

# *Tutorial: The Key to Sustainable Enterprises*

**ESG, Knowledge Graphs, and Digitalization**

**Part II: Use case Digital Product Passport (DPP)**

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# Part II: Use Case **Digital Product Passport**

## Outline

- ▶ The Framework: Green Deal and Sustainable Products Initiative
- ▶ Use Case **Digital Product Passport (DPP)**
- ▶ Outlook

## Key figures

**The first climate-neutral continent**  
by 2050

**At least 55% less**  
net greenhouse gas emissions by  
2030, compared to 1990 levels

**3 billion**  
additional trees to be planted in the  
EU by 2030



# Green Deal

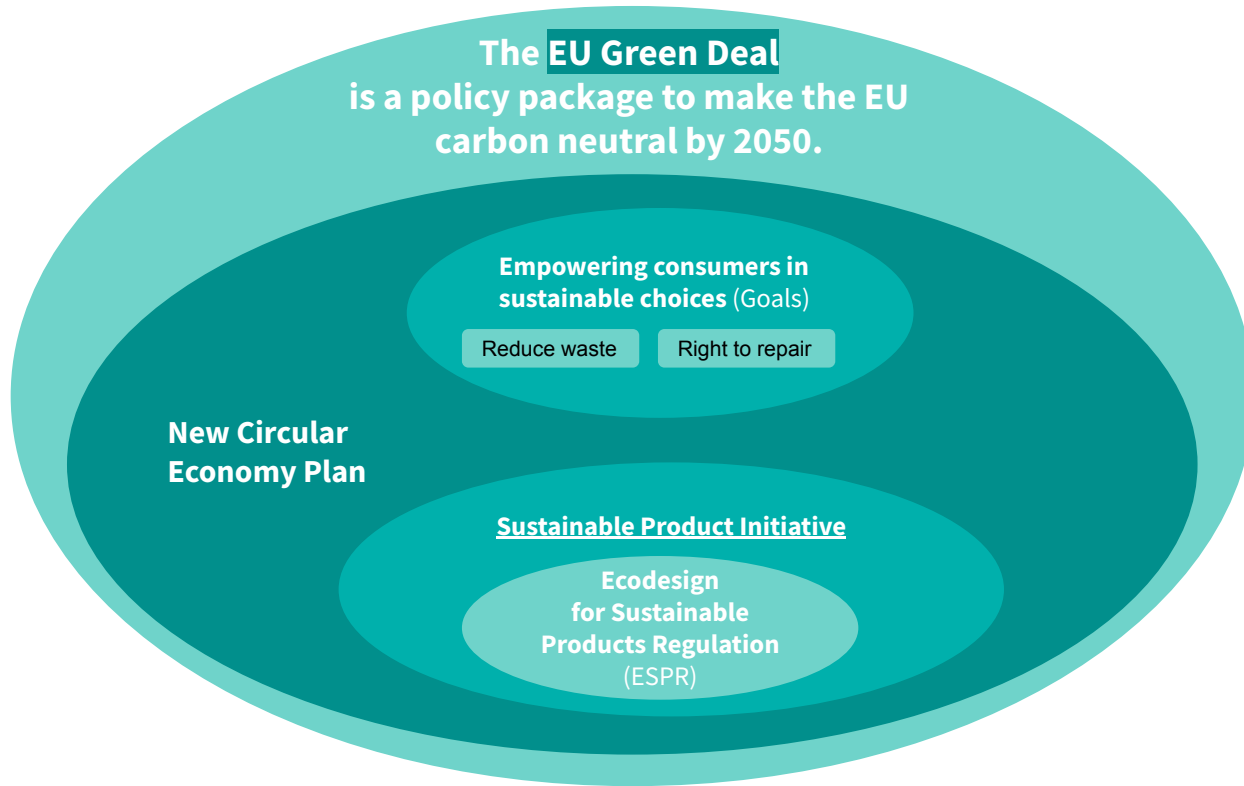
# Framework - The European Green Deal

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- ▶ The **European Green Deal** will improve the **well-being** and **health generations** by providing:
  - ▶ **fresh air, clean water, healthy soil and biodiversity**
  - ▶ renovated, **energy efficient buildings**
  - ▶ **healthy and affordable food**
  - ▶ more **public transport**
  - ▶ **cleaner energy** and cutting-edge clean technological innovation
  - ▶ **longer lasting products** that can be **repaired, recycled and reused**
  - ▶ **future-proof jobs** and skills training for the transition
  - ▶ **globally** competitive and **resilient industry**



# Sustainable Products Initiative



## Focus areas

- Climate
- Energy
- Environment and oceans
- Agriculture
- Transport
- Industry
- Research and innovation
- Finance and regional development
- New European Bauhaus



- ▶ **Ecodesign for Sustainable Products Regulation (ESPR)** replaces the initial **Ecodesign Directive** (2009) and covers the “broadest possible range of products” and more **Ecodesign criteria**
- ▶ **Ecodesign and Energy Labeling Working Plan 2020-2024** ([GEN - 1221.00](#))  
Analysis, recommendation, and selected product groups and horizontal activities
  - ▶ [Ecodesign Working Plan 2020-24](#)
- ▶ **Implementing act** for each of the regulated product groups

## **31 product groups and horizontal initiatives**

- *Universal external power supplies*
- *Professional laundry appliances*
- *Professional dishwashers*
- *Professional cooking appliances*
- *Low temperature emitters*
- *Enterprise network equipment*
- *Small network equipment for home and office*
- *Industrial Smart Sensors*
- *---*
- *Recycled Content*
- *Scarce and critical raw materials*
- *Lightweight design*

# 15 Product groups and Initiatives (Phase 1)

Product groups & horizontal initiatives	Primary energy savings PJ			Resource efficiency	Other environmental impacts	Regulatory coverage and feasibility	Cost-effectiveness	Industrial competitiveness	Recommendations
	Use phase	2030 Material content	Rate						
<b>Product groups</b>									
Professional laundry appliances and dishwashers	53		++	++	++	+++	+++	+++	+++
Professional cooking appliances	117		+++	+	++	++	++	++	++
Low temperature emitters	170		+++	+	+	++	++	+++	++
Swimming pool heaters	14-63		++	+	+	++	++	+++	+
Enterprise network equipment	22	3	+	+	+	++	+++	+++	+
Small network equipment for home and office use	69	7	++	+	+	+	++	++	++
Universal external power supplies		12-27	+	+++	+	+	++	+	++
Uninterruptible power supplies	55	1	++	+	+	++	++	++	+++
Industrial smart sensors	76-152	5	+++	++	+	++	++	++	+++
<b>Horizontal initiatives</b>									
Lightweight design		180	+++	+++	+	++	+++	+++	++
Recycled content		160	+++	++	+	+	+	+	+
Ecological profile			+++	++	++	++	++	++	++
Durability and firmware		175-1052	+++	+++	+	+++	+++	+++	+++
Application software			+++	++	+	+	++	+++	+
Scarce and critical raw materials			+++	+++	+	++	+++	+++	+++

# Energy Labeling Regulations

- ▶ The energy **labeling requirements** for individual product groups are created under the EU's energy labeling framework regulation, in a process coordinated by the European Commission.
- ▶ 16 of the product groups require an energy label.
- ▶ The **Energy Labeling Regulation** (2017) serves for recognition of the best-performing products by consumers
- ▶ **Products** must have a **re-scaled energy label** on their packing, showing an **A-G scale** (initiated in 2021).



## 16 product groups (2023)

- **dishwashers**
- **electric motors**
- **electronic displays (TVs)**
- **air conditioners**
- **mobile phones, tablets**
- **Game consoles**
- **lighting products**
- **refrigeration**
- **water and space heaters**
- **vacuum cleaners**
- **ventilation**
- **washing machines and washer-dryers**
- **tyres**
- **computers and servers**

# Supply Chain Act for Germany (LkSG)

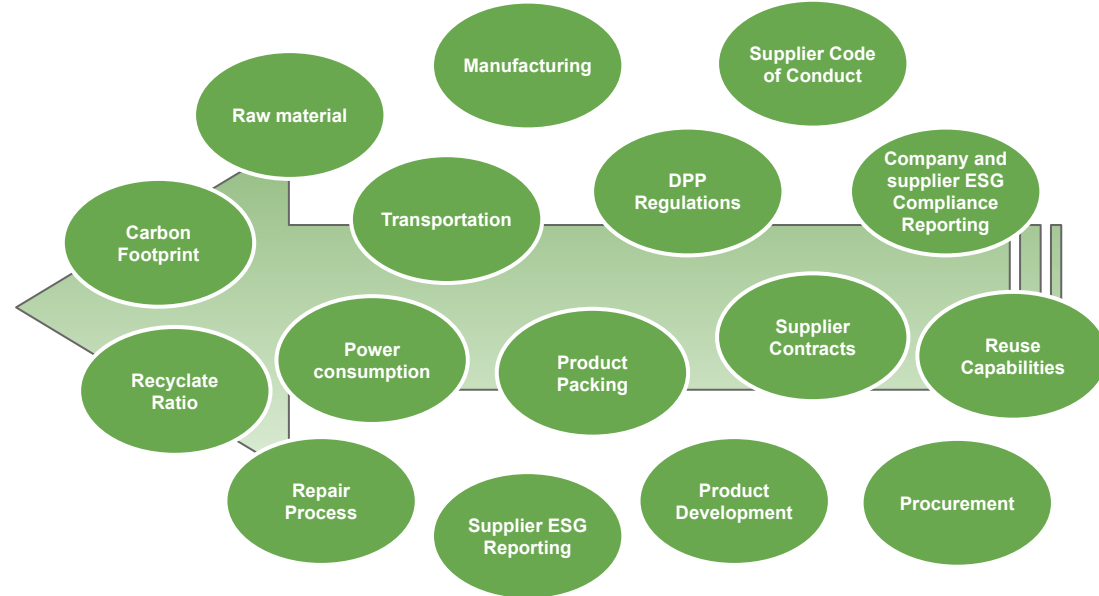
- ▶ The **Supply Chain Due Diligence Act** has been in force in **Germany** since **Jan. 1, 2023**.
- ▶ **Federal Office for Economic Affairs and Export Control** / Bundesamt für Wirtschaft und Ausfuhrkontrolle @DE (**BAFA**)
- ▶ Obligation to **establish an ESG risk management system** to identify and minimize the **risks of human rights violations** and **environmental damage** for all Enterprises in Germany,
  - ▶ with a workforce of **3.000** or more employees, from **2024**, with a workforce of **1.000** or more employees
- ▶ **Corporate Sustainability Reporting (CSR)** including supplier data
- ▶ **Statement** of company **principles**
- ▶ **Results of the risk analysis** on environmental and human rights risks
- ▶ **Measures** for **prevention and remediation**
- ▶ Description of **procedures for ensuring compliance**

***Lieferkettensorgfaltspflichtengesetz (LkSG)***



# Digital Product Passport (DPP)

# Digital Product Passport focus areas



# Digital Product Passport (DPP)

- ▶ The **Digital Product Passports** is an electronic record of a product which presents **product data** collected throughout its **entire lifecycle** used to illustrate product **sustainability, environmental** and **recyclability** facts and compliance.
- ▶ Only **food, feed, pharmaceutical products, living plants and products of human origin** are **excluded** from the rule as part of the **European Green Deal**. As a result, any business selling a product on the EU market will need to provide a **product passport** for both the **finished product** and each of its **individual parts**.
- ▶ The product needs to **carry a link** to the product passport on the product itself.



*The **DPP regulation** is currently being **drafted** by the European Commission, with **final approval anticipated in the year 2024** and **implementation** of the first product groups scheduled **for the year 2026/27**.*

- ▶ **Unique product identifier & label**
  - ▶ GTIN, GS 1 link, QR code, RFID
- ▶ **Basic product data**
  - ▶ Name, model, batch, manufacturing date, warranty details, technical parameters, estimated product lifetime
- ▶ **Material data**
  - ▶ Origins of raw materials and components, **critical raw materials (CRM)**, **material recycle ratios** and related **supplier details**
- ▶ **Repair data**
  - ▶ Repair capability, spare parts availability, specific repair events and reasons
- ▶ **Sustainability data**
  - ▶ Carbon footprint of the manufacturing and distribution processes and use phase footprint, resource and energy efficiency
- ▶ Commitment to **ethical business practices**, **transparency**, and **fairness**

- ▶ Implementation starts for **three Product categories in 2024**, prototype in progress, managed by CIRPASS DPP initiative.
- ▶ **Batteries**
  - ▷ [New EU Battery Regulation](#) - entered into force 17 August 2023
- ▶ **Textiles**
  - ▷ EU Strategy for Sustainable and Circular Textiles (2022)
- ▶ **Electronics**
  - ▷ Ecodesign for Sustainable Products Regulation (2022)
- ▶ **Construction Products**
  - ▷ [Construction Products Regulation](#) (2022)
- ▶ **Other Products**
  - ▷ Announced in 2024

***CIRPASS DPP Initiative (Digital Europe Association) to ensure a **gradual piloting and deployment of DPPs** based on common rules, principles, standards, **taxonomies**.***

# Sample: Toyota Sustainability Data Book (6.2023)

## Recycling

### L Raw Materials Used and Recycled Materials Use Rate: Global

GRI 301-1, 301-2, 306-4

	(million tons)		
Amount of raw materials used	2019	2020	2021
All materials	14.54	12.32	13.66
Iron	9.4	7.97	8.83
Aluminum	1.33	1.12	1.25
Others	3.81	3.24	3.58

	(%)		
Ratio of recycled materials used	2019	2020	2021
Ratio of recycled materials used in raw materials	24	24	25

### M Vehicles Recycled in Accordance with the End-of-life Vehicle Recycling Law: Toyota Motor Corporation

SASB TR-AU-440b.3 GRI 301-3

	(thousand vehicles)		
	2019	2020	2021
Amount of appropriate End-of-life vehicle treatment and recycling processed		623	585

	(%)		
Recycling rate	2019	2020	2021
Vehicle recovery rate <sup>*1</sup> (converted into a per-vehicle value)	99	99	99
ASR <sup>*2</sup> recycling rate <sup>*3</sup>	96	96	96

	(thousand tons)		
	2019	2020	2021
ASR processing volume	24	143	136

\*1 Calculated by combining the percentage recycled through the dismantling and shredding processes, approximately 83% (quoted from the report by the council of the End-of-Life Vehicle Recycling Law), with the remaining ASR rate of 17% and the ASR recycling rate of 96%.

\*2 Automobile Shredder Residue: Residue after End-of-life vehicles are shredded

\*3 Recycling volume/amount collected

### O Information on Vehicles Recycled in Accordance with SASB<sup>†</sup> Standards: Toyota Group

SASB TR-AU-440b.2

	(million tons)
	2021
Weight of vehicles recovered	1.16

	(%)
	2021
Vehicle recovery rate <sup>*4</sup> (converted into a per-vehicle value)	99

<sup>†</sup> Sustainability Accounting Standards Board

#### •Organizational Boundary•

• Domestic results of Toyota Motor Corporation, Daihatsu Motor Co., Ltd. and Hino Motors, Ltd.

### P Parts Recycled: Toyota Motor Corporation

GRI 301-3

	(units)		
	2019	2020	2021
Drive battery	39,184	40,694	41,366

	(units)		
	2019	2020	2021
FC stack	4	26	39

	(tons)		
	2019	2020	2021
Magnet <sup>*5</sup>	6.0	10.0	7.5
Lead wheel balance weight <sup>*6</sup>	69.7	59.7	58.4

	(million units)		
	2019	2020	2021
Bumper	0.658	0.535	0.544

<sup>\*5</sup> Magnets used in drive motors

<sup>\*6</sup> Weights used to adjust rotation balance when joining a wheel and tire

### N Remanufactured and Used Parts Supplied (for Repair and Replacement): Toyota Motor Corporation

GRI 301-1, 301-2, 301-3, 306-4

		(units)					
		2019		2020		2021	
		Remanufactured/ used parts	Reference: Replacement with new parts	Remanufactured/ used parts	Reference: Replacement with new parts	Remanufactured/ used parts	Reference: Replacement with new parts
Remanufactured parts	Automatic transmission	855	52	714	49	655	65
	Power steering gear	3,391	1,673	3,102	1,654	3,429	1,782
	Torque converter	794	2,569	750	2,230	645	2,265
Used parts		26,716	—	24,100	—	21,008	—

### Q Bulk Supply System<sup>†</sup> Oil Supply Rate<sup>‡</sup>: Toyota Motor Corporation

GRI 306-2

	(%)		
	2019	2020	2021
Drive battery	64.0	63.7	48.8

<sup>†</sup> A system of directly filling tanks at dealers or supplying oil using tanker trucks rather than oil cans and so on to reduce container usage

<sup>‡</sup> Percentage of oil (by bulk supply system) in volume sold by parts distributors

In principle, fractions are rounded down to the nearest unit. For this reason, the total and the breakdown totals do not always match.

Sustainability Data Book

50



# Standards and Principles

- ▶ **Classification system for Greenhouse Gas (GHG)** emissions a company is creating through **operations, energy usage** and the **entire value chain**
  
- ▶ **Classifies emissions based on where they originated from**
  - ▶ **Scope 1** - direct emissions generated onsite from activities a company owns
    - Company facilities and vehicles
  - ▶ **Scope 2** - indirect emissions caused by purchased energy
    - Purchased energy, heating, cooling and steam
  - ▶ **Scope 3** - all other indirect emissions outside the company controlled by other actors in the value chain (**15 categories**)
    - **Upstream:** Capital goods, business travel, fuel & energy, transport and distribution, employee commuting, ...
    - **Downstream:** Transport and distribution, processing and use of sold products, end of life treatments, ...

- ▶ **Sustainability Standards, Code of Conduct**
  - ▶ Adherence to **national laws** and regulations
  - ▶ **Human and labor rights**
  - ▶ **Environmental and climate protection**
  - ▶ Business **ethics**
  - ▶ High standards of **safe working conditions**
  - ▶ **Fair and respectful treatment** of employees
  - ▶ **Transparency** and checks
  - ▶ Corrective measures by the responsible party
  
- ▶ **Material, asset, component and packing related details**
  - ▶ **Rare earth elements** use (group of 17 metals)
  - ▶ **Ratio of recycled materials** used in raw materials
  - ▶ **GHG Scope 3** (upstream, 15 categories) data
  - ▶ **Repair and reuse capabilities** of components and packaging

## ▶ Design Methodologies

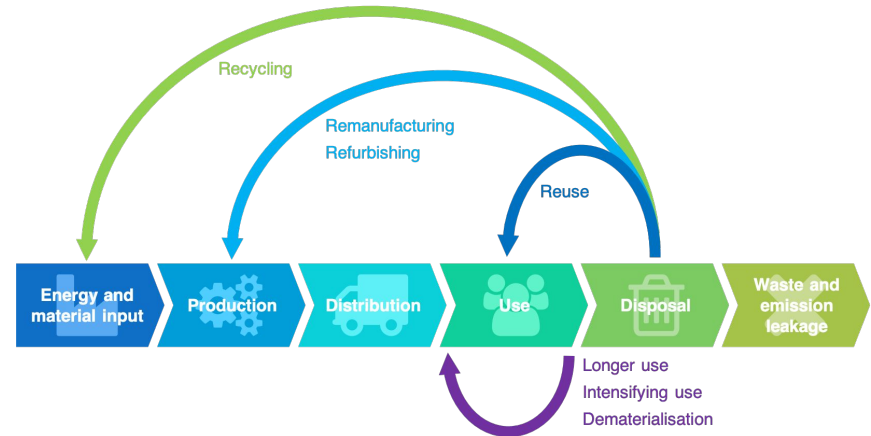
- Circular Design
- Cradle to Cradle concept
- Double Materiality concept

## ▶ Classification and Labeling Standards

- ECLASS, IEC CDD, VDA\*
- GTIN, UPC, EAN, GS1 Digital Link
- RFID, QR code, bar code (Automatic identification and data capture (AIDC))

## ▶ Frameworks

- Model Based Engineering
- Digital Twin - Asset Administration Shell (AAS)



\*German Automotive Industry Standard  
\*\* CC BY 4.0, "The Circular Economy concept",  
9 Dec-2020

# GS1 GTIN / Digital Link example

- ▶ **QR Code, RFID**
- ▶ **GTIN:** 4005906003717
- ▶ **GS1 Digital Link (minimal)**
  - Manufacturer / Marketplace base address
    - <https://ulm.poolparty.biz/01/4005906003717>
  - or GS1 base address
    - <https://id.gs1.org/01/4005906003717>
- ▶ **GS1 Digital Link (DPP)**
  - <https://ulm.poolparty.biz/01/4005906003717/10/ABC/21/123456?17=231231&linkType=DPP>

**Adelholzener Mineral Water**

**GTIN:** 4005906003717



**GTIN:** 4005906003717

**Expiration day:** 31-Dec-2023

**Batch:** ABC

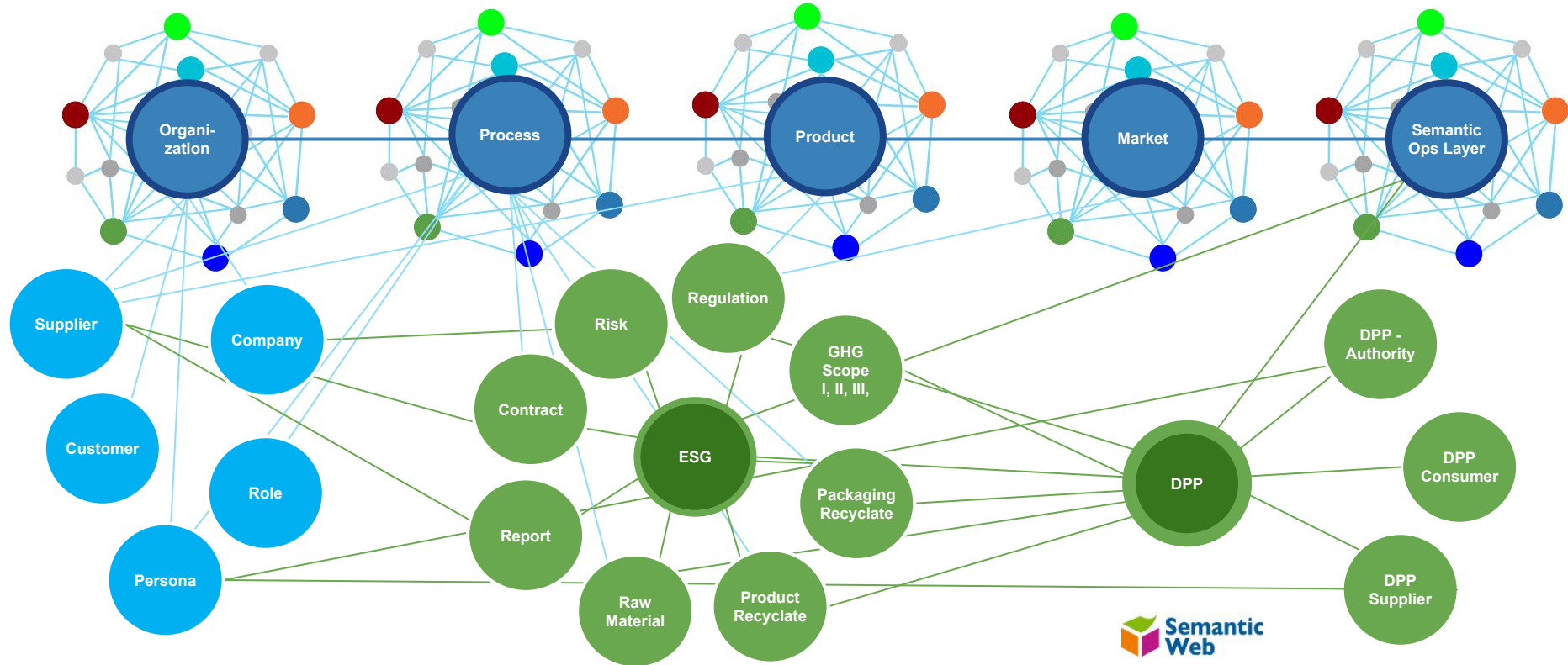
**Serial number:** 123456

**linkType:** **DPP**

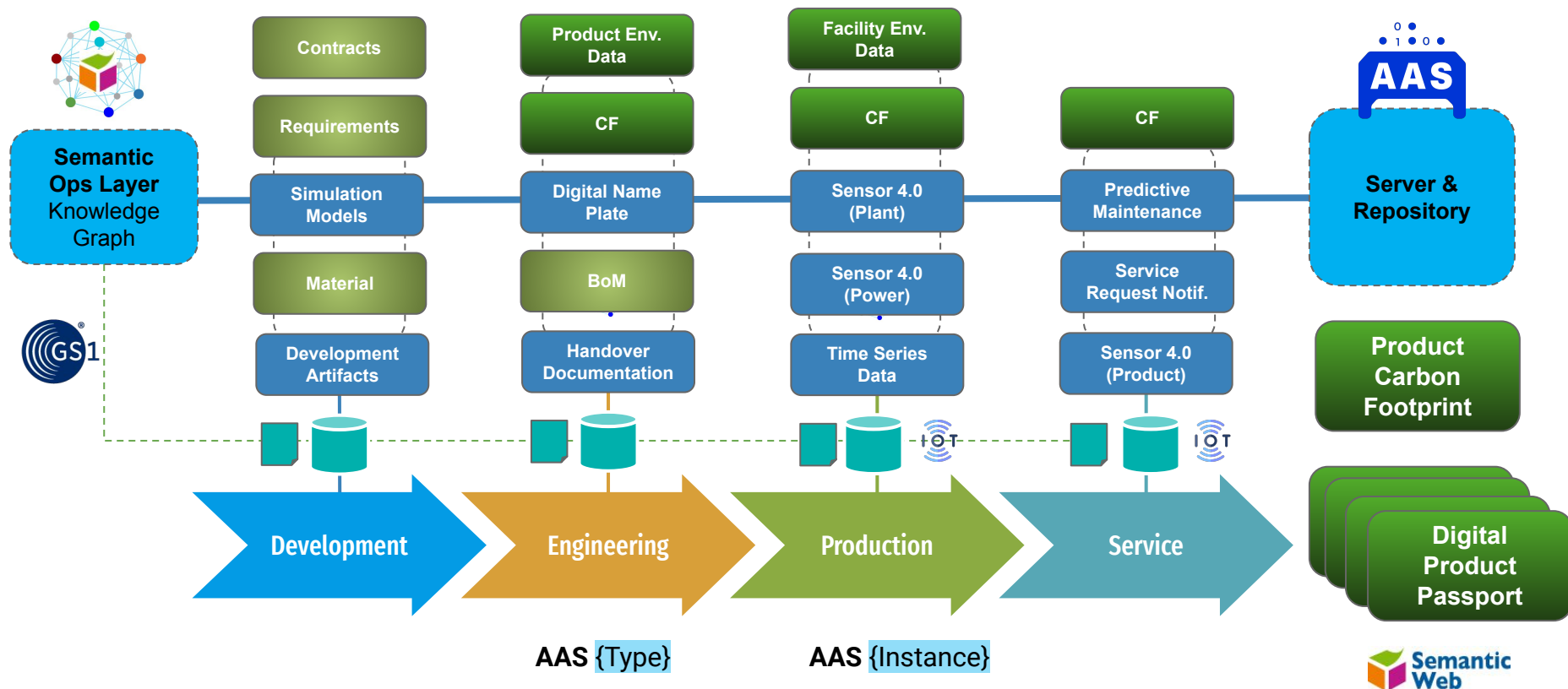


# Best Practices

# Knowledge Graph - Enterprise & ESG submodels



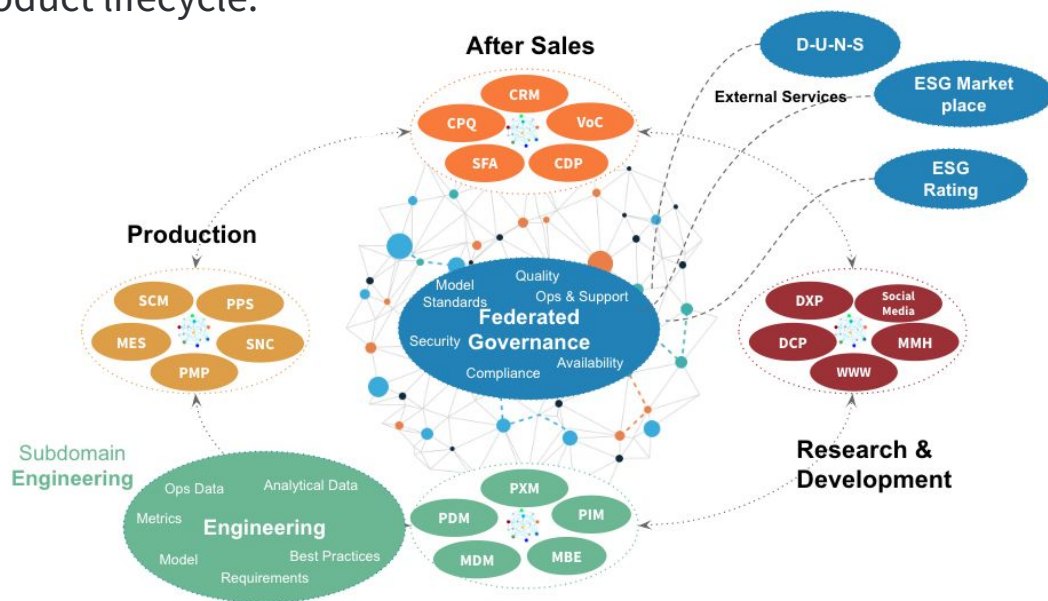
# Digital Twin - Asset Administration Shell (AAS)



- ▶ The Asset Administration Shell is the basis of the "**Digital Nameplate**", which is supplemented by further **product** and **process** information and thus leads to the "**Digital Product Passport**".
  
- ▶ **AAS submodels** (submodel ID)
  - ▶ **Digital Nameplate** for Industrial Equipment (02006)
  - ▶ **Facility Related Environmental Data** (Interopera, 2022.04, 6/23)
  - ▶ **Product Related Environmental Data** (Interopera, 2022.05, 6/23)
  - ▶ **Carbon Footprint** (02011)
  - ▶ Hierarchical Structures enabling **Bills of Material** (02011)
  - ▶ **Time Series Data** (02008)
  - ▶ **Sensor 4.0** (02029)
  - ▶ **Handover Documentation** (02004)
  - ▶ **iiRDS Handover Documentation**

# Digital Thread and Digital Twin

- ▶ **Digital thread** is a **communication framework** that **connects all data silos** and objects across complex products, customer requirements and supply bases and provides an integrated view of an asset throughout the entire product lifecycle.



## Data Mesh

- Data as a product
- Subdomain-driven ownership of data
- Self-service Data Platform
- Federated Governance incl. **Semantic Industry and Business Models**

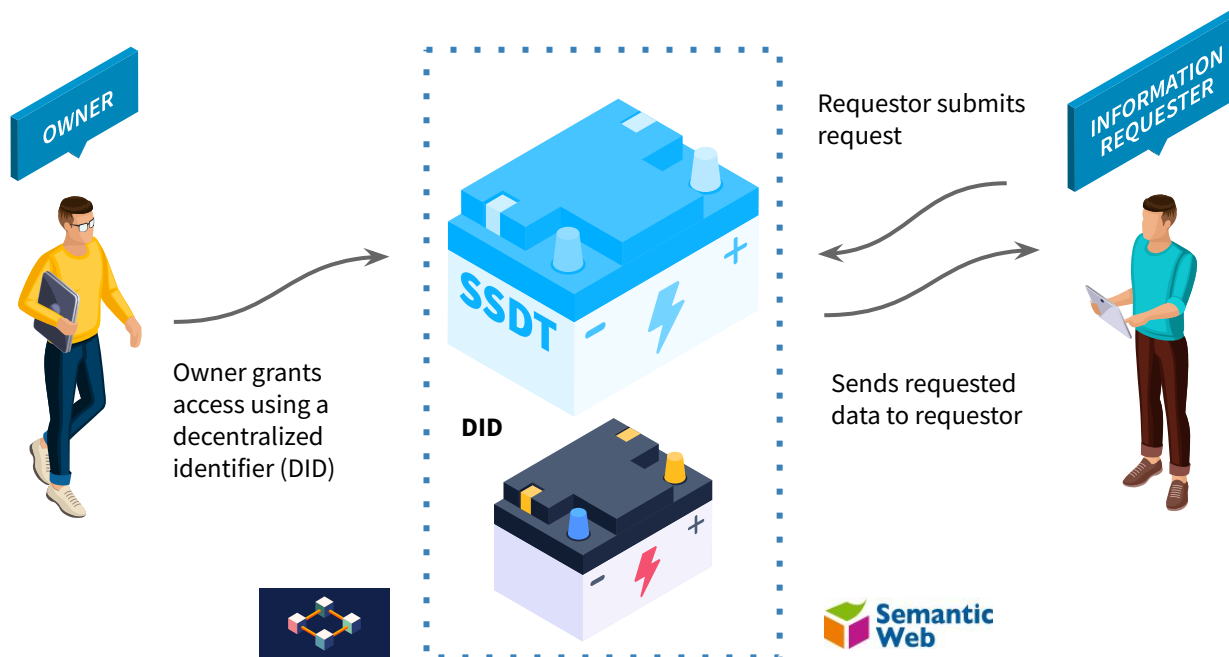


# Initiatives

- ▶ **Battery Self-Sovereign Digital Twin (SSDT)**
  - ▶ The battery **SSDT can store and receive information about the battery from outside sources**, respond to internal and external queries, and verifiably assert its identity and the information it stores/presents.
  - ▶ Because the battery SSDT leverages **self-sovereign identity**, the battery can assert its own identity with the help of an **external trust anchor** or a **blockchain (DID)**.

*European Self-Sovereign Identity Framework (ESSIF) makes use of Decentralized Identifiers (DIDs) and the European Blockchain Services Infrastructure (EBSI).*

## Self-Sovereign Digital Twin (SSDT)



## Green Deal Dataspace

Federated ecosystem for resilience and sustainability



### Challenge

The frequency of global crises such as pandemics, wars, and disasters has increased, and building shared solutions using data connections is crucial to mitigate their impact. The Green Deal Dataspace (GDDS) supports risk and crisis management solutions and offers a platform to build projects and services and provides access to existing ones.

### Success

The Green Deal Dataspace is a central projection surface for solutions to strengthen resilience and sustainability. It's a pioneering cross-domain data space that enables participants to showcase their own solutions or explore and discover resources for their projects. The PAIRS and SPELL platforms are examples of prominent use cases of the GDDS.

### Components

- » IDS Broker
- » IDS Connector
- » IDS Clearing House
- » IDS App Provider
- » Advaneos Trusted Data Hub



### Benefits

- » *Through the transparency of the GDDS crises and their effects can be detected earlier.*
- » *An IDS-based solution is implemented, and first prototypes have been tested in a use case.*
- » *The data marketplace offers participants access to an extensive compilation of over 2 million open data sets.*

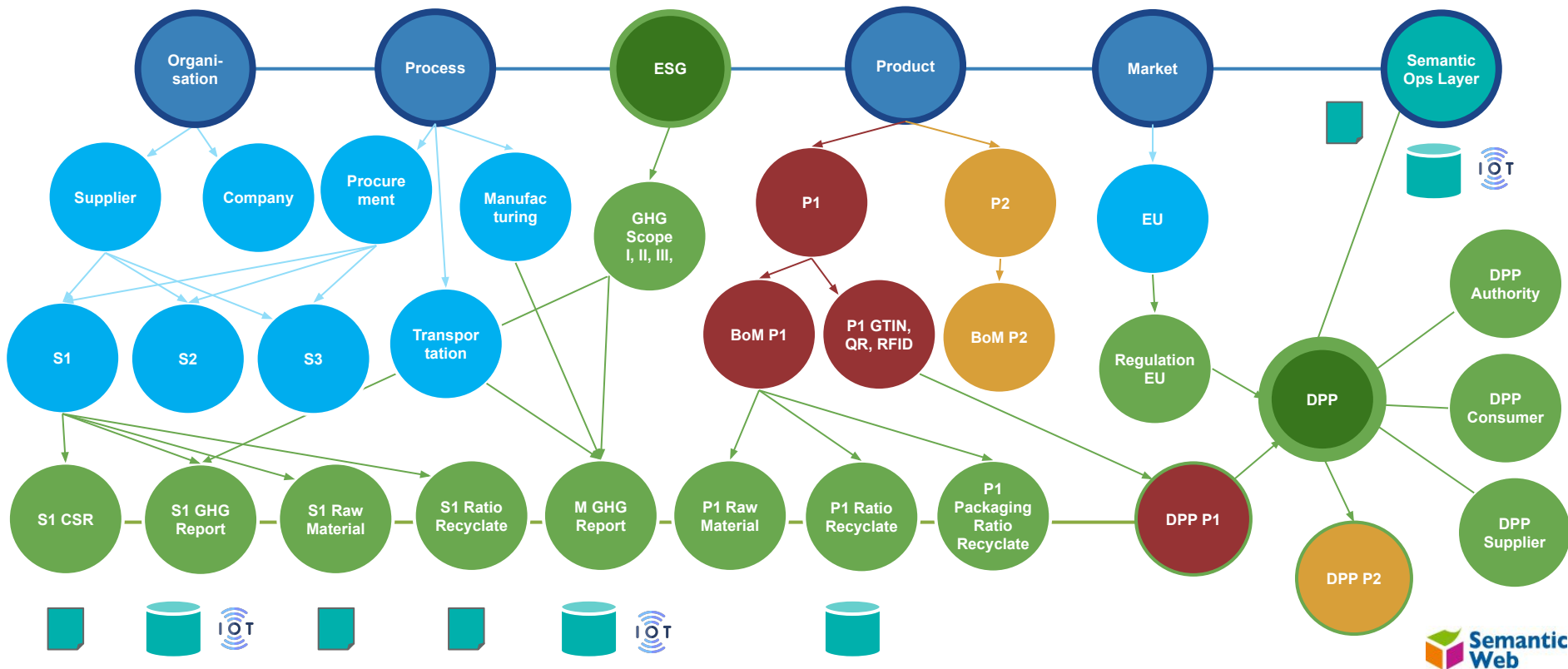


<https://internationaldataspaces.org/>

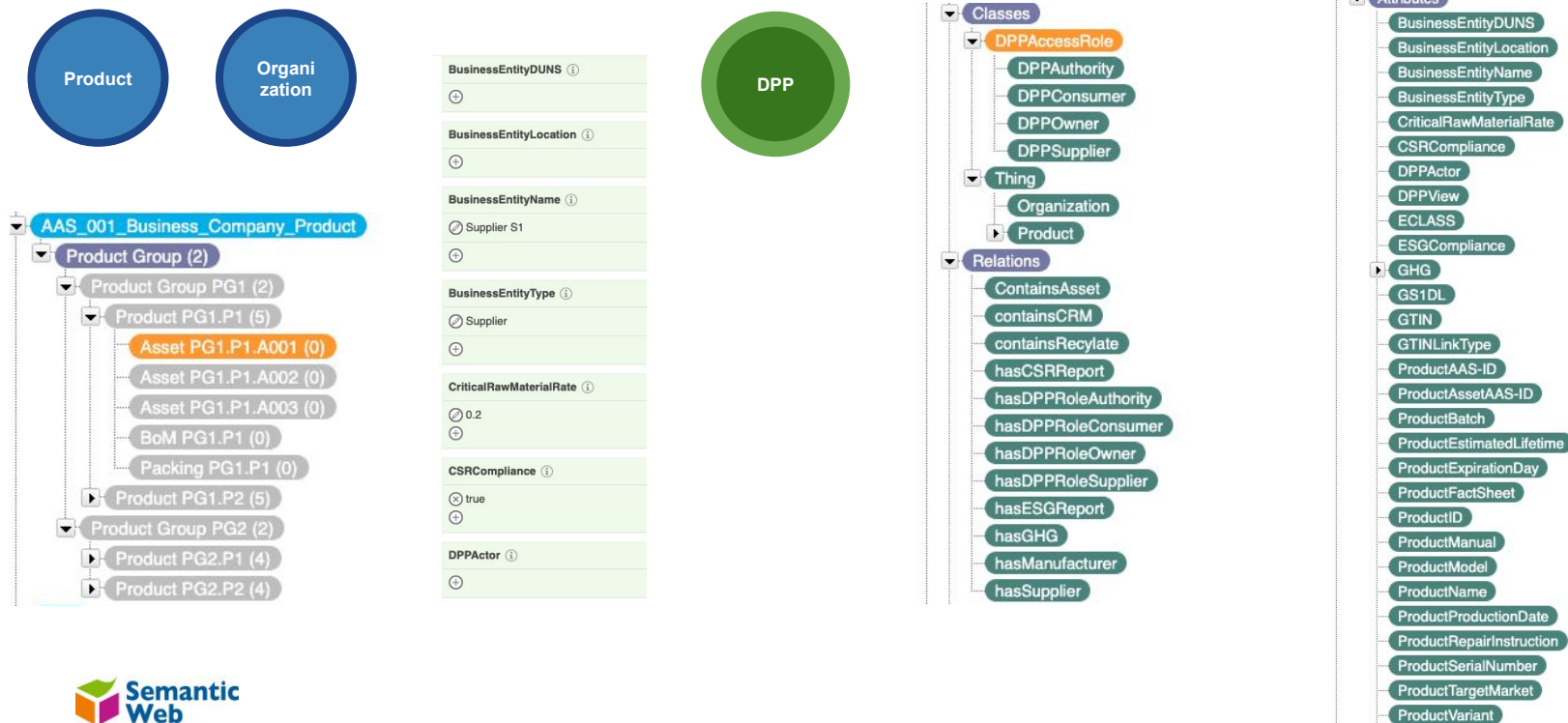


# DPP Prototype

# DPP Knowledge Graph Network



# Prototype model and sample data



# SPARQL queries (authority vs consumer view)

```
PREFIX swc: <http://schema.semantic-web.at/ppt/>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX skos: <http://www.w3.org/2004/02/skos/core#>
```

```
SELECT ?product ?attrName ?value WHERE {
  GRAPH
    <https://ulm.poolparty.biz/aas/001/Business_Company/Product/thesaurus>
  {
    ?s ?attr ?value ;
    skos:prefLabel ?product
  }
  GRAPH
    <https://ulm.poolparty.biz/aas/AAS/001/Business_Company_Ontology> {
    <https://ulm.poolparty.biz/aas/AAS/001/Business_Company_Ontology>
    swc:containsAttributeProperty ?attr .
    ?attr rdfs:label ?attrName
  }
  GRAPH <https://ulm.poolparty.biz/DPPConsumerFacets> {
    <https://ulm.poolparty.biz/DPPConsumerFacets>
    swc:linksToAttributeProperty ?attr
  }
}
```

	product	attrName	value
1	"Product PG1.P1"en	"ProductSerialNumber"en	"12345679"
2	"Product PG1.P1"en	"ProductRepairInstruction"en	<a href="https://ulm.poolparty.biz/001/AAS/PG1.P1/RepairInstructions/12345679">https://ulm.poolparty.biz/001/AAS/PG1.P1/RepairInstructions/12345679</a>
3	"Asset PG1.P1.A001"en	"GS1DL"en	<a href="https://ulm.poolparty.biz/01/4005906003717/10/ABC/217-231231&amp;linkType=DPP">https://ulm.poolparty.biz/01/4005906003717/10/ABC/217-231231&amp;linkType=DPP</a>
4	"Asset PG1.P1.A001"en	"GHG"en	"14.3"xsd:float
5	"Asset PG1.P1.A001"en	"GHG"en	"4.2"xsd:float
6	"Asset PG1.P1.A001"en	"GHG"en	"6.7"xsd:float
7	"Asset PG1.P1.A001"en	"GHG"en	"3.4"xsd:float
8	"Asset PG1.P1.A001"en	"CriticalRawMaterialRate"en	"0.2"xsd:float
9	"Asset PG1.P1.A001"en	"ProductBatch"en	"ABC"
10	"Asset PG1.P1.A001"en	"CSRCompliance"en	"true"xsd:boolean
11	"Asset PG1.P1.A002"en	"GHG"en	"9.9"xsd:float
12	"Asset PG1.P1.A002"en	"CriticalRawMaterialRate"en	"0.15"xsd:float
13	"Asset PG1.P1.A002"en	"CSRCompliance"en	"true"xsd:boolean
14	"Packing PG1.P1"en	"GHG"en	"2.8"xsd:float
15	"Packing PG1.P1"en	"CriticalRawMaterialRate"en	"0.0"xsd:float

DPP  
Authority

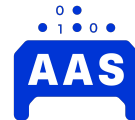
	product	attrName	value
1	"Product PG1.P2"en	"ProductTargetMarket"en	"European Union"
2	"Product PG1.P1"en	"ProductSerialNumber"en	"12345679"
3	"Product PG1.P1"en	"ProductVariant"en	"001"
4	"Product PG1.P1"en	"ProductRepairInstruction"en	<a href="https://ulm.poolparty.biz/001/AAS/PG1.P1/RepairInstructions/12345679">https://ulm.poolparty.biz/001/AAS/PG1.P1/RepairInstructions/12345679</a>
5	"Product PG1.P1"en	"GTINLinkType"en	<a href="https://ulm.poolparty.biz/01/4005906003717/10/ABC/217-231231&amp;linkType=DPP">https://ulm.poolparty.biz/01/4005906003717/10/ABC/217-231231&amp;linkType=DPP</a>
6	"Product PG1.P1"en	"ProductProductionDate"en	"2023-09-15"xsd:date
7	"Product PG1.P1"en	"RareEarthElementsRate"en	"0.02"xsd:float
8	"Product PG1.P1"en	"ProductTargetMarket"en	"European Union"
9	"Asset PG1.P1.A001"en	"BusinessEntityType"en	"Supplier"
10	"Asset PG1.P1.A001"en	"RecylateMaterialRate"en	"0.22"xsd:float
11	"Asset PG1.P1.A001"en	"ProductAssetAAS-ID"en	<a href="https://ulm.poolparty.biz/001/aas/123456">https://ulm.poolparty.biz/001/aas/123456</a>
12	"Asset PG1.P1.A001"en	"ESGCompliance"en	"true"xsd:boolean
13	"Asset PG1.P1.A001"en	"BusinessEntityName"en	"Supplier S1"
14	"Asset PG1.P1.A001"en	"RawMaterialRate"en	"0.8"xsd:float
15	"Asset PG1.P1.A001"en	"GS1DL"en	<a href="https://ulm.poolparty.biz/01/4005906003717/10/ABC/217-231231&amp;linkType=DPP">https://ulm.poolparty.biz/01/4005906003717/10/ABC/217-231231&amp;linkType=DPP</a>

DPP  
Consumer



# Outlook

- ▶ **ESG (DPP) ecosystem**, integrated with **all** business **processes**, **models** and **data**
- ▶ **Semantic standards (W3C) and components**
  - ▷ Knowledge Graph (W3C, RDF, SKOS, OWL, SPARQL)
  - ▷ LinkedData
  - ▷ Concept and term extraction for reports and contracts
  - ▷ Semantic Operations Layer (SPARQL endpoint, Data Catalog, Unified namespace)
- ▶ **Industry standards**
  - ▷ ECLASS, GS1, Data Spaces
  - ▷ W3C and industry vocabularies and ontologies
  - ▷ Asset Administration Shell
- ▶ **New emerging technologies**
  - LLM, GAI, RAG
  - Blockchain





# Thank you!