Digital Product Passport and Digital Battery Passport
powered by AAS, EDC & OPC UA

Digital product passports (DPP) as part of European broader regulatory

European Green Deal

EU Plan: climate-neutral by 2050, safeguard biodiversity, establish a circular economy and eliminate pollution, while boosting the competitiveness of the European industry

agreed

Ecodesign for Sustainable Product Regulation (ESPR)

- Proposed in Mar 2022, as central part to the Commission's strategy for eco-friendly and circular products
- Aims to promote environmental sustainability across a broader range of products

Requires **digital product passports based** on harmonized European Standards (hEN)

Entered into force

Battery Regulation

- Entered into force in Aug 2023 replacing the EU Battery Directive
- Provides a legal framework aiming to promote sustainability, circularity, safety and transparency

Mandates a **battery passport** for all EV, LMT, and industrial (>2kWh) batteries starting Feb 2027

Proposal

End-of-Life Vehicle Regulation

- Proposed in Jul 2023
- Will replace the End-of-life Vehicle Directive
- Governs the entire vehicle lifecycle, from design to end-of-life treatment

Mandates a **circularity vehicle passport**

# Most product groups require a DPP and are affected by JTC 24

Main Regulations
ESPR
Batteries (Traction and industry)
Toys
Detergents
Construction Materials
Critical Raw Materials

- Iron & steel
- Aluminium
- Textile, notably garments and footwear
- Furniture, including mattresses
- Tyres
- Detergents
- Paints
- Lubricants
- Chemicals
- Energy related products
- ICT products and other electronics

DPP for Building Resilient Manufacturing Supply Chains

Or: How to provide scalable product data, cross-platform

- Supplier needs to verify component / raw materials are within spec

- ESG Reporting: Supplier needs to report hazards of materials provided

- Manufacturer needs to digitally verify data from supplier on-the-fly during production planning

- Manufacturer needs to calculate carbon footprint of product manufactured (PCF)

- From 2027: Manufacturer needs to produce digital description of product to European Commission
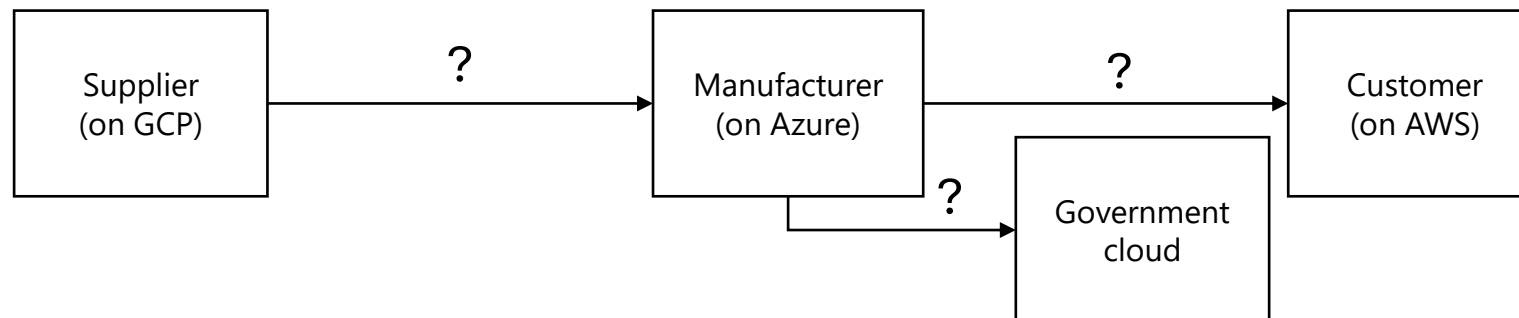
Example: Battery in EV

🔋   CATL delivers battery to Automotive OEM with (machine-readable) Digital Battery Passport, it includes battery PCF.
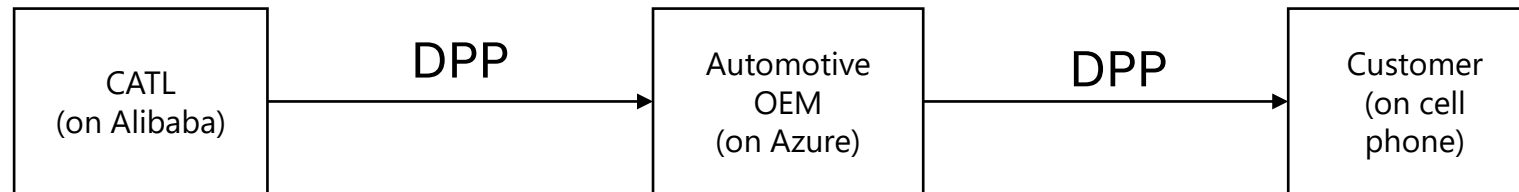
🚗   OEM installs the battery in their EV and uses PCF for total EV PCF calculation to be entered into DPP.

▦   OEM creates DPP for EV, accessible via QR code sticker on car for customer to read.

📱   Customer buys EV and scans QR code with their cell phone, gets directed to human-readable version of DPP.

```
┌──────────────┐           ┌──────────────┐           ┌──────────────┐
│    CATL      │    DPP     │  Automotive  │    DPP     │   Customer   │
│ (on Alibaba) │ ─────────▶ │     OEM      │ ─────────▶ │  (on cell    │
│              │            │  (on Azure)  │            │    phone)    │
└──────────────┘           └──────────────┘           └──────────────┘
```

Example: Data in Battery DPP ("Battery Passport")

📄 Digital Nameplate (serial number, manufacturer address, year of manufacturing)

🛒 Materials used, which ones are hazardous and where they came from

🚭 Product Carbon Footprint (PCF – Scope 1, 2 & 3 emissions, calculation method, CO2 equivalence)

⏰ Remaining Useful Lifetime: Number of charging cycles, cell condition

👤 Owner info: Current owner, contact information

The Key to Reducing Costs: Data Interoperability

We need…

1. A common **Interface** (Analogy: A Book)

2. A common **Data Format** (Analogy: The Latin Alphabet)

3. A common **Data Model** (Analogy: The English Language)

4. Common **Semantics** (Analogy: The Plot and Characters from the Novel)

Only when all 4 things are present can we truly understand each other!

DPP with an IEC standardized interface & data format/model/semantics

Interface: OpenAPI-compatible (REST and Data Space Protocol)

Data Format: OPC UA Nodeset file

Data Model: OPC UA Modelling Language

Semantics: I4AAS Companion Spec & Asset Admin Shell Submodel Templates

Leveraging IEC Standard OPC UA Building Blocks for the DPP & DBP

- Mapping from AAS to OPC UA defined in Details of the Asset Administration Shell Spec Part 1
    - OPC UA Information Model for AAS is defined in section 7.7
    - I4AAS OPC UA Companion Spec v1, IDTA-OPCF Joint Working Group developing a new version!

- UA Cloud Library REST Interface
    - An OpenAPI-compatible Interface for accessing online OPC UA Information Models

- Rich Ecosystem of free & professional OPC UA modelling tools
    1. CESMII's Smart Manufacturing Profile Designer
    2. Siemens OPC UA Modeling Editor (SiOME)
    3. Beckhoff TwinCAT 3 OPC UA Nodeset Editor
    4. Unified Automation UaModeler
    5. Beeond EdgeXStudio
    6. Free OPC UA Modeler
    7. ProSys OPC UA Modeler
    8. IBH OPC UA Editor
    9. OOI Address Space Model Designer (OOI ASMD)
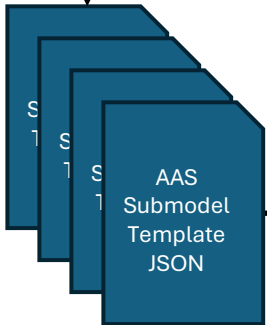   10. … and many more open-source projects…

AAS Submodel Template -> OPC UA Nodeset Conversion Tool
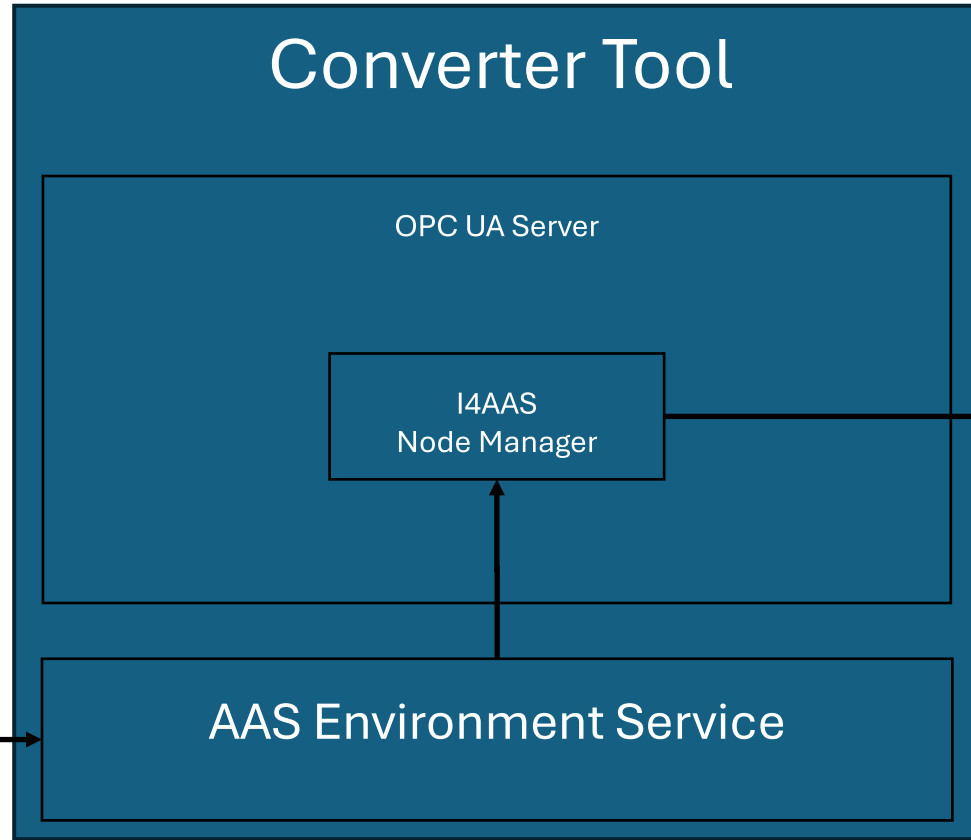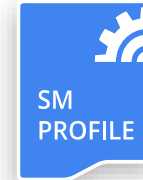
Leveraging Standard AAS Building Blocks for the DPP & DBP

- IEC AAS Submodel Templates
  - Semantic descriptions for a range of asset types
  - Can be automatically converted to OPC UA nodesets

- Catena-X AAS REST Interface
  - An OpenAPI-compatible interface for AAS Repositories/Registries

- CEN/CENELEC JWG24
  - An OpenAPI-compatible interface for the DPP

Dataspace Connectors
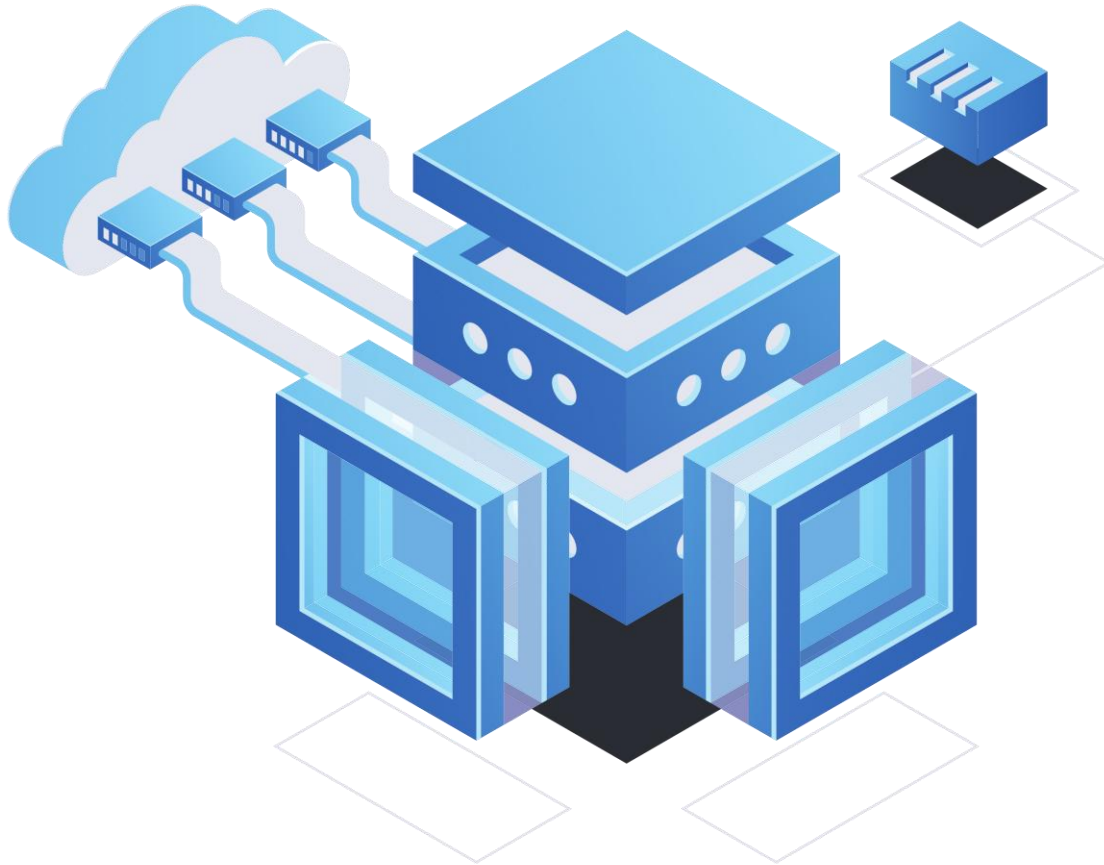
One example is the Eclipse Dataspace Connector, an **open-source framework** hosted by the Eclipse Foundation for building **secure, globally-scalable data-sharing services**. EDC provides highly customizable components for creating control planes, decentralized identity systems, and federated data catalogs. **Backed by leading companies and cloud providers**, EDC gives developers the tools they need to deliver innovative solutions for data exchange networks. Other projects are targeting dataspace connectivity issues, e.g. Data4Industry.

Next step: Integration and testing of Dataspace Connectors.

eclipse-edc.github.io

Use Case: Combining Ecosystems – OPC UA & AAS implementing EU Digital Product Passport Together with OPCF/DTC/CESMII/Manufacturing USA
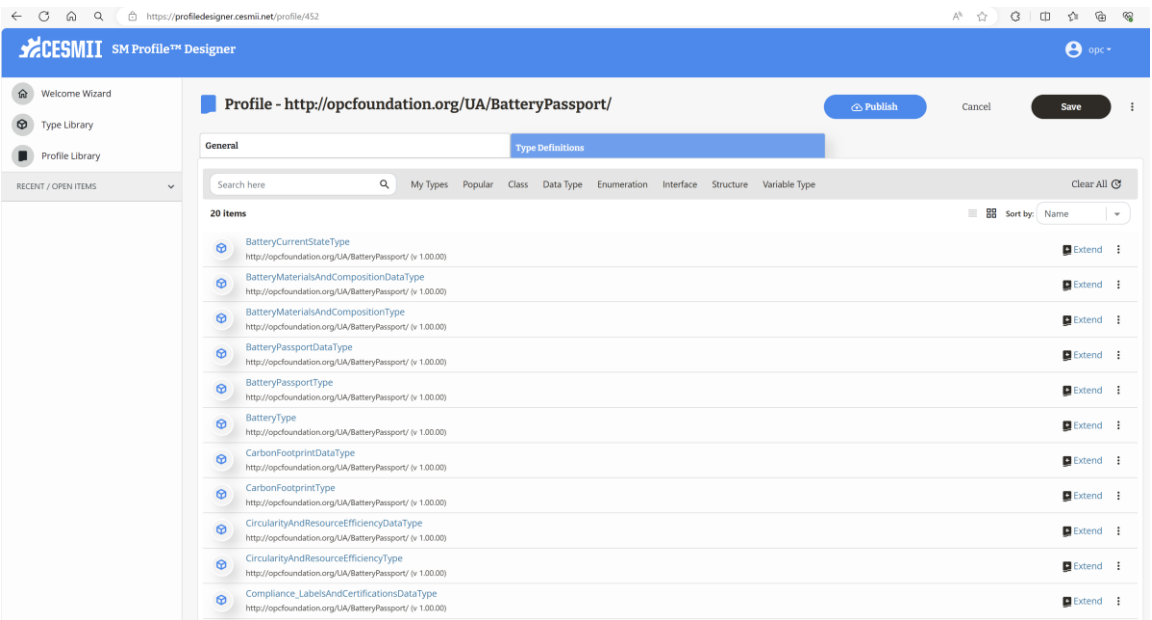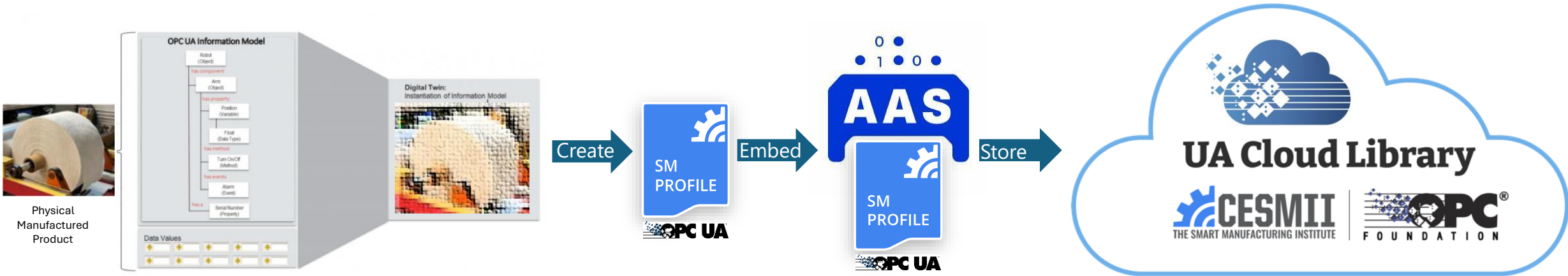
profiledesigner.cesmii.net (free online OPC UA editor)

UA Cloud Library Multi-Tenant, Multi-Cloud Architecture
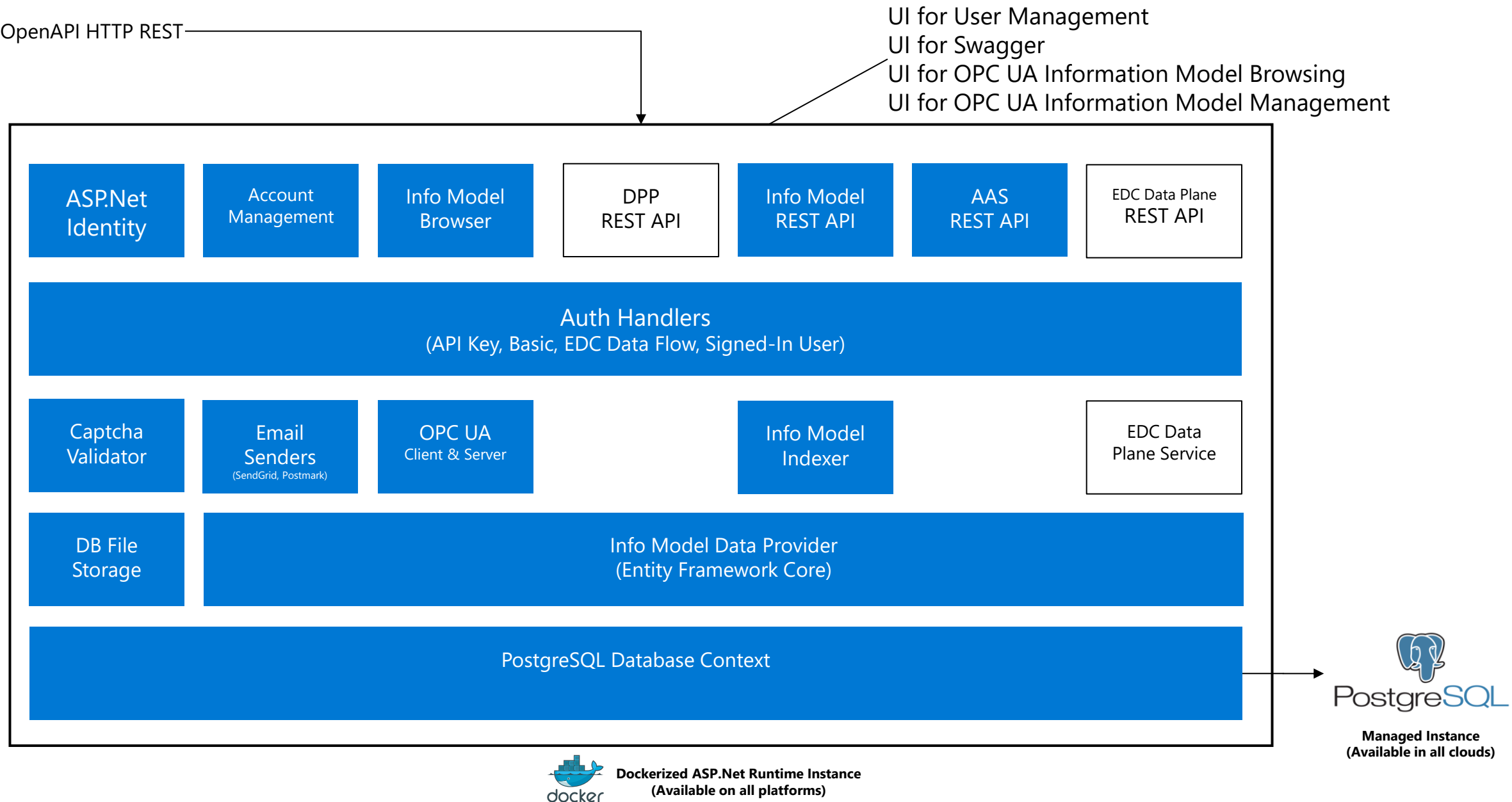
OpenAPI HTTP REST

UI for User Management
UI for Swagger
UI for OPC UA Information Model Browsing
UI for OPC UA Information Model Management

ASP.Net Identity	Account Management	Info Model Browser	DPP REST API	Info Model REST API	AAS REST API	EDC Data Plane REST API

Auth Handlers
(API Key, Basic, EDC Data Flow, Signed-In User)

Captcha Validator	Email Senders (SendGrid, Postmark)	OPC UA Client & Server	Info Model Indexer	EDC Data Plane Service

DB File Storage	Info Model Data Provider (Entity Framework Core)

PostgreSQL Database Context

PostgreSQL
Managed Instance
(Available in all clouds)

docker
Dockerized ASP.Net Runtime Instance
(Available on all platforms)

OPC Foundation Cloud Initiative Reference Architecture (Dataspace-relevant)

Data from Supplier

Eclipse Dataspace Connector

ERP Database

data from Product usage

Product Database

Connected Product Time-Series Database

Cloud MES Service

OPC UA PubSub data from production

Production Lines Time-Series Database

Customer ERP Database

Focus of ECA project

UA Cloud Library (OPCF Hosted)

Dynamic Data Processor

UA Cloud Library (Ind. data plane)

OpenAPI REST

Eclipse Dataspace Connector

Dataplane Protocol

Eclipse Dataspace Connector (Control plane)

Dataspace Protocol

Product Customer

Enterprise Cloud (Manufacturer)

Legend:

Database

Open-Source Component

CarbonFootprintAAS

UA Cloud Library

Loaded Nodesets

http://opcfoundation.org/UA/
http://industrialdigitaltwin.org/UA/CarbonFootprintAAS/

Required Nodesets Missing from UA Cloud Library

(none)

Nodeset Browser

- ⊟ Root
  - ⊟ Objects
    - ⊞ Server
    - ⊞ Aliases
    - ⊞ Locations
    - ⊞ **Asset Admin Shells**
    - ⊟ **Submodels**
      - ⊟ **CarbonFootprint**
        - ⊞ **TransportCarbonFootprint**
        - ⊞ **ProductCarbonFootprint**
    - ⊞ **Concept Descriptions**
  - ⊞ Types
  - ⊞ Views

Selected Node Value   Edit

(none)

Nodeset File   Copy

Download node values   Download

Save node values   Save

Example: New Catena-X (Automotive) User Journey

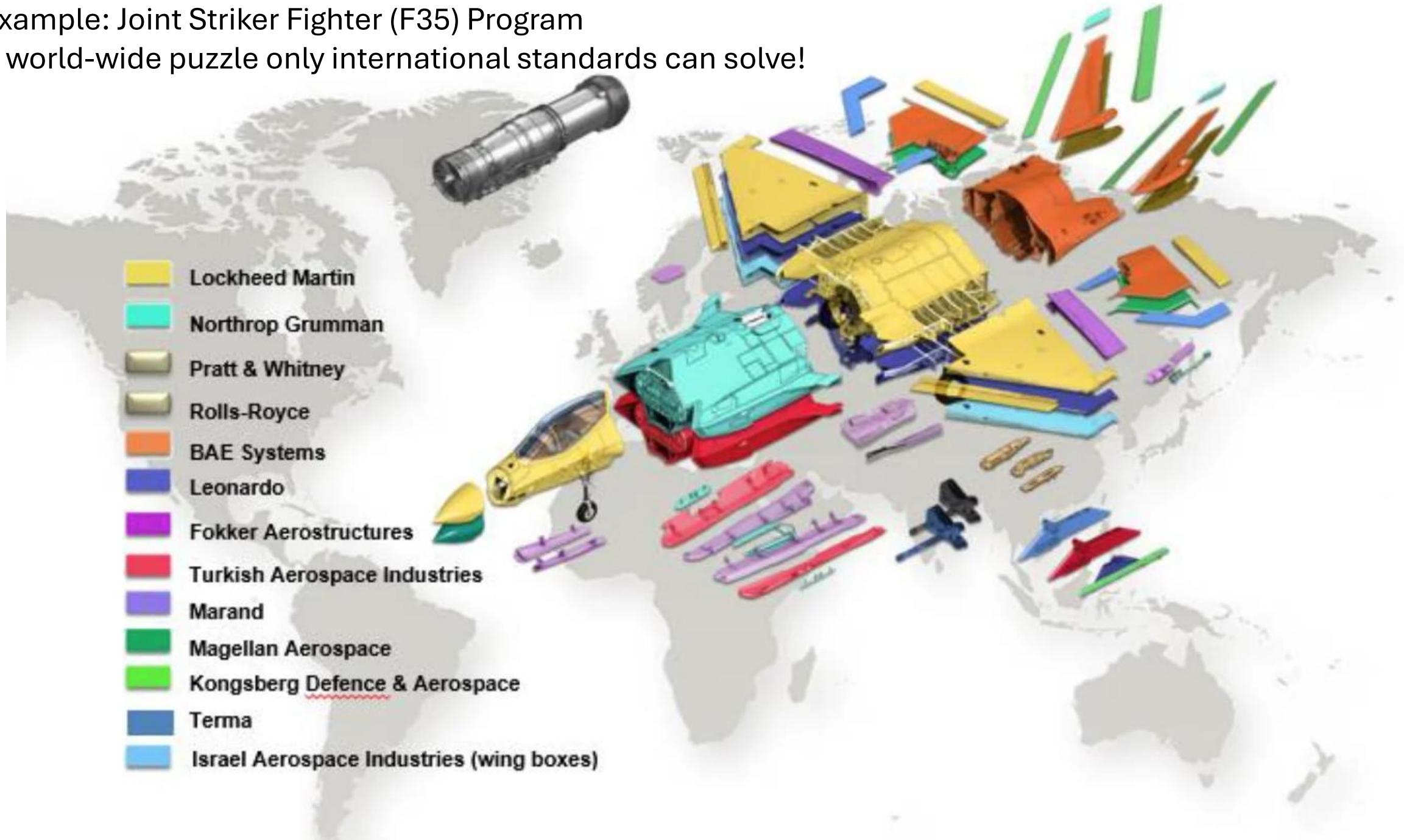1. All Catena-X SAMM templates are now available in OPC Foundation UA Cloud Library.

2. Catena-X template is loaded into new OPC Foundation online UA Nodeset Editor and values are entered.

3. Edited Catena-X nodeset file is uploaded to another UA Cloud Library instance and hosted online on behalf of the supplier.

UA Nodeset Editor

Load → Upload →
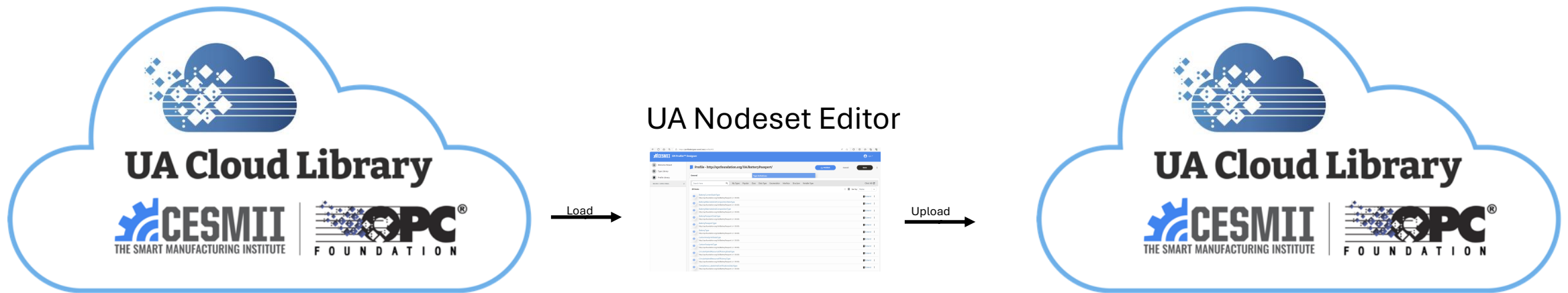
Example: Joint Striker Fighter (F35) Program
A world-wide puzzle only international standards can solve!

Legend:
- Lockheed Martin
- Northrop Grumman
- Pratt & Whitney
- Rolls-Royce
- BAE Systems
- Leonardo
- Fokker Aerostructures
- Turkish Aerospace Industries
- Marand
- Magellan Aerospace
- Kongsberg Defence & Aerospace
- Terma
- Israel Aerospace Industries (wing boxes)

NEW WORK ITEM PROPOSAL (NP)

PROPOSER:	DATE OF PROPOSAL:
Secretariat	**2025-02-21**

DATE OF CIRCULATION:	CLOSING DATE FOR VOTING:
2025-02-28	**2025-05-23**

New Working Group in IEC TC65 JWG29

IEC TC 65 : INDUSTRIAL-PROCESS MEASUREMENT, CONTROL AND AUTOMATION

SECRETARIAT:	SECRETARY:
France	Mr Didier GIARRATANO

NEED FOR IEC COORDINATION:	HORIZONTAL FUNCTION(S):
SC 3D,SC 41	

ASPECTS CONCERNED:

Digital content,Information security and data privacy

TITLE OF PROPOSAL:

Industrial Automation Product Data

☒ STANDARD   ☐ TECHNICAL SPECIFICATION   ☐ PUBLICLY AVAILABLE SPECIFICATION

PROPOSED PROJECT NUMBER:

SCOPE
(AS DEFINED IN ISO/IEC DIRECTIVES, PART 2, 14):

The document contains Industrial Automation Product Data as information models and interfaces with defined semantics for digital use for industrial manufactured products, small and big assemblies and manufacturing systems.

It supports the entire lifecycle and supply chain. Specifically, the data covers lifecycle stages from planning, designing, producing, using, maintaining, repairing, and disposing.

Industrial Automation Product Data with standardized digital information supports industrial digital twins and circular economy, as well as carbon footprint aggregation with the relevant environmental impact factors.

The following standards are leveraged as a baseline: IEC 63283-2 Smart manufacturing - Part 2: Use cases and IEC 63278-4 Asset Administration Shell for industrial applications - Part 4: Applications of Asset Administration Shell. In addition, the IEC 62264 Enterprise-control system integration series is used to define IEC CDD properties with their semantics.

The Industrial Automation Product Data standard defines the semantic of properties in sufficient detail for the general usage e.g. for digital product passports and production systems. The standard specifies how the data are created, collected, used and maintained along the supply chain.

TARGET DATE(S)	FOR FIRST CD:	2025-12-31	FOR PUBLICATION:	2027-12-31

ESTIMATED NUMBER OF MEETINGS:	FREQUENCY OF MEETINGS:	DATE OF FIRST MEETING:	PLACE OF FIRST MEETING:
40	20 per year	2025-06-18	web

RELEVANT DOCUMENTS TO BE CONSIDERED:

IEC 61360 Common data dictionary

IEC 63278-1 Asset Administration Shell for industrial applications - Part 1: Asset Administration Shell structure

IEC 62541-5 OPC Unified Architecture - Part 5: Information Model

IEC 62541-6 OPC Unified Architecture - Part 6: Mapping

IEC 62541-14 OPC Unified Architecture - Part 14: PubSub

RELATION TO AND IMPACT ON EXISTING WORK:

Standards for the DPP developed in CEN/CLC/JTC 24.