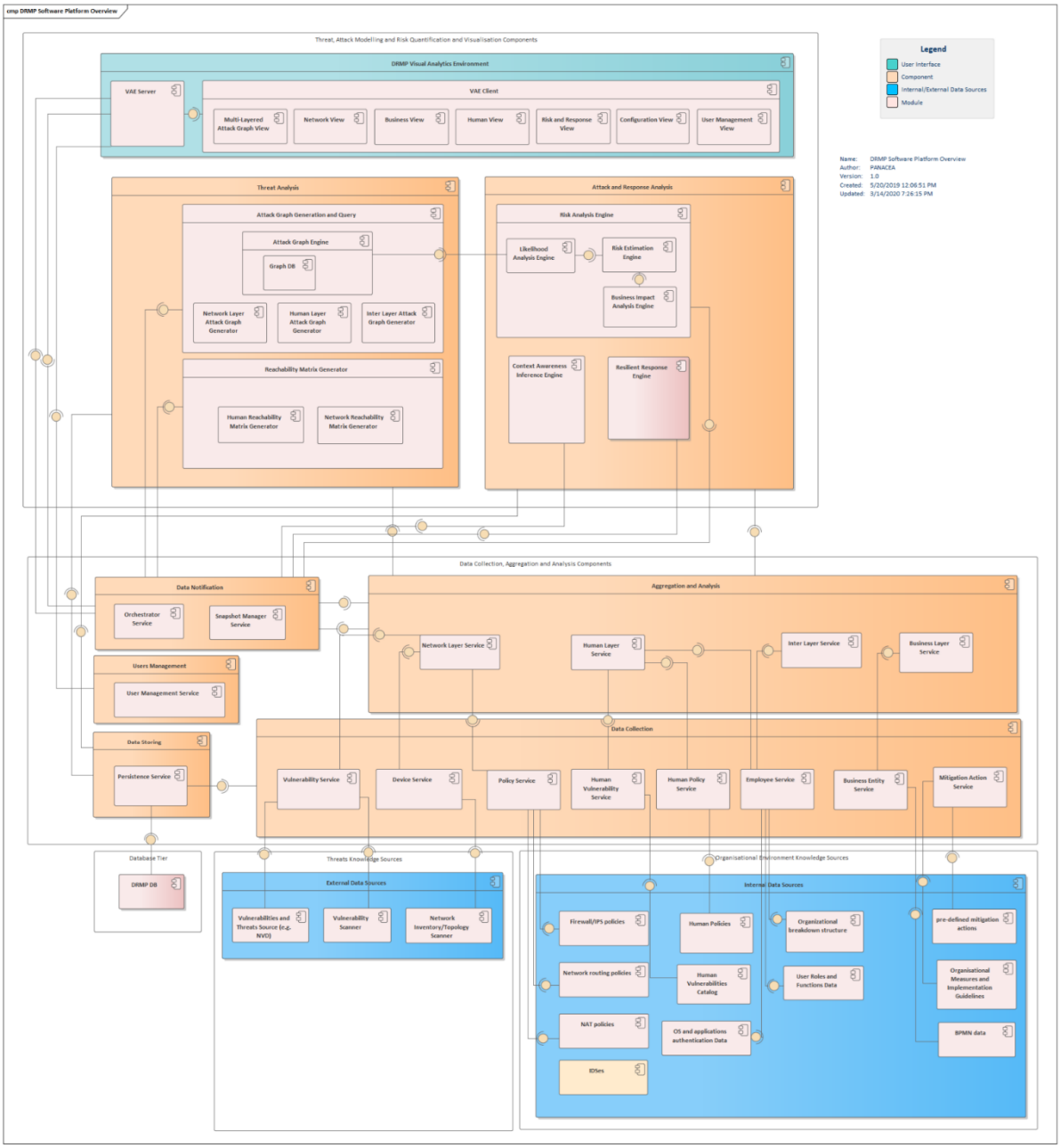


Figure 3: DRMP High-Level Architecture

5. **ENTRUST (GA: 101095634) [P60]** Fact Sheet

ENTRUST aims to enhance the security of Connected Medical Devices (CMDs) using Zero Trust principles throughout their lifecycle. A key innovation within its proposed Trust Management Architecture is the use of distributed ledger technology (DLT). DLT is planned as the foundation for issuing and managing first-ever real-time Conformity Certificates for CMDs. These certificates, updated based on runtime attestation mechanisms and dynamic trust assessments, would provide continuous, verifiable assurance of a device's security posture, recorded immutably on the distributed ledger.

Standards Relevance: Application of blockchain for verifiable credentials/certificates (**W3C VC**, **ASTM D8558** concepts) in the medical device context (relevant to **ISO 13485**).

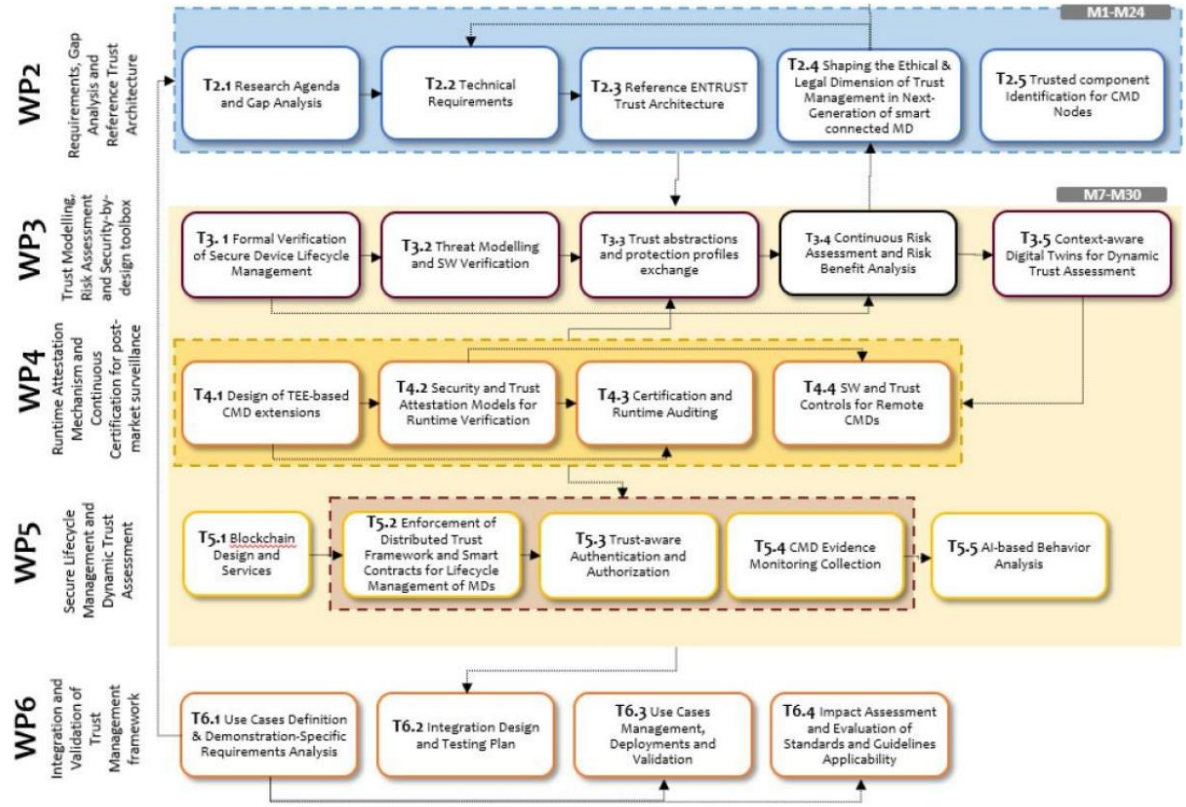


Figure 1: Pert Chart highlighting the inter-dependencies of WP2 with the technical WPs as well as with the experimentation and validation WP, namely WP6

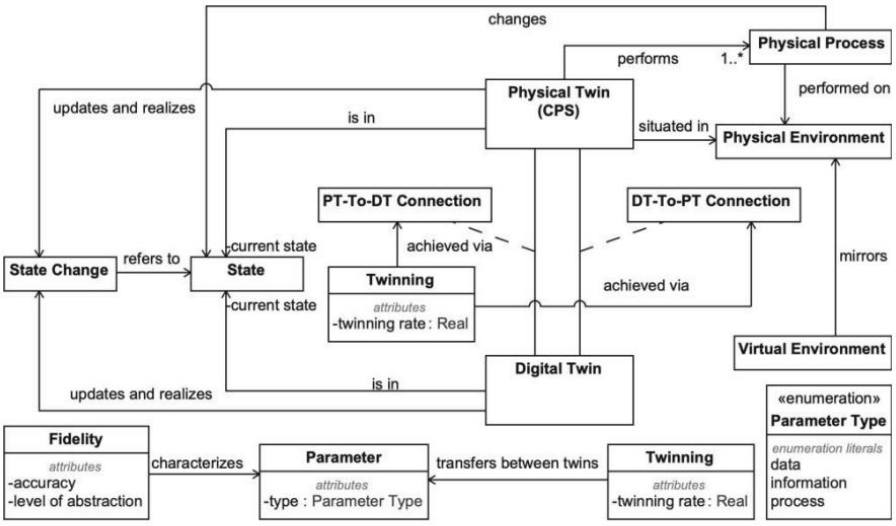


Figure 17 Part of the conceptual model for digital twin, physical twin, and their relations [53]

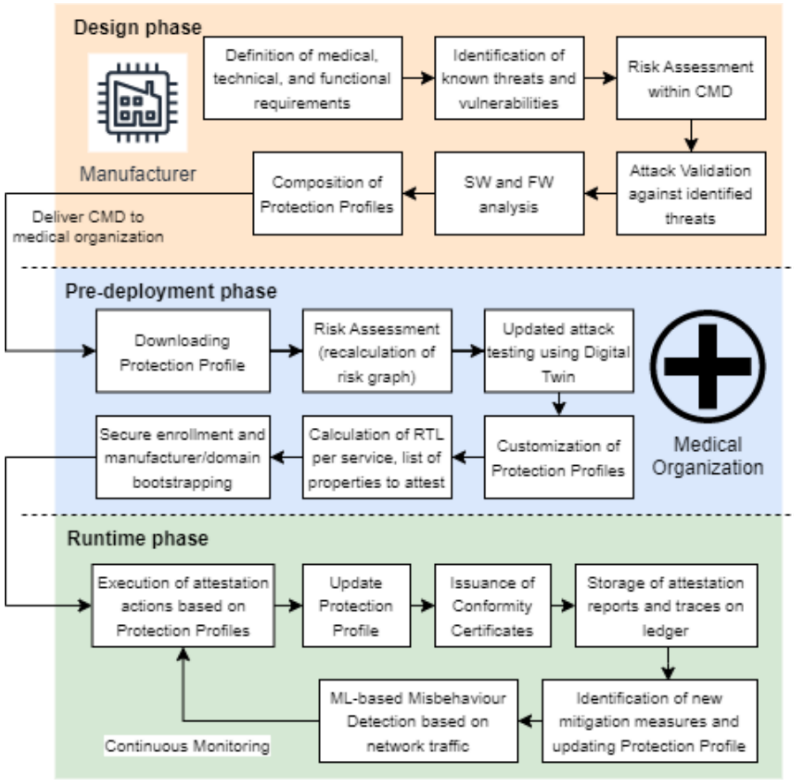


Figure 5: High-level description of ENTRUST action workflow

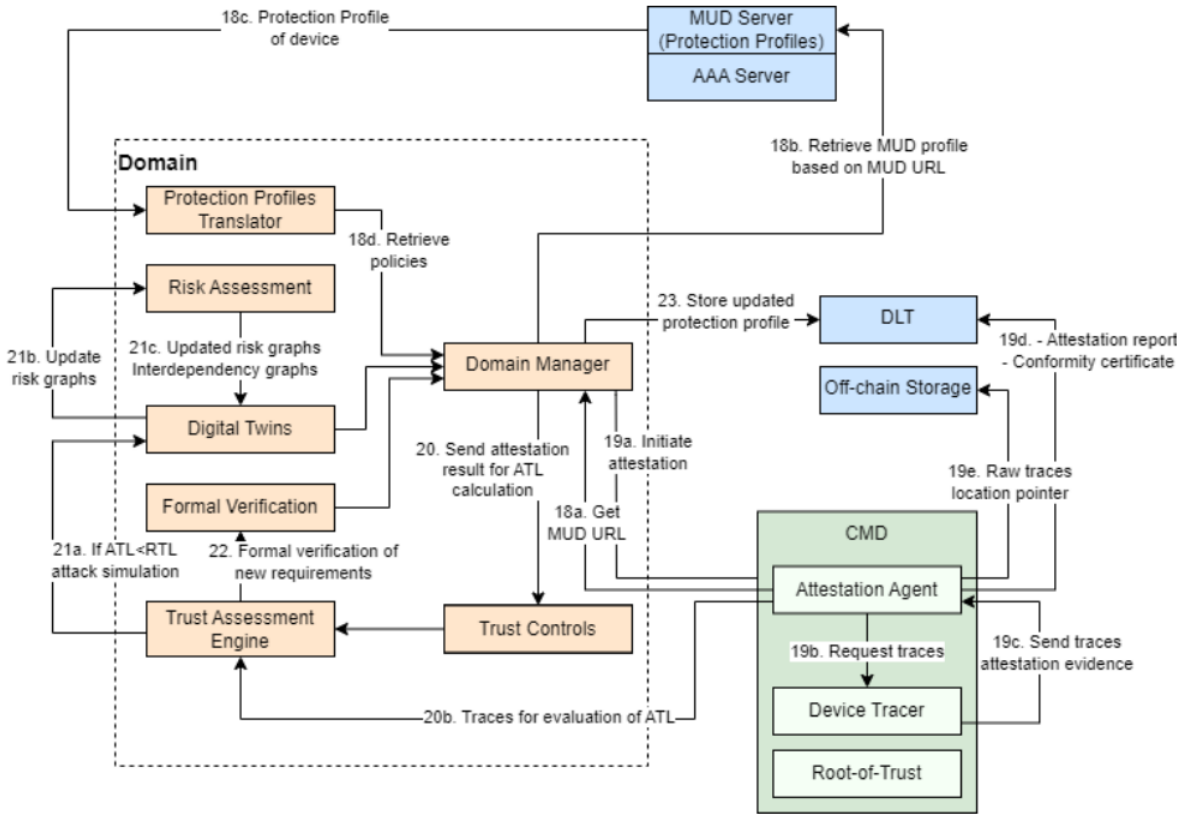


Figure 2.1.3: ENTRUST action workflow - Runtime phase.

6. **ASCLEPIOS (GA: 826093) [P58]** Fact Sheet

ASCLEPIOS focused on enhancing trust in cloud-based healthcare services by protecting sensitive data using advanced cryptography. The framework integrated several cutting-edge techniques: Searchable Symmetric Encryption (SSE) for secure cloud data querying, Attribute-Based Encryption (ABE) with revocation for fine-grained access control, and Functional Encryption (FE) to enable privacy-preserving statistical analysis directly on encrypted medical data. It also developed new attestation protocols for verifying device integrity using Trusted Execution Environments (TEEs). Blockchain or DLT were not mentioned as core cryptographic components in the provided description.

Standards Relevance: Focuses on PETs (**ISO/IEC 20889**) and TEEs, complementary to secure DLT systems.

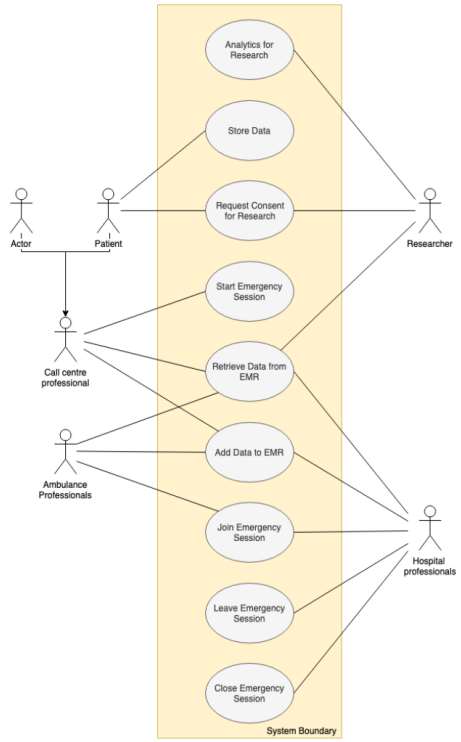


Figure 2: Demonstrator 1 use case diagram

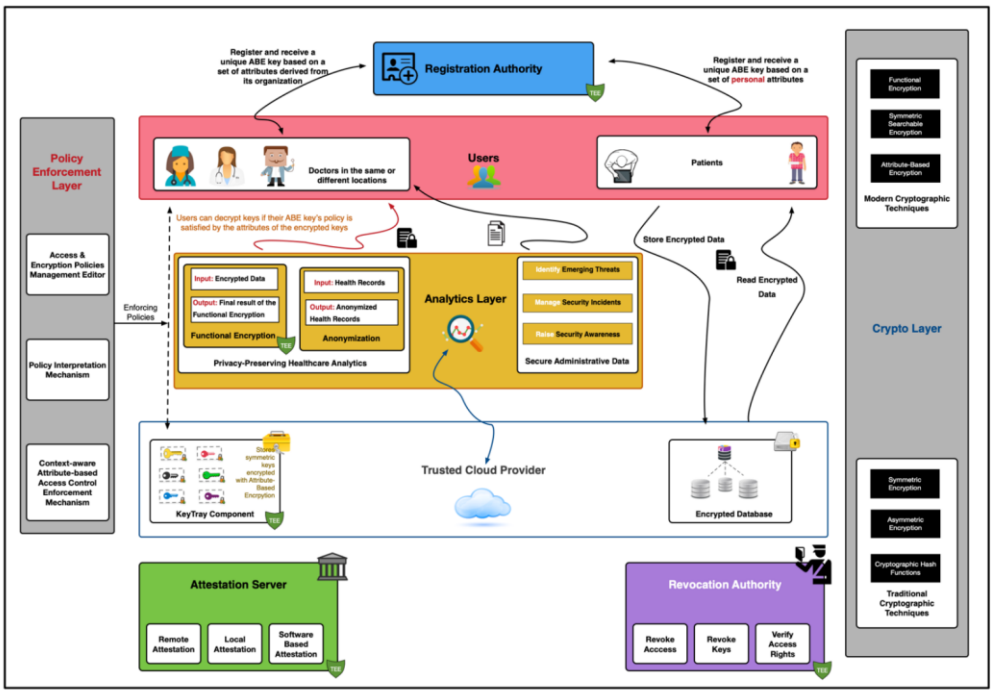


Figure 7: ASCLEPIOS Architecture

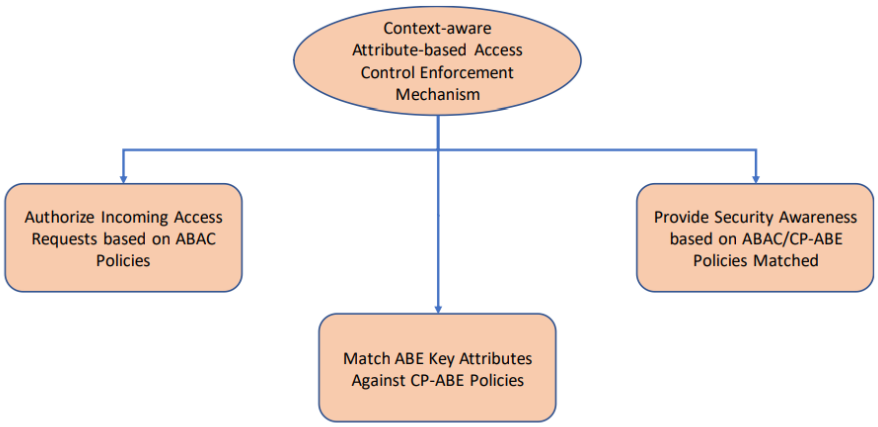


Figure 12: Context-aware Attribute-based Access Control Enforcement Mechanism

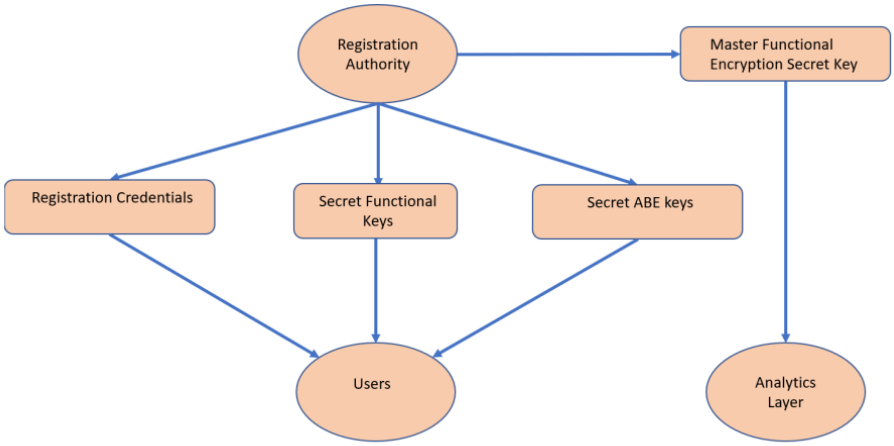


Figure 15: Registration Authority

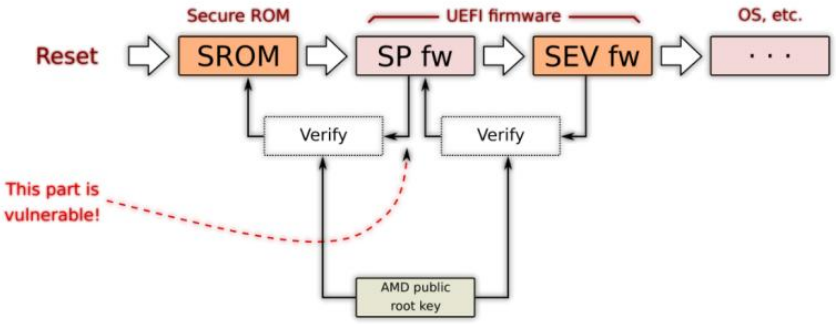
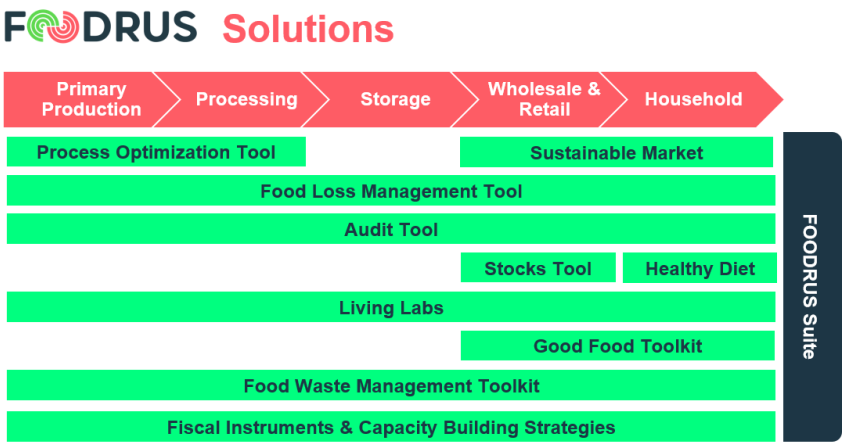


Figure 8: Broken trust chain in early AMD SEV implementations.

7. **FOODRUS (GA: 101000617) [P20]** Fact Sheet

FOODRUS aimed to reduce food loss and waste (FLW) in the agri-food chain through innovative solutions tested in Spanish, Danish, and Slovak pilots. The project incorporated blockchain technology in two key areas: firstly, underpinning a municipal "Pay As You Throw" (PAYT) scheme to securely track waste and manage incentives; secondly, enabling a novel FLW prevention certification process. This certification uses blockchain to provide transparent and immutable proof of compliance with FLW reduction practices for businesses along the food chain.

Standards Relevance: Verifiable claims (**ISO 59020**, **ASTM D8558**) and traceability.



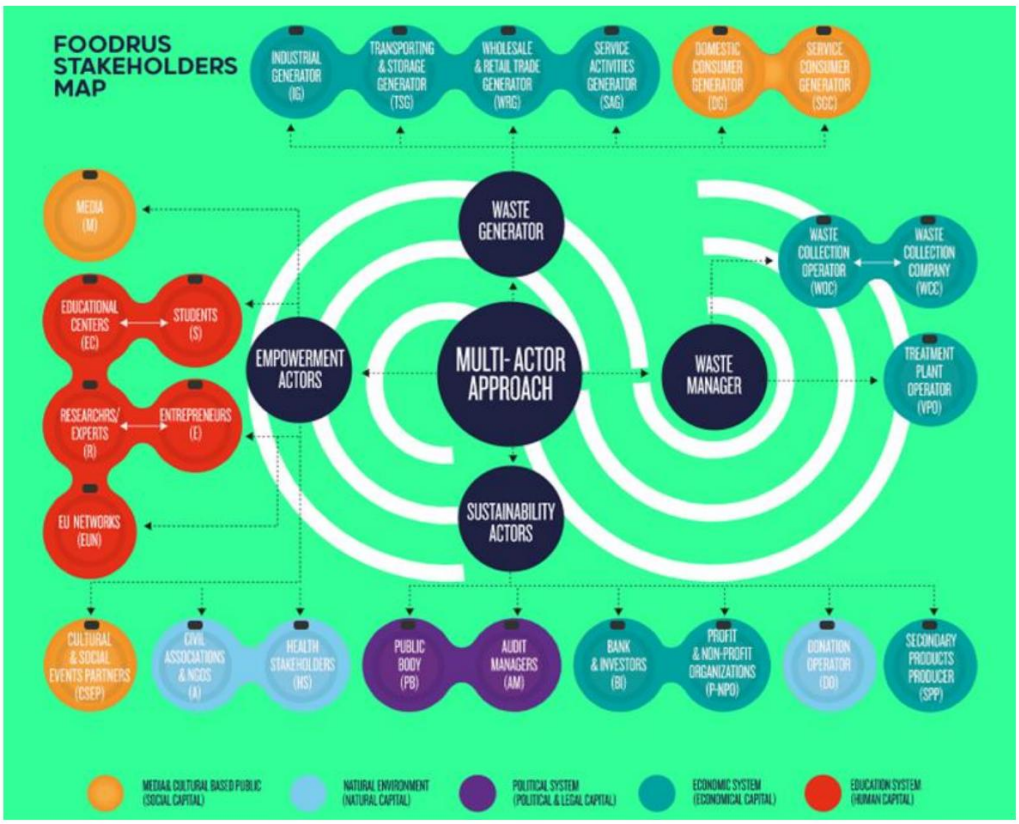


Figure 2. Stakeholder mapping in FOODRUS project (source www.foodrus.eu)

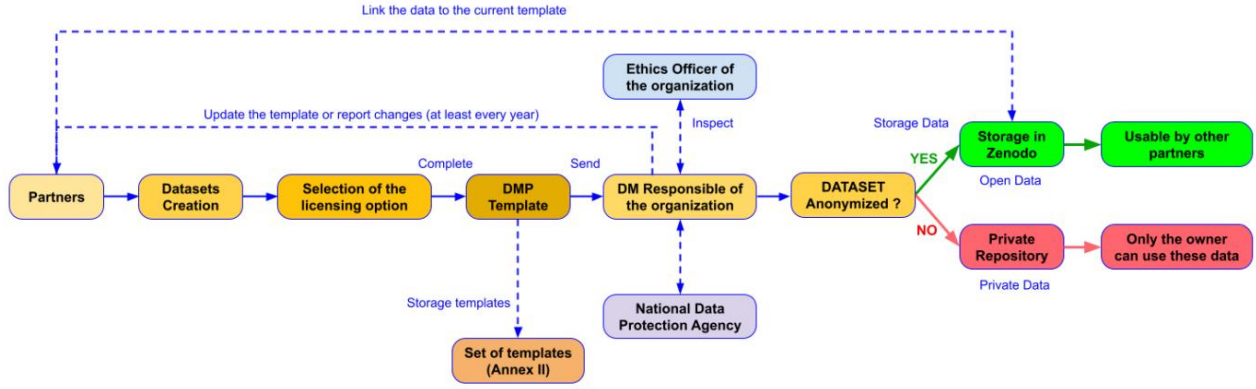


Figure 2. DMP Procedure. Source: Own elaboration.

8. **KONFIDO (GA: 727528) [P4]** Fact Sheet

KONFIDO aimed to enhance the security and trustworthiness of interoperable eHealth services, specifically building on the OpenNCP platform for cross-border Patient Summary and ePrescription exchange. It implemented a multi-pillar technological framework including security extensions using CPU hardware enclaves (Intel SGX), security solutions based on photonic technologies (potentially for key generation using PUFs), homomorphic encryption mechanisms for privacy-preserving processing, customized eIDAS-compliant eID support, enhanced SIEM solutions, and disruptive logging/auditing mechanisms based on blockchain technology to ensure integrity and accountability.

Standards Relevance: Direct use of blockchain for secure auditing, integrating with **eIDAS** and PETs (**ISO/IEC 20889**).

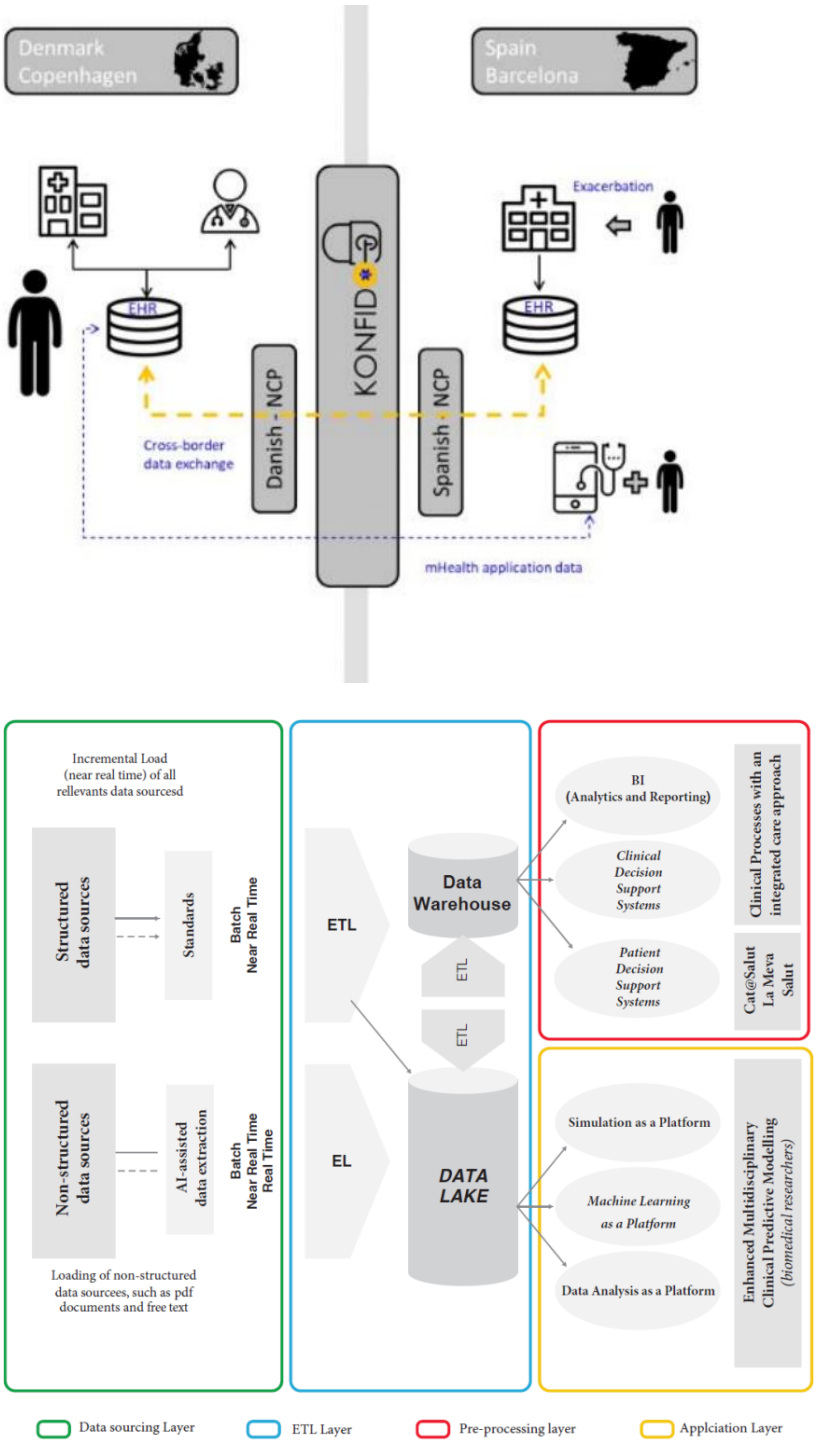


Figure 5 - High Level Architecture of the enhanced Electronic Health Record of Catalonia.

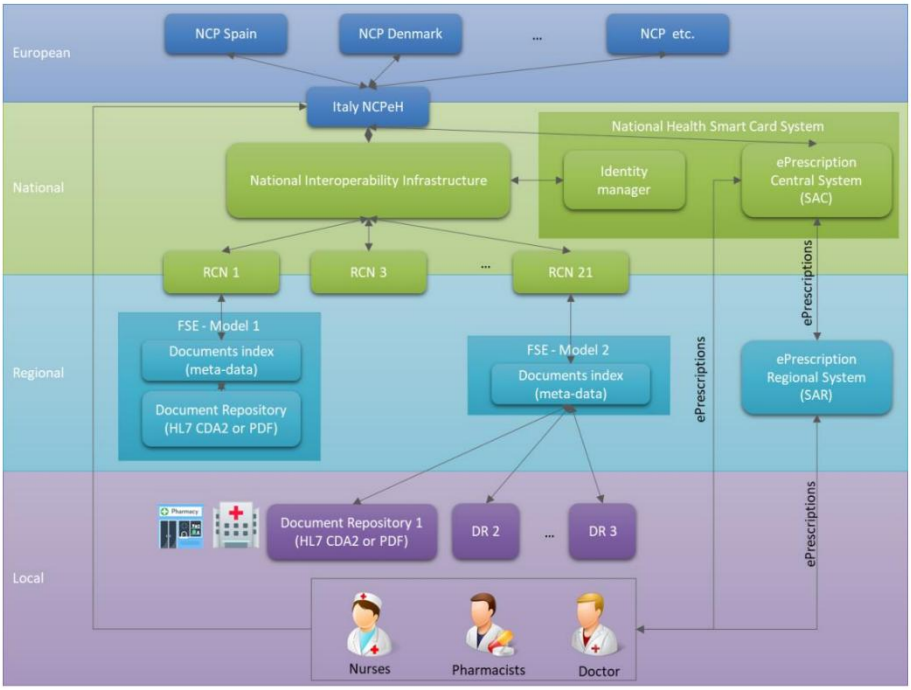


Figure 23 - Italian pilot reference infrastructure

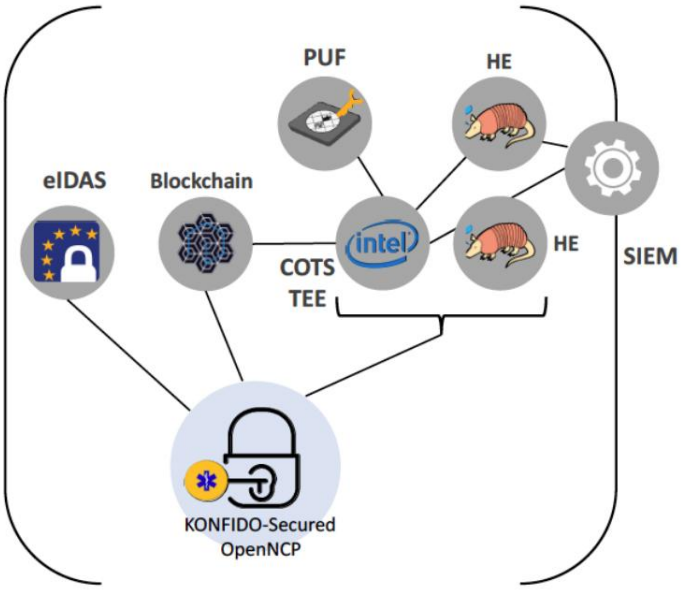


Figure 5 – Direct and Indirect Interaction of Components with OpenNCP

9. **HMCS (GA: 854670) [P54]** Fact Sheet

Handheld Molecular Contaminant Screener (HMCS), by Next Generation Sensors BV, aimed to develop a portable device for real-time detection of risk-related substances (pesticides, antibiotics, bacteria) in agro-food products using a novel portable mass spectrometry technology. The project description explicitly mentions combining the mass spectrometry sensors with blockchain technology. This DLT integration likely serves to create secure, immutable, timestamped records of the on-the-spot test results, providing a verifiable audit trail for food safety assessments conducted throughout the supply chain directly at the sampling point.

Standards Relevance: Creating verifiable records (**ASTM D8558**) from sensor data.

2.3.2 EIC Accelerator Projects

1. **TNT (Guardtime OU, 779291) [P51]** Direct link

Truth-not-Trust (TNT) developed TrueTrail (TT), a log security solution utilizing Guardtime's proprietary, production-grade blockchain technology based on hash-based cryptography (likely Keyless Signature Infrastructure - KSI). This blockchain acts as a decentralized trust anchor, providing mathematical proof of log record integrity and immutability. TrueTrail enables massive-scale, automated, and independent verification of logs, detecting tampering by malicious insiders or external attackers in real-time and ensuring long-term record validity, crucial for cybersecurity incident response in healthcare and other sectors.

Relation to healthcare: Securing healthcare system logs is a key use case for cybersecurity solutions.

Standards Relevance: Data integrity foundational to secure systems (**ISO/TC 307** Security).

2. **PatientDataChain (SETRIO SOFT SRL, 879228) [P22]** Direct link

PatientDataChain explicitly employs blockchain technology and smart contracts to disrupt patient-provider medical record exchange. The blockchain provides an immutable, tamper-proof log of healthcare records. Smart contracts are used to map and manage patient-provider relationships, giving patients granular control (accept, reject, modify) over who can access their data. The architecture is decentralized, aiming to put data control firmly in the hands of patients while facilitating secure data sharing and potentially incentivizing anonymized data contribution for research.

Relation to healthcare: Directly applied to healthcare domain.

Standards Relevance: Implements patient consent via smart contracts (**ISO/TC 307**), relevant to GDPR and potentially **W3C DID/VC** for patient identity.

3. **B-LOCS (Arxum GmbH, HORIZON-EIC-2021-ACCELERATORCHAL) [P34]** Direct link

The Blockchain-based Laboratory Operations Control System (B-LOCS) provides real-time, audit-proof monitoring for Good Manufacturing Practice (GMP) conformity in pharmaceutical labs. It records events (e.g., file creation, deletion, modification) from laboratory software systems onto a blockchain via smart contracts. These smart contracts contain the predefined, immutable GMP-relevant business logic. Any deviation from this logic detected in the event stream triggers real-time alarms, ensuring process integrity and preventing data tampering in regulated environments critical for drug development and production.

Relation to healthcare: Specifically targets Good Manufacturing Practice (GMP) conformity in pharmaceutical laboratories, using blockchain and smart contracts for real-time, audit-proof monitoring of laboratory operations and data integrity, critical for drug safety and development.

Standards Relevance: Uses smart contracts (**ISO/TC 307**) for regulatory compliance monitoring (GMP).

4. **ChemChain (My Chemical Monitoring BV, H2020-SMEInst-2018-2020-1) [P17]** Direct link

ChemChain aimed to create a trusted, open-source blockchain infrastructure for tracking chemical-related information throughout supply chains. The platform intended to record data about chemicals in raw materials and products immutably as they change hands. This decentralized approach was designed to enhance transparency, facilitate regulatory compliance (e.g., REACH), support circular economy initiatives by enabling better tracking of substances in products for recycling, and build trust among supply chain partners by providing a verifiable history of chemical composition and handling.

Relation to healthcare: Relates to healthcare through ensuring the safety and compliance of chemicals used in pharmaceuticals, medical devices, or products impacting consumer health, and facilitating risk management for recyclers/waste operators.

Standards Relevance: Traceability (**GS1**) for chemical components, supporting circularity (**ISO 59040** data needs) and compliance.

5. **DigiPharm (DIGIPHARM SWITZERLAND GMBH, 879228) [P33]** Direct link

DigiPharm developed a platform to accelerate the adoption of value-based healthcare agreements using blockchain-based smart contracts. These smart contracts automate the execution and verification of payment terms based on treatment performance and patient outcomes, reducing administrative burden, errors, and potential fraud. The platform also introduced a cryptocurrency token (DPH) as part of an incentive system, potentially rewarding data contribution, adherence, or participation within the value-based healthcare ecosystem facilitated by the blockchain solution.

Relation to healthcare: Directly applied to healthcare domain.

Standards Relevance: Uses smart contracts (**ISO/TC 307**) and tokenization (**IEEE 2418.7**) for healthcare finance models.

6. **Preemie (Tellspec Inc, 879228) [P18]** Direct link

The Preemie system for personalized nutrition in preterm infants uses blockchain technology primarily for supply chain traceability and authenticity verification. Specifically, it traces the origin of donor human milk used in NICUs and milk banks, creating an immutable record of its source and handling. This DLT application enhances safety and transparency within the milk banking process, ensuring that NICUs can trust the provenance and integrity of the milk they administer, complementing the core function of analyzing milk composition via spectroscopy and AI.

Relation to healthcare: Directly involved in neonatal healthcare, using blockchain for traceability and authenticity confirmation of donor human milk provided to preterm infants in Neonatal Intensive Care Units (NICUs) and milk banks.

Standards Relevance: Traceability (**GS1**) and authenticity verification (**ASTM D8558** concepts) in a critical healthcare supply chain.

2.3.3 Cascade Funding Projects (NGI)

1. **Aria (Dcentric Health, WOMEN TECHEU) [P26]** Direct link

Aria provides a blockchain-based medical records application focused on patient empowerment and data control, utilizing Web3 technologies. It aims to give citizens secure access to their full medical

history stored immutably on a decentralized network. Patients control sharing permissions for their tamper-proof records with providers or researchers, potentially earning rewards (facilitated via Aria's wallet) for contributing anonymized data to research. The system integrates with healthcare provider systems via API to streamline data flow within this patient-centric ecosystem.

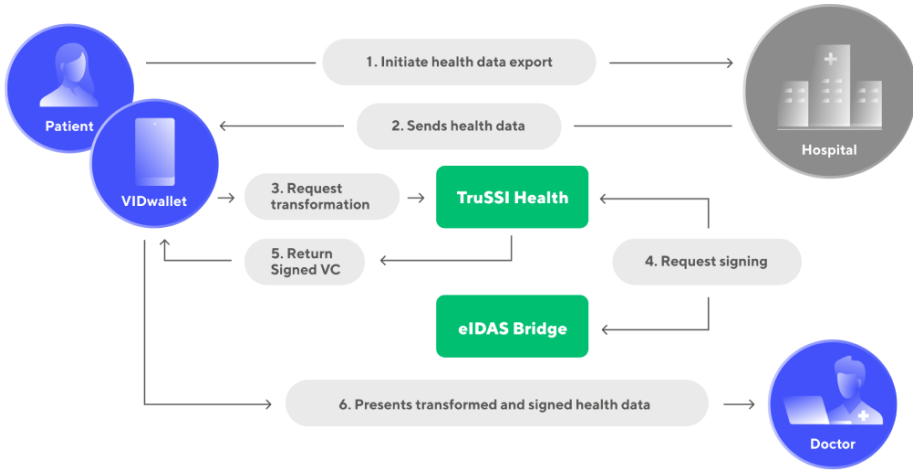
Relation to healthcare: Directly applied to healthcare domain.

Standards Relevance: Leverages **W3C DID/VC** concepts for patient control and potentially tokenization (**IEEE 2418.7**) for rewards.

2. **Trussihealth (ONTOCHAIN) [P23]** Direct link

Trussihealth developed middleware to bridge traditional health data formats with decentralized identity standards. It converts health data from HL7 FHIR format into W3C Verifiable Credentials (VCs). To ensure trustworthiness and legal validity, it integrates an "eIDAS bridge" tool to apply qualified or advanced electronic signatures to these VCs. This enables patients to hold verifiable, legally recognized copies of their health data in their Self-Sovereign Identity (SSI) wallets (e.g., VIDwallet), enhancing data portability and interoperability in compliance with eIDAS 2 principles.

Relation to healthcare: Directly applied to healthcare domain.



Standards Relevance: Directly implements **W3C VC** standards, bridging with healthcare data formats (FHIR) and **eIDAS**.

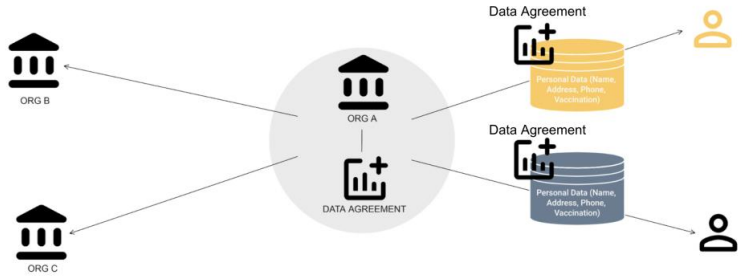
3. **PS-SDA (ONTOCHAIN) [P24]** Direct link

Provenance Services with Smart Data Agreements (PS-SDA) enhances the iGrant.io MyData Operator platform by integrating blockchain for data provenance and GDPR compliance enforcement. It extends Data Agreement specifications (based on W3C DID:mydata) to include provenance metadata, storing these agreements immutably on a DLT. Smart contracts guarantee the creation of Data Agreements (mutually signed by organization and individual) during B2B data exchanges and enforce GDPR rules. The provenance trail allows auditing and verification of legitimate data processing rights. Demonstrated in a health data space for diabetes.

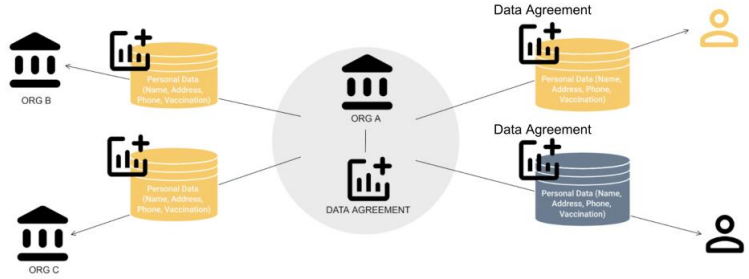
Relation to healthcare: Directly applied to healthcare domain.

Standards Relevance: Implements **W3C DID** and uses smart contracts for GDPR compliance.

Data Agreements in **data sharing:**
Mutually signed between an organisation and an individual



Data Agreements in **data sharing**:
Extended with provenance data and enforced via smart contracts

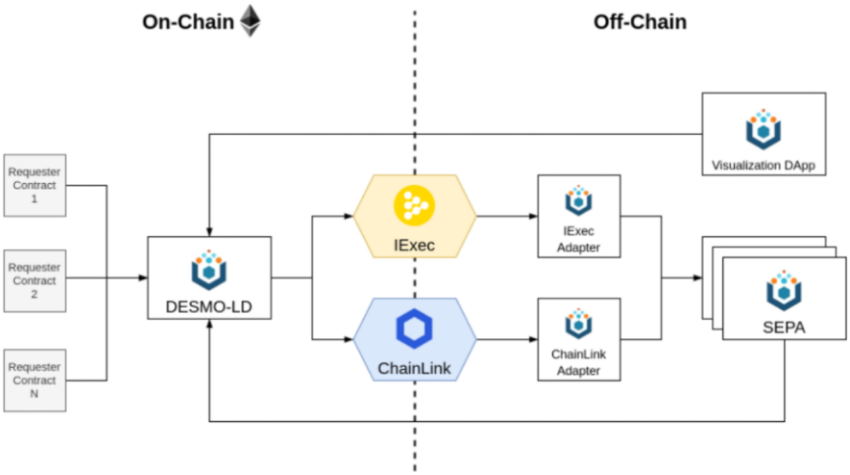


4. **DESMO-LD (ONTOCHAIN) [P40]** [Direct link]

Decentralized Smart Oracles for Trusted Linked Data (DESMO-LD) enables Ethereum smart contracts to securely access off-chain Linked Data sources, particularly IoT data described using Web of Things (WoT) ontologies. It acts as a decentralized oracle system, potentially leveraging ChainLink and iExec adapters. Requests for data are handled by smart contracts, which select appropriate nodes (Things Description Directories - TDDs) to resolve queries and perform data quality control, providing trustworthy real-world data feeds to on-chain applications, relevant for smart mobility or environmental/health monitoring.

Relation to healthcare: Creates decentralized smart oracles for linked data, potentially including IoT data from environmental or health monitoring, enabling trustworthy off-chain data feeds for on-chain healthcare applications or smart contracts.

Standards Relevance: Addresses oracle problem for linking blockchain (**ISO 23257**) to external semantic data (WoT/Linked Data).

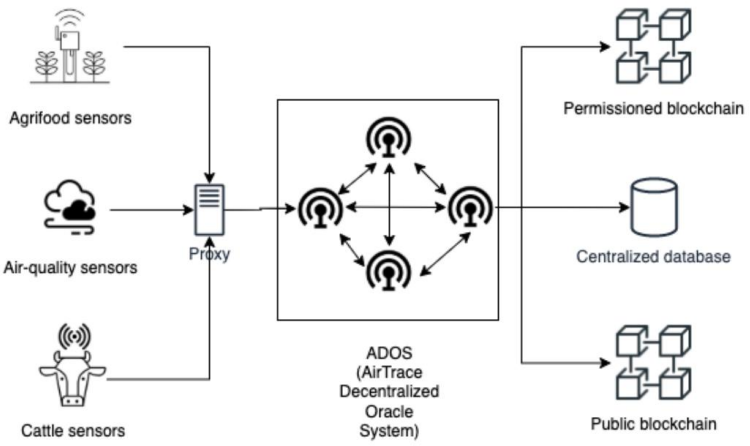


5. **ADOS (ONTOCHAIN) [P39]** [Direct link]

AirTrace Decentralized Oracle System (ADOS) provides an AI-enhanced oracle for IoT data integrity. Before injecting sensor data into a blockchain, ADOS uses anomaly detection algorithms (considering geospatial or ontological relationships between devices, potentially run via iExec TEEs) to calculate a Data Quality Factor (DQF). This DQF is then recorded on-chain alongside the data hash/reference, providing a verifiable measure of data reliability for auditing purposes, crucial for applications relying on trustworthy IoT data, such as remote health monitoring.

Relation to healthcare: Relevant to healthcare scenarios involving remote patient monitoring or connected medical devices where data reliability is critical.

Standards Relevance: Addresses oracle problem for trusted IoT data (**IEEE P2418.1**).



6. **GUEDHS (TrustChain) [P25]** [Direct link]

GUEHDS focuses on trustworthy and privacy-preserving secondary use of health data, implementing a Federated Learning (FL) framework based on PySyft. While FL keeps raw data local, GUEDHS adds a governance layer using a distributed ledger to audit data access permissions and consent management. It maps healthcare data governance actions to the PROV-DM provenance model, allowing data custodians to monitor and control the use of their data within the federated network, demonstrated via a tripledemic clinical study.

Relation to healthcare: Directly applied to healthcare domain.

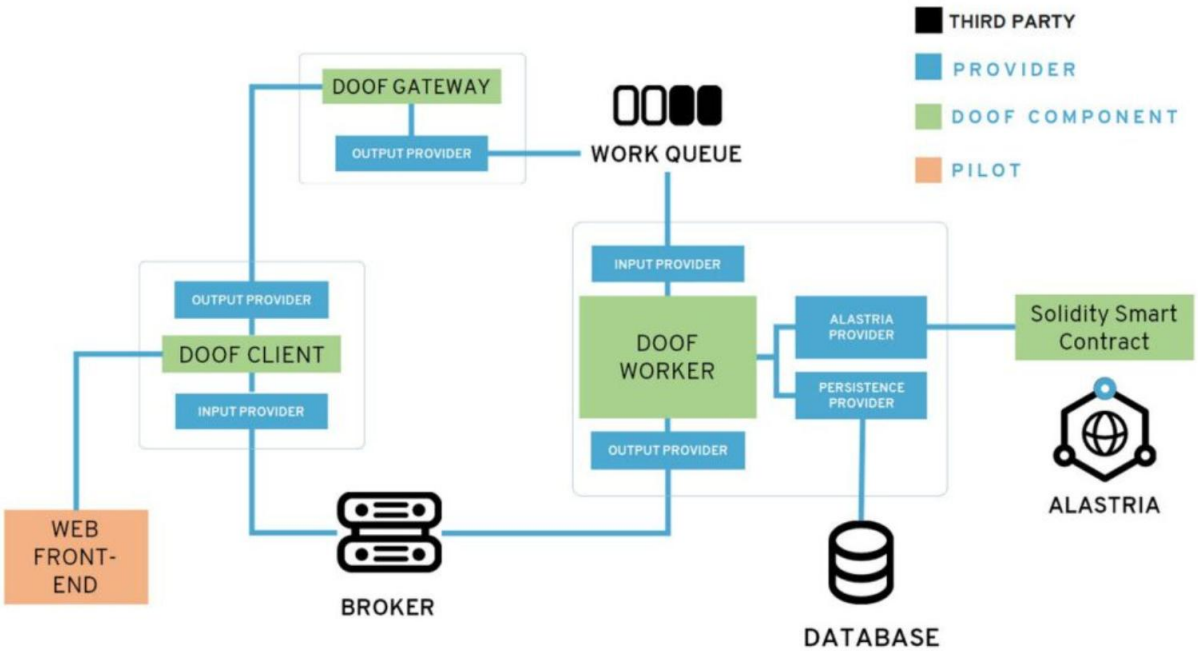
Standards Relevance: Combines PETs (FL) with blockchain for auditable governance (**ISO/TC 307** Governance).

7. **DOOF (TrustChain) [P56]** Direct link

Data Ownership Orchestration Framework (DOOF) provides SDKs, libraries, and smart contracts (deployed on Alastria) to enable decentralized consent management and enforce data rights according to GDPR and the Data Act. It allows individuals to control the visibility and sharing of their personal data, demonstrated with smart home IoT device data (air quality), but applicable to other domains like health. It features a configuration tool and a web-based data exchange platform for user interaction.

Relation to healthcare: Mentioned as applicable horizontally to sectors including health, enabling GDPR/Data Act compliance for health-related device data.

Standards Relevance: Uses smart contracts (**ISO/TC 307**) for regulatory compliance (GDPR, **Data Act**).



8. **AI-MetaBloQ (TrustChain) [P28]** Direct link

AI-MetaBloQ developed a Distributed Ledger Technology (DLT) based Marketplace combined with a Reactive AI tool specifically for managing human biosamples and associated patient data. The DLT marketplace facilitates secure, transparent, and regulatory-compliant data exchange and service provision between patients/donors, biobanks, and researchers. It incorporates decentralized digital identity principles ("Ledger of Me"). The reactive AI assesses biosample quality in real-time based on pre-analytical data and predicts suitability for research, enhancing the value and utility of shared biospecimens.

Relation to healthcare: Directly targets the biomedical research and biobanking sector, providing a DLT marketplace with AI for managing, quality assessing, and facilitating the exchange of human biosamples and associated patient data between donors, biobanks, and researchers.

Standards Relevance: Combines DLT marketplace with **W3C DID/VC** concepts.

9. **MultiPass (TrustChain) [P43]** [Direct link]

Multi-chain product passports (MultiPass) addresses the interoperability challenge for Digital Product Passports (DPPs) by enabling verifiable DPP data to be stored across multiple, potentially incompatible ledgers. It uses a trust delegation framework (inspired by TUF) rooted at the product creator to manage custody and locate current data pointers securely. A semantics interoperability module and Relationship-Based Access Control enhance cross-domain data understanding and access control. Relevant for tracking medical devices or pharmaceuticals across different custodian systems.

Relation to healthcare: It is relevant to healthcare for tracking the lifecycle and verifiable data (materials, manufacturing, usage) of medical devices and pharmaceuticals across complex supply chains involving multiple stakeholders and systems.

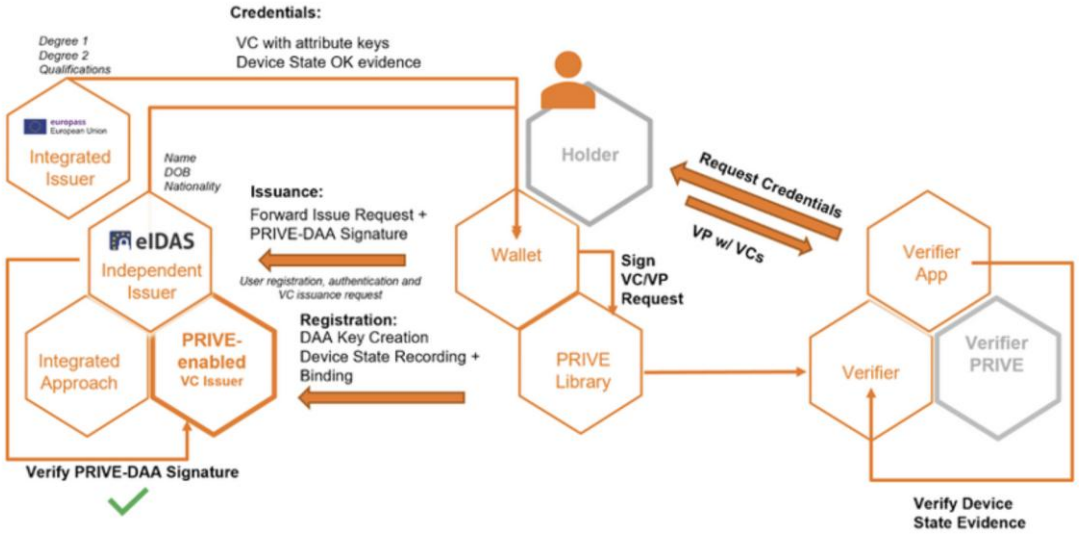
Standards Relevance: Addresses DPPs (**ISO 59040**) and interoperability (**ISO 23257**, **ISO/TR 6277**).

10. **PRIVÈ (TrustChain) [P55]** [Direct link]

PRIVÈ enhances Self-Sovereign Identity (SSI) wallet security by enabling the use of hardware-based keys (via Trusted Components like TPMs or Secure Elements) for managing Verifiable Credentials (VCs). It developed an open-source library extension for wallets that uses Attribute-based Direct Anonymous Attestation (DAA-A) protocols. This allows holders to prove possession of credentials and device integrity with higher assurance (meeting eIDAS LoA requirements) without revealing unnecessary information, crucial for sensitive credentials like medical qualifications.

Relation to healthcare: It's particularly valuable in healthcare for securing high-assurance credentials, such as verifying the qualifications and identity of medical professionals accessing sensitive systems or data.

Standards Relevance: Advanced implementation of **W3C VC** security aligned with **eIDAS**.



Use Case Scenario: "Sustainability for inter-Mobility"; Image taken from: https://github.com/NGI-TRUSTCHAIN/PRIVE

11. **SSITIZEN (TrustChain) [P57]** Direct link

SSITIZENS combines SSI with blockchain-based e-money tokens to improve social inclusion and public service delivery. It uses digital identity standards (EBSI, Alastria ID mentioned) enabling vulnerable citizens to securely authenticate and present verifiable credentials to access services or apply for social aid (including healthcare benefits). The e-money tokens, managed on a blockchain, facilitate transparent and traceable disbursement of aid, redeemable by local merchants, supporting local economies while ensuring aid reaches intended recipients securely.

Relation to healthcare: Focuses on social inclusion and public services, explicitly including access to healthcare benefits for vulnerable citizens through secure authentication using SSI (EBSI/Alastria ID) and transparent aid distribution via blockchain-based e-money tokens.

Standards Relevance: Implements **W3C DID/VC** aligned with **EBSI** and tokenization (**IEEE 2418.7**).

12. **Trade on Chain (TrustChain) [P31]** Direct link

This project built an open-source blockchain platform to digitize and automate international trade contracts, aiming to reduce complexity and barriers for SMEs. It utilizes Self-Sovereign Identity (SSI) and Verifiable Credentials (VCs) for secure party identification and authentication within a decentralized environment. Smart contracts automate key processes like payments based on predefined conditions (e.g., delivery confirmation) and compliance checks. Integration with customs and payment systems streamlines the end-to-end trade flow, applicable also to the trade of medical supplies.

Relation to healthcare: Its relevance to healthcare lies in facilitating the secure, efficient, and trusted global exchange of medical supplies, equipment, and pharmaceuticals.

Standards Relevance: Leverages **W3C DID/VC** and smart contracts (**ISO/TC 307**) for trade.

13. **CHECKS (TrustChain) [P44]** Direct link

CHECKS developed a verification service to enhance trust in e-commerce by allowing SMEs (web shops) to provide verifiable public data about their business identity and credentials. It leverages blockchain and SSI technologies (compatible with did:alas, did:ebsi) and implements standards like DIF's Linked Verifiable Presentations. A Verifiable Data Service enables self-sovereign management of this public data, while the Verification Service allows consumers to easily authenticate web shops, reducing fraud risk. Relevant for verifying online sellers of health products or supplements.

Relation to healthcare: In the healthcare context, this can be used to increase consumer trust by verifying the authenticity and credentials of online pharmacies, health product retailers, or supplement vendors.

Standards Relevance: Implements **W3C DID/VC** and DIF standards compatible with **EBSI**.

Section 3: Bibliography / Sources Consulted

3.1 Introduction

This section provides the bibliography compiled during the research for D1. It includes academic papers, conference proceedings, technical reports, standards documents, project documentation, websites, and other relevant sources consulted to build the state-of-the-art analysis. The list is structured based on the reference list presented in Chapter 9 of the updated D1 report.

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Section 4: Stakeholder Engagement Strategy to Expand on Deliverable 1 Findings

4.1 Introduction: Building on the State-of-the-Art Analysis

The State-of-the-Art Analysis (Deliverable 1, hereafter D1) provided a comprehensive overview of the current landscape of blockchain standards relevant to circular supply chains, particularly in agriculture and healthcare. It identified key standards, enabling technologies, dominant application patterns from EU projects, and significant gaps/challenges (e.g., interoperability, SME adoption, integration with circularity metrics, data quality). During the compilation of the report, the research underpinning D1 involved engagement with various stakeholders through the analysis of project documentation (CORDIS, EIC, NGI), review of publications from standardization bodies (ISO, IEEE, CEN-CENELEC, ETSI, W3C, GS1), and consultation of academic literature and industry reports. While direct stakeholder interviews or workshops were not part of the scope for generating D1 based on the provided inputs, the selection of projects and standards reflects the key actors and priorities within the European blockchain ecosystem relevant to circular supply chains, particularly in agriculture and healthcare.

This section outlines a targeted stakeholder engagement strategy designed specifically to build upon the findings of D1 to advance from a descriptive assessment to a more actionable, practitioner-informed roadmap. This strategy is currently in the planning phase and has not yet been implemented; rather, it represents a forward-looking set of recommendations to enhance and complement the findings of the initial analysis. The goal is not general outreach, but rather a focused effort to deepen the understanding of the identified issues, validate the analysis with real-world experience, and gather specific input needed to formulate actionable recommendations for future standardization efforts and policy support. This engagement is crucial for moving beyond the 'state-of-the-art' towards practical solutions and effective standard adoption.

The **primary objectives** of the stakeholder engagement strategy are:

1. **Identify Needs and Gaps:** Gather insights from stakeholders on current challenges, requirements, and gaps in blockchain standards relevant to circular SCM in target sectors.
2. **Monitor the Landscape:** Track ongoing standardization activities within key SDOs (ISO, CEN-CENELEC, IEEE, ETSI, W3C, GS1, etc.) and relevant industry initiatives.
3. **Gather Feedback:** Collect feedback on proposed standards, technical specifications, use cases, and best practices from potential implementers and users (including SMEs).
4. **Facilitate Consensus Building:** Provide platforms for discussion and dialogue among diverse stakeholders to foster consensus on priority areas and technical approaches.
5. **Promote Adoption:** Raise awareness about relevant standards and encourage their adoption by industry, technology providers, and policymakers.
6. **Provide Input to SDOs:** Consolidate stakeholder feedback and technical insights into concrete contributions (e.g., comments on drafts, new work item proposals) to relevant standardization committees and working groups.

7. **Ensure Alignment:** Foster alignment between standardization efforts, EU policy objectives (Green Deal, CEAP, Data Strategy, eIDAS 2), and the practical needs of European businesses, especially SMEs.

4.2 Identification of Key Stakeholder Groups

A successful engagement strategy must target all relevant actors within the ecosystem. Key groups include:

4.2.1 Standardization Bodies (SDOs)

- **International:** ISO (TC 307, TC 323, JTC 1/SC 42 for AI), IEEE (P2418 series), ITU-T, W3C, ASTM International.
- **European:** CEN-CENELEC (JTC 19), ETSI (ISG PDL).
- **National:** DIN, BSI, AFNOR, etc. (as relevant).
- **Domain-Specific:** GS1 (Supply Chain Identification & Data), potentially others in agriculture/healthcare.
- **Engagement Goal:** Monitor activities, participate in committees/working groups, submit contributions, establish formal liaisons.

4.2.2 Industry and Business Associations

- **Sectoral:** Associations representing agriculture, food production, healthcare providers, pharmaceutical manufacturers, medical device companies, logistics, waste management, recycling industries.
- **Cross-Sectoral:** Associations focused on digital technologies, blockchain, circular economy, SMEs (e.g., SMEunited).
- **Engagement Goal:** Understand industry needs and pain points, disseminate information, gather feedback on usability and relevance, identify pilot opportunities, represent SME perspectives.

4.2.3 EU-Funded Projects and Research Initiatives

- **Blockchain/DLT Projects:** CORDIS projects (RIAs/IAs), EIC Accelerator projects, NGI Cascade Funding projects (ONTOCHAIN, TrustChain, etc.) focused on DLT applications.
- **Circular Economy Projects:** Initiatives focusing on DPPs, resource efficiency, reverse logistics, etc.
- **Related Technology Projects:** Initiatives working on IoT, AI, Big Data, Cybersecurity relevant to SCM.
- **Coordination Actions:** Projects like BlockStand itself, TRACE4EU, potentially others coordinating standardization or deployment.
- **Engagement Goal:** Share findings, identify synergies, learn from implementation experiences, gather technical requirements, avoid duplication of effort, leverage project results for standardization input.

4.2.4 Policymakers and Regulatory Bodies

- **European Commission:** DG CNECT, DG GROW, DG ENV, DG SANTE, DG AGRI, JRC.
- **European Parliament:** Relevant committees (e.g., ITRE, ENVI, IMCO).
- **National Ministries & Agencies:** Relevant bodies in Member States dealing with digitalization, environment, economy, health, agriculture.
- **Data Protection Authorities:** Ensuring alignment with GDPR.
- **Engagement Goal:** Understand policy priorities, provide technical input on feasibility/impact of regulations (e.g., ESPR/DPPs, Data Act, eIDAS 2, AI Act), ensure standards support policy goals, raise awareness of standardization benefits.

4.2.5 Technology Providers and SMEs

- **DLT Platform Providers:** Companies developing core blockchain protocols and platforms.
- **Solution Providers:** Companies building applications on top of DLTs for SCM, traceability, sustainability reporting, etc.
- **Consultancies:** Firms advising businesses on DLT and circular economy implementation.
- **SMEs:** Businesses operating within agricultural, healthcare, or related circular supply chains who are potential users or participants in DLT systems.
- **Engagement Goal:** Understand technical capabilities and limitations, gather feedback on standard implementability, identify SME-specific barriers and needs, promote standards adoption, facilitate matchmaking.

4.2.6 End-Users and Civil Society Organizations

- **Consumer Organizations:** Representing end-user interests regarding transparency, product information, and data privacy.
- **Environmental NGOs:** Advocating for robust circular economy practices and environmental protection.
- **Patient Advocacy Groups:** Representing patient interests in healthcare data management and privacy.
- **Academic Researchers:** Contributing technical expertise and independent analysis.
- **Engagement Goal:** Understand societal expectations and concerns, ensure standards address ethical considerations, gather feedback on usability and trust, promote public acceptance.

4.3 Engagement Methods and Activities

A multi-faceted approach is required to effectively reach and engage these diverse stakeholder groups:

4.3.1 Direct Participation in SDOs

- Actively participating in relevant technical committees and working groups within ISO, CEN-CENELEC, IEEE, ETSI, W3C, etc.

- Submitting formal contributions, comments on draft standards, and potentially New Work Item Proposals (NWIPs) based on project findings and consolidated stakeholder feedback.
- Seeking formal liaison status where appropriate.

4.3.2 Workshops and Focus Groups

- Organizing targeted workshops (physical, virtual, or hybrid) focusing on specific topics (e.g., DPP standards for textiles, blockchain interoperability for food traceability, SME challenges in DLT adoption).
- Conducting smaller focus groups with specific stakeholder types (e.g., SMEs, recyclers, healthcare data managers) to delve deeper into particular issues.
- Presenting interim findings and gathering structured feedback.

4.3.3 Surveys and Questionnaires

- Designing and distributing online surveys to reach a broader audience and gather quantitative data on needs, priorities, and barriers related to blockchain standards for circular SCM.
- Targeting specific stakeholder groups with tailored questionnaires.

4.3.4 Bilateral Meetings and Interviews

- Conducting targeted interviews with key experts, industry leaders, policymakers, and representatives from influential projects or organizations.
- Holding bilateral meetings to discuss specific collaboration opportunities or gather in-depth insights.

4.3.5 Liaison with Related Initiatives

- Establishing formal or informal links with other relevant EU projects (CSAs, RIAs, IAs), industry alliances (e.g., Catena-X, GAIA-X), and standardization coordination bodies.
- Participating in joint workshops or events to share knowledge and align activities.

4.3.6 Dissemination and Communication Channels

- Maintaining a project website with up-to-date information, reports, and event announcements.
- Utilizing social media (e.g., LinkedIn, X) for broader outreach and engagement.
- Publishing reports, white papers, policy briefs, and potentially academic articles.
- Presenting findings at relevant conferences and industry events.
- Developing accessible summaries and explainers, particularly targeting SMEs.

4.3.7 Public Consultations and Feedback Mechanisms

- Making key draft deliverables or position papers publicly available for comment via the project website or dedicated platforms.

- Providing clear channels for stakeholders to submit feedback and inquiries.

4.4 Expected Outcomes and Impact

The intended outcomes of this comprehensive stakeholder engagement strategy include:

- **Consolidated Requirements:** A clear understanding of the priority standardization needs for blockchain in circular SCM for agriculture and healthcare, including SME-specific requirements.
- **Informed Contributions:** High-quality, evidence-based contributions submitted to relevant SDOs, influencing the development of practical and widely accepted standards.
- **Increased Awareness & Adoption:** Greater awareness among stakeholders about the role of blockchain and the importance of standards, leading to increased willingness to adopt standardized solutions.
- **Stronger Ecosystem:** A more connected and collaborative European ecosystem for blockchain and circularity, with better alignment between research, industry, policy, and standardization.
- **Policy Support:** Ensuring that standardization efforts effectively support the implementation of key EU policies like the Green Deal, CEAP, and digital single market strategies.
- **Enhanced Relevance:** Ensuring that the project's outputs (reports, recommendations) are directly relevant and valuable to the target stakeholders.

4.5 Monitoring and Evaluation

The effectiveness of the engagement strategy should be continuously monitored and evaluated through:

- Tracking participation rates in workshops, surveys, and consultations.
- Analyzing the quality and relevance of feedback received.
- Monitoring the uptake and citation of project contributions within SDOs.
- Assessing website traffic and social media engagement metrics.
- Gathering qualitative feedback from key stakeholders on the engagement process.
- Regularly reviewing and adapting the strategy based on evaluation findings.

The outlined structured approach can effectively engage the necessary stakeholders to ensure that blockchain standardization efforts meaningfully contribute to a more circular and sustainable European economy.