TWIN
Architecture Webinar

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(updated July 2025)

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Agenda

1. Introduction - Why TWIN?
2. Architectural Overview
3. Practical Case Using an Initial Version of the TWIN Sandbox
4. TWIN Roadmap

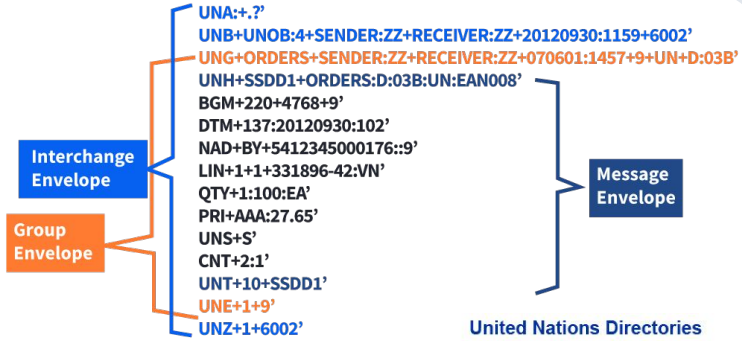
Why TWIN?

(From a technology perspective)

Introduction (I)

Historical perspective

- **Digitization of trade and supply chains is not a new topic**
  - **EDI : companies to exchange documents in a peer to peer basis**
- **Traditional pillars:**
  - **Global approach** → standards and interoperability are fundamental
  - **Data Models** (ex. BSP from UN/CEFACT) and data dictionaries
  - **Data transmission formats**
    - ex. field-delimited text or XML, such as GS1 BMS
  - **Message interchange protocols** (ex. EDIFACT)
  - **Dedicated networks** (ex. EDIVAN)
  - **Identification standards** (ex. GS1 Identifiers)
  - **Registries** of actors, locations, ... (ex. GS1 Global Registry, UN/LOCODE)
  - **Traceability standards** (ex. EPCIS)



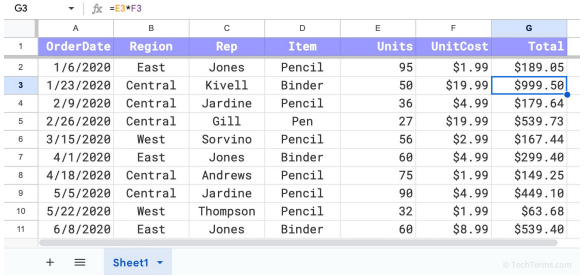
United Nations Directories for Electronic Data Interchange for Administration, Commerce and Transport

UN/EDIFACT

Introduction (II)

Historical perspective

- When there was no widespread adoption yet, around 2000, then the Internet and the Web came into play with:
  - Simpler and cheaper ways of communication: email, FTP, HTTP
  - Ubiquitous format for digital documents exchange: PDF
  - spreadsheet-like, simple formats easily downloadable: CSV
  - Web interfaces to facilitate ubiquitous access to information
  - Web APIs: REST APIs, JSON format
- Later in the 2010 decade, cloud services were commoditized, facilitating the deployment of bespoke Web applications to solve ad-hoc needs of organizations.



	A	B	C	D	E	F	G
1	OrderDate	Region	Rep	Item	Units	UnitCost	Total
2	1/6/2020	East	Jones	Pencil	95	$1.99	$189.05
3	1/23/2020	Central	Kivell	Binder	50	$19.99	$999.50
4	2/9/2020	Central	Jardine	Pencil	36	$4.99	$179.64
5	2/26/2020	Central	Gill	Pen	27	$19.99	$539.73
6	3/15/2020	West	Sorvino	Pencil	56	$2.99	$167.44
7	4/1/2020	East	Jones	Binder	60	$4.99	$299.40
8	4/18/2020	Central	Andrews	Pencil	75	$1.99	$149.25
9	5/5/2020	Central	Jardine	Pencil	90	$4.99	$449.10
10	5/22/2020	West	Thompson	Pencil	32	$1.99	$63.68
11	6/8/2020	East	Jones	Binder	60	$8.99	$539.40

State of the Art

Historical perspective: Where are organizations at the first quarter of the 21st century?

Maturity **Level 1**:

- Organizations still conducting business informally through the Internet email or FTP exchange: excel sheets, CSV files, PDFs, desktop apps ...
- Caveats: *Manual processes, time-consuming, error-prone, no auditability...*

Maturity **Level 1.5**:

- Affordable and easy-to-manage cloud services : AWS, GCP. **Bespoke** API-based integrations intra-company or intercompany
- Caveats: limited scope and multiple assumptions → *inflexible and expensive*

Maturity **Level 2: SaaS platforms** or "data hubs"

- Used to collaborate in a similar way that Web 2.0 social platforms work
- Caveats: *Data silos. Low levels of privacy and no data-sovereignty. Vendor lock-in. Too much power for certain actors.*

This evolution has led to **data silos** and limited interoperability.

Maturity Level 3 - Aspirations

Value Chain Ecosystems. Decentralization. Self-sovereignty. What is needed?

- 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)
- **Access rights and policies**: 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

Our 2025 Arsenal and Context

2025 - TWIN time: New assets we count with

Powerful software infrastructure services

- Commoditized clustering ex. Kubernetes
- Ad-infinitum scalable data stores (such as ScyllaDB)
- Global, decentralized storage for blob availability (such as IPFS)
- Verifiable Registries (public DLTs) with increasing throughput (ex. IOTA)

Decentralization and self-sovereignty

- Verifiable Credentials. Organizational Wallets. eIDAS2 ...
- Data Space frameworks, protocols and ecosystem governance
  - IDSA, Gaia-X

Modernization of classic supply chain standards towards the Web

- UN/CEFACT Vocabulary. GS1 Web Vocabulary. EPCIS 2.0
- Semantic interoperability implemented through JSON-LD (linked data)

Interest by regulators in decentralized approaches

- ESPR DPP, UN/CEFACT UNTP

Well-known open source approaches

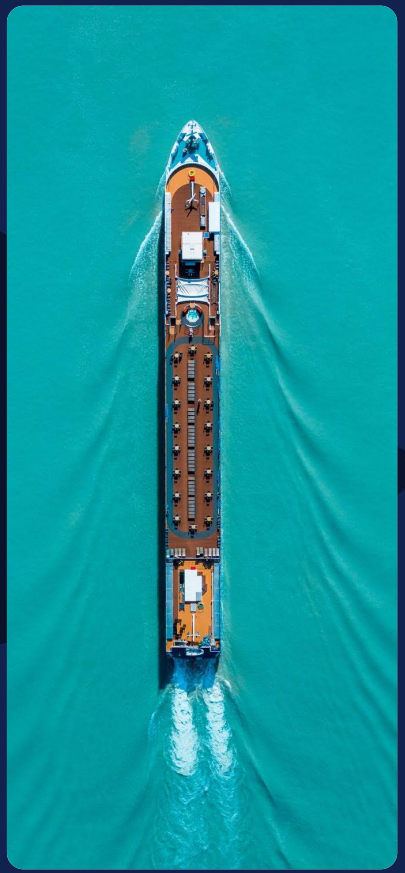
- To facilitate adoption, collaboration and meritocracy

Maturity Level 3

Value Chain Ecosystems. The same pillars apply but implemented differently.

Pillar	Evolution
Global approach and interoperability	Modernized standards: GS1 & UN/CEFACT Vocab, ICC DSI, ...
Data Models	Semantic Web Ontologies and Linked Data Vocabularies (generic and sectoral specific)
Data transmission formats	JSON-LD (enabling semantic interoperability)
Message interchange protocols	Data Space Connector Protocols on top of HTTP (REST, WebSocket)
Dedicated networks	Internet
Identification standards	The classical ones + several methods for Decentralized IDs
Registries	The classical ones + Federated or fully decentralized (DLT). Self-onboarding of actors is now feasible.
Traceability	EPCIS 2.0 (based on JSON-LD and REST APIs)

Architectural Overview



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

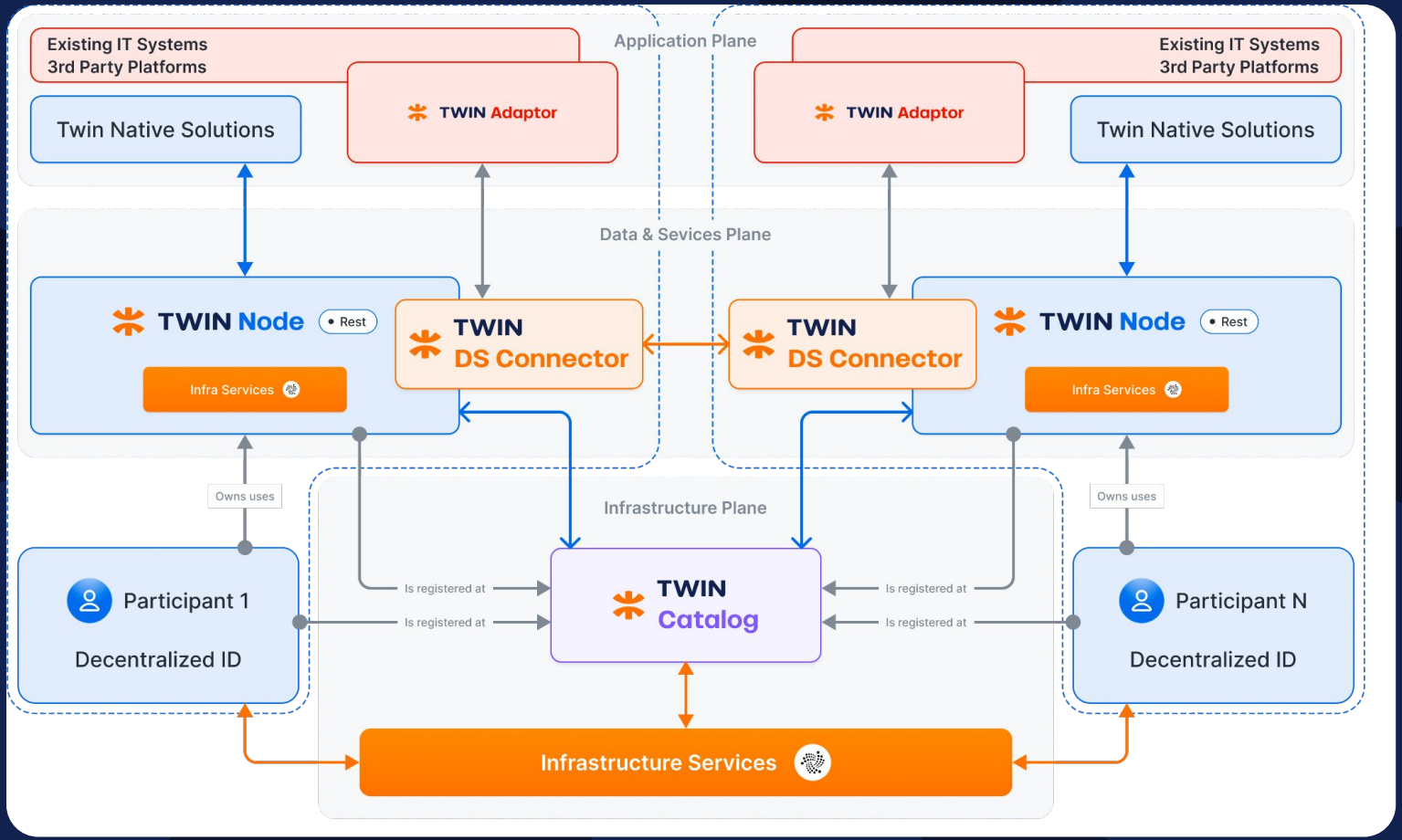
A Verifiable Credential that attests that a Participant or Service is compliant with the rules defined by a TWIN Ecosystem.

5 TWIN Node

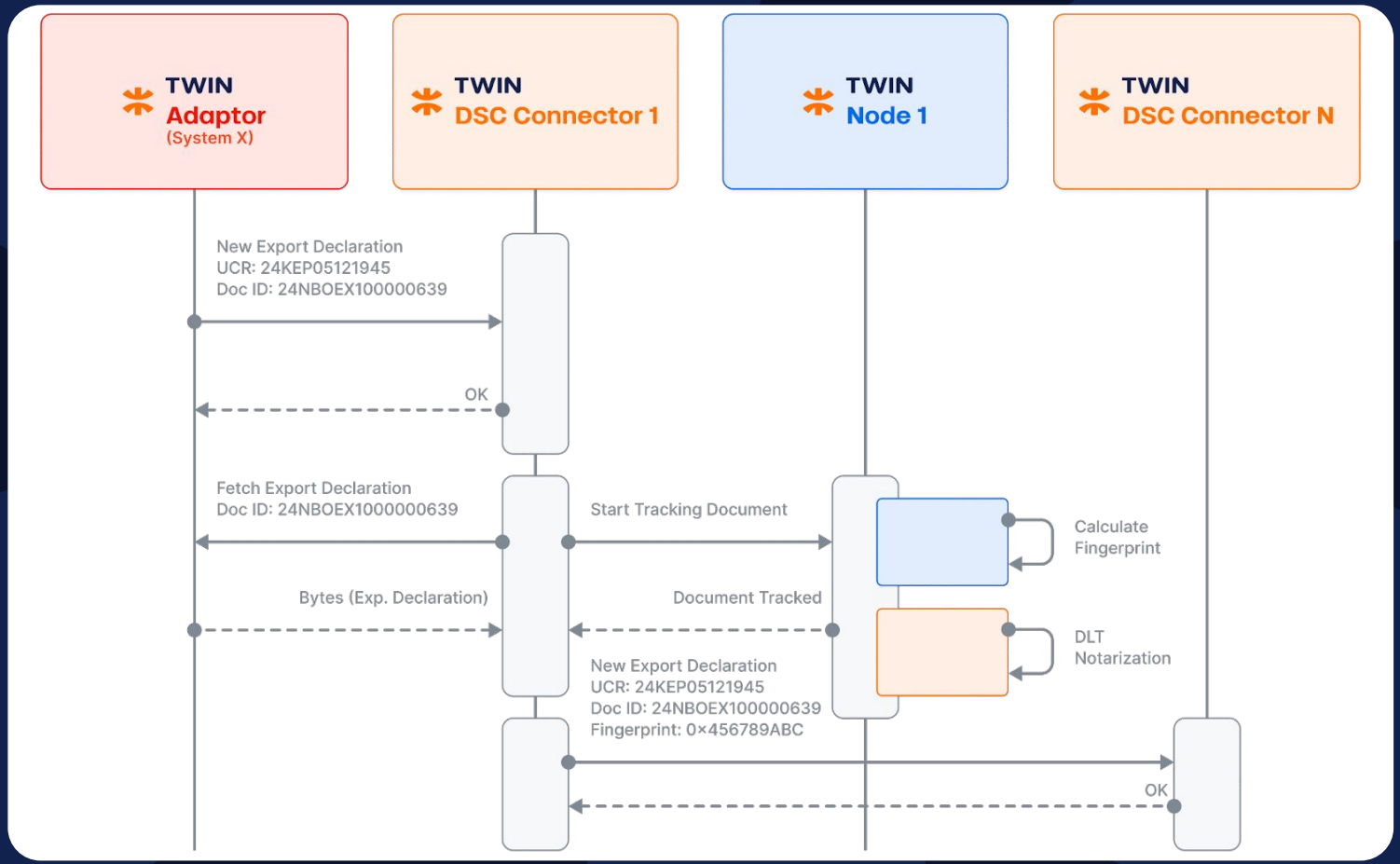
Software (Agent) that enables Participants to interact within a TWIN ecosystem.

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

High Level Picture



Data Space Protocol Example



TWIN Node Anatomy

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.

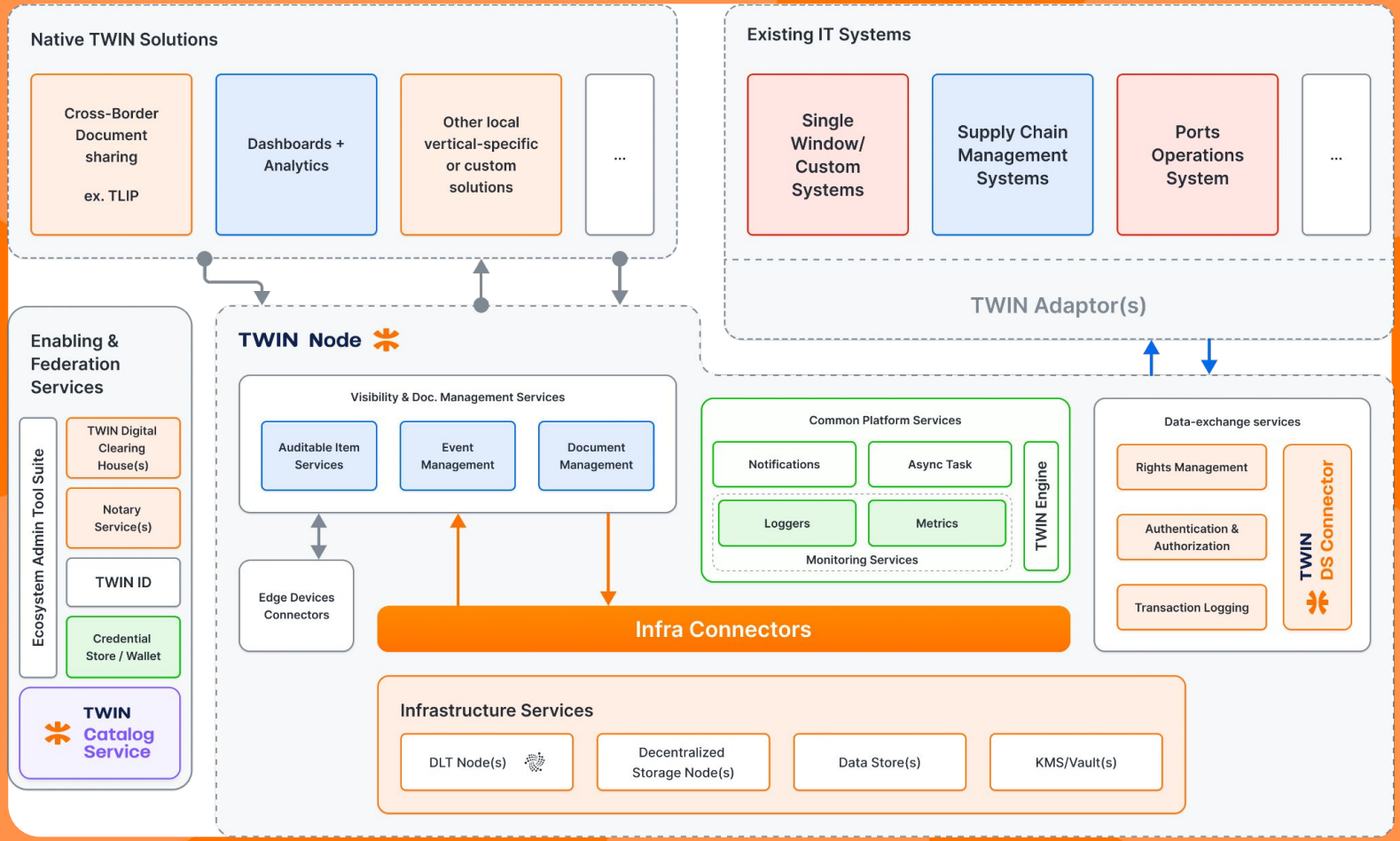
4 Document Management Services

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.

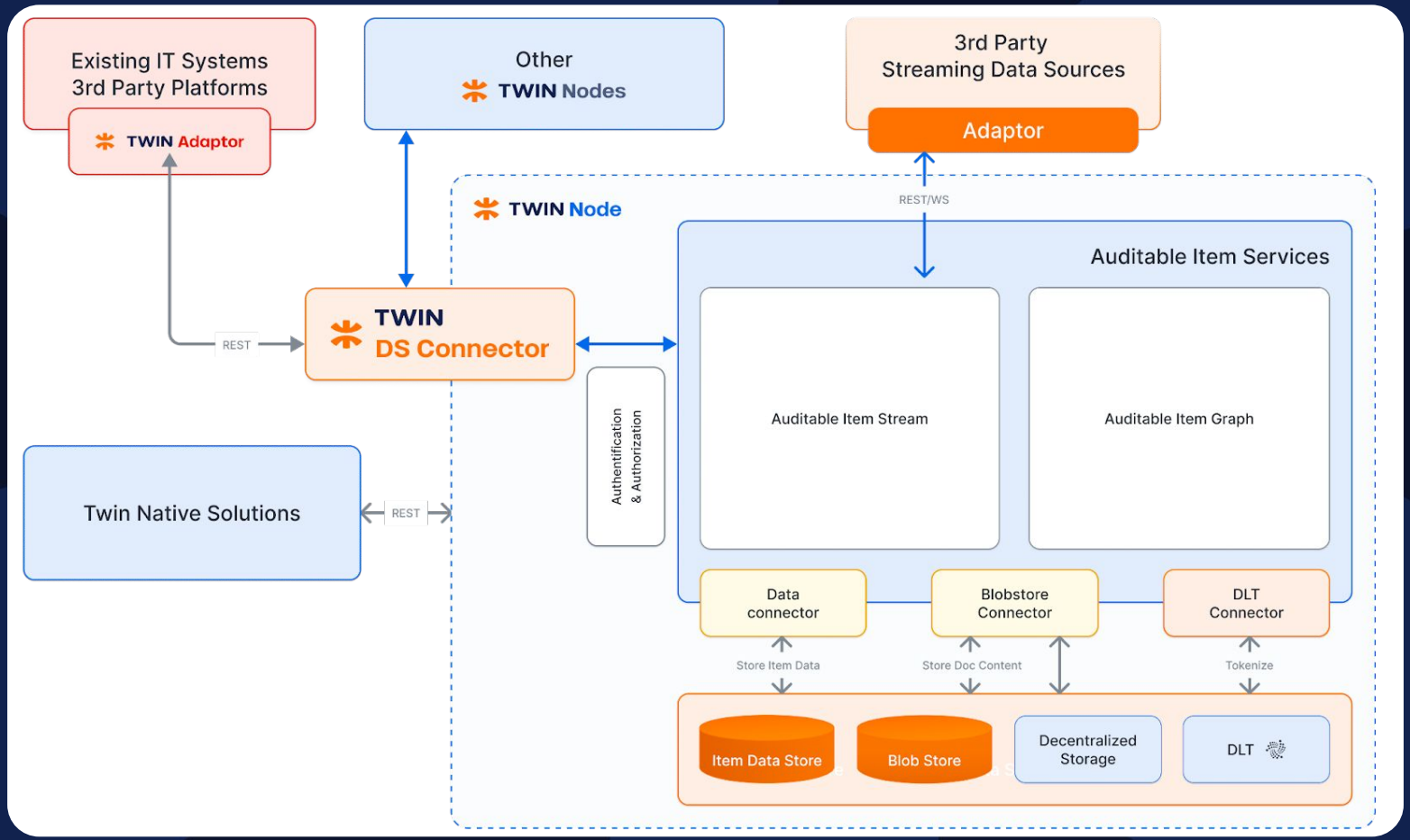
Anatomy of a TWIN Node



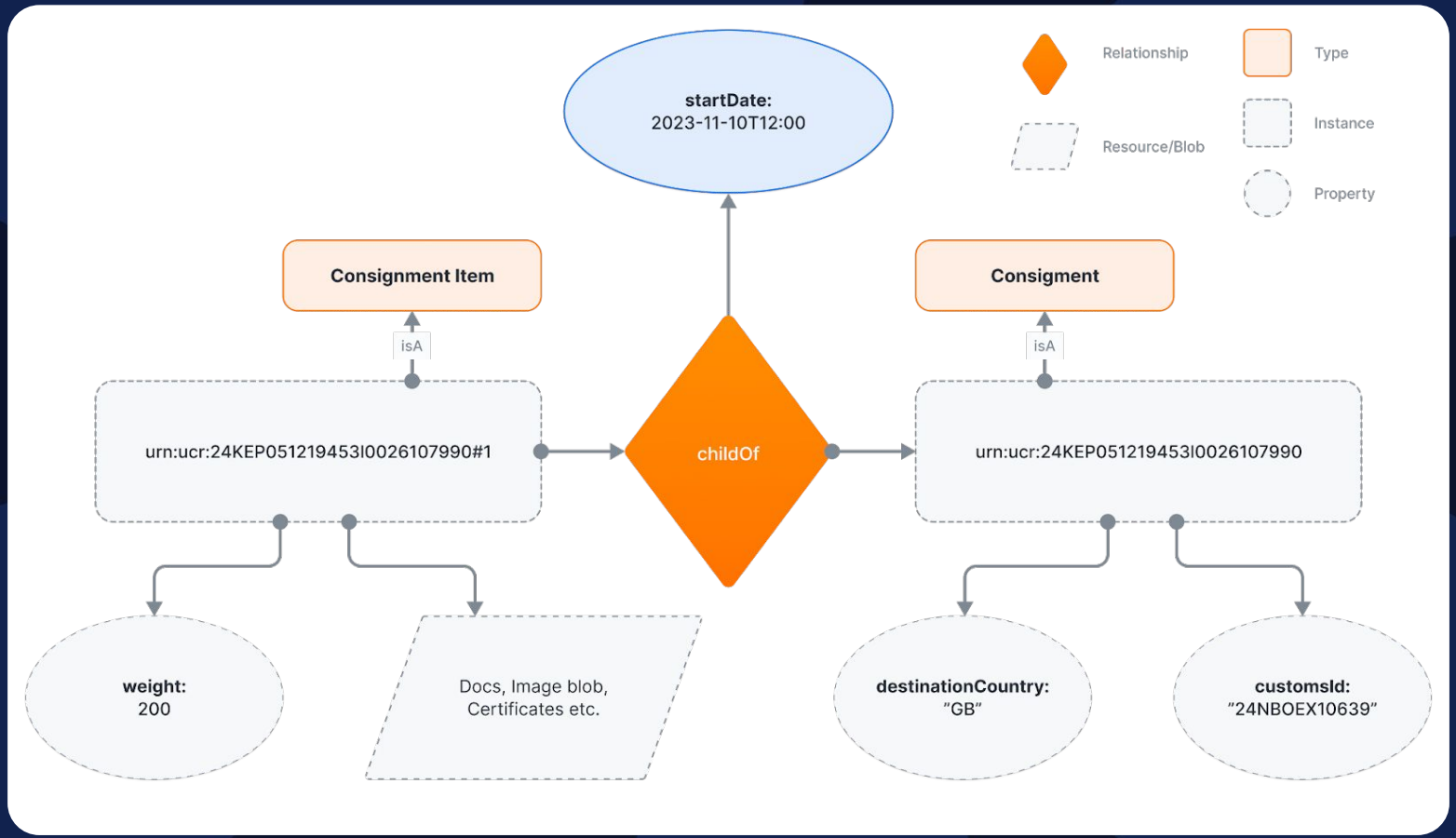
TWIN Node Main Services

Auditable Item Services

Auditable Item Services

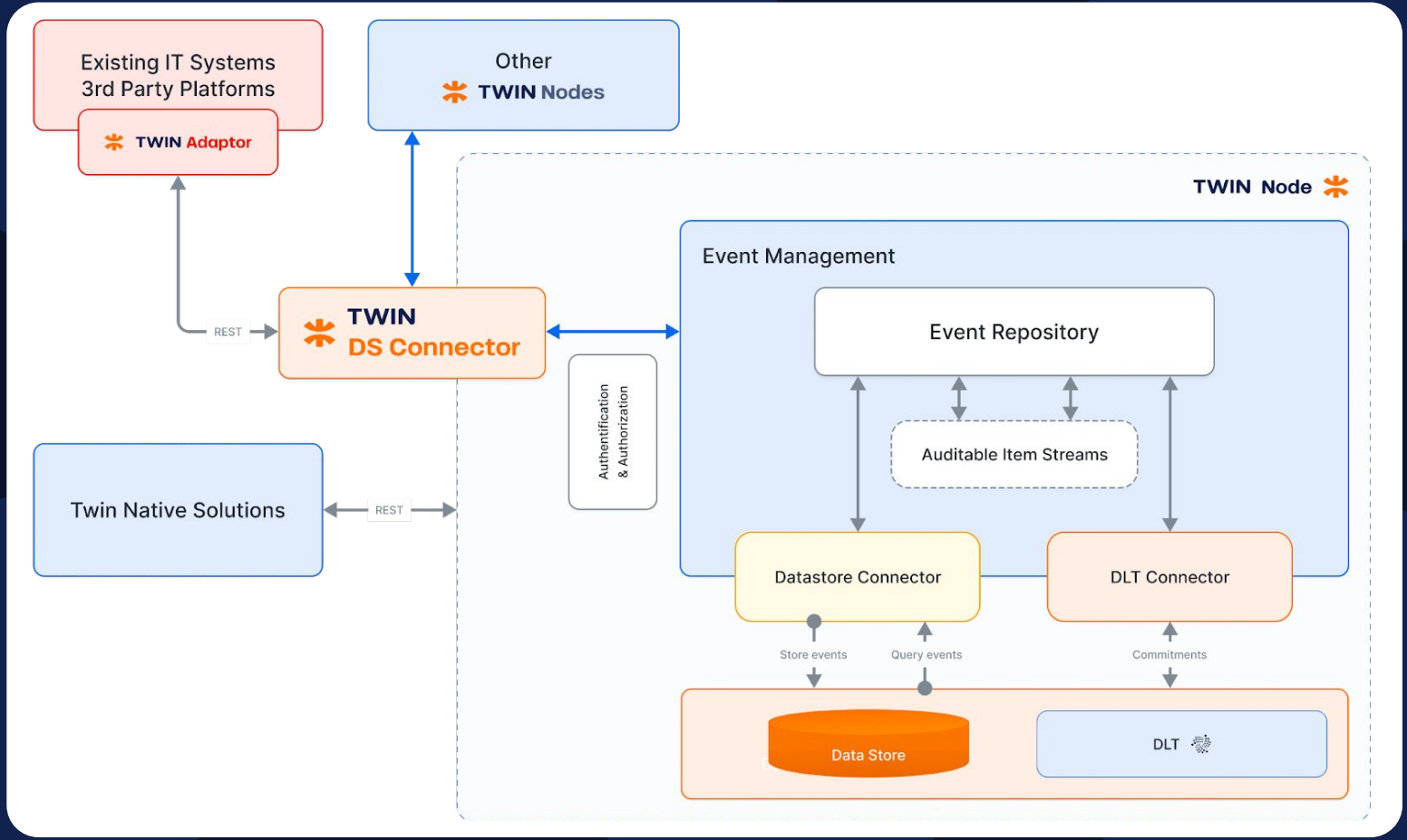


Auditable Item Graph - Data Model



Event Management

Event Management Services

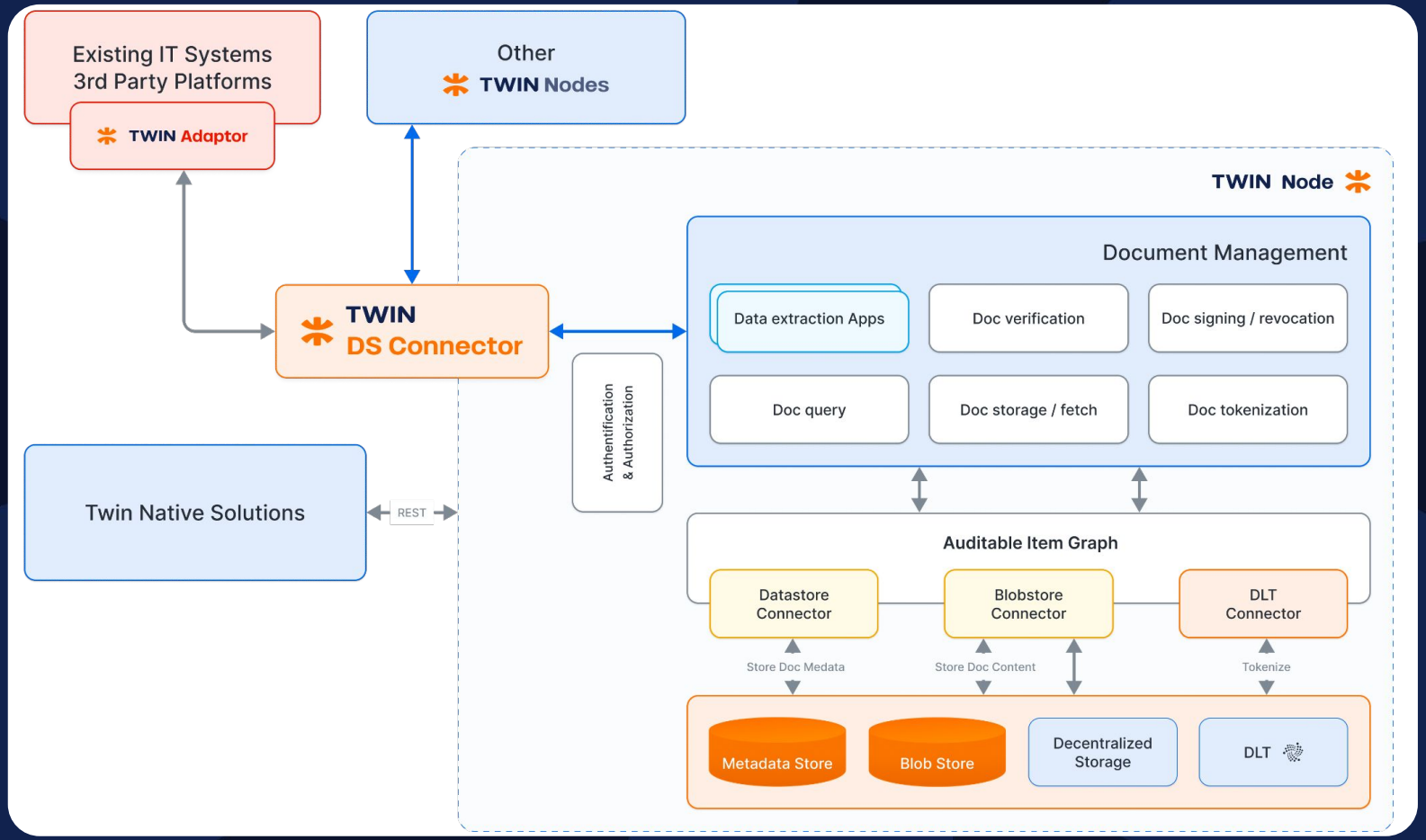


TWIN Event Example (EPCIS ++)

	event ID	`ni:///sha-256;f12640477da404f845f5e4a2d4071fdecda7cb1af6fc0fd89462654cf2b94f43?ver=CBV2.0`
What	event type	`Visibility`
	target	`https://id.gs1.org/01/09521987654327/21/202301`
When	observed at	`2024-09-12T15:00:03.321Z`
	recorded at	`2024-09-12T15:05:03.321Z`
Where	location	`https://id.gs1.org/414/9521999100003`
Who	generator	`did:iota:ebsi:0xb62afcd0150d048ea0679af61d28d0eb1ad1b969f411b03997194df232b27383`
Why	business step	`inspecting`

Document Management

Document Management Services

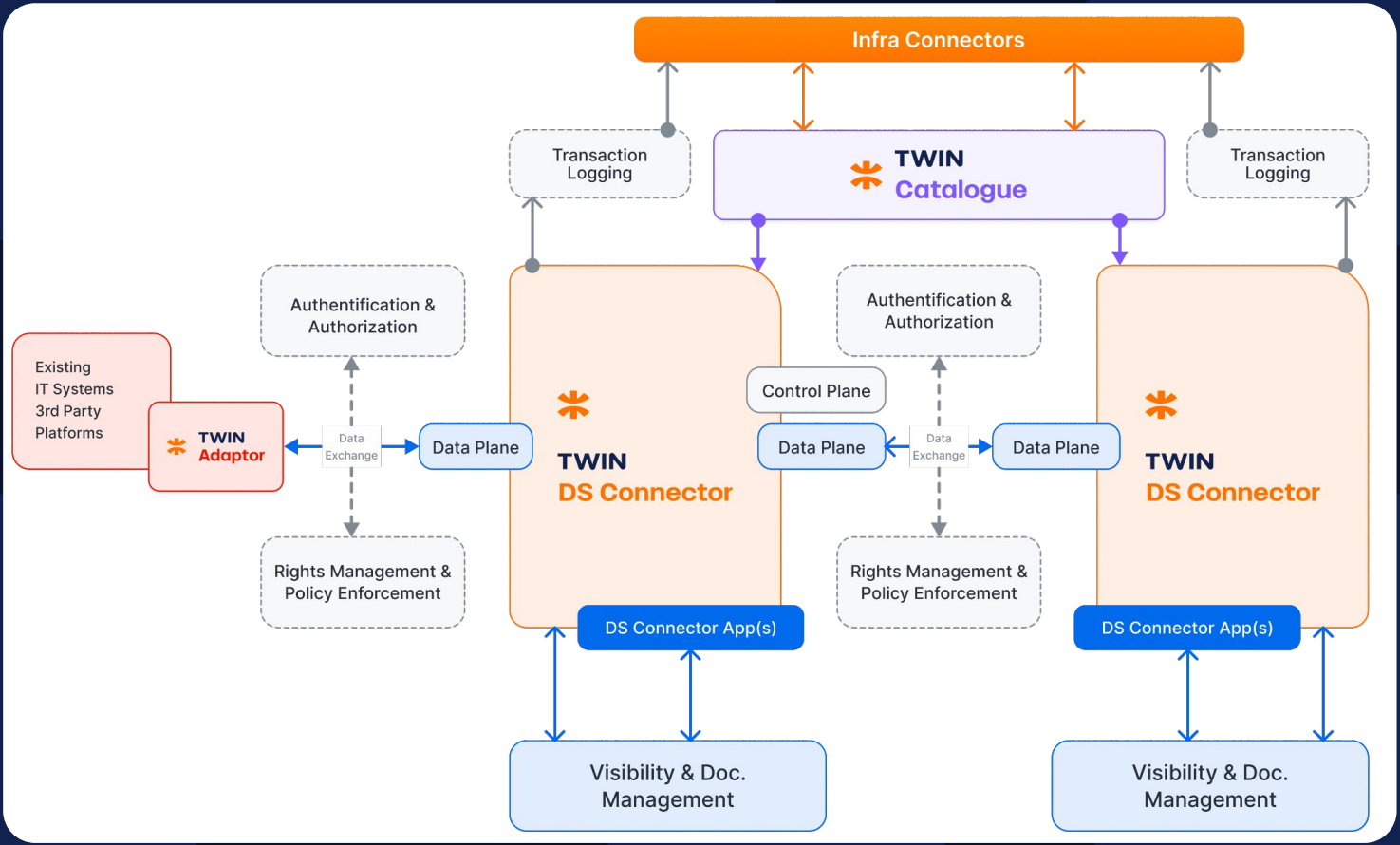


Document Metadata Properties Example

Name	Event ID	Description
Details	Document ID	urn:docId:337:b0ff65af9768c9a24b9579c953c8a856b5f3e197b2...
	Document Type	unece:DocumentCodeList#851
	Revision Number	2
	Item referred	https://id.gs1.org/01/09521987654327/21/202301
Content	Content size	5671
	file format	application/xml
	content locator	urn:fs-blob:7df6bdb4cb31ad118c9dfb3053f8cd671330e9538bfe...
Timestamps	Issued at	2024-09-12T 15:05:03.321Z
	Created ad	2024-09-12T 15:05:03.321Z
Party	Issuer party	did:iota:0xb62afcd0150d048ea0679af61d28d0eb1ad1b969f411b...
	Sender party	did:iota:0xd7258832d2c578426f2d33ce320cf485b3707ae99b90...
Proof	Fingerprint	c6b6f54aecdec6f37de08ae4a2375eceb1d69115c28c2738c9155...

TWIN Data Space Connector

Data Space Connector Overview



Practical Case

Practical Case

Consignment creation and document attestation (tokenization)

Performed in the TWIN Workbench (single-node sandbox environment at https://workbench.twindev.org).

Steps:

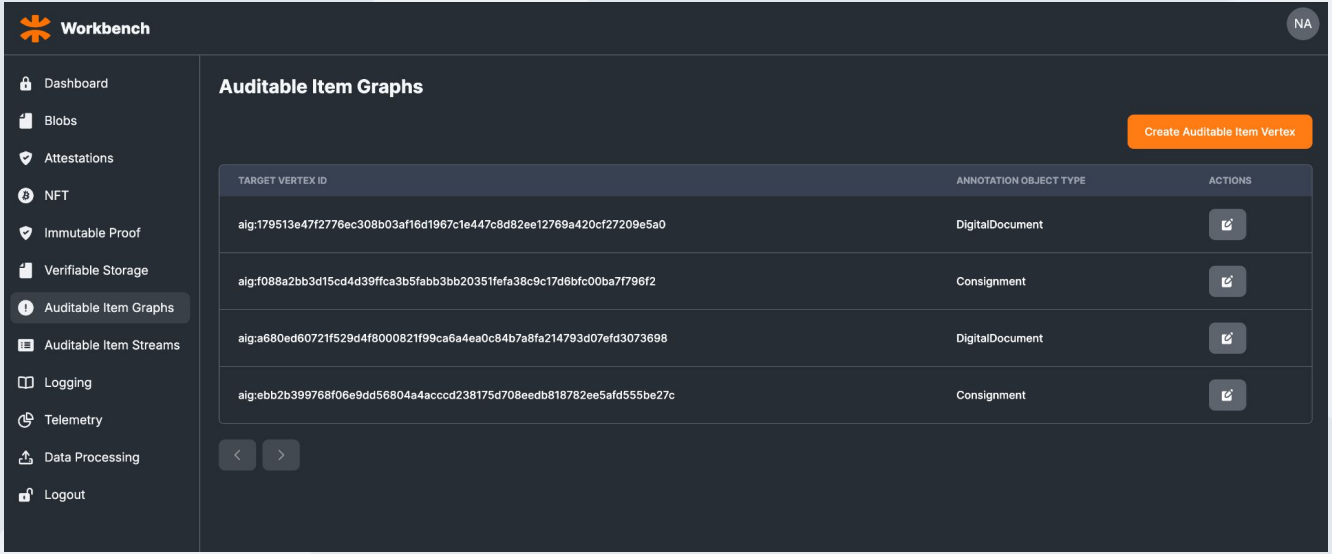
1. **Create Auditable Item**

   A Consignment represented using the UN/CEFACT Vocab)

2. **Associate a Document with the original Consignment**

   - Upload Document (Phytosanitary Certificate)
   - Attest Document via NFT
   - Create Auditable Item (to represent the Document)
   - Link Document to Consignment

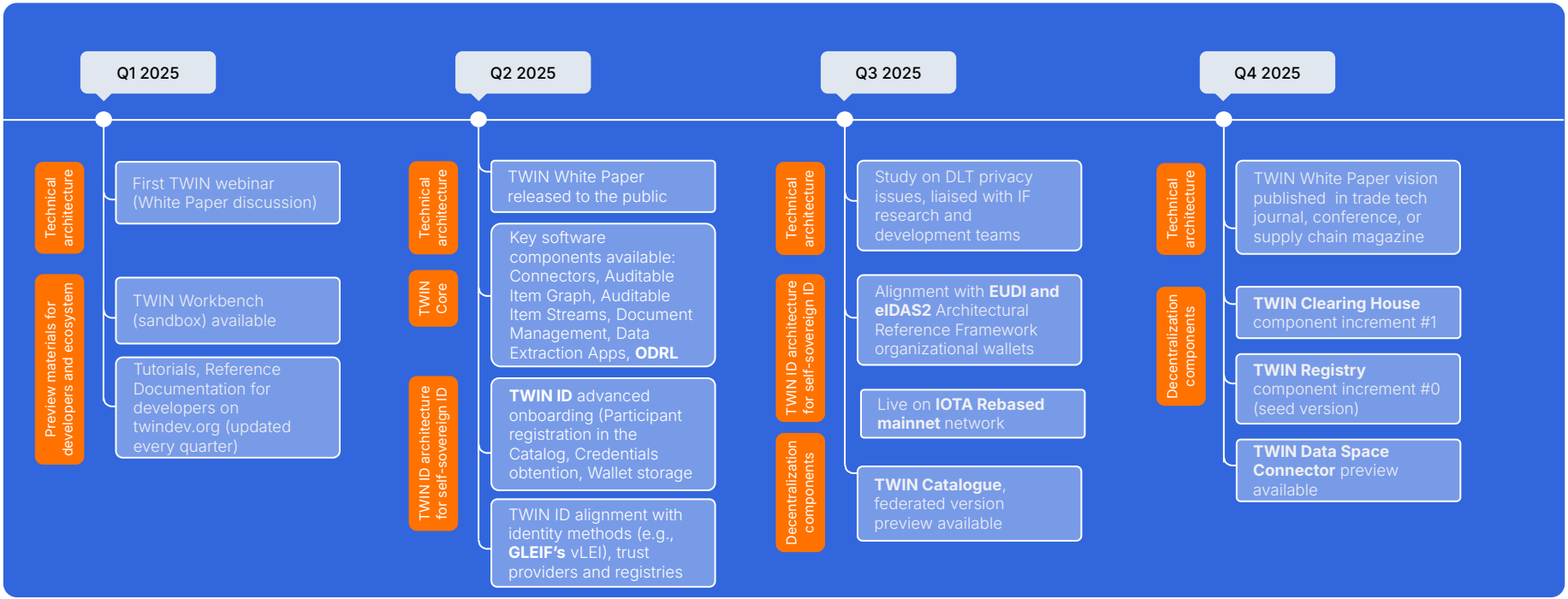
3. **Verify on the Ledger**



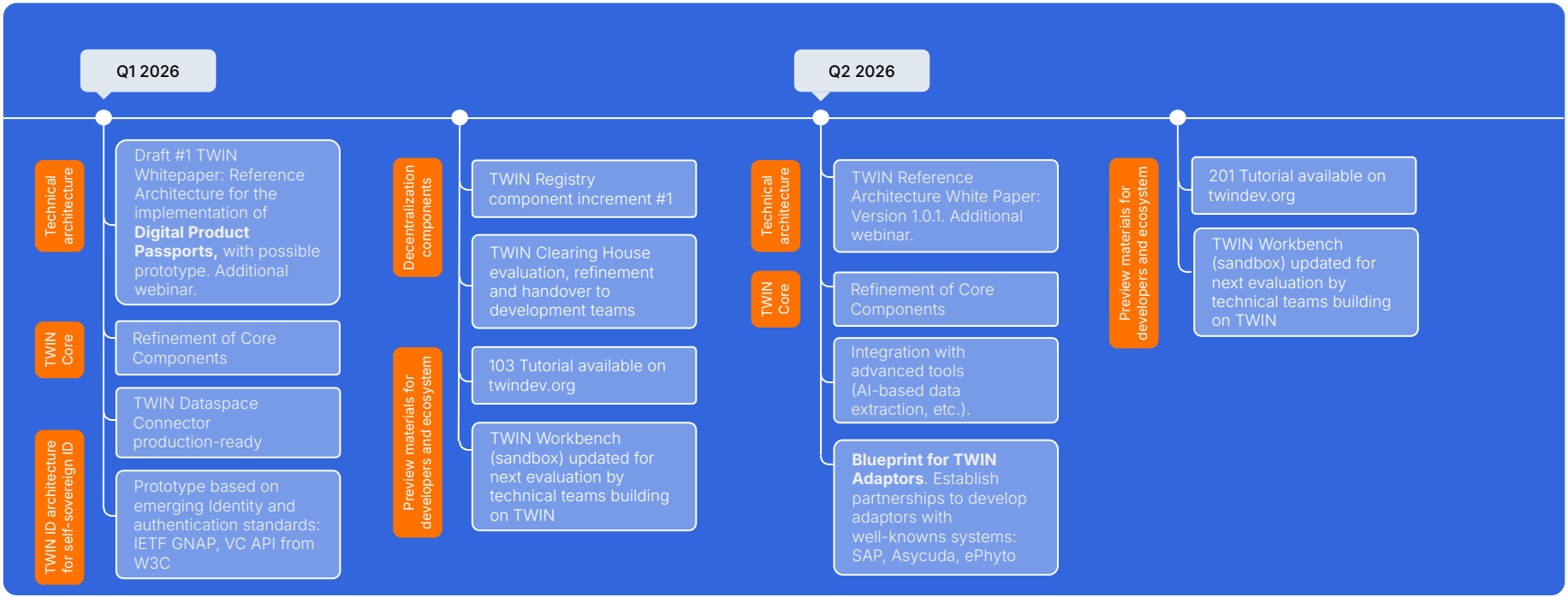
TWIN Roadmap

TWIN Technical Roadmap 2025

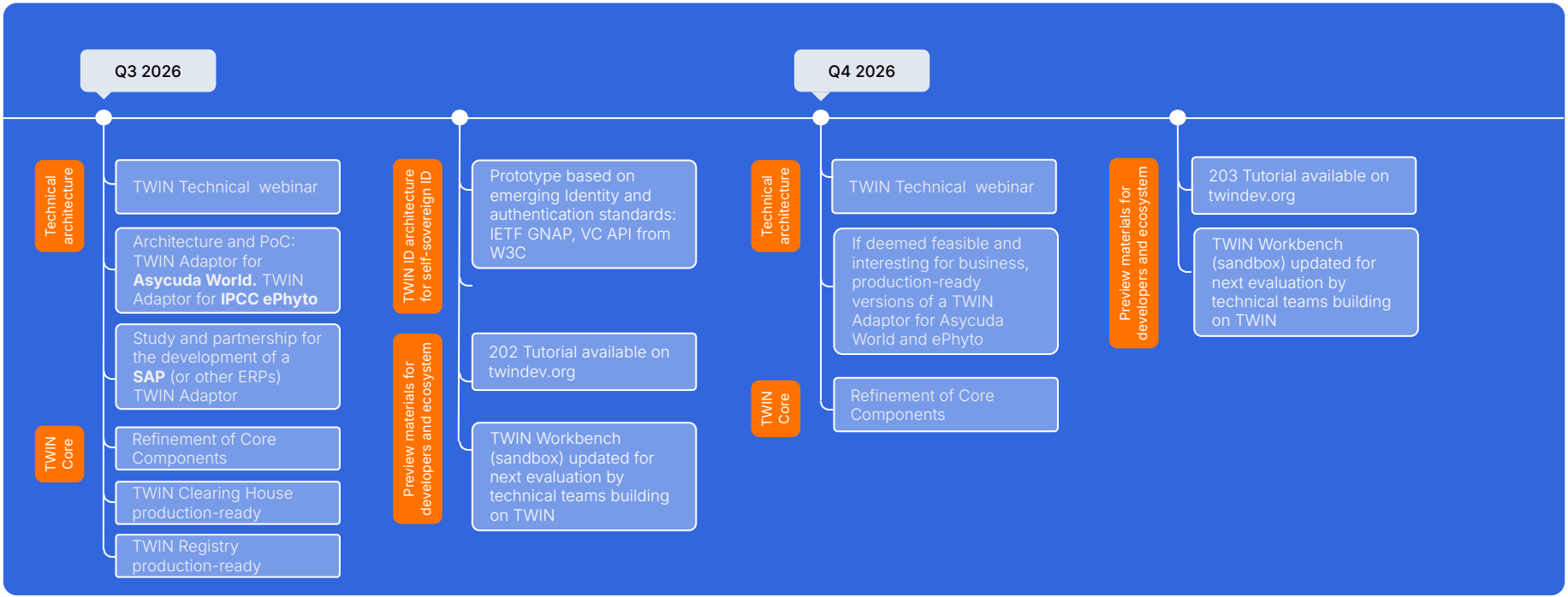
The technical roadmap outlines key milestones for TWIN's architecture, TWIN Core components, relevant initiatives, emerging technology evaluations, and prototype validation before transitioning to development.



TWIN Technical Roadmap 2026



TWIN Technical Roadmap 2026



TWIN

Thank you!