Digital Trust Ecosystem in Healthcare

Marco Cuomo and Daniel Fritz
Blockchain in Healthcare Conference
University of Zürich
20 October 2021

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Agenda

- Why Blockchain - The 5 A's

- Consortium approach - PharmaLedger

- Use cases

- Governance and Legal Implications

- Q&A

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Blockchain – the 5 A's

Asset
manage assets like cryptocurrency (solves the double spend problem), products, and data

Audit
immutability, no changes possible without consensus

Automate
leverage smart contracts

Anonymize
protect privacy

All for one, one for all
consortium approach, no single/central authority

PharmaLedger

Innovative Medicines Initiative (IMI)
## *Europe's partnership for health*

IMI1: 2008-2014

€2 bn budget
59 projects

The Innovative Medicines Initiative is the largest public-private partnership aiming to boost pharmaceutical innovation in Europe and to speed up the development of better and safer medicines for patients. IMI is a joint undertaking between the European Union and the pharmaceutical industry association EFPIA.
www.imi.europa.eu

IMI2: 2014-2024

€3.3 bn budget
More ambitious
Greater scope

60 projects so far

imi

> €5 bn

€2.5 bn

efpia

€2.5 bn

Partnership 2008 - 2024
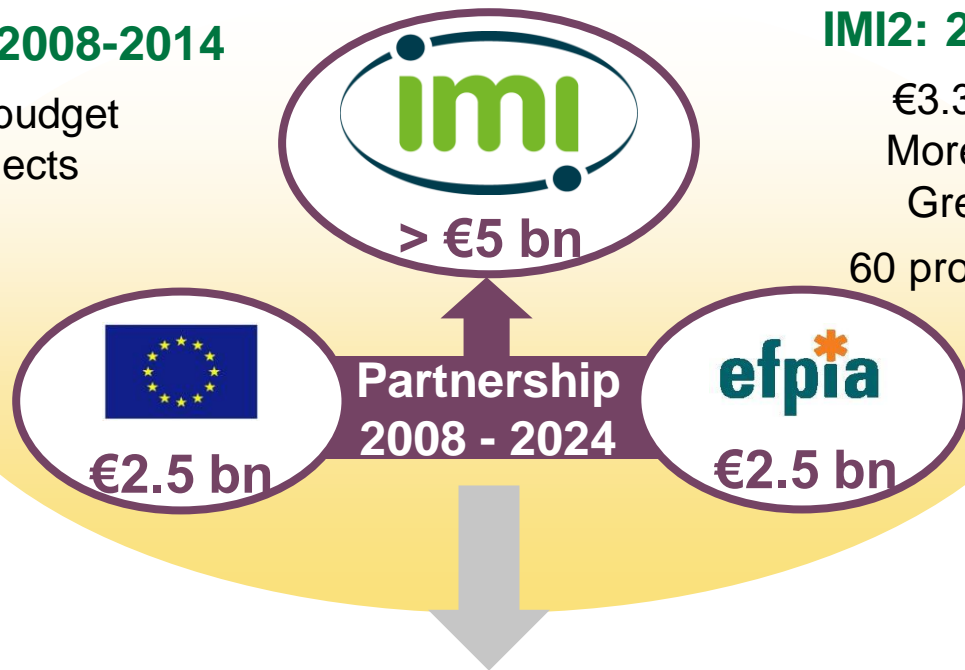
PharmaLedger – Blockchain Enabled Healthcare

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PHARMALEDGER IN A NUTSHELL

Who? Pharmaceutical companies, hospitals, universities, patient organizations, tech companies... **building an ecosystem!**

Why? To **empower patients**, increase **digital trust**, enable medicine drug traceability and **data privacy**, and foster a **new culture of collaboration in healthcare**.

What? A blockchain-based **platform proven through reference use cases** in supply chain, clinical trials and health data. A governance function for sustainability and legal, regulatory and data privacy compliance.

How? A public-private partnership of like-minded, **collaborative partners working together and engaging patients, HCPS, regulators**, other IMI projects and 3rd parties through several communication channels.

Duration
3 years
Jan 20 – Dec 22

Consortium
29 partners

EEAB
External expert advisory board
10 members

Budget
22 million Euros

Focus Areas
Supply Chain, Clinical Trial, and Health Data

Ethics Board
6 members

NOVARTIS
PDM
Arteevo
Ekon
abbvie
BAYER
janssen
novo nordisk
Roche
Boehringer Ingelheim
ICSI
DEMOCRITUS UNIVERSITY OF THRACE
Bambino Gesù OSPEDALE PEDIATRICO
EPF European Patients Forum

POLITÉCNICA
RomSoft
TECHNOVATIVE SOLUTIONS
CERTH CENTRE FOR RESEARCH & TECHNOLOGY HELLAS
AstraZeneca
gsk
MSD
Pfizer
ucb Inspired by patients. Driven by science.
Onorach
Uniklinikum Würzburg UK
Hospital de Espírito Santo E.P.E.
iNCM
EF CCr
KU LEUVEN CITIP

PharmaLedger

The Consortium

29 complementary partners from 10 EU Member States, Switzerland, Israel & US

- **12 EPFIA members** → ABBV, AZN, BAYER, GSK, JANSEN, MSD, NOVO, NVS, PFE, ROCHE, UCB, BI

- **5 SMEs** (Blockchain/ICT) → RMS, PDM, AVO, TVS, EKN

- **4 Research & Tech. Universities** UPM, CERTH ICSI & DUT

- **1 Social & legal sciences Uni** → KUL

- **2 Patients organizations** → EPF, EFGCP

- **1 Government authority** → INCM

- **1 CRO** → ONO

- **3 Hospitals** → OPB, HES, UKW
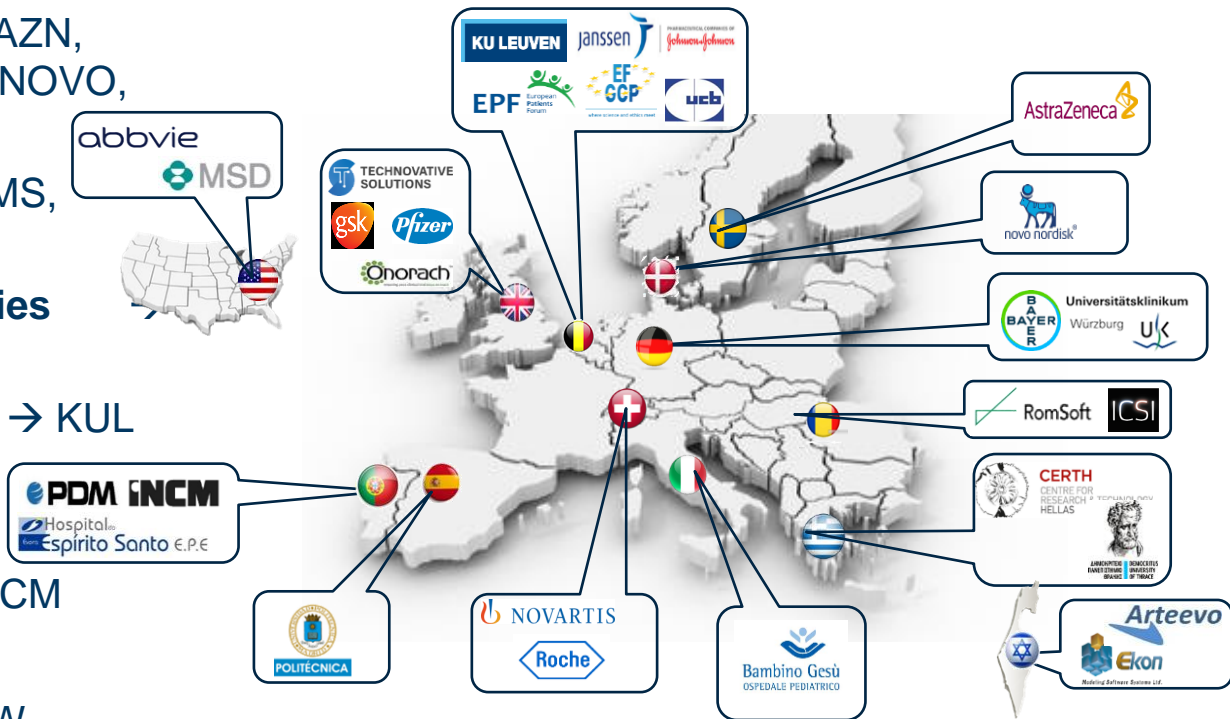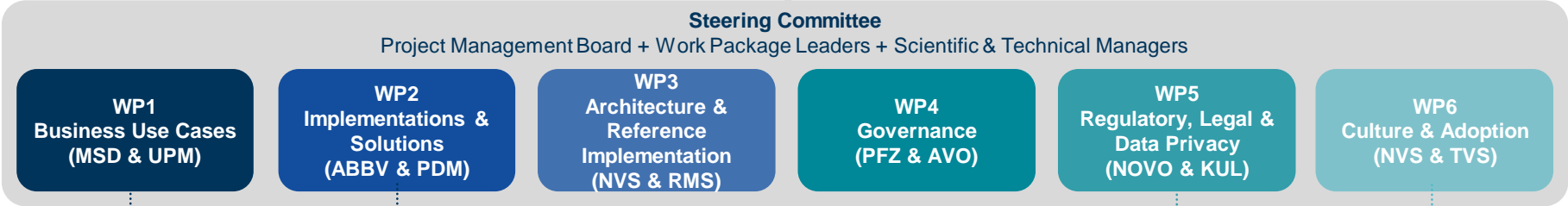
PROJECT ORGANIZATION & GOVERNANCE

PharmaLedger

EU & EFPIA
(Innovative Medicine Initiative)

External Expert Advisory Board

Project Management Board
Project Leader: NVS | Coordinator: UPM

Ethics Board

Steering Committee
Project Management Board + Work Package Leaders + Scientific & Technical Managers

| **WP1** **Business Use Cases** **(MSD & UPM)** | **WP2** **Implementations & Solutions** **(ABBV & PDM)** | **WP3** **Architecture & Reference Implementation** **(NVS & RMS)** | **WP4** **Governance** **(PFZ & AVO)** | **WP5** **Regulatory, Legal & Data Privacy** **(NOVO & KUL)** | **WP6** **Culture & Adoption** **(NVS & TVS)** |

DRA1 | Supply Chain
J&J, Bayer & PDM
DRA2 | Health Data
UCB & UPM
DRA3 | Clinical Trial
UCB & ONO, OPGB

Scientific Manager
CERTH

Sustainability & Innovation Manager PFZ

Ethical / Legal Manager
NOVO & KUL

Dissemination & Communication Manager TVS & NVS

Technical Manager
NVS & RMS

General Assembly
One representative from each consortium member entity

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DTE - Digital Trust Ecosystem
the vision

Healthcare DTE (PharmaLedger)

Education DTE

Other DTEs:

Construction
Automobile
Energy
Garment/Fashion
Many more...

Gartner defines **digital ecosystem** as an interdependent group of actors (enterprises, people, things) sharing standardized digital platforms to achieve a mutually beneficial purpose.

- Independent but collaborating parties
- Establish trust in interdependent ecosystems
- Cryptographically & blockchain established trust
- Organised per industry or geographical location
- Common best practices

Building the Healthcare DTE PharmaLedger Architecture

DTE Applications

| Use Case 1 | Use Case 2 | Use Case 3 |

DTE Reusable Artefacts & Standards

| DSU Types | APIs | Identities Cryptography | DTE Best Practices |

Open Data Sharing Units (OpenDSU)

Hierarchical Ledgers & Blockchains

VALUE CHAIN - USE CASES VIEW

Clinical Trial eRecruitment	Clinical Trial eConsent	Clinical Trial IOT devices	Clinical Supply	Finished Goods Traceability	Epi - Electronic Product Information	Anti-Counterfeiting	Personalized Medicines
Anonymized matching of qualified patient to trial requirements	**Auditable** and immutable ICF	**Dynamic acquisition** and processing **of data**	**Immutable** record keeping	Leverages industry **standards**	Achieves **EMA key principles** for EPI	**Multifactor product Authentication**	Establishes a trusted environment for **patient-centric** decentralized applications
Enable **voluntarily enrollment**	**Dynamic** and **real time** ICF management	**Remote** patient monitoring	**Creates trust** among partners	Introduces **digital identity**	**Environmental** foot print – CSR	Authentication feature **agnostic**	Uses blockchain's trusted network to leverage **RWE for research**
Less dependency of intermediaries	**Less** protocol **deviations**	**Real-time** notifications	**Interoperable** data points for decision making	**Reliable demand signals**	**Multi-use of barcodes** as digital key for delivering bundled digital services and value	ACDC (anti-counterfeiting data collaboration) **regulatory** and **law enforcement** value	Uses **Machine Learning and AI**
Lower time and cost	Specific **versions** can be managed	**Pilot** real study with Pediatric heart failure patients and 2 devices	**Improved** ability to track **drug accountability** and reconciliation	Near real-time access to **seamless** and **accurate supply information**		**Leveraging ePI** one app for additional anti-counterfeiting check	**Value-Based** health delivery in clinical practice
	Administratively **agile**		Value added for clinical **sites/investigators** (reduce admin burden)				
	Pilot real study with Pediatric heart failure patients						

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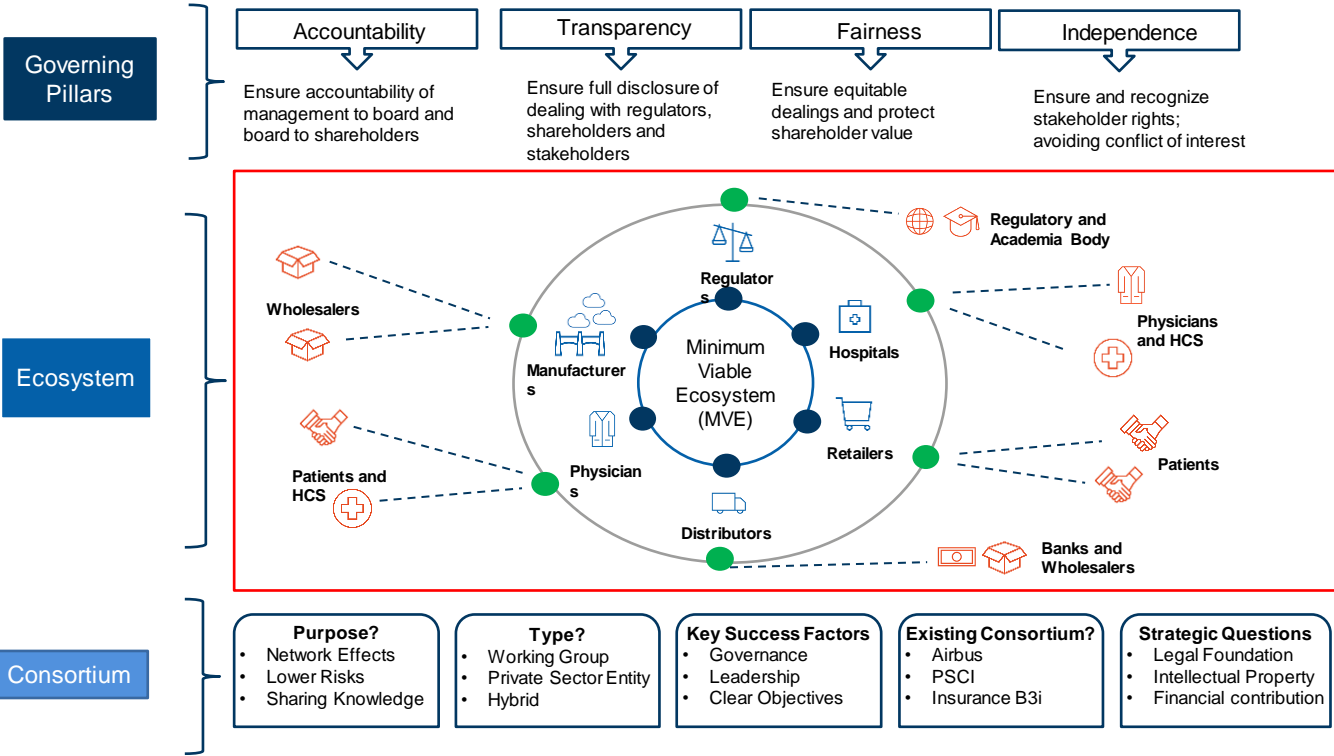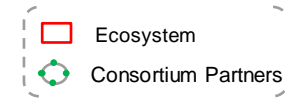
Governance

The BLT
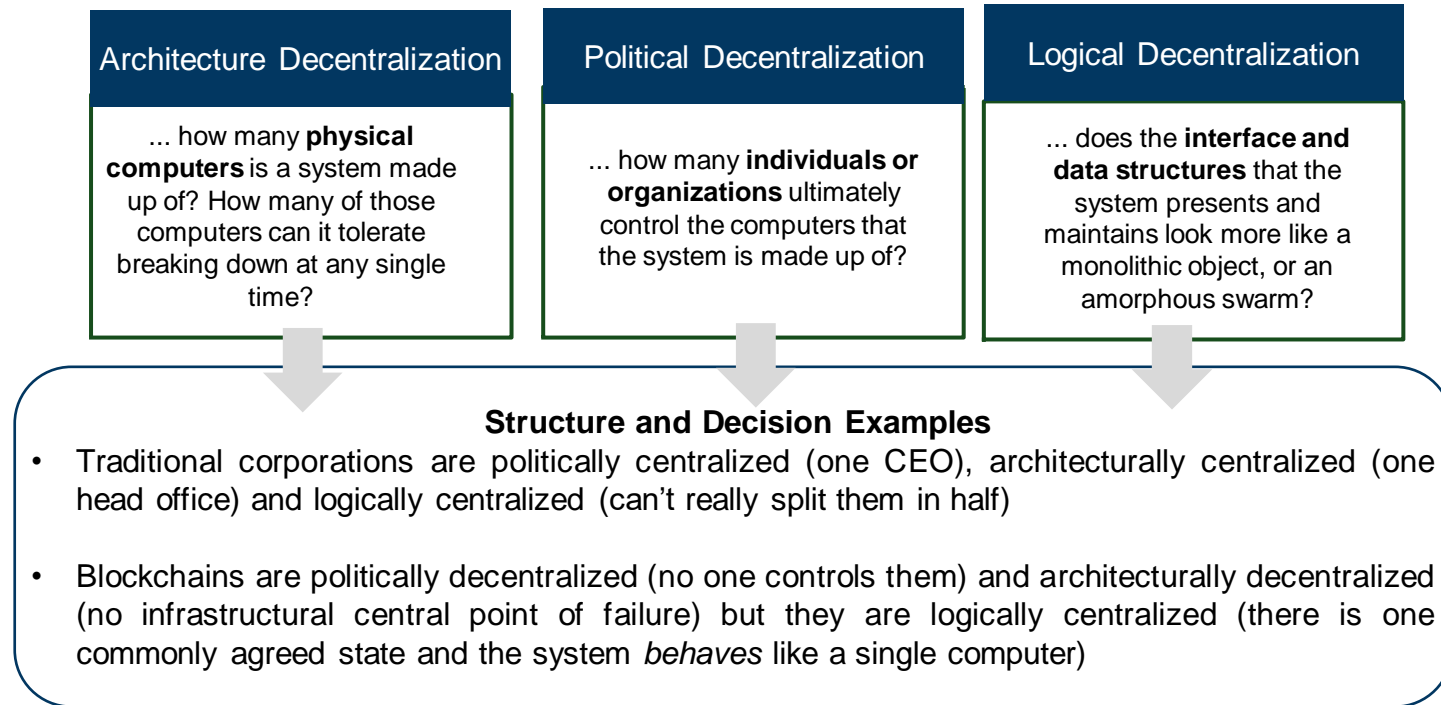## (Business Legal Technology Sandwich)

Legal Implications
- Identity
- Antitrust
- Consortium Agreement
- Legal form
- Data Privacy / Confidentiality
- Regulated Industry (Patient Safety)
- Existing legislation
- Ethics
- Jurisdiction
- Liability
- Informed Consent
- Intellectual Property

Ecosystem Big Picture

Legend:
- Ecosystem
- Consortium Partners

Governing Pillars

Accountability	Transparency	Fairness	Independence
Ensure accountability of management to board and board to shareholders	Ensure full disclosure of dealing with regulators, shareholders and stakeholders	Ensure equitable dealings and protect shareholder value	Ensure and recognize stakeholder rights; avoiding conflict of interest

Ecosystem

Minimum Viable Ecosystem (MVE)

- Regulators
- Hospitals
- Retailers
- Distributors
- Physicians
- Manufacturers

- Wholesalers
- Patients and HCS
- Regulatory and Academia Body
- Physicians and HCS
- Patients
- Banks and Wholesalers

Consortium

Purpose?	Type?	Key Success Factors	Existing Consortium?	Strategic Questions
• Network Effects • Lower Risks • Sharing Knowledge	• Working Group • Private Sector Entity • Hybrid	• Governance • Leadership • Clear Objectives	• Airbus • PSCI • Insurance B3i	• Legal Foundation • Intellectual Property • Financial contribution

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Novartis Pharma AG: Marco Cuomo

Blockchain: Decentralization

Architecture Decentralization	Political Decentralization	Logical Decentralization
... how many **physical computers** is a system made up of? How many of those computers can it tolerate breaking down at any single time?	... how many **individuals or organizations** ultimately control the computers that the system is made up of?	... does the **interface and data structures** that the system presents and maintains look more like a monolithic object, or an amorphous swarm?

Structure and Decision Examples

- Traditional corporations are politically centralized (one CEO), architecturally centralized (one head office) and logically centralized (can't really split them in half)

- Blockchains are politically decentralized (no one controls them) and architecturally decentralized (no infrastructural central point of failure) but they are logically centralized (there is one commonly agreed state and the system *behaves* like a single computer)

Source: Vitalik Buterin: https://medium.com/@VitalikButerin/the-meaning-of-decentralization-a0c92b76a274

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Definition of Governance, Ecosystem and Consortium

Terms	Definition
Governance	• system of rules, practices, and processes by which an entity is directed and controlled. • Governing models involves balancing the interests of the company's stakeholders, such as shareholders, executives, customers, suppliers, financiers, the government, and the community. • Consortium Agreement (CA) defines onboarding, decision making, IP, etc.
Ecosystem	• network of organizations—including suppliers, distributors, customers, competitors, government agencies, and so on—involved in the delivery of a specific product or service through both competition and cooperation. • as in a biological ecosystem, entities co-evolve through cooperation and competition, thus, creating a constant evolving relationship in which each entity must be flexible and adaptable in order to survive • an Ecosystem may consist of participating entities of a Consortium • Eg: eBay, Amazon Marketplace, Uber, Healthcare Ecosystem
Consortium	• group made up of two or more individuals, companies, or governments that work together to achieving a common objective. • Entities jointly pool resources, and is only responsible for obligations set out in a consortium agreement • Entities in a consortium remains independent in their daily business operations, as is outside the agreed objectives • Eg: Airbus, Hyperledger, Insurance B3i

... a Consortium can build an Ecosystem

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Novartis Pharma AG: Marco Cuomo

Governance Model Options
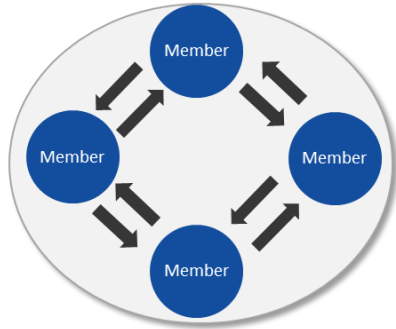
Ecosystem led
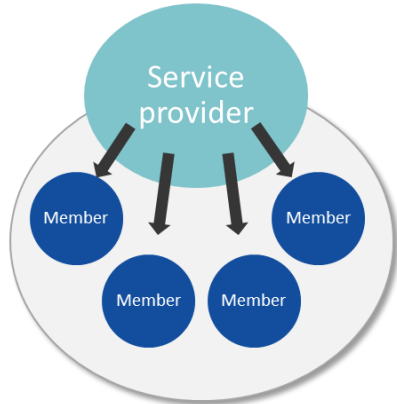
Service provider led
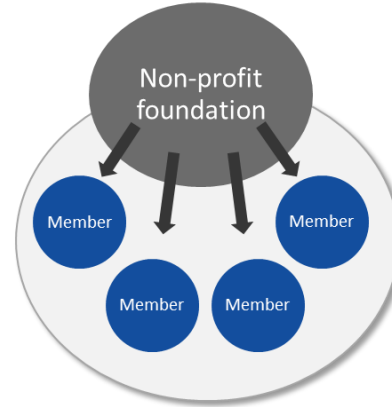
Foundation Led
(Independently Governed)
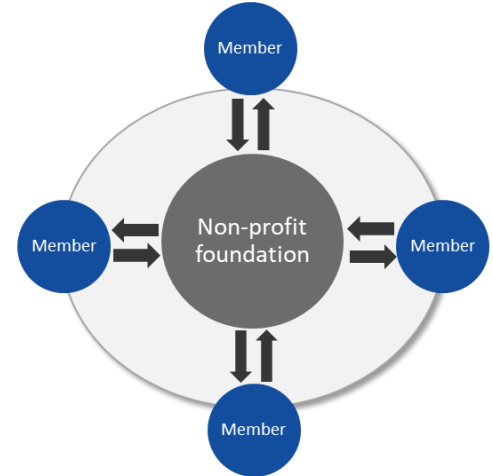
Foundation Led
(Ecosystem Governed)

R O A D M A P

Year 1 **Design & Foundations**	Year 2 **Development & Deployment**	Year 3 **Validation & Sustainability**
2020	**2021**	**2022**

Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4

Q1 / Q2 (2020)
- PharmaLedger Kick-Off
- Use-case short-list
- Use-case specification
- Marketing & Engagement
- Est. Ethical & Legal requirements' framework

Q3 / Q4 (2020)
- Use-case definition
- Platform Architecture Planning and Development
- Specification for application & tools
- Blockchain protocol selection
- Design Platform Governance & Operating Model

Q1 / Q2 (2021)
- Reference Domain applications development
- Architecture – blockchain platform & API implementation
- Governance Application, Legal & Ethical framework implementation

Q3 / Q4 (2021)
- Platform Sustainability Planning
- Continuous Platform Enhancement
- Continuous Platform Promotion and 3rd Party engagement
- Use-case pilot implementation

Q1 / Q2 (2022)
- Reference Domain Application Evaluation and validation
- Guidelines and lessons learnt
- Implement Governance and Operating Model
- Continuous Platform Promotion and 3rd Party engagement
- Strategic Positioning

Q3 / Q4 (2022)
- Continuous Platform Sustainability
- Wide communication of project results
- **Blockchain-Enabled-Healthcare!**

Q & A

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PharmaLedger Platform Overview
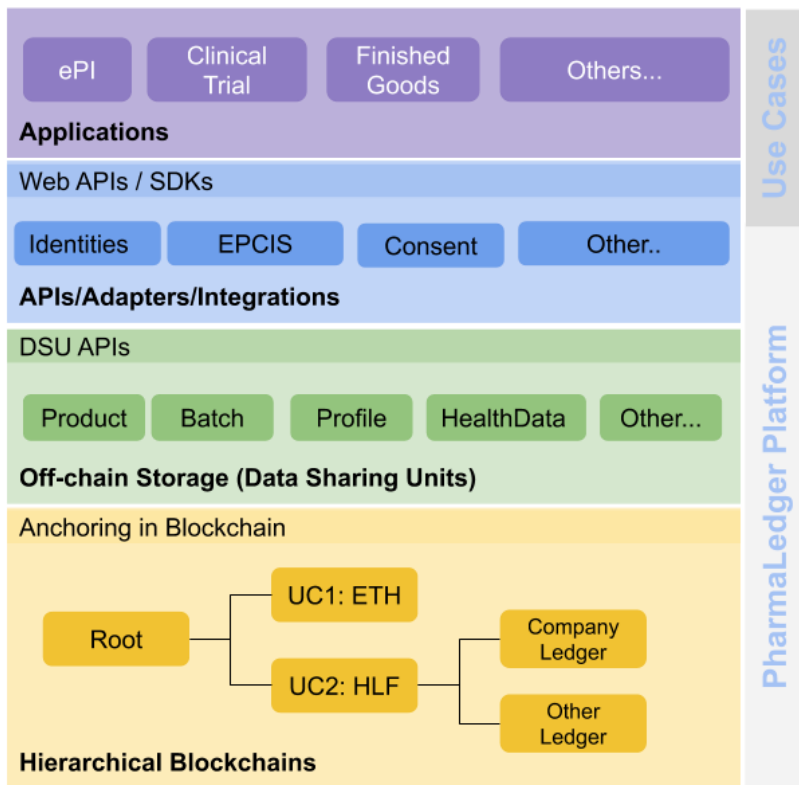
Applications — *Use Cases*
- Legacy Systems, Systems of Records etc.
- Edge Devices (Mobile Apps, IoT, WebApps)

Integration — *APIs, Adapters etc.*
- Bridges between Application and Blockchain platform
- Abstraction layer for Applications

DSU — *Data Sharing Units*
- Encapsulates Data and Business Logic (code)
- Build-in Data Privacy and Confidentiality
- Supports integration with Decentralized Identities & Verifiable Credentials
- Enables secure sharing

Anchor — *Hashlinks, Versions*
- Link the DSU in Blockchain
- Guarantees integrity, traceability, provenance, immutability

Blockchain — *Hierarchical Blockchains*
- Use case specific Blockchain technologies
- All Blockchains are anchored in the Root Blockchain

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SUPPLY CHAIN **FINISHED GOODS** TRACEABILITY

The Pharma Supply Chain **Today**
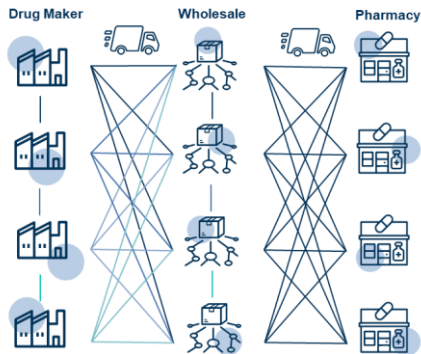
- No end-to-end visibility
- Delayed and distorted demand signals
- Manual reaction on recalls
- Siloed information & high number of IT interfaces

Future Vision
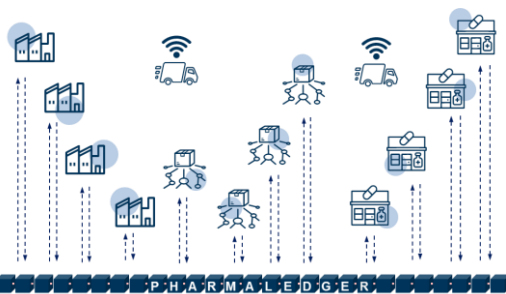
- Increased patient safety
- Fast and efficient recalls
- Optimized cost for the benefit of the health systems
- Simplified IT interfaces & unlocking previously siloed information

PharmaLedger

The Pharma Supply Chain is complex – every node in the chain is consuming & providing data from/to other nodes.

The use case looks at methods of data capture and transfer, on/off chain storage in a mobile and integrative flexible architecture which will allow for a trusted downstream supply chain visibility with near real time data availability.

PharmaLedger connects the supply chain eco-system for trusted and accelerated information sharing and facilitates incorporating new partners into the eco system, including patients.

| Patient safety | Public Health | Trust in Industry | Economy |
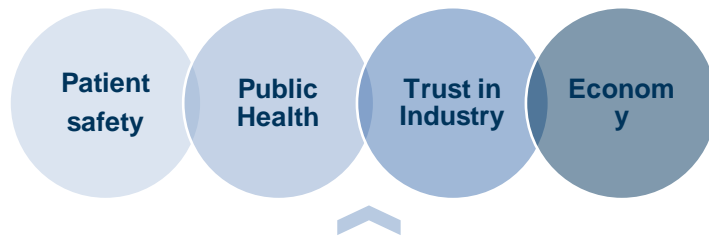
Blockchain and PharmaLedger Value Proposition

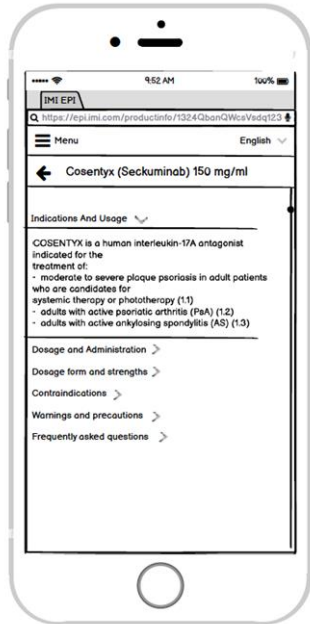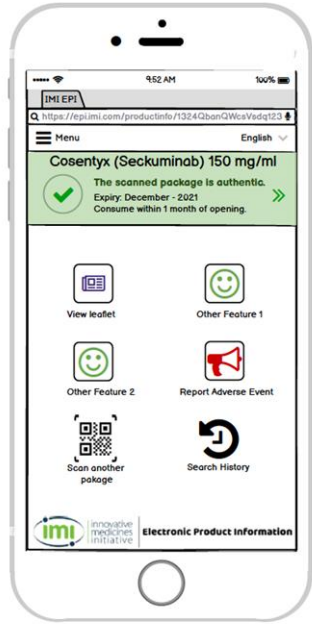|	
Trust	**Secure & timely supply** of product, with digital identities
Interoperability	**Leveraging industry standards,** such as Advanced Shipping Notices and Electronic Product Coding Information Services for end to end traceability
Immutability	**Secure and immutable sharing of** information for reliable demand signals and counterfeit detection
Traceability	**Increasing regulatory compliance,** providing product provenance and chain of custody

Supply Chain eLeaflet – ePI

Create & Update
Manufacturers, 100+

Review & Approval
Health Authorities, 20+

Publish & Version Control
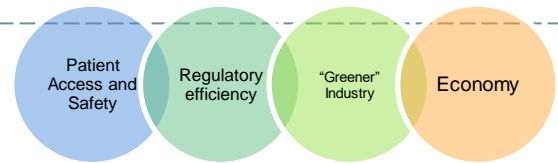**Manufacturers, 100+**

HCP & Patients, millions

Description

This use case starts with the creation of the **ePI in digital form** by the manufacturer, the **review and approval** of the ePI with the Health Authorities, **updates** to the ePI and **dissemination** of the ePI to the Patient/ Health Care Practitioner/ Provider (HCP).

Content Updates
Languages

Review and Approval between Manufacturer and Health Authority

Patient Safety and Convenience

Blockchain and PharmaLedger Value Proposition

Trust
Transparent and immutable review and approval transaction records.
Smart contracts set the transaction rules so only approved eLeaflets are published

Interoperability
Facilitates transactions between manufacturer systems and multiple health authorities with easy access for Patient with 'One App'

Security
Decentralised system for storing ePI provides secure platform, instead of central database, providing resilience against cyber attacks

Privacy
Data Self-Sovereignty and Anonymity are paramount and not negotiable

Patient Access and Safety

Regulatory efficiency

"Greener" Industry

Economy

(Phone screen 1)

IMI EPI
https://epi.imi.com/productinfo/1324QbanQWcsVsdq123

☰ Menu   English ⌄

Cosentyx (Seckuminab) 150 mg/ml

✓ The scanned package is authentic.
Expiry: December - 2021
Consume within 1 month of opening.

View leaflet   Other Feature 1

Other Feature 2   Report Adverse Event

Scan another package   Search History

imi innovative medicines initiative   **Electronic Product Information**

(Phone screen 2)

IMI EPI
https://epi.imi.com/productinfo/1324QbanQWcsVsdq123

☰ Menu   English ⌄

← Cosentyx (Seckuminab) 150 mg/ml

Indications And Usage ⌄

COSENTYX is a human interleukin-17A antagonist indicated for the treatment of:
- moderate to severe plaque psoriasis in adult patients who are candidates for
aystemic therapy or phototherapy (1.1)
- adults with active psoriatic arthritis (PsA) (1.2)
- adults with active ankylosing spondylitis (AS) (1.3)

Dosage and Administration ⟩
Dosage form and strengths ⟩
Contraindications ⟩
Warnings and precautions ⟩
Frequently asked questions ⟩

Anti-Counterfeiting Process Overview

Multi-Factor Packaging Authentication (MFPA) and Anti-Counterfeit Data Collaboration (ACDC)

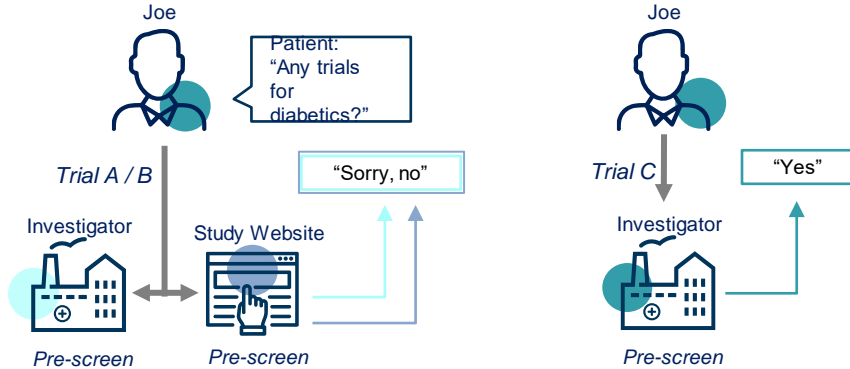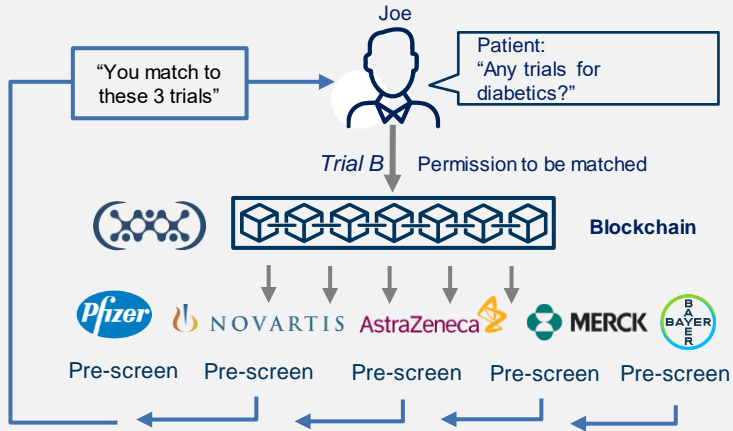| Suppliers	Inputs	Process	Outputs	Customers
Patient	DataMatrix scan with app	Access eLeaflet (ePI)	eLeaflet	Patient
Manufacturer	Global Trade ID Number Batch Expiry Serial Number	Perform MFPA checks: 1. Valid ePI product? 2. Valid serial No.? 3. Valid prod. status? 4. Feature available? 5. Suspect product?	Results	Patient
Patient	Authentication Feature Input	Manufacturer verifies feature(s)	Results ✔ or ✖	Patient
Patient Manufacturer	Results of checks & Business rules	Anti-Counterfeit Data Collaboration (ACDC)	Analytical reports and real-time alerts	Manufacturer Law Enforcement

CLINICAL TRIAL **RECRUITMENT**

Current State

Joe

Patient: "Any trials for diabetics?"

Trial A / B

"Sorry, no"

Investigator

Study Website

Pre-screen

Pre-screen

Joe

Trial C

"Yes"

Investigator

Pre-screen

Future State

Joe

"You match to these 3 trials"

Patient: "Any trials for diabetics?"

Trial B   Permission to be matched

Blockchain

Pfizer   NOVARTIS   AstraZeneca   MERCK   BAYER

Pre-screen   Pre-screen   Pre-screen   Pre-screen   Pre-screen

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The use case intends to create a patient centric, industry-wide clinical trial recruitment solution. **The solution would aggregate clinical trials and screening criteria across the whole industry, and would use a matching algorithm to match the patient to relevant clinical trials.**

Blockchain and PharmaLedger Value Proposition

PharmaLedger

Decentralized — Creates a **shared ledger of permissions, accessible by network participants**, without putting any one party in charge

Immutable — Creates a **permanent record of trials submitted by sponsors**. Would discourage any illegitimate use of the trial matching infrastructure

Trust — **Cross-industry record of match attempts** could be shared with patients, increasing understanding of which trial criteria may be causing their match or failure
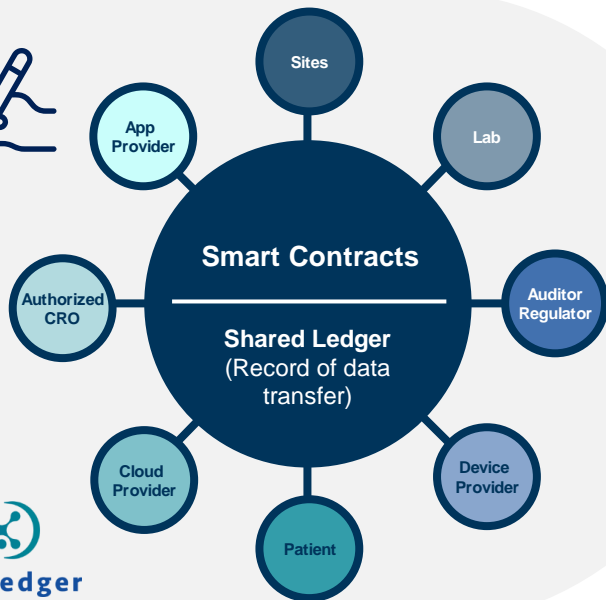
Transparency   **Data Integrity**   **Auditability**   **Trust**

CLINICAL TRIAL **E-CONSENT**

If a potential trial participant does not feel confident, empowered, or safe when reviewing the informed consent document, the likelihood of their participation is lowered, impacting recruitment in the clinical trial.

The purpose of this use case is to **provide all clinical trial actors** (trial participant, healthcare organization, sponsor and representatives/CROs, ethics committees, vendors and regulatory authorities) **with a blockchain based platform for trial oversight** leveraging the status of digital consents provided by trial participants.

Smart Contracts

Shared Ledger
(Record of data transfer)

- Sites
- App Provider
- Lab
- Authorized CRO
- Auditor Regulator
- Cloud Provider
- Device Provider
- Patient

PharmaLedger

- Transparency
- Data Integrity
- Auditability
- Trust

Blockchain and PharmaLedger Value Proposition

Immutability — Creates an **immutable entry on the blockchain**, recording when consent was obtained, which is immediately visible to appropriately permissioned users in compliance with GDPR

Trust — Reduces or eliminates audit findings and **decreases opportunities for fraudulent data**, by increasing the consistency of information being viewed across investigative sites

Smart Contracts — Smart contracts can be implemented to **lock access to trial systems until consent has been obtained**, ensuring compliance with GCP

Traceability — Have the traceability to allow **sharing of clinical trial data with different parties involved**, any changes in consent status are applied in near real-time

Privacy — Ability for **sponsors to anonymously contact subjects directly to request consent for samples** or data to be used in other research activities, optimizing the materials already collected