



gaia-x

Tech-X & Hackathon #9

2026 28-29 ATHENS
MAY GREECE

In partnership with



gaia-x
Hub Greece

LMS
Laboratory for
Manufacturing Systems
& Automation



Day 1 | Thursday, 28.05.26



9:30 – 17:30 (18:00 Networking Reception)



In partnership with

A white rounded rectangular box containing two logos. On the left is the gaia-x logo with the text "gaia-x" and "Hub Greece" below it. On the right is the LMS logo, which includes a stylized profile of a head and the text "LMS Laboratory for Manufacturing Systems & Automation".



Welcome & Opening Tech-X 2026



9:30 – 10:00

Kosmas Alexopoulos

- Professor Laboratory for Manufacturing Systems & Automation (LMS), University of Patras
- Coordinator Gaia-X Hub Greece

Eleni Dede

- Director of Communications and Sustainable Development, Information Society

Christoph F. Strnadl

- CTO Gaia-X



In partnership with



Agenda | Day 1 (Morning) | 28.05.26

	Time	Slot	Speaker(s)
	9:30 – 10:00	Welcome & Opening Tech-X 2026 & Hackathon #9 <ul style="list-style-type: none">Gaia-X Hub GreeceInformation SocietyGaia-X	<ul style="list-style-type: none">Kosmas AlexopoulosEleni DedeChristoph Strnadl
STRATEGIC	10:00 – 10:20	Shaping Trusted Data Spaces: Greece in Europe's Digital Transformation	Kosmas Alexopoulos Laboratory for Manufacturing Systems & Automation (LMS), Uni Patras
ECOSYSTEM	10:20 – 10:40	Gaia-X Enabled Federated Data Spaces for Resilient Manufacturing	Emmanouil Bakopoulos Laboratory for Manufacturing Systems & Automation (LMS), Uni Patras
ECOSYSTEM	10:40 – 11:00	DSSC-[12] Technical Results and Outlook	Daniel Alonso (BDVA)
	11:00 – 11:30	Networking Coffee & AR Game	
ECOSYSTEM	11:30 – 12:10	Federated Trust and the IMXC Use Case	Klaus Ottradovetz (Atos)
ECOSYSTEM	12:10 – 12:40	X-Road 8 Spaceship Development Activities	Petteri Kivimaki (NIIS)
ECOSYSTEM	12:40 – 13:00	Myrtus Project: A SHACL-based remote Danube extension	Giulia Biagioni (TNO)

Shaping Trusted Data Spaces: Greece in Europe's Digital Transformation

10:00 – 10:20



- **Kosmas Alexopoulos**, Laboratory for Manufacturing Systems & Automation (LMS), University of Patras; Coordinator Gaia-X Hub Greece

In partnership with



Shaping Trusted Data Spaces Greece in Europe's Digital Transformation

No trusted data, no trustworthy AI.

Thursday 28 May 2026, 10:00-10:20

Dr. Kosmas Alexopoulos

Gaia-x Hub Greece

Laboratory for Manufacturing Systems & Automation (LMS)



In partnership with



The need: making data accessible

The hard part is not connecting data. It is trusting it.

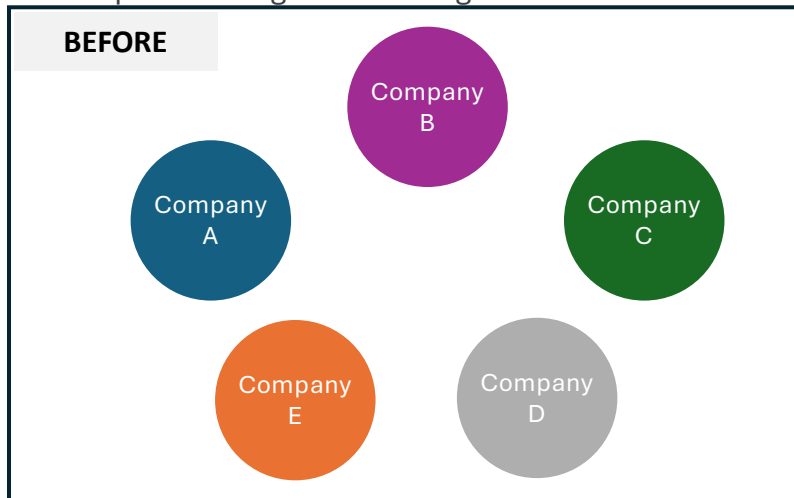


From data silos to trusted data spaces

- Today data is siloed, fragmented, and locked within organizations
- Companies must collaborate on data without losing IPR or competitive advantage
- Trust needs to be enforced through identity, policy control, and auditability
- Shared data enable new value streams
- Connecting two sources is usually easy, but scale-up is challenging

Europe needs digital sovereignty

- Avoid dependency on foreign platforms
- Regulatory compliance (GDPR, DGA, Data Act) requires transparent and governed usage

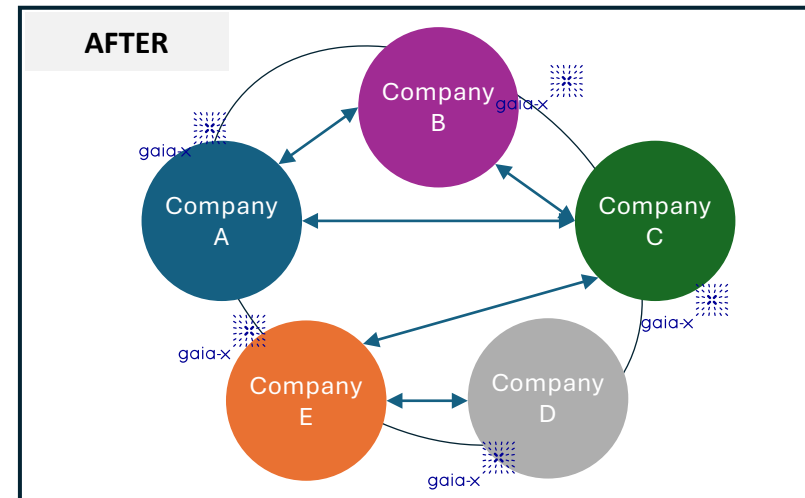


A Trust Framework is needed to enable data-exchange at scale



Dataspaces

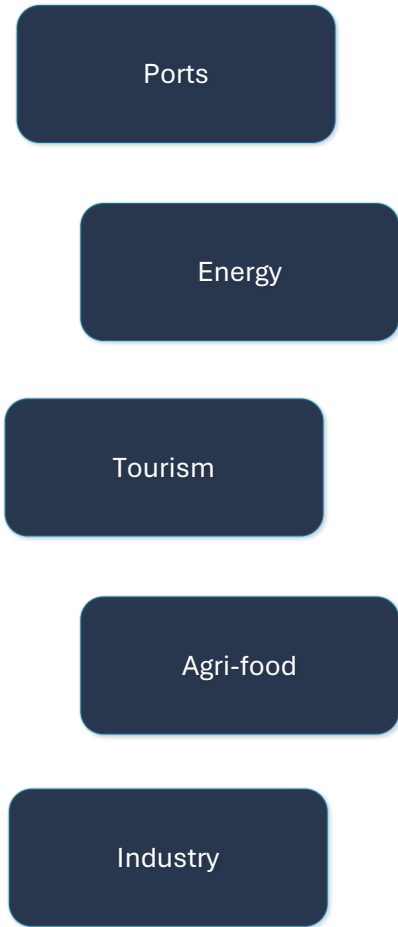
- Provide sovereign, secure, federated data sharing while ensuring data ownership remains with the provider.
- Allow organizations to collaborate and innovate with shared data without surrendering control of it.



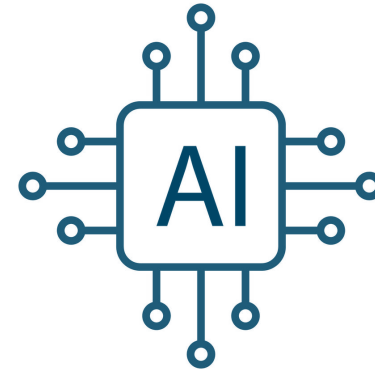
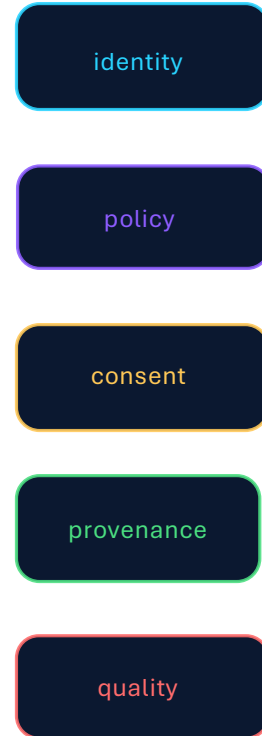
#GaiaX #TechX

The bottleneck for AI is no longer code. The bottleneck is trust.
AI raises the value of data spaces (by raising the cost of untrusted data)

Greek value networks



Trust layer



models are hungry
for governed data

Benefits



Data spaces make AI usable where trust matters.

Greece today: connecting national strengths to European data spaces

Connecting value networks



Hub Greece brings Greek data holders, cloud/data-sharing providers and value-added service providers into the European Gaia-X ecosystem.

operated by LMS

Infrastructure

Energy

Mobility

Security & Resilience

Economy

Manufacturing

Agriculture

Tourism

People

Skills

Health

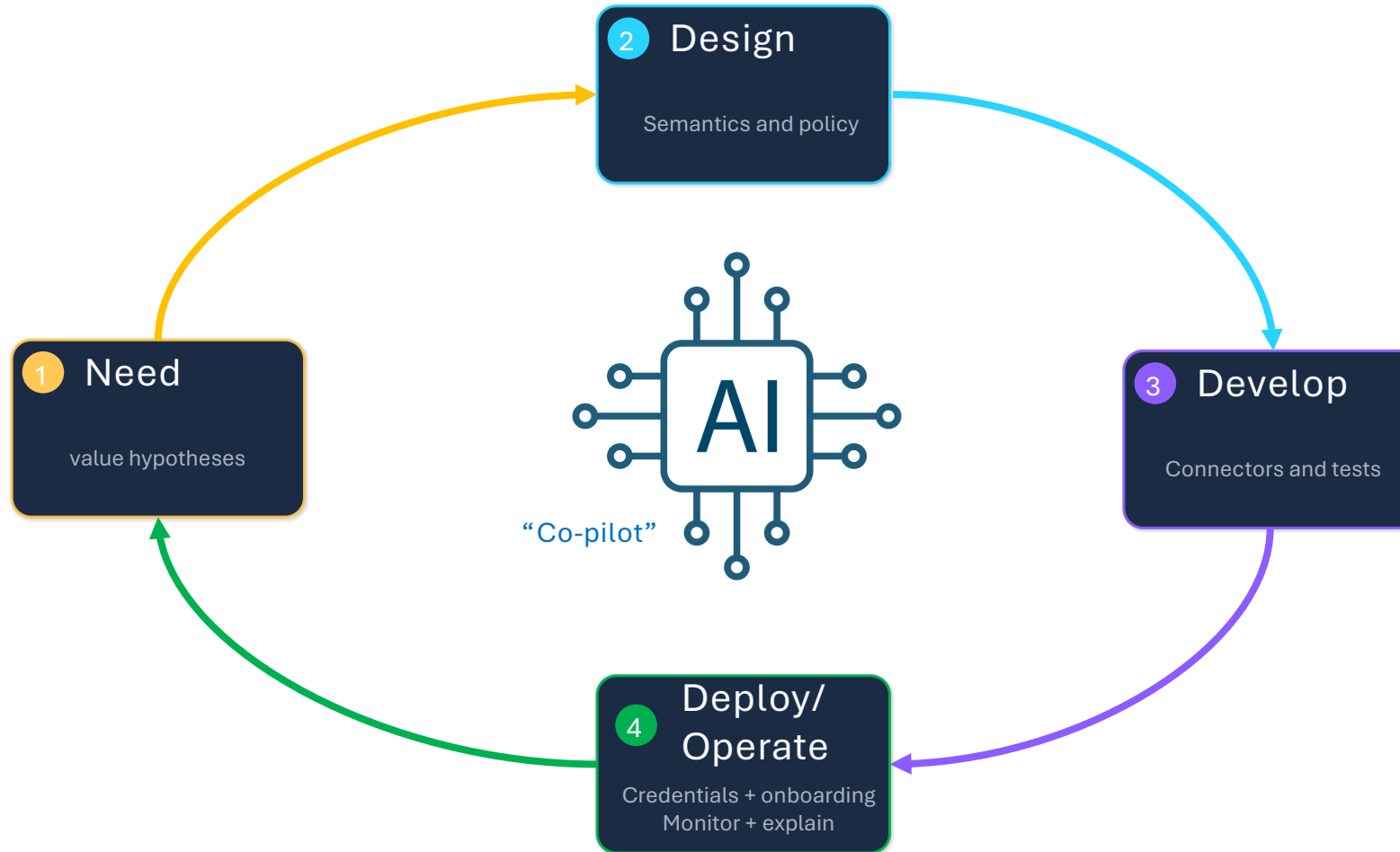
Public Services

Gaia-x SME accelerator

A mechanism to lower the entry barrier for SMEs, startups and business groups to join European data-space innovation.

The bottleneck for AI is no longer code. The bottleneck is trust.

AI raises the value of data spaces



AI does not make data spaces obsolete.
It makes them more necessary.

Need discovery: from datasets to decisions

Ask AI for better decisions



Decision-making canvas

PROMPT

“I am a Greek port authority, a ferry operator and an island energy provider.

What shared data products could reduce congestion, emissions and energy peaks — without exposing commercially sensitive data?”

AI output becomes a first conversation item, not the answer.

Data products

- aggregated berth occupancy
- ferry arrival windows
- weather + demand
- signals
- anonymised visitor
- flows

Controls

- purpose limitation
- aggregation thresholds
- credential-gated access
- 30-day retention

Value hypothesis

- reduce port congestion
- shift island energy peaks
- lower emissions
- improve visitor experience

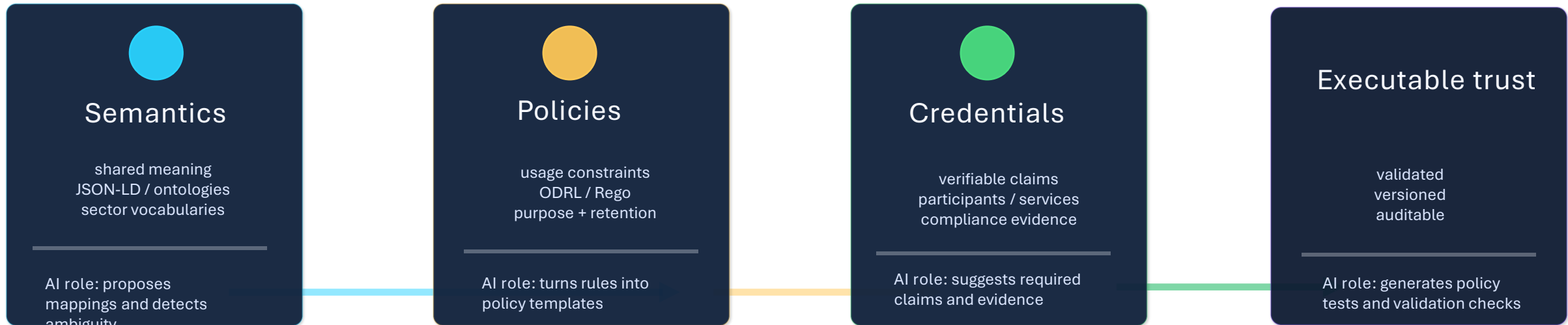
Stakeholders

- port authority
- ferry operator
- energy provider
- municipality

AI can turn messy stakeholder intent into a structured, challengeable starting point.

AI-assisted design of trusted data spaces

AI helps translate requirements into semantics, policies, credentials, and validation checks



PROMPT
“Use ferry-demand data only for congestion reduction, not for commercial profiling.”

AI-assisted translation + human validation



```
{  
  "purpose": "congestion_reduction",  
  "aggregation": "required",  
  "profiling": "prohibited",  
  "retention": "30 days",  
  "credential": "verified-actor"  
}
```



AI can help making trust explicit, testable, and executable (while keeping humans in control)

#GaiaX #TechX

Develop: AI-assisted development needs trust guardrails

From vibe coding to “trust” coding

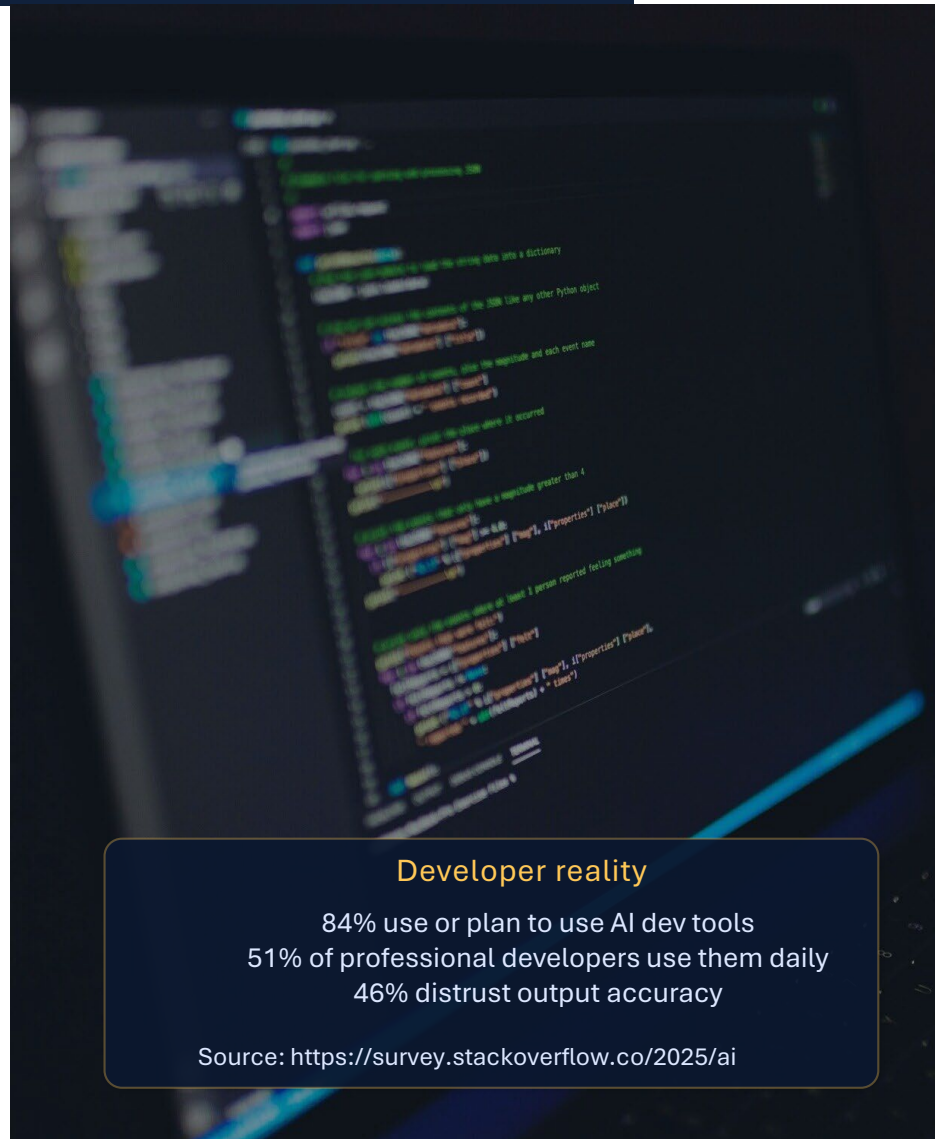


```
$ trust deploy --with-policy --with-provenance --with-human-review --with-tests
```

Vibe coding gets a demo running.
Trust coding gets it into a federation.

- ### Guardrails for data-space development
- generated connector boilerplate
 - policy test cases
 - credential fixtures
 - CI checks for compliance
 - human review before federation

Faster prototypes are good.
Federated production requires guardrails.



Developer reality

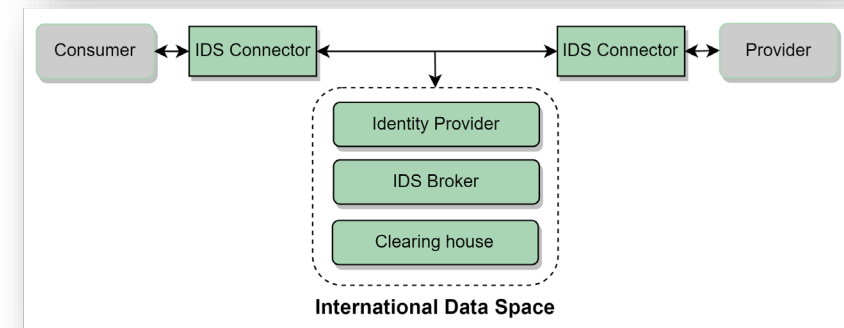
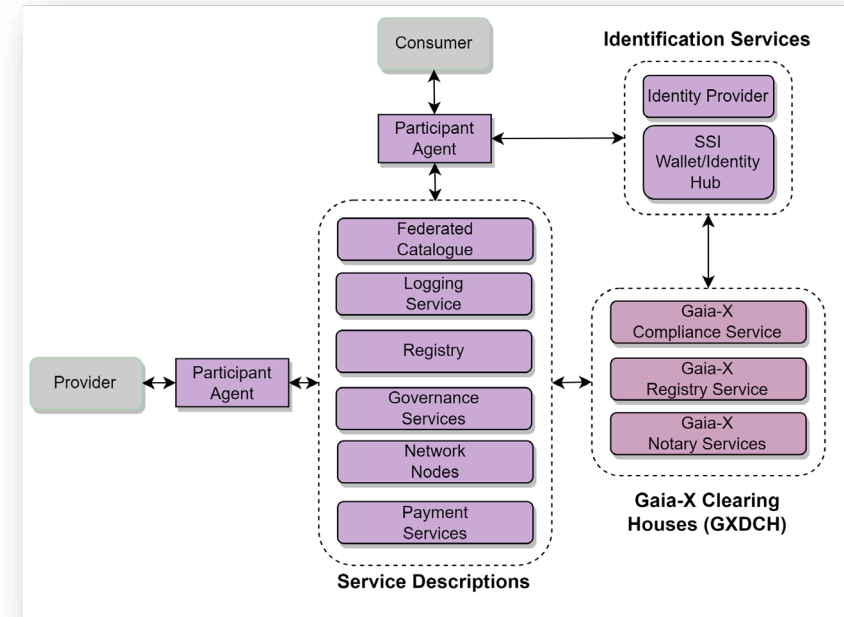
- 84% use or plan to use AI dev tools
- 51% of professional developers use them daily
- 46% distrust output accuracy

Source: <https://survey.stackoverflow.co/2025/ai>

Dataspace sandbox: testing trust before scaling

Test before invest

- What the Sandbox Provides
 - ❖ A controlled, secure environment for experimentation
 - ❖ Supports multiple data-space frameworks
 - ❖ Enables end-to-end validation of data-exchange flows
- Supported Architectures
- Gaia-X-based deployments
 - ❖ Federated catalogue,
 - ❖ self-descriptions,
 - ❖ identity wallets,
 - ❖ Compute-to-Data
- IDS-based deployments
 - ❖ Data sovereignty, usage control, connectors, brokers
 - ❖ Ideal for industrial peer to peer data sharing




The sandbox is where we can turn data-space concepts into tested, reusable, federation-ready patterns.

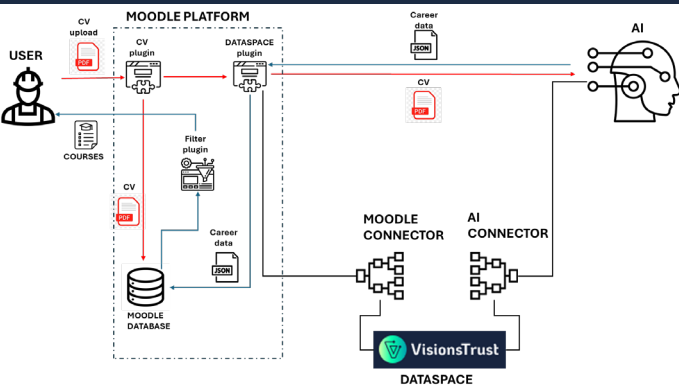
#GaiaX #TechX

EU projects that matter


Trusted data spaces in skills, circularity, and manufacturing AI



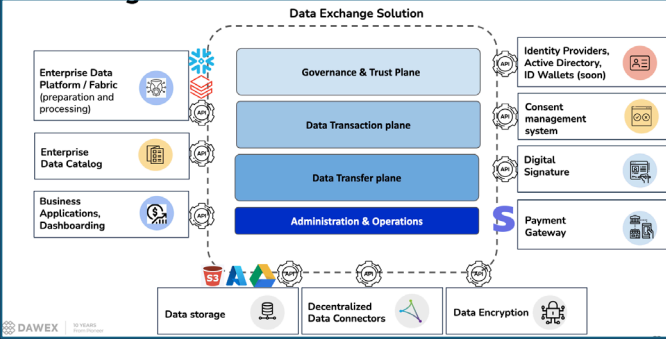
A common European Data Space for Skills connecting key stakeholders across Europe




- Skills profiling
- Data Space connection
- AI service consumption
- Learning and job matching
- Progress and certification



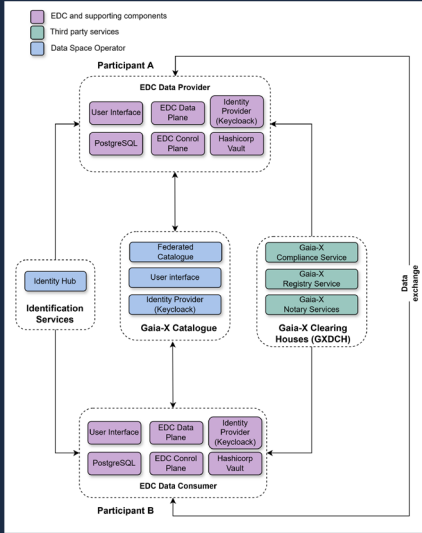
A data space to increase circularity through data for the plastics industry



- Enable trusted data sharing
- Connect plastics value chains
- Support circularity services
- Harmonise plastics data
- Onboard SMEs securely



The Testing and Experimentation Facility to validate new AI technologies in manufacturing context.



- Validate manufacturing AI
- Enable secure data exchange
- Deploy Gaia-X connectors
- Support SME onboarding
- Test industrial AI services

Laboratory for Manufacturing Systems (LMS)

Active partner in dataspace initiatives



- Gaia-X member
- Greece Hub Coordinator

- IDSA member
- Competence Center in Manufacturing for Greece

- IMX-C member

Contact

Dr. Kosmas Alexopoulos

Email:

alexokos@lms.mech.upatras.gr

info@gaiax.gr

#GaiaX #TechX

Trust is the new “API”

The next competitive advantage is not having data.
It is being able to share it safely, verify it, and use it with confidence.

Dr. Kosmas Alexopoulos | alexokos@lms.mech.upatras.gr

Thank you!



In partnership with



Gaia-X Enabled Federated Data Spaces for Resilient Manufacturing

10:20 – 10:40



- **Emmanouil Bakopoulos** – Laboratory for Manufacturing Systems & Automation (LMS)

In partnership with





Gaia-X Enabled Federated Data Spaces for Resilient Manufacturing



10:20 – 10:40

Emmanouil Bakopoulos

Research Engineer
Laboratory for Manufacturing
Systems and Automation (LMS)



In partnership with

The block contains two logos. On the left is the Gaia-X logo, which includes a starburst icon, the text 'gaia-x', and 'Hub Greece' below it. On the right is the LMS logo, which features a stylized profile of a head with a brain-like pattern inside, the text 'LMS', and 'Laboratory for Manufacturing Systems & Automation' below it.



Flex4Res Project

Data Spaces for Flexible Production Lines and Supply Chains for Resilient Manufacturing

Objectives:

- ❖ Implementation of an open platform
- ❖ Resilience assessment toolbox
- ❖ Reconfiguration strategies toolbox
- ❖ Test and validate into industrial pilots



Call: HORIZON-CL4-2022-TWIN-TRANSITION-01

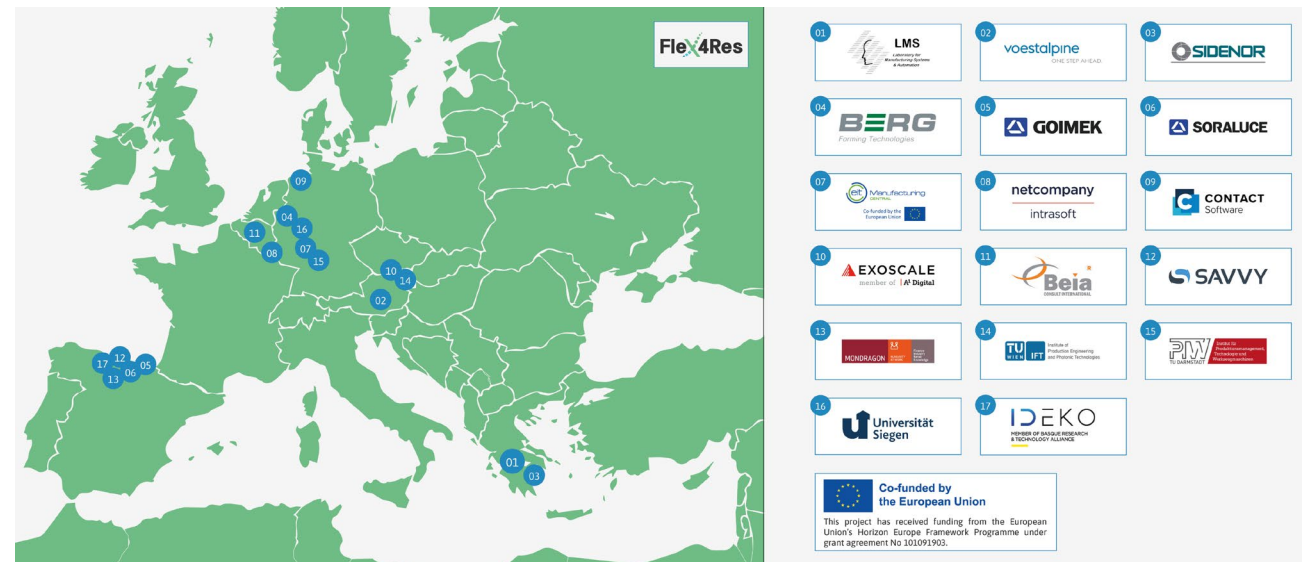
Type of action: HORIZON Innovation Actions

Funding: 8 Million € funding amount

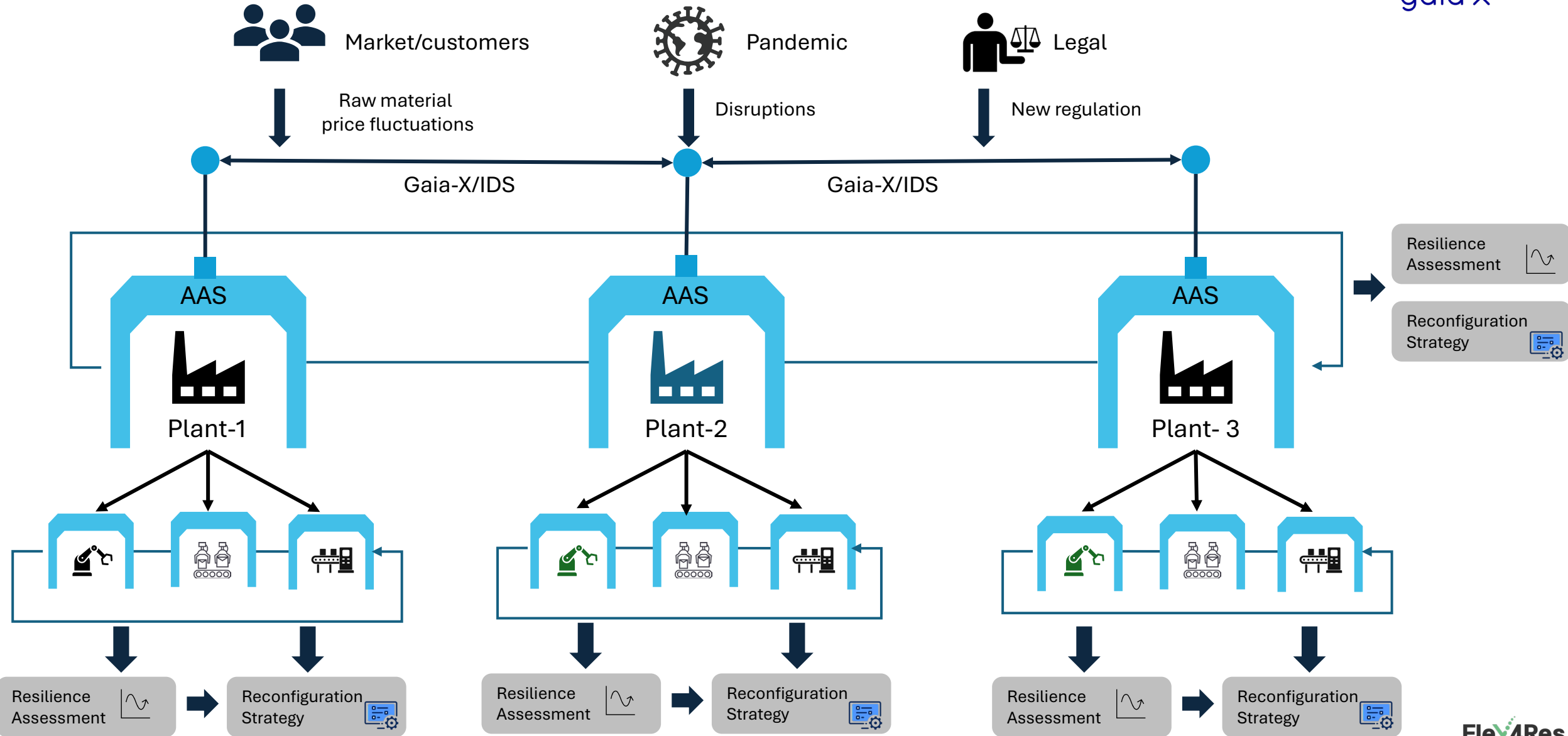
Starting date: 1 January 2023

End date: 31 December 2025

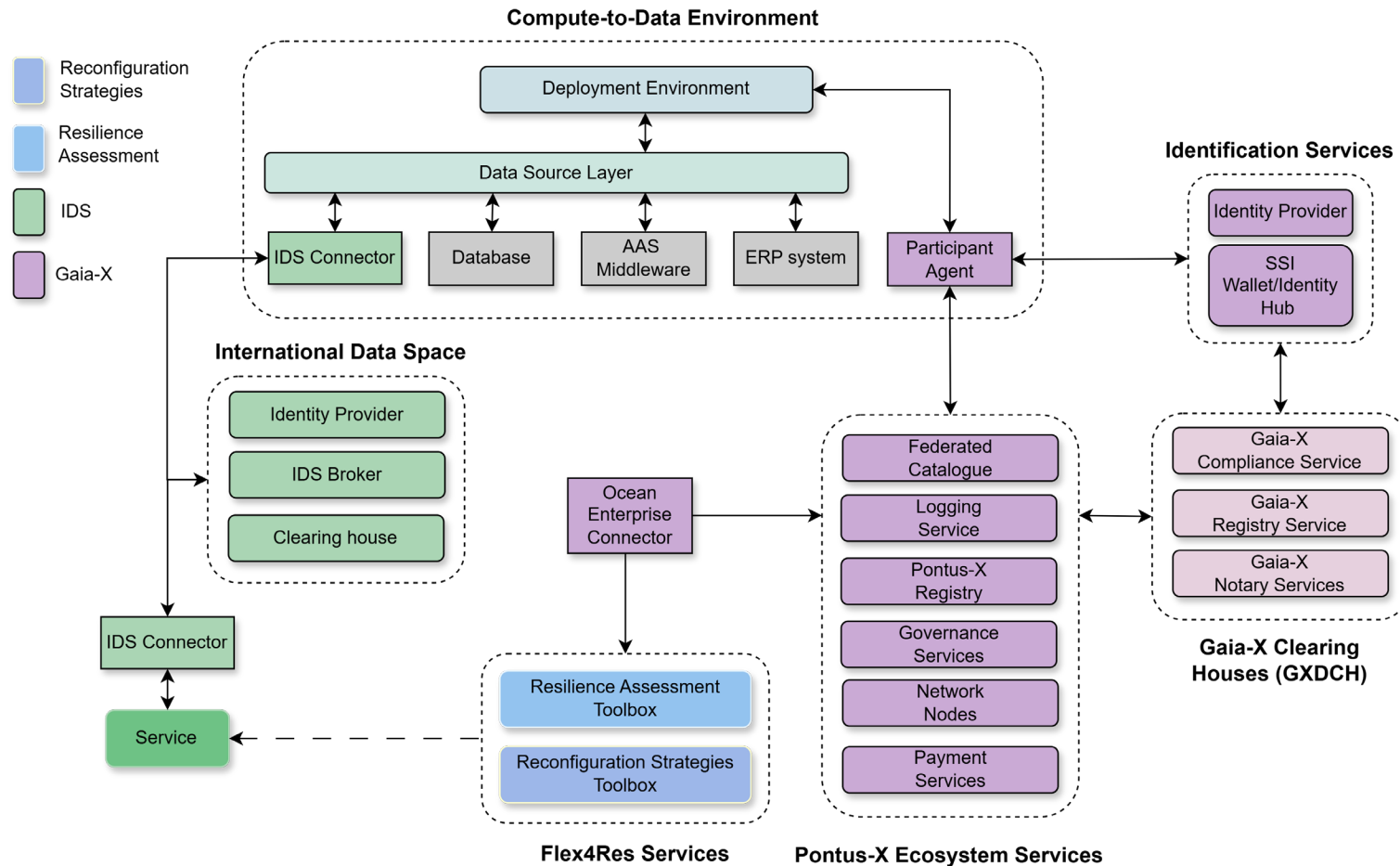
Duration: 36 months



Motivation







Project Approach

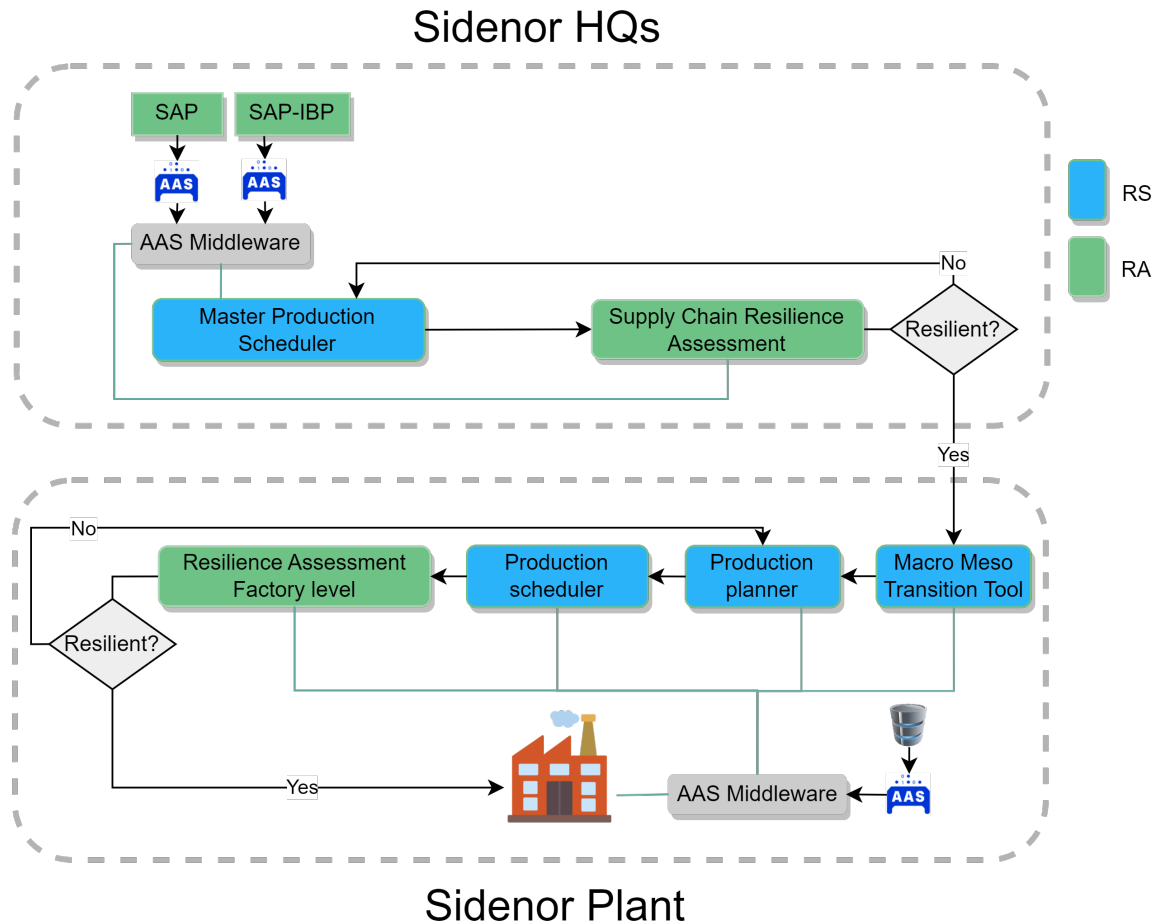


- Bridge IDS & Gaia-X through a compute-to-data setup
- Participant can access service and data from Pontus-X
 - Local sources
 - Pontus-X
 - IDS data space
- Enabling services to operate across organizational and system boundaries

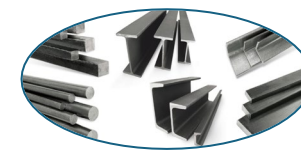
Use Cases

	Macro level	Meso level	Micro level
Constant reconfiguration of supply plans – <u>Sidenor use case</u>			
Reconfiguration of manufacturing processes during production – <u>Voestalpine use case</u>			
Production planning optimization – <u>Goimek use case</u>			
Reconfiguration measures after a tool change – <u>Hans Berg use case</u>			

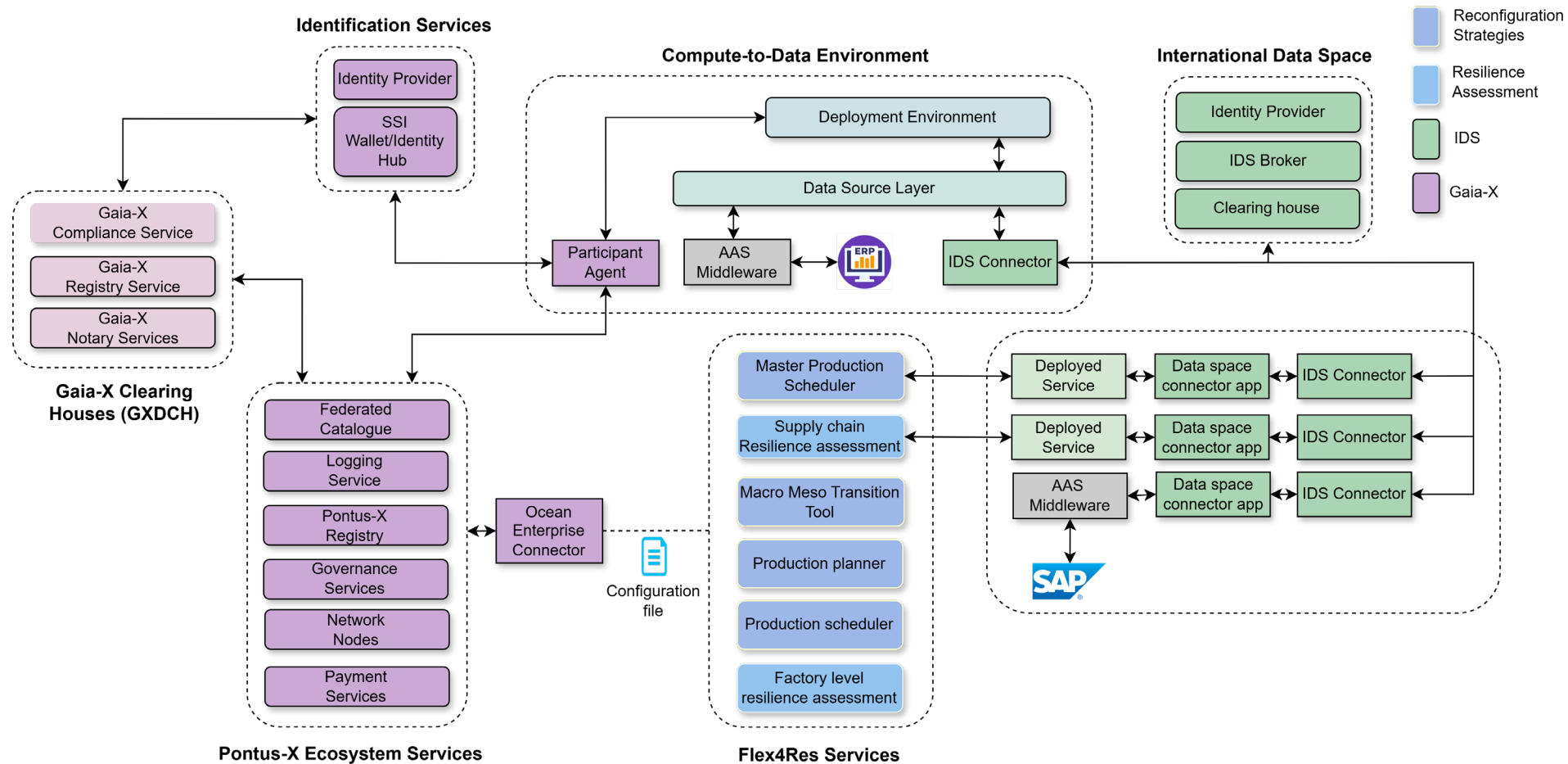
Sidenor Use Case



- Sidenor Group produces several products for the global market and also the supply of raw materials comes from the global market.
- The facilities need to produce several products (e.g., merchant bars, plates, wide rods and more) for the local, and global customers
- SIDENOR operates five production facilities in Balkans

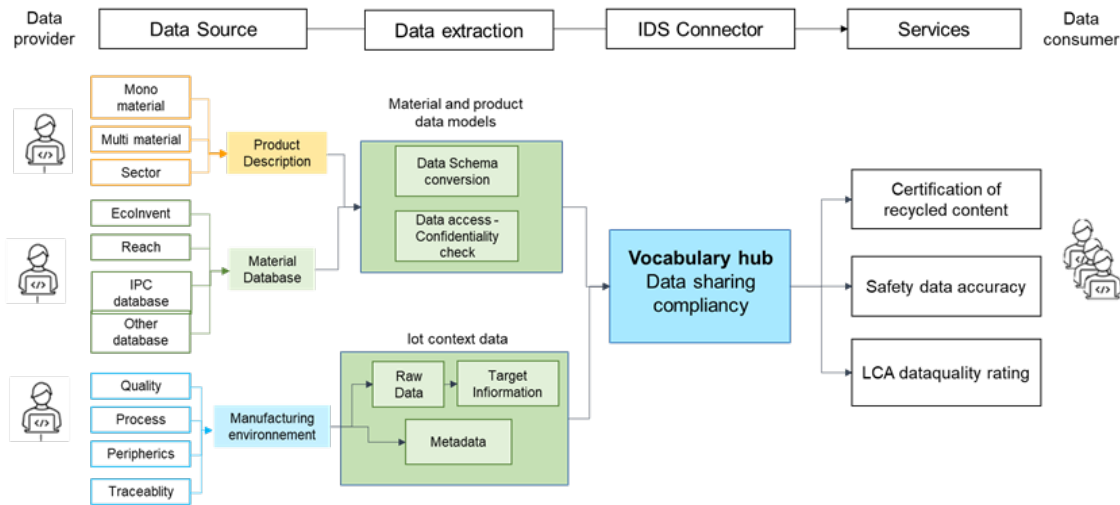


Sidenor Use Case



CircPlastX Project

A Data Space to Increase Circularity Through Data for the Plastics Industry



CircPlastX aims to create a data space for the plastics industry to enhance circularity through data sharing along the value chain. Societal and regulatory pressure is pushing companies to use more recycled materials and provide detailed information on materials used.

CircPlastX will offer three services:

- MaaS for recycled plastics,
- Data quality for substances,
- And LCA data rating.

These services will be co-developed and tested with industry partners, contributing to Green Deal goals and the digitization of the industry.

Call: DIGITAL Action Grant Budget-Based [DIGITAL-AG]

Type of action: DEP

Project Duration: 36 months

Starting date: 1 February 2025



Thank you!

Emmanouil Bakopoulos | bakopoulos@lms.mech.upatras.gr



In partnership with



LMS

Laboratory for
Manufacturing Systems
& Automation





DSSC-[12] Technical Results and Outlook

10:40 – 11:00



- Daniel Alonso – BDVA



In partnership with



Data Spaces Support Center (DSSC) - Technical Results and Outlook -



Thursday, 28 May (10:40 – 11:00)

Daniel Alonso

Senior Technical Lead (BDVA)

Technical Architecture Board (DSSC)

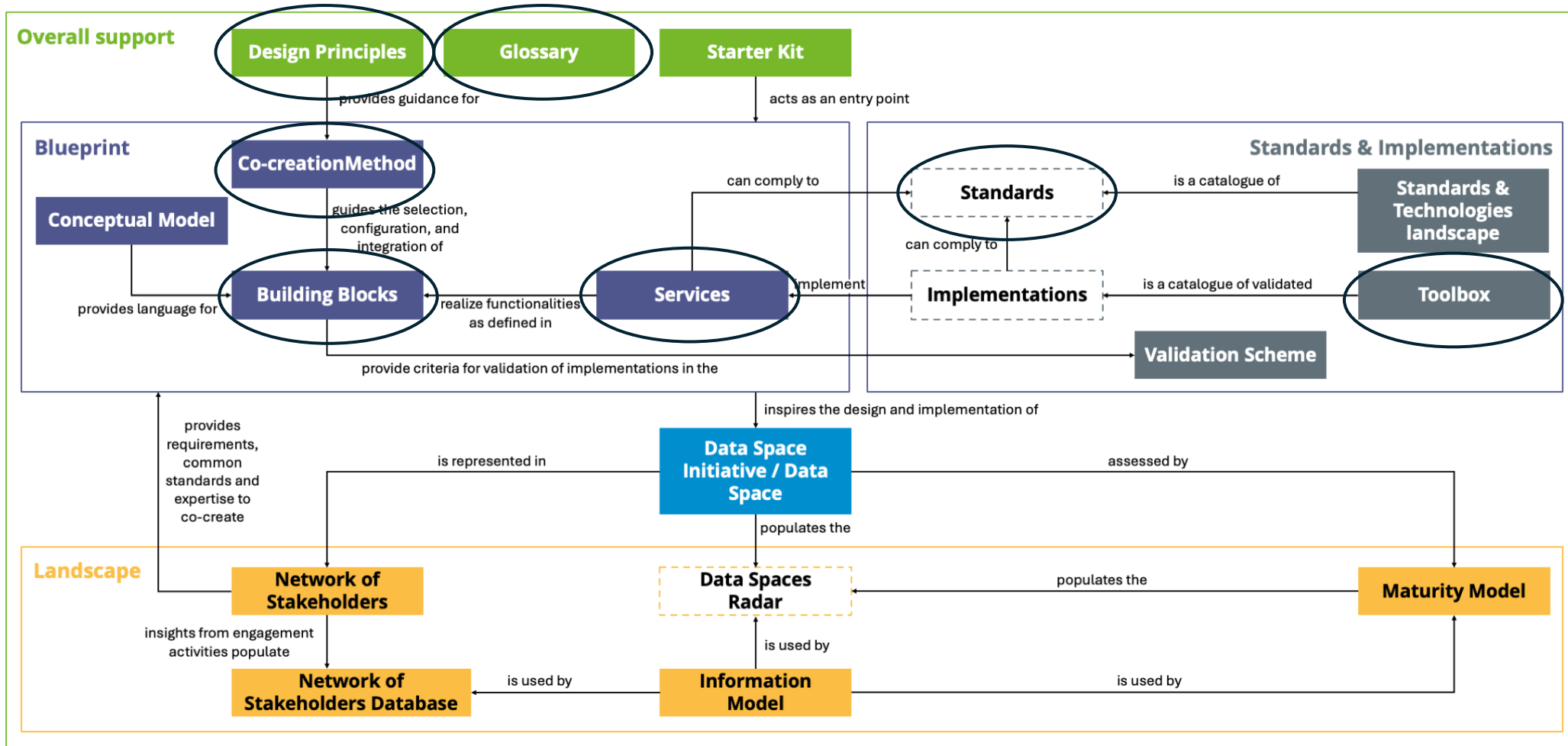


DATA SPACES
SUPPORT CENTRE

In partnership with



DSSC assets based approach



Legend: Assets owned by the DSSC Assets not owned by DSSC

Note: this figure represents the DSSC asset model. It shows relationships between assets, without adhering to a strict UML language. The conceptual model defines further concepts and language.

DSCS Glossary

<https://blueprint.dssc.eu/?pane=glossary>

Consistent and coherent terminology for DSSC communication and publications

- Context, scope, alignment
- Legal definitions
- Criteria and explanatory text
- Modular and interlinked
- Roles and instances

Data Space: interoperable framework, based on common governance principles, standards, practices and enabling services, that enables trusted data transactions between participants

Design principles



Guidelines that assist data space initiatives in making informed decisions while minimizing the risks of data space design and development flaws

S#	Description
1	Incentives and synergies between data space participants
2	Discoverability, Availability, and Accessibility of Data
3	Transparency
4	Establishing Trust and Security in Data spaces
5	Ensure compliance with EU legal framework and norms
6	Ensure Participants Rights in Data Sovereignty
7	Promote Participation Through Inclusivity
8	Promote Environmental sustainability
9	Reusability of Data
10	Establish a fit-for-purpose contractual framework
11	Adaptable data space governance framework
12	Pursuit Quality by Design
13	Ensure Data Interoperability in data spaces

Building on Top of Foundational Technical Standards

- W3C ODRL (Open Digital Rights Language): policy expression language to provide a flexible and interoperable framework for representing statements about the usage of content and services. Express access and usage policies to a dataset.
 - W3C Verifiable Credentials: enable the creation, sharing, and verification of digital credentials in a secure and privacy-respecting manner. Tamper-evident and cryptographically verifiable. Issued for identification and to indicate that a participant is compliant with something
 - W3C DCAT (Data Catalogue) v3: facilitate the interoperability of data catalogues published on the web. Framework for describing datasets in a way that makes them easily discoverable and accessible. Facilitate data integration and reuse across different platforms and domains
-
- Data Space Protocol (DSP): explains (i) how datasets are deployed as DCAT Catalogs and usage control is expressed as ODRL Policies, (ii) how agreements that govern data usage are syntactically expressed and electronically negotiated, (iii) how datasets are accessed using Transfer Process Protocols
 - OpenID for Verifiable Credentials
 - Eclipse Dataspace Decentralized Claims Protocol

DSSC technical building blocks

Semantics, technical interfaces
(APIs), observability

Identification, trust, access
& usage policies

Publication, discovery,
value-added services

Technical

Data interoperability

Data models

Data exchange

Provenance & traceability

Data sovereignty & trust

Identity & attestation management

Trust framework

Access & usage policies
enforcement

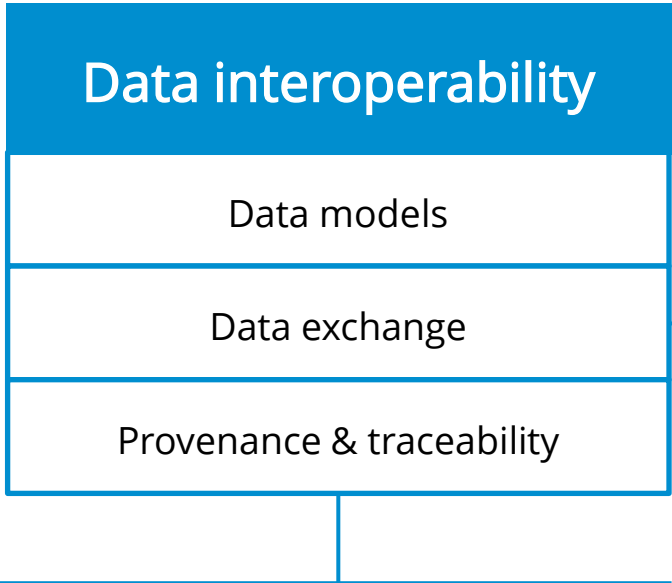
Data value creation enablers

Data, services
& offering descriptions

Publication & discovery

Value creation services

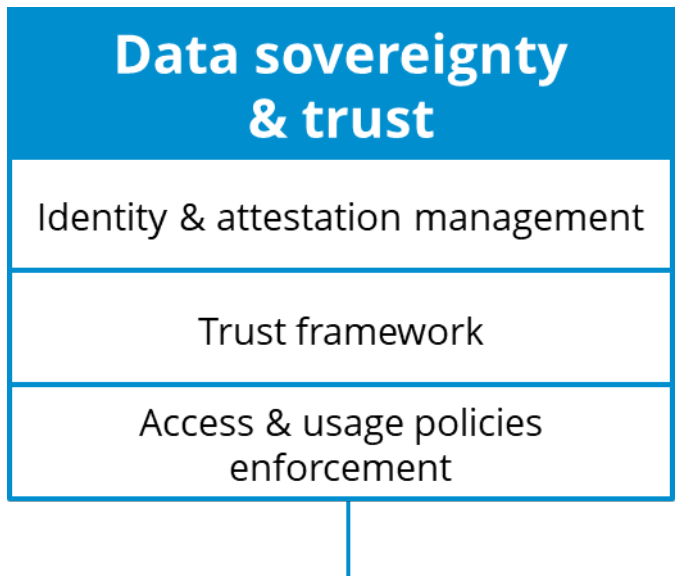
DSSC building block: description of related functionalities and/or capabilities that can be realised and combined with other building blocks to achieve the overall functionality of a data space



- Ontologies, application profiles, data schemas
- Vocabulary services
- Data model development
- Data model governance
- Data model integration
- Data model abstraction
- Data models across data space

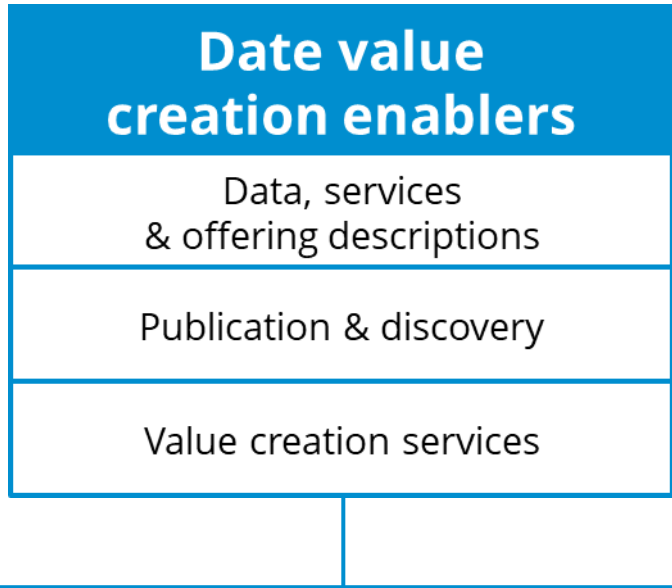
- Monitor for better compliance, business, trustworthiness purposes
- Actual exchange of data (provenance)
- Other aspects of the transaction (observability -> states of the DSP machine / 3 protocols)
- Part of the data product -> data models, e.g. W3C PROV-O

- Transfer process - > in the “data plane” (linked to the “control plane”)
- Dataspace Protocol (state machine: REQUESTED, STARTED, COMPLETED, SUSPENDED, and TERMINATED)
- To be implemented into a transmission protocol (e.g. REST-APIs, or similar)
- Connected to the data model through the data schemas



- Manage and exchange of credentials
- Attestation -> verifiable credentials and presentation
 - Identity Attestations
 - Membership Attestations (also referred to as attestations of participation in a data space)
 - Compliance Attestations according to the data space governance
- W3C VC, DiDs, OIDC4VC, DCP
- Rulebook and compliance criteria
- Processes and technical means for validation
- Accredited sources of trust: trust anchors and trust service providers
- ISO/IEC 17000:2020 - Conformity assessment, ETSI TS 119 612 (Trusted Lists), W3C SHACL (automated compliance verification)
- Use and extension of existing FWs: Gaia-X

- Who can access data, how data access is granted and controlled, what actions can (not) be performed, how usage is controlled
- Policy Creation and Validation
- Enforcement of policies during the various stages of a data transaction
- W3C ODRL, DSP
- Best practice: policy administration, information, decision and enforcement

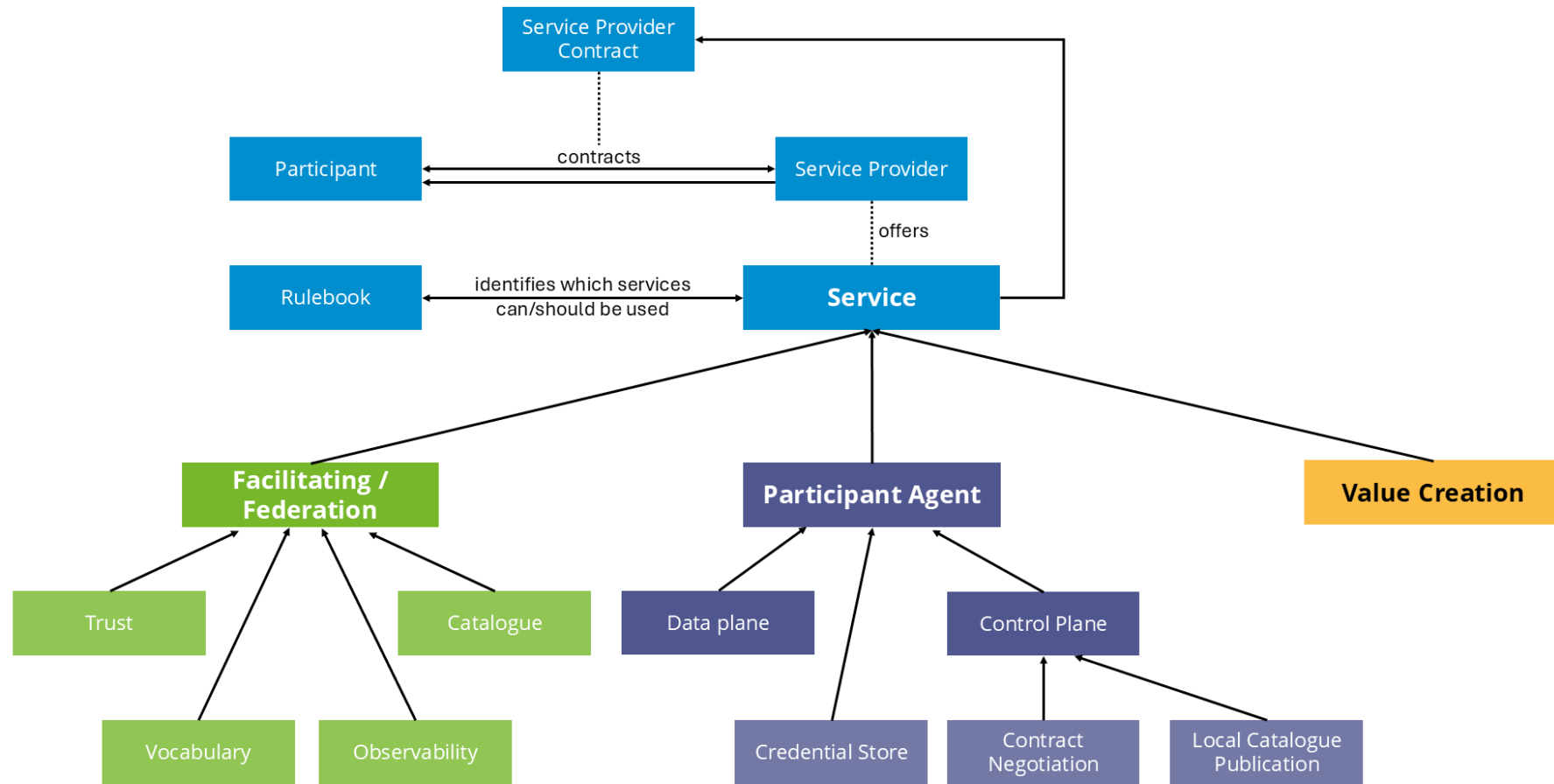


- Data Space offering: data product + services
- Creating, validating, updating, managing metadata
- DCAT & DCAT-AP
- Sectorial metadata

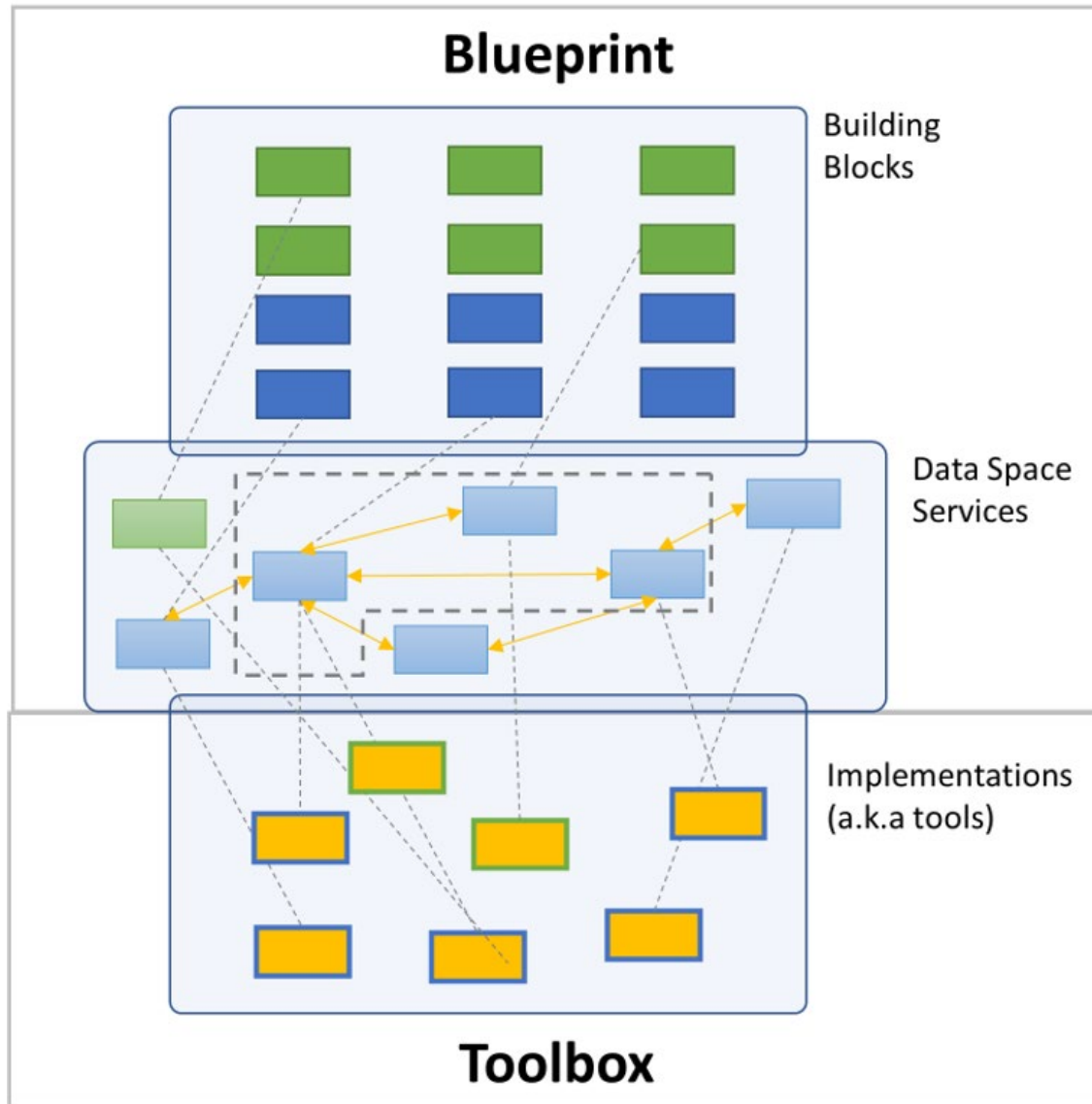
- Unlock, generate and maximize the value of data shared within a data space, providing additional functionalities on top of the core process of data sharing or data transaction
- Taxonomy
- Composition of services
- Information model -> description
- Services management framework









- Brings together providers and potential consumers
- Providers expose descriptions as offerings, consumers search among offerings to determine whether the characteristics and terms and conditions meet their needs and requirement
- Catalogues in the DSP (catalogue protocol)
- Implementation through a connector (that displays the offering of this participant), or through a catalogue

From building block capabilities to services



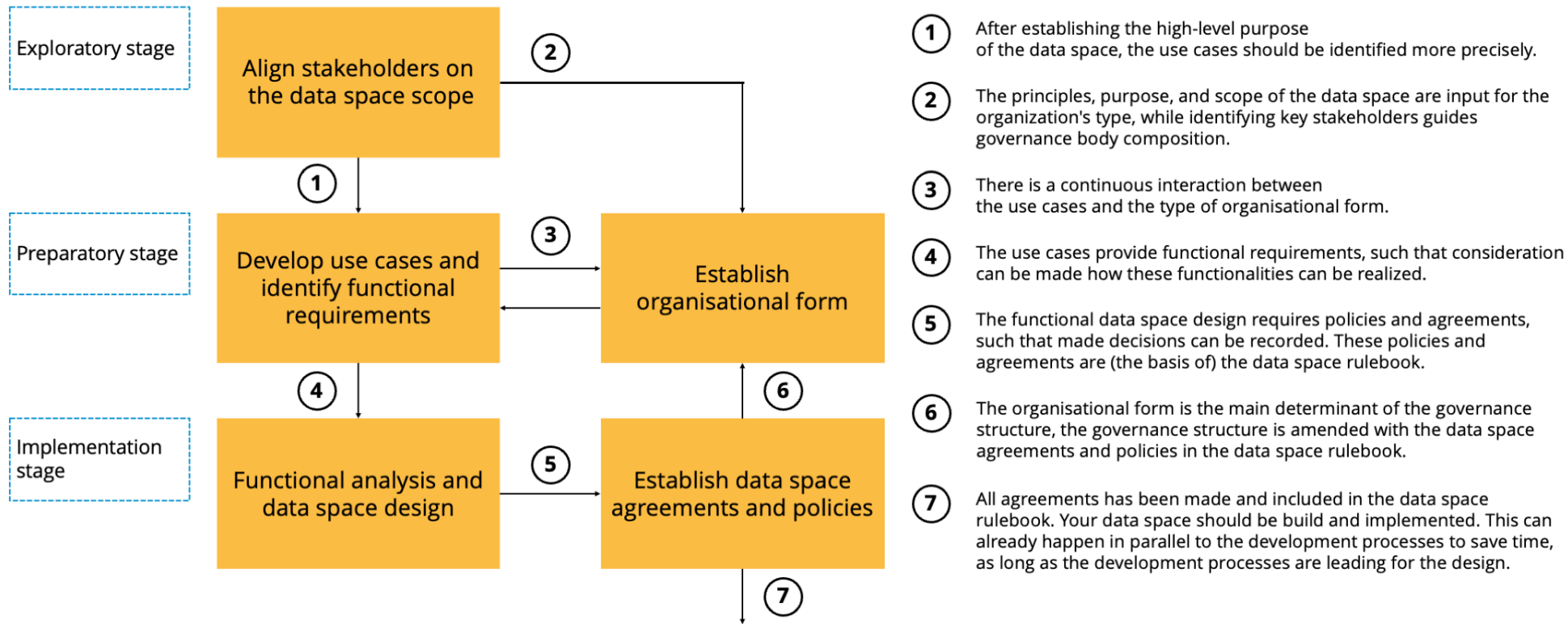
DSSC Toolbox: a collection of real implementations



Name	Service type	Building blocks	Maintainer	Assessment information	Blueprint version
Ocean Enterprise Provider	Participant Agent service	PM, OGA, CF, RC, UCD, DM, DSI	Ocean Enterprise Collective (OEC)	 	v1.5
Ocean Enterprise Market	Value Creation service	BMD	Ocean Enterprise Collective (OEC), deltaDAO AG	 	v1.5
Nautilus Participant Agent	Participant Agent service	PM, OGA, CF, RC, UCD, DM, DSI	deltaDAO AG	 	v1.5
Ocean Enterprise Catalogue and Aquarius Catalogue Cache	Catalogue service	DPD, UCD, DSI, DM, CF, RC, BMD	Ocean Enterprise Collective (OEC), deltaDAO AG	 	v1.5

DSSC co-creation method

Increase the speed of development by guiding participants through a sequence of questions directly connected to the building blocks. In this way, the Co-Creation Method aims to quickly determine the most appropriate implementation, aiming to increase the success chances of a data space



DSSC forward looking (research agenda)

- Standards, Data Act (article 33)
- Machine interpretable rulebooks (comparable, improving interoperability, automation), Machine-Readable Trust as a Foundation for Cross-Space Federation
- Expanding Claim-Based Participation Models
- AI for data spaces at large
- AI driven data annotation and structuring, AI-Enabled Interoperability
- End-to-End Lineage and Transparency
- Advancing the development of technical services
- Metadata for Algorithmic Assets and AI-Driven Services
- Federated Catalogs for Scalable, Distributed Discovery
- Convergence Between Participant Services and Value-Added Capabilities

Data Spaces Support Center 2



- Focused on adoption and impact
- Contribute to AI Continent Action Plan and European Data Union Strategy (AI Factories, Data Labs, AI readiness of data)
- Maturity and extension of building blocks and blueprint
- Further standardization
- AI & data spaces
- Connection / interoperability between data spaces



Thank you!

Daniel Alonso | daniel.alonso@bdva.eu



In partnership with



LMS

Laboratory for
Manufacturing Systems
& Automation



Networking Coffee/AR Game
11:00 – 11:30



Complete AR & real-world challenges to become the ultimate **Data Wizard!**

Visit the **Gaia-X Discovery Quest Booth** in the Expo area to find out more!



Connect with fellow participants in a fun, new environment.



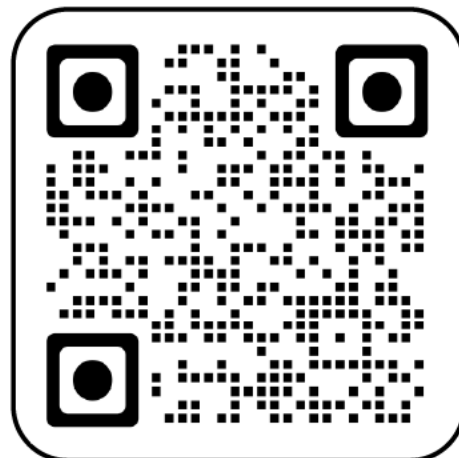
Explore key Gaia-X concepts like trust, compliance, data economy, and interoperability.



Use Augmented Reality to make these concepts come to life.



Turn the summit into an **interactive, educational** adventure.



SCAN TO DOWNLOAD

Scan the QR code to download the **Gaia-X AR app** and compete in the Gaia-X Discovery Quest!



Federated Trust and the IMXC Use Case

11:30 – 12:10



- Klaus Ottradovetz – Atos



In partnership with



LMS

Laboratory for
Manufacturing Systems
& Automation





X-Road 8 Spaceship Development Activities

12:10 – 12:40



- **Petteri Kivimaki – NIIS**



In partnership with



Nordic Institute for Interoperability Solutions (NIIS)



Ensures the development and strategic management of digital government solutions that allow its members to provide excellent digital public services.



Estonia



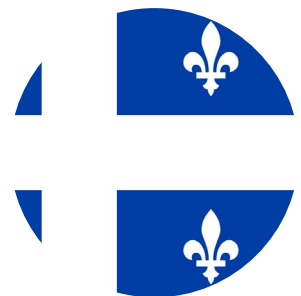
Finland



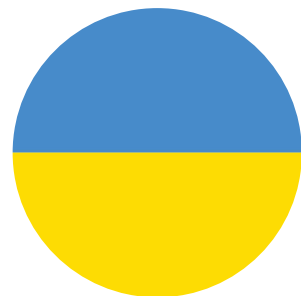
Iceland



Schleswig-Holstein



Québec



Ukraine



The Faroe Islands



Åland

#GaiaX #TechX

NIIS Journey

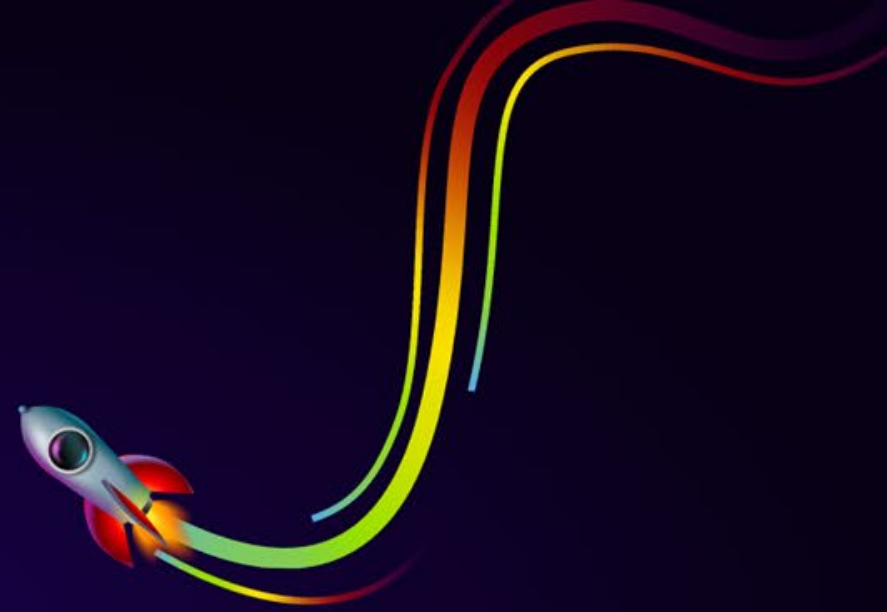


#GaiaX #TechX

NIIS Dataspace Journey



#GaiaX #TechX



Introduction to X-Road®



X-Road®

- A free and open-source data exchange solution
 - Open source software (MIT licence)
 - x-road.global
- Digital Public Infrastructure (DPI)
 - One of the most deployed DPIS worldwide
 - undp.org/digital/digital-public-infrastructure
- Digital Public Good
 - Recognised by the Digital Public Goods Alliance
 - digitalpublicgoods.net

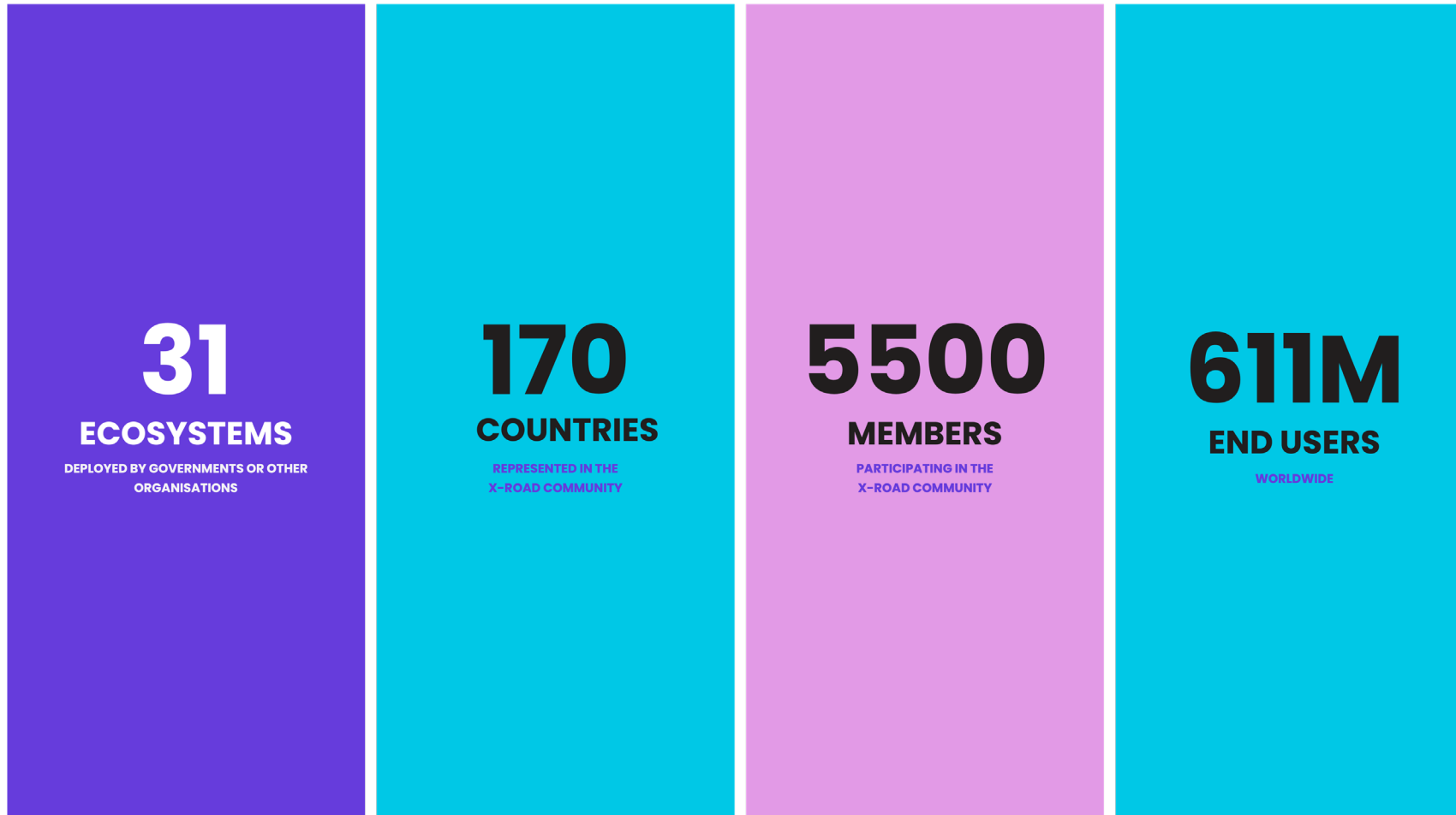


X-Road Journey

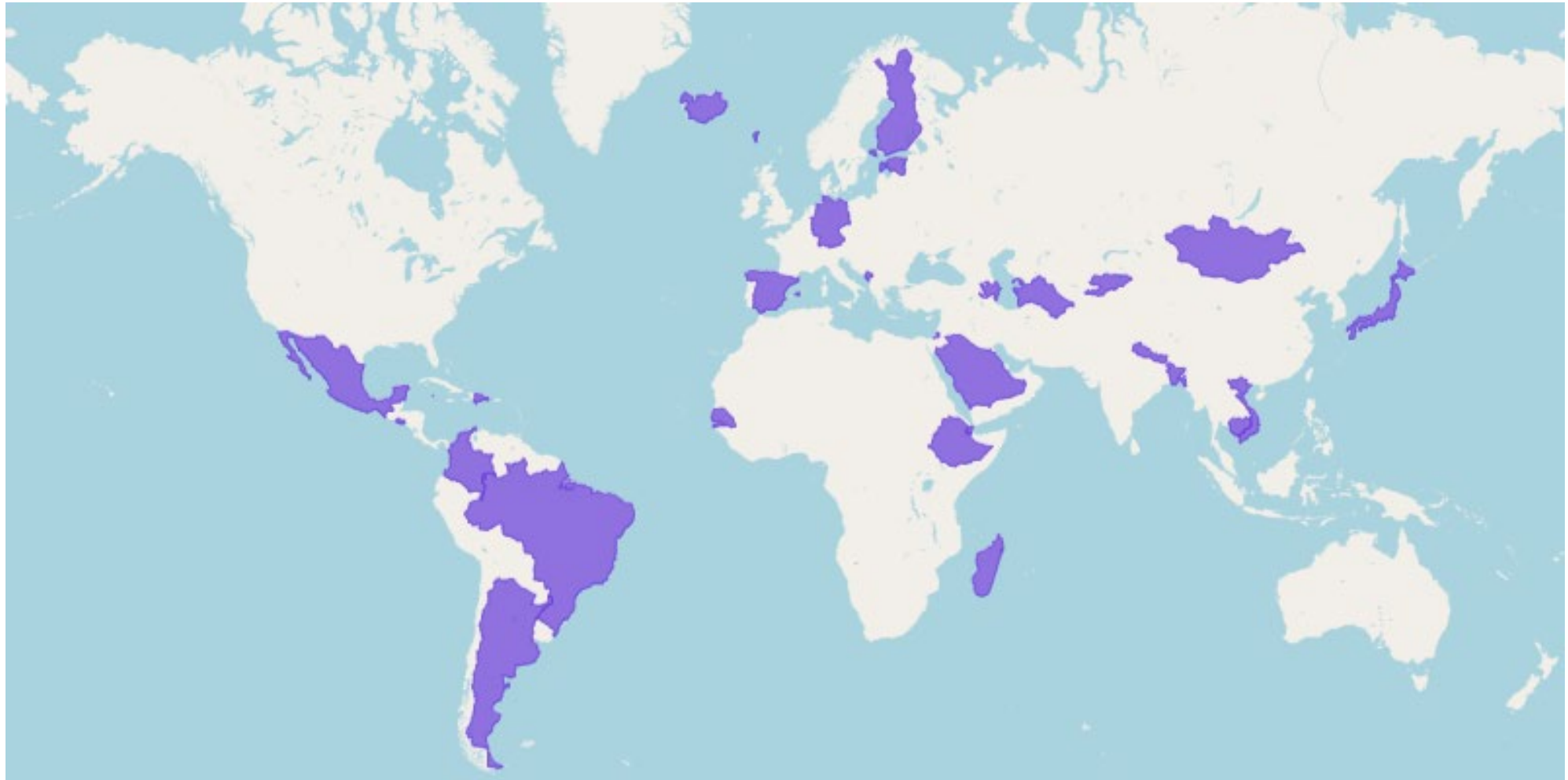


#GaiaX #TechX

X-Road in Numbers

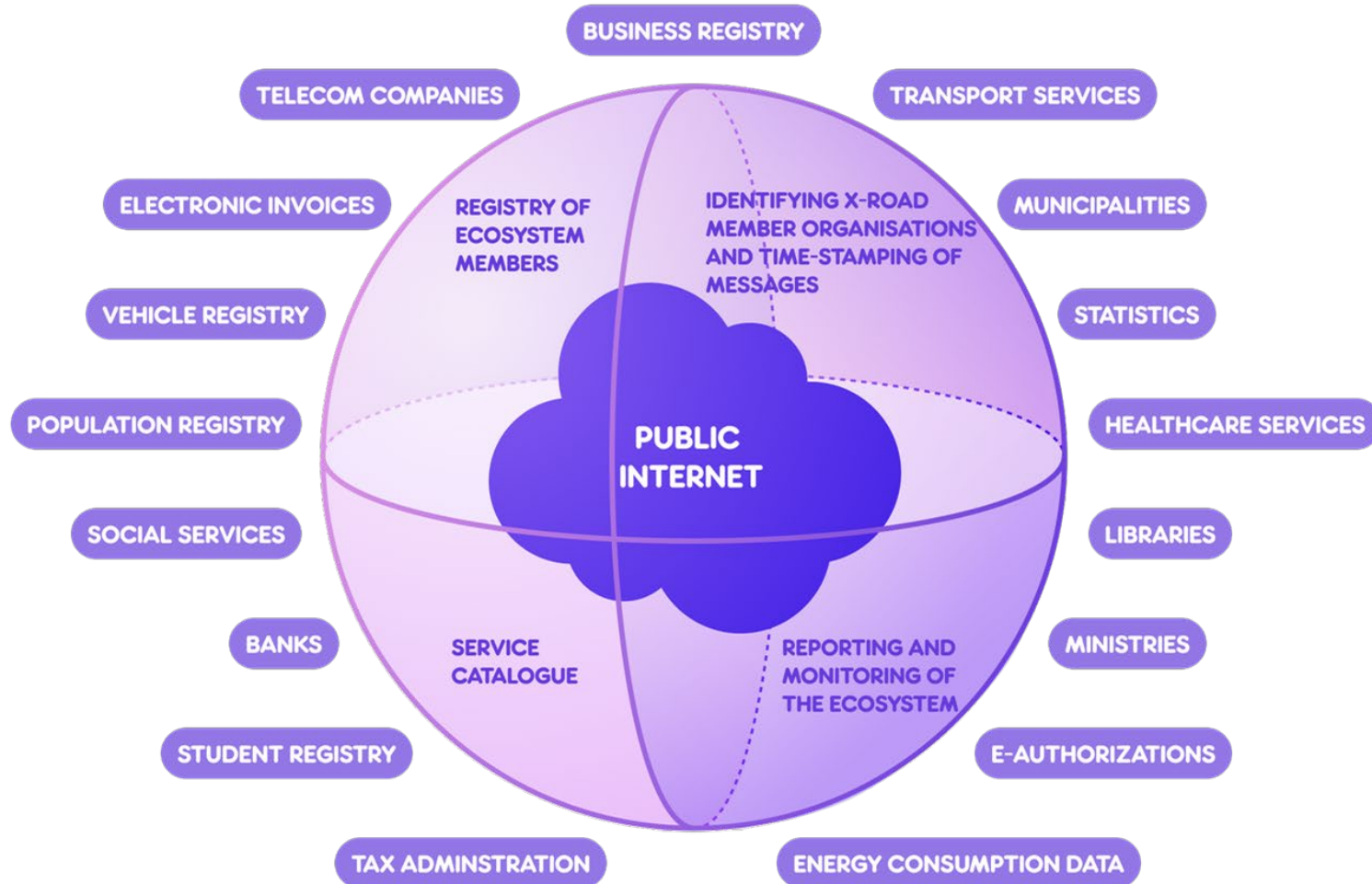


X-Road Ecosystems on a Map

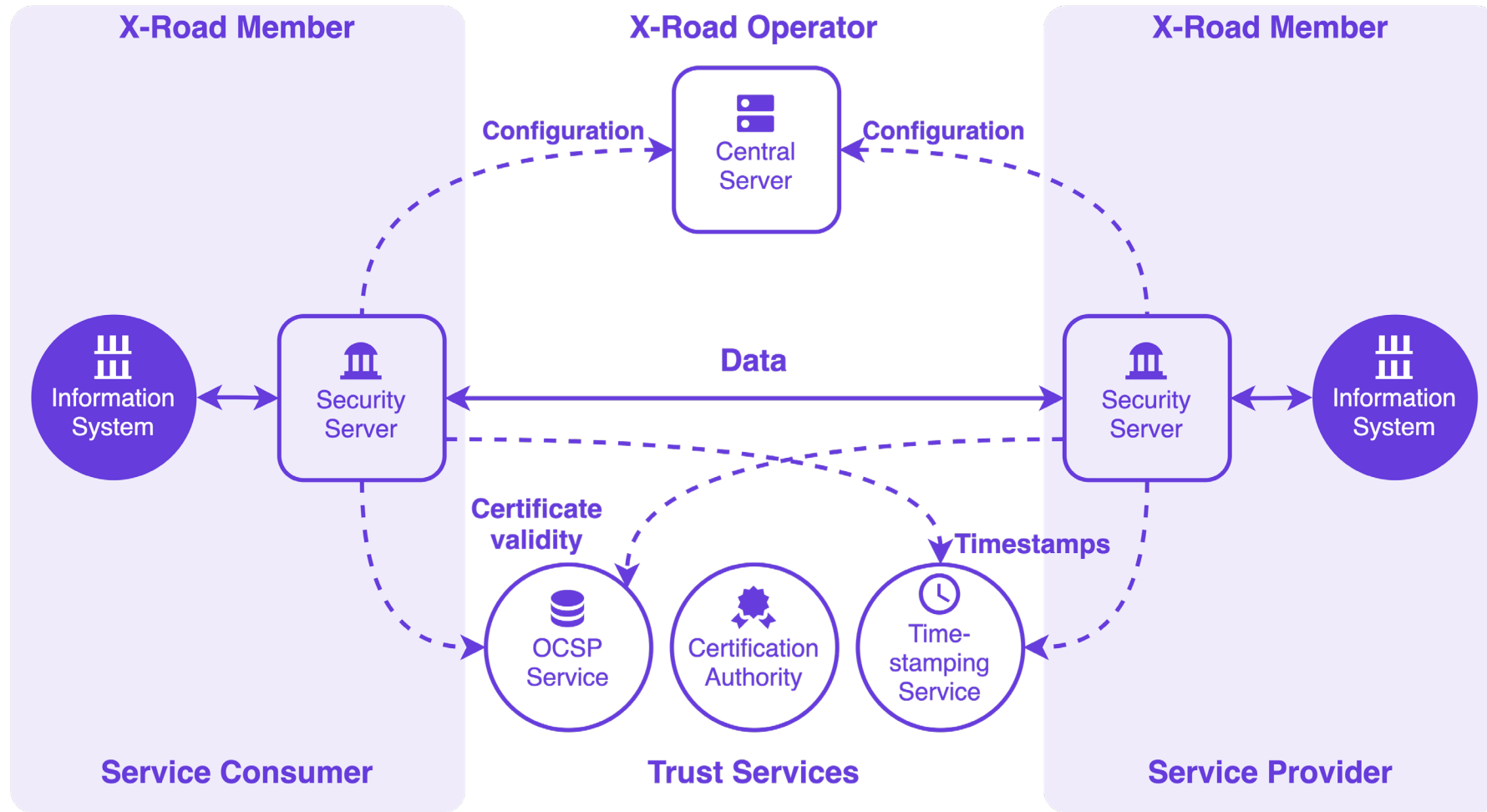


#GaiaX #TechX

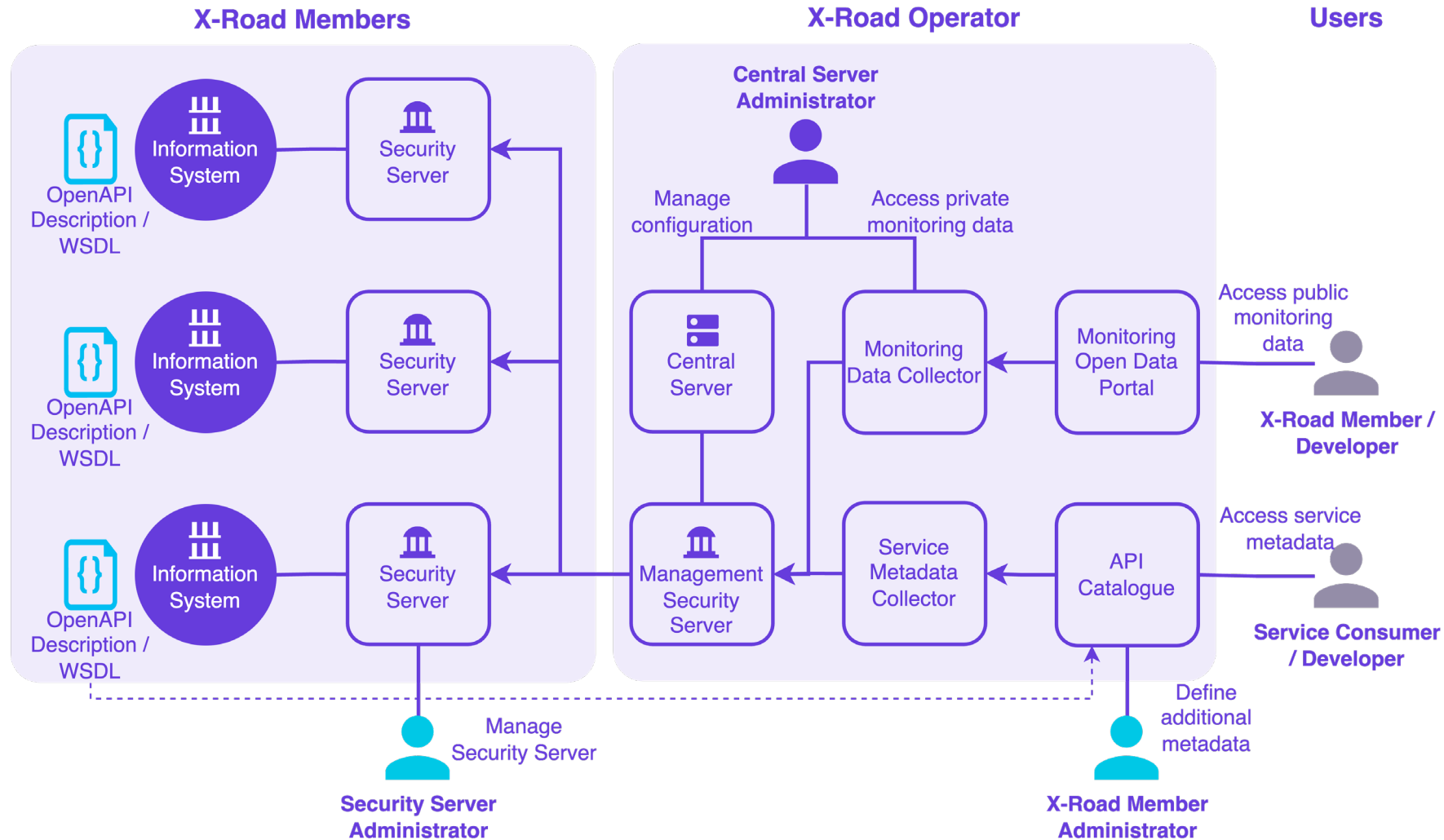
X-Road Ecosystem



Data Exchange in X-Road



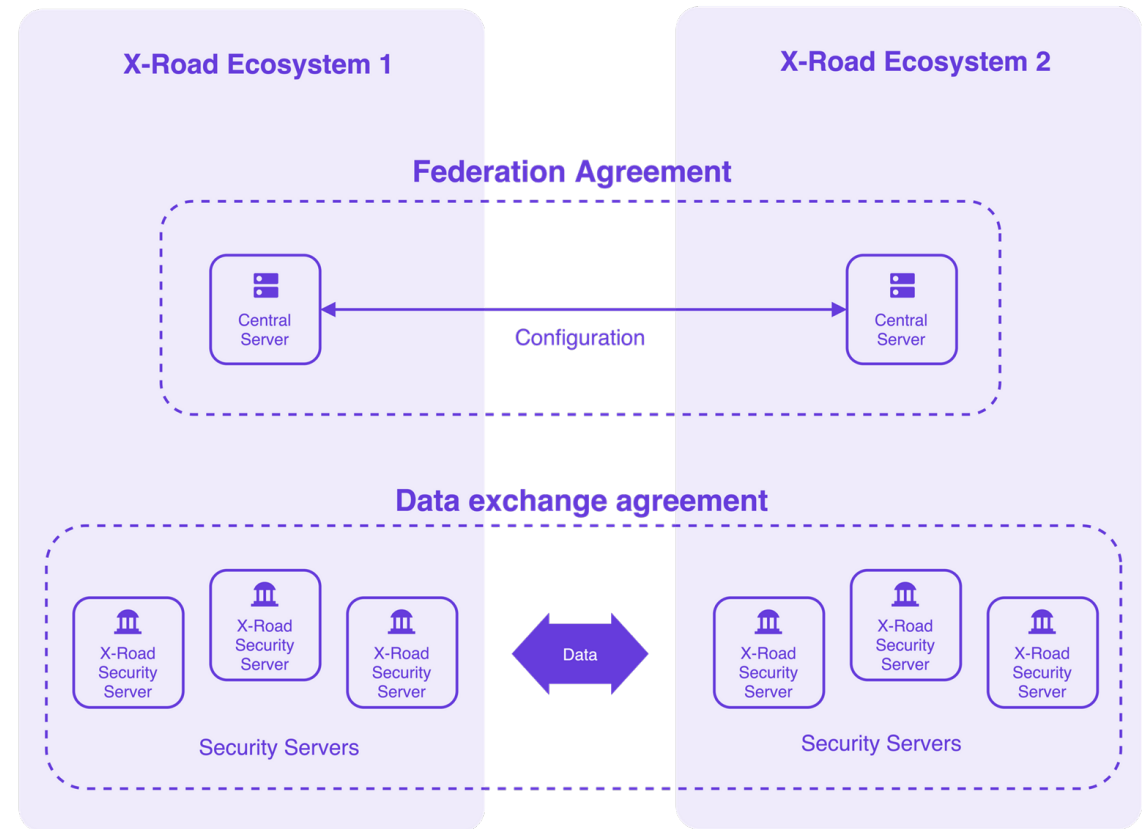
Monitoring and Data Discovery



X-Road Federation

Available since 2014 (X-Road 6.0-)

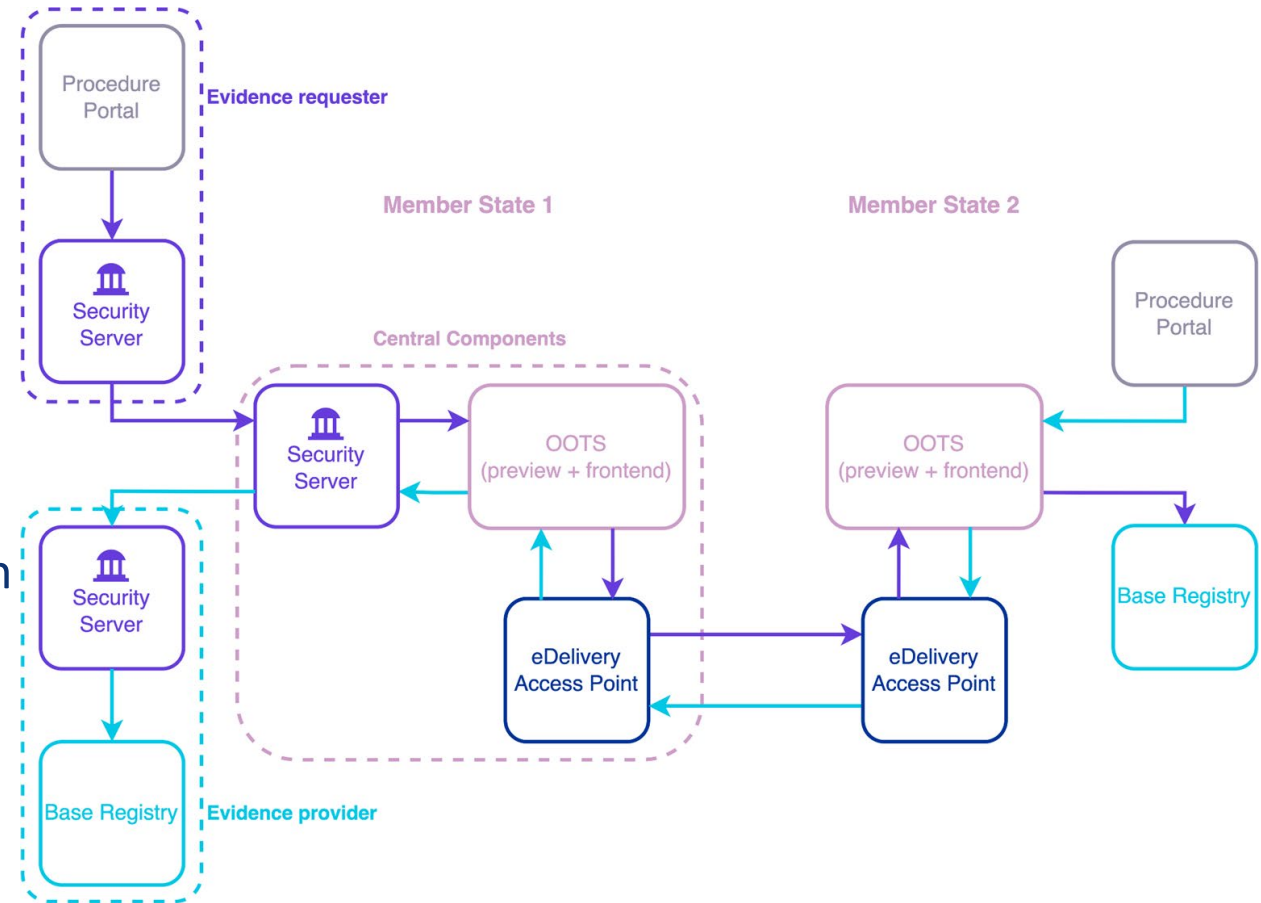
- Federation is a **one-to-one relationship between two ecosystems**.
- Members of the federated ecosystems can publish and consume services with each other as if they were members of the same ecosystem.
- Federation is not only about technology – agreements are also needed between X-Road operators and user organisations.



Enabling the Once Only Principal

National OOTS solution compatible with the European Union OOTS


- A national X-Road ecosystem can be connected to the European Union OOTS.
- Existing interfaces and integrations used at the national level can be reused for cross-border data exchange.
- Estonia and Finland have adopted this approach in their EU OOTS implementations.





X-Road 8 "Spaceship"

Nurtures the proven ecosystem model and security while it takes X-Road to the next level by providing a solid data space infrastructure. 🚀



Transition to a Dataspace Solution



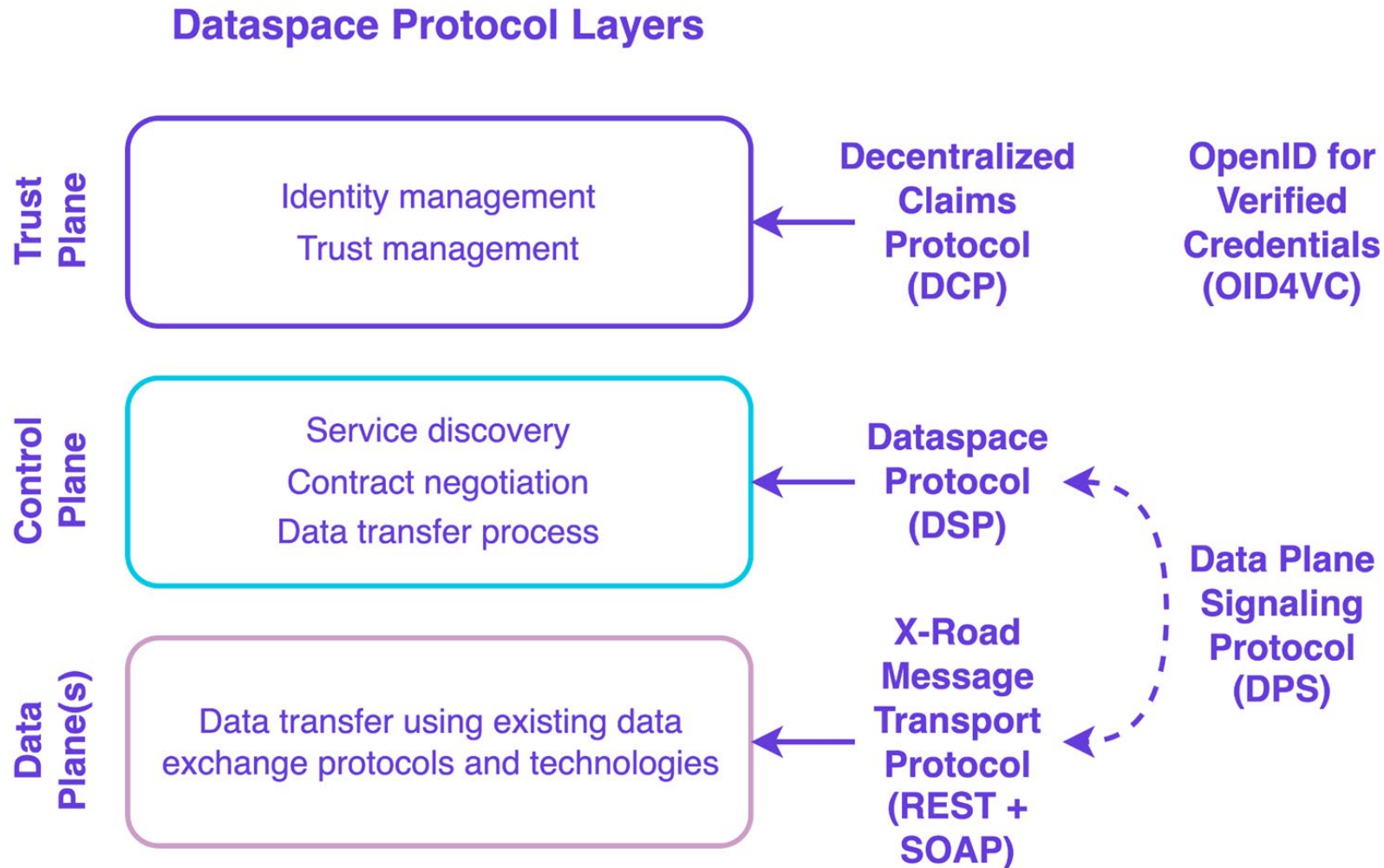
Current state

- X-Road has its own **custom protocol stack** and being interoperable with other data exchange ecosystems requires building and maintaining custom ecosystem-specific gateway solutions.
- **NIIS is primarily responsible** for maintaining and developing X-Road.

Target state

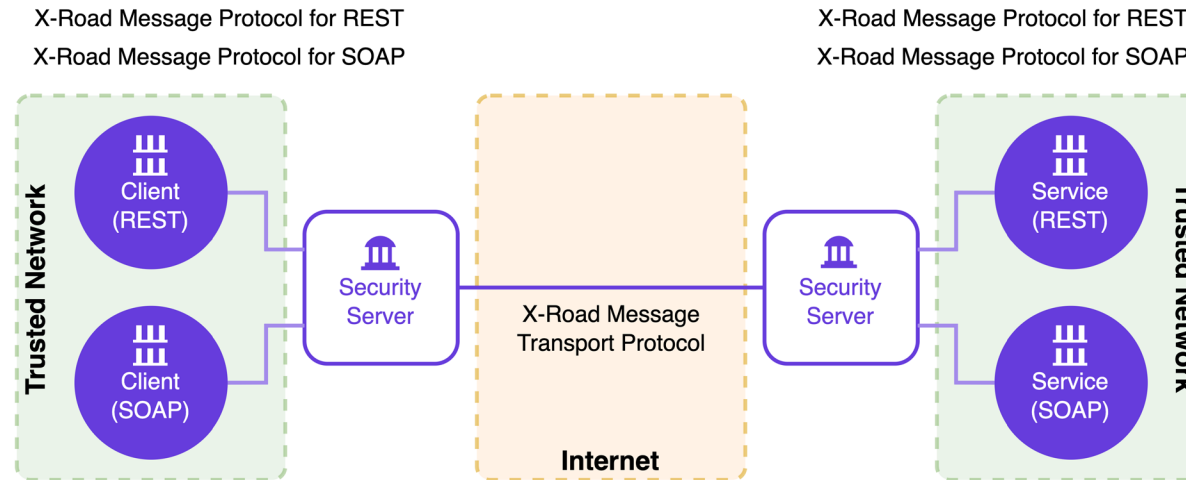
- X-Road uses the **standard dataspace protocol stack** and is interoperable with other data exchange ecosystems that follow the same standards and specifications.
- X-Road is **built on existing open-source components** maintained by international developer communities. NIIS contributes to their maintenance, but its **main focus is developing new business features**.

X-Road's Dataspace Protocol Stack

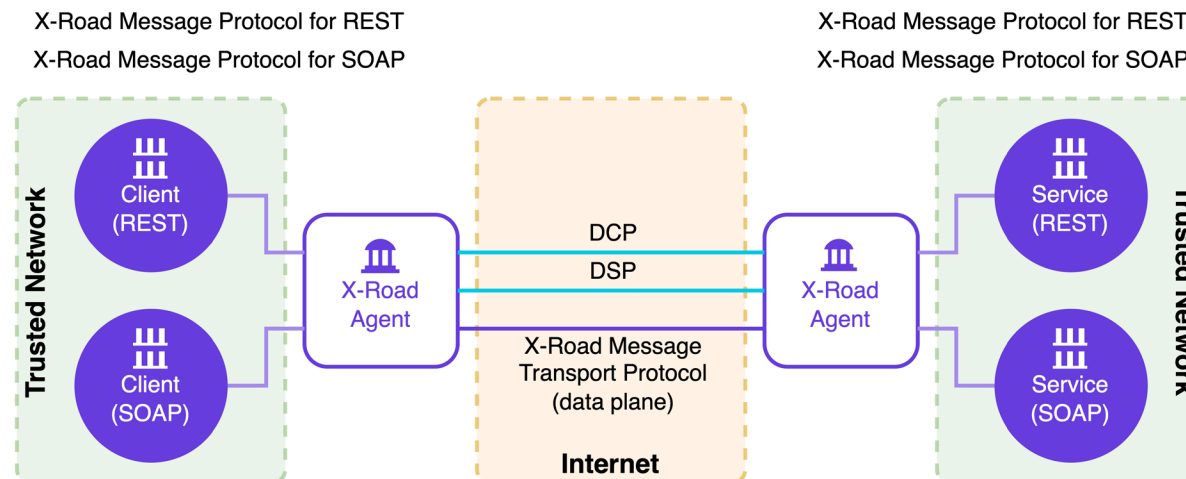


X-Road Protocols

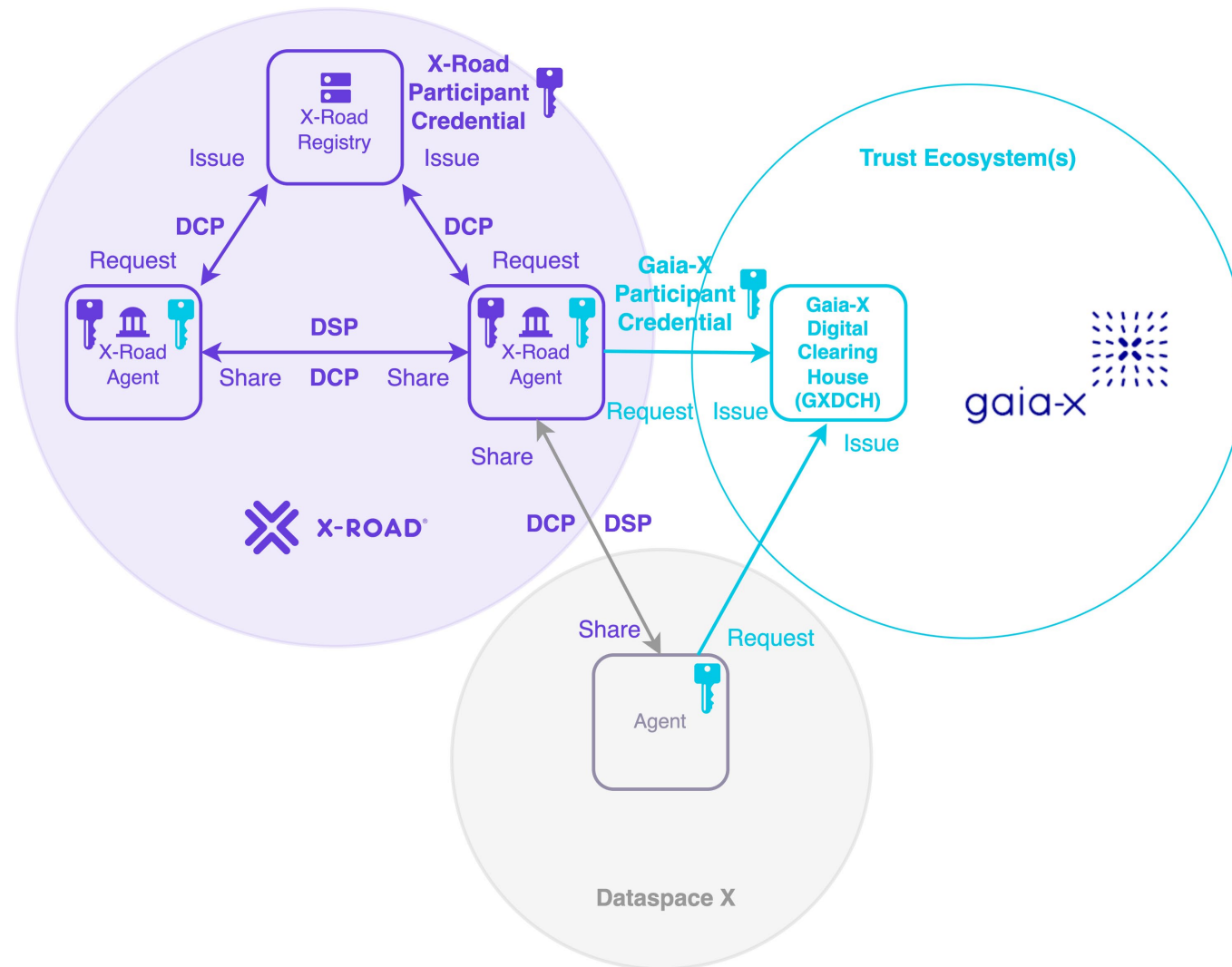
Before X-Road 8



Starting from X-Road 8



Technical Interoperability with the Gaia-X Trust Framework



Decentralised Claims Protocol (DCP), Data Space Protocol (DSP)

#GaiaX #TechX

X-Road 8 Timeline



Some Implementation Challenges

- Maintain protocol-level backwards compatibility
- Continue supporting the current multi-tenancy model
- Manage DID and credential lifecycles for participants operating multiple agents
- Map and synchronize existing access control policies to ODRL-based policy models
- Support multiple parallel service description models (OpenAPI, WSDL, DCAT)
- Align X-Road terminology, APIs, and component architecture with dataspace concepts and standards



Thank you!

Petteri Kivimäki | petteri.kivimaki@niis.org



In partnership with



LMS

Laboratory for
Manufacturing Systems
& Automation



Myrtus Project: A SHACL-based remote Danube extension

12:40 – 13:00

- Giulia Biagioni – TNO



In partnership with



Myrtus Project: A SHACL-based remote Danube extension



Giulia Biagioni, Coen Leeuwen & Bart Driessen



In partnership with





Financed by: Horizon Europe (Grant No. 101135183),

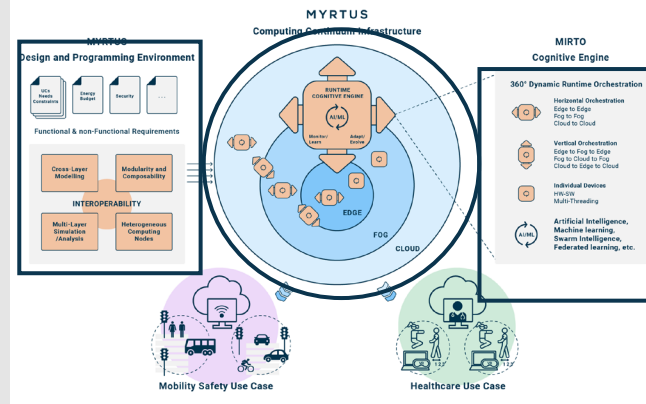
Topic: HORIZON-CL4-2023-DATA-01-04 – Cognitive Computing Continuum

Duration: 1 January 2024 – 31 December 2026

Creates a solution to orchestrate the cloud–fog–edge continuum
– in a sustainable and secure way

Myrtus is built on three pillars
Design & Programming Environment
Reference Architecture

AI Driven cognitive engine enabling dynamic orchestration, optimization, and autonomous decision-making across the continuum.



Myrtus Partners



UNIVERSIDAD POLITÉCNICA DE MADRID



Secure Onboarding of New Entities in Myrtus

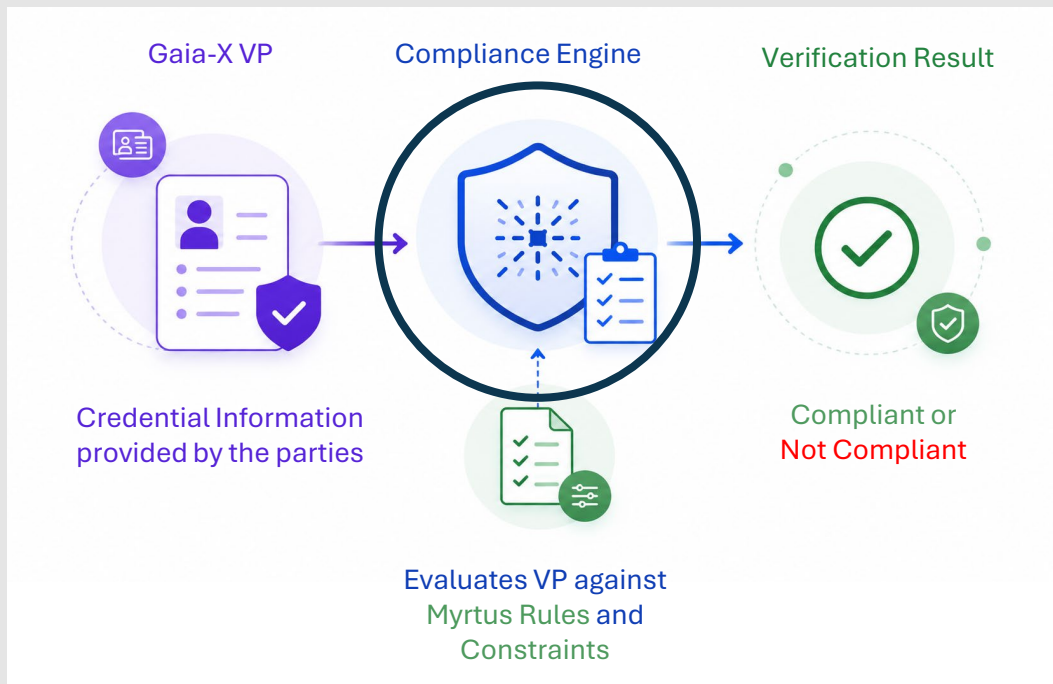


Myrtus AI cognitive engine leverages a compliance service using **Gaia-X Verifiable Presentations** and **Verifiable Credentials** to authorize new entities joining the ecosystem and ensure compliance with Myrtus requirements

Ensures trust in the ecosystem: only compliant and verified entities are allowed to join Myrtus.

Compliance Validation

Gaia-X Compliance Framework



Myrtus Rules

Legal person:

- Subject must have valid registration number
- Subject must be based in EU

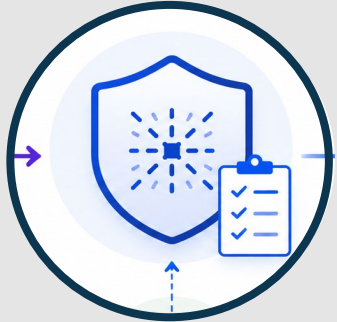
Legal Entity Identification (LEI) code

- Subject must have a valid LEI code
- LEI country code must be based in EU

Terms and conditions

- Subject must have accepted the Gaia-X legal terms and conditions

Integration with Gaia-x Compliance Framework



Initially, from the [Gaia-X Compliance Framework](#), we only used the [Verifiable Presentation](#) (VP), which was evaluated using the compliance engine and compliance rules developed within Myrtus.

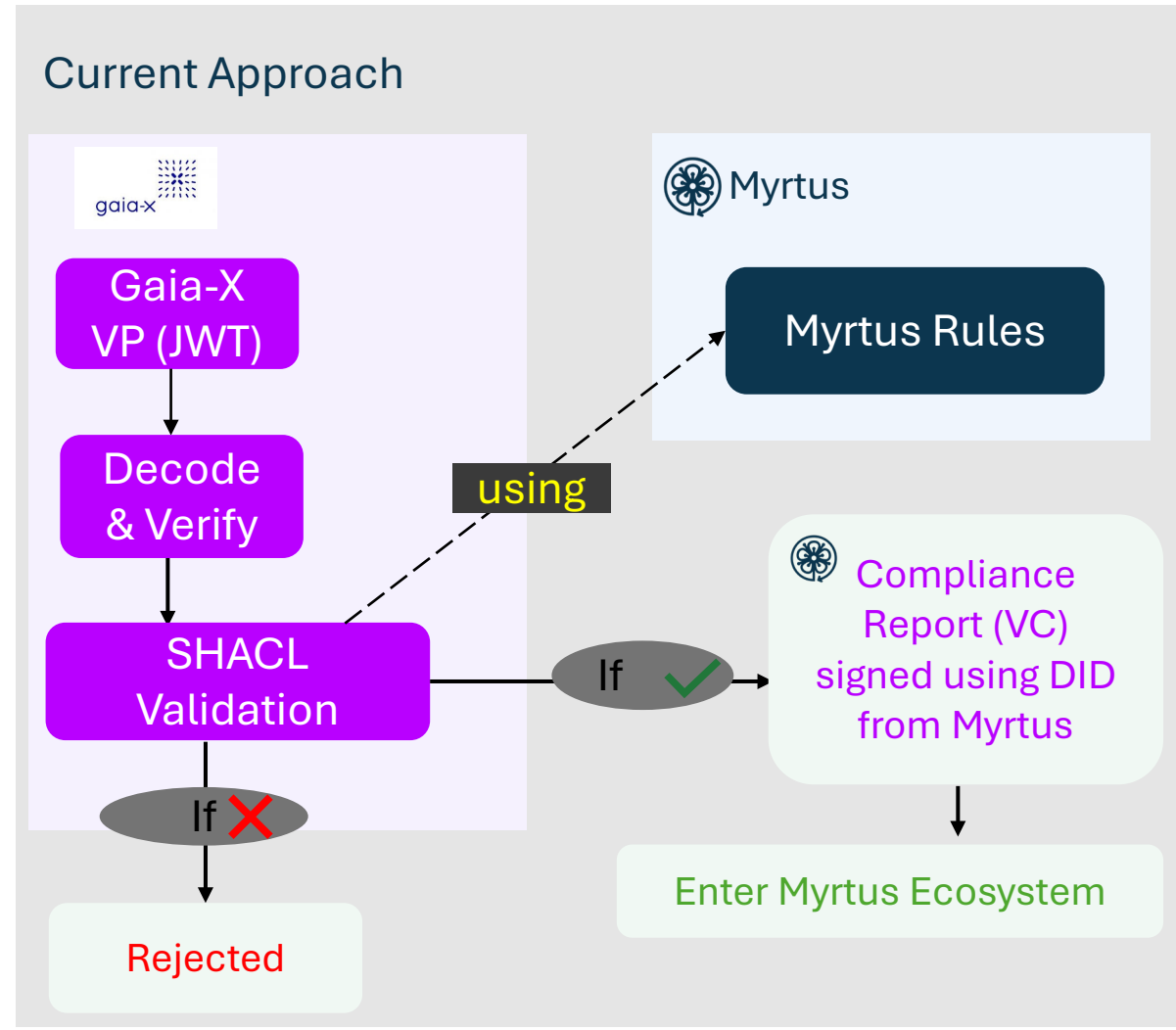
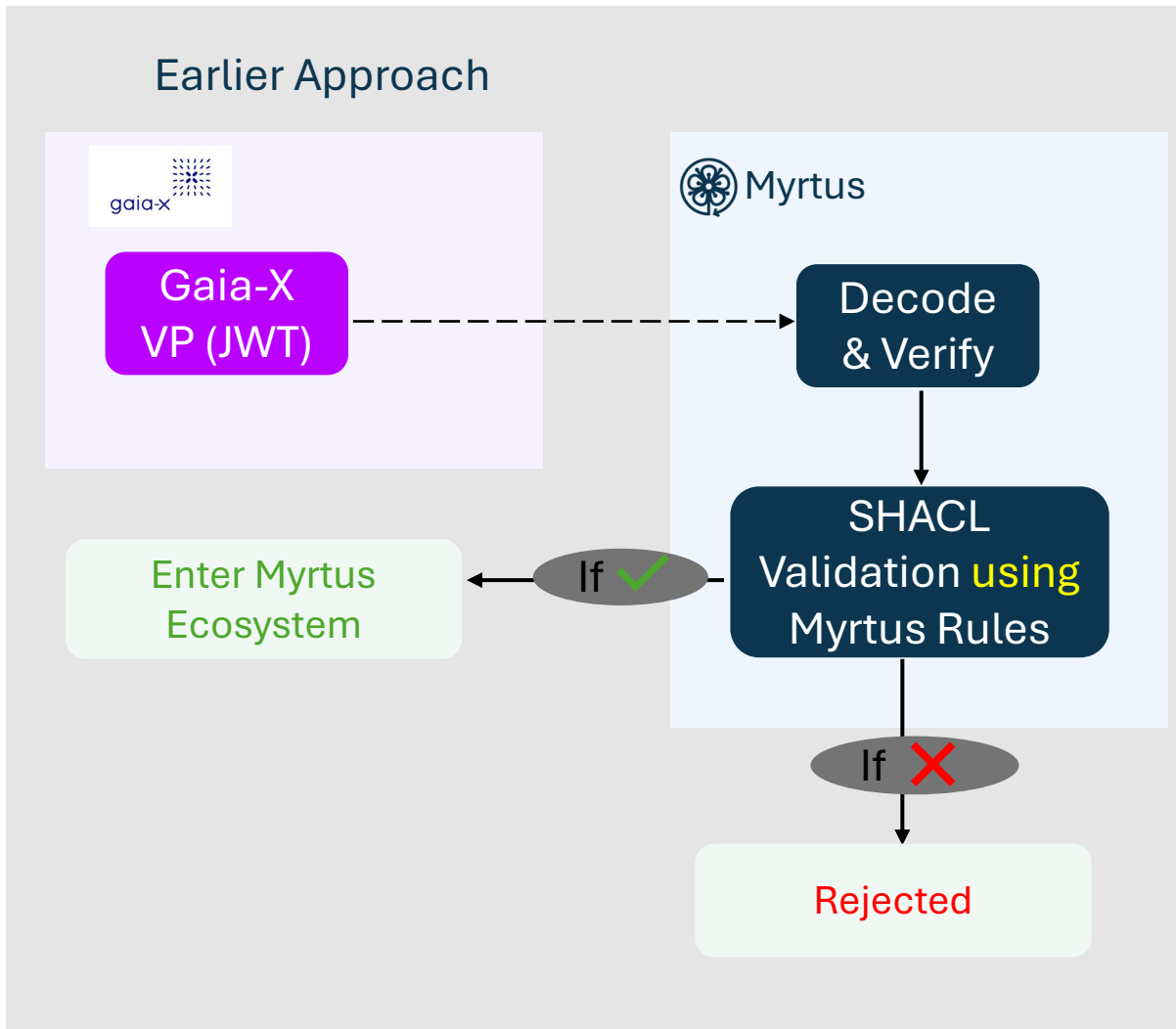
Myrtus: A Computing Continuum Platform, Gaia-X Summit 2025, Digital Ecosystems in Action



At the same summit, [Danube](#) was presented as the new extensible compliance engine of [Gaia-X](#), and we look forward to integrating it into our process.

January 2026 - May 2026: work on the integration of Danube with Myrtus

Connecting Danube with Myrtus



DEMONSTRATION

Project

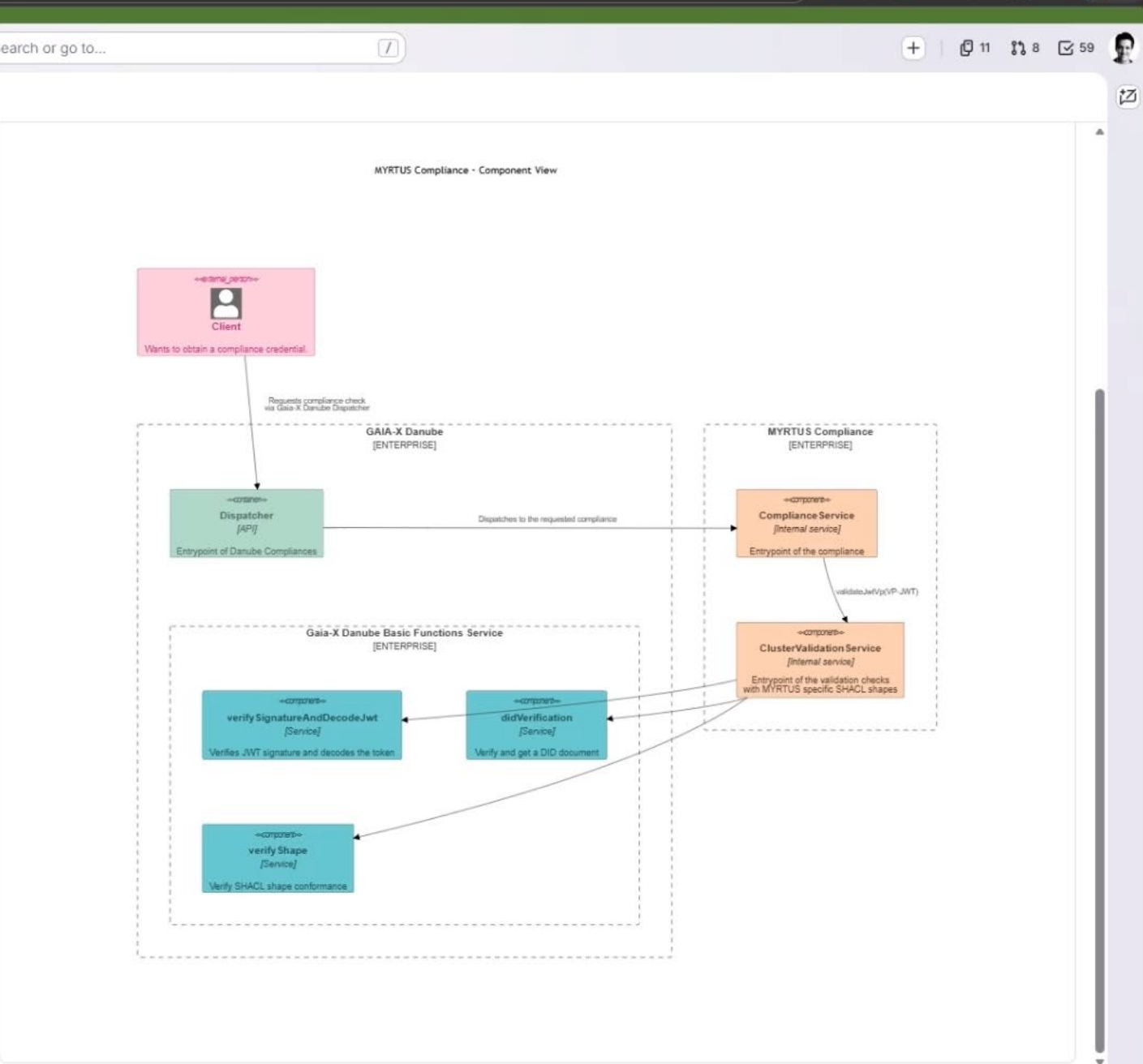
- Trust_Framework
- Pinned
- Work items
- Merge requests 0
- Branches
- Issue boards
- Manage
- Plan
- Code
- Merge requests 0
- Repository**
- Branches
- Commits
- Tags
- Repository graph
- Compare revisions
- Snippets
- Locked files

MYRTUS / Trust_Framework / Repository

Files

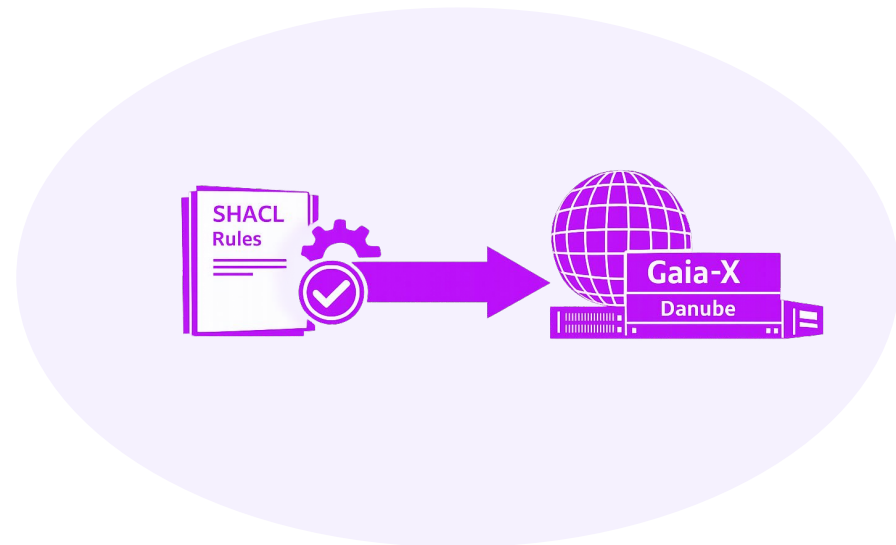
Search files (*.vue, *.rb...)

- .idea
- compliance_api
- shapes
- ui
- .dockerignore
- .gitignore
- Dockerfile
- README.md
- compliance-api.yml
- components.md**
- deployment.yaml
- pyproject.toml
- requirements.txt
- ruff.toml
- sequence.md



back

Benefits of Delegating Validation to Danube



Separation of concerns Maintain SHACL rules independently from the validation engine

Reduced maintenance effort No need to maintain a custom validation service

Standards alignment Leverage the Gaia-X compliance framework for interoperable validation

Improved interoperability Rules can be reused across systems supporting Gaia-X

Faster development Focus on rule definition rather than implementation of validation logic

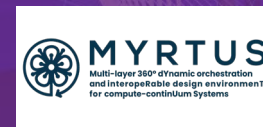
Thank you!



Giulia | giulia.biagioni@tno.nl

Coen | coen.vanleeuwen@tno.nl

Bart | bart.driessen@tno.nl



Special Thanks to



Delphine Clearhout



Giuditta Del Buono

In partnership with



Networking Lunch/AR Game
13:00 – 14:00



Complete AR & real-world challenges to become the ultimate **Data Wizard!**

Visit the **Gaia-X Discovery Quest Booth** in the Expo area to find out more!



Connect with fellow participants in a fun, new environment.



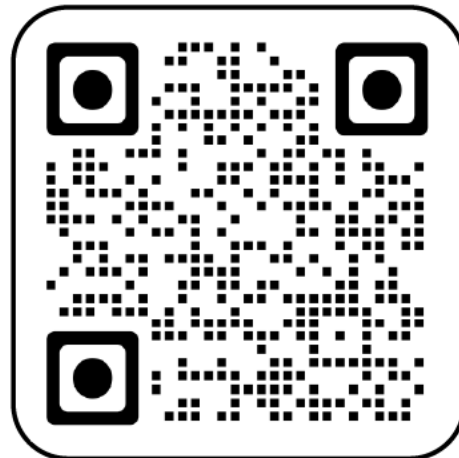
Explore key Gaia-X concepts like trust, compliance, data economy, and interoperability.



Use Augmented Reality to make these concepts come to life.



Turn the summit into an **interactive, educational** adventure.



SCAN TO DOWNLOAD

Scan the QR code to download the **Gaia-X AR app** and compete in the Gaia-X Discovery Quest!

Agenda | Day 1 (Afternoon) | 28.05.26

	Time	Slot	Speaker(s)
STRATEGIC	14:00 – 14:40	Gaia-X Evangelists Panel: Practices & Perspectives	<ul style="list-style-type: none">▪ Catherine Simonnin (Orange)▪ Antonio J. Jara (Libelium)▪ Christoph F. Strnadl (Gaia-X)
ECOSYSTEM	14:40 – 15:05	Decade-X: From development strategy, SSI, semantic hub to development	Vincent Legrand (Airbus)
ECOSYSTEM	15:05 – 15:30	Data4NuclearX: Technical Status	<ul style="list-style-type: none">▪ Franck Martin (EDF)▪ Benoit Tabutiaux (IMT)
	15:30 – 16:00	Networking Coffee & AR Game	
TECH	16:00 – 16:25	Bring Your Own Rules Made Easy: Using OPA and Rego with Gaia-X Danube	Stefan Dumss (Posedio)
TECH	16:25 – 16:55	Data Quality in the Era of Data Spaces	Antonio J. Jara (Libelium)
CONNECTOR	16:55 – 17:25	FIWARE: Technology Update	Stefan Wiedemann (SEAMWARE)
	17:25 – 17:30	Wrap Up	Christoph F. Strnadl (Gaia-X)
	18:00	Network Reception	

Gaia-X Evangelists Panel: Practices & Perspective



14:00 – 14:40



In partnership with

A white rounded rectangular box containing two logos. On the left is the Gaia-X logo with the text "gaia-x" and "Hub Greece" below it. On the right is the LMS logo, which includes a stylized profile of a head and the text "LMS Laboratory for Manufacturing Systems & Automation".

Gaia-X Evangelists Panel Practices and Perspectives



Dr. Christoph Strnadl
Moderator

Gaia-X



Dr. Antonio J. Jara
CTO

Libelium



Catherine Simonnin
Tech Lead
Trust & Innovation

Orange



Kai Meinke
Cofounder &
Business Lead

deltaDAO AG

#GaiaX #TechX

Decade-X: From development strategy, SSI, semantic hub to development

14:40 – 15:05

- Vincent Legrand – Airbus
- Jonas Stilling – Fraunhofer ISST



In partnership with



Agenda

- DECADE-X Introduction & Roadmap
- Development insights
- DECADE-X Operations

DECADE-X in a nutshell



The initiative started in 2022, addressing the growing need to exchange data across the highly complex & interdependent aerospace industry

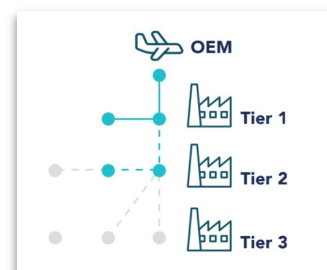
Our challenges & context

- Steep ramp up for the whole supply chain requires **multi-tier visibility** and **collaboration** to mitigate risk and prevent disruption
- Need Multi-tier traceability to address **sustainability** challenges (CO2, substance, recycling), and export **regulation** in unstable geopolitical context
- Need to prepare supply chain for new **development** with seamless collaboration
- Need to comply with data exchange **regulation** focusing on data **sovereignty** especially in Europe

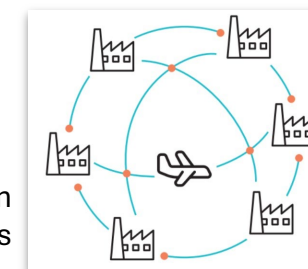
Our vision

Build together the **Aerospace & Defence digital ecosystem** between aerospace manufacturers, OEMs and SMEs (around 10 000 actors) for multi-tier collaboration to strengthen our supply chain through digital sovereign continuity

Excellence from company level to industry level



From current discontinued digital supply chain landscape...

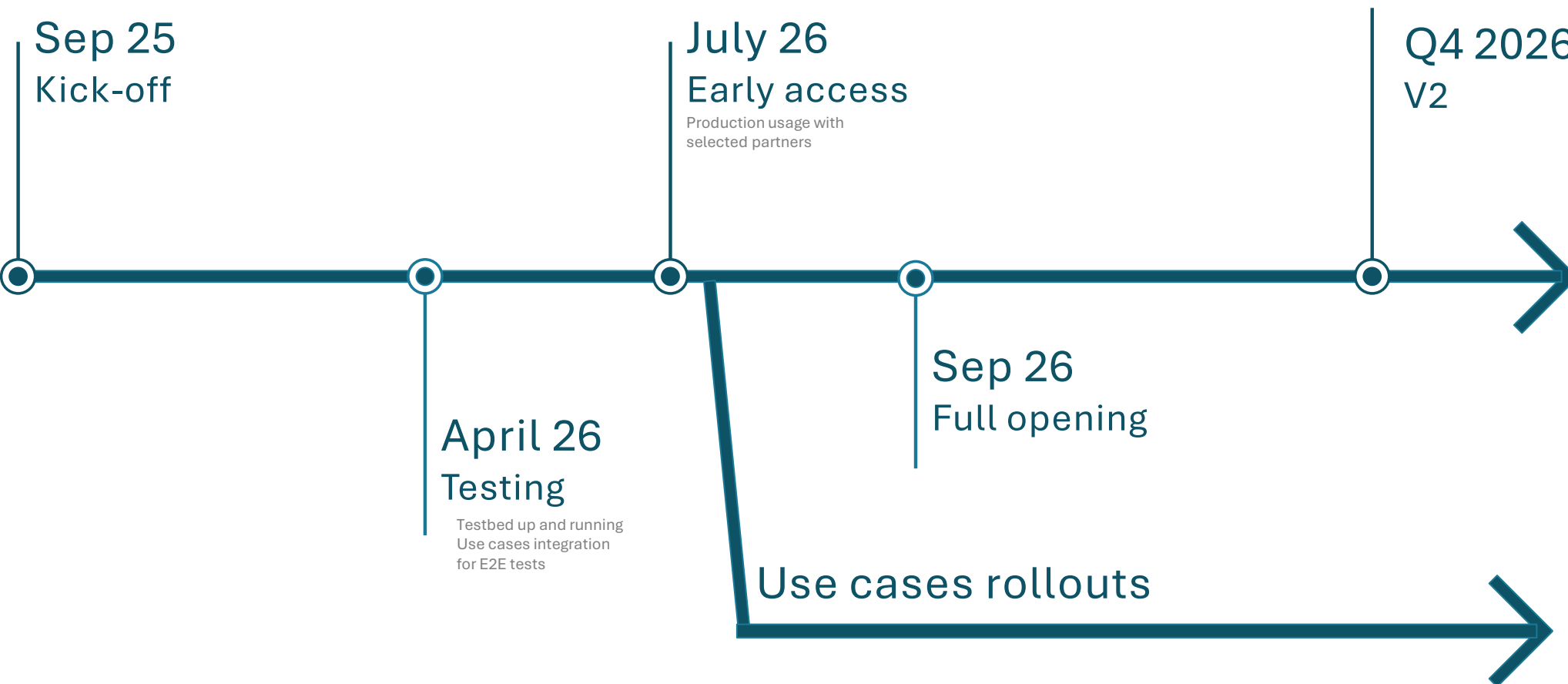


...to new end-to-end Ecosystem with partners

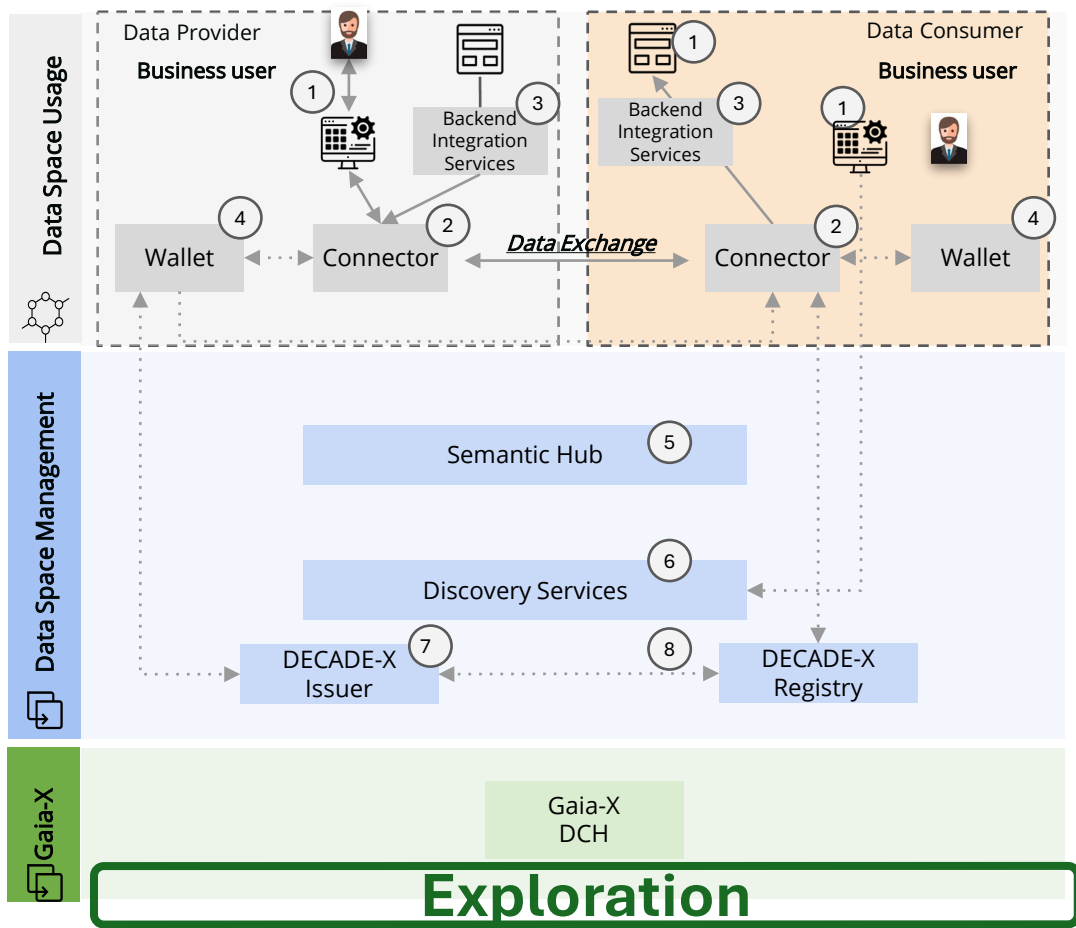


#GaiaX #TechX

DECADE-X V1 Key dates



DECADE-X V1 at a glance



Components	Description
1 Bus App.	Business application(s) are the entry point for end-users to gain access to dataspace. It's UC dependant and install on each participants ecosystem. It could be a specific DECADE-X app, or company internal app.
2 Connector	The connector base on EDC is a technical component aiming as performing the communication between Data providers and Consumers, it's connected to the federated service for identity mgt, discovery services, and ensure data transfer with other EDC.
3 Backend integration	Backend Integration Services refers to the set of technical functionalities and components that operate "behind the scenes" of a participant's Connector to make the bridge between the dataspace's external, standardized and the internal, proprietary IT systems of the data provider organization.
4 Wallet	Wallet component is used to store and manage the digital identity of the participants (could be company/site of physical person depending of the UC) when working with DID.
5 Semantic Hub	A semantic hub acts as a central "dictionary" for a dataspace ecosystem, providing a shared language and definitions (vocabularies, ontologies, and data models) to ensure all participants can consistently understand and interpret data, thereby enabling seamless data sharing and interoperability.
6 Discovery Services	Discovery services act as a public directory service to discover organisations and services (connectors) part of the ecosystem.
7 D-X Issuer	Issuer Service issues the Decade-X Membership credentials to new participants. Stored and used in wallets.
8 D-X Registry	The DECADE-X DCH extends GAIA-X rules with domain-specific governance, operating registry and compliance services containing and validating the DID* of the trusted issuers.

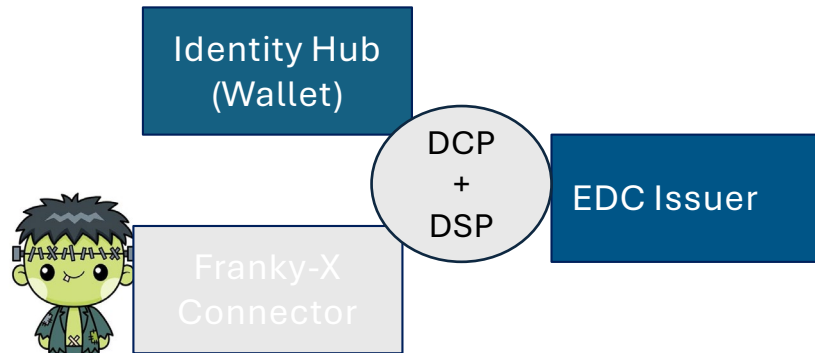
DEVELOPMENT

Credentials Management in DECADE-X

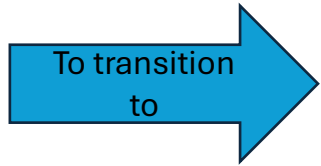
- ✓ Verifiable Credentials for companies compliant with Gaia-X specifications
- ✓ Credential verification implemented (including revocation check)

DEVELOPMENT

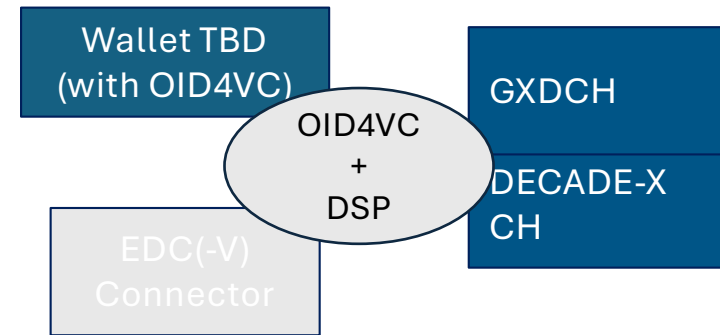
DECADE-X Version 1



Including:
EDC Connector
+ Some Tractus-X extensions
+ Some Factory-X extensions
+ Aerospace-X developments



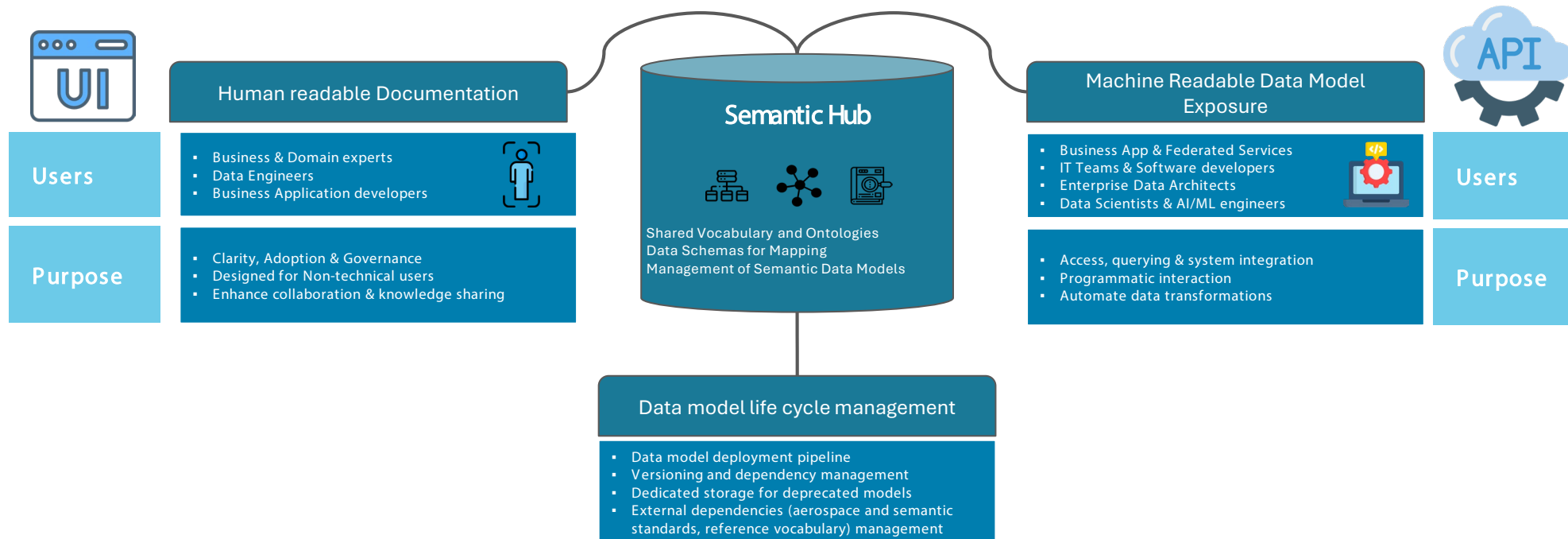
DECADE-X Version 2



Hopefully standard!
With OID4VC Extension

Focus on Semantic Hub component

<https://vocabulary.decade-x.org/>



DEVELOPMENT



#GaiaX #TechX

Use Cases status and Application template

For users:

Collaborate with common business use-cases

Effective Co-Development
(Collins, Safran, Thales, Liebherr, Airbus)

- Techn Workflow (Smart doc) **V1**
- MBSE (smart doc) (Data Centric) **V1**
- V2**

Trustful traceability
Conformity & Sustainability
(Collins, Thales, Liebherr, Safran, Airbus)

- Product Conformity: Multitier smart CoC **V1**
- CoC & ARC full digitalisation / link with physical tracking **V2**
- Part passport along life cycle (in service)
- Export Control: ECCN sharing **V1**
- Battery passport for substances (ASSN)
- Product passport for sustainability (CO2...)

Supply Chain Resilience
(Collins, BoostAerospace, Thales, Liebherr, Airbus)

- Critical Stock Monitoring **V1**
- Quick non conformity resolution **V2**
- Demand cascade for SME (Study with Gifas)

DEVELOPMENT

... and for developers: SDK and application blueprint to standardize and speed up development and integration with dataspace components (based on React / node.js)



decade-x-nodejs-sdk Private

This repository contains shared libraries that can be used by DECADE-X application builders

TypeScript • 0 • 0 • 0 • 3 • Updated 3 weeks ago • ⚙️

decade-x-bizapp-blueprint Private

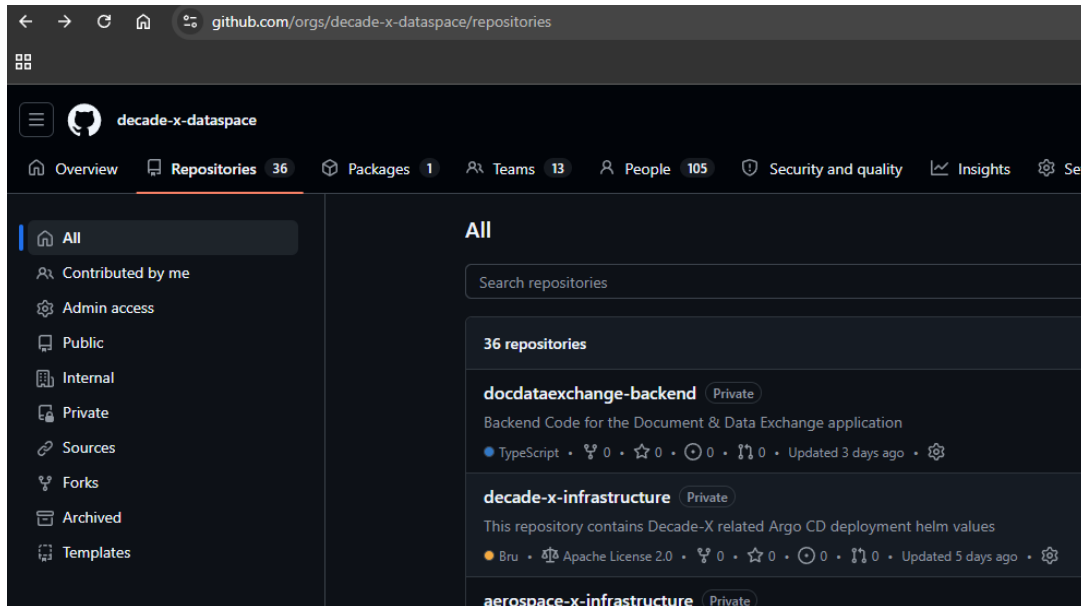
Standard templates containing all you need to build DECADE-X business apps

#GaiaX #TechX

Development Strategy

From private to Open Source

DECADE-X Version 1: developed on a closed source management, due to open summer '26



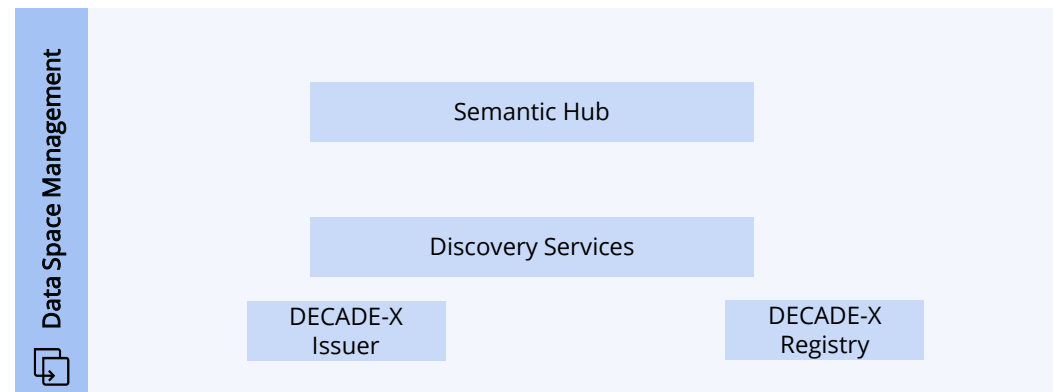
- ✓ <https://github.com/orgs/decade-x-ecosystem>
- Software licensed under Apache 2.0
- Semantic Models licensed under CC BY 4.0



#GaiaX #TechX

Production Environment setup

- Trusted Cloud (SecNumCloud certified)
- Early access (requiring whitelist) for co-design partners in July 2026
- Full opening in September 2026
- Operated currently by DECADE-X, with a dedicated operating company setup in progress



Testbed

For application developers and testers

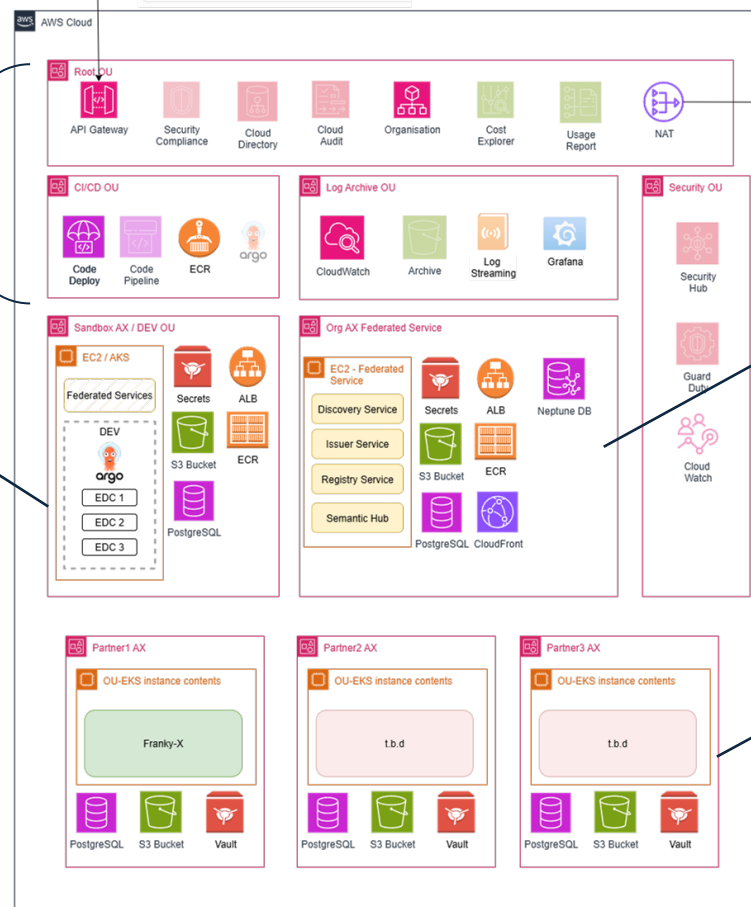
OPERATIONS

Administration and CI/CD orchestration

Developers playground: for testing new applications

DECADE-X Test Management plane: issuer, registry, semantic hub, ...

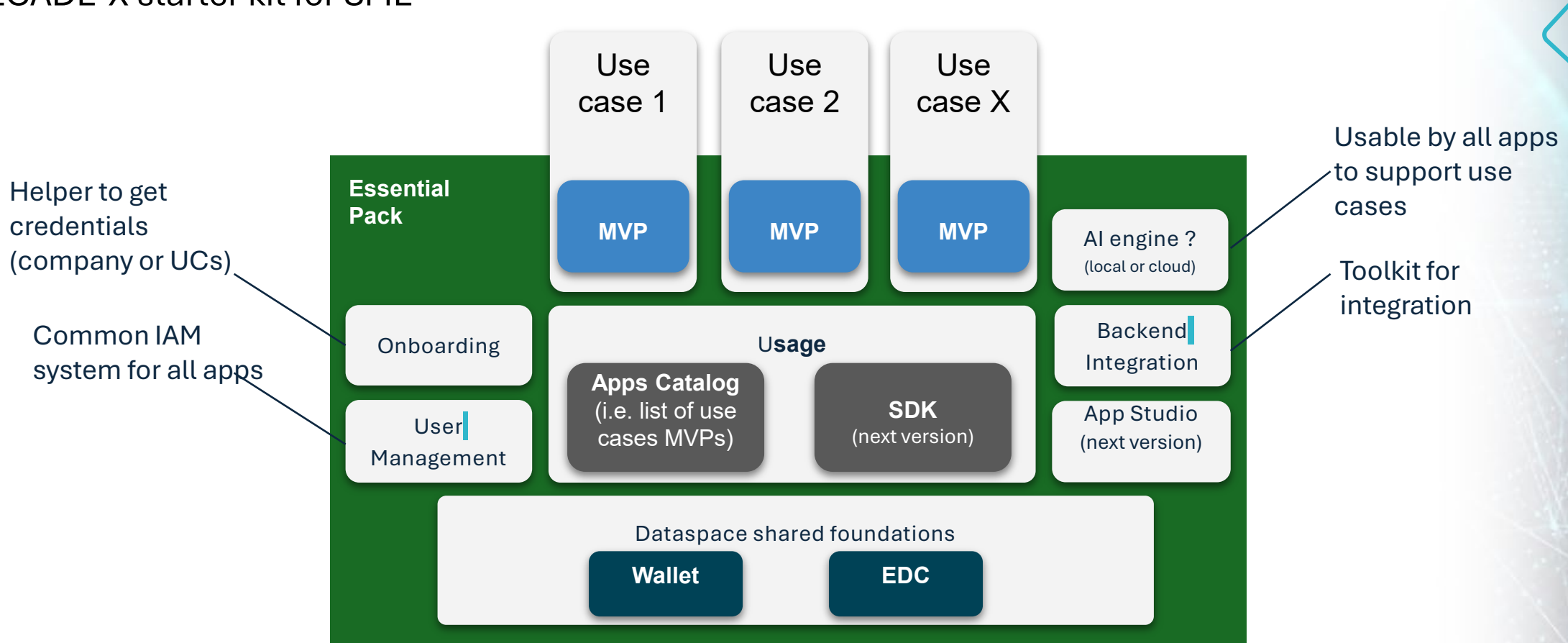
Test and demo area: easily instantiates a participant's environment: connector, wallet and aps to be tested by users, or for demo and training purpose



#GaiaX #TechX

Essential Pack





DECADE-X starter kit for SME

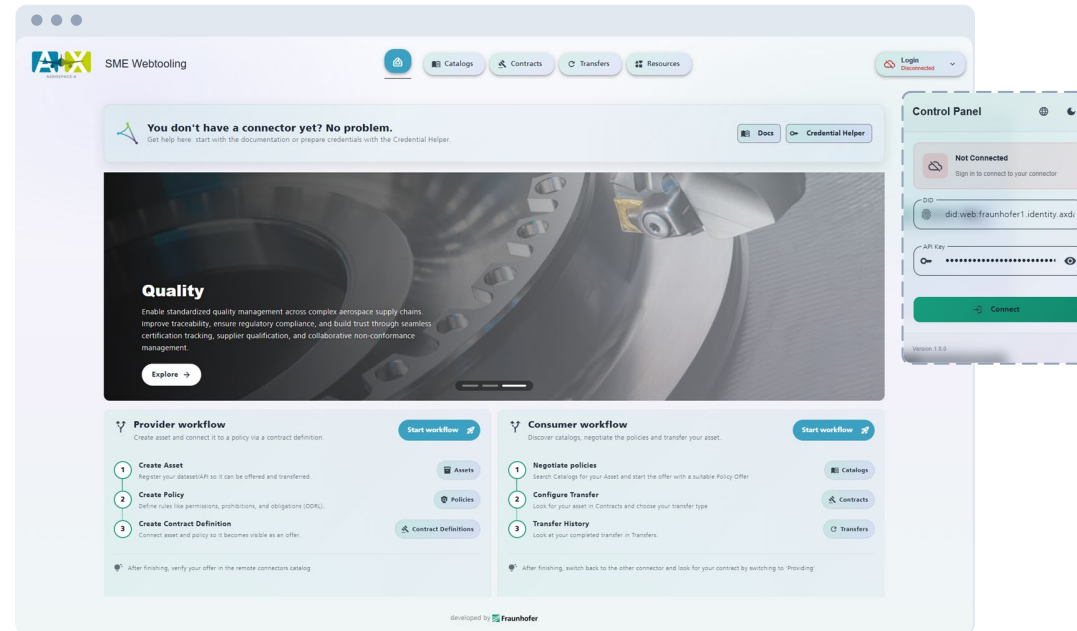


OPERATIONS

Exploring areas

SME WebTooling - Credential helper

-  **UI for Connector Interaction**
Intuitive web interface for visualizing complex Dataspace interactions
-  **Aerospace-X Credential Helper**
Fast & compliant credential generation for Aerospace-X
-  **Built-In Data Upload and Storage**
Backend for data storage and asset provisioning via API Endpoint
-  **Decentralized connection**
Connect to dataspace connectors via SSI or X-API-Key authentication



More services are on the way!

DEVELOPMENT



#GaiaX #TechX



Thank you!

Name | email



In partnership with

The block contains two logos. On the left is the gaia-x logo, which includes a starburst icon, the text 'gaia-x', and 'Hub Greece' below it. On the right is the LMS logo, which features a stylized profile of a head with a brain-like pattern inside, the text 'LMS', and 'Laboratory for Manufacturing Systems & Automation' below it.





Data4NuclearX: Technical Status

15:05 – 15:30



- **Franck Martin** – EDF (online participation)
- **Benoit Tabutiaux** – IMT



In partnership with



Context



Climate change requires an exit from fossil fuels
(80% of the energy consumed in the world).

A vast nuclear program has been launched addressing both the construction of new nuclear power plants and the maintenance of the existing ones, with an **ambitious timeline**

To achieve these goals, a strong **growth of data exchange** within a **multi-tier collaborative** environment is required

The Nuclear Sector is highly **regulated**, with **sensitive data**. **Security** in data exchange is fundamental

Data4Nuclear-X project



The objective of Data4Nuclear-X is to build the sovereign digital trust space for data exchanges within the nuclear industry

3 priority use cases from the construction of new nuclear plants to the maintenance of existing ones

Use case #1

Digitization and sharing of files relating to work carried out on operational sites and files relating to

Monitoring Of Interventions

on new construction sites

Complete traceability of production processes from raw materials to finished product

Use case #2

End-to-end digitization of the investigation of **Manufacturing Non-Conformities**

To track a nonconformity event and the corrective process

Use case #3

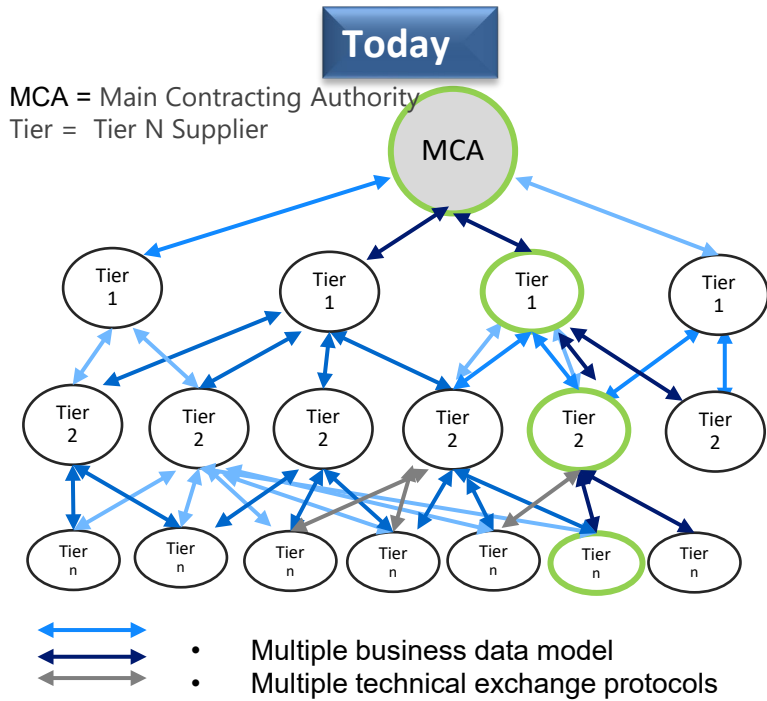
Digitization and sharing of **Manufacturing Tracking Files** on existing sites

To aggregate data from all suppliers involved in a construction project

Data Exchange based on these use cases are already in production but...

#GaiaX #TechX

The problems we need to solve

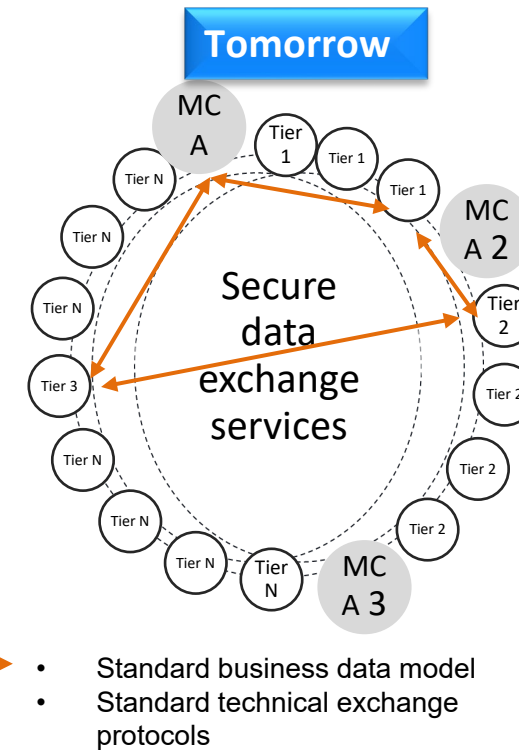


Security/Trust

Sovereignty

Normalization

Multi-tier Governance



Scalability issue : The MCA must assess and declare in its system

- Each Tier1 supplier before exchanging data with it
- Each Tier1 employee before giving access to its system

Hierarchical issue

- A Tier-N can only exchange data with its direct contractors



Decentralized identity

- Each participant (legal and natural person) must prove its compliance to the nuclear sector rules and can be automatically onboarded

Data Access Contract / data Usage Agreement

- Allowing any to any secured data exchange

Decentralized Data Exchange


- To guarantee confidentiality

Interoperability

- Because most of our suppliers will be involved in other dataspace

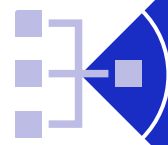


Sensitive Data Exchange and the need for more standards




Confidentiality : data access is limited only to authorized persons

- Decentralized data exchange
- Decentralized Identities




Traceability : end-to-end data access or data modification tracking

- Connector traceability feature
- Traceability federated service



Integrity : data has not been willingly or unwillingly altered during the exchange process

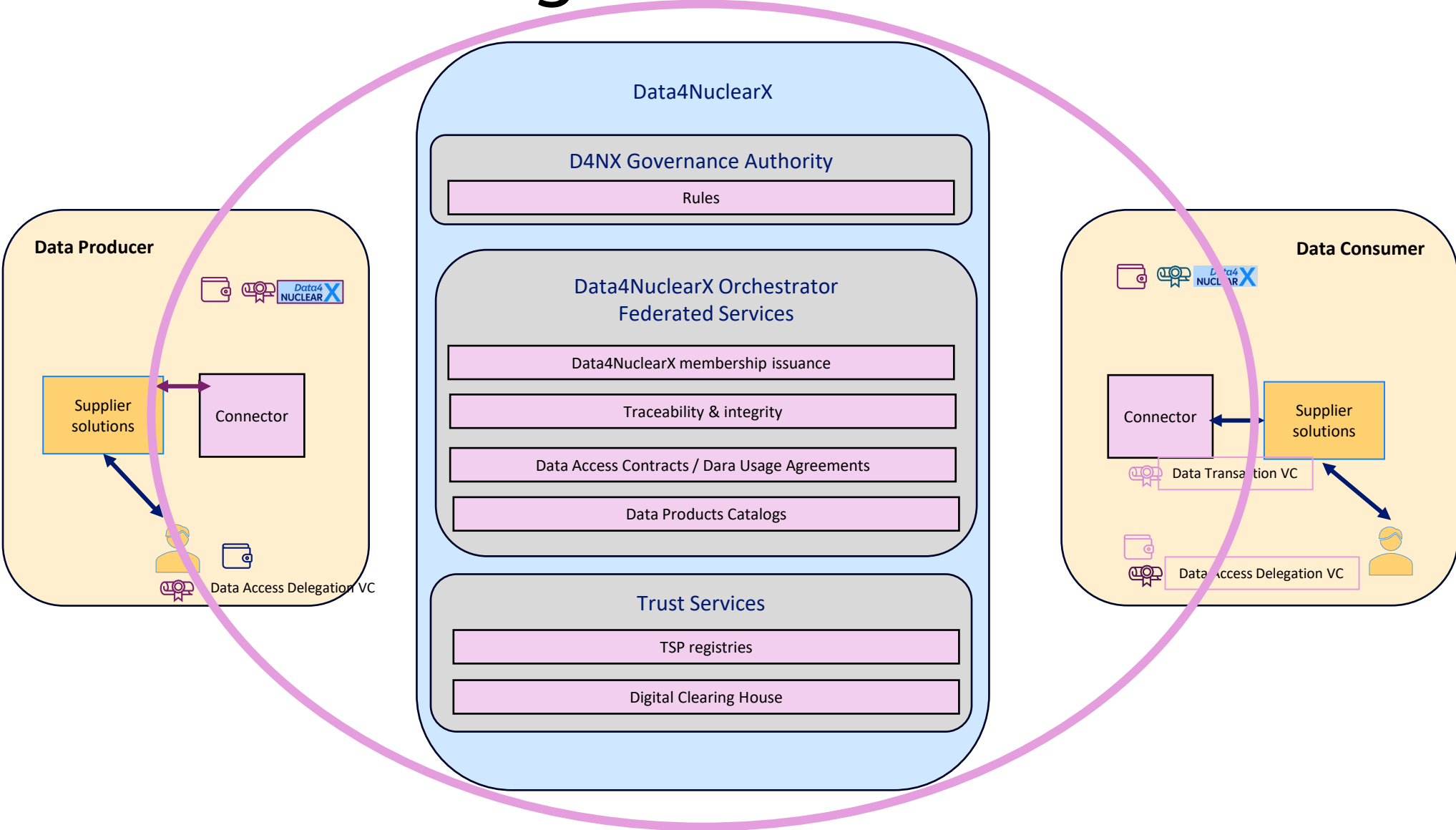
- Connector integrity feature
- Integrity Federated service



Availability : data exchange is available when needed

- Software components

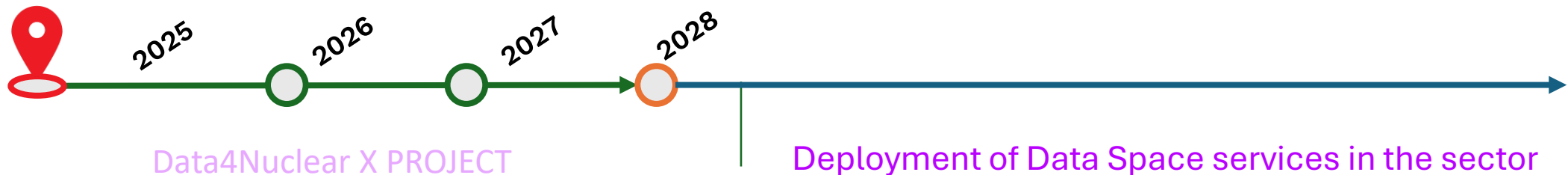
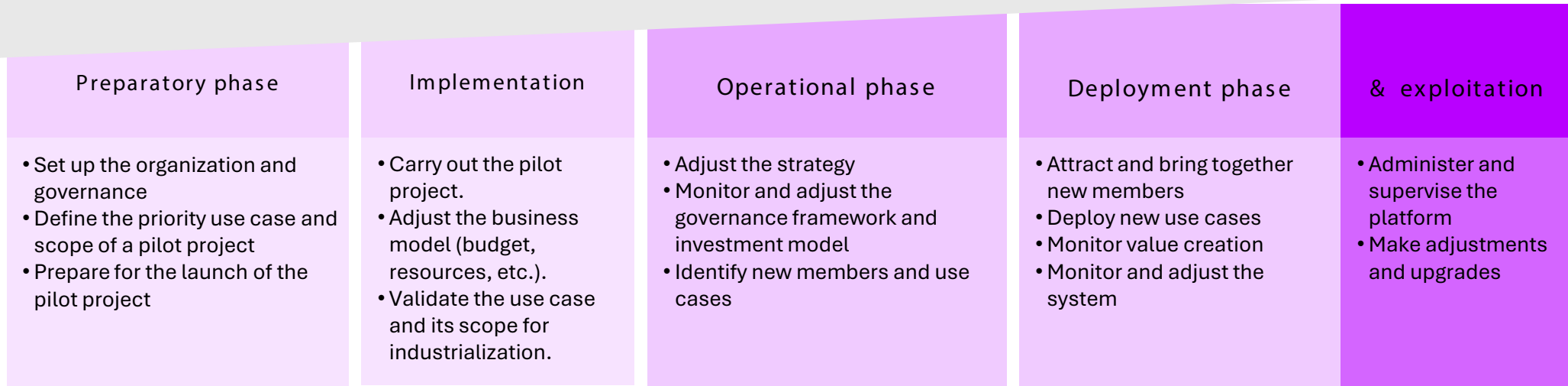
Data4Nuclear-X targeted solution



Roadmap

Build

Deploy & Run



Testing the Nuclear Data Space on use cases starting in the second year of the project

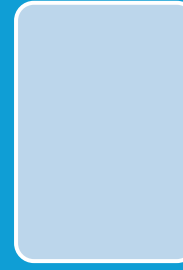
#GaiaX #TechX

GAIA-X current and further works

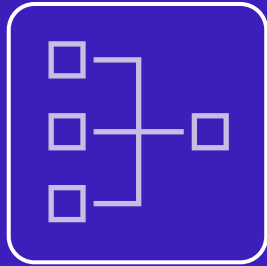


PRC

- Definitions of label and criteria on software component or technical services (such as wallets, connectors or Identity providers) to help industries to select them
- Next : more ontologies (cyber security maturity, export control compliance, ...)

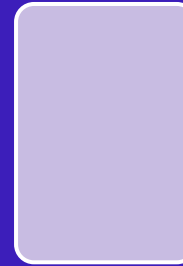


We MUST be able to control the software stack and services between participants

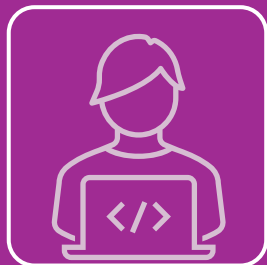


Data Exchange working group

- Definition of Data Access Contract / data Usage Agreement ontologies
- Observability standard



We MUST be able to track access and data exchanges



ICAM

- Human in the loop



We MUST be able to identify the person responsible for an action



Thank you!

Franck Martin franck-f.martin@edf.fr / Benoit Tabutiaux benoit.tabutiaux@imt.fr



In partnership with



Networking Coffee/AR Game
15:30 – 16:00



Complete AR & real-world challenges to become the ultimate **Data Wizard!**

Visit the **Gaia-X Discovery Quest Booth** in the Expo area to find out more!



Connect with fellow participants in a fun, new environment.



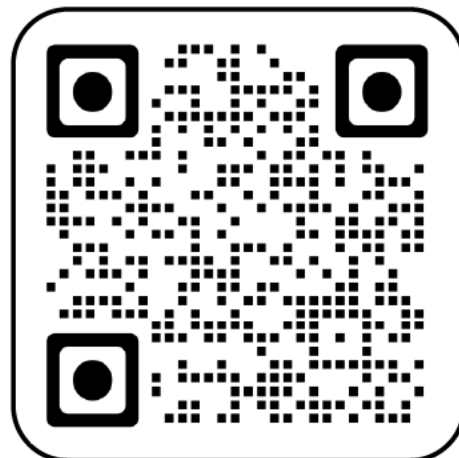
Explore key Gaia-X concepts like trust, compliance, data economy, and interoperability.



Use Augmented Reality to make these concepts come to life.



Turn the summit into an **interactive, educational** adventure.



SCAN TO DOWNLOAD

Scan the QR code to download the **Gaia-X AR app** and compete in the Gaia-X Discovery Quest!

Bring Your Own Rules Made Easy: Using OPA and Rego with Gaia-X Danube

16:00 – 16:25



- Stefan Dumss – Posedio



In partnership with





Bring Your Own Rules Made Easy



Using OPA and Rego with Gaia-X Danube



In partnership with



Agenda



1. Gaia-X Danube: from baked-in rules to Rego
2. Open Policy Agent (OPA)
3. Gaia-X & OPA: a OPA extension
4. A Rego rule for a Gaia-X credential
5. Lessons learned

From baked-in rules to OPA + Rego



- Loire: one rulebook baked into the core engine
 - See last years talk
- Danube (Trust Framework 3.0): rules become an extension point
 - Compliance Dispatcher; the Loire ruleset is now just one extension
 - Bring Your Own Rules (BYOR)
 - Meta-Registry enables cross-ecosystem trust
- Where does the rule engine behind the Dispatcher come from?
 - Gaia-X AISBL ships reference tooling in TypeScript
 - We reached for OPA + Rego instead

Open Policy Agent



- CNCF graduated, general-purpose policy engine
 - Decouples policy decisions from your application
- Rules written in Rego — declarative, datalog-inspired
 - Input: arbitrary JSON. Output: a decision (allow / deny / structured)
- A mature ecosystem that already solves similar problems
 - Battle-tested Policy as Code e.g. in Kubernetes admission, Envoy authz, Terraform, CI/CD gates
 - Bundles, decision logs, tests, IDE tooling and a conformance suite come with it

Gaia-X OPA: a Rego rule engine for Gaia-X



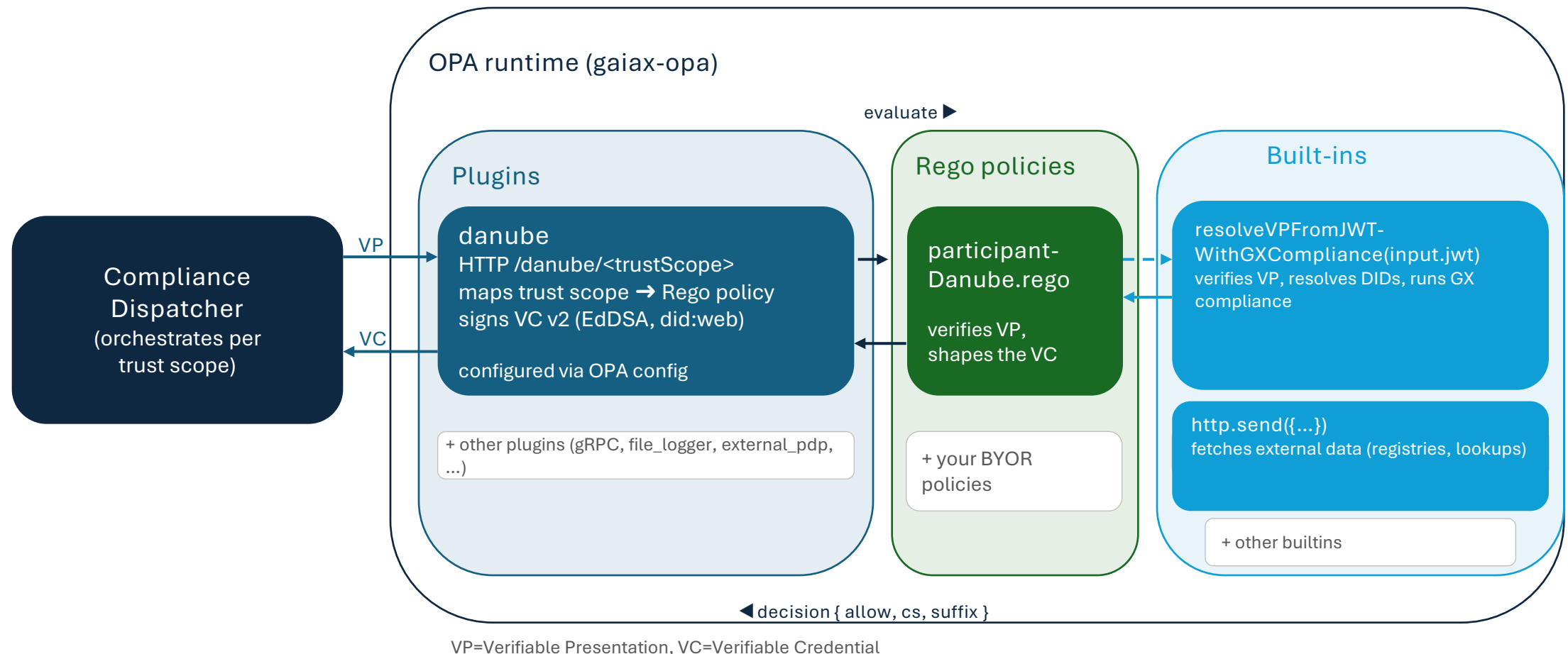
- Built-ins and plugins for OPA — extends OPA, reuses the core for everything else
 - Open-source Go library on top of our gaia-x-go SDK
 - Listed in the Gaia-X toolkit registry (docs.gaia-x.eu/#/toolkit)
 - Already Presented at Tech-X: EuProGigant Manufacturing Ecosystem Gateway and Tech-X 2024 Product Carbon Footprint policy-as-code talk
- Gaia-X-specific built-ins on top of stock OPA
 - Verify a Verifiable Presentation and its enclosed
 - Resolve DIDs and load JSON-LD contexts

Gaia-X OPA: what's new in 2026



- New Danube plugin: OPA as a compliance service
 - Drops in behind Danube's Compliance Dispatcher, or runs standalone
 - Each configured trust scope gets its own HTTP endpoint, accepts a VP-JWT, returns a signed VC-JWT
- Rego decides, the plugin signs
 - Policy returns a structured result: { allow, deny, cs, suffix, type, context }
 - Plugin assembles a VC v2 from the result and signs it with the configured JWK
- Rules can live on both sides of the line
 - Most checks stay declarative in Rego
 - the plugin owns crypto, VC assembly and policy registration

OPA, plugin and Rego: how the pieces fit



Rego policy (1/3): resolve and validate the VP



```
package compliance.legalPerson
default allow := false
```

```
# Gaia-X built-in: verify signature, resolve DIDs, load contexts
```

```
re := resolveVPFromJWTWithGXCompliance(input.jwt)
```

```
# Gather the VCs we need
```

```
vat_id_vcs[vc]      if some vc in re.vcs; vc.credentialSubject["gx:vatID"]
```

```
country_code_vcs[vc] if some vc in re.vcs; vc.credentialSubject["gx:countryCode"]
```

```
# Shape checks – every deny adds to the error list
```

```
deny contains "no VC with gx:vatID" if count(vat_id_vcs) == 0
```

```
deny contains "country codes do not match" if count(country_codes) != 1
```

Rego policy (2/3): cross-check the Pontus-X registry



Look up the participant in the Pontus-X registry

```
registry := http.send({
  "method": "GET",
  "url": concat("", ["https://cache.registry.pontus-x.eu/v1/identities?search=",
                    urlquery.encode(base_cs["schema:name"])]),
  "force_cache": true, "force_cache_duration_seconds": 3600 })
```

Refuse if the registry entry does not match with the credential

```
deny contains sprintf("registry vatID %q != credential %q", [r_vat, vat]) if {
  r_vat := registry.body.data[0].credentialsData["gx:VatID"]["gx:vatID"]
  r_vat != base_cs["gx:vatID"]
}
```

Rego policy (3/3): structured output the plugin signs



New Base credential subject

```
base_cs := {"gx:vatID": vat, "gx:countryCode": cc, "schema:name": name}
```

Enrich with registry data once the cross-check passes

```
cs := object.union(base_cs, {  
  "px:walletAddress": registry.body.data[0].walletAddress,  
  "px:presentationUrl": registry.body.data[0].presentationUrl })
```

Hand the draft VC to the danube plugin to sign

```
type      := "np:Participant"  
context  := {"np": "http://newparticipant.test/ns#", "px": "http://pontus-x.eu/ns#"}  
result   := {"allow": allow, "errors": deny, "cs": cs,  
             "suffix": name, "type": type, "context": context}
```

Lessons Learned

- **The good**
 - BYOR fits Rego: each compliance rule ships its own bundle, no fork of the core engine
 - Rules stay declarative and unit-testable and rule authors don't touch Go
 - Crypto lives in Go, not Rego
 - OPA bundles + decision logs give you distribution and an audit trail
 - Danube plugin slots into the Compliance Dispatcher, or runs standalone
 - Rego with OPA offers Graph representation of the validation path
- **The bad: harder than the title suggests**
 - JSON-LD canonicalization: most of the real work hides here
 - E.g. Rename a credential field without updating the rule, and verdicts go wrong silently
 - Rego is easy, but writing “correct” Gaia-X rules is a domain-modelling problem
 - The Compliance Dispatcher is new: its spec and extension are still moving



Thank you — questions?

Stefan Dumss · Posedio GmbH



In partnership with

The block contains two logos. On the left is the gaia-x logo, which includes a starburst icon, the text 'gaia-x', and a small Greek flag icon with the text 'Hub Greece' below it. On the right is the LMS logo, which features a stylized profile of a head with a brain-like pattern inside, the text 'LMS', and the full name 'Laboratory for Manufacturing Systems & Automation' below it.



From Data Quality Scores to Verifiable Evidence: Gaia-X Pattern for Trustworthy Data Products

16:25 – 16:55



- Antonio J. Jara – Libelium



In partnership with



Data Quality in the Era of Data Spaces

Moving from static validation to portable semantic assurance.

Dr. Antonio Jara, CTO
jara@libelium.com

Iris Cuevas, Head of Lab
i.cuevas@libelium.com



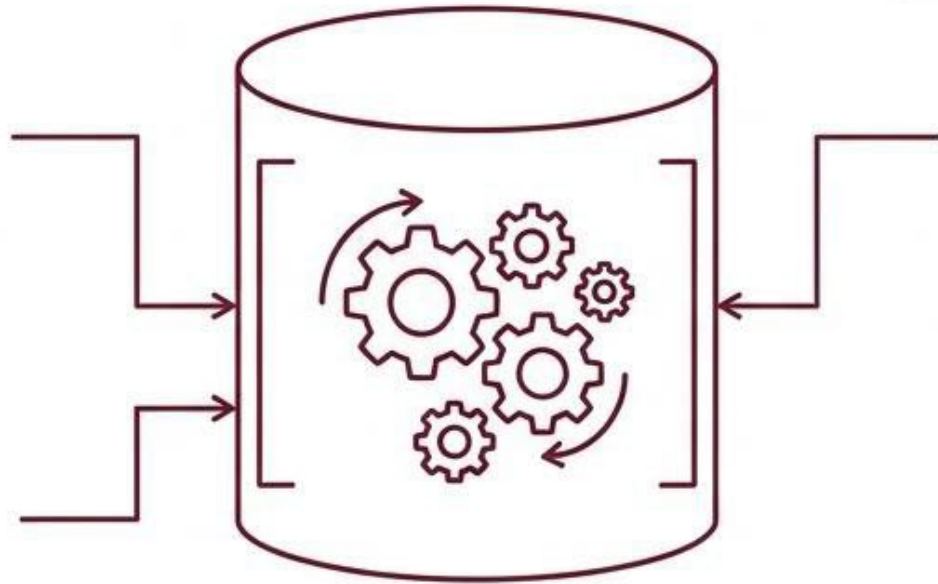
Tech-X & Hackathon #9
2026 28-29 ATHENS
MAY GREECE

gaia-x 



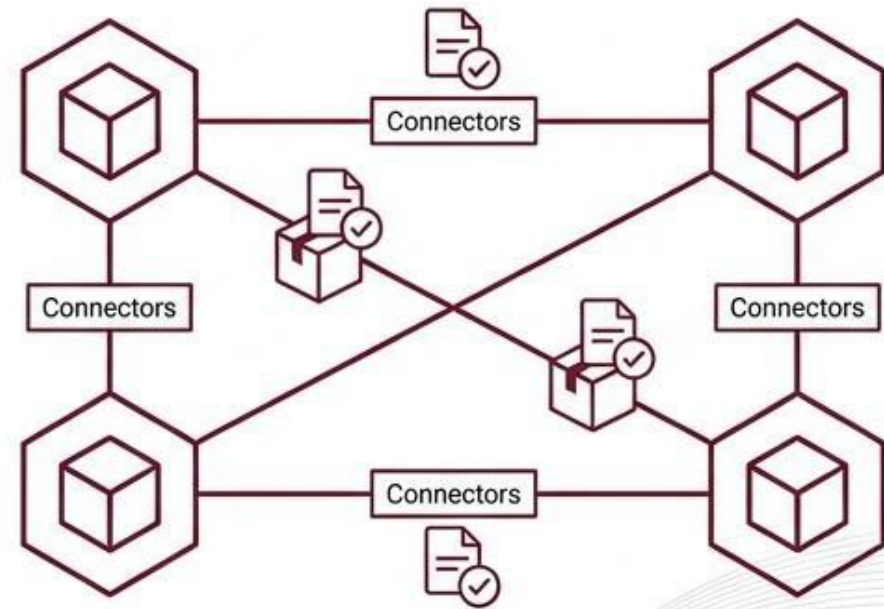
The Core Shift: From Validation to Assurance

Centralized Validation



The consumer controls the pipeline. Quality is a set of internal operational checks (nulls, types, freshness) over owned tables.

Federated Assurance

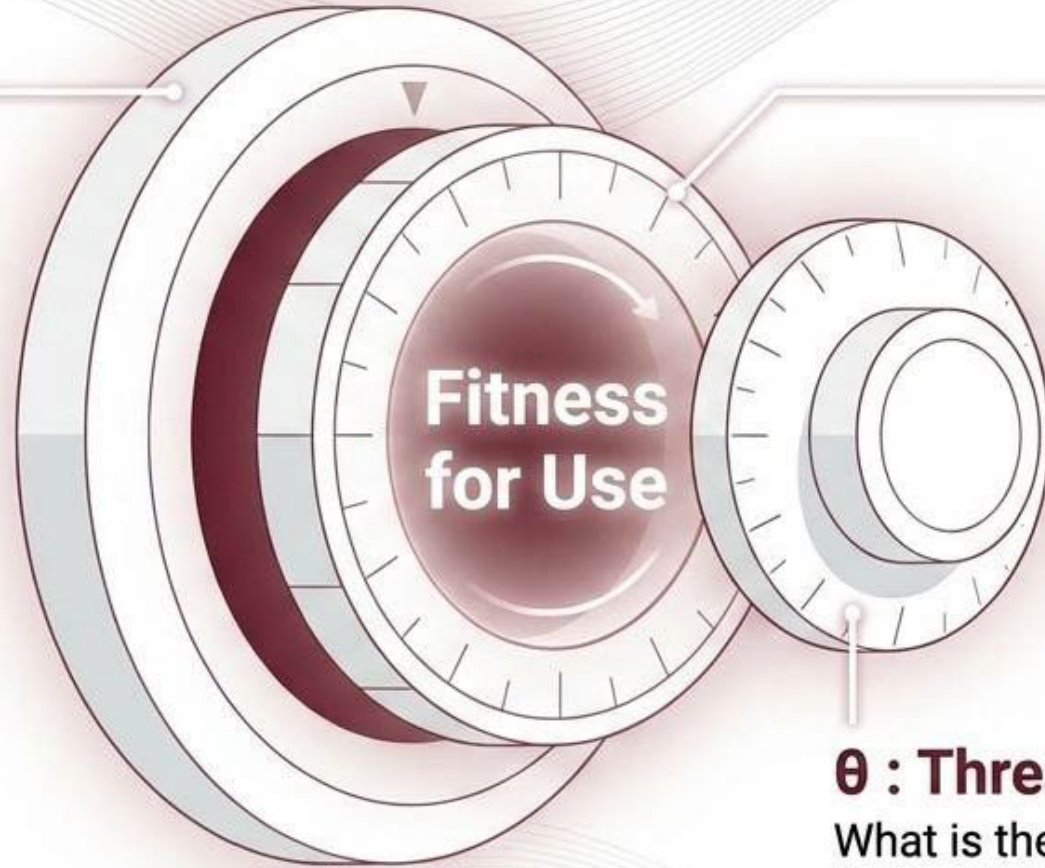


The consumer rarely controls the source, pipeline, or sensors. Quality becomes a form of transferable evidence that survives federation.

Unlocking Fitness for Use

d : Dimension

What characteristic are we measuring?
(e.g., Accuracy, Freshness)



m : Metric

What is the exact evaluation method? (e.g., Z-score outlier detection, max staleness)

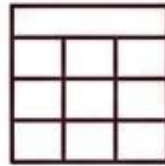
θ : Threshold

What is the acceptable decision criterion?
(e.g., > 0.95 confidence, < 2ms latency)

Data quality is not a universal scalar. It is the measurable degree to which a data product satisfies explicit requirements for a declared context.

Classical Dimensions Are No Longer Enough

Classical DW Dimensions



- Accuracy
- Completeness
- Consistency
- Timeliness
- Uniqueness
- Validity

Necessary for table-level operational health.

Data-Space Requirements



- **Provenance:** Origins, lineage, and responsible agents.
- **Sensor Reliability:** Calibration age, security posture, tamper resistance.
- **Policy Conformance:** Alignment with Gaia-X/IDSA usage contracts.
- **Semantic Interoperability:** Compatibility with NGS-LD schemas and vocabularies.
- **AI Readiness:** Drift metrics, bias evidence, spatial representativeness.

The EU AI Act makes this shift explicit: high-risk AI training datasets must carry auditable evidence of representativeness and relevance.

The Crisis of Decentralized Trust

When you do not own the sensor, how do you trust the data?



Local Validation
is insufficient



Data crosses
organizational borders






The need for
Portable Assurance

Quality can no longer remain trapped in proprietary monitoring tools.
It must evolve into a transferable, machine-actionable credential.



The Paradigm Shift in Data Quality

Redefining Fitness for Purpose

Dimension	Classical DQ	Data Space DQ
Ownership	Internal	Shared
Metric Location	Trapped in local dashboards	Attached to the data payload
Trust Model	Implicit (Organization-bound) 	Verifiable (Contract-bound) 
Target Output	Cleansed Tables	Certified Data Products 



Decoding the Data Quality Standards

A Layered Architecture of Trust



The Unified Quality Evidence Stack

Standard	Enterprise Scope	Dataset Scope	Sensor/IoT Scope	Semantic Exchange
DAMA & UNE 0079	Focuses purely on Enterprise Process (Planning, Stewardship, Governance).			
ISO/IEC 25012 & UNE 0081		Focuses strictly on Dataset Evaluation (Metrics, Thresholds, Reporting).		
IEEE 2700 & P2510			Anchors the Sensor Layer (Calibration, Hardware Accuracy, Digital Logical Units).	
W3C DQV, PROV & NGS-LD				Powers the Semantic Exchange (Machine-actionable metadata, Trust chains).

Key Insight: These standards are **complementary**, not substitutable. IEEE P2510 guarantees the physical sensor, UNE 0081 grades the dataset, and **NGSI-LD carries the evidence.**

The Core Principle

Quality Evidence Must Travel With The Data



Raw Data

+



Semantic Context
(NGSI-LD)

+



Usage Policy
(Gaia-X)

+



Quality Evidence
(ISO/IEEE)

=



The Trustworthy
Data Product

A dataset is only as valuable as the verifiable evidence attached to it.

Operationalizing Quality

Extending Smart Data Models (SDM)

The Goal

Make quality evidence queryable and machine-actionable.

The Method

Libelium extends standard NGSi-LD payloads to include IEEE P2510 sensor indices and pipeline health metrics.

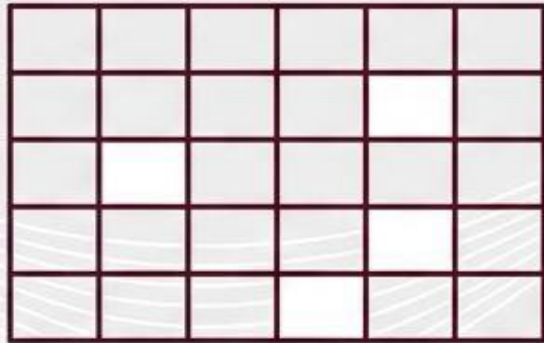
The Result

Two distinct representation patterns (Pattern A & Pattern B) that balance real-time performance with audit-grade evidence.



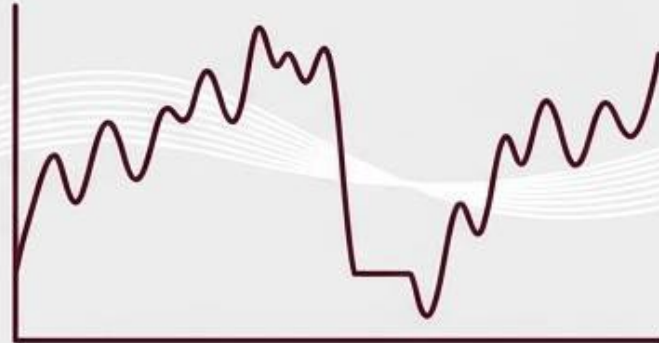
Context Changes the Shape of Quality

Data at Rest (Batch)



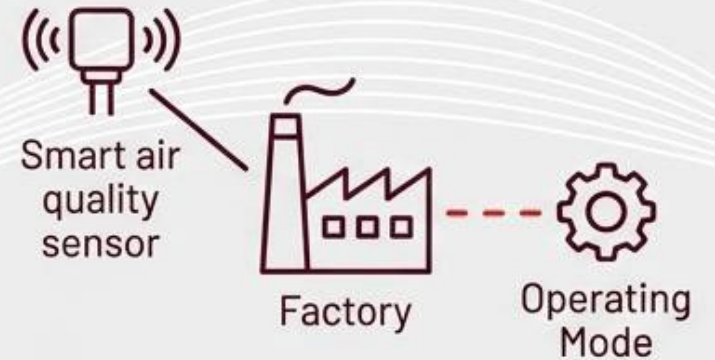
Measured via null ratios and absent attributes. Assessed via static dataset profiles.

Data in Motion (Stream)



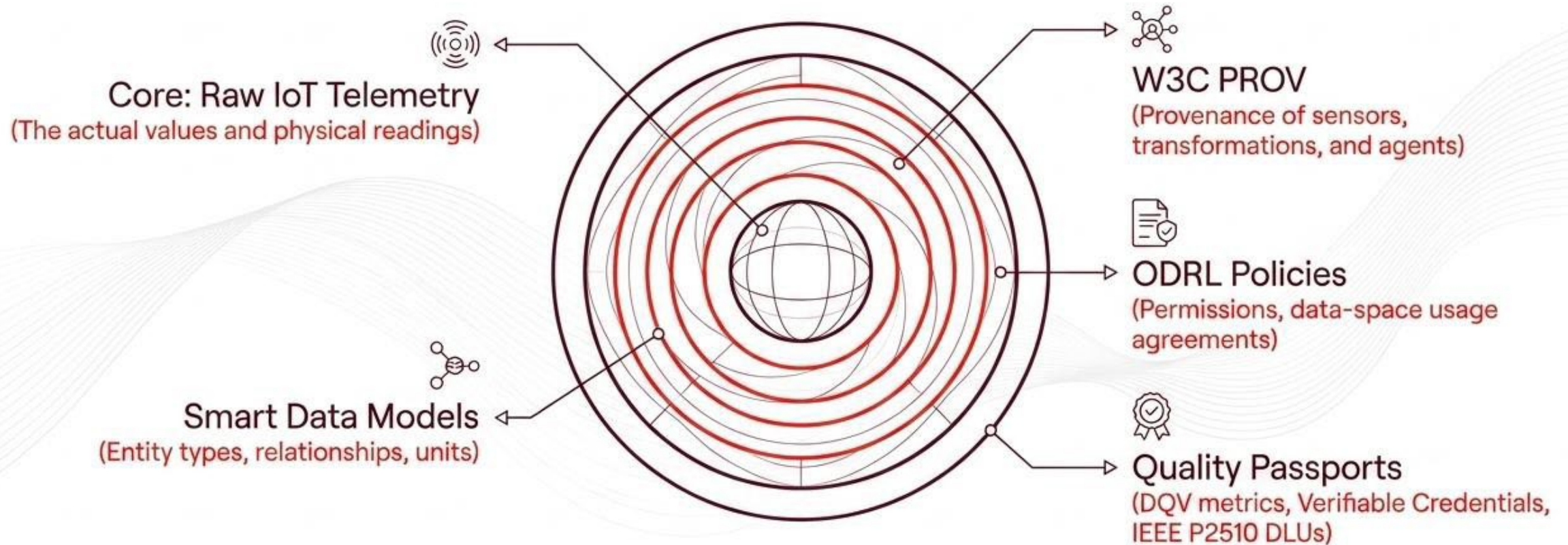
Measured via gap duration, missing bursts, and sampling regularity. Null ratios fail to capture critical event outages.

Data in Context (Semantic)



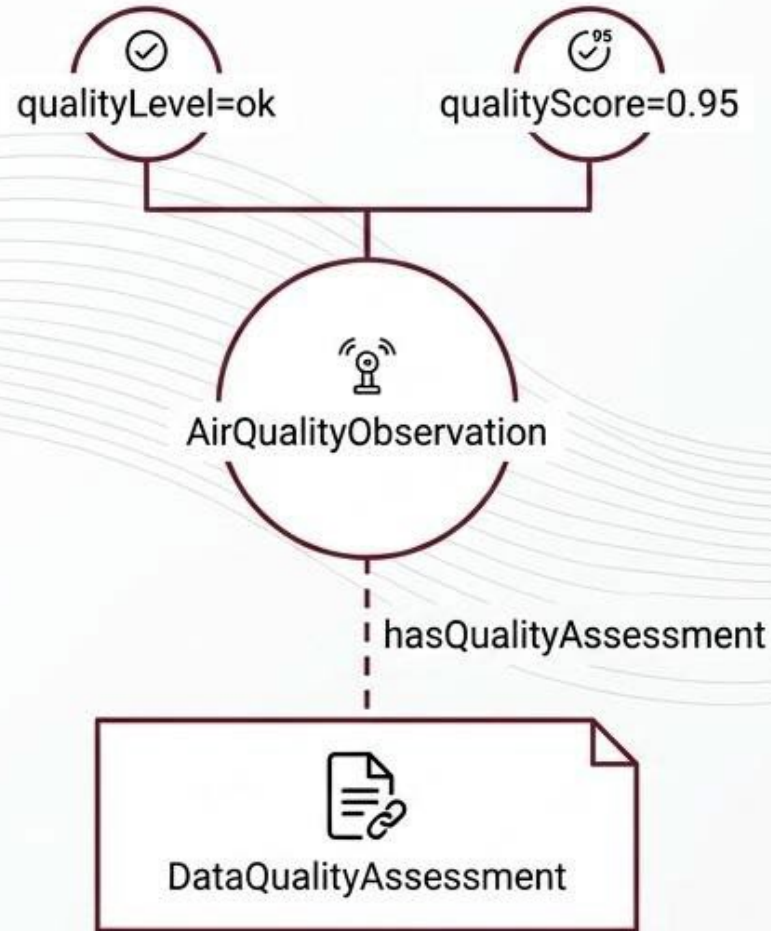
Measured by contextual relevance. Data may be mathematically complete but unusable if asset hierarchy, operating mode, or semantic state are missing.

The Natural Unit of Trust



Instead of publishing raw files, data space participants publish this bundle.
Quality evidence travels with the data.

Semantic Exchange via NGSI-LD



Property-level metadata enables high-speed operational routing and context broker filtering.

Linked entities preserve audit-grade evidence, rule execution histories, evaluator identities, and verifiable Gaia-X credentials.

Takeaway: This dual pattern preserves both runtime performance and regulatory auditability.

Composable Tooling: Execution vs. Representation

Execution Layer



Great Expectations, Deequ, dbt,
Databricks, Monte Carlo.

Run checks, batch profiles, stream
monitors, anomaly detection.
Results remain isolated inside
proprietary tool boundaries.

Semantic Translation Layer

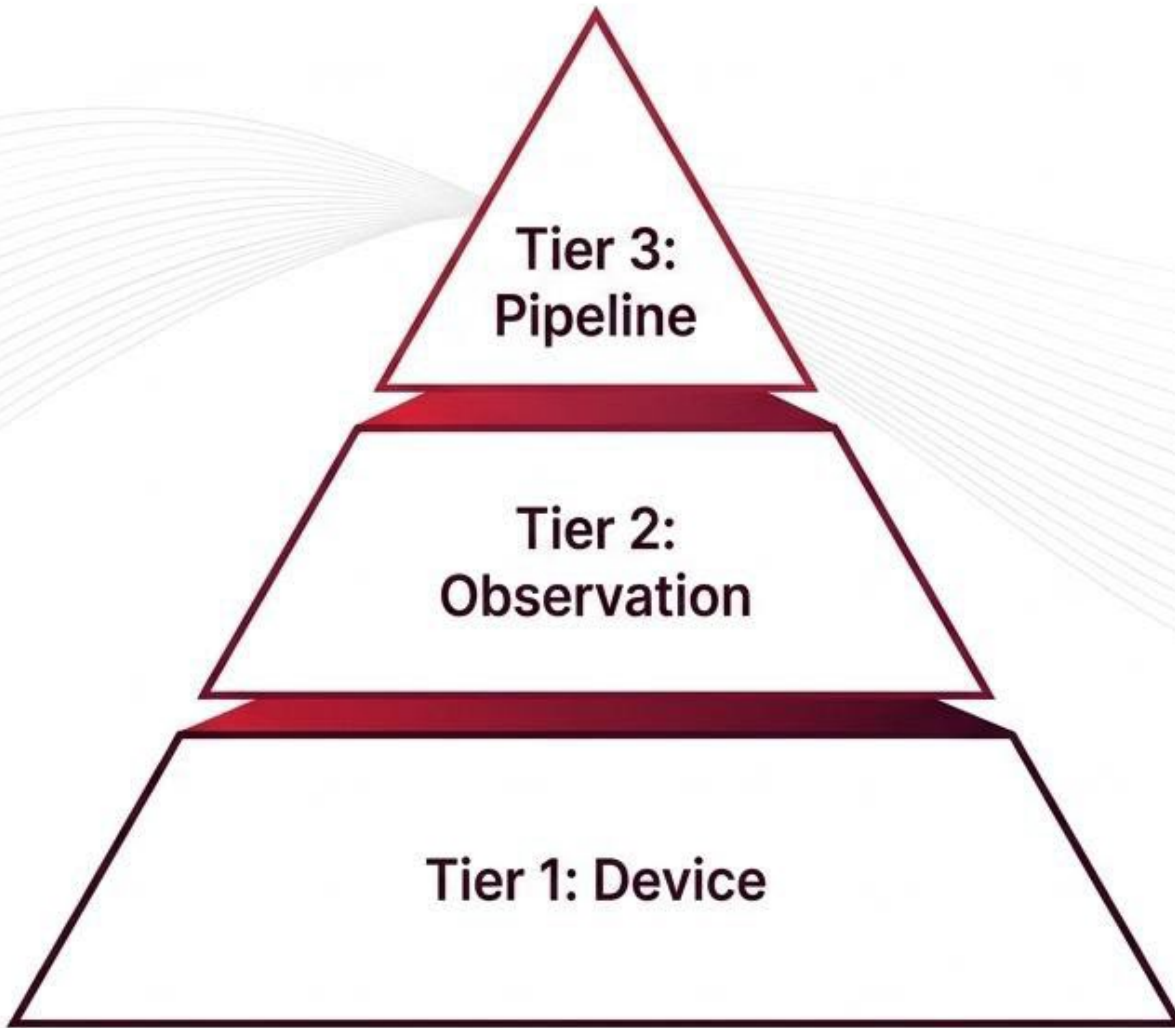
Representation Layer






W3C DQV, NGSI-LD, Gaia-X
Verifiable Credentials.

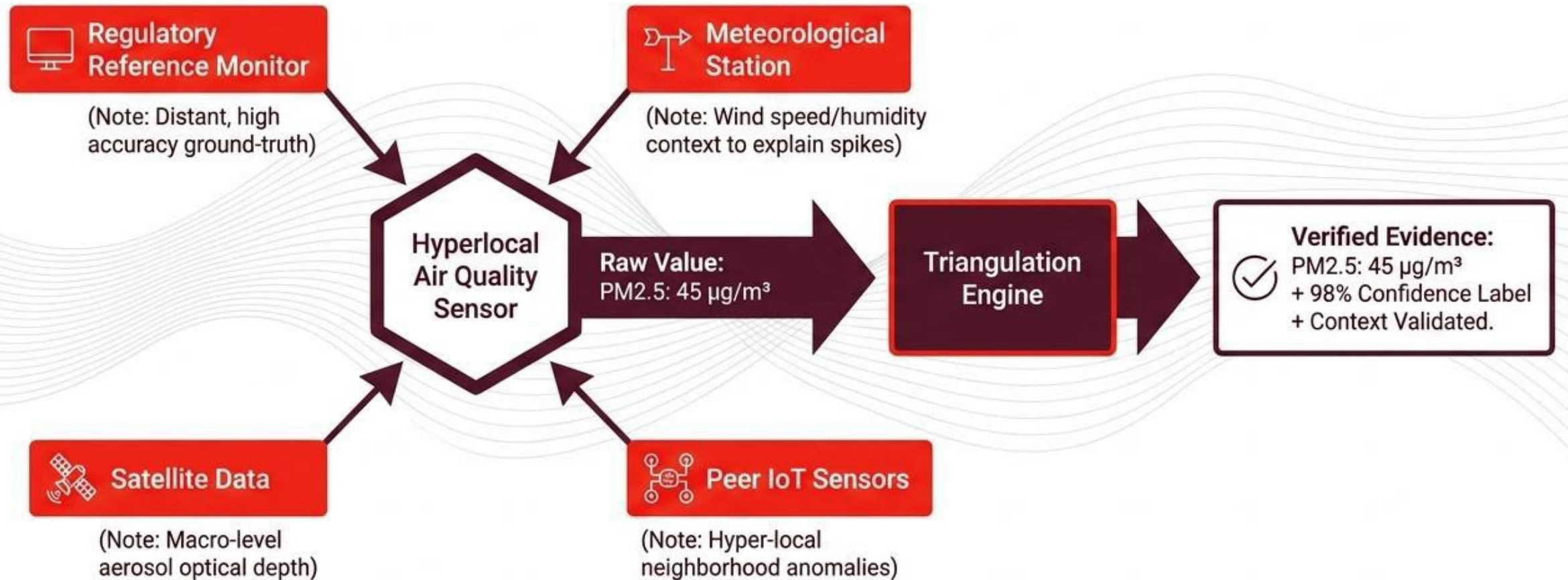
Execution outputs are normalized
into a common ontology, attached
to data products, and made
usable by data-space connectors.

The Air Quality Evidence Hierarchy



Parameters	Standard
Sampling cadence regularity, gap duration, watermark lateness, data-loss windows, broker freshness. 	DAMA / UNE 0079 stream metrics
Measurement plausibility, contextual anomaly status, uncertainty intervals, imputation status. 	ISO 25024 applied to streams
Calibration date/method, hardware precision bounds, firmware version, tamper resistance, power state. 	IEEE P2510

Context Validation Through Triangulation



Cross-validation transforms internal sensor assertions into external marketplace evidence.

Bridging the Gap at the Edge

Integrating Physical IoT Quality with IEEE P2510

The Blind Spot



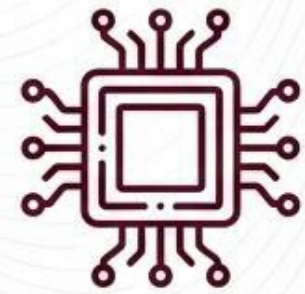
Classical DQ ignores sensor physics.

The Physical Reality



Calibration status, tamper resistance, energy levels, and firmware security.

The Digital Logical Unit (DLU)

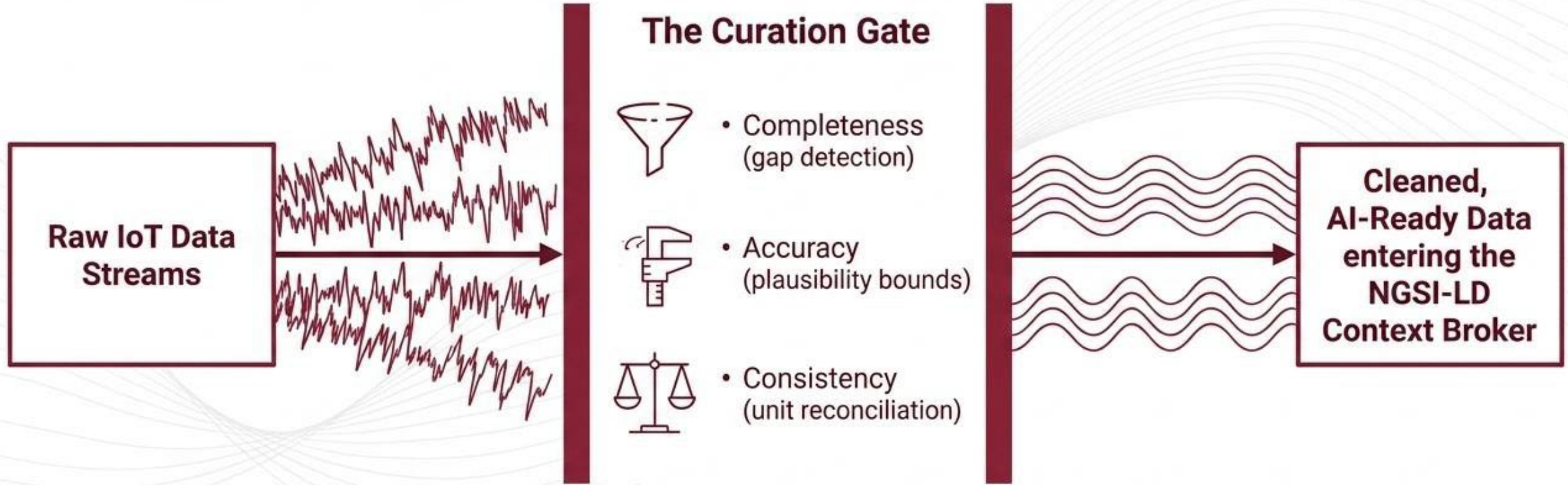


IEEE P2510 translates physical sensor reliability into a queryable digital index.

High-quality AI cannot be trained on uncalibrated, unverified hardware.
The DLU bridges physical operations with digital analytics.

The Curation Firewall

Protecting the Context Broker



Core Rule: No data enters the context broker without passing a curation gate and receiving metadata tagging.

Pattern A: Fast Filtering

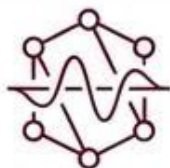
Sub-properties for Machine Interpretability

Raw Payload

```
{  
  "temperature": 17.2  
}
```

Enriched NGSI-LD Payload (Insight Data Enricher)

```
{  
  "temperature": {  
    "value": 17.2,  
    "qualityLevel": "validated",  
    "qualityScore": 0.92,  
    "qualitySource": "IEEE_P2510_Rule_X"  
  }  
}
```



Strategic Purpose: Enables real-time digital twins to instantly filter out suspect or outlier data without complex external queries. Preserves backward compatibility.

Pattern B: Audit-Grade Evidence

The DataQualityAssessment Entity



Strategic Purpose: Essential for Data Space certification, ISO 17029 compliance, and detailed execution logs.



Continuous Pipeline Observability

Monitoring Freshness, Volume, and AI-Drift



Databricks Intelligence

Automated freshness and completeness tracking using historical commit patterns.



Great Expectations

Rule-based validation, distribution checks, and schema enforcement.



Feedback Loop

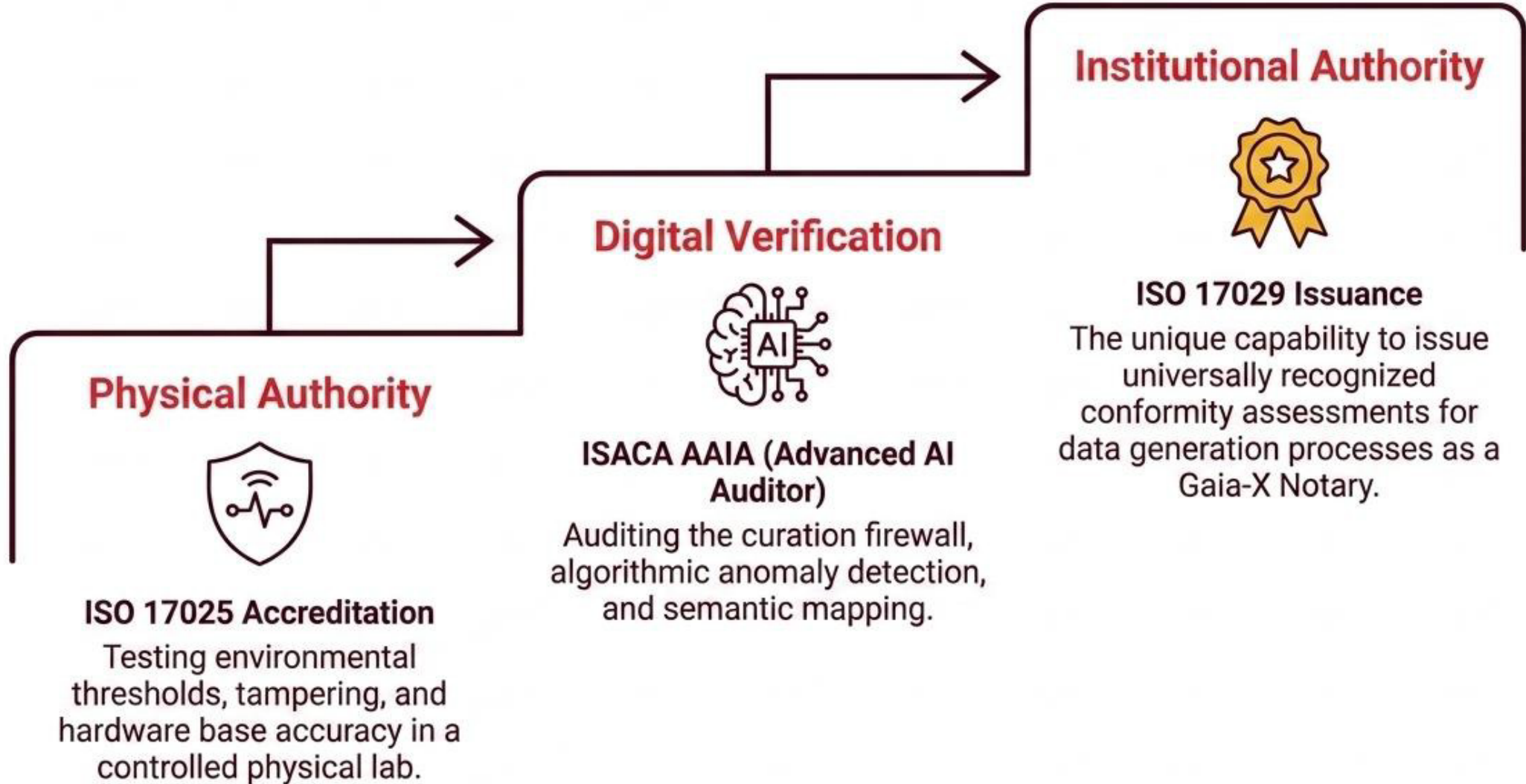
Pipeline anomalies are published back into the NGSI-LD semantic graph, altering the DataQualityAssessment.



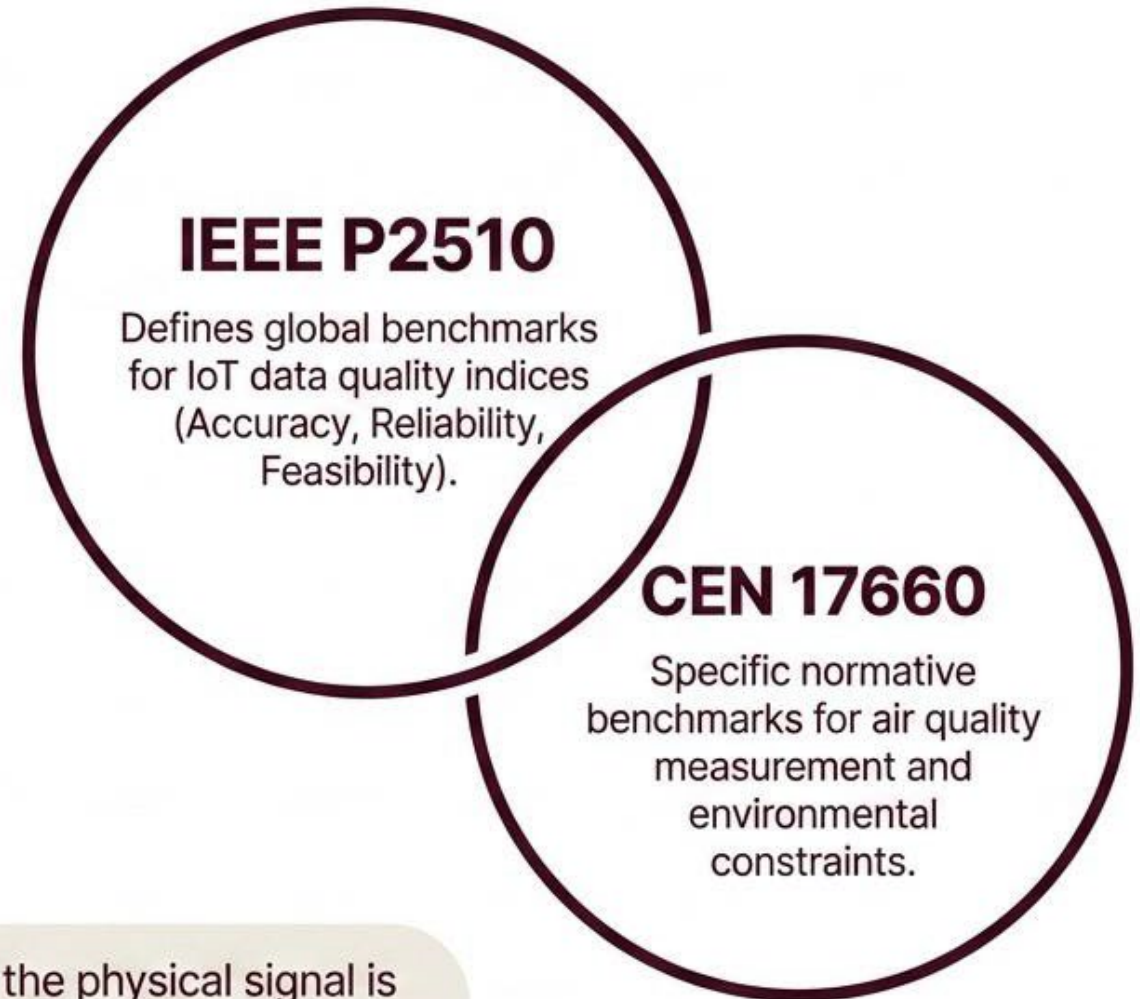
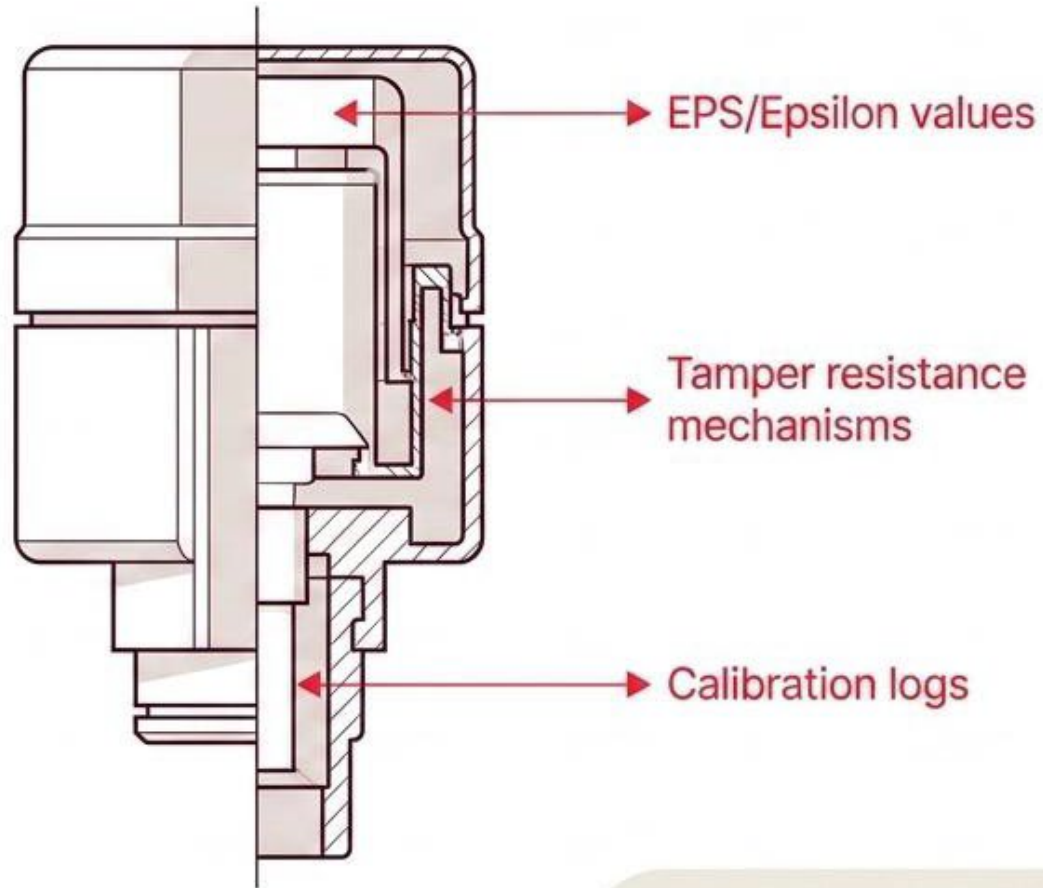
Key Concept: Continuous evidence ensures downstream AI models are protected from stale or drifting datasets.



The Libelium Trust Triad



Step 1: Anchoring Trust in Hardware Truth



Trust begins at the edge. If the physical signal is compromised, downstream AI logic is invalid.

Operationalizing Quality in NGSI-LD

The Goal

Make quality evidence queryable and machine-actionable across federated marketplaces.

The Method

Extending standard NGSI-LD Smart Data Models (SDM) to embed IEEE P2510 sensor indices directly into the data product.

The Result

A standardized payload carrying both the measurement and the cryptographic proof of its trustworthiness.





Smart Data Models: Representation Patterns

Pattern A: Operational Speed

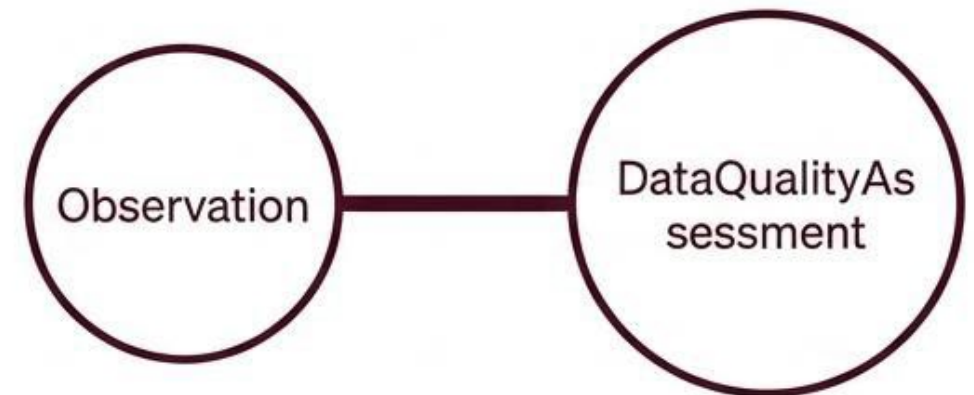
Sub-properties



Fast filtering. Query all measurements where `qualityLevel = valid`. Human and machine interpretable.

Pattern B: Institutional Audit

Related Metadata Entities



Audit trails and certification evidence. Stores detailed rule execution logs, DIH assessments, and hardware calibration records.

The Data Quality Assessment Ecosystem

From Standards to Smart Data Models

1. DATA QUALITY STANDARDS & VALIDATION (INPUTS)



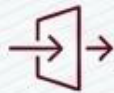
IEEE P2510
(Sensor Params: EPS, Security, Calibration)



DAMA (DMBOK DQ Framework) & ISO 8000
(Global DQ Standard)

Defines rigorous global benchmarks & metadata indices.

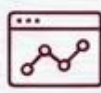
3. DATA QUALITY MONITORS & CURATION (OPERATIONALIZATION)



CURATION FIREWALL
(Gate, Filter)



AI-DRIVEN DETECTION
(Brain chip)



PIPELINE/DATASET MONITORS
(Dashboard)

Pre-broker validation, ML-based checks, automated freshness monitoring.

2. TYPES OF ANALYSIS (ASSESSMENT CORE)



ACCURACY
Target, market and medicalization



COMPLETENESS
Puzzle to ansors & completeness



RELIABILITY
Anchor descriptions & on-moctrennate



TIMELINESS
Data timeness and timesliminiute



RELEVANCE
Filter to bowi and anel relevance



CONSISTENCY
Linked chain & chontn analys

SMART DATA MODELS METADATA
(NGSI-LD + SDM)

Sensor Indices

Context

Policy

Provenance

4. TYPES OF ANOMALIES & DRIFTING (DETECTED ISSUES)



OUTLIERS
Red dot pranchmarks & deciror of outliers



MISSING DATA
Empty box a resontans trust of missing data



DRIFTING
Trend line calls after an drifting (Trend line)



INCONSISTENCIES
Inconsistencies (Conflicting arrows)

TRUSTED DATA PRODUCTS & CERTIFICATION (OUTCOME)



DATA QUALITY LABEL
(DIH Certified)

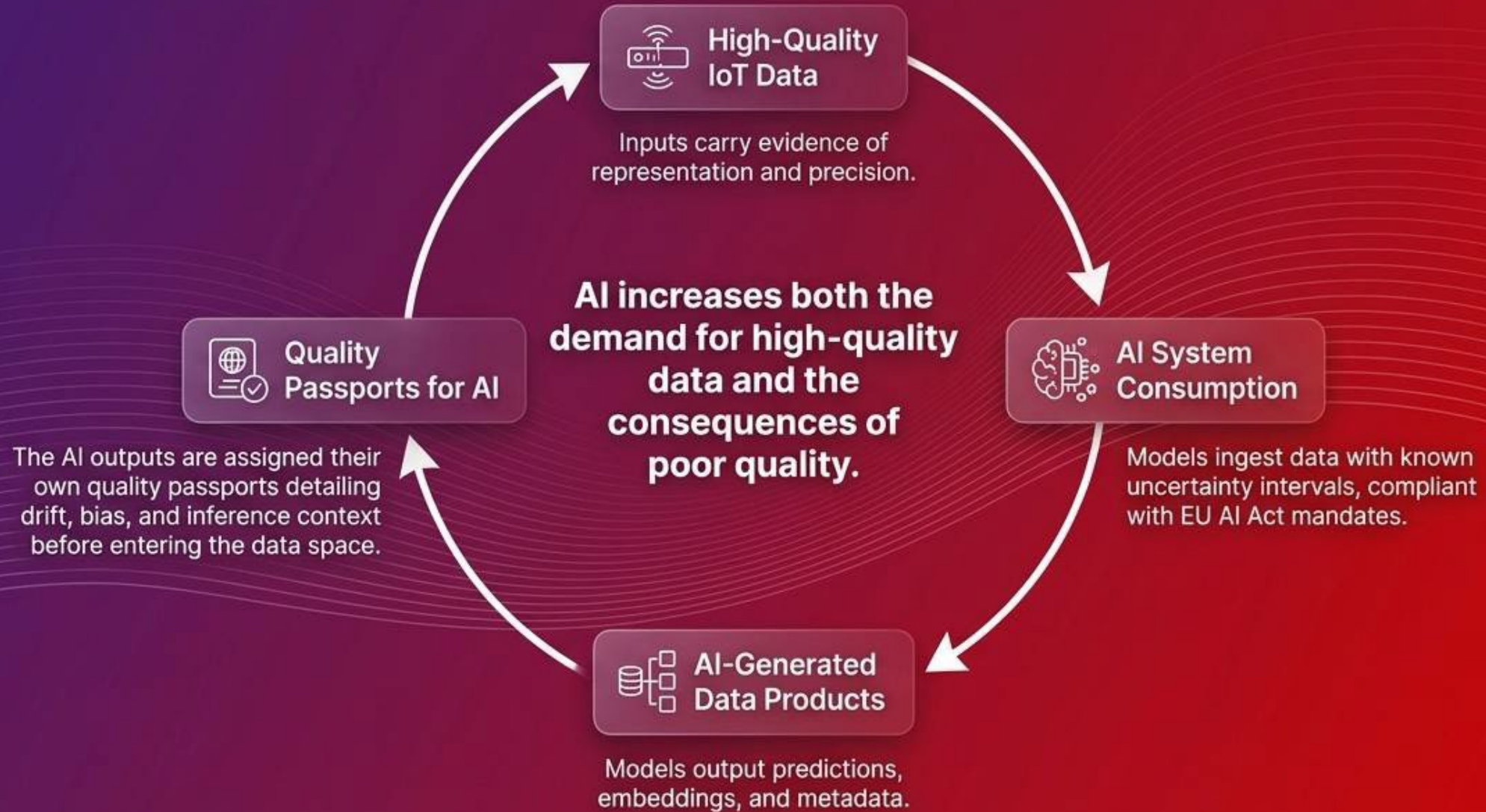
Auditable evidence, increased trust, reduced integration costs. Enables reliable Digital Twins & Industry 4.0.

The Output: The Verifiable Data Quality Label



- ✓ Issued directly as a Verifiable Credential (VC).
- ✓ Drastically reduces integration costs for SME data consumers.
- ✓ Pre-validates AI-training datasets for EU AI Act compliance.

The AI Accountability Loop



The Marketplace Trust Deficit



In a sovereign Data Space, participants do not trust metrics; they trust authorities



Self-assessed metrics fail in federated markets.

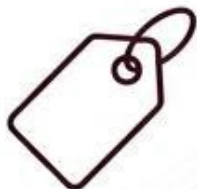


Data must carry mathematical guarantees.



Guarantees must be backed by a recognized Trust Anchor.

From Engineering Metric to Market Property



Pricing & Discoverability

Datasets with documented provenance, explicit quality vectors, and verifiable labels command premium marketplace value and higher catalog visibility.



Integration Friction

Smart Data Models and semantic quality layers drastically reduce the due-diligence and schema-mapping costs for data consumers.



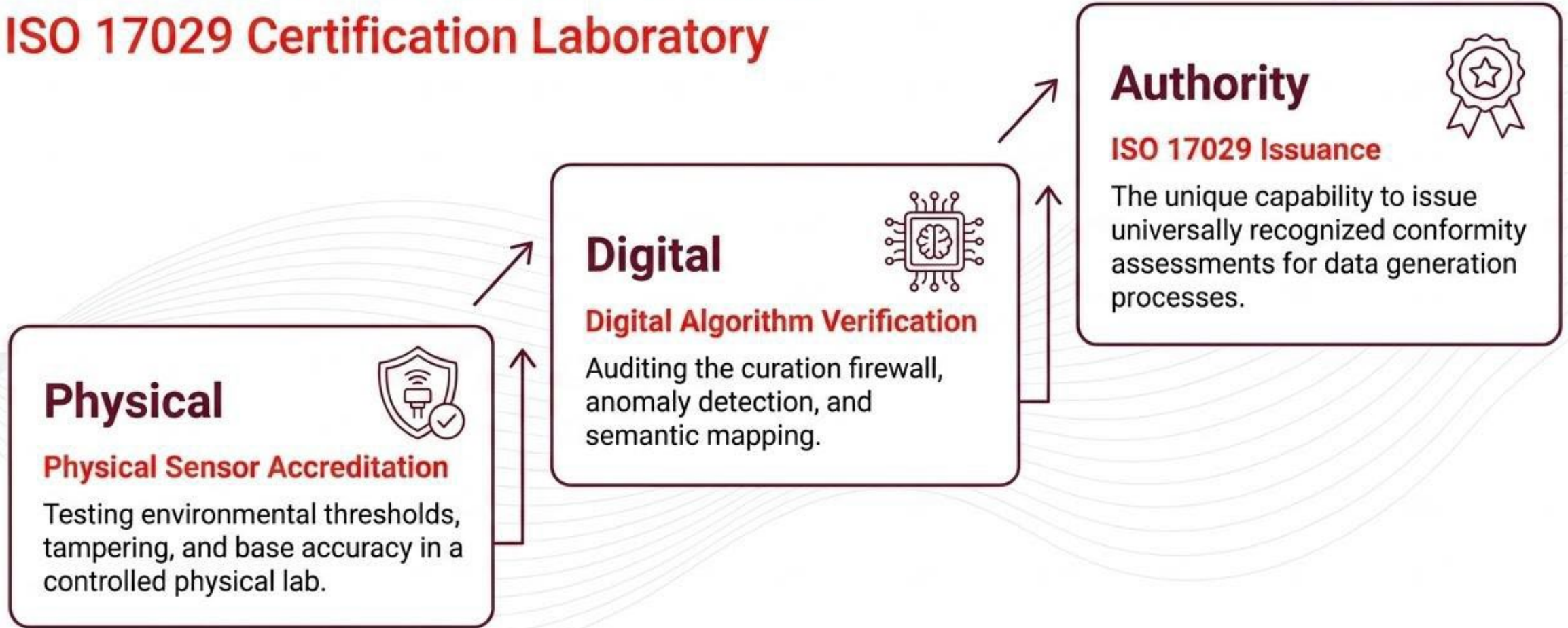
Liability & Risk

Transparent uncertainty bounds and explicit usage exclusions protect data providers from contractual risk and regulatory non-compliance.

Quality is a differentiator that allows providers to monetize trust.

The Libelium Trust Anchor

ISO 17029 Certification Laboratory



Physical lab accreditation translates directly to digital trust in Gaia-X.

Building the Gaia-X Trust Ecosystem

Frictionless, Monetizable Data Sharing



Libelium's quality labels integrate natively with Gaia-X Clearing Houses, acting as verifiable credentials that unlock frictionless data negotiation and premium monetization.



The Business Impact of Certified Data

Value Creation for Industry 4.0 and Smart Cities



Reduced Friction

Standardized payloads cut data integration costs. Due diligence is pre-completed by the Libelium label.



Trusted AI

AI models trained on certified data comply with emerging regulations and reduce hallucination/drift risks.



Premium Monetization

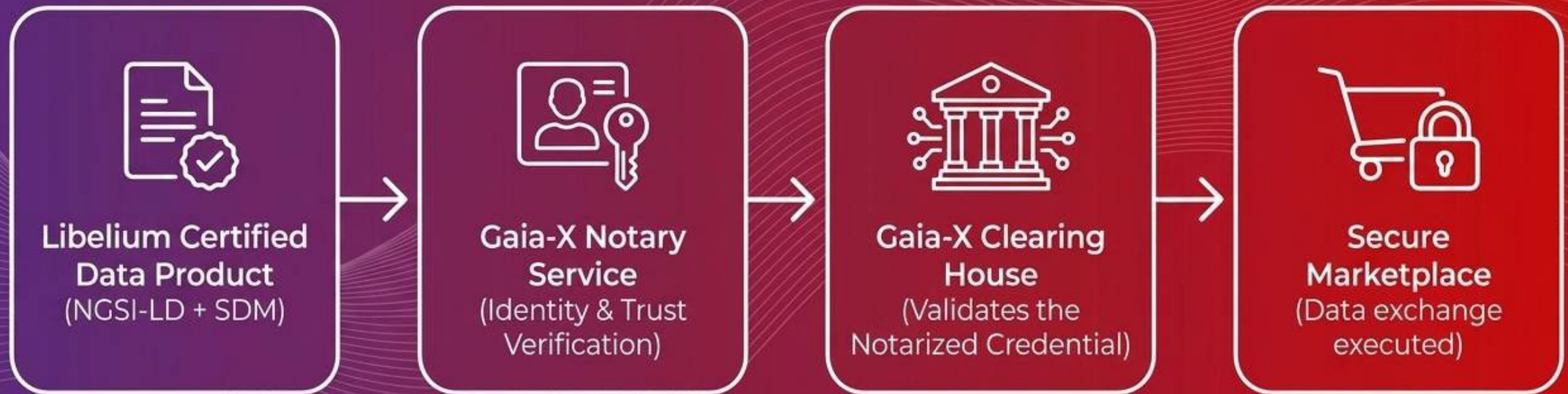
Certified datasets command premium pricing in data spaces due to guaranteed Service Level Objectives (SLOs).



The Paradigm Shift in Data Quality

Dimensions	Self-Assessed Metrics	Verifiable Evidence (Libelium)
Source of Truth	Internal dashboards	Cryptographic proofs
Governance	Best-effort policies	Institutional auditing (ISO 17029)
Output Format	Proprietary logs	Standardized Verifiable Credentials (VCs)
Market Interoperability	Siloed within platforms	Natively queryable via NGSi-LD
AI Readiness	Requires manual due diligence	Ready for EU AI Act compliance

Frictionless Sharing in the Gaia-X Gaia-X Ecosystem

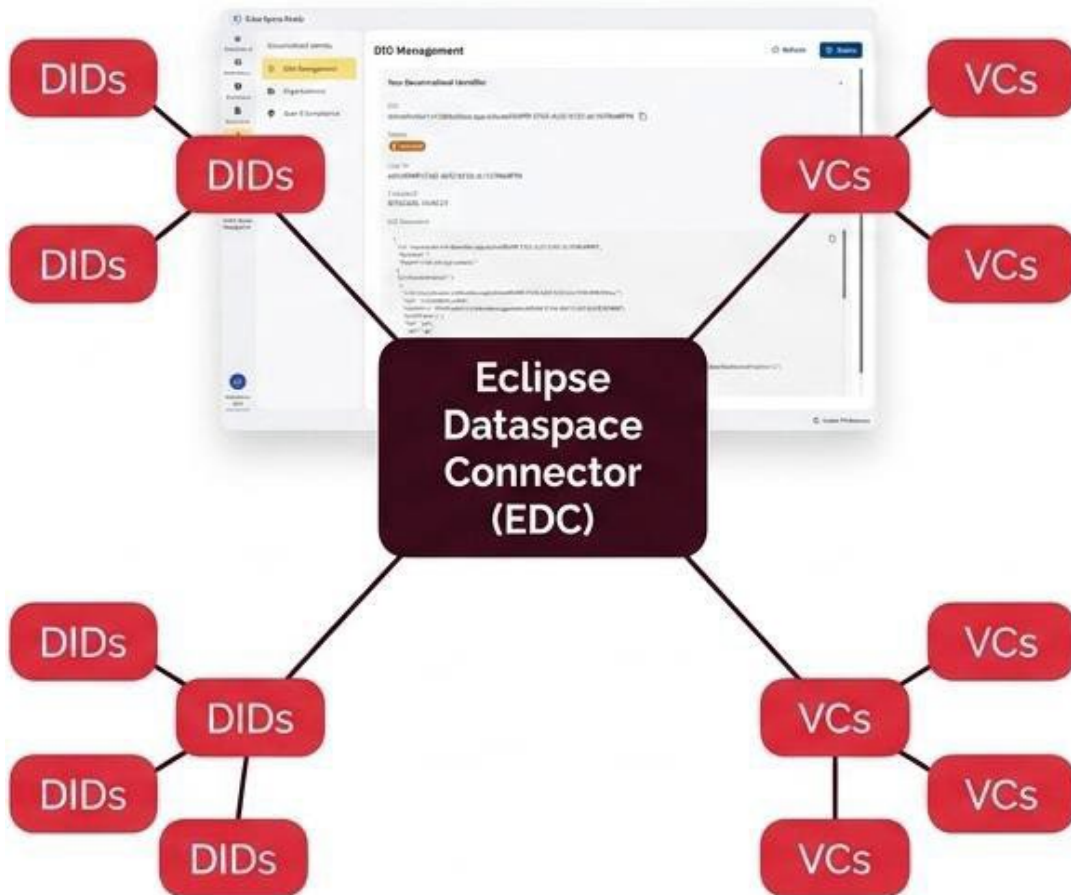


Libelium's quality labels integrate natively with Gaia-X Clearing Houses, acting as the cryptographic key that unlocks frictionless data negotiation.

Powering the EU LDT Toolbox



The Identity Fabric



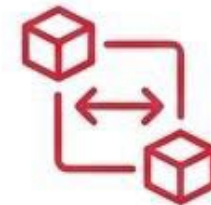
The Impact



Decentralized identity ownership ensures city sovereignty over Smart City data.



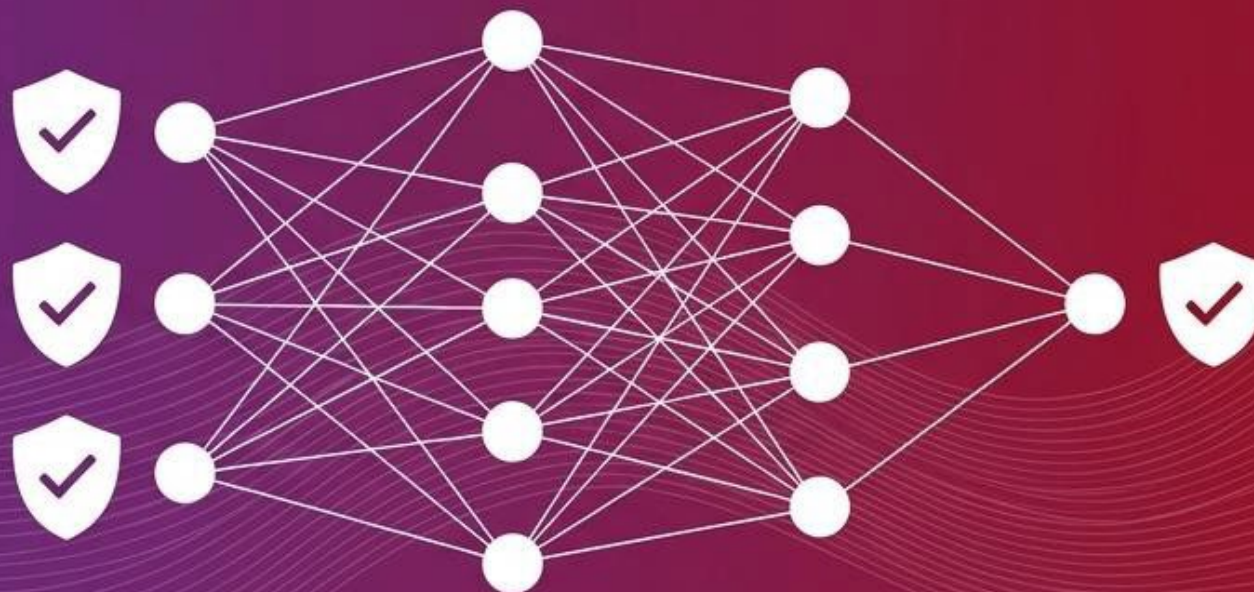
Libelium's Notary services validate organizational roles and data compliance across the federation.



Enables seamless, horizontally scalable data exchange between previously siloed municipal platforms.

The Citcom.ai TEF Imperative: Trusted AI

CitCom^{AI}



Verifiable Evidence In, Compliant AI Out

The EU AI Act mandates strict provenance and quality tracking for training data.

Self-assessed datasets expose developers to unacceptable regulatory and hallucination risks.

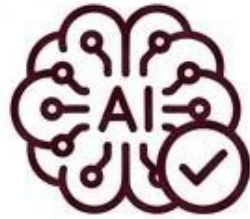
Libelium's Data Quality Label provides the definitive audit trail required for Citcom.ai's advanced machine learning pipelines.

The Business Impact of Certified Data Products



Reduced Friction

Standardized payloads and SDM patterns cut data integration costs. Due diligence is pre-completed by the Libelium label.



Trusted AI

Models trained on certified data comply with emerging regulations and dramatically reduce drift and hallucination risks.



Premium Monetization

Certified datasets command premium pricing in federated marketplaces due to cryptographically guaranteed Service Level Objectives (SLOs).



Trust is not assumed. It is verified.

Standardize your IoT Data Products with Libelium.

Discover the ISO 17029 Data Quality Laboratory.



FIWARE: Technology Update

16:55 – 17:25



- **Stefan Wiedemann – SEAMWARE**



In partnership with



LMS

Laboratory for
Manufacturing Systems
& Automation

FIWARE Data Space Connector

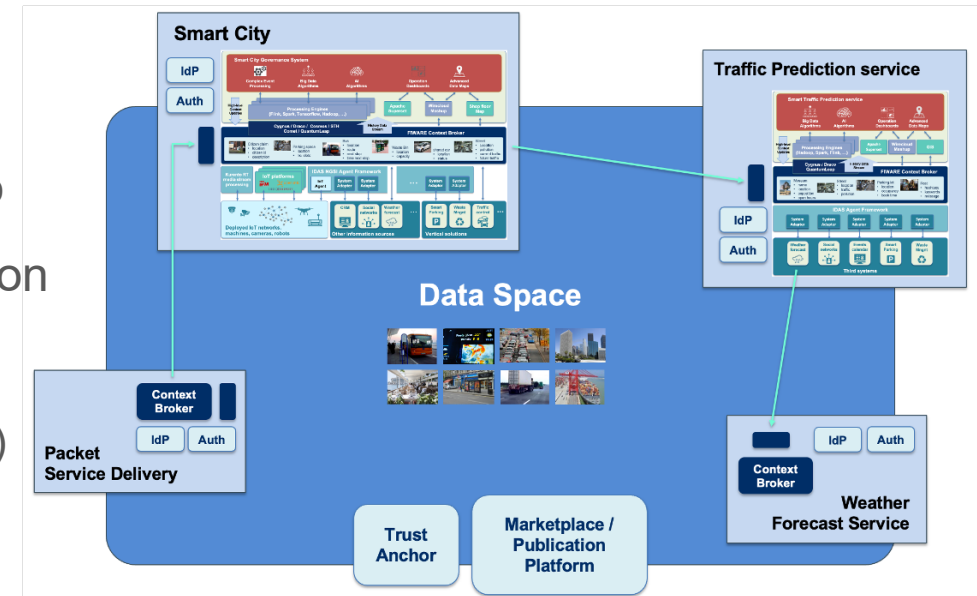
Integration of the Dataspace Protocol

Stefan Wiedemann - Senior Software Engineer & Member FIWARE TSC



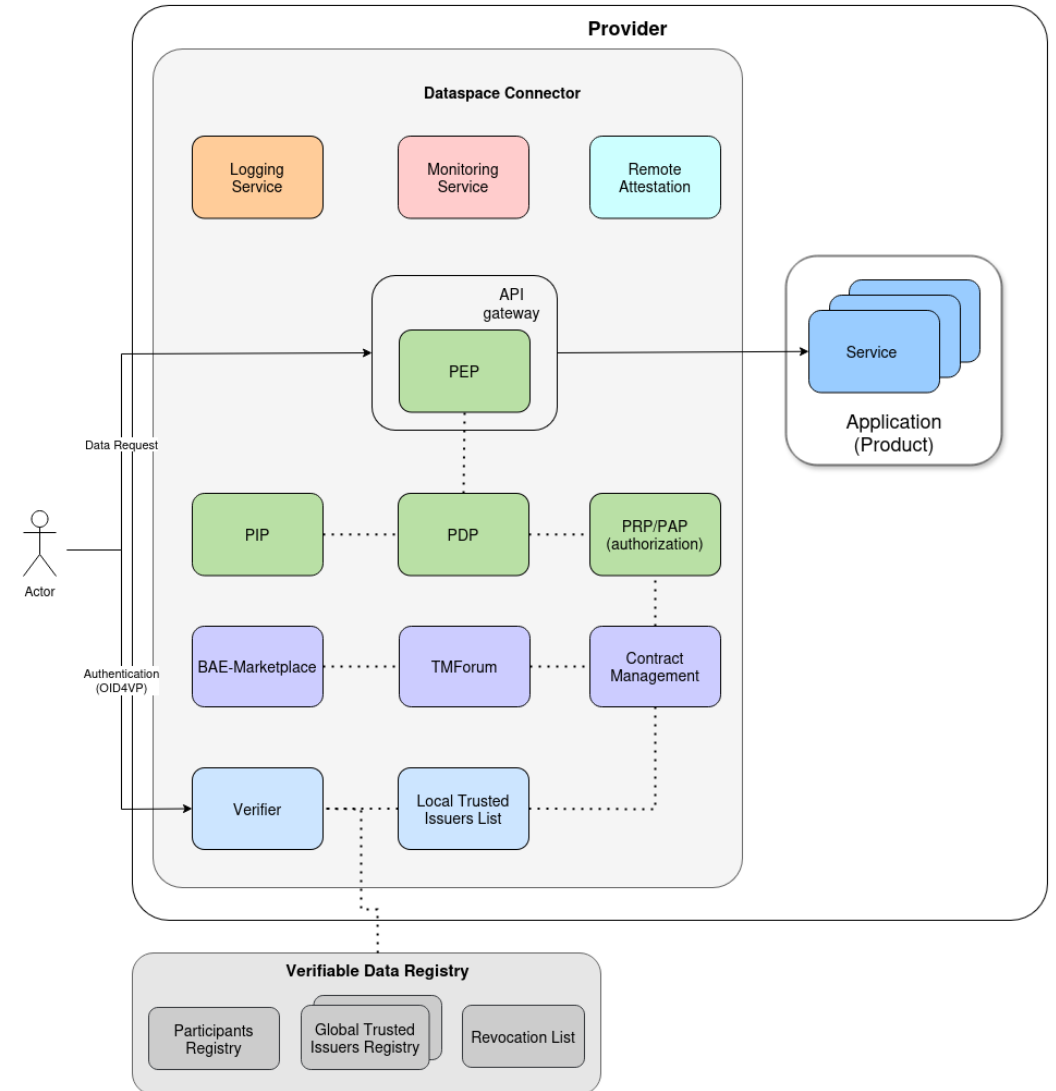
FIWARE Data Space Connector - Vision

- Not just about organizations publishing data, but also about enabling application providers to offer services
 - for accessing, processing, visualizing and interpreting data
 - APIs & GUIs serving Applications directly to end users
- Not just about organizations consuming plain data, but also about enabling users of organizations to consume application services
 - natural persons as first class citizens (employees, customers)
 - devices or software agents owning identity
- Allow Organizations to extend their systems through the Dataspace in a **Trusted**, **Sovereign** and **Agile** manner



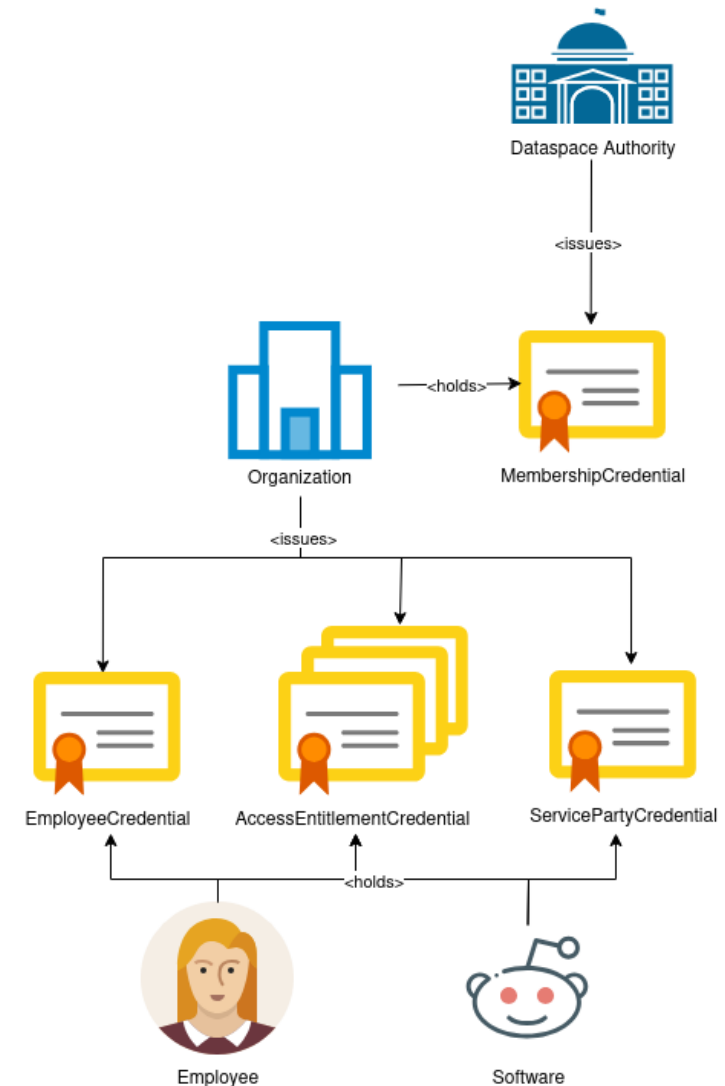
FIWARE Data Space Connector

- Microservice Architecture, allowing Participants to integrate services based on their needs
- standardized Protocols and APIs
 - OpenId4VC to authenticate(EUDI Wallet RAF compliant)
 - ODRL for authorization Policies
 - TMForum APIs marketplace functionality
- established Open Source Components
 - Apisix as PEP/Gateway
 - Open Policy Agent for Policy evaluation
 - Keycloak for Credentials Issuance



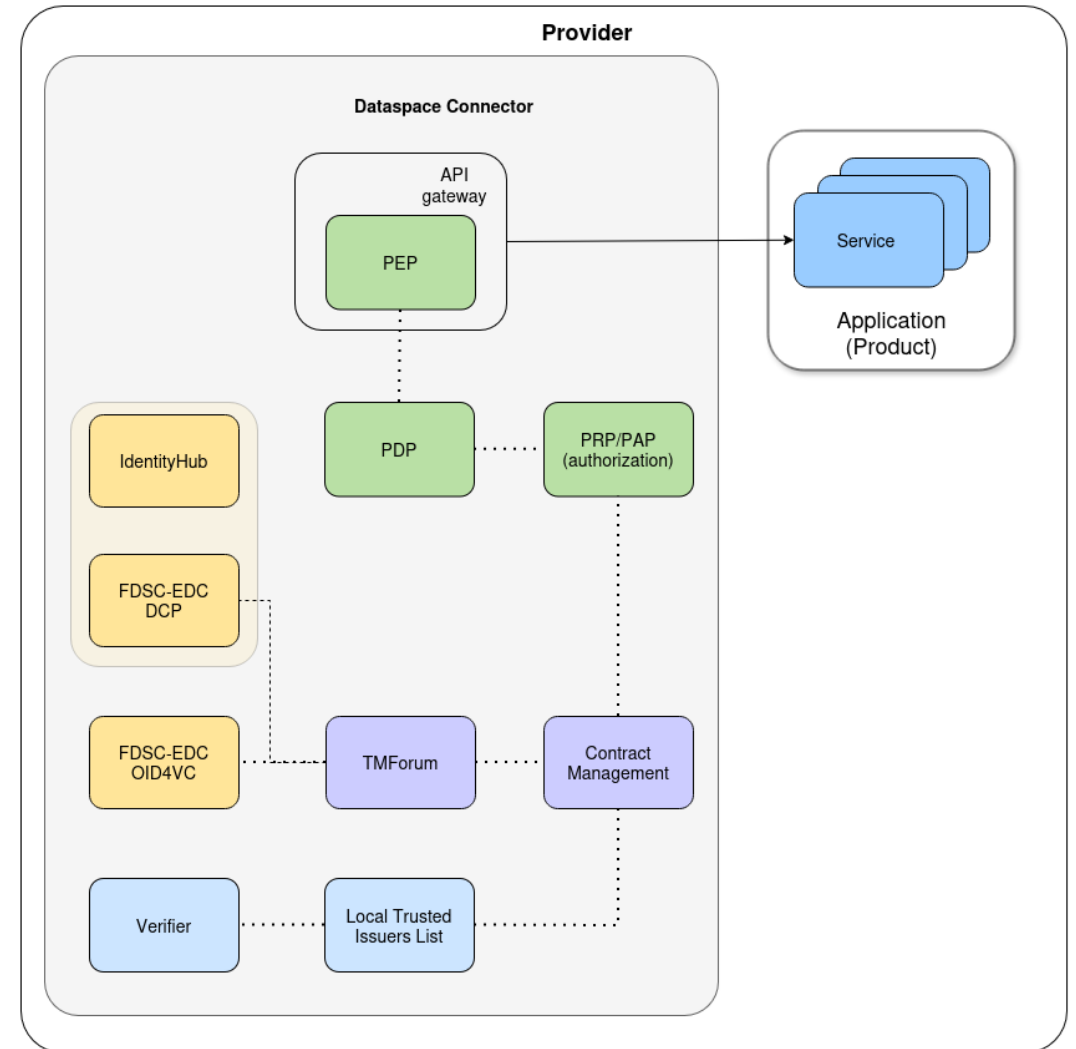
FIWARE Data Space Connector - OpenId4Verifiable Credentials

- OpenId 4 Verifiable Credentials defined by [OpenId Foundation](#)
- presentation of Verifiable Credentials based on OAuth 2.0
- allows identification of persons, devices, software agents etc. instead of pure organizational identity
- users can be entitled by their organization and act independently inside the Dataspace



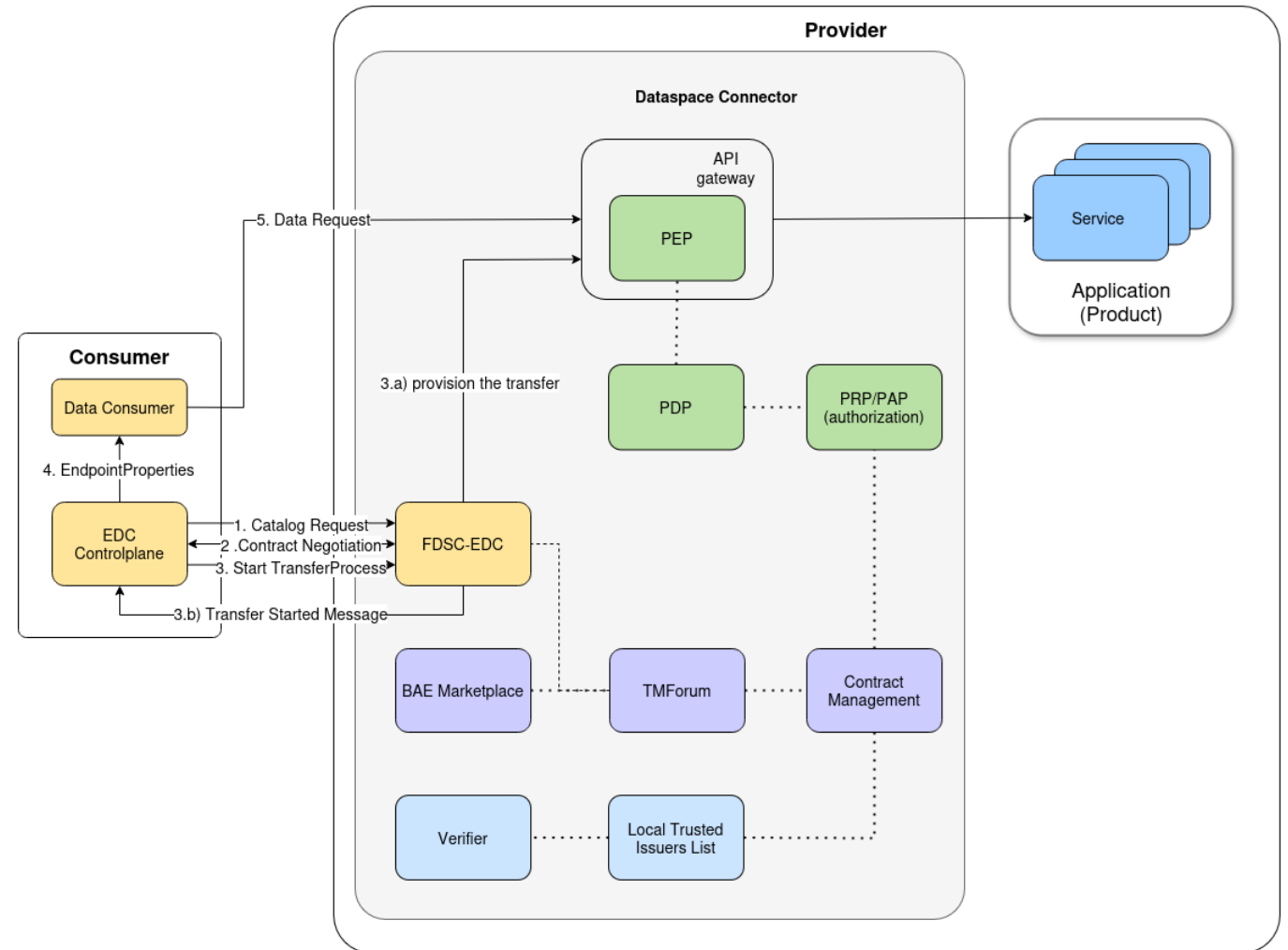
FIWARE Data Space Connector - DSP Integration

- Extension of EDC Implementation through its SPI's
 - no custom DSP implementation
 - future compatibility easier to ensure
- Separate Data Space Protocol and Decentralized Claims Protocol
 - allows the Auth-Framework to support DCP and OpenId4VP
- Storage of DSP Entities(Catalogs, Offerings, Agreements etc.) as corresponding entities in TMForum
 - automatic integration to the FIWARE DSC Contract Management



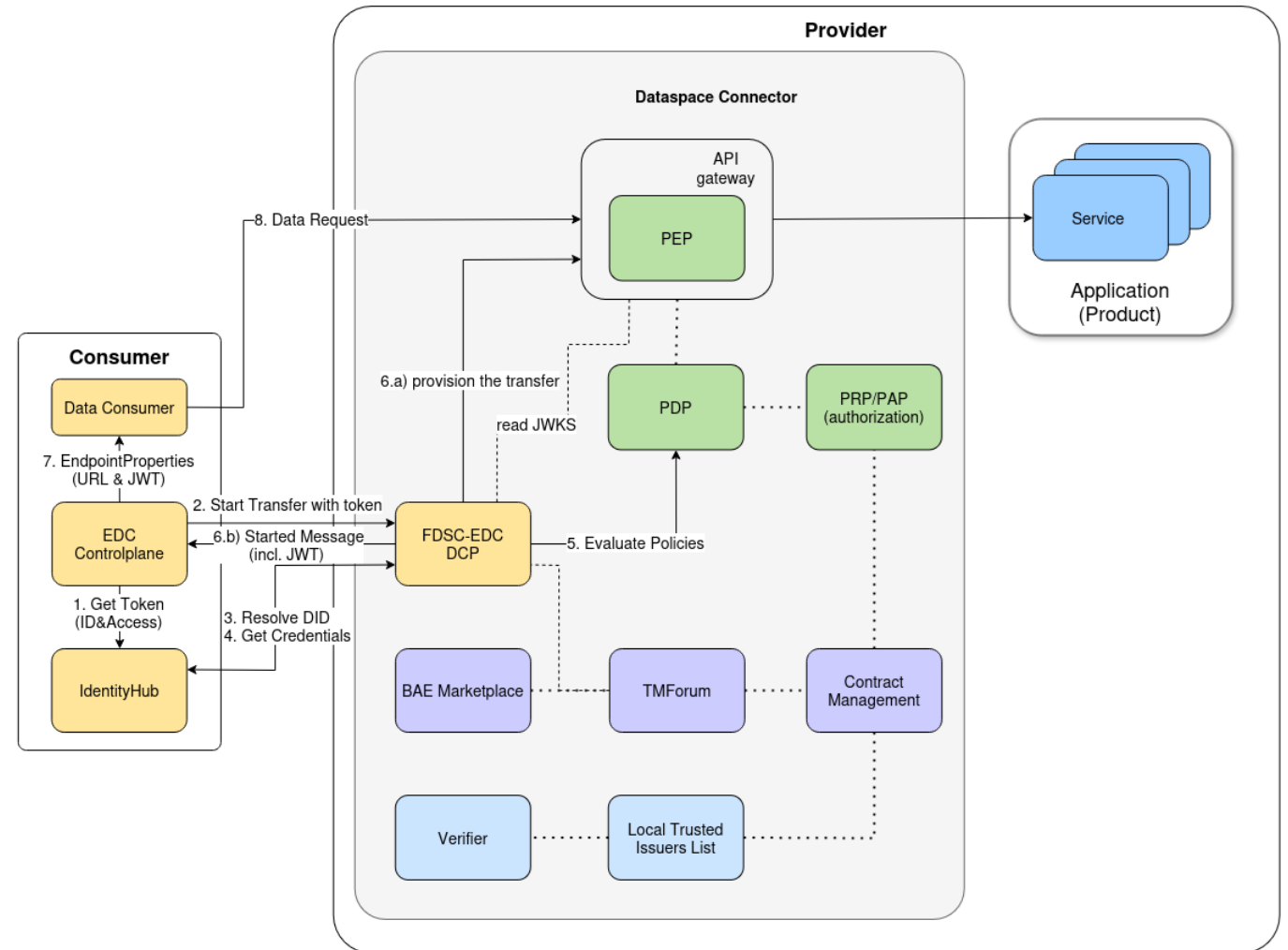
FIWARE Data Space Connector - DSP Integration

- Catalog serves information stored at TMForum - Products can be contracted through DSP or TMForum
- Contract Negotiation stored as “Quotes” in TMForum, integrating with its negotiation flow
- Transfers are provisioned at the APIGateway(acting as Dataplane) as new route
- information about the new route is delivered through Started Message
- Consumer registered as Trusted Issuer



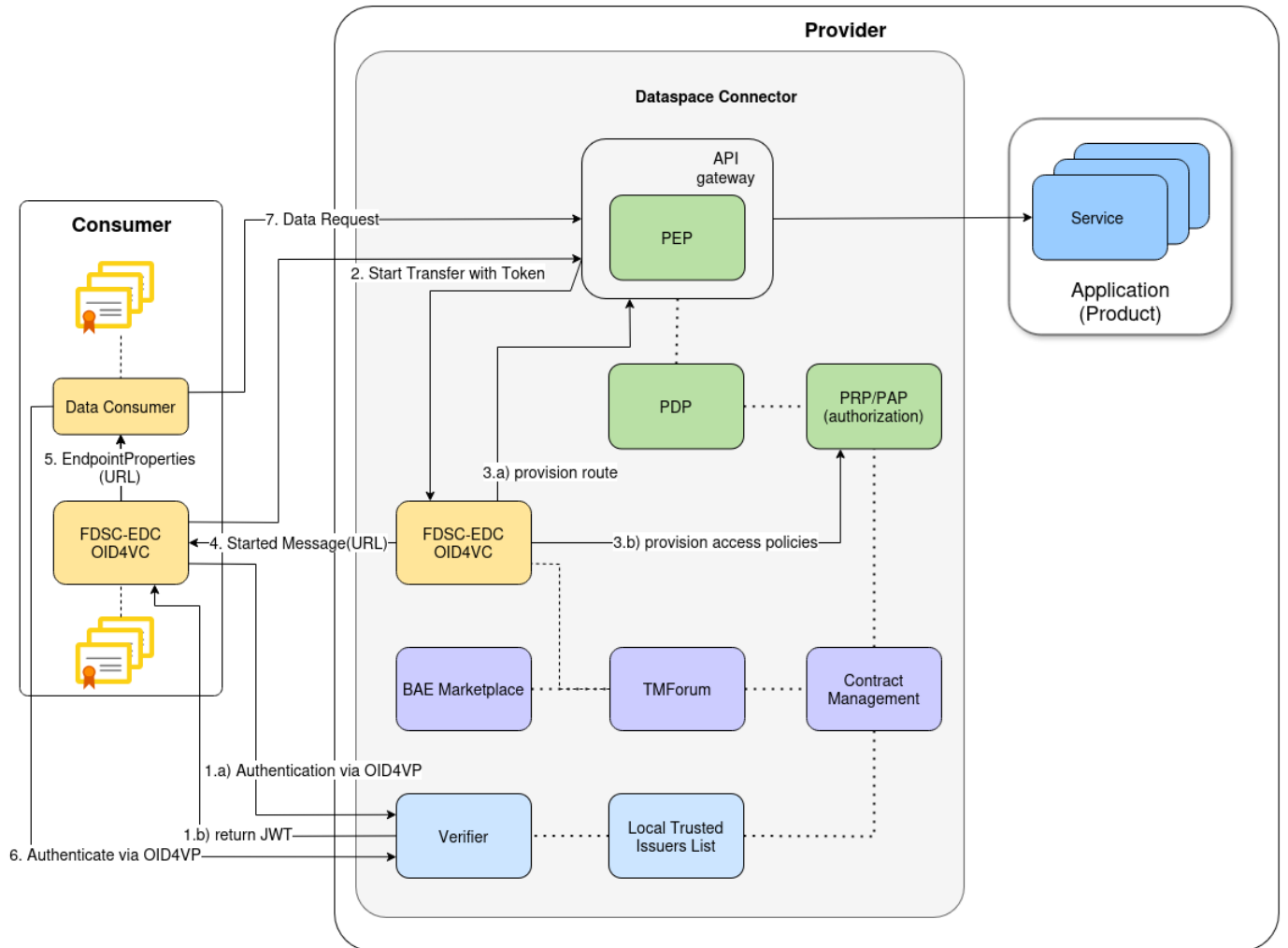
FIWARE Data Space Connector - DCP Integration

- integration of IdentityHub
- usage of the PDP for policy evaluation - addition of policy functionality at runtime
- provisioning at the APIGateway, token verification through Apisix standard mechanism



FIWARE Data Space Connector - OID4VC Integration

- Credentials hold by Connector and Data Consumer
- authentication through [OID4VP-Client-Lib](#) at Verifier
- transfer provisioned at APIGateway&PAP - policy enforcement on request
- Data Consumer Service and Connector act under their own identity
- allows usage of user-focused services, like GUI-Applications





Funding information and communication compliance



Plan de Recuperación,
Transformación y Resiliencia



Financed by
the European Union

Project: DSIRE – Data Spaces Interoperability and Reusable Enablers

Grant file: TSI-100130-2024-158

This activity is carried out within the framework of the **DSIRE** project and has been funded by the Ministry for Digital Transformation and Public Administration, through the State Secretariat for Digitalisation and Artificial Intelligence (SEDIA), under the 2024 call for technological products and services for data spaces, within the Sectoral Data Spaces Programme of Spain's Recovery, Transformation and Resilience Plan.

Funded by the European Union – NextGenerationEU

The views and opinions expressed in this presentation are those of the author(s) only and do not necessarily reflect those of the European Union or the European Commission. Neither the European Union nor the European Commission can be held responsible for them.

- FIWARE Data Spaces:
 - <https://github.com/FIWARE/data-spaces>
- FIWARE Data Space Connector:
 - <https://github.com/FIWARE/data-space-connector>
- FDSC-EDC:
 - <https://github.com/SEAMWARE/fdsc-edc>
- Presentation:
 - <https://github.com/wistefan/presentations/tree/main/tech-x-athen>



Networking Reception/AR Game
17:30 – 20:30