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International Digital Value Creation (DVC) Networks for Manufacturing Competitiveness & Sustainability

The IMX Council Showcase - Connect & Make Data Work at Scale to Improve Resilience, Productivity and Innovation in Manufacturing

Whitepaper, Hannover, Germany – April 20th, 2026

The manufacturing industry is connecting suppliers, manufacturers and customers across domains and regions to design, produce, operate and maintain key products, which increasingly requires **end-to-end digitalization** to provide a seamless customer experience for all the involved stakeholders and to allow processes to be integrated – including the effective use of AI across the value network. Furthermore, to support circular economy goals and to fulfill regulatory requirements concerning traceability and transparency, cooperation between multiple players along the value chain is needed. This close cooperation along and across the value chains results in interconnected value creation networks, where success depends not only on the performance of individual companies, but on the strength, reliability, and data-driven integration of their partners' ecosystem. Hence, end-to-end digitalization and the ability to connect and make data work internationally across manufacturing processes is becoming a key enabler for the effective and efficient set up and operation of **International Digital Value Creation (DVC) networks**.

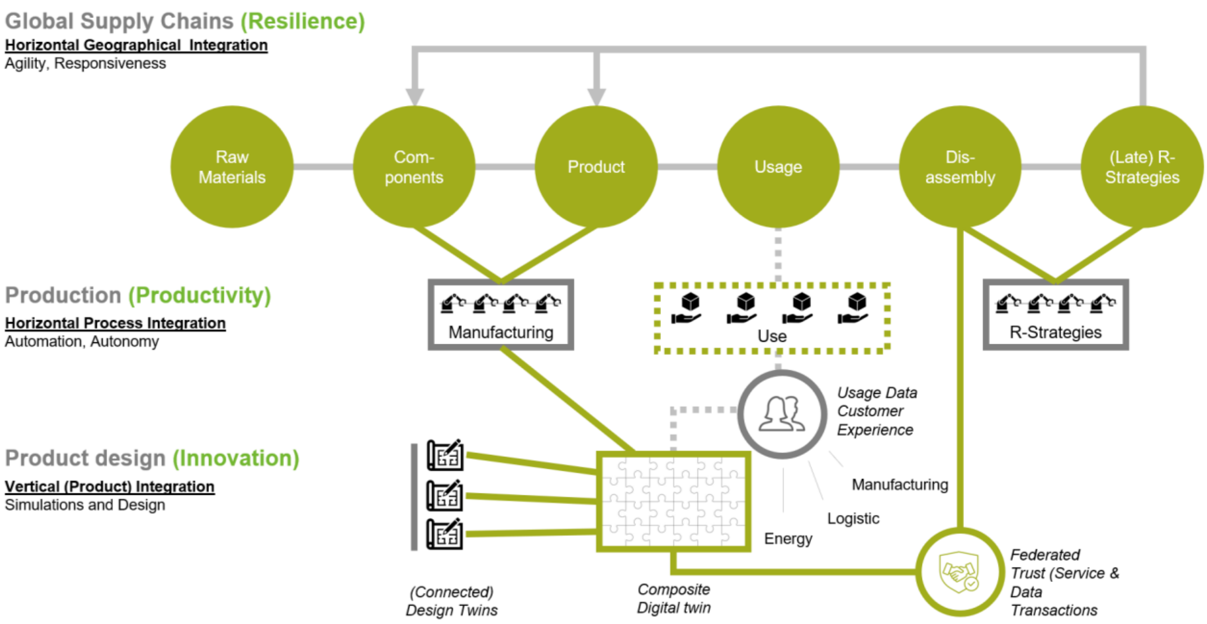

Figure 1: Digital Value Creation (DVC) networks & multi-level end-to-end digitalisation

DVC networks augment manufacturing competitiveness & improve **innovation** cycles, **productivity** and **resilience** and foster an effective use of resources at product, process and supply chain levels. Therefore, there is a pressing need for global data collaboration and interoperability in the manufacturing sector enabling and supporting global industrial AI innovations.

Such a cooperation requires semantic alignment and harmonization across technical, business and organizational levels, while ensuring that each individual participant and system retains sovereign control over its data. This is essential to establish a trusted environment where data can be exchanged in a secure, controlled, and transparent manner. The **innovation, productivity, sustainability and resilience benefits** for manufacturing industry behind an effective **operation of global industrial DVC networks** are undeniable. However, to implement the required digital transformation of the industrial value chain, manufacturing industry needs to address **three initial, yet critical barriers** that no single company, country, or organization can solve on its own:

1. **Globally validated DVC network identities**; including participants, machinery, equipment and AI-Agent IDs.
2. Globally validated common **standardised agreements** among **DVC participants**:
   a. **Compliance** to agreed data models, defined data, protocols and shared services
   b. Secure, commercially and legally binding **trusted data transactions** and use of **services**
   c. Protection of **Intellectual Property Rights (IPR)**.
3. **Globally validated capability** to **discover** and pool **data, services** and **offerings** (e.g. AI-ready data products) across the **DVC network**.

The **International Manufacturing-X Council (IMXC)** brings together representatives from 15 countries providing the international partnership for exchange and alignment on these critical elements. IMXC is driven by several national initiatives represented by leading edge manufacturing DVC stakeholders. Each country contributes, fostering pre-competitive collaboration in full accordance with anti-trust regulations that benefits the entire manufacturing sector internationally. By focusing on a federated data ecosystem and specific industrial digital value creation networks, IMXC identifies, on one hand, solutions that could lower or even suppress these common barriers. On the other hand, IMXC supports the development of sustainable, resilient, and competitive industrial solutions and prototypes them – amongst others in common **IMXC Showcases**. This collaboration is essential for tackling global challenges, as it allows for the harmonization of standards and the creation of trustworthy data ecosystems and digital value creation networks.

The success of IMXC is based on the active participation of leaders and decision-makers from the public, private, industrial and academic sectors. By fostering continuous dialogue and collaboration, the initiative aims to shape a future where manufacturing is not only more competitive but also more equitable and environmentally conscious. This collective effort underscores the importance of global cooperation in addressing the challenges and opportunities of a data-powered AI-driven digital age.

The IMXC Showcase

To demonstrate the potential of this **interconnected international manufacturing DVC network approach**, the IMXC Showcase highlights the tangible benefits of data interoperability and federated, secure and sovereign industrial data ecosystems and industrial DVC networks. The core of the showcase is the implementation of global industrial digital value creation networks that enable use cases demonstrating **data-driven and AI-oriented cooperation of systems across domains, geographies and the IT/OT convergence**. By validating these concepts through real-world applications, at a global scale, IMXC aims to inspire broader adoption and investment in data-driven intelligent manufacturing technologies.

The IMXC Showcase, powered by LNI 4.0 and all IMXC members, demonstrates cross-country and inter-company vertical and horizontal data exchange based on industry standards and federated trust. The IMXC Showcase is built on agreed participant guidelines and principles:

- Decentralised operation, both for productive as well as supporting services.
- Use of a limited set of standard protocols and data models, highlighting the capability to integration and interoperability.
- Integration into regional standards.
- Aligned among Architectural Reference Models. The CESMII i3X (https://www.i3x.dev/), the Open Data Spaces Reference Architecture (ODS-RAM) (https://open-dataspaces.gitbook.io/ods-docs) and the MX-Port of Manufacturing-X (https://factory-x.org/factory-x-introduces-the-mx-port-concept/).

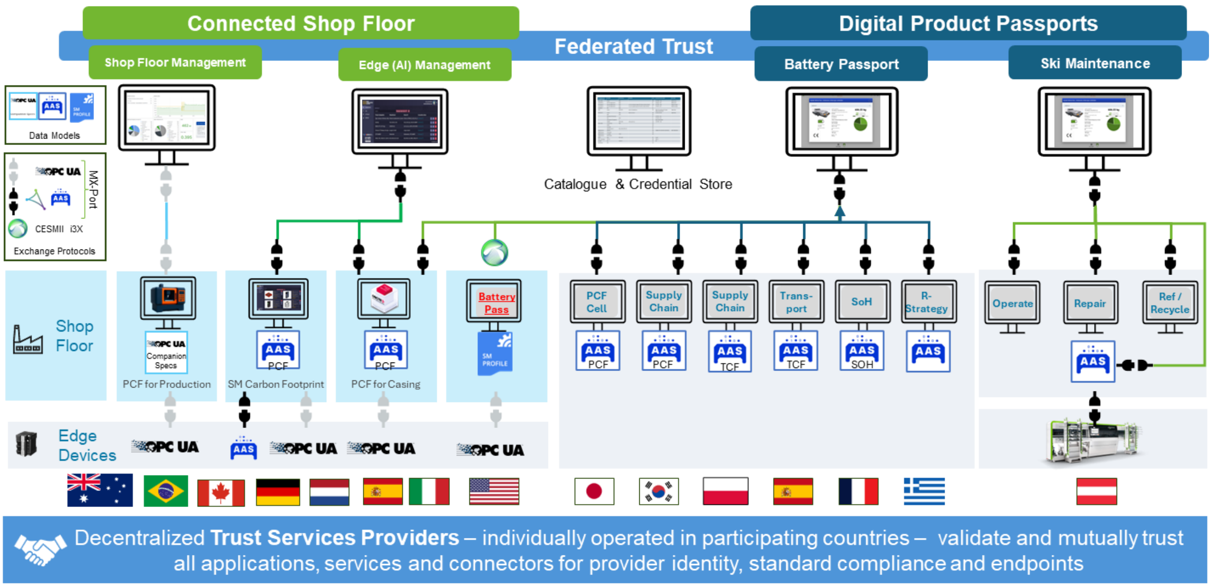

Figure 2: IMXC Showcase @ HM2026: Conceptual architecture

The IMXC showcase provides integrations for both Data Spaces (IT Systems) across business applications as well as integration on the factory shopfloor (OT Systems) in the Edge AI Management use case demonstrating OT/IT convergence and process horizontal integration for increased autonomy.

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Industrial Digital Value Creation Network: Digital Battery Passport (DBP)

Digital Battery Passport Lifecycle Management Use Case

Use case overview

The Digital Battery Passport (DBP) use case is following the lifecycle of a car battery. It allows to effectively pool DBP information and dig into details of each lifecycle stages (e.g. production in the factory shopfloor, assembly, usage, recovery, …) whilst maintaining a consistent end-to end view of the data in a DBP implemented using the IDTA 02035 Standard Data Model.

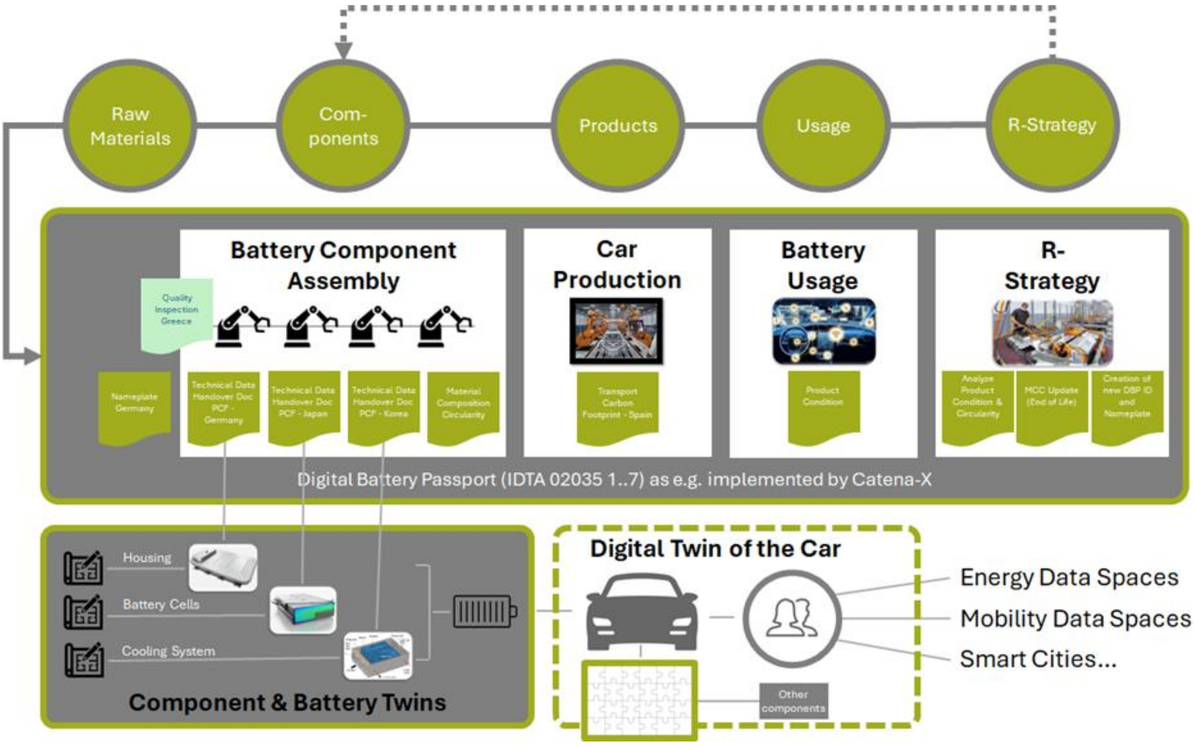

Figure 3: Battery Lifecycle Digital Value Creation network process view

Digital Network

The IMXC use case is implemented by connecting individual business applications from different countries – all feeding the information into a digital twin business application providing the full traceability of data from the different providers along the lifecycle.

Details of each life cycle step can be viewed in the individual applications, which include data from battery production, assembly (including the calculation of the Product Carbon Footprint (“PCF”) and the Statement of Health (“SOH”) of the battery based on real-world usage. The individual business applications which contribute to the update of the Digital Battery Passport along the lifecycle are:

Step 1: Battery Housing (Germany)

The casing changes its PCF based on the production time. The simulation delivers values for night and day shift. During the day shift solar power is used instead of fossil energy sources and therefore reduces the PCF of the battery casing.

Business applications: Virtual Factory to show the production facility, GEC ONCITE-X to change the simulated value (night or day PCF) & CX-Gateway to exchange the PCF data between Supplier & Customer.

Step 2.1: Battery Cell Data (Japan)

The node contributes standardized battery cell manufacturing, quality, and traceability data to the Digital Battery Passport (DBP). The Product Carbon Footprint (PCF) for the battery cells are calculated and put into standardized Asset Administration Shell (AAS) format. The PCF data are shared with the data space via the connector. In addition, the lifecycle view provided by the DBP enables selected downstream insights from usage and health evaluation to be fed back into future cell engineering and manufacturing optimization, supporting continuous improvement across the battery value creation network. When Japanese companies participate, Verifiable Credentials are issued after their authenticity has been verified by a corporate authentication infrastructure located within Japan. This enables trust sovereignty as part of the federated trust framework.

Step 2.2: Battery Cell Data (USA)

The node consumes the standardized Digital Battery Passports (BDP) and exposes each as an element within the CESMII i3X definition, rendering the manufacturing, quality, traceability and Product Carbon Footprint (PCF) data as standardized data elements contextualized against the "*IsPartOf*" relationship. External graph relationships from the parent component can then be associated with other elements in an CESMII i3X model, enabling data consumers to understand how the battery is related to the manufactured product in which it is installed.

Step 3: Battery Assembly (Poland)

The node serves as the physical assembler of the EV Battery Pack, executing the manufacturing operations and provisioning data for the final Digital Battery Passport (DBP). Leveraging the Asset Administration Shell (AAS) standard, the system constructs a precise Bill of Materials (BOM) tree utilizing the *HierarchicalStructures* submodel. This establishes "*IsPartOf*" relationships to seamlessly integrate the data of all utilized subcomponents into the final product's unified record. Concurrently, the system calculates the carbon footprint generated strictly during the physical assembly process and securely records this value within the standardized Carbon Footprint sub-model (IDTA-02035-3). To ensure a trusted and sovereign data exchange, the complete product structure and passport data are subsequently made available via a local Eclipse Dataspace Components (EDC) connector. Acting as a Data Provider within the federated data space, the Polish node enables downstream participants to perform authorized retrieval of the Bill of Materials (BOM) graph and aggregate the total carbon footprint across the entire value chain.

Step 4: PCF-Calculation (Korea)

The Product Carbon Footprint (PCF) is a key requirement for the Digital Battery Passport (DBP) and carbon neutrality. However, accurately tracking PCF remains a challenge due to incompatible data across fragmented global supply chains. The PCF calculation use case demonstrates how Asset Administration Shell (AAS) and data space connectors can securely and transparently integrate global battery metrics.

Step 5: Transport (Spain)

Multiple applications; e.g. SQS dspacer_PCF, contribute to the information of the Digital Battery Passport (DBP). The transport & logistics PCF application demonstrates how data space connector interoperability protocols such as DSP implemented as part of Tractus-X EDC baseline facilitate trusted and sovereign data exchange across multiple EDC implementations. The use of IDTA Asset Administration Shell (AAS) standardised sub-models ensures that data from multiple sources can be effectively integrated and aggregated in a single DBP across the full product lifecycle.

Step 6: Statement of Health (France)

The State of Health (SOH) ensures the overall, long-term condition of the battery. The relevant information — such as current capacity and performance — is continuously updated in the use case, and shared with the DPP application, through the Data4Industry-X solution, building on OPC-UA protocol, Asset Administration Shell (AAS), and interoperable, decentralized data space connectors.

The Statement of Health use-case also demonstrates how SOH data products are published in Data4Industry-X data product marketplace, and exchanged with the DPP application through a governed, traceable and trusted data transaction.

Step 7: R-Strategy (Greece)

The application is a decision-support tool for battery End-of-Life Management. Each battery is represented through its own Asset Administration Shell (AAS), from which the tool retrieves relevant AAS submodel data, including real-time information from the Digital Battery Passport (DBP), such as Remaining Capacity (RC), Full Cycles (FC), and Negative Events (NE). Based on these inputs, the R- Strategy tool evaluates the battery condition and recommends the most suitable circular strategy (i.e., Reduce, Reuse, Remanufacture, Recycle, Recover)

Step 8: Integration of DVC (Germany)

Key building blocks for the Digital Product Passport implementation within the Battery Lifecycle use case are delivered by a German partner. With its AAS Platform, the central infrastructure for storing, managing and retrieving Asset Administration Shell (AAS) data across the value network are provided.

The Viewer enables intuitive access and visualization of distributed AAS data, supporting transparency and usability across stakeholders.

In addition, a demonstrator-specific Process Flow Application to illustrate the end-to-end lifecycle of the battery and the interaction between participating systems is developed. This application supports the understanding of cross-company data flows and highlights the orchestration of distributed digital twin information.

Together, these components enable consistent handling, accessibility and visualization of AAS-based data, contributing to interoperable and scalable Digital Battery Passport scenario within the IMXC Showcase.

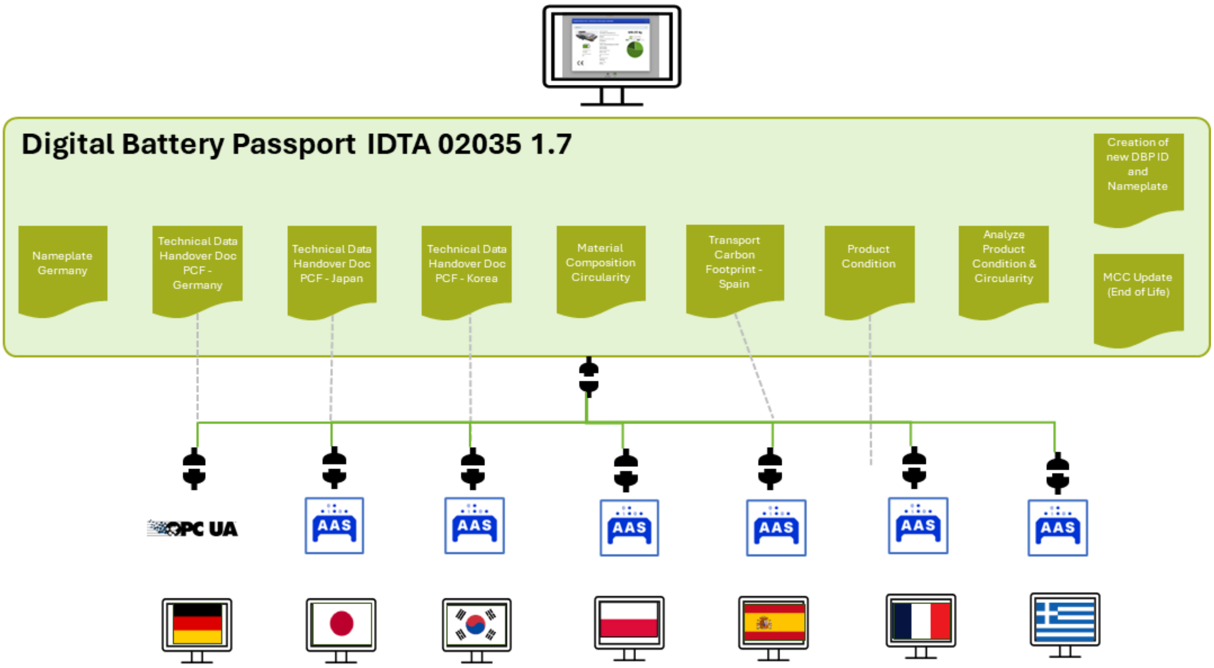

Figure 4: Business applications from exemplary countries contribute to one Digital Battery

Industrial Digital Value Creation Network: Digital Product Passport (DPP)

Ski Maintenance & End-of-Life (EoL) Management Use Case

Use case overview

This usecase exploits the Digital Product Passport (DPP) as an enabler for advanced digitalization across organizations. As shown in the figure below, responsible **Economic Operators** (Ski Manufacturers) can document repair actions down to the item level, ensuring a consistent product history. Independent **Repair Shops** report repairs back to the DPP system, providing a traceable service history on the products. Optionally, a **Refurbisher** may retrieve and update DPP data, optimise reuse, and can take legal responsibility for the renewed product from the original manufacturer. The **Recycler** leverages DPP data to improve material recovery and deactivates the DPP at end-of-life. Together, these actors form a closed loop of data, technology, and responsibility.

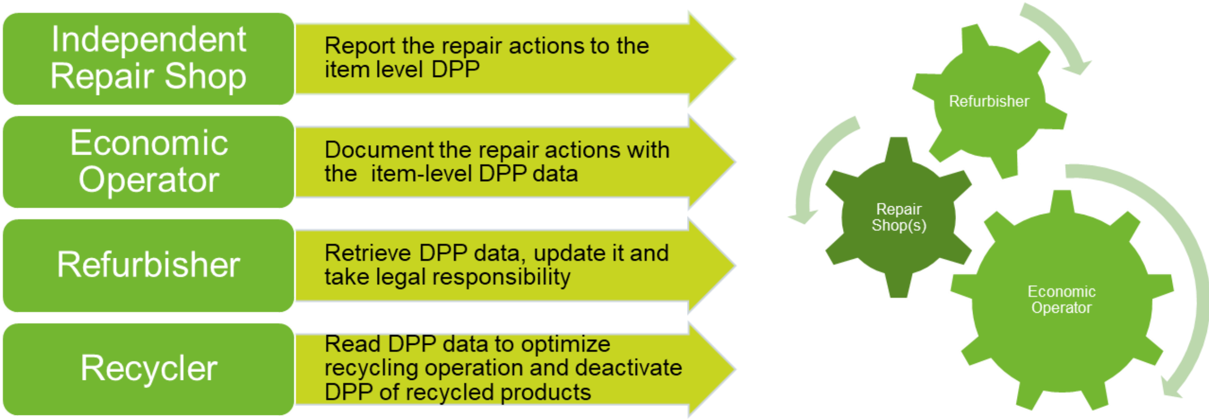

Figure 6: Process overview

Digital Network

In the showcased use case, the product – skis manufactured by Atomic Austria – undergoes regular service routines *(at dealer level)* after every few usage days, with processes increasingly automated through advanced machinery such as the Jupiter system by Wintersteiger Sports Division. To ensure an optimal skiing experience, service parameters can be precisely determined and retrieved via the Digital Product Passport (DPP) data carrier from the manufacturer specific to individual skis. This high level of automation enhances operational efficiency by reducing time, cost, and material consumption, which is an especially critical factor in the growing rental market. Additionally, it enables the creation of reliable and transparent product histories, strengthening trust and value in the aftermarket.

To enable effective collaboration across multiple vendors and stakeholders, ensuring semantic interoperability between systems is critical. The Digital Product Passport (DPP) using an implementation backed by the Asset Administration Shell (AAS), provides a robust foundation for seamless communication among interconnected systems. Leveraging IDSA Dataspace Protocols

(DSP) and Gaia-X trust framework facilitates secure authentication and access, supported by stringent authorization policies. In this context, Salzburg Research and AIT serve as key strategic partners.

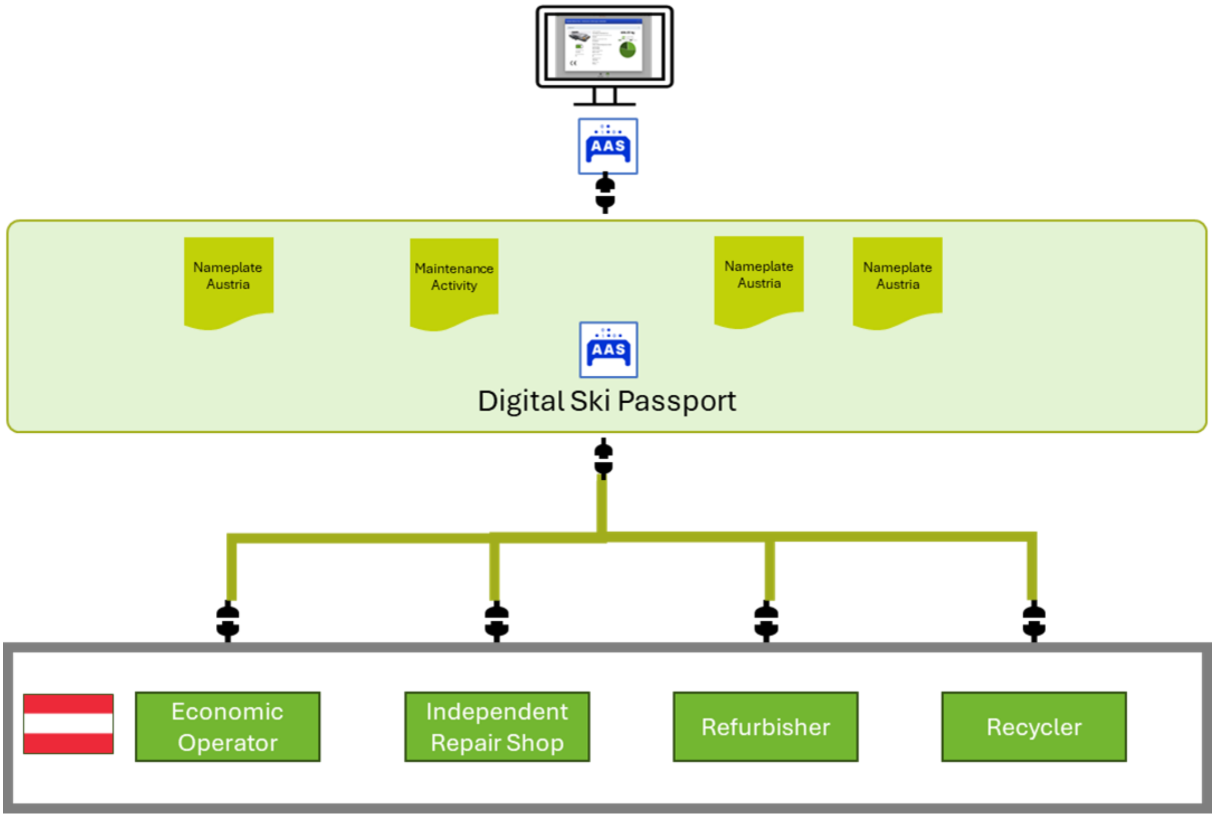

Figure 7: Integration overview

Edge AI Management use case

Edge Computing has emerged to place computing capability as close to the source of data in the shopfloor as needed, in order to reduce transmission latency and bandwidth use. Another advantage is the reduction of operational costs by minimizing the amount of data that needs to be transmitted and processed in a centralized or cloud-based location. Having originally been driven by digitalisation use cases such as predictive maintenance, this approach translates very well to the current drive to utilise AI in production environments. A further aspect is the possibility of enabling new business models through distributed data-based applications on shared hardware. This is exemplified by distributed control approaches based on e.g. IEC 61499. Because of the growth of industrial AI applications, who benefit from processing at the edge, this technology is currently expected to be driven technologically further. Typically, an Edge Gateway can process data from field devices and then send only the relevant data towards the cloud, reducing bandwidth needs. While respecting real-time application needs, it can send data directly back to the field device. This is especially relevant to software updates on the field level. To jointly solve the onboarding of edge devices in a multi-vendor edge management system the uniform use of standards (e.g. AAS or OPC UA) by the devices enables them not only to be mutually identified across vendor boundaries, the devices can also to be enriched further with information such as CPU or memory usage, being relevant for the application deployment. By that industrial AI applications are executable in structured and transparent edge environments as illustrated in Fig 5 being secured by the measures defined through the dataspace. The data exchange is executed using the IMXC principles.

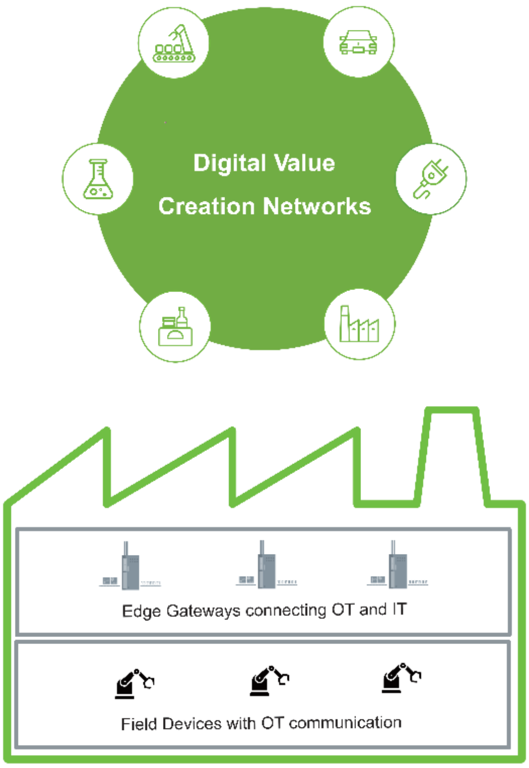

Figure 5: Integration of Edge AI and manufacturing dataspaces

Data spaces live on data as their key resource, and for industrial products this means that the industrial production process provides the data. Integrating data sources from industrial shop floors into a data ecosystem is achieved through edge devices that in a typical shopfloor are a range of devices from multiple vendors. This use case deals with the interoperability and AI computing ability of multi-vendor edge solutions for leveraging production data for the data space. The cross-vendor configuration of these critical data sources based on AAS description of the devices is realized in the demonstration. This demonstration is aimed at further improving this cross-vendor workability of edge solutions on an international scale to serve industrial AI solutions.

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Outlook of the IMXC Showcase

Data is crucial for AI. In the manufacturing context, data is heterogenous, highly distributed across stakeholders and needs to be ready for use from the edge to the cloud and across the full product and process lifecycle. Moreover, manufacturing data is valuable as it is often related to company IP and knowledge that has been generated over many years. Hence, agile, sovereign and trusted access to data becomes essential for AI-powered optimization of intelligent production workflow automation and supply chain operation. The IMXC Showcase demonstrates how manufacturing data spaces become a key enabler for vertical and horizontal integration of data value chains. The IMXC illustrates for the first time, industry effectively making data work with trust internationally where it is needed (from the edge to the cloud), when it is needed (across the full product lifecycle and digital passport), with the stakeholders that are needed (across supply chains at a global scale) and from their own systems and platforms (interoperable identities & credentials).

Statement of Thomas Hahn, Spokesperson of the IMX Council

"Interoperability and trusted data exchange are the key enablers for the future of global manufacturing," says Thomas Hahn. "With the IMXC Showcase at the Hannover Messe 2026, we demonstrate how international partners from government, industry, research, industry associations and other stakeholders from around the world collaborate on federated and secure industrial data ecosystems. The Digital Product Passport (DPP) is a crucial business case for sustainable and transparent industry applications. For the shopfloor integration the Edge AI Management enables future use cases. By integrating international industry standards such as AAS, OPC UA, CESMII I3X and EDC, we are setting an important milestone on the path to a connected, resilient, and competitive industry. We invite companies worldwide to join this initiative and actively shape the future of the industrial data ecosystems."

Acknowledgment and Partners

The IMXC Showcase is realized by strong international partners. Our special thanks go to:

Atomic Austria, Atos, ARVATO Systems, AIT Austrian Institute of Technology, Brainport Industries, Catena-X Association, Catena-X Competence Center Spain, CESMII, Cofinity-X, Confindustria, Congatec, conplement, Data4Industry-X, Dawex, Digital Factory Vorarlberg, DMG MORI, Engineering, EXPLITIA, FESTO, Fujitsu, Gaia-X, Gaia-X Hub Austria, German Edge Cloud, GIZ, Hilscher, IDTA, Innovalia, IOFDS, Kyungnam University, Labs Network Industrie 4.0 (LNI 4.0), Laboratory for Manufacturing Systems and Automation of University of Patras, micronex, Microsoft, Mitsubishi Electric, Nestfield, NTT, OPC Foundation, Orbiter, Plattform Industrie 4.0 Austria, Politecnico di Milano, Quantum Surf, RCEI, Salzburg Research, Schmersal, SM4RTENANCE, SQS, SIGA, Siemens, SiMa.ai, Smart Industry NL, Sovity, Standardization Council Industrie 4.0 (SCI 4.0), Toshiba, T-Systems, The University of Tokyo, TRUMPF, University of New South Wales, VDMA, Weidmüller, Wintersteiger Sports and XITASO