

Catena-X: Exploring and Deploying its Open Source Components


FT RPD CED INW-CN | YANG Shaopeng

What is Catena-X ?

Catena-X is the **first** collaborative, **open** data ecosystem for the automotive industry of the future, linking global players into end-to-end value chains - as simply, securely and independently as never before.


Catena-X is the industrial policy **lighthouse** project for the digitalization of supply chains.

Vision



**Funded by
the European Union**
NextGenerationEU

Supported by:




Federal Ministry
for Economic Affairs
and Climate Action

on the basis of a decision
by the German Bundestag





This is a work result of the
**Catena-X Automotive Network
Consortium Project**, supported by the
German Federal Ministry for Economic
Affairs and Climate Action.
Funding code: 13IK004*

Shared global **DATA SPACE**

- One **operating model** and **federated operating system** for the data space
- Customer value journeys** for common GOALS enabled by open, multi vendor marketplaces



- Foundational services and **standards** built upon **OSS (KITs)** with dedicated **developer journeys**



- Neutral governance**, incl. conformity assessment body

Driving forces of policies:

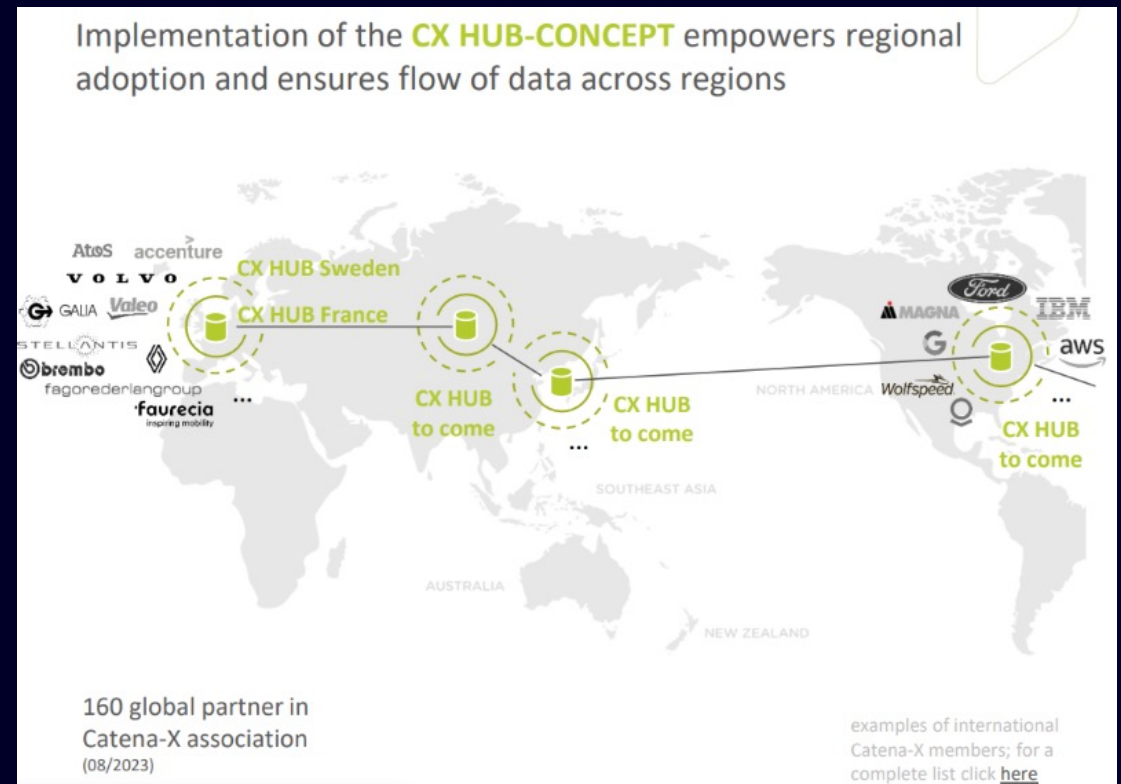
- CBAM: Carbon Border Adjustment Mechanism
- Battery Passport

What is Catena-X ?

- Initiation & status quo
Proposed by BMW and SAP in 2021, 160 [members](#) as of: 08.2023.



- EU Operator: Cofinity-X 10.2023
<https://www.cofinity-x.com/products-and-services>



Catena-X Data Ecosystem Concept



The significance of data spaces

The widespread usage of data in business processes and ecosystems plays a significant role in most economies - and it will be the essential foundation for the future of the data economy and AI. Organizations can exploit the quality and size of internally generated data, but a substantial portion comes from external sources.

To maintain data value and trust across ecosystems, it is essential to establish a reliable method, along with the technical and software infrastructure for sharing data. The solution is data spaces, offering both multi-organizational agreements and technical infrastructure to facilitate trusted data sharing between one or more participants - forming a value creating ecosystem.

In a data space, data providers can trust that their partners will handle the data responsibly, and that they get value for the shared data. Consumers, on the other hand, can trust that the data they utilize comes from a trustworthy source. This can be built by design in data spaces.

As a non-profit organization, the International Data Spaces Association (IDSA) is committed to establishing standards for data spaces, ensuring that the features mentioned before and related built into every data space by design. Within a defined governance framework, these standards guarantee secure data sharing between participants while supporting trust and data sovereignty.

Data Connectors

To share data, the participants of a data space need an ID Connector. This software translates data between different systems, applications, or platforms. It enables trusted and secure data sharing between participants, allowing data to flow seamlessly across different systems and devices.

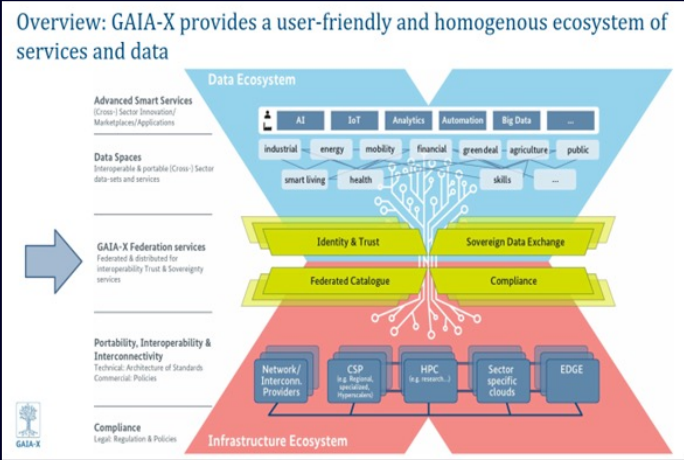
The data connector facilitates two important roles: providing Data Exchange Services and safeguarding trust enforcing usage policies and interoperability measures. Enabling various functions such as management services, cloud infrastructure, lightweight APIs, and IoT gateways, data connectors serve as the bridge enabling the utilization of data for concepts such as digital twins, AI, and federated learning.

However, due to diverse data and sharing requirements, different connector variants are necessary. The technical ID Connector concept may differ significantly from those for data marketplaces or industrial cloud platforms, though they must seamlessly integrate open data.

To achieve reliability in a data space, the interoperability of connectors requires verification. To achieve this goal we already have a set of usable standards, but additional are required. For this reason, IDSA developed the DataSpace Protocol.

The key to data spaces is the data connector

- Connects participants in a data space - to share value, benefit from data
- Ensures trust through ISO Certification and cyber security assessment
- Connects to trust frameworks and identity management
- Includes identity & policy management, secure data usage control
- Guarantees interoperability
- Understands and enforces data usage policies
- Master for other connectors of diverse feature sets



THE FIRST OPEN & COLLABORATIVE DATA ECOSYSTEM

Technology & Architecture
The network foundation is build upon shared services and GAIA-X / IDSA principals - We all can take ownership

Working Model
All industry players join forces to build, operate and utilize the data ecosystem - Right from the start

Decentral	Open Source	Standards (e.g. for interoperability)
Catena-X Automotive Network		
Neutral Governance	Ecosystem Kits	

and many more

Research	Transfer	Recycling	IoT / 4.0
OEM	Catena-X Automotive Network		Operators
1st-tier	n-tier	SME	Software

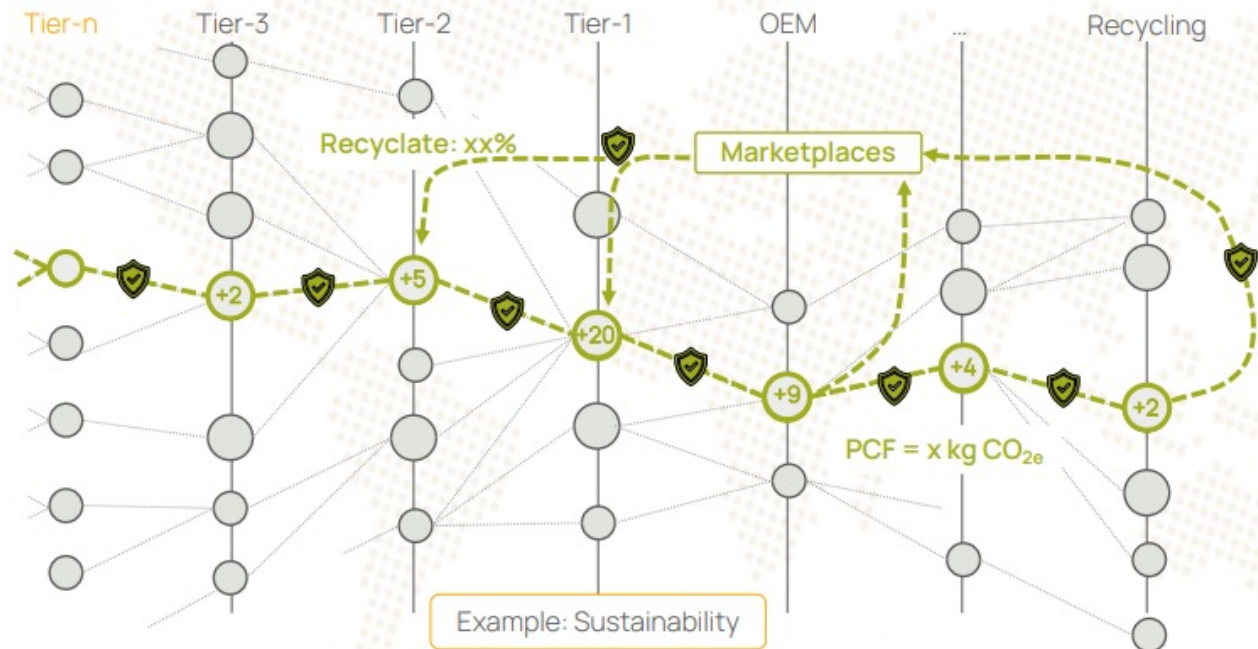
and many more

Catena-X Data Ecosystem

Build a **global data space** that can host our industry

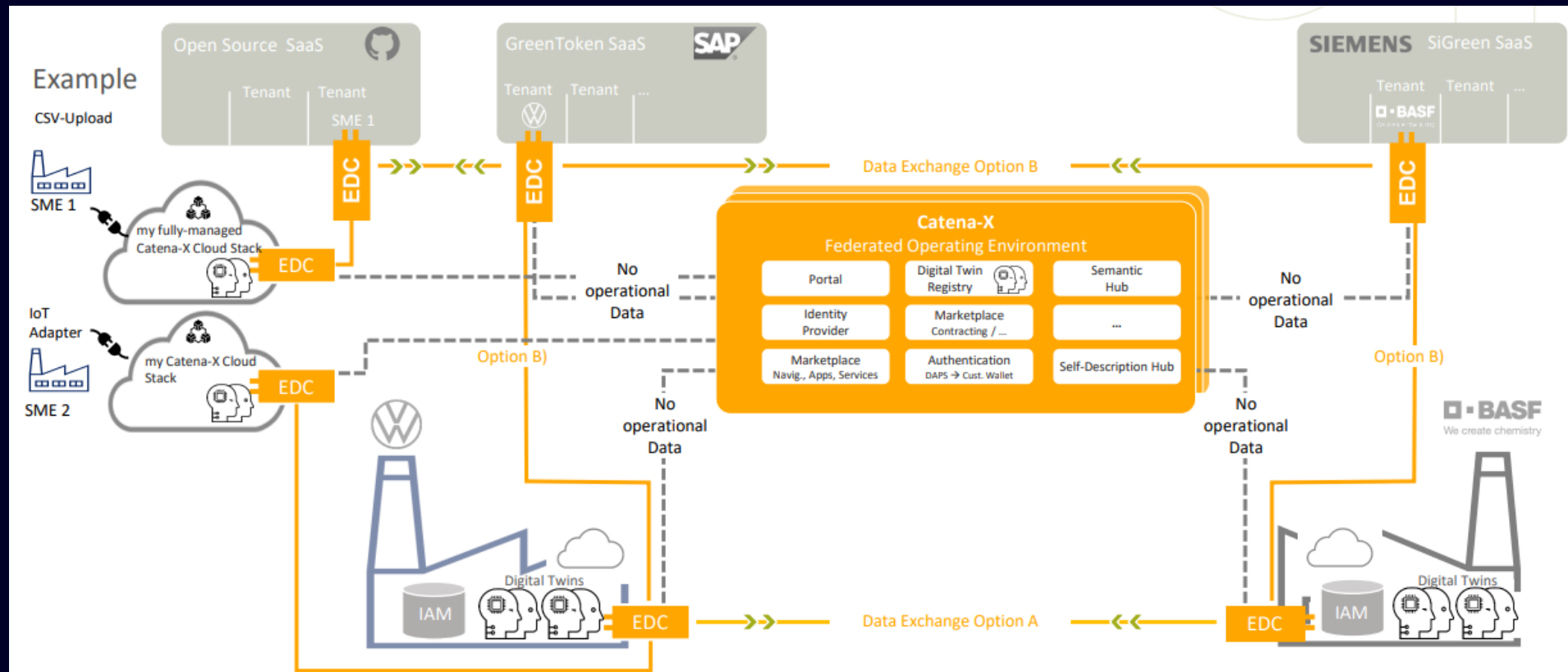


Create the first **data driven value chain**; incorporating all participants via **interoperable** and trusted solutions



How Catena-X Works – GAIA-X Ready Architecture

- Core assets: EDC, Portal



Use cases of Catena-X

Siemens participates and contributes to 8 of 10 use cases

Use Case Integration



Traceability	
Sustainability	
Circular Economy	
Quality Management	
Demand and Capacity Management	
Business Partner	
Data and model-centric Dev. & Operat. support	
Modular Production	
Manufacturing as a Service	
Online Control and Simulation	

■ Product teams with Siemens participation

■ No Siemens contribution

★ Top use cases



10 Initial Use Cases

Solutions to current top issues in the European automotive industry



One operating system

GAIA-X, Catena-X modules and services combined result in an operational overall system



Transfer & Scale Out

Activation and onboarding of users and providers, especially with a focus on SMEs

Tractus-X

Tractus-X: official open-source project for Catena-X under Eclipse Foundation ([Github](#)).

The screenshot shows the Eclipse Tractus-X GitHub repository page. The top navigation bar includes links for Overview, Repositories (77), Projects (26), Packages, and People (12). The main content area features a 'README.md' file with a welcome message and the Tractus-X logo, which includes the Eclipse logo and the text 'Tractus-X Where we build dataspaces!'. Below the logo is an 'About Us' section describing the project's mission and goals. To the right, there is a 'People' section with avatars of team members and a 'Top languages' section showing a bar chart for Java, Python, TypeScript, Go, and C#.

Overview Repositories 77 Projects 26 Packages People 12

README.md

Welcome to Eclipse Tractus-X 🤖

ECLIPSE
Tractus-XTM
Where we build dataspaces!

About Us

Eclipse Tractus-X is a collaborative, open-source project aimed at driving the digital transformation of the automotive industry and beyond. Our mission is to enable secure, efficient data exchange and seamless collaboration across the supply chain using trusted open standards.

Eclipse Tractus-X is the home of the reference implementations used in [Catena-X](#) and in several projects from [Manufacturing-X](#). The project develops solutions that foster interoperability between various stakeholders, providing an open ecosystem for data-driven applications. This includes reference implementations and models for **supply chain, compliance, sustainability and more**.

For the latest Tractus-X release, see the [Changelog](#) on our [webpage](#).

Our Vision

Our goal is to create open, scalable and secure reference implementations for a digital ecosystem in the automotive and many other industries that:

- Enable collaboration between suppliers, manufacturers, and partners.
- Facilitate transparency and sustainability in automotive industrial processes.
- Drive innovation across industries through open and community-driven standards.

People

Top languages

Java Python TypeScript Go C#

Tractus-X

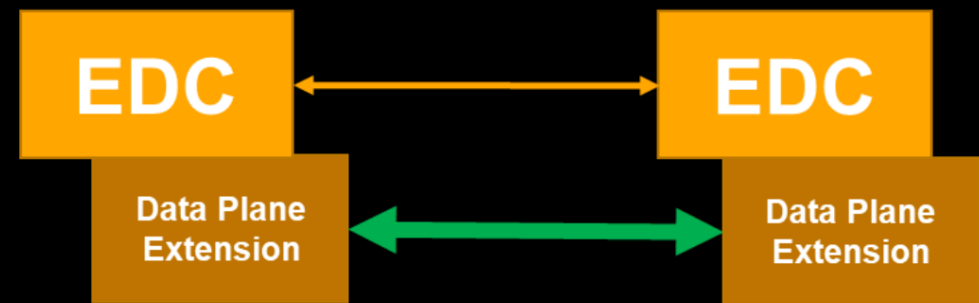
KIT, short for Keep It Together, offers open-source resources and comprehensive documentation designed for the use cases of Catena-X ecosystem.

Technically, it could be containerized images (Kubernetes based).

KITs ▾	Developer Hub	Tutorials	Co
Kits General			
Behaviour Twin			
Business Partner			
Circularity			
Connector			
Customs			
Data Trust & Security			
Data Chain			
Data Driven Quality Management			
Data Governance			
Demand and Capacity Management			
Digital Twin			
Eco Pass			
Environmental and Social Standards			
Industry Core			

Behaviour Twin KIT	>
Business Partner KIT	>
Circularity KIT	>
Connector KIT	▾
Changelog	
Adoption View	▾
Adoption View	
Working with Policies	
Policies in Catena-X	
Software Development View	>
Operation View	
Customs KIT	>
Data Chain KIT	>
Data Trust & Security KIT	>

while the actual data exchange then takes place via the appropriate channel extension. In this way, a highly scalable data exchange is made possible.

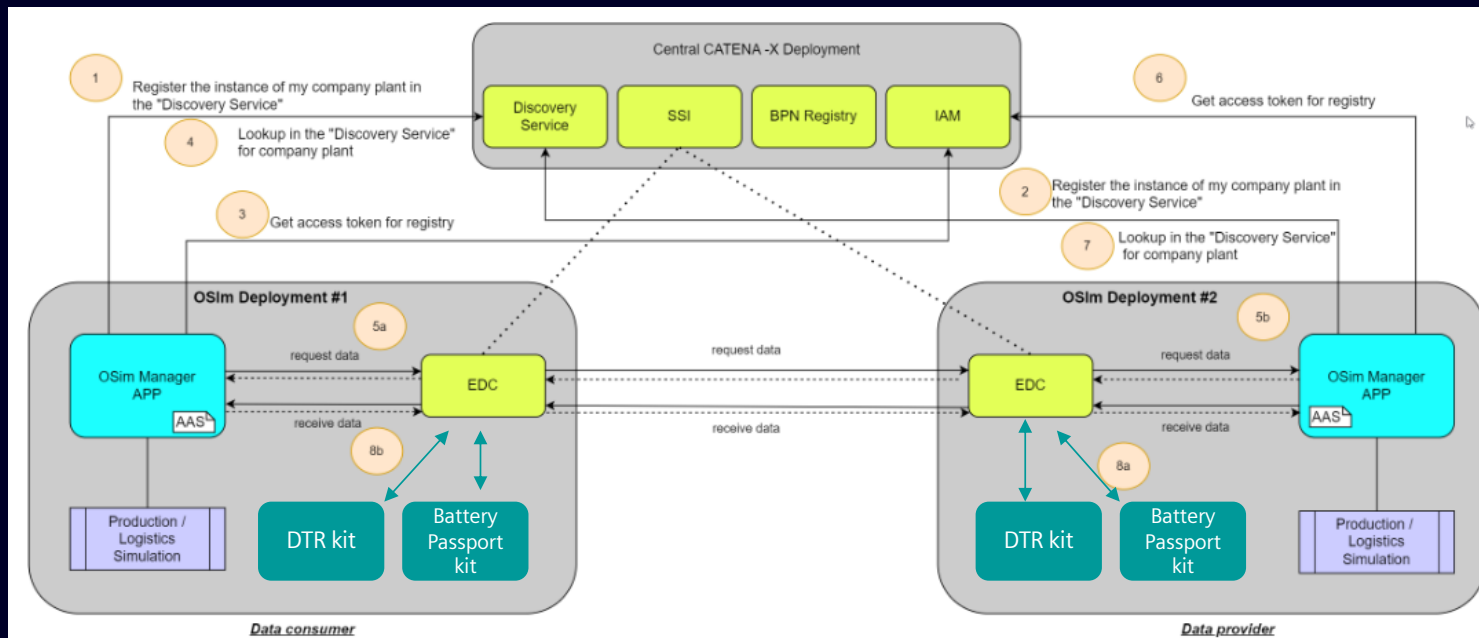


The architecture of the EDC combines various services that are necessary for the above principles:

- An interface to the Identity Provider service, currently IDSA's Identity And Trust Protocol communicating with the Managed identity Wallet. This central service provides the identity and the corresponding authentication of the participants in the data exchange. (There is no authorization at this point). Decentralized solutions will also be supported

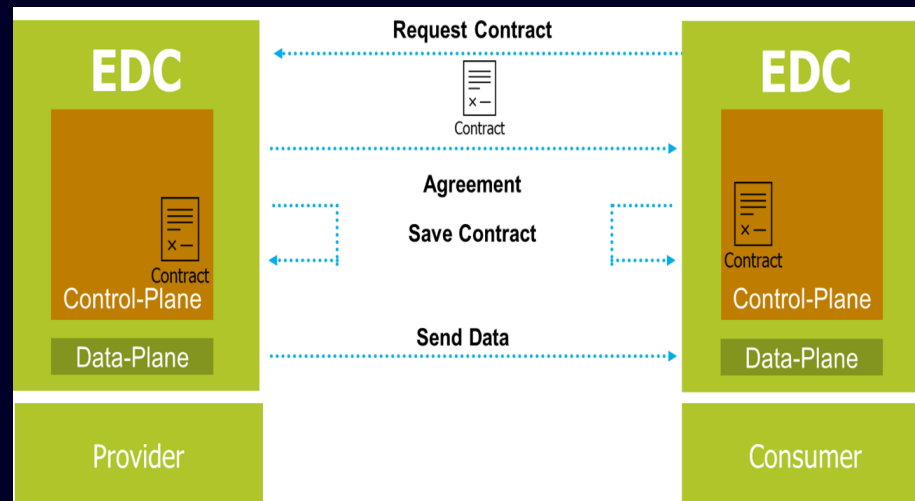
Tractus-X for Catena-X example

Open source kits deployed at data consumer/provider side exchange data to realize different use cases.



EDC Kit: Core of exchange between dataspaces

- **Control-Plane:** administration, resource management, contract negotiation and administer data transfer.
- **Data-Plane:** heavy lifting of transferring and receiving data streams.



❖ Control plane

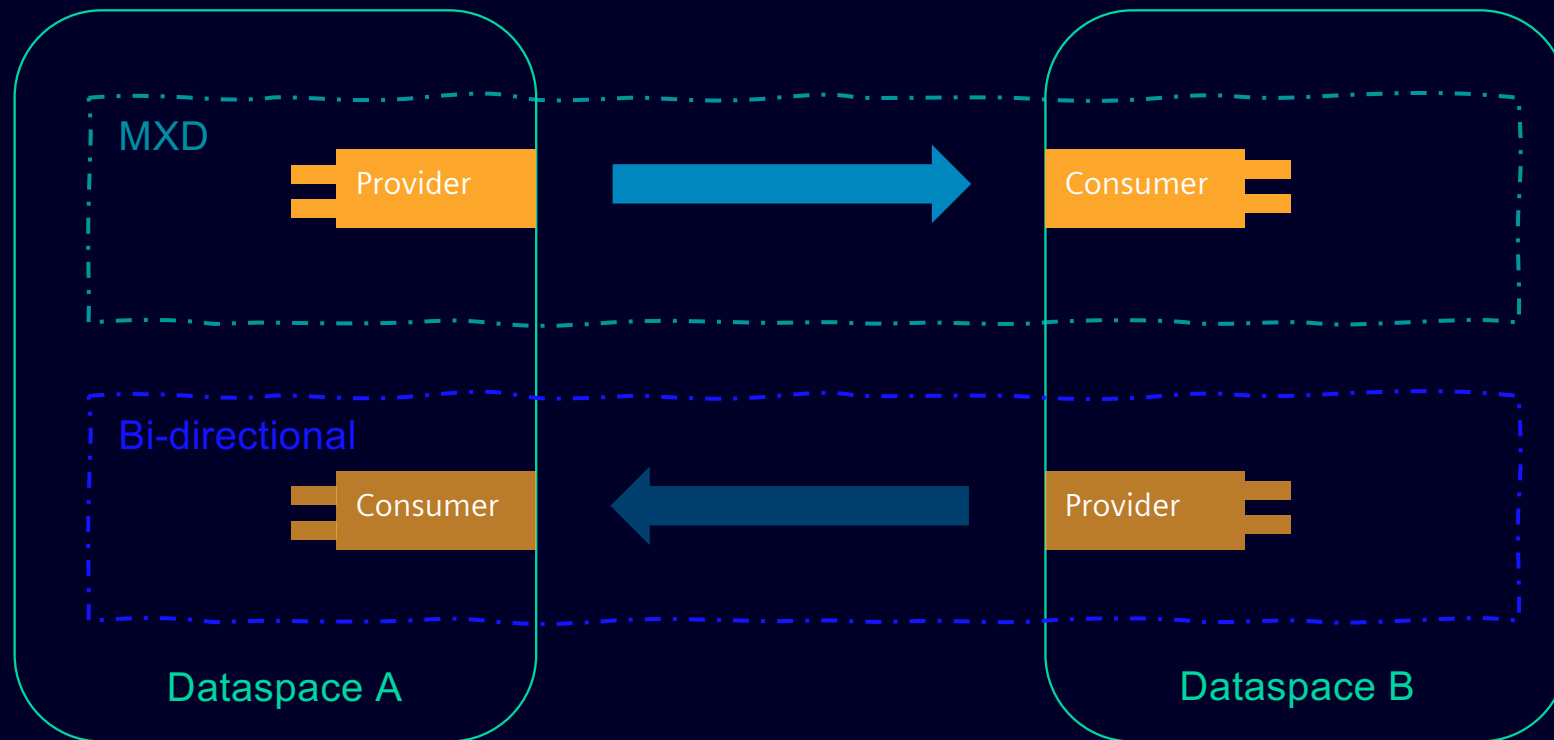
- **Asset:** stores only meta data, like dataAddress filed.
- **Policy:** Policies are used to express what requirements a subject (e.g. a communication partner) must satisfy in order to be able to perform an action. Policies are [ODRL](<https://www.w3.org/TR/odrl-model/>) serialized as JSON-LD.
- **Contract definition:** Contract definitions are how assets and policies are linked together, comprised of a contract policy and an access policy.
- **Catalog:** data offerings of a connector and one or multiple service endpoints to initiate a negotiation for those offerings.
- **Contract negotiation:** target one asset between a provider and a consumer connector.
- **Contract agreement:** both provider and consumer reached FINALIZED state. Final offer is approved always by provider.
- **Transfer process:** record data transfer.

❖ Data plane

- Url location of data

Tractus-X EDC and MXD (Minimum Tractus-X Dataspace)

- MXD: requires a provider EDC and a consumer EDC
- Bi-directional: additional corresponding provider EDC and consumer EDC

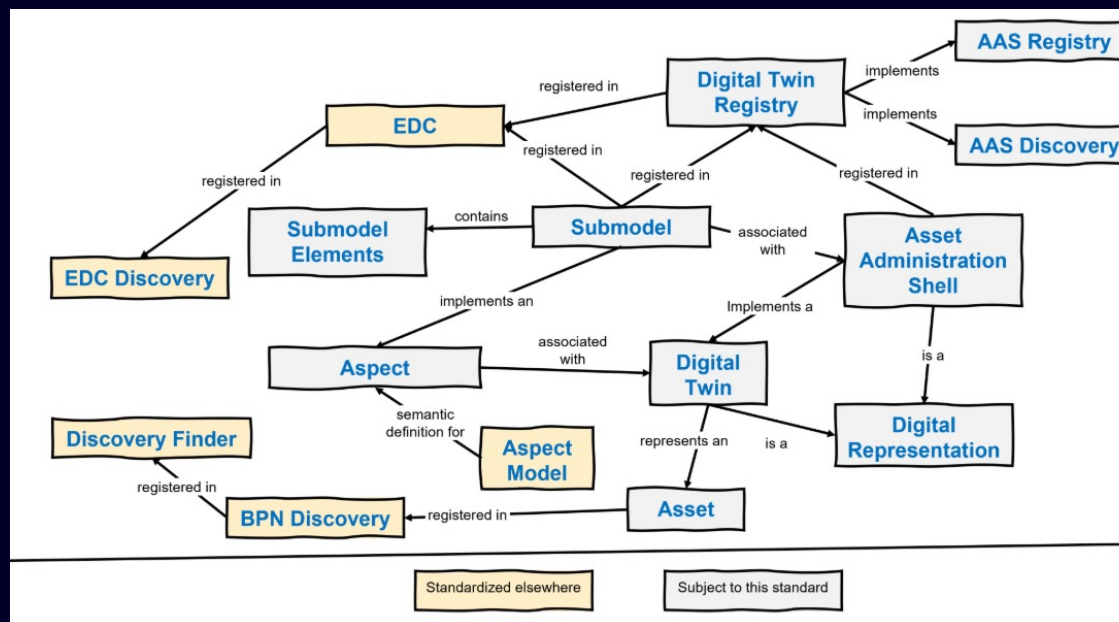


Digital Twin Kit: trace parts and materials across the entire value chain

Digital Twin (DT) describes a digital representation of an asset sufficient to meet the requirements of a set of use cases.

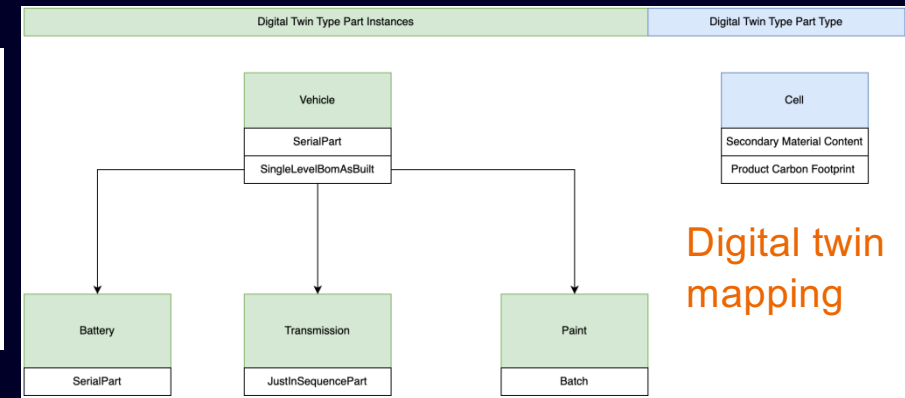
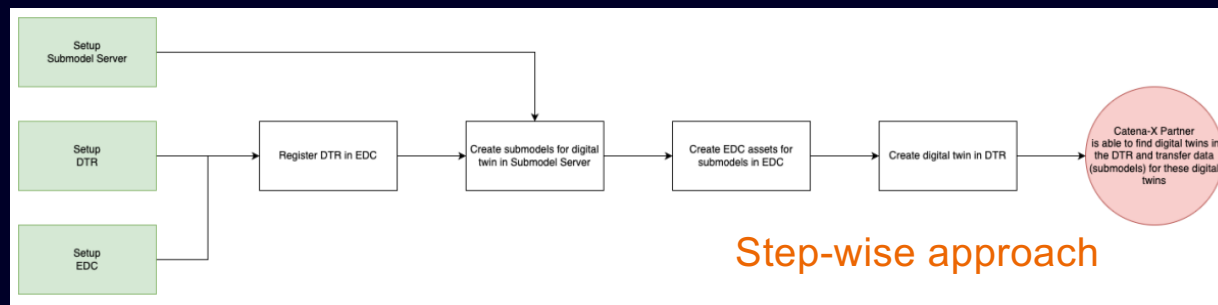
Digital Twin Registry (DTR) is an operated solution which lists Digital Twins and their respective Aspects.

Asset Administration Shell (AAS) is a key concept of Industry 4.0 (or "Industrie 4.0" in German), maintained by the Industrial Digital Twin Association (IDTA), and is used to describe an asset electronically in a standardized manner.



CATL Deployment @202412

- 1st real data exchange between automotive manufacturer(BMW) and battery supplier(CATL) for digital twin and battery passport use case.
- Tight schedule: very last week before 2024 Christmas.
- Battery passport digital twin example
 - Vehicle
 - Battery
 - Cell
 - Transmission
 - Paint



// Summary

With **open data** and **open source**, we can quickly integrate different companies around the globe.

This is precisely what **Catena-X** aims to achieve as an open and collaborative data ecosystem for the automotive industry. It leverages a shared global data space and an architecture built on open standards, including components like the Enterprise Data Catalog (EDC) and Digital Twin Registry, to facilitate seamless data exchange.

Furthermore, **Tractus-X**, a suite of open-source tools, actively supports Catena-X use cases, enabling scalable and transparent data flows. This approach tackles critical industry challenges like traceability, sustainability, and quality management, fostering rapid integration and collaboration across complex value chains, with Siemens actively participating in its development.

QA & Thank you!



Unrestricted | © Siemens 2025 | FT RPD CED INW-CN | Yang Shaopeng

SIEMENS