TWIN IOTA

Building with TWIN

2nd Webinar

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Agenda

1. Intro & TWIN Initiative Updates
2. TWIN in Depth Recap
3. Educational Case of Study
4. TWIN Hands-On
5. What’s Next?

Intro & TWIN Updates

TWIN Foundation

TRADE MARK AFRICA

TONY BLAIR INSTITUTE FOR GLOBAL CHANGE

CHARTERED INSTITUTE OF EXPORT & INTERNATIONAL TRADE

WORLD ECONOMIC FORUM

GLOBAL ALLIANCE FOR TRADE FACILITATION

IOTA FOUNDATION

Oversee the open source development, drive public partnerships and engage governments.

Learn about the initiative:

www.twin.org

Learn about the technology:

www.twindev.org

TWIN Ecosystem
Trade & Logistics Information Pipeline

Since 2020, TradeMark Africa and the IOTA Foundation have deployed TWIN technology in East Africa through TLIP, connecting Kenyan exporters, logistics firms, and government agencies. Integrated with the Kenya Revenue Authority, KenTrade, the Kenyan Single Window System, TLIP streamlines digital trade data exchange, ensuring secure and transparent access.

Powered by TWIN

Faster, Error-Free Trade

TWIN enables TLIP to accelerate cross-border goods movement and eliminate errors through touch-free document and data sharing.

Seamless Integration

Open, interoperable interfaces connect government agencies with private sector platforms for end-to-end trade digitalization.

Real-Time Access & Accuracy

Traders receive critical trade documents instantly, while authorities make informed decisions with consistent, reliable data.

Created in partnership with

Kenya Revenue Authority · KenTrade · KEPHIS · AFA · TradeMark Africa · IOTA

TWIN Ecosystem

A growing ecosystem of industry consortiums powered by TWIN

UK Border Trade Demonstrators 2

TWIN was trialed by UK government departments and border authorities under the Ecosystem of Trust and Border Trade Demonstrators, proving its ability to streamline data capture across various goods and enhance border efficiency.

Virtual Watch Tower

The Virtual Watch Tower is a community-driven network that connects individual monitoring hubs to enhance visibility across supply chains. It leverages TWIN's digital infrastructure to enable seamless data exchange, transparency, and collaboration in global trade.

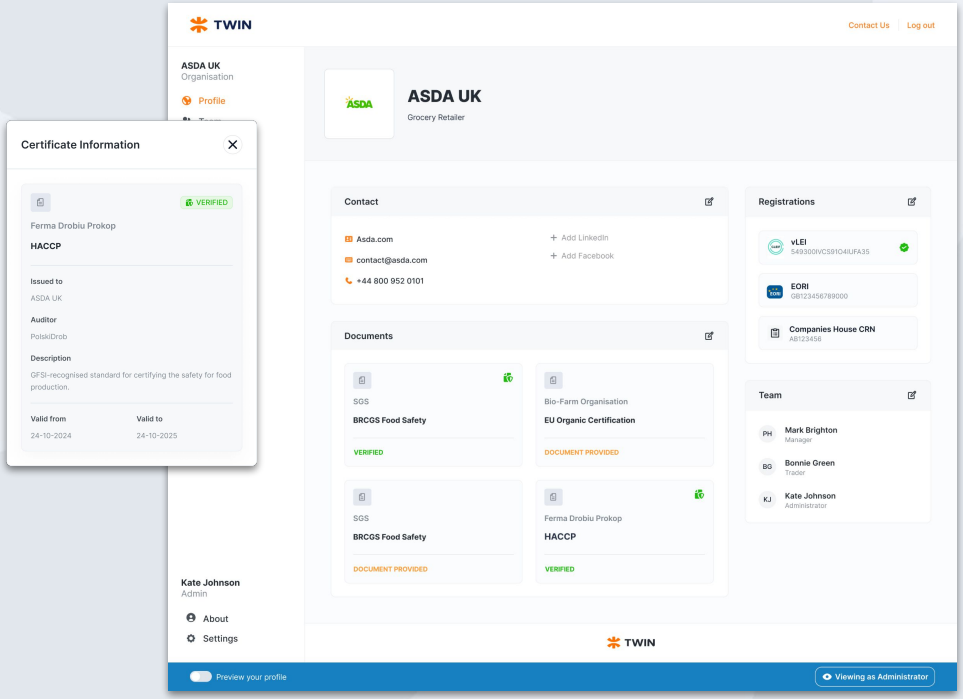
MISSION

The EU-funded MISSION (Maritime Just in Time Optimization) project uses TWIN to optimize maritime traffic by reducing port congestion and fuel consumption. TWIN facilitates connectivity with existing systems while ensuring security and auditability of shared maritime data.

RESULD

The Responsible Supply Chains and Logistics Due Diligence (RESULD) consortium digitizes plant-based products trade from Kenya to the Port of Rotterdam, using TWIN to enable collaboration across systems and establish an end-to-end data pipeline, ensuring traceability and trust.

TWIN & GLEIF Partnership



Key points

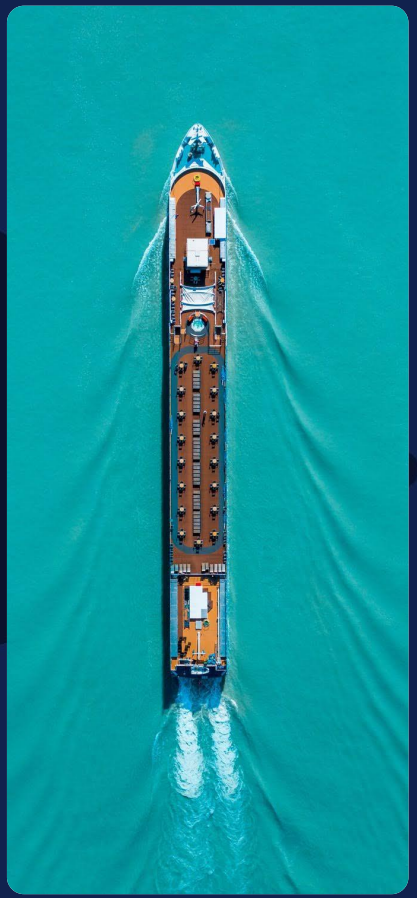
- **GLEIF: Global Legal Entity Identifier Foundation**
- **LEIs:** Legal Entity Identifiers
- **Directory:** open data access for for regulators, business and public
- **Transparency:** verify who is who
- **vLEI:** Verified LEI

TWIN Tech in depth (recap)

TWIN Architecture (Why)

Value Chain Ecosystems. Decentralization. Self-Sovereignty.

- Transparent **rules** (governance) to participate in:
  - Who are the trust anchors that can perform attestation
  - Schemas, default policies, ...
- A commoditized **software agent** that can expose the data / documents that want to be shared through a common **protocol**
- **Discovery** of: Participants, the data they offer and the software agent that expose it (on the Internet)
- **Rights management**: Policies that express which data is shared to whom and under which conditions
- **Authentication**: Participants prove their identity and attributes without a priori knowledge among them
- **Verifiable data**, as data is not in a central place, but directly controlled by each participant
- **Evolution** not revolution → We want you to reuse your existing maturity level 2 assets and classic ones that were adopted years ago



Key Definitions

1 TWIN Ecosystem

A value / supply chain ecosystem composed of: the governance (rules) and infrastructure (software + hardware).

2 Participant

An actor that participates in a TWIN ecosystem → Identified by a DID. Roles: Operator, Provider, Consumer → Of Services.

3 Trust Anchor

Parties properly accredited to be trustworthy anchors to digitally sign statements or claims about an object.

4 Compliance Credential

A Verifiable Credential that attests that a Participant or Service is compliant with the rules defined by a TWIN Ecosystem.

5 TWIN Node

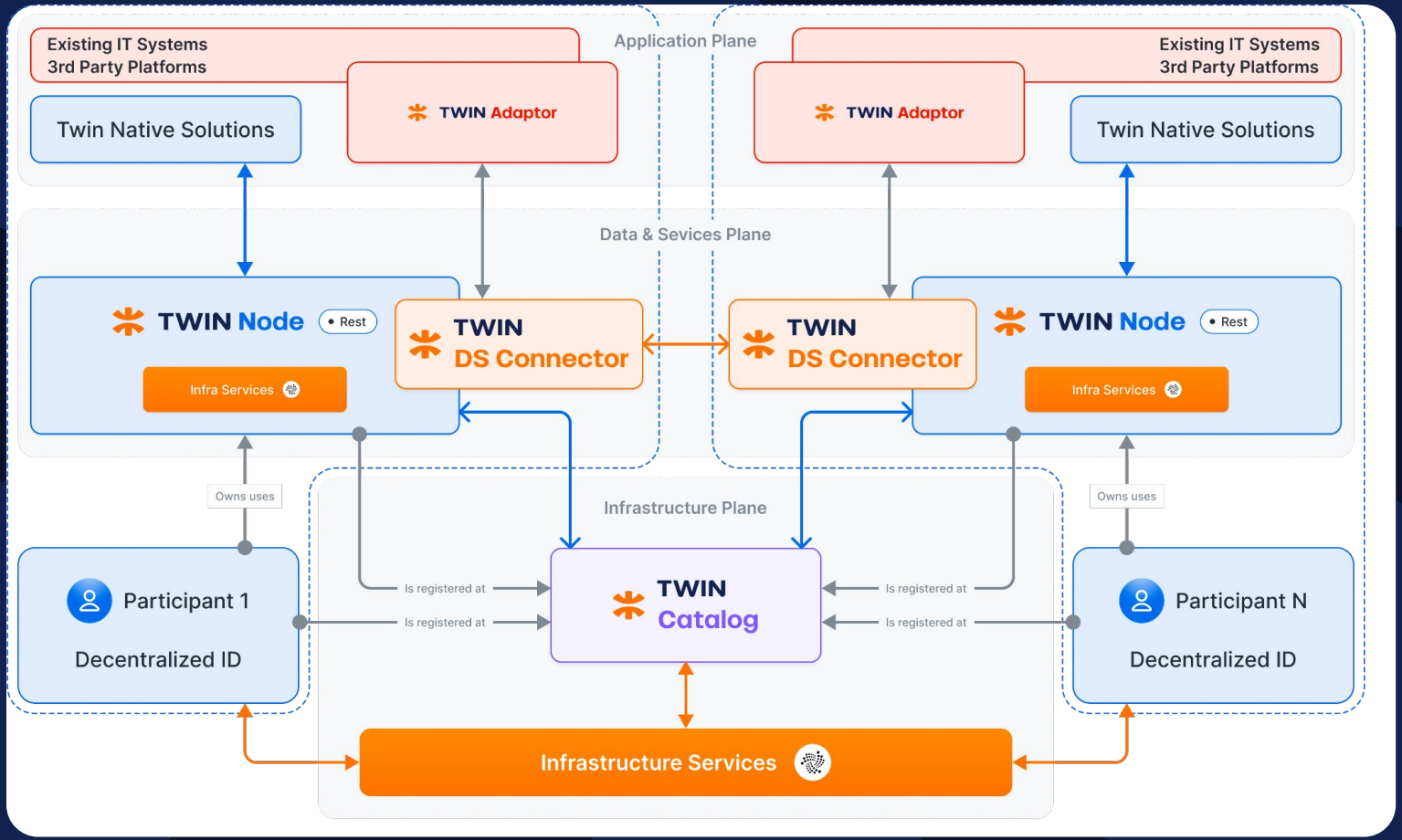
Software (Agent) that enables Participants to interact within a TWIN ecosystem.

- DLT Node (IOTA, IPFS) ⊆ TWIN Node
- TWIN DS Connector ⊆ TWIN Node

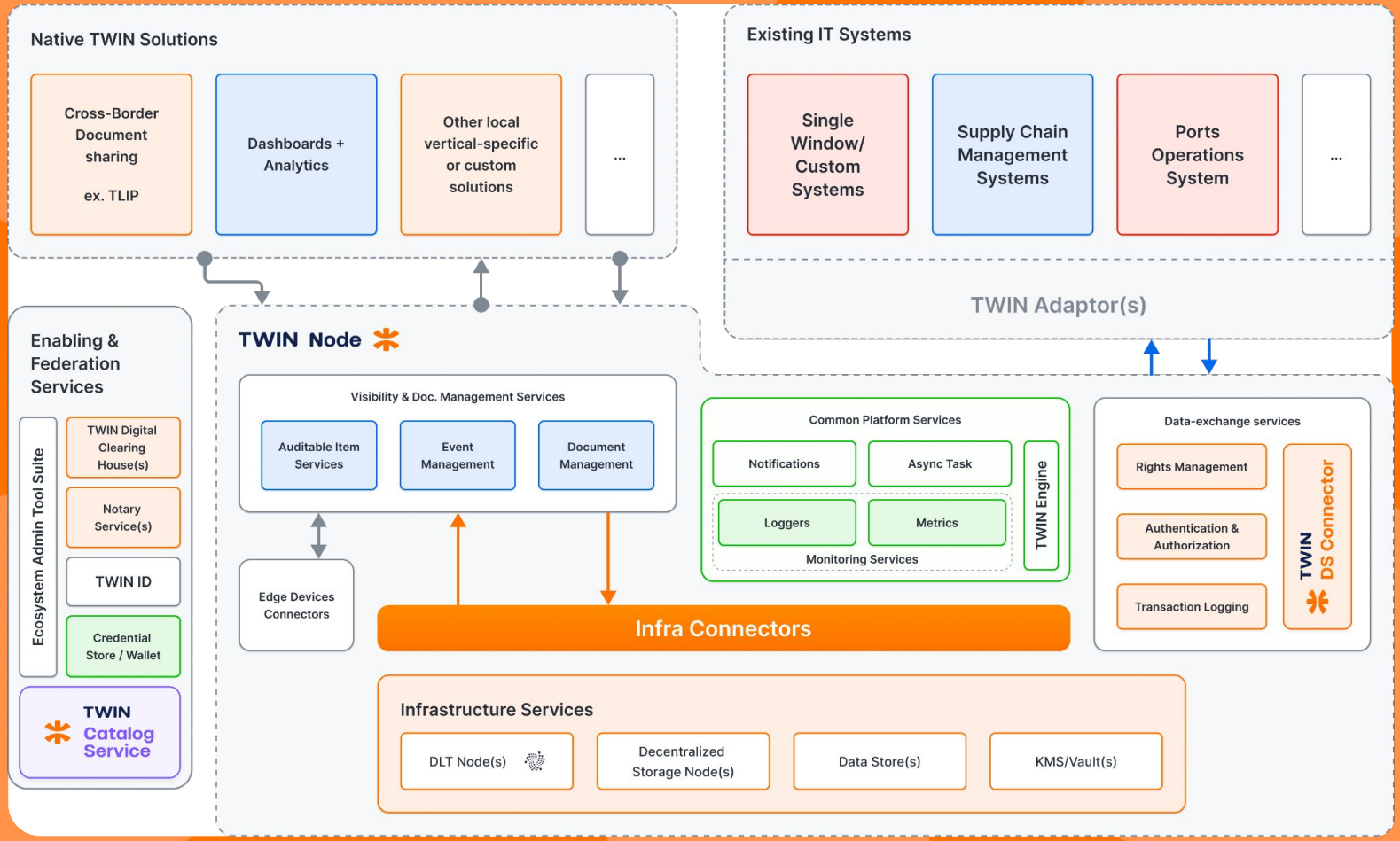
6 TWIN Data App

Self-contained, self-descriptive software package that can be distributed and deployed to extend the functionality of a TWIN Node.

High Level Architecture



Anatomy of a TWIN Node



Key Services and Frameworks

1 Decentralized Trust Framework

Attests participants' and Service attributes and enabling **seamless onboarding** and interaction without a priori knowledge.

2 Federation Services

Enable the clearance, publication and **discovery of participants** and the **services** they publish, allowing for federated decentralized interactions.

3 Visibility Services

Encompass **auditable** (through DLT connectors) **object representations** as a digital twin through its properties, relationships, business events (GS1 EPCIS 2.0) and related resources (e.g., associated documents or external data resources).

These services are **application-agnostic**, based on open standards (notably Linked Data Vocabularies from schema.org, GS1, and UN/CEFACT) and REST APIs.

4 Document Management Services

Facilitate **document storage** (multi-version), document **resolution**, document **traceability** and **authenticity**, data extraction and document transformation, including multiple representation as per different industry standards (W3C VC, eInvoice, eBill of Lading, etc.).

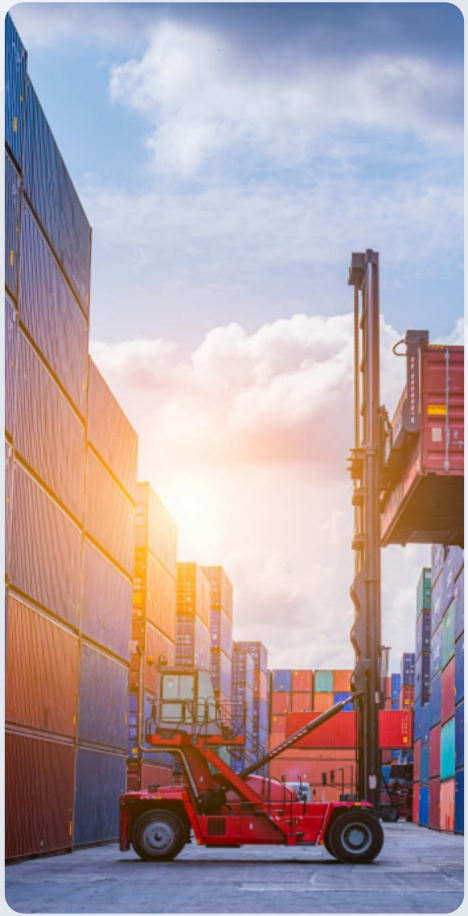
5 Data Exchange Services

Facilitate data (or document) exchange among the different ecosystem participants. The main enabler on the "TWIN Node" side is the "**TWIN Dataspace Connector**" which publishes REST endpoints that allow participants to publish and subscribe to "**supply/value chain activity**" information.

TWIN Key Use Cases

What Are the Key Use Cases for TWIN?

- **Document and data exchange** in international trade, e.g., providing advance information throughout a consignment journey, including digital trade certificates to pre-clear consignments, minimising the frequency of manual document and physical inspections, and facilitating **trade finance** instruments.
- **Environmental and sustainability compliance**, declarations, and assessments can be supported with traceable evidence – particularly in cases such as critical raw materials or capturing deforestation surveillance monitoring data – facilitating the issuance and exchange of **Digital Product Passports**.
- **Supply chain visibility and optimization**, by increasing transparency and enabling data exchange and data verifiability through the use of Data Spaces and immutable ledger entries.
- ...



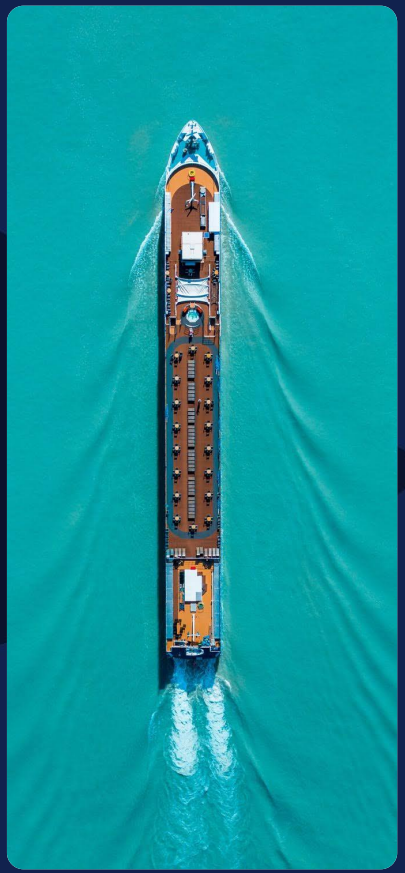
TWIN as the Substrate of EU DPP Systems (I)

DPP Challenge	CEN/CENELEC Standard	TWIN Asset	Comment
Unique identification	prEN 18219	Auditable Item Graph *(complemented with a Digital Link resolver)*	AIG manages the digital twin associated to each product uniquely identified. A TWIN-based DPP solution needs to also deploy a DL resolver
Data Carriers	prEN 18220	Edge Device Connectors	To bridge the physical world with TWIN
access rights management, information system security, and business confidentiality	prEN 18239	Rights Management components.	Through W3C ODRL policies businesses can keep confidentiality in a flexible and extensible manner.
System interoperability	prEN 18223	Linked Data native support	TWIN facilitates semantic interoperability and compliance with sector-specific regulations

TWIN as the Substrate of DPP Systems (II)

DPP Challenge	CEN/CENELEC Standard	TWIN Asset	Comment
Data exchange protocols	prEN 18216	Data Space Connector. OID4VP for authn.	DPP actors can exchange data through a RESTful API using JSON-LD. Common authentication mechanisms based on OID4VP and IOTA.
data storage, archiving, and data persistence	prEN 18221	AIG, Document Management components Data store / object store connectors	Maximum flexibility supporting multiple models on-premise and public cloud. Extensibility. TWIN to support DPP backup services.
Data authentication, reliability and integrity	prEN 18246	Data integrity proofs based on IOTA. IOTA Identity. W3C VCs.	W3C Digital Identity standards + unique features of IOTA concerning immutability, traceability and auditability
APIs for the product passport lifecycle management and searchability	prEN 18222	TWIN Data Apps TWIN Engine	A TWIN Data App can be used to implement the DPP API on top of the AIG and document management components

Architecture Zoom-In: Data Exchange



Key Definitions - Data Exchange

1 TWIN Catalogue

A Federation Service that realizes a catalogue of compliant Participants and the resources they offer to ecosystems.

2 Data Resource

A collection of data of interest to ecosystem participants and available for access or download in one or more representations (or aggregations). It might be the subject of ODRL Policies.

3 Service Offering

A representation of a set of Data Resources which a Provider aggregates and exposes through an API endpoint. It might be the subject of ODRL Policies.

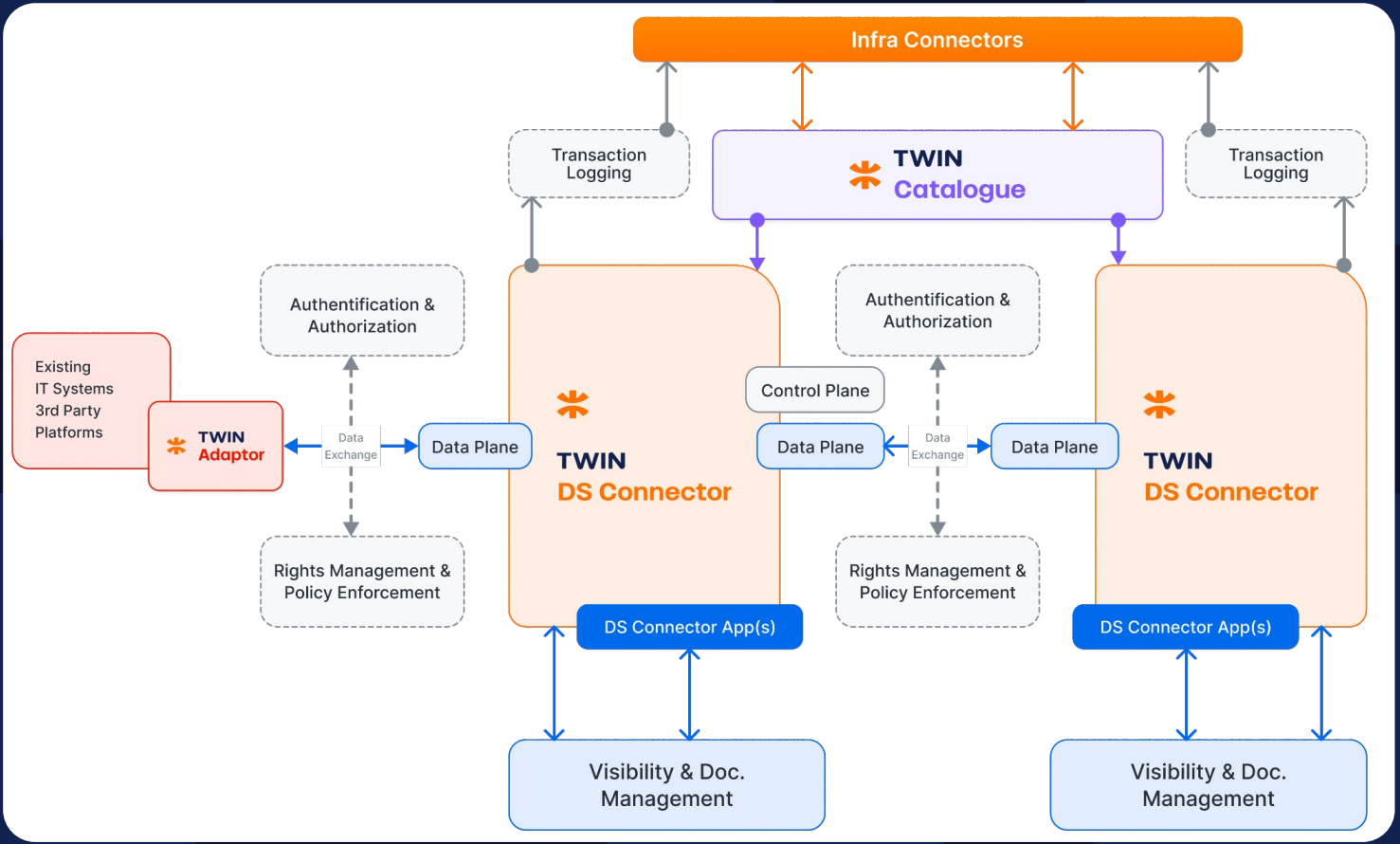
4 DS Connector

The technical core component of the Data Exchange Services of a TWIN Node. A TWIN Data Space Connector can be extended with one or more *TWIN Data Apps*, named **TWIN DS Connector Apps**.

5 ODRL Policy

A set of rules that define uses and re-uses of data that are conformant with existing regulations or to the constraints assigned by a Data Provider.

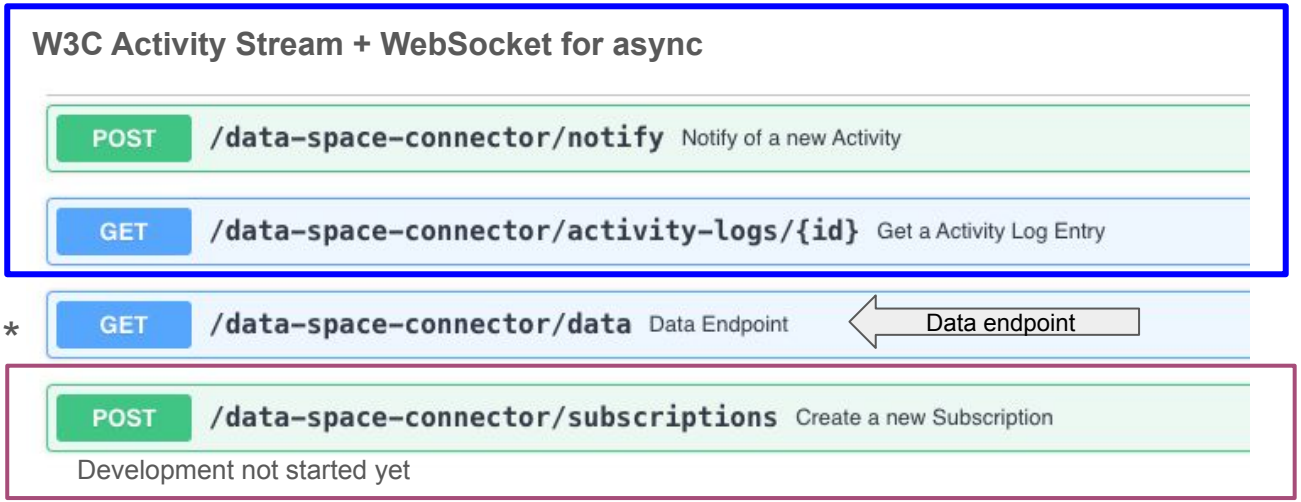
Data Exchange Architecture



TWIN Catalogue API Overview

POST	/federated-catalogue/participant-credentials	Present a Compliance Credential
POST	/federated-catalogue/service-offering-credentials	Present a Service Offering Credential
POST	/federated-catalogue/data-resource-credentials	Present a Data Resource Credential
POST	/federated-catalogue/data-space-connector-credentials	Present a Data Space Connector Credential
GET	/federated-catalogue/participants	Get a list of the participant entries
GET	/federated-catalogue/participants/{id}	Get a participant
GET	/federated-catalogue/service-offerings	Get a list of the service entries
GET	/federated-catalogue/service-offerings/{id}	Get a Service Offering entry
GET	/federated-catalogue/data-resources	Get a list of the data resource entries
GET	/federated-catalogue/data-resources/{id}	Get a Data Resource entry
GET	/federated-catalogue/data-space-connectors	Get a list of the Data Space connectors entries
GET	/federated-catalogue/data-space-connectors/{id}	Get a Data Space Connector entry

TWIN DS Connector API Overview



*Data endpoint still in early stage. RFC under discussion

** IDSA protocol (negotiation) will be under scope in future releases

Educational Case of Study

3-Way Document Sharing

Educational Case Study: 3-Way Document Sharing

Chicken Exporter

Request Inspection

Issue Vet. Certificate

GŁÓWNY INSPEKTORAT WETERYNARII

Veterinary Inspectorate

Share Data / Docs

Freight Forwarder

Present Vet. Certificate

Food Standards Agency

Educational Case Study: 3-Way Document Sharing

- **Trade Lane**: Chicken meat supply chain. Poland → UK (simplification, EU transit not considered, etc.)
- **Regulation**: Export Consignments involving chicken must have a Veterinary Certificate issued by the exporting country authority, GIW in Poland.
- Participants
  - Biz - *Chicken meat exporter* from Poland
  - Gov - *Poland Veterinary Agency* (GIW)
  - Biz - I*nternational Freight Forwarder*
  - Gov - *UK Food Standards Agency (FSA)*

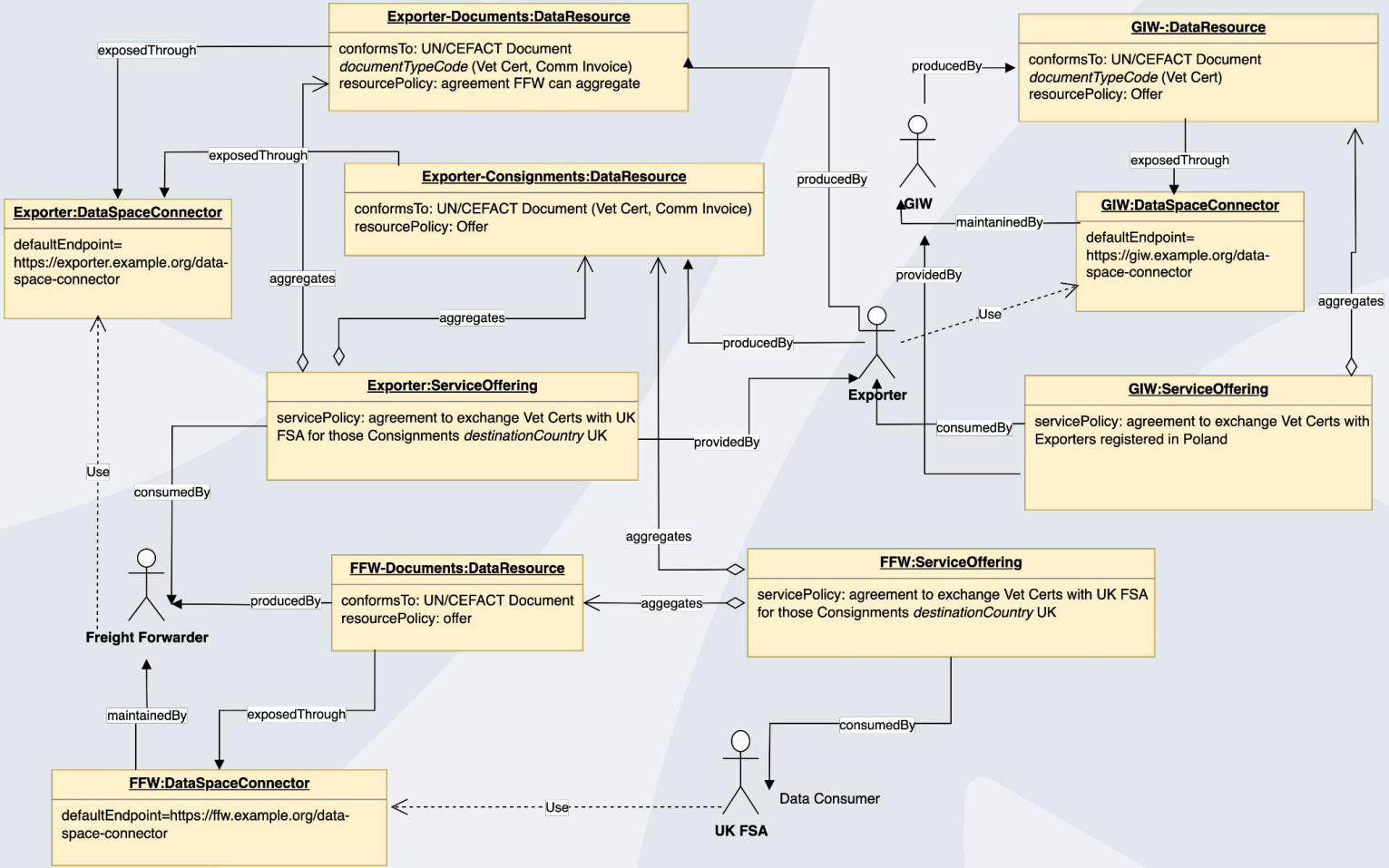
- Interactions
  - G2B → GIW issues a veterinary certificate concerning a consignment sold by the chicken exporter
  - B2B → The *Chicken Exporter* shares consignment data and documents (incl. Vet Cert.) with the Freight Forwarder
  - B2G → The *Freight Forwarder* shares consignment data and Vet. Cert. with the *UK FSA*, that needs to check for compliance.

TWIN Modelling

Participant	Type	Data Resources	Service Offerings	Permissions
GIW	Gov (PL)	GIW-DR-1 Veterinary Certificate (UN/CEFACT Document)	Query by Cert. Id Aggregates: GIW-DR-1	Exporters registered in Poland
Chicken Exporter	Biz (PL)	CE-DR-1 Documents (*Commercial Invoice, Vet. Cert.*) CE-DR-2 *Consignments* (UN/CEFACT)	Query by *globalId* Aggregates: CE-DR-1, CE-DR-2	Freight Forwarder (customer-service provider agreement)
Freight Forwarder	Biz (UK hq)	FFW-DR-1 Documents (*docs shared by customers + other trade docs directly managed*)	Query by *globalId* Aggregates: FFW-DR-1, CE-DR-2	UK FSA Consignments *destinationCountry* UK, Vet. Cert. Documents
UK FSA	Gov (UK)	N/A in our case study	N/A in our case study	N/A

Note: Assumption is that all participants have been cleared and onboarded using Trust Service Providers / Trust Anchors

TWIN Modelling - UML View



JSON-LD Representation .- Examples (I)

Participant - Exporter

```
{
  "@context": [
    "https://w3id.org/gaia-x/development",
    {
      "isicV4": "https://schema.org/isicV4"
    }
  ],
  "type": "LegalPerson",
  "registrationNumber": {
    "type": "EORI",
    "eori": "PL527288386100000"
  },
  "legalAddress": {
    "type": "Address",
    "countryCode": "PL"
  },
  "legalName": "Kurczak Food",
  "isicV4": "1010"
}
```

Company's public legal Info

Data Space Connector - FFW

```
{
  "@context": [
    "https://w3id.org/gaia-x/development",
    "https://schema.twindev.org/federated-catalogue/types.jsonld"
  ],
  "id": "https://my-ds-connectors.example.org/ds-connector-ffw",
  "type": [
    "DataSpaceConnector",
    "DataExchangeComponent"
  ],
  "identity": "did:iota:testnet:0x10acbf6ed80e914c074aa46fbc4b2ce94d74c860958d930f83df13f1027533fe",
  "defaultEndpoint": {
    "endpointURL": "http://localhost:22222/data-space-connector"
  },
  "subscriptionActivityEndpoint": {
    "endpointURL": "/subscriptions"
  },
  "pushActivityEndpoint": {
    "endpointURL": "/notify"
  },
  "pullDataEndpoint": {
    "endpointURL": "/data"
  },
  "offeredResource": {
    "https://twin.example.org/data-resources/exporter-consignments-817a9d": {
      "type": "DataResource",
      "name": "Consignments Resource"
    },
    "https://twin.example.org/data-resources/ffw-docs-2f246": {
      "type": "DataResource",
      "name": "Documents Resource"
    }
  },
  "maintainer": "did:iota:testnet:0xac534b750ac453d573a55954760af140f87358c7be9a18000a831c452c32f246"
}
```

endpoint information

Dataset and DSC App blueprint at https://github.com/gtscio/twin-webinar2-demo

JSON-LD Representation .- Examples (II)

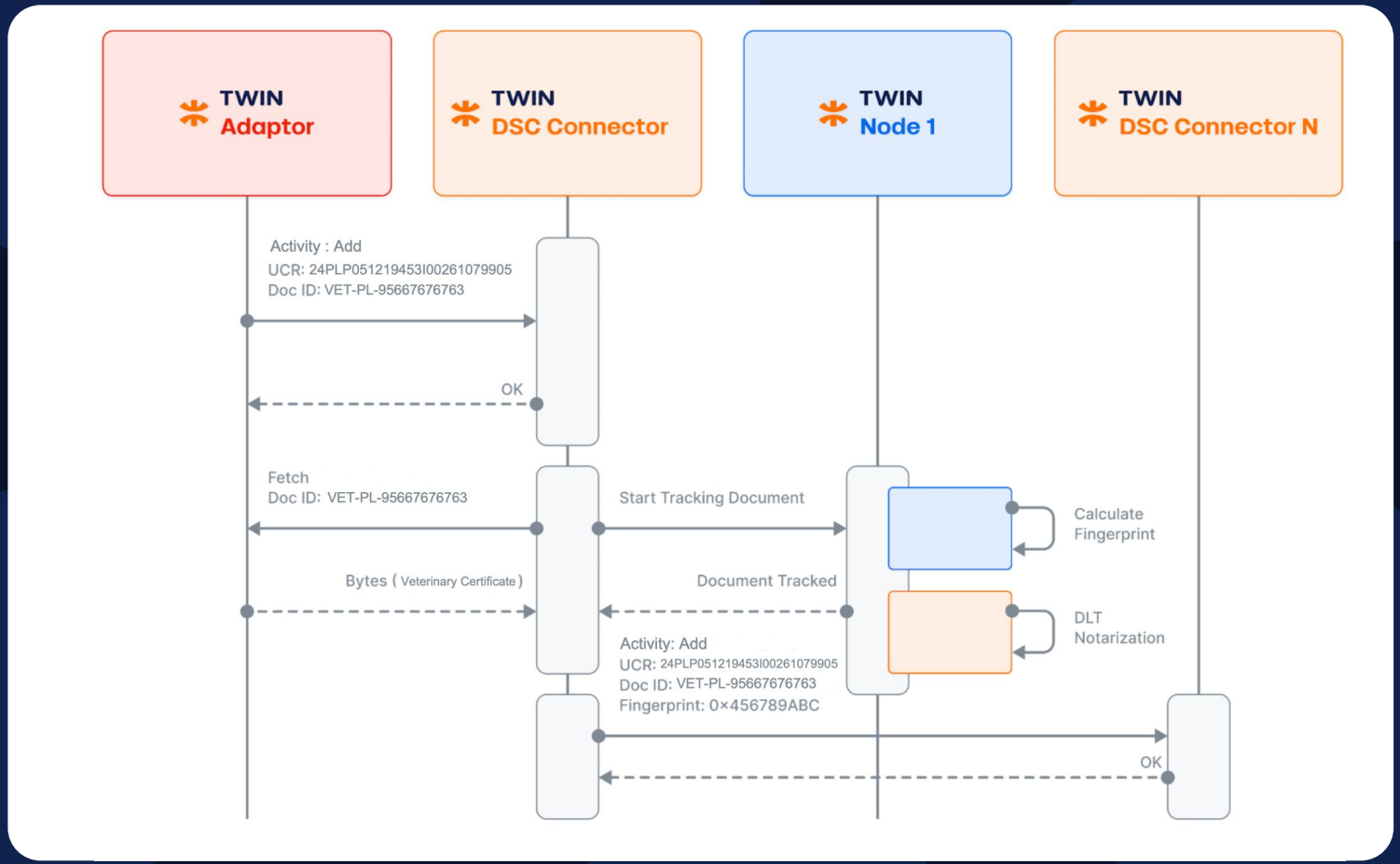
Data Resource - GIW (Vet Cert.)


```
{
  "@context": [
    "https://w3id.org/gaia-x/development",
    {
      "conformsTo": "http://purl.org/dc/terms/conformsTo"
    }
  ],
  "id": "https://twin.example.org/data-resources/vet-cert-doc-6ce567",
  "type": "DataResource",
  "producedBy": {
    "id": "did:iota:testnet:0xfcfa55894cab90504af7eaf38087addd5f77791a89bd3ebbe76d9c2b1a6ce567",
    "type": "LegalPerson"
  },
  "exposedThrough": "https://my-ds-connectors.example.org/giw-ds-connector",
  "copyrightOwnedBy": {
    "id": "did:iota:testnet:0xfcfa55894cab90504af7eaf38087addd5f77791a89bd3ebbe76d9c2b1a6ce567",
    "type": "LegalPerson"
  },
  "license": "http://licenses.example.org/phyto-doc",
  "conformsTo": {
    "@context": "https://www.w3.org/ns/credentials/v2",
    "type": "JsonSchema",
    "jsonSchema": {
      "type": "object",
      "properties": {
        "type": {
          "type": "string",
          "const": "Document"
        },
        "documentTypeCode": {
          "type": "string",
          "const": "unece:DocumentCodeList#853"
        },
        "issuerParty": {
          "type": "string",
          "const": "did:iota:testnet:0xfcfa55894cab90504af7eaf38087addd5f77791a89bd3ebbe76d9c2b1a6ce567"
        }
      }
    }
  },
  "resourcePolicy": {
    "@context": [
      "http://www.w3.org/ns/odrl.jsonld"
    ],
    "@type": "Offer",
    "uid": "http://example.com/policy-data-resource-giw:1010",
    "assigner": "did:iota:testnet:0xfcfa55894cab90504af7eaf38087addd5f77791a89bd3ebbe76d9c2b1a6ce567",
    "permission": [
      {
        "target": "https://twin.example.org/data-resources/vet-doc-6ce567",
        "action": "aggregate"
      }
    ]
  },
  "name": "Veterinary Certificate Documents Data Resource"
}
```

Service Offering - FFW → UK FSA


```
{
  "@context": "https://w3id.org/gaia-x/development",
  "aggregationOfResources": [
    "https://twin.example.org/data-resources/ffw-docs-2f246",
    "https://twin.example.org/data-resources/exporter-consignments-817a9d"
  ],
  "description": "Allows to retrieve Consignment and Documents Data",
  "id": "https://twin.example.org/service-offerings/ffw-query-service",
  "name": "Query Service Offering for Freight Forwarder",
  "providedBy": {
    "id": "did:iota:testnet:0xac534b750ac453d573a55954760af140f87358c7be9a18000a831c452c32f246",
    "type": "LegalPerson"
  },
  "servicePolicy": [
    {
      "@context": [
        "http://www.w3.org/ns/odrl.jsonld",
        {
          "jsonPathSelector": "twin:jsonPathSelector",
          "twin": "https://w3id.org/twin/odrl/"
        }
      ],
      "@type": "Agreement",
      "assignee": "did:iota:testnet:0x83e99fd9b8804966fd474da212aa93a5769f39f2150714a3c6701d20b5353975",
      "assigner": "did:iota:testnet:0xac534b750ac453d573a55954760af140f87358c7be9a18000a831c452c32f246",
      "description": "Allow the UK FSA to query this service",
      "permission": [
        {
          "action": "read",
          "constraint": {
            "leftOperand": {
              "@id": "https://w3id.org/twin/odrl/propertyValue",
              "jsonPathSelector": ".destinationCountry"
            },
            "operator": "eq",
            "rightOperand": "GB"
          },
          "target": {
            "type": [
              "Asset",
              "https://vocabulary.uncefact.org/Consignment"
            ]
          }
        },
        {
          "action": "read",
          "constraint": {
            "leftOperand": {
              "@id": "https://w3id.org/twin/odrl/propertyValue",
              "jsonPathSelector": ".documentTypeCode"
            },
            "operator": "eq",
            "rightOperand": "unece:DocumentCodeList#853"
          },
          "target": {
            "type": [
              "Asset",
              "https://vocabulary.uncefact.org/Document"
            ]
          }
        }
      ],
      "uid": "http://example.com/policy0-ffw-offering:1010"
    }
  ],
  "type": "ServiceOffering"
}
```

Data Space Protocol Interactions



TWIN DS Connector - W3C Activity Stream

POST /data-space-connector/notify


```
{
  "@context": [
    "https://www.w3.org/ns/activitystreams",
    "https://vocabulary.uncefact.org/unece-context-D23B.jsonld"
  ],
  "generator": "did:iota:testnet:0x1ee831611a9fe9877c82e05075d9670c4970b4fd0904c208082ee50e45817a9d",
  "id": "https://twin.example.org/act7",
  "type": "Add",
  "actor": {
    "id": "did:iota:testnet:0x1ee831611a9fe9877c82e05075d9670c4970b4fd0904c208082ee50e45817a9d",
    "type": "LegalEntity"
  },
  "object": {
    "type": "Document",
    "documentTypeCode": "unece:DocumentCodeList#853",
    "identifier": "VET-PL-9566767676",
    "identificationType": "GIW-Veterinary-Certificate",
    "issueDateTime": "2024-09-22T10:10:10Z",
    "issuerParty": {
      "id": "did:iota:testnet:0xfcfa55894cab90504af7eaf38087addd5f77791a89bd3ebbe76d9c2b1a6ce567"
    }
  },
  "target": {
    "globalId": "24PLP051219453I00261079905",
    "type": "Consignment"
  },
  "updated": "2025-09-22T12:13:25Z"
}
```


The Exporter notifies the FFW that a Vet. Cert. is available for a Consignment

TWIN Hands-On

TWIN - The Codebase - The Packages

Base Layer

- Fundamentals (Is, Guards, i18n)
- Cryptography
- Tools (TypeScript to Schema, TypeScript To OpenAPI)
- Standards (Schema.org, DID, ODRL, GS1, UN/CEFACT)
- Data (JSON-LD)
- API Core

Components, Connectors

- Logging, Telemetry, Background Tasks, Event Bus
- Entity Storage (MySql, Mongo, Scylla, AWS, Azure, GCP)
- Blob Storage (IPFS, AWS, Azure, GCP)
- Messaging (AWS)
- Vault (Hashicorp)

DLT Connectors

- Wallet / Gas Station
- Identity
- NFT
- Verifiable Storage

Building Blocks

- Auditable Item Graph
- Auditable Item Streams
- Document Management
- Attestation
- Immutable Proof
- Rights Management
- Data Processing (Extraction, Conversion)
- Federated Catalogue
- Future: Identity Management
- Future: Supply Chain

Engine

- Engine Core
- Engine REST Server

Node

- TWIN Node

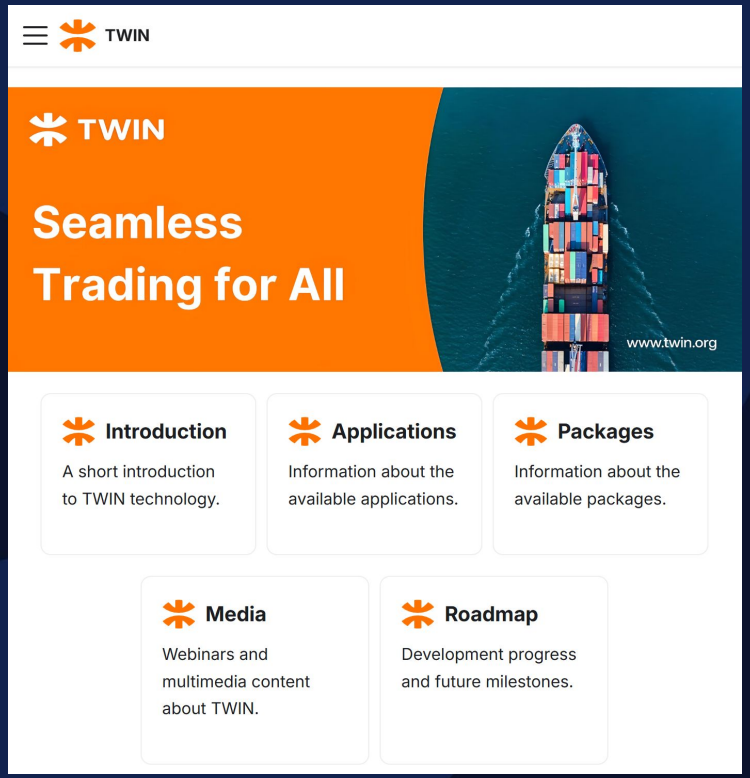
UI

- React UI Components
- Svelte UI Components
- Identity Components (Future)

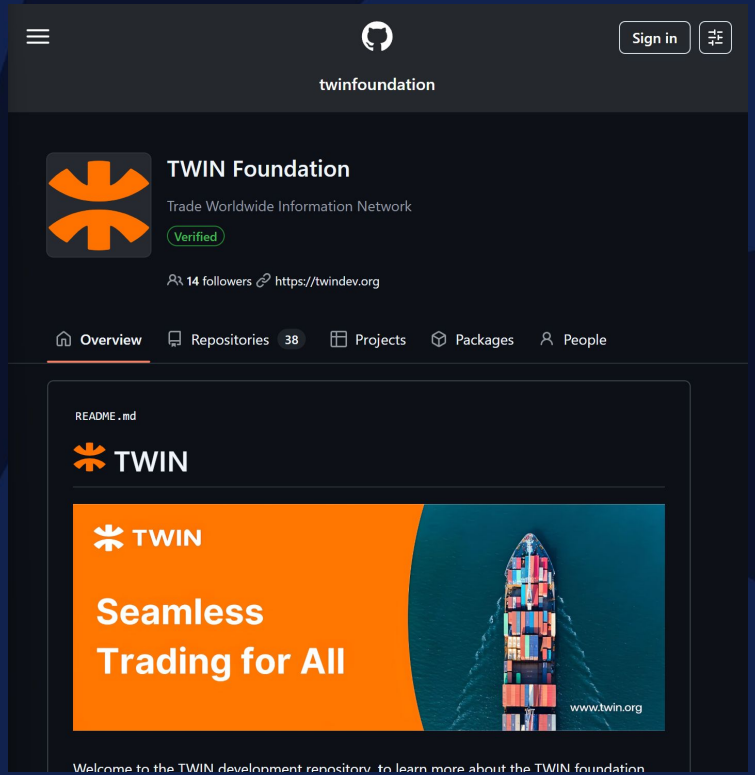
Applications

- Playground
- TWIN Identity
- TWIN UK
- TLIP

TWIN - Open Source Resources



https://twindev.org/



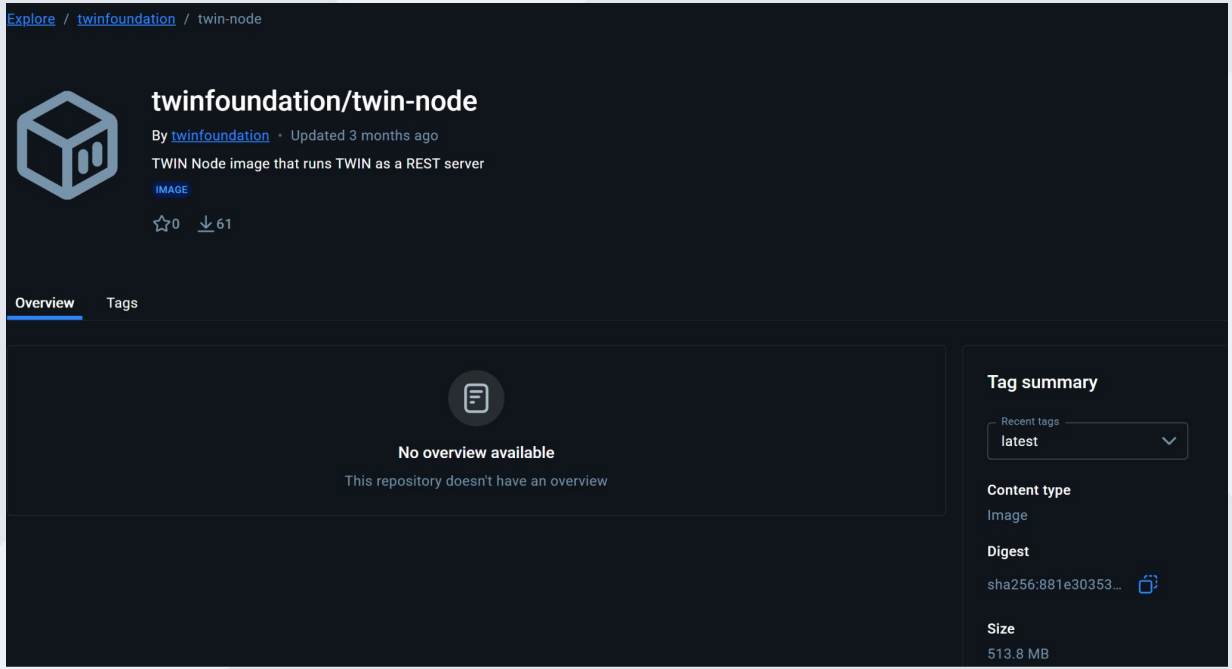
https://github.com/twinfoundation

TWIN Node Local Deployment

Steps:

1. **Find the TWIN Node in Dockerhub**

   https://hub.docker.com/r/twinfoundation/twin-node



TWIN Node Local Deployment

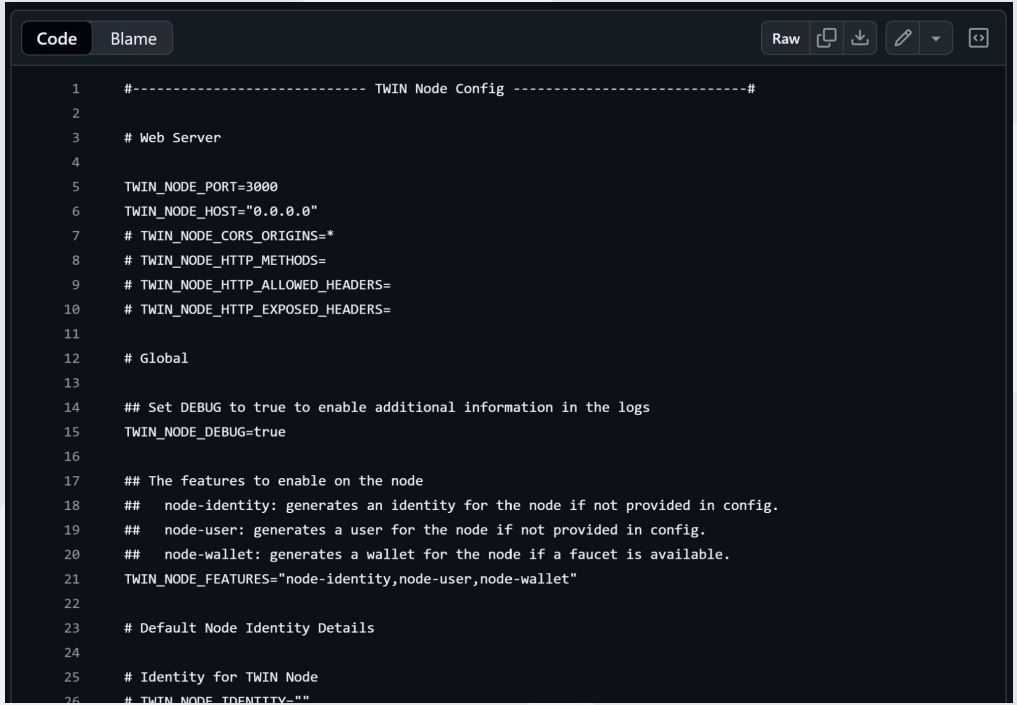
Steps:

1. **Find the TWIN Node in Dockerhub**

   https://hub.docker.com/r/twinfoundation/twin-node

2. **Check and edit the configuration variables**

   - Download sample .env
   - Adapt as needed



TWIN Node Local Deployment

Steps:

1. **Find the TWIN Node in Dockerhub**

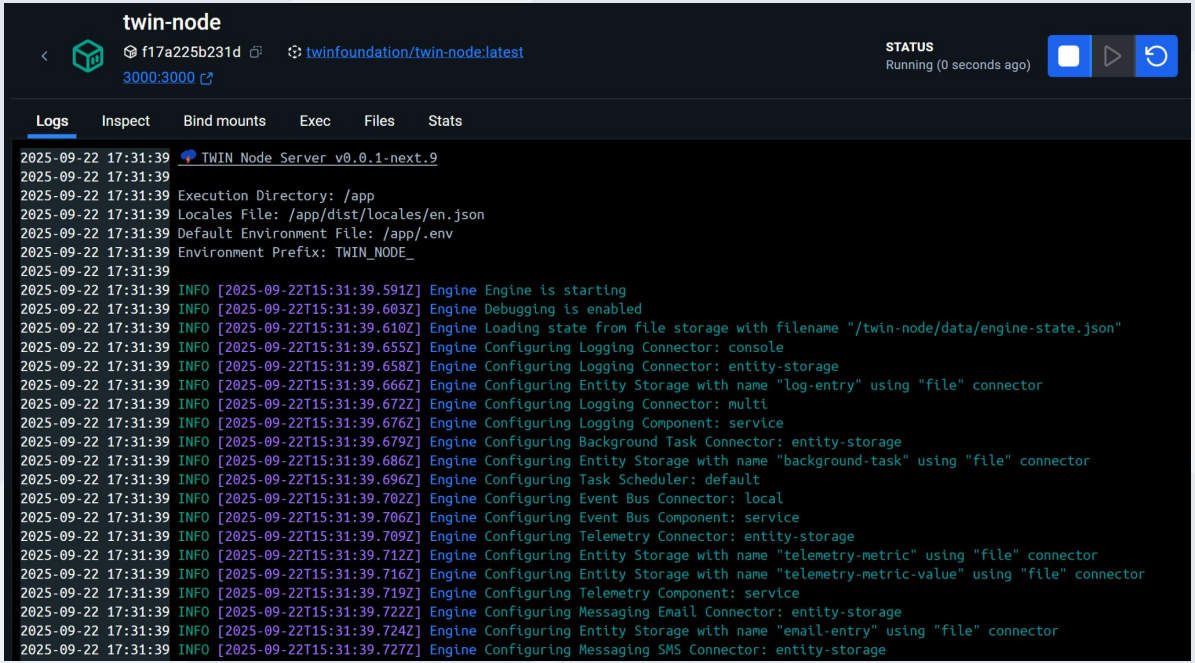
   https://hub.docker.com/r/twinfoundation/twin-node

2. **Check and edit the configuration variables**

   - Download sample .env
   - Adapt as needed

3. **Run the docker image**

   docker run -d --name twin-node --env-file .env -p 3000:3000 twinfoundation/twin-node:latest



TWIN Node Local Deployment

Steps:

1. **Find the TWIN Node in Dockerhub**

   https://hub.docker.com/r/twinfoundation/twin-node

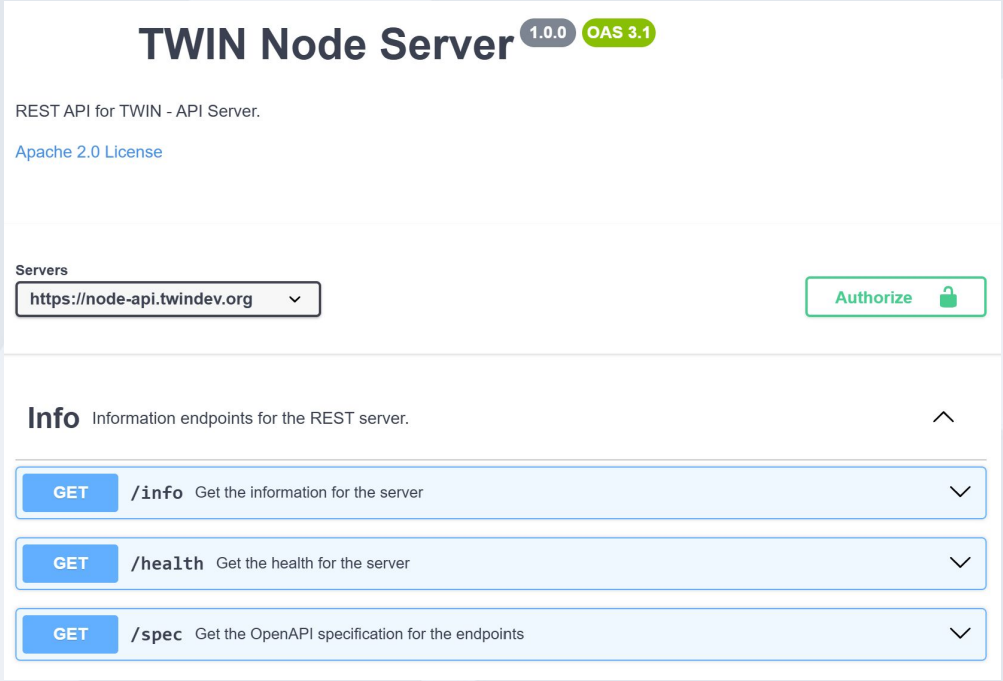
2. **Check and edit the configuration variables**

   - Download sample .env
   - Adapt as needed

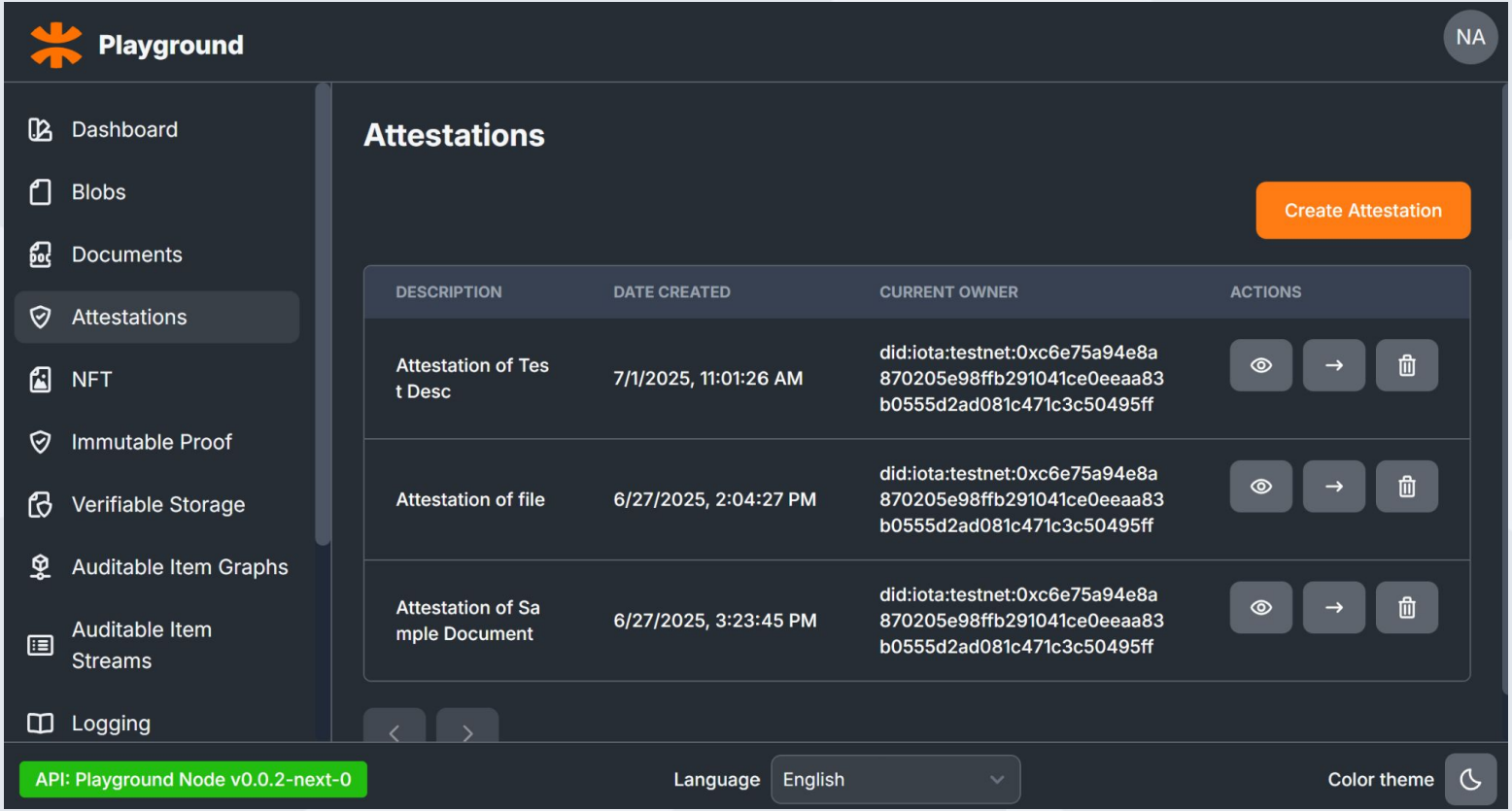
3. **Run the docker image**

   ```
   docker run -d --name twin-node --env-file .env
   -p 3000:3000 twinfoundation/twin-node:latest
   ```

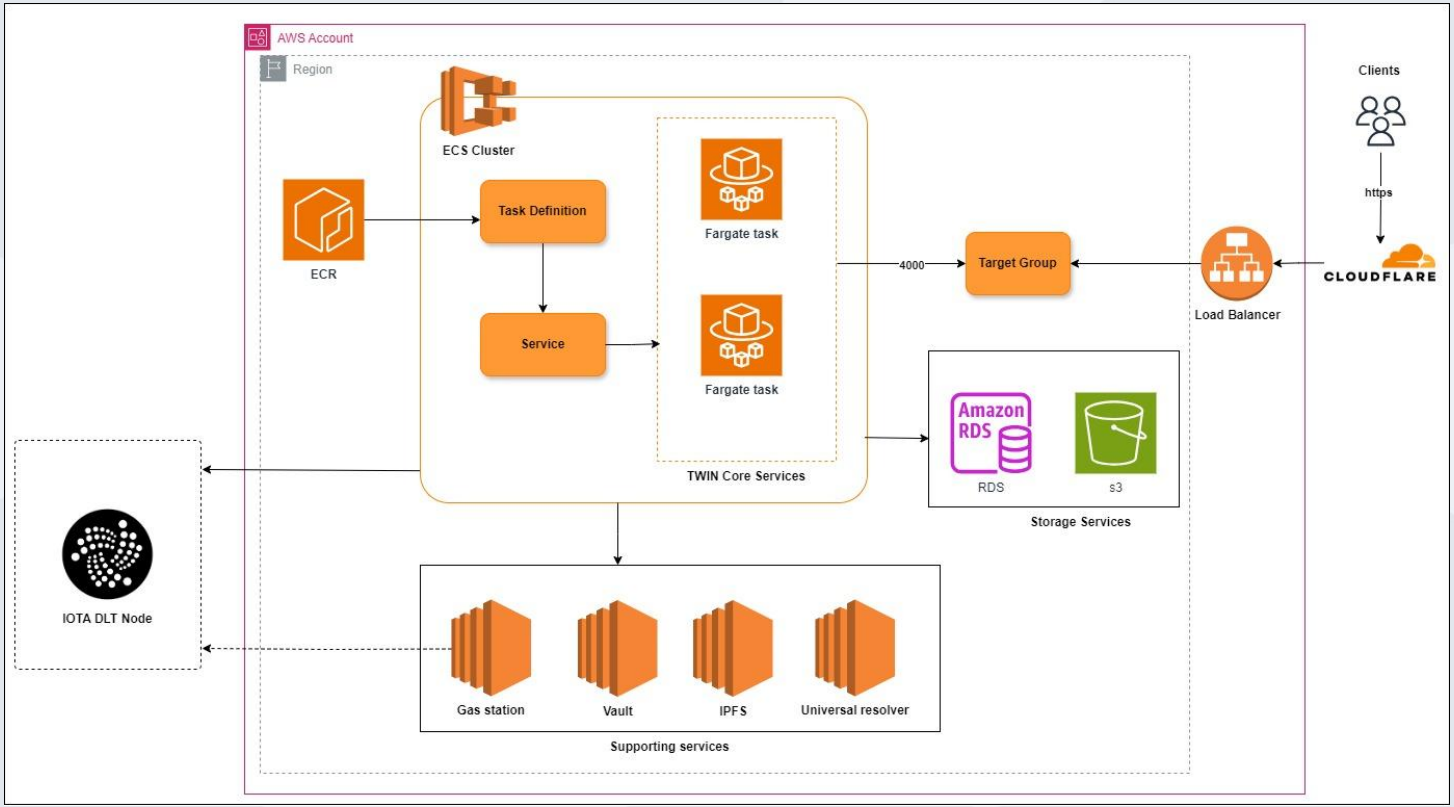
4. **Verify running endpoints**



TWIN Playground



TWIN Node AWS Deployment (RDS and S3)



What’s Ahead?

What's Ahead?

- Release **1.0 version of the RA White paper** at the end of the 2025
- **Scientific paper** to gain peer reviews of our TWIN Architecture
- Creation of a tangible **TWIN Community**:
  - a truly **open source development model** with target end of Q4-2025
  - develop **tutorials and blueprints** → Contributions welcome!!!
- **Continuous refinement** with main development focus on:
  - Rights Management, Data Space Connector (query and subscribe interfaces)
  - Decentralization of the TWIN Catalogue, Onboarding : Clearing House, Registries, etc.
- TWIN ID **organizational identity tool** to facilitate onboarding processes
- Next Webinar:
  - **Mid January 2026** → Building with TWIN (Webinar 3)
  - Potential topics for next Webinars: *TWIN ID, Tokenization (MLETR), Deep Dive DPP Case Studies, …*

TWIN

Thank you!

For questions, reach us at
info@twin.org

Homework Materials

You Can Have a Look At

- https://github.com/gtscio/twin-webinar2-demo → The **dataset** of the educational case of study “3-way document sharing” and a blueprint “Data Space Connector App”
- https://youtu.be/EWvEPuEX5Ng → **Screencast**: 3-way document sharing implementation sketch
- https://github.com/twinfoundation → The TWIN codebase
- https://twindev.org → The TWIN reference development documentation
- https://schema.twindev.org → Schemas
- https://playground.twindev.org → The TWIN Playground
- https://hub.docker.com/u/twinfoundation → Docker Hub