

TwInsider Session #2 - DT Federation with Data Space

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TwinEU

The background of the slide is a dark blue gradient with a complex network of thin, light blue lines connecting numerous small dots. Some dots are highlighted in a brighter cyan color, creating a sense of a dynamic, interconnected system.

TwinEU

DT Federation

The TwinEU Approach

The TwinEU approach towards Digital Twin federation

Digital Twin Federation: The enablement of multiple digital twins, developed by different stakeholders and platforms, to interoperate and share data and models in a standardized, synchronized, and semantically consistent manner to provide a holistic view of complex systems or ecosystems in the energy sector

TwinEU Digital Twin Federation is a **networked ecosystem of interoperable digital twins** that share, exchange, and reason over data through a **dataspace-oriented architecture**, ensuring semantic interoperability, data sovereignty, and trusted data exchange across organizational boundaries

TwinEU framework does not consider the federation as just technical interlinking—it is also a **governed, trust-enabled dataspace** that connects heterogeneous digital twins through **shared semantics, metadata, and policy compliance**

Rationale Behind the TwinEU Reference Architecture

Federated DT Framework



Address the need for a common and federated framework to enable interoperability among Digital Twins in the European energy sector

Cross-Border Coordination



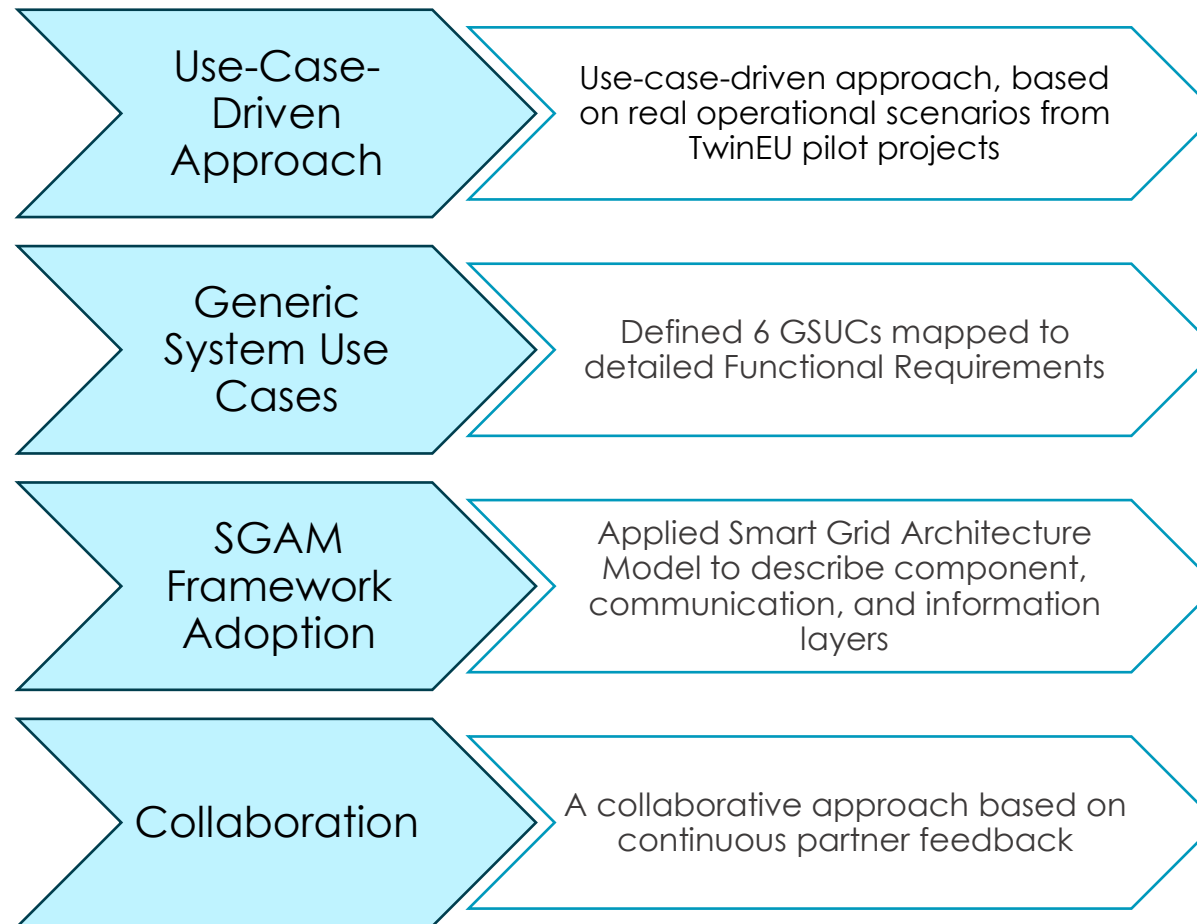
Facilitate collaboration among heterogeneous actors and support cross-border, pan-European coordination while preserving each operator's autonomy in their local or national context

European Initiatives Alignment



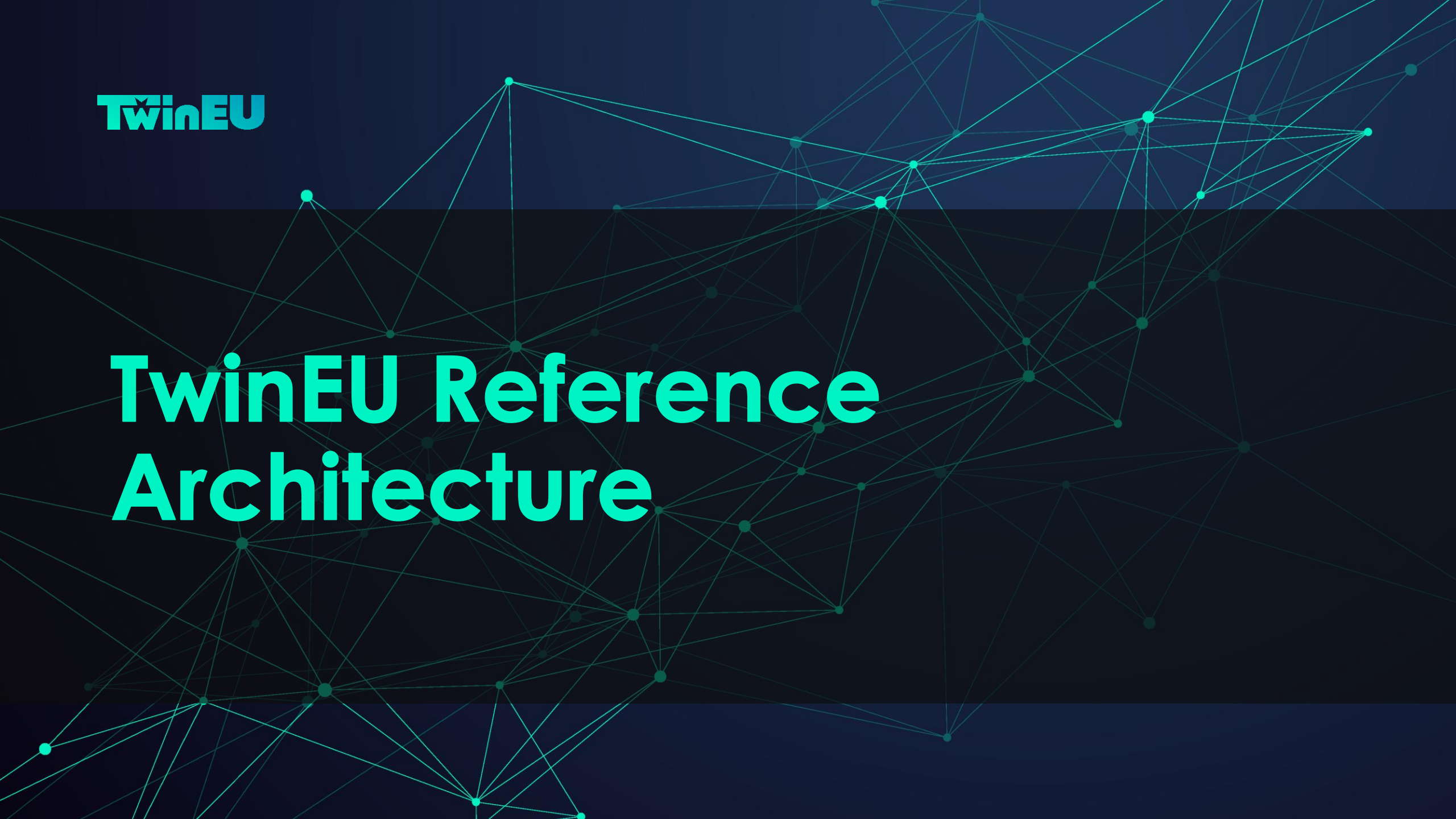
Ensure compatibility with GAIA-X, European Data Spaces, and IDS frameworks

Design approach to the TwinEU RA

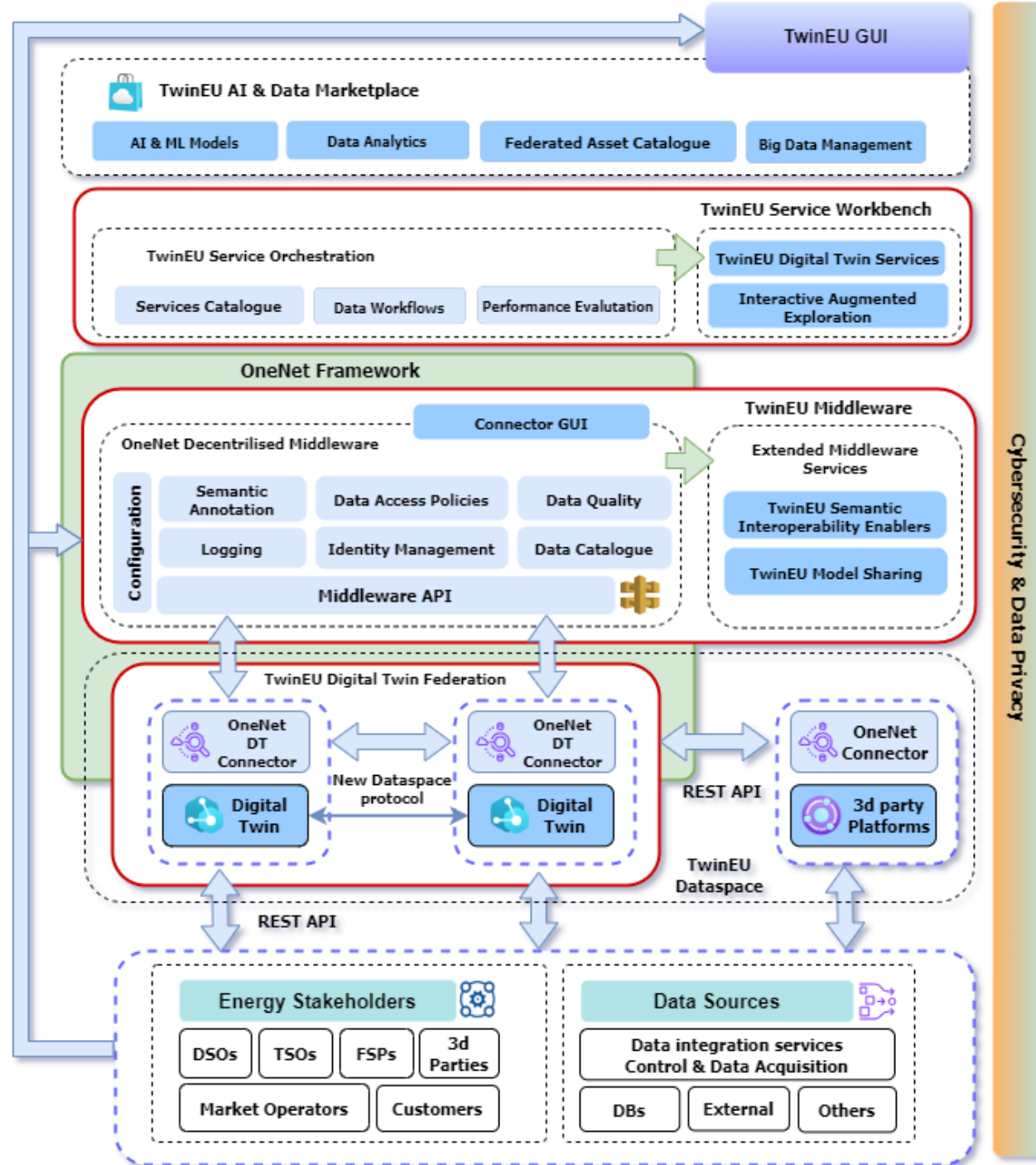


The TwinEU logo is located in the top left corner. It consists of the word "TwinEU" in a bold, white, sans-serif font. A small white star is positioned above the letter 'i' in "Twin".

TwinEU

The background of the slide is a dark blue gradient with a complex network of white lines and dots. The dots, representing nodes, are scattered across the frame, and the lines, representing connections, form a dense web that fills the background. The overall aesthetic is technological and interconnected.

TwinEU Reference Architecture



AI & Data Marketplace

AI/ML Models, Data Analytics and Big Data Mgmt supporting DT development

Service Workbench

Provides TwinEU DT services and AR Exploration module

Federation Layer

DT Connector embedded in each Digital Twin **Middleware** providing Data Quality, Data Access Policies, IDM, Semantic Interoperability, Data/Model sharing and Data catalogue

DT Layer

External DTs managed by energy stakeholders (TSO, DSO, etc.), outside the TwinEU platform

Core Reference Architecture Pillars

Federation of Digital Twins

Enable **secure, decentralized collaboration among energy stakeholders** by orchestrating interoperability between their Digital Twin systems

Data Spaces Integration

Implement the core principles of European Data Spaces, ensuring **secure, sovereign, and policy-driven data exchange** between energy stakeholders.

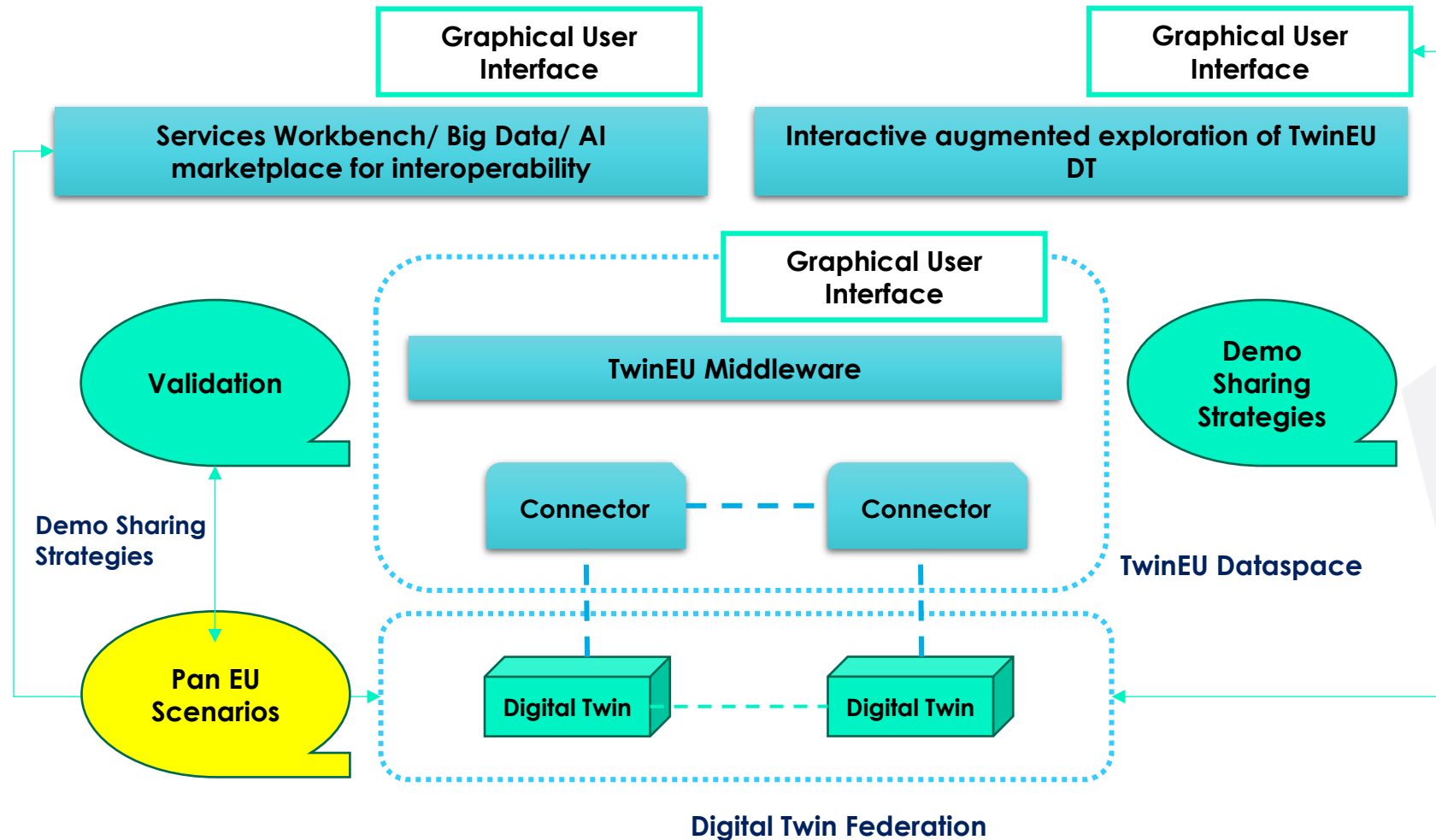
Model Sharing and Reusability

Facilitate the reuse and exchange of **Digital Twin models** across domains and applications through standardized interfaces

Semantic Interoperability

Ensure semantic alignment of exchanged data by adopting **common vocabularies, ontologies, and data models**

Reference Architecture simplified



The TwinEU logo, featuring the word "TwinEU" in a bold, white, sans-serif font. A small white star is positioned above the letter 'i' in "Twin".

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TwinEU Middleware

DT Federation Layer

TwinEU Middleware in the TwinEU digital ecosystem

The TwinEU middleware: A scalable, unified platform for federated Digital Twin integration which enables data and model sharing

Component Integration

Digital Twin Federator connects tools, services, platforms, and DTs within the TwinEU Middleware Platform, ensuring data and model sharing

Data Management

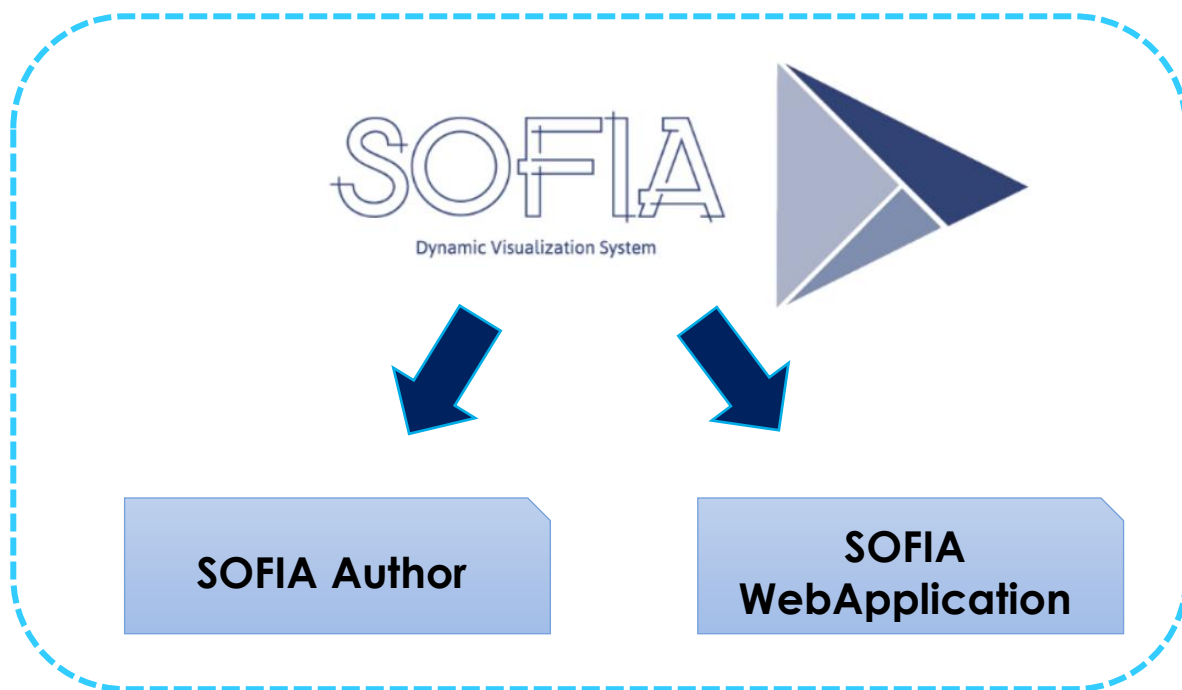
The middleware supports managing data, models, and resources, ensuring alignment with Data space reference architecture models

Service integration

Enables access to data and services for energy stakeholders

TwinEU Middleware development

TwinEU Middleware development is based on European Dynamic's Web Application Generator platform **SOFIA**



SOFIA comprises of two sub-modules: The **Author Application** which is used to dynamically configure the presentation of the data, the menus, graphs, and user access and the **Web Application** which visualizes the data in various configurations and graphics. It is built on **JAVA Spring boot, Angular, Redis, MySQL** Databases and **Docker** technologies.

➡ **TwinEU Connector
Graphical User Interface**

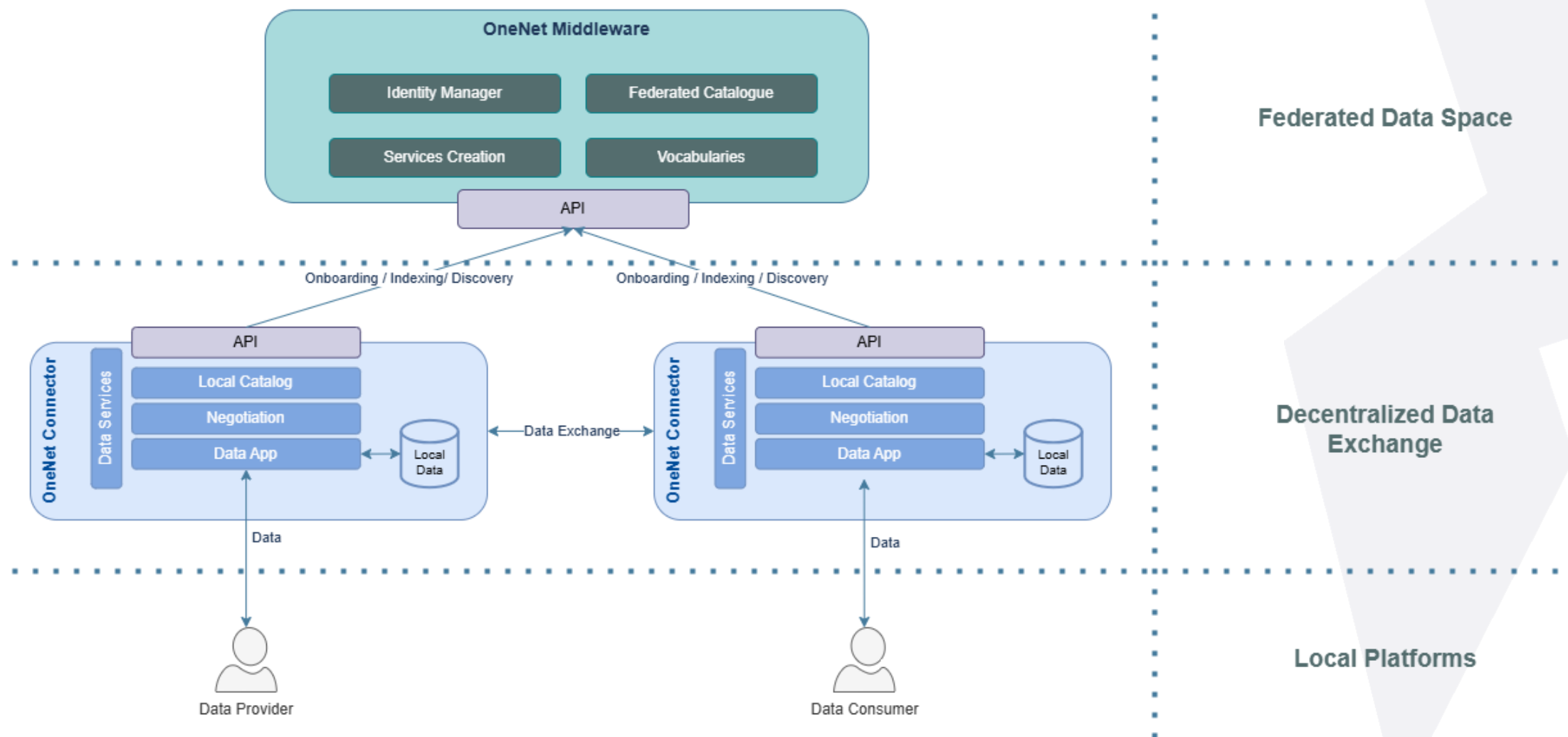
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TwinEU Connector

The Data Space enabler

Decentralized Data Space



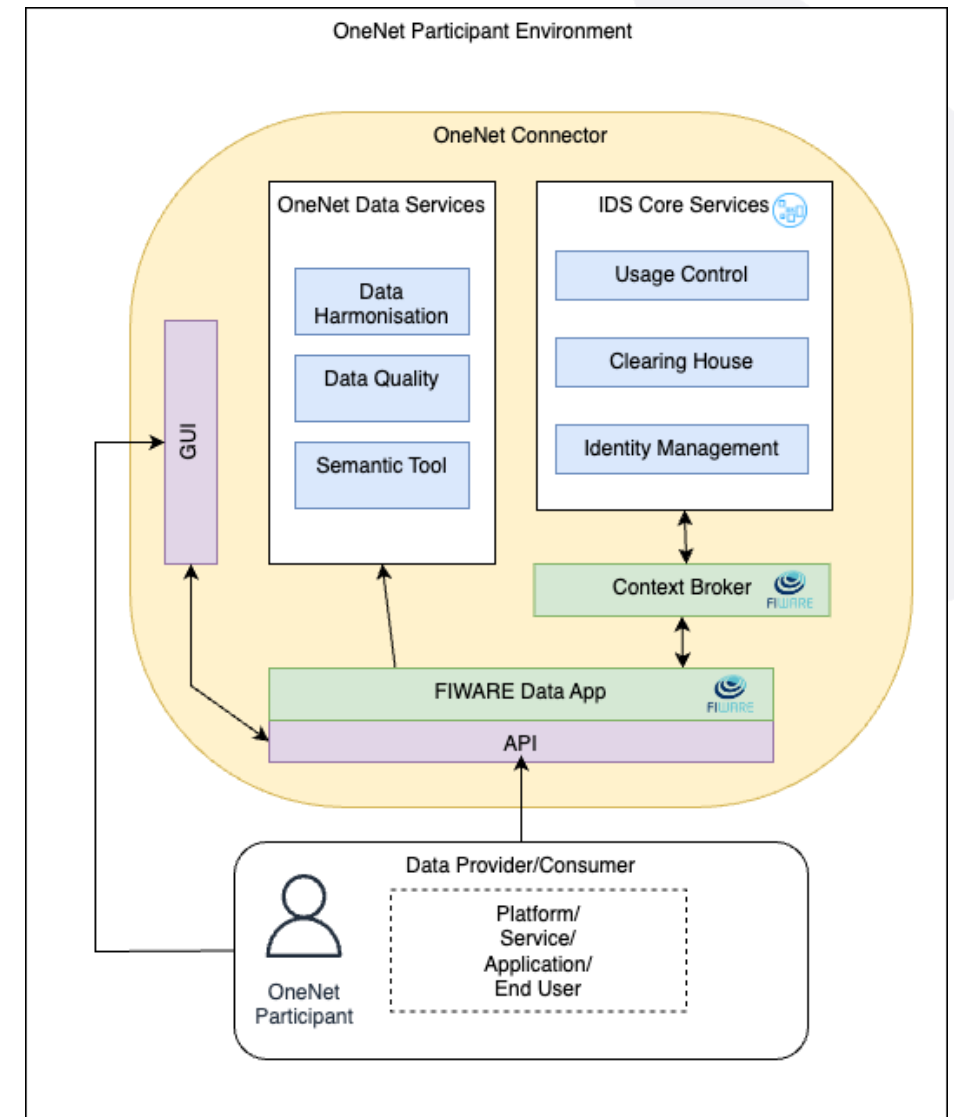
Starting Point: OneNet

Main Characteristics

- + FIWARE Context Broker fully integrated in the Connector Architecture
- + Additional Data Services (e.g., CIM Data Harmonization Tool)
- + Standardized Interfaces
- + Open GUI for facilitating the Connector usage

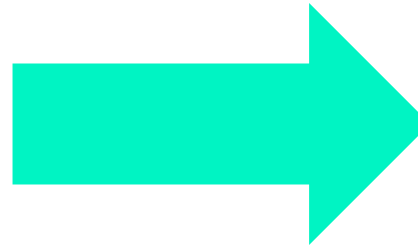
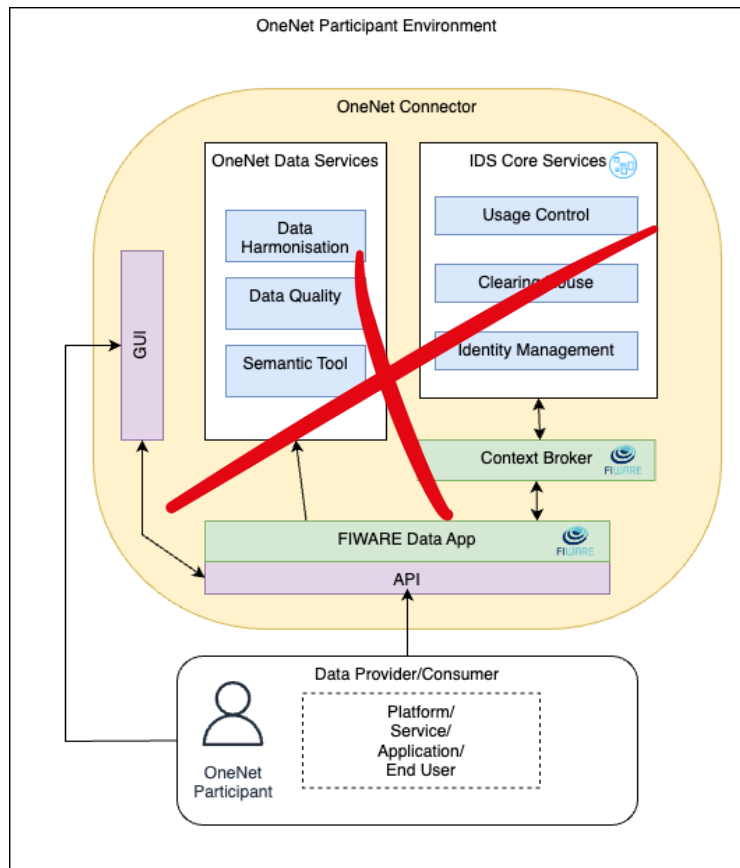
The energy context... Tailoring for Energy Domain

- + 10 services categories
- + 64 energy services
- + Vocabularies adoption

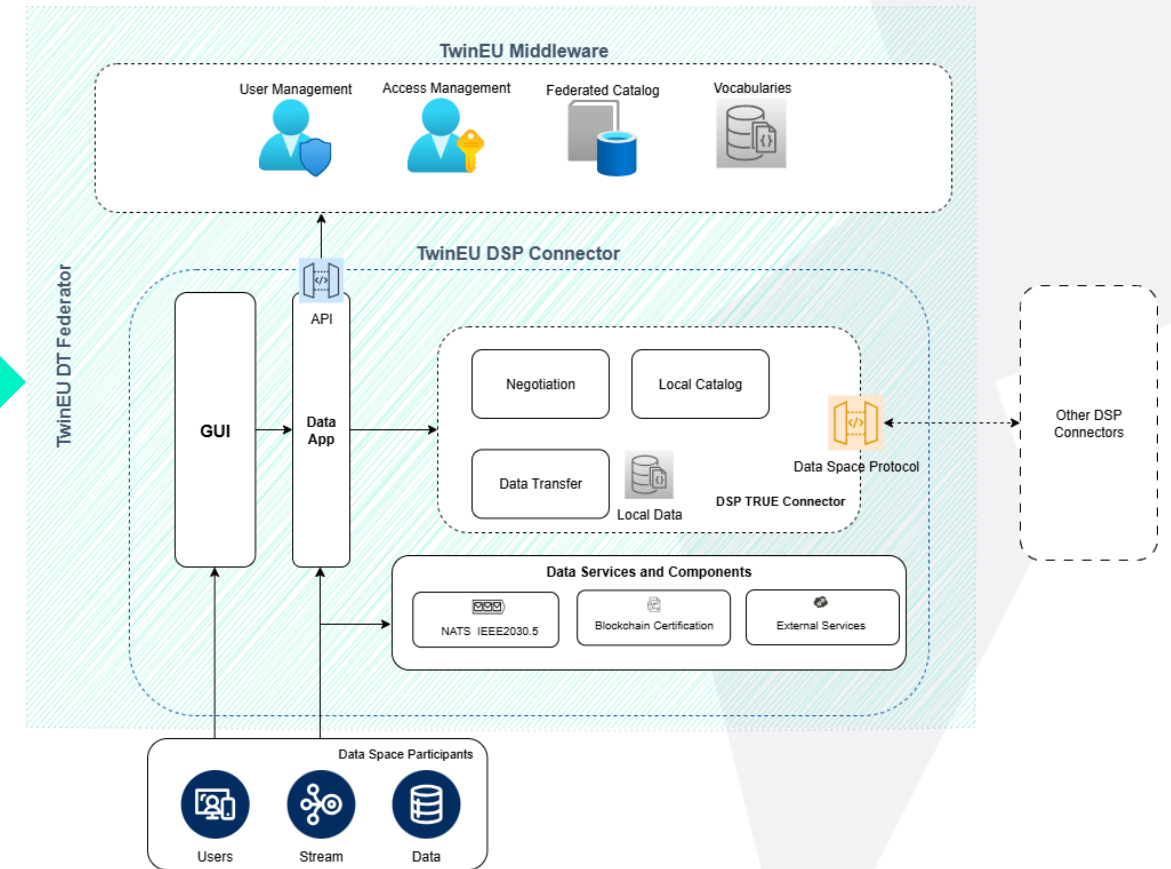


TwinEU Evolution

From OneNet Connector...



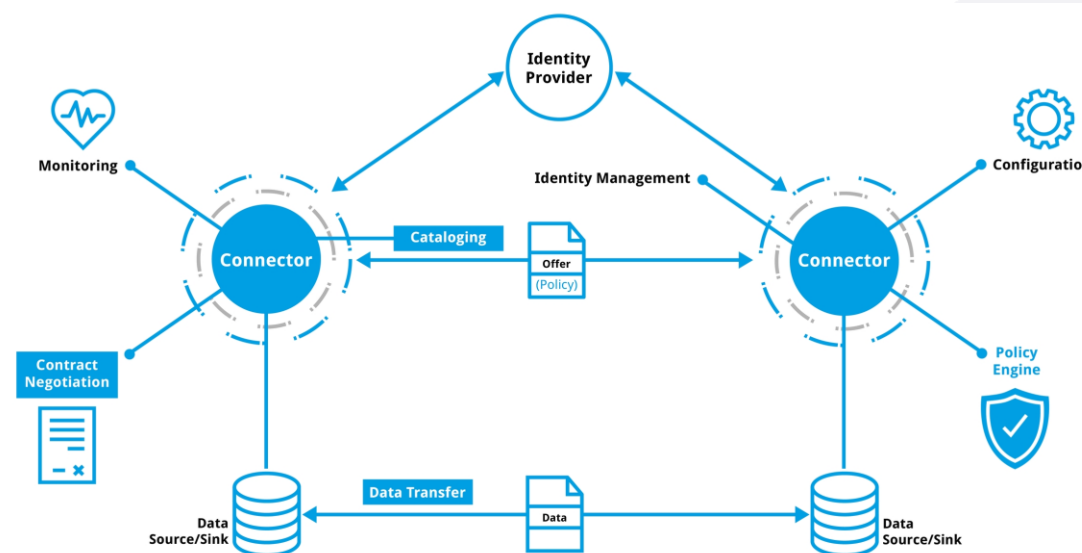
...to TwinEU **DSP** Connector



Data Space Protocol

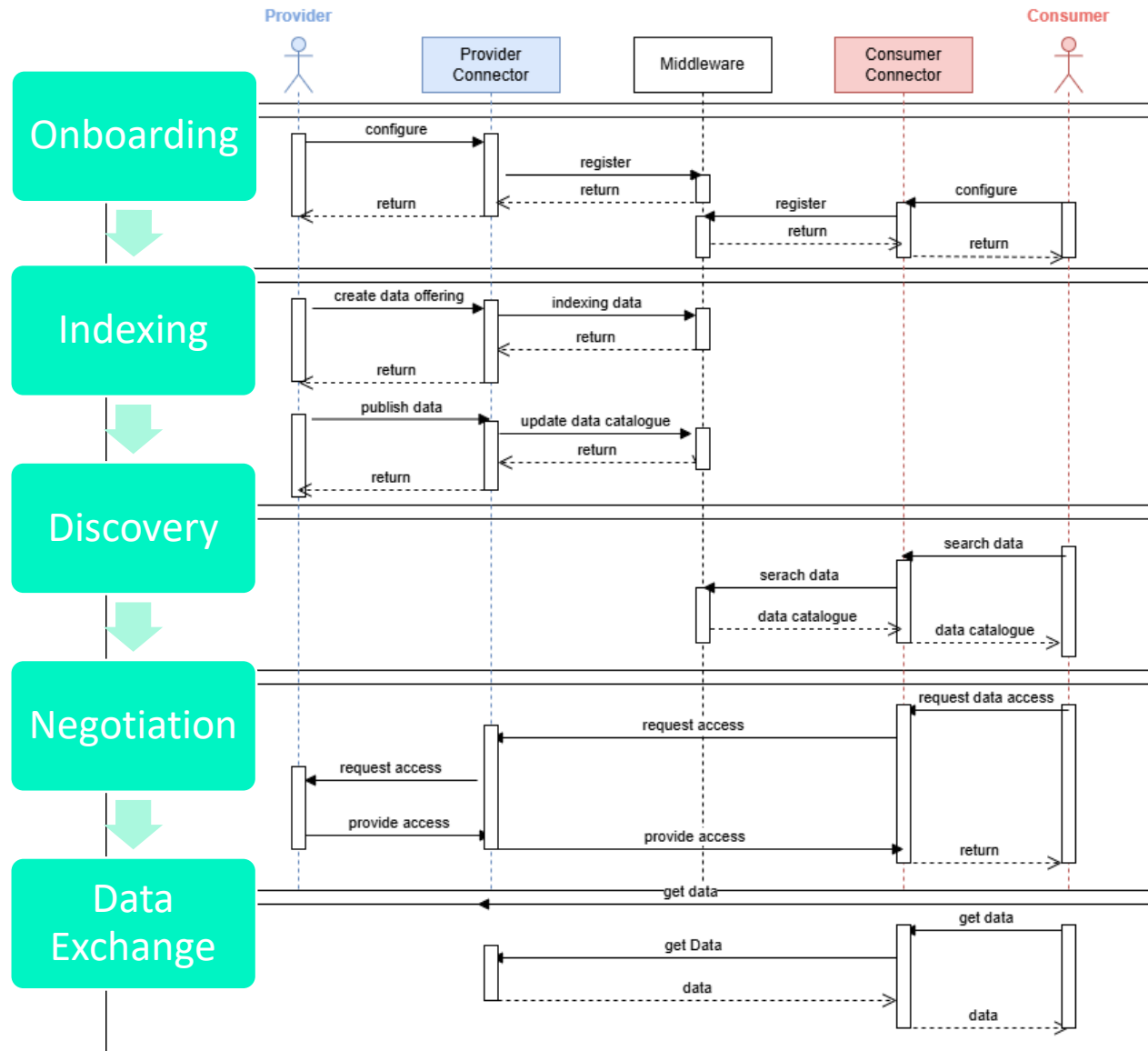
The **Dataspace Protocol** is a set of specifications designed to facilitate interoperable data sharing between entities governed by usage control and based on Web technologies. These specifications define the schemas and protocols required for entities to publish data, negotiate Agreements, and access data as part of a federation of technical systems termed a Dataspace.

The Dataspace Protocol is used in the context of Dataspaces with the purpose to support **technical interoperability** across **Data Spaces**



[Dataspace Protocol 2024-1 | IDS Knowledge Base](#)

Main processes



Additional Features

- + **Integration of external services (Push Mechanism)**

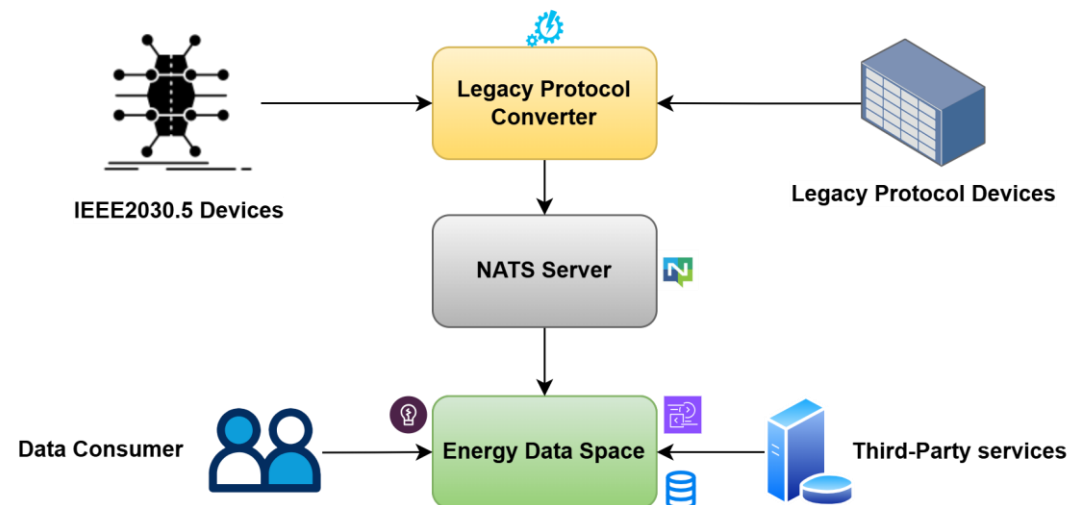
- + Provide data to external service in a (near) real-time way, maintaining the features related to the Data Space

- + **Blockchain Transaction Notarization**

- + Logging and Certification of data transaction in an immutable and secure way

- + **New Standards (IEEE2030.5) and real-time communication protocols (NATS)**

- + Integration of new standards and protocols for a wider support



Next

- + **Submission under LFE (ongoing with OneNet)**

- + Creation of technical community for continuous development and maintenance

- + **Technical and Semantical Interoperability**

- + Extensions of Vocabularies and Standard Data Models

- + **Support to real-time communication**

- + Additional Communication protocols and mechanisms (e.g. Kafka)

- + **Common European Energy Data Space (CEEDS)**

- + Integration and deployment with other DS Technologies (DSP Connectors, EDDIE, SIMPL...)



Thank you!

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