FACTORY-X

Factory-X

The Digital Ecosystem for Factory Outfitters and Operators

PART OF MANUFACTURING-X

Funded by the European Union
NextGenerationEU

Supported by:
Federal Ministry for Economic Affairs and Climate Action
on the basis of a decision by the German Bundestag

Factory-X
Project Overview

- Business Models
- Operating Model
- Transfer Measures

Factory-X
Use Cases

Manufacturing-X

- M-X Guidance Board
- International Manufacturing-X

Factory-X
Kernel

Manufacturing-X

Motivation & Big Picture

International Manufacturing-X (IM-X): Make Data Work

IM-X will implement a federated, decentralized and collaborative data ecosystem for smart manufacturing. Open, global and cross-industry, following FAIR Data Principles.

Reorganize and increase flexibility and autonomy of industrial value chains and networks.	**Resilience**
Increase efficiency and enable data-driven solutions for GHG/CO2 balancing and circular economy.	**Sustainability**
Accelerate digital innovations and enable new data-driven business models to create new value for manufacturing	**Competitiveness**

Motivation & Big Picture

Foundational Framework for IM-X

A common guideline for IM-X activities and international stakeholders.

Strategic Goals

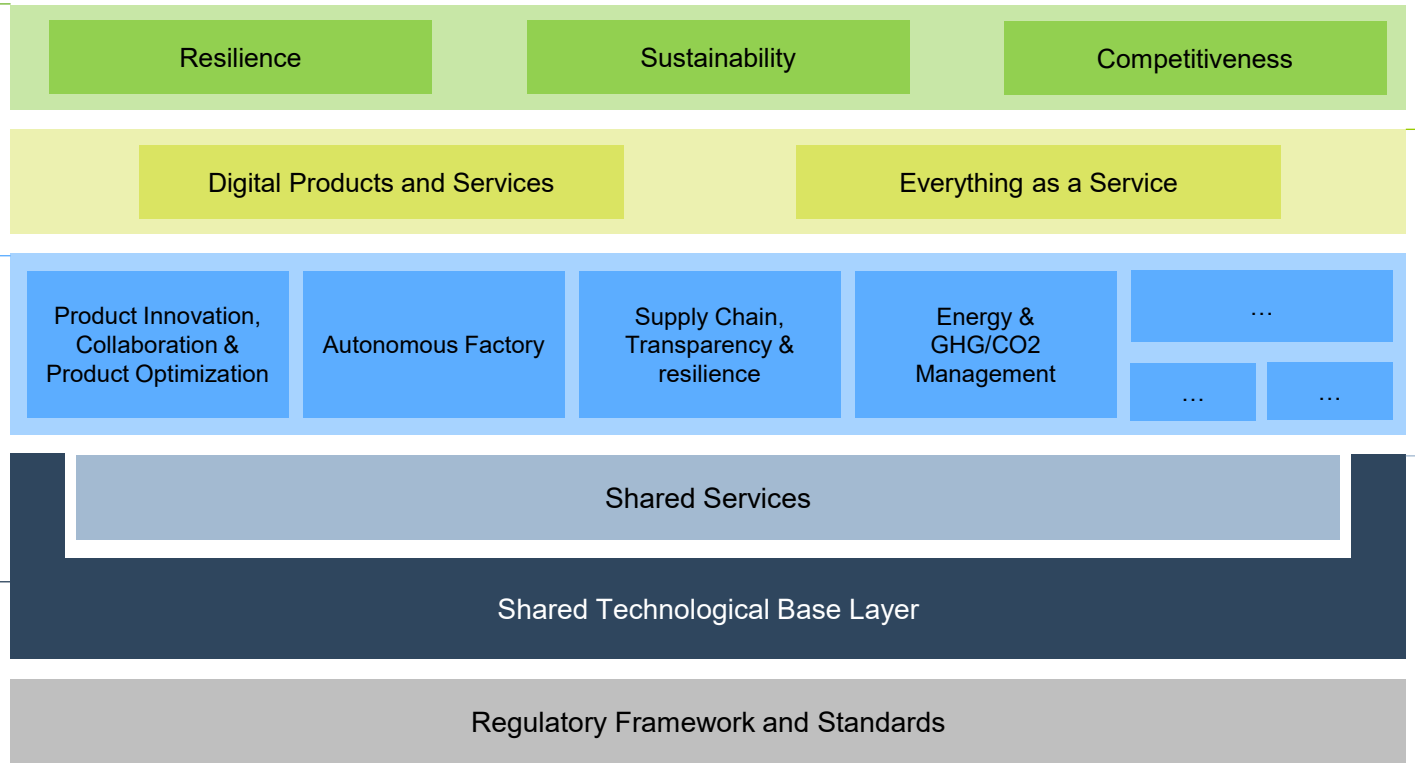
International Manufacturing-X develops the foundations for a resilient and competitive industry in a sustainable society.

Exemplary Cross-Industry Use Cases

International Manufacturing-X addresses cross-industry use cases based on a collaborative use of data with high economic and ecological impact.

Foundation

International Manufacturing-X defines global standards and runs a basic technical infrastructure to guarantee interoperability and sovereignty.



Business Models

International Manufacturing-X enables innovative business models based on a interoperable data-ecosystems

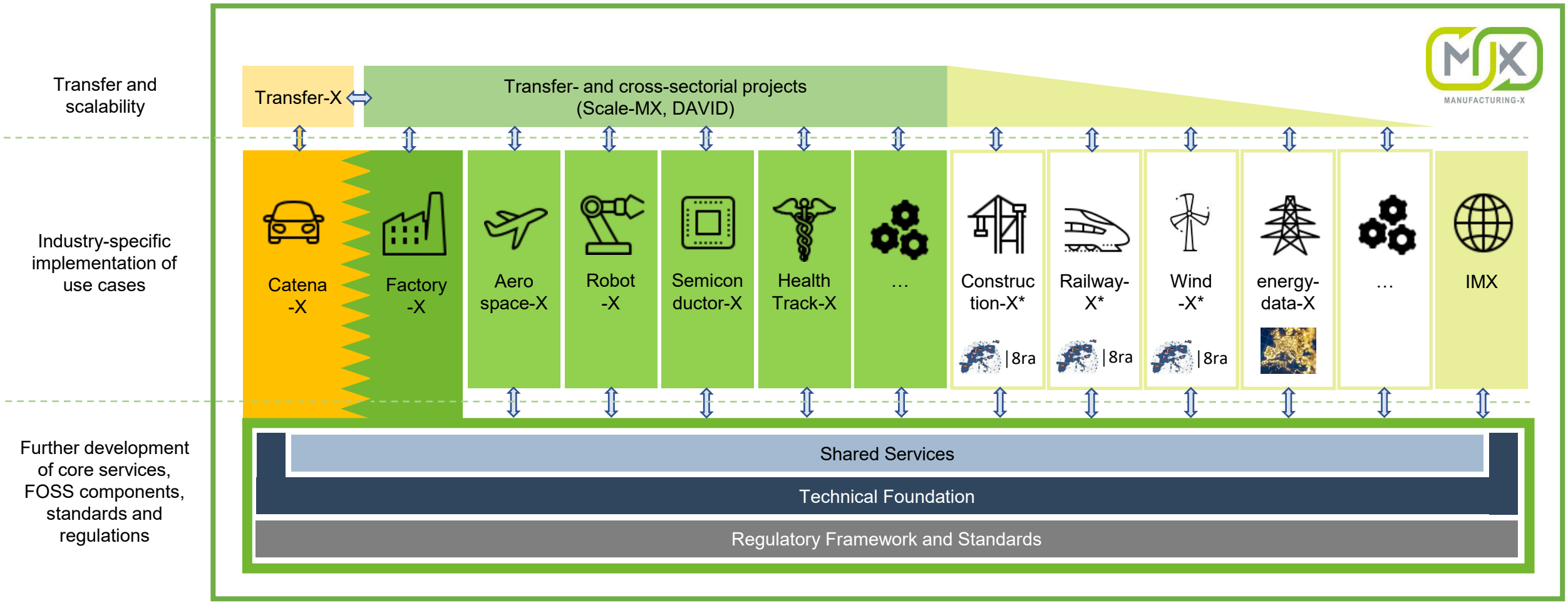
Capabilities

International Manufacturing-X enables development and deployment of fundamental services driving the federated data ecosystem.

Requirements

International Manufacturing-X builds on a common technical, organizational and legal framework and contributes to the future development in cooperation with international law.

Germany
Cooperation between the projects



*Project in preparation

All icons by icons8

MX wide coordination

Our focus

- Collaboration with international stakeholders through meetings, conferences and workgroups to ensure that Manufacturing-X is well aligned internationally.
- Tight collaboration with all projects under the Manufacturing-X umbrella to identify gaps, overlaps and discrepancies, that need to be resolved in order to achieve interoperability.
- Working with all projects under the Manufacturing-X umbrella to understand specific requirements for governance and at the same time identify aspects that need to follow a joint governance

Goal

Ensure the interoperability of all projects under the Manufacturing-X umbrella both on a national as well as on an international level.

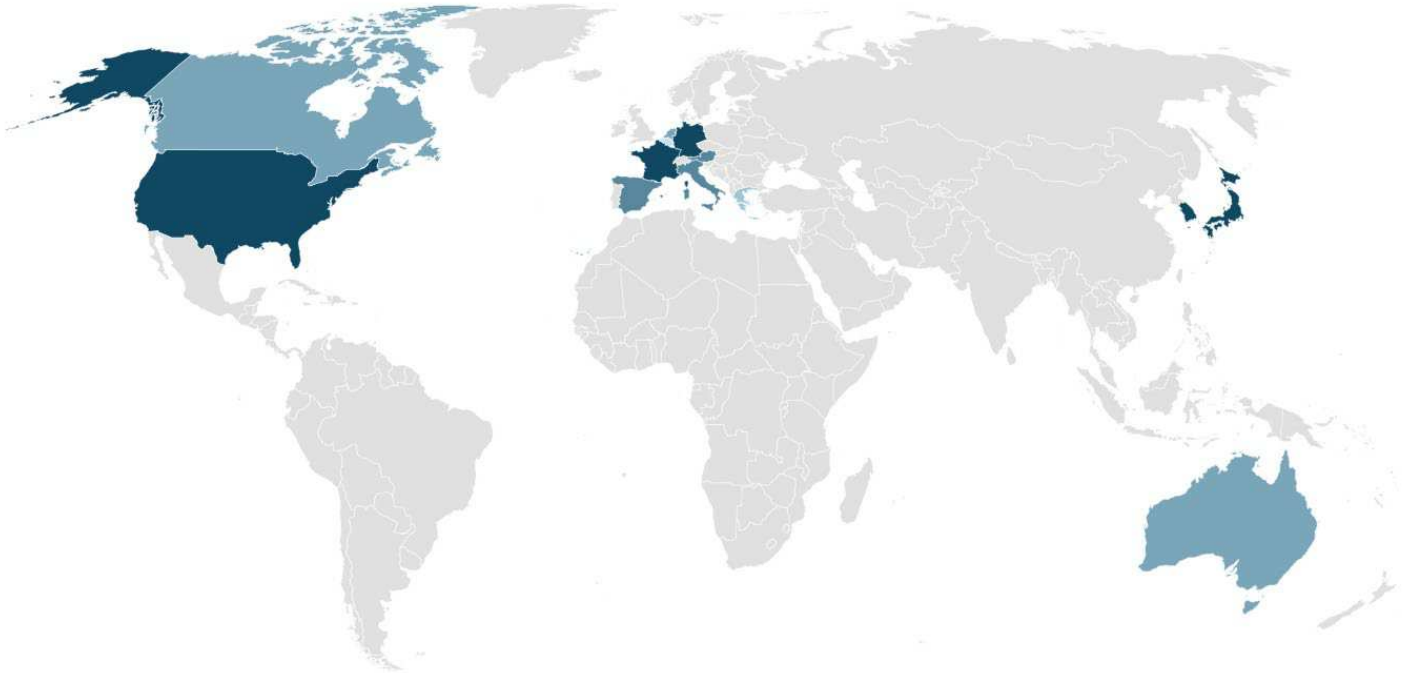
Key Results

- Launch of the International Manufacturing-X Council.
- Launch of the Manufacturing-X Guidance Board
- Launch of various Factory-X and Manufacturing-X web sites
- Proposal for a cross Manufacturing-X Governance

Landscape of Initiatives in the Context of global manufacturing

Manufacturing-X is international. Our intention is to trigger international R&D, partnerships, cooperation, standardization and deployment with and for customers globally.

Initiatives Involved in Establishing the IMX Council



What has happened so far:

2023 July

Initiation Brussels, Belgium

2023 October

Inauguration Tokio, Japan

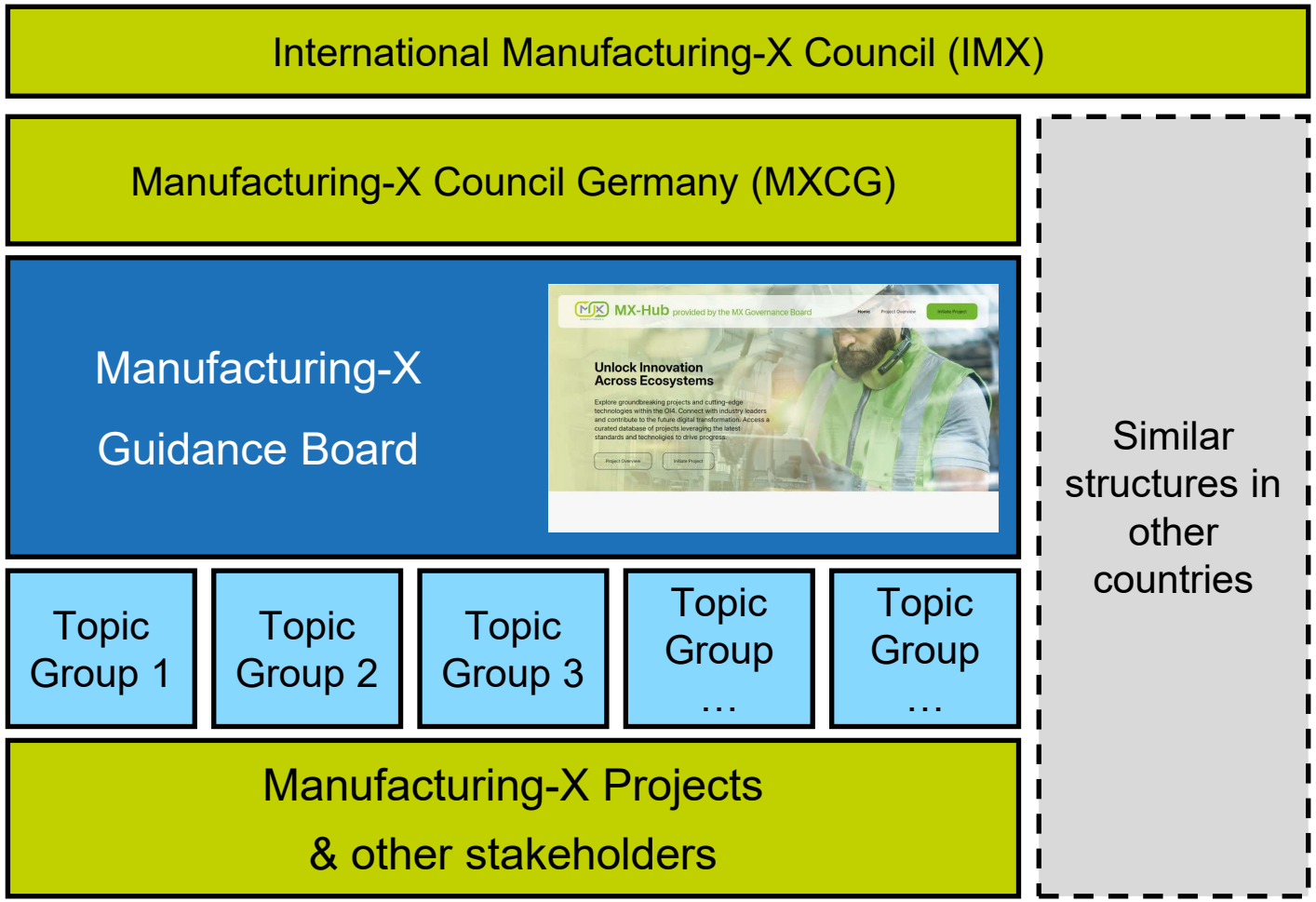
2024 February

Kick-off Paris, France

2024 Novem.

November 5th in USA/CESMI

Making Manufacturing-X successful nationally
Manufacturing-X Guidance Board



What we do:

- **Identify:** analyze the participating projects for overlap including risks of incompatibility and redundancy,
- **Prioritize:** identify alignment potentials and sort them for expected impact to reach the stated goal,
- **Evaluate:** structure and compare options for each alignment potential,
- **Decide:** draw up a joint way to move forward together across all alignment potentials,
- **Communicate:** create transparency about the degree of alignment of all M-X projects and all decisions taken by the M-X Guidance Board
- **Advocate:** create transparency about the technology, administrative and organizational approaches how to become M-X compliant interoperable to a broad audience to inform potential upcoming projects.
- **Cooperate:** with other standardization initiatives like Gaia-X, Catena-X, IDTA, ISO, IEC, … in order to reuse what is already established

Data Governance in Factory-X

Data governance aims to ensure the quality of data, minimize risks associated with data management

Data governance in the context of Factory-X involves defining policies and procedures for data sharing, including data access, usage, and protection

Data governance enables that data providers have control over their data when sharing data for business or regulatory purposes

Data governance enables effective decision-making and compliance with relevant regulations

Roles and Standards will be Use Case generic, while Processes and Responsibilities will be rather individual

Data Governance in the context of Factory-X

- **Data governance is a discipline within data management that focuses on ensuring the quality, security, and availability of an organization's data**
- **It involves defining and implementing processes, standards, responsibilities and roles for data collection, ownership, storage, processing, and use**
- **The goal is to maintain high-quality, secure data that is easily accessible for use cases such as the ones considered in Factory-X**
- **Factory-X considers four dimension for data governance goals:**
  - Quality: Data should not loose aspects of its information content due to quality loss of any kind
  - Collaboration: Data should be made usable for interactions between roles and possibly also between organizations
  - Value: Data should be utilized to generate value for the overall manufacturing process
  - Sovereignty: Data sharing should not result in a loss of control over data so shared

Factory-X
Project Overview

The Digital Ecosystem for
Factory Outfitters and Operators

The Factory-X Consortium

FACTORY-X

Industrial Partners

ARVATO SYSTEMS, BASF We create chemistry, berger, codewerk, DMG MORI, Empolis, EPLAN, FESTO, GEC, hilscher, ifm, igus, inovex, InstaWerk, Lenze engineered to win, matchory, ANALYTICS, OPEN INDUSTRY 4.0 ALLIANCE, PAKIC, PHOENIX CONTACT, prenode, Proalpha, RIF Engineering & Consulting, SAP, Scheer, SCHUNK, sdfs, SICK Sensor Intelligence., SIEMENS, soffico, software AG A SOFTWARE GMBH BRAND, TRUMPF, T-Systems, TÜV SÜD, UHLMANN GROUP BEYOND PACKAGING, WITTENSTEIN

Associations & Research Partners

August-Wilhelm Scheer Institut Digital Research, Fraunhofer, IFW Institut für Fertigungstechnik und Werkzeugmaschinen, ISW, RUHR UNIVERSITÄT BOCHUM RUB, smartFactory, Catena-X, ESTAINIUM Association, LNI4.0, VDMA, zvei electrifying ideas

Associated Partners

ARENA2036, bayern innovativ Innovation leben, BECKHOFF, BOSCH, Digital Data Chain Consortium, EVIDEN, IDTA, Sharecat, STANDARDIZATION COUNCIL INDUSTRIE 4.0, zvei electrifying ideas

Factory-X is a Lighthouse Project for Manufacturing-X

- Building the **open** and **collaborative digital ecosystem** for Factory Outfitters and Operators upon Catena-X and concepts of Platform Industry 4.0
- Focus on **11 dedicated use cases** to extend the existing horizontal supply chain-oriented use cases and add vertical use cases to integrate the operation of shop floors
- Under the leadership of Siemens and SAP, **47 partners** are working together in this strong consortium, supplemented by **10 associated partners**
  (companies, associations and research institutions)
- **Manufacturing-X wide coordination** and establishment of an **international Manufacturing-X network**
- Project started on February 1st, 2024
- Completion of Project by June 2026

Factory-X Partners

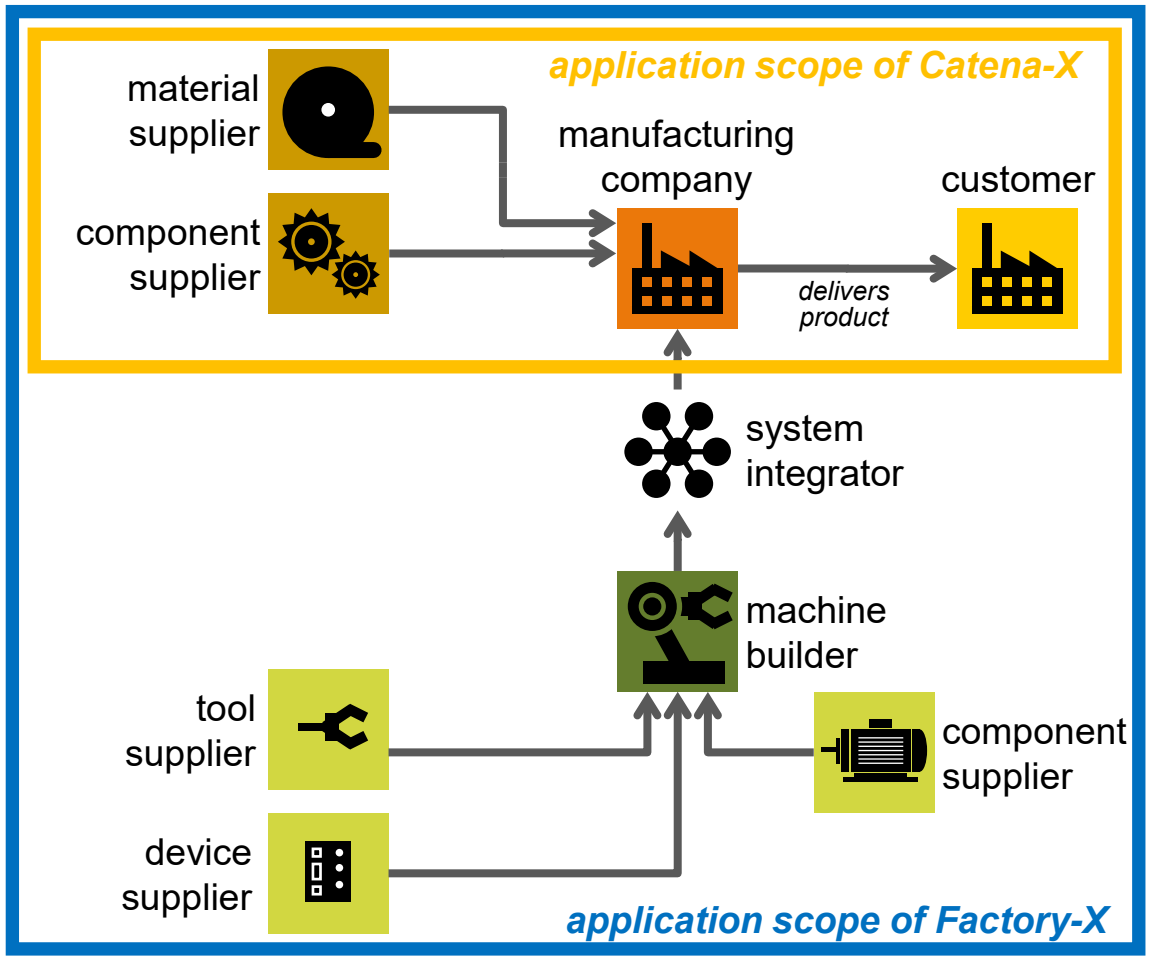
- August Wilhelm Scheer Institut
- Arvato Systems Digital
- BASF
- Berger Holding
- Catena-X e.V.
- Codewerk
- DMG MORI
- Empolis
- EPLAN
- Estainium
- Festo
- Fraunhofer
- German Edge Cloud
- Hilscher
- ifm diagnostic
- IFW - Leibniz Universität Hannover
- igus
- inovex
- InstaWerk
- ISW - Universität Stuttgart
- Lenze
- LNI e.V.
- Matchory
- MT Analytics
- Open Industry 4.0 Alliance
- Pakic
- Phoenix Contact
- prenode
- proALPHA
- RIF Engineering & Consulting
- Ruhr-Universität Bochum
- SAP
- Scheer GmbH
- SCHUNK
- SDFS Smarte Demonstrations-fabrik Siegen
- SICK
- Siemens
- SmartFactory-KL e.V.
- soffico
- Software GmbH
- TRUMPF
- T-Systems
- TÜV SÜD Chemie Service
- Uhlmann Group
- VDMA e.V.
- WITTENSTEIN
- ZVEI e.V. (FE)

Factory-X Associated Partners

- ARENA2036 e.V.
- Bayern Innovativ
- Beckhoff Automation
- Digital Data Chain
- Eviden
- IDTA e.V.
- Robert Bosch
- Sharecat Solutions
- VDE e.V.
- ZVEI e.V.

Supply Chains in Manufacturing Industries

Illustration

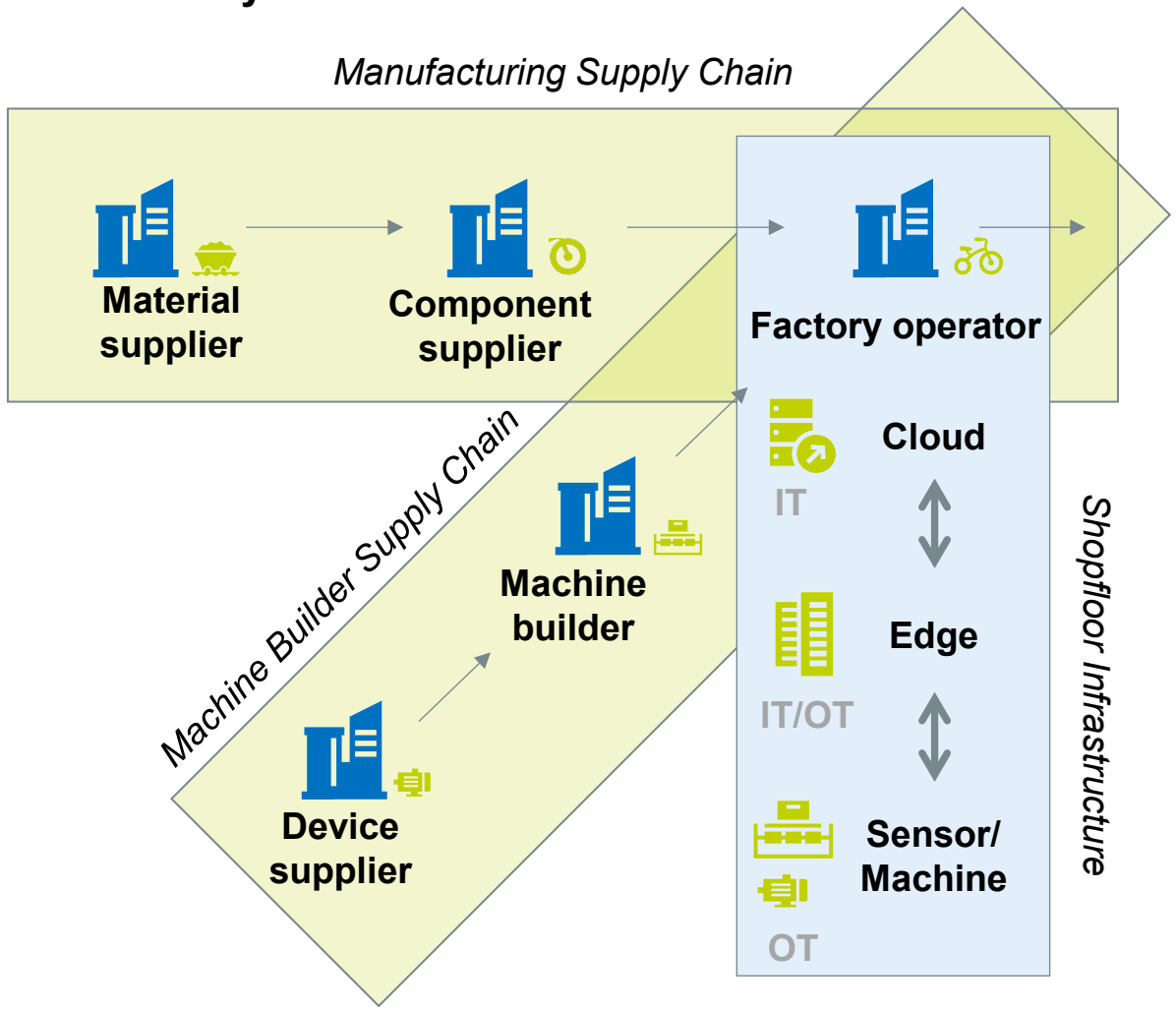


From the perspective of a manufacturing company, there are two different supply chains:

- Supply chain regarding the **product** of the manufacturing company
  - All deliveries from suppliers that are **integrated** into the manufacturing company's product
  - Application scope of Catena-X
- Supply chain regarding the **production system** of the manufacturing company
  - All deliveries from suppliers that are needed to **build** and **operate** the manufacturing company's production system
  - Expansion of application scope of Catena-X by Factory-X

Strategic goals from the Factory-X project world

The Factory-X Continuum



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  - Expansion of application scope of Catena-X by Factory-X

Factory-X Digital Ecosystem
What is our intention and goal?

Creating the fundament of an open and collaborative data space!

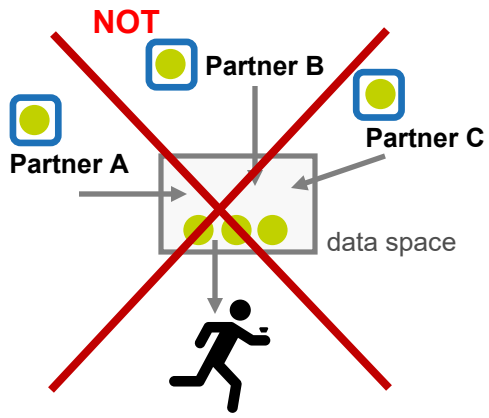
What is a data space?

… the scientific, academic answer

- "Interoperable framework, based on common governance principles, standards, practices and enabling services, that enables trusted data transactions between participants.",
  Source: glossary of Data Spaces Support Centre, https://dssc.eu/

… our motivation, philosophy and pragmatic understanding

- exchange of data between two partners in a partner network with purpose and mutual benefit, and of course in a data sovereign, trustful, secure etc. way.

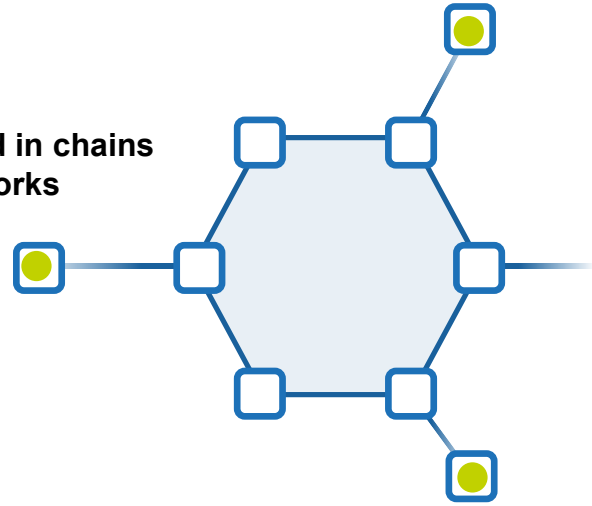


Principal exchange mechanism

Legend:

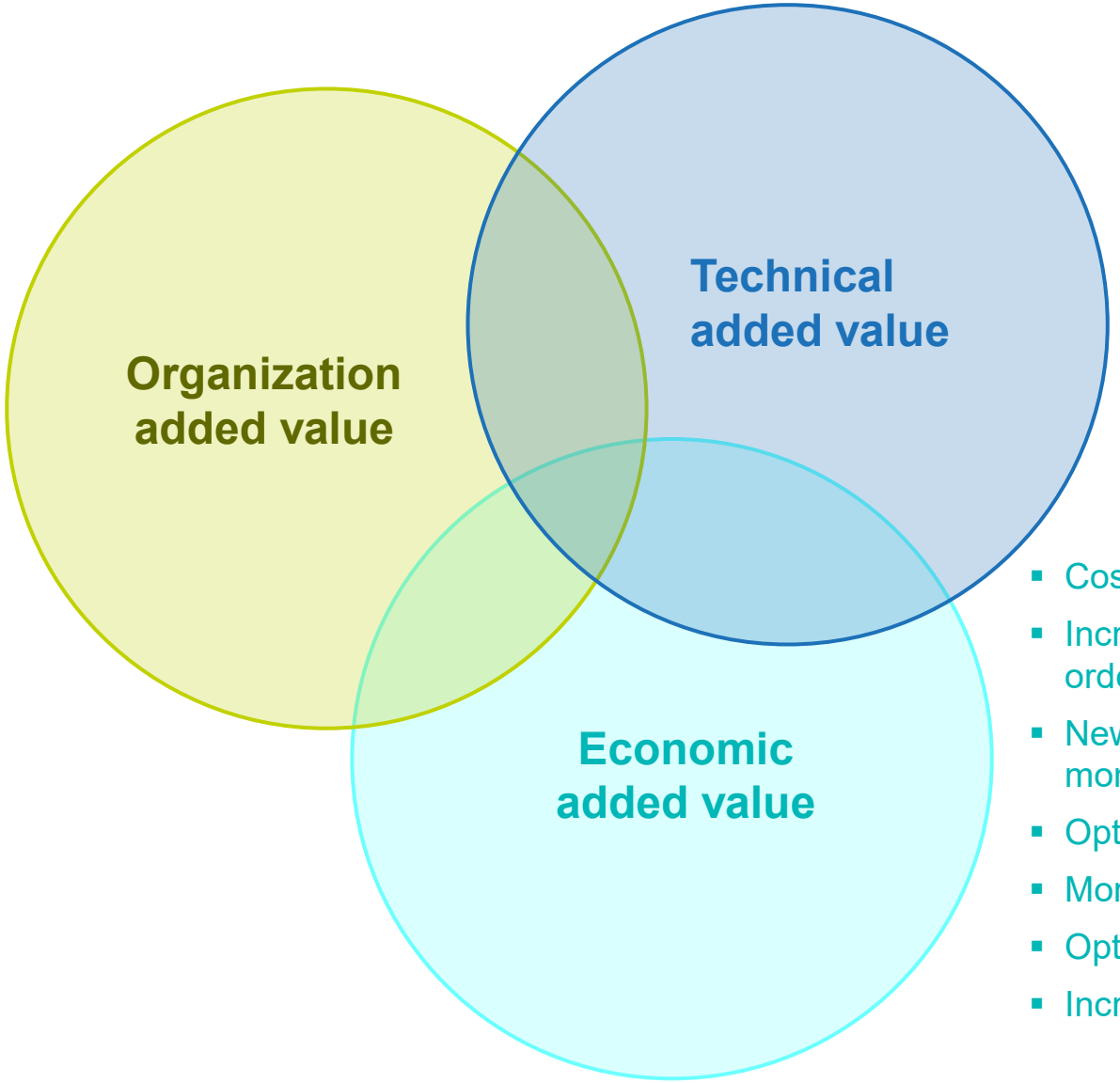
- Partner A, B, C …
- Data (exchange)

Illustrated in chains and networks



Added value of the FX digital ecosystem: Efficiency, Interoperability, Growth

- Standardized contracts for more clarity
- Standardized data formats ensure redundancy-free data storage
- Automatized product updates reduce maintenance effort
- Digital collaboration simplifies collaborative planning



- Data sovereignty & data ownership
- Efficient data exchange through a standardized, non-proprietary interface
- Real-time communication for fast-response processes
- AI & ML-supported analyses by optimized data availability

- Cost & productivity benefits by standardization
- Increased sales through wider reach & new orders
- New business models (“X-as-a-Service”) & data monetization
- Optimized services by better data usage
- More efficient demand & capacity management
- Optimized value chains
- Increased customer satisfaction

Factory-X
Our North Star

Qualities

- Interoperability
- Trust & Security
- Scalability
- (Data) Sovereignty

MX-Port Layer	Components for configurations
FX Discovery	A1 A2
FX Access & Usage Ctrl.	B1 B2
FX Gate	C1 C2
FX Converter	D1 D2 D3
FX Adapter	application specific

options

Scope of Factory-X

- Factory-X takes into account the large and diverse range of machine builders, factory outfitters and factory operators.
- Recognizing this heterogenous partner set-up and the wide range of use cases, Factory-X understands that a **"one-size-fits-all"** approach will no work
- Factory-X aims to serve as the technical foundation for cross-industry collaboration within Manufacturing-X[1]

Factory-X is committed to provide building blocks to realize a digital ecosystem with certain qualities

- Factory-X develops and validates use case applications for factory outfitters and operators in a prototypical manner.
- The Factory-X Kernel, with its core element **"MX-Port concept[2]"**, enables the realization of industry-agnostic digital ecosystems.

1) see cooperation between the projects, link: https://factory-x.org/manufacturing-x/
2) several concrete MX-Port configurations using different technologies will be proposed and provided

Factory-X
The MX-Port concept

Generic structure of MX-Port

- Layered structure with different functional manifestations per layer
- Use case can configure specific MX-Port according to its needs

Layer	Purpose
MX Discovery	. . . is used to find business partners, data assets (e.g. devices) or business applications.
MX Access & Usage Ctrl.	. . . is used to ensure that data providers can define the data access and usage as well as restrict the access and usage of the provided data.
MX Gate	. . . is used to exchange data in a uniform way.
MX Converter	. . . provides the semantic model for the data to be exchanged.
MX Adapter	. . . enables any business application to use the MX-Port.

Factory-X – The MX-Port
to solve the communication challenges of Manufacturing-X applications!

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Challenges

- **To cover different domain needs**
  - Regulated/non-regulated
  - Automotive/machinery/aerospace// semiconductor/robotics/ etc.
- **To cover different deployment scenarios**
  - Edge to cloud to edge
  - Supply-chain to shopfloor and vice versa
- **To include well established technologies**
  - Communication across data spaces (e.g., EDC, IDSA)
  - Communication from data spaces to shop-floor and vice versa (e.g. AAS, OPC UA)
- **To include brownfield scenarios**
  - Different digitalization concepts are existing (e.g., CESMII Smart Manufacturing Profiles)
- **Future-oriented & interoperable**
  - Covering regional and domain needs
  - Open for future concepts (e.g., WoT, 6G)

Concept

1. **Enable business-oriented Factory-X qualities**
   (Interoperability, Trust & Security, Scalability, (Data) Sovereignty)
2. **Deliver an architecture that enables all Manufacturing-X applications to be to realized**
3. **Interoperable across scenarios w/ MX-Port architecture & standardized interfaces**

Layer	Components for configurations
MX Discovery	A1 A2
MX Access & Usage Ctrl.	B1 B2
MX Gate	C1 C2
MX Converter	D1 D2 D3
MX Adapter	application specific

options

Implementation

Individual configurations …

Layer	MX-Port "Leo"
MX Discovery	ID-Link
MX Access & Usage Ctrl.	AAS security
MX Gate	AAS-REST
MX Converter	AAS sub model
MX Adapter	application specific

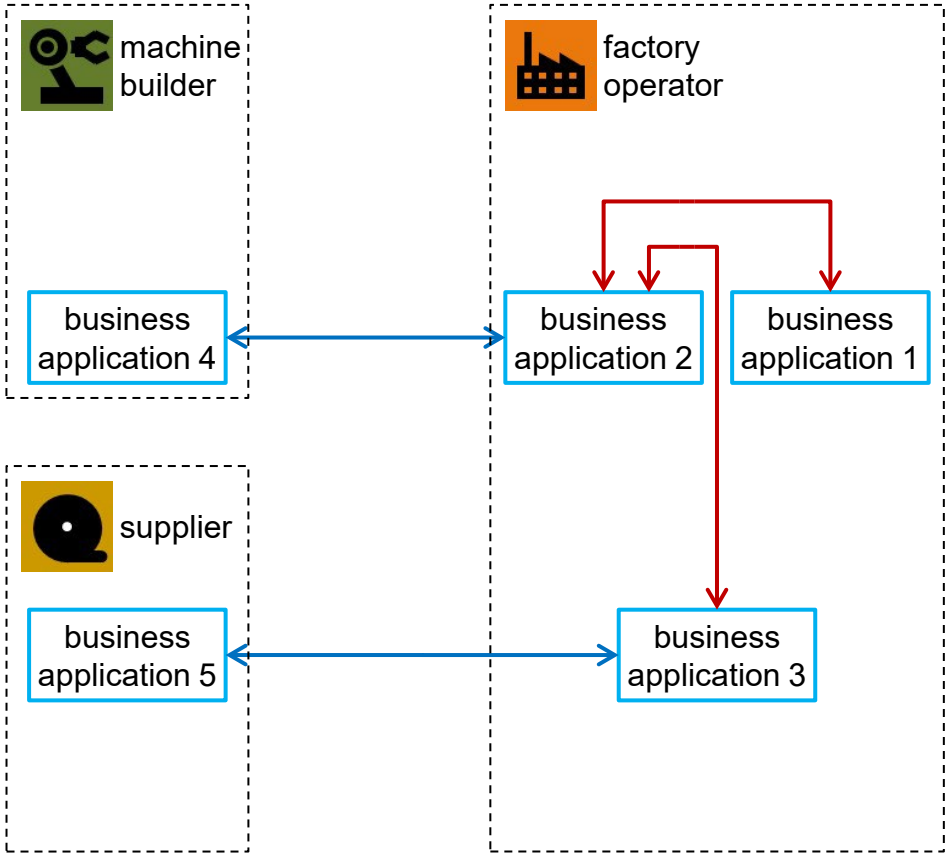
Layer	MX-Port "Hercules"
MX Discovery	Data Space Protocol / Decentral Claims Protocol
MX Access & Usage Ctrl.	
MX Gate	AAS-REST
MX Converter	AAS sub model
MX Adapter	application specific

Layer	MX-Port "Orion"
MX Discovery	Data Space Protocol / Decentral Claims Protocol
MX Access & Usage Ctrl.	
MX Gate	UADP OPC UA TCP HTTP(S) NetConf
MX Converter	OPC UA Companion Spec OPC UA Meta Model
MX Adapter	application specific

…

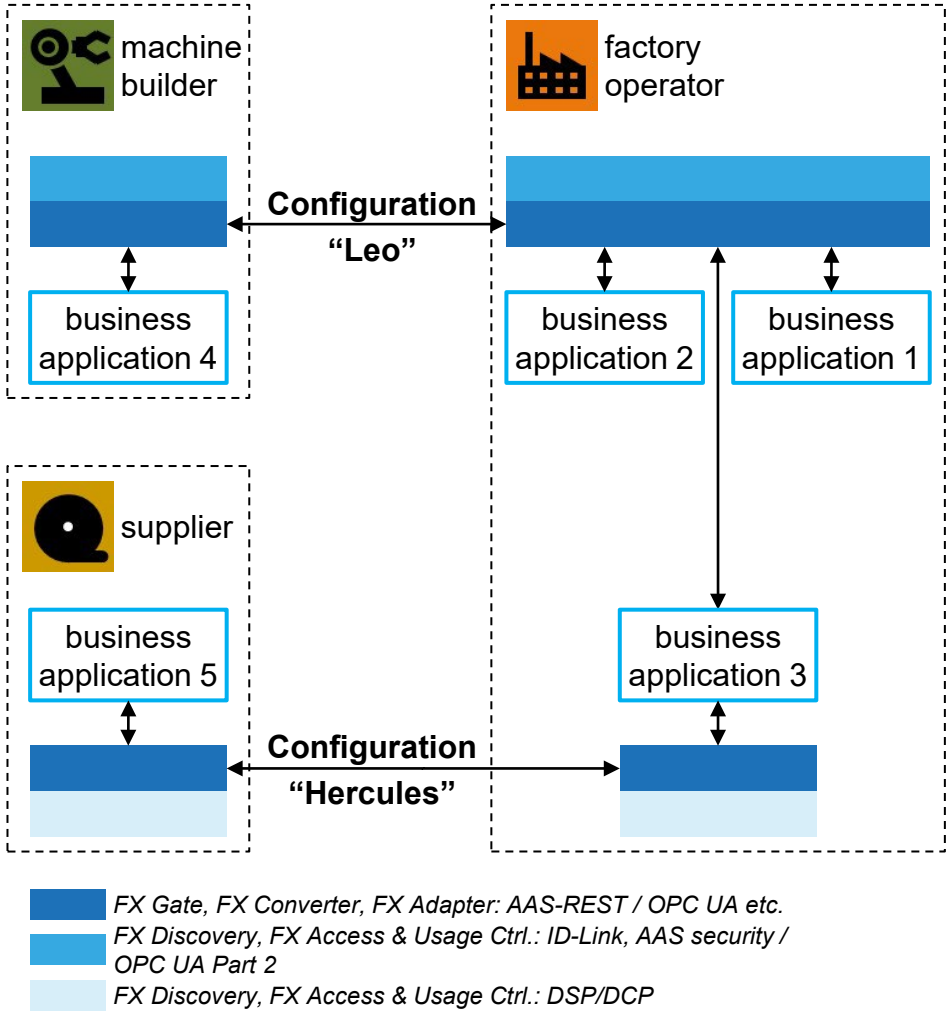
Example how to combine “Leo” and “Hercules”
Opposite MX-Ports must be configured the same

Usage View



design decision of use case

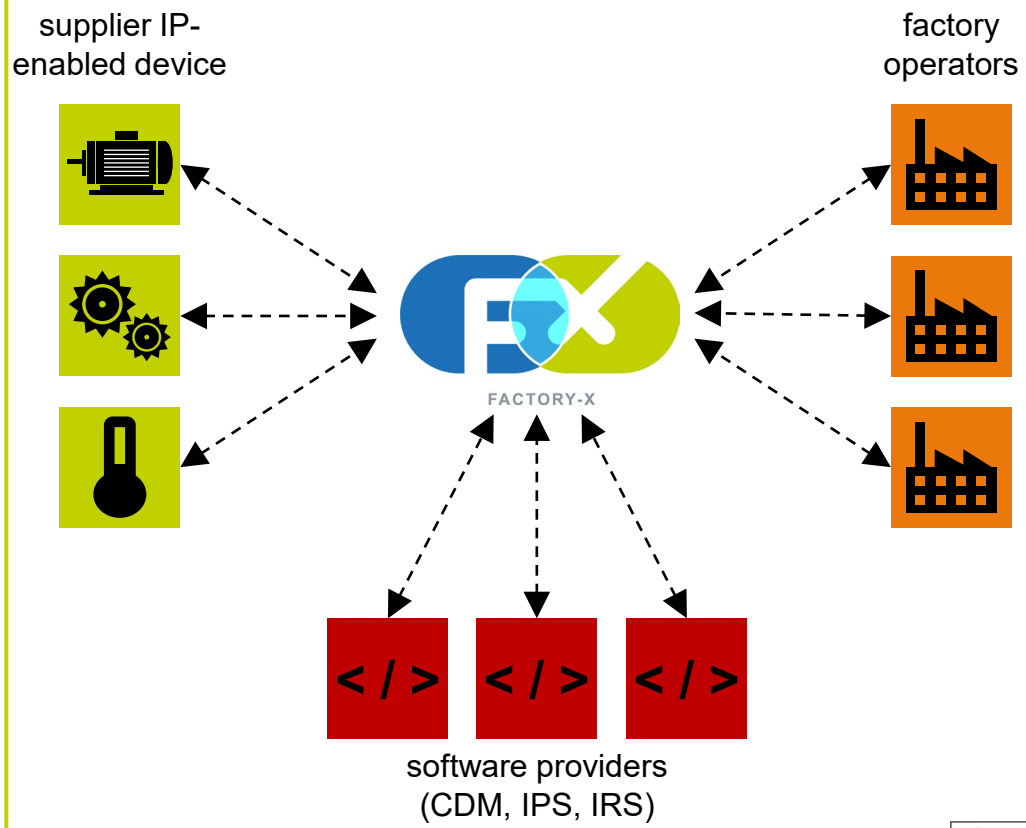
Technical View



FX Gate, FX Converter, FX Adapter: AAS-REST / OPC UA etc.
FX Discovery, FX Access & Usage Ctrl.: ID-Link, AAS security / OPC UA Part 2
FX Discovery, FX Access & Usage Ctrl.: DSP/DCP

Use Case “Information Update and Change Service”
Factory-X lays the foundation for a multi-sided platform*

Illustration



Source: G.G. Parker, M.W. Van Alstyne, S.P. Choudary: Platform Revolution

Overall business impact of Factory X

- The platform (in form of a business stakeholder) uses digital technology to **connect** two or more market participants via the platform and facilitate their business interaction

Example HMI Demonstrator

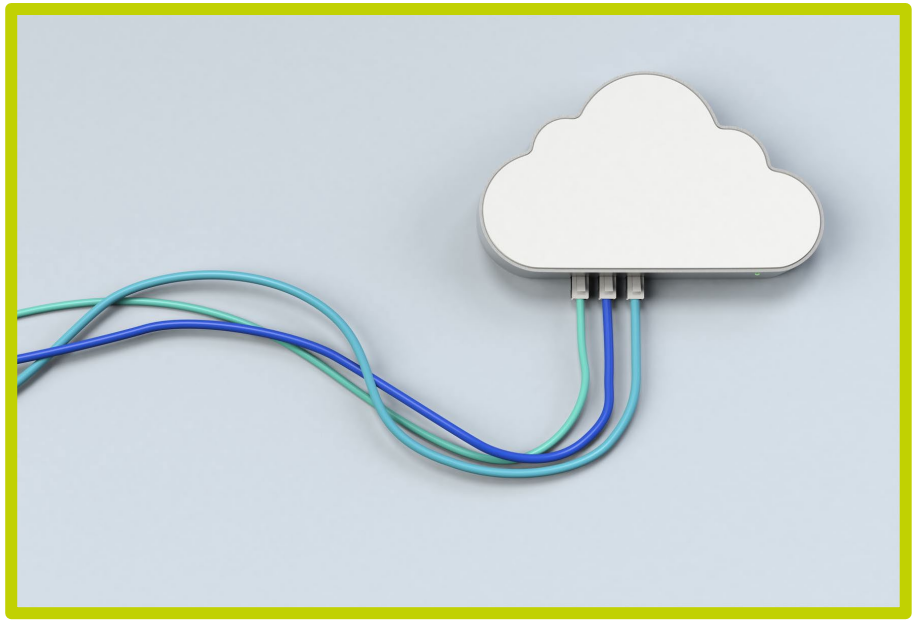
Market participants

- Supplier of IP-enabled devices
- Factory operators
- Software providers

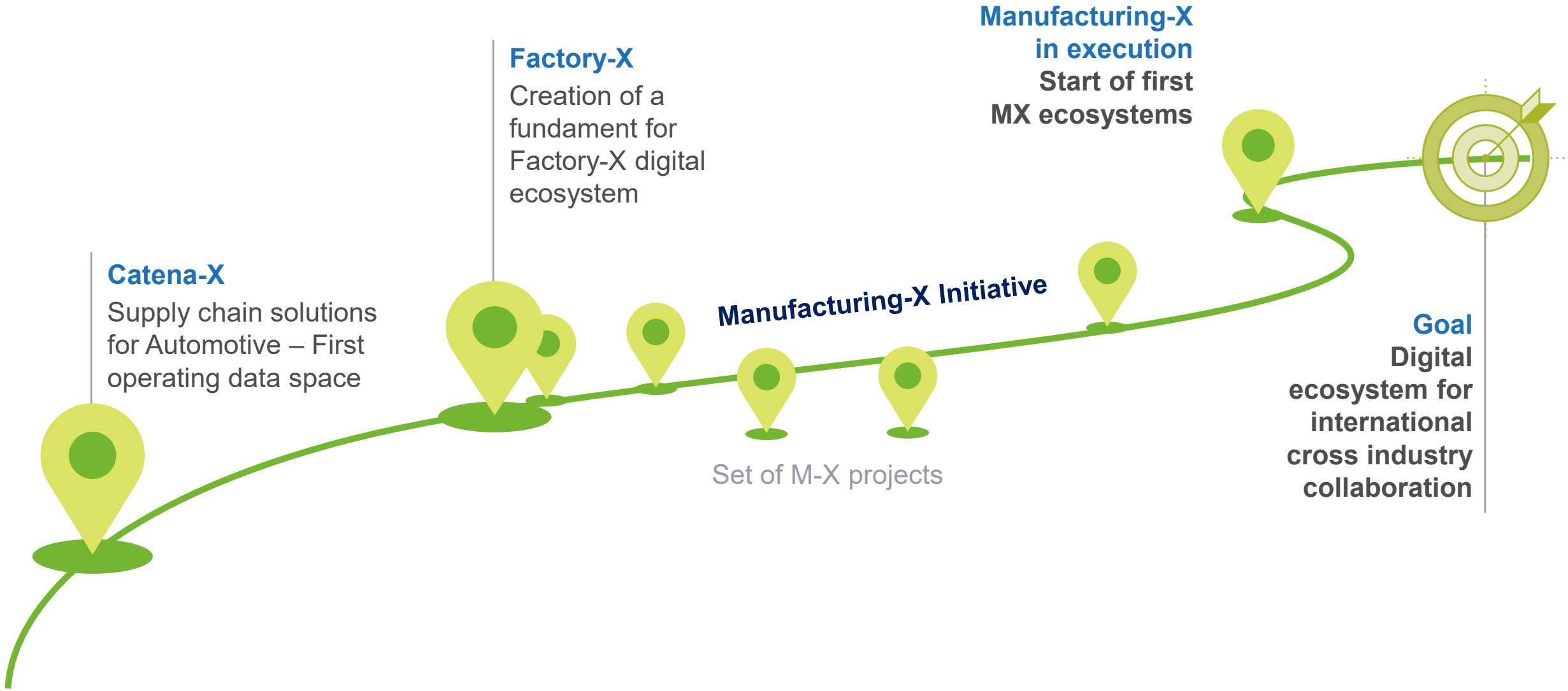
The platform provides benefits for all market participants and supports their individual interests

Key Objectives of Factory-X

- Creation of a Factory-X digital ecosystem, considering existing standards
- Cross-manufacturer data consistency for engineering, device information and condition monitoring
- Contribution to sustainability through CO2 footprint- and energy management, as well as digital solutions to support a circular economy
- Provision of digital solutions for "as a Service" business models (e.g., marketplace/pay-per-part, remote control/monitoring)
- Traceability of materials, data, and products along the entire supply chain
- Update and change management for devices in the field



Factory-X
Open collaboration of factory outfitters and operators



Business Models

Our focus

- Gather and analyze existing business model from various sources
- Select F-X relevant use case candidates for business models
- Develop data ecosystem driven roles and interactions among participants
- Develop a procedure to enable participants of the ecosystem adapt their business model
- Build demonstrator for data driven business models in selected use cases

Goal

Development of F-X data ecosystem driven business models and procedures with suitable frameworks and tools

Key Results

- White Paper "Business models in data ecosystems"
- Summary of analyzed business models
- F-X adapted procedure to develop business models in a "do-it-yourself" way
- Demonstrator based on the logic for one use case

Operating Model

Our focus

- Define the roles, responsibilities and requirements for the decentralized FX-ecosystem
  - Scan and adapt existing operating models, e.g. Catena-X, Mobility Data Space, others
- Define standardization and certification process which covers the specific FX-quality characteristics
  - Interoperability, scalability, trust and sovereignty define guardrails
- Establish a regulatory Framework for the data exchange
  - Defining requirements for the intra- and inter-company communication to lower the complexity
- Organizational interoperability between different data ecosystems (Manufacturing-X level)
  - Preventing from lock-in effects in a single operating company

Goal

- Enable a secure, trustworthy and transparent ecosystem
- Enable scalable & interoperable solutions from minimal up to full-stack systems
- Establish normative documents as a common ground for tenderers, data users and data providers

Key Results

- Fundamental organization of the ecosystem embodied in its components, their relationships to each other, and to the environment, and principles and guidelines governing their design and evolution over time
  - Including e.g. roles and responsibilities, lifecycle management, standardization process, certification process and their respective requirements.

Transfer measures

Our focus

- Development of standardized transfer packages: formats, methods and content
- Assembled and comprehensive transfer packages ready for their application
- Engagement of target groups through forums and workshops and collection of feedback
- Testing of transfer packages tailored to selected target groups
- Creation of scalable transfer packages for SCALE-MX

Goal

Preparation of Factory-X-specific transfer packages and of their distribution in the manufacturing industry

Key Results

- Comprehensive transfer packages for an efficient application in the industrial environment
- Successful engagement of target groups, enabling the adoption and scaling of Factory-X innovations

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Factory-X Kernel

Interoperable Communication and Information Exchange

FACTORY-X

Our focus

- Definition of a scalable architecture and their belonging building blocks to integrate software applications of different vendors and usage scenarios.
- Re-use existing specifications and standards (e.g. IEC, Tractus-X, IDTA, OPC Foundation) to integrate IT and OT cross vertical and cross company.
- Integrate existing software applications largely unchanged to protect investments and IP of the ecosystem participants.
- Support an affordable way for SME to develop their offerings in digitalization.

Goal

Lay the technical foundation for interoperability of all projects under the Manufacturing-X umbrella based on requirements of MX- Use Cases and general MX- consortia qualities.

Key Results

- Analysis of general requirements of cross company / cross vertical integration of existing software applications.
- Conceptualization of the necessary transformational steps and deduction of the belonging functional components.
- Map the functional components to already existing specifications and standards and derive the MX-Port as the central concept out of it.
- Start of specification of the MX-Port components Interfaces

Factory-X Use Cases

11 Use Cases of Factory-X

11 Use Cases for horizontal and vertical data transfer

Integrated Toolchains and Collaborative Engineering

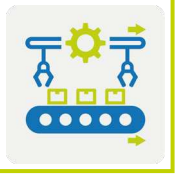
Information Update and Change Service

Collaborative Information Logistics

Condition Monitoring led Services

Modular Production

Manufacturing as a Service - On Demand Manufacturing



Autonomous Operation-as-a-Service

Traceability

Energy-Consumption and Load Management

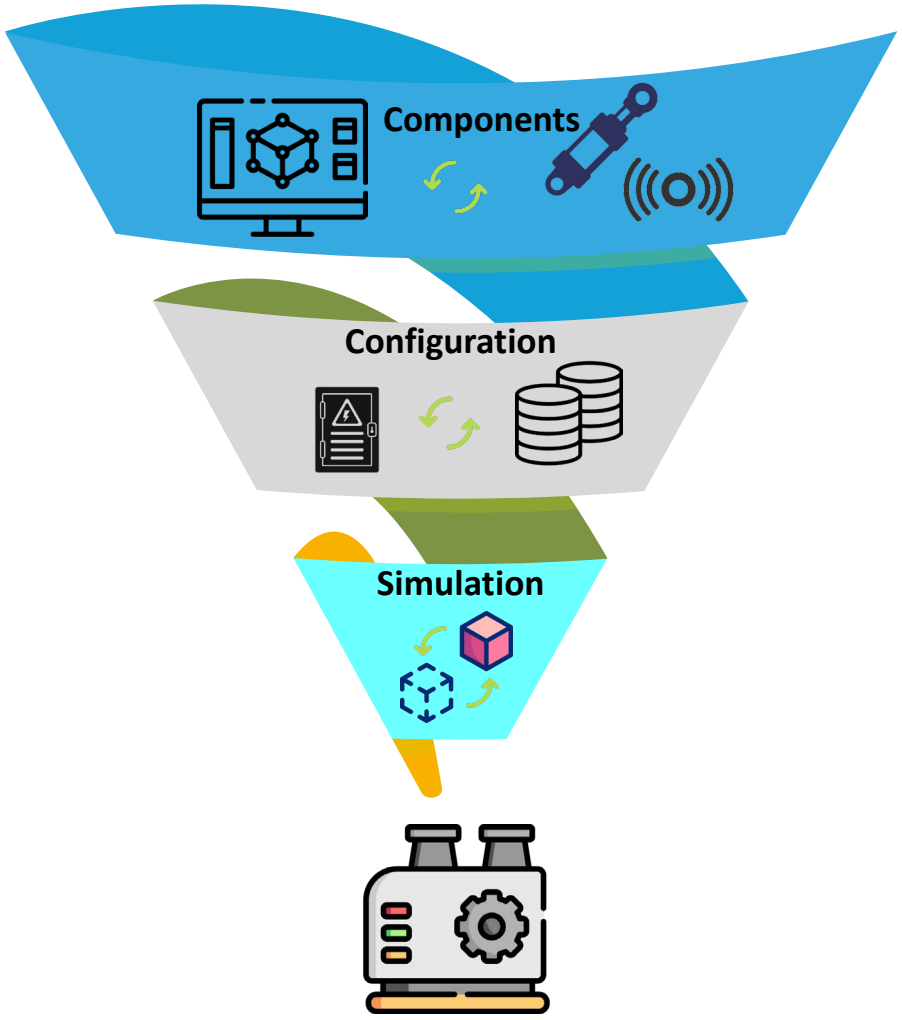
Carbon Footprint Management

Circular Economy

Factory-X Kernel & Basis Services

Integrated Toolchains & Collaborative Engineering

Productivity by Engineering Data Continuity



The Goal

- Increase productivity of engineering processes
- Facilitate & accelerate collaborative engineering
- Integrated Toolchains for digital engineering from virtual solution finding and configuration to simulation

The FX Solution in Detail

- Data continuity along integrated vendor-independent toolchains based on common standards
- Collaborative use of engineering data based on a trusted framework
- Digital twins for simulating and optimizing production processes and systems during life cycle

Integrated Toolchains & Collaborative Engineering

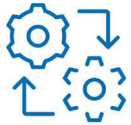
Productivity by Engineering Data Continuity

FACTORY-X

Your Benefit

Accelerate engineering processes:
Several companies are often involved in engineering processes and many tools are used. Breaks and loss of information often occur at the interfaces. Standardization promotes the loss-free exchange of data, reducing time-consuming rework and increasing the efficiency and quality of processes.

Data sovereignty ensures a competitive advantage:
Data sovereignty is crucial for companies to maintain control over their data. It makes it easier to adhere to compliance guidelines, prevents data loss and enables the targeted sharing of sensitive information. This promotes trust in collaborative engineering processes, supports innovation partnerships and secures competitive advantages.



Digital twins for factories:
Integrated engineering toolchains create digital twins that are enriched with relevant information for the virtual planning, design and commissioning of production facilities. These digital twins enable the simulation, forecasting and optimization of production processes and systems over entire life cycle.

Information Update and Change Service

Instant Updates, Automated Changes!

The Goal

- Solutions for automated and reliable update services and common device management
- Information throughout the entire life cycle about the current status of operating equipment
- Efficient software updates across the variety of equipment installed in the factory

The FX Solution in Detail

- Data spaces enable automated notification and provision of information between manufacturers and users
- Transparency is created across the variety of operating equipment
- Updates to functionality and security are fulfilled efficiently and in compliance with regulations

Information Update and Change Service

Instant Updates, Automated Changes!

FACTORY-X

Your Benefit

Automated notifications
Standardized information on product changes across all product suppliers and machine builders save manual effort and allow for reliable adaptation to new circumstances.

Secure lifecycle management
Standardized information enables the exploration of the current software status across all installed products in the factory, while your company's data remains protected.

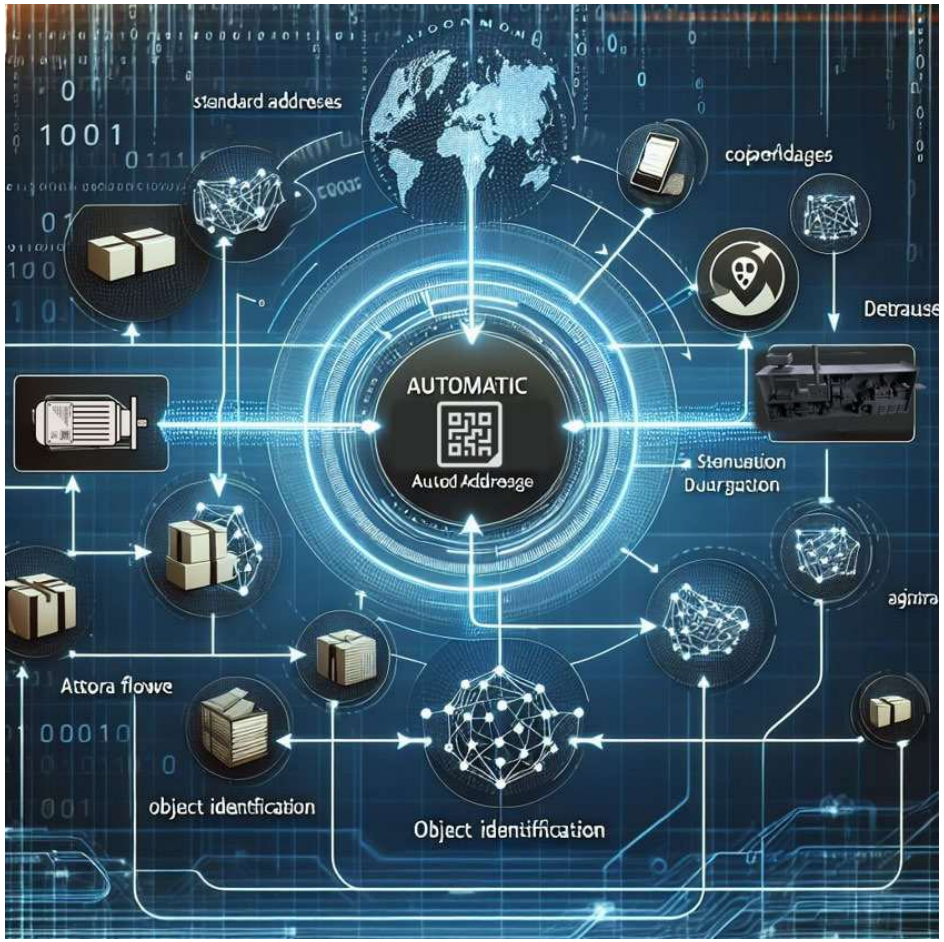
Faster updates and compliance
Efficient update procedures ensure that your products are up to date and fulfil new regulatory requirements such as the EU Cyber Resilience Act.

Increased product availability and longevity
An improved information flow increases the flexibility and resilience of your systems.

Collaborative Information Logistics

Standardize Smart, Exchange Fast!

FACTORY-X



The Goal

- Exchange of asset information via standardized B2B interfaces for more efficient processes among manufacturers, operators, and service providers.
- Based on existing standards, a scalable solution is specified, which can be implemented by software providers.

The FX Solution in Detail

- In exemplary user journeys like machine documentation, reports and component information the standardized B2B interfaces are prototypically implemented to achieve interoperability between applications.
- The dataspace ensures that the solution works with many stakeholders.

Collaborative Information Logistics

Standardize Smart, Exchange Fast!

FACTORY-X

Your Benefit

As a **factory operator** you benefit from better software applications that can manage and exchange information of assets. Information can be exchanged between legal entities allowing reduced search times, higher information quality and better transparency and control of your assets and machines.

As a **software provider** you benefit from standardized information models, application interfaces and connectors so that you can provide business value to your customers easier.

As a **component or machine supplier** you benefit from blueprints for providing asset information to your customers. Information requests can be automized and your customers get the possibility to provide relevant information back to you. Paper based information provisioning can be avoided and regulatory requirements fulfilled. The dataspace is the foundation for monetizing data related services.

As a **service provider** you benefit from a standardized way of exchanging information between your customers by reducing the complexity of interface configuration and its management.

Condition Monitoring Led Services

Enable new digital services to increase equipment availability cost-efficiently

Image generated by ideogram.ai

The Goal

Identify and remove barriers to data sharing between parties to enable the widespread adoption of condition monitoring as a trigger for a new era of proactive, automated and remotely controlled services.

The FX Solution in Detail

- Basis for data-driven, proactive, and automated services
- Simplified and trustworthy data sharing through standardized mechanisms and models
- Industry-aligned integration increases trust in implementation and fosters adoption

Condition Monitoring Led Services

Enable new digital services to increase equipment availability cost-efficiently

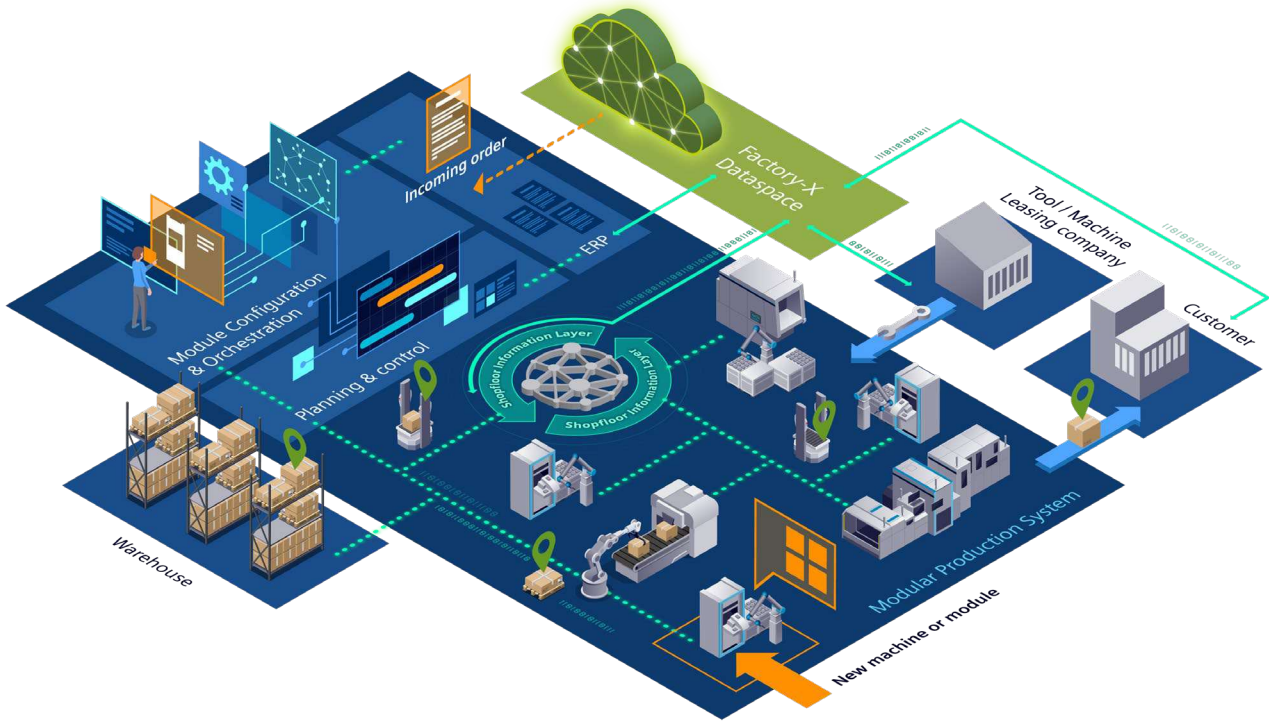
FACTORY-X

Your Benefit

- Increased machine availability – detecting issues before they become problems to the equipment and affect production, while keeping maintenance costs at check
- Faster and accurate decisions - are made based on data-driven insights that can be accessed immediately incl. by other parties
- Efficient work - work can be planned effectively (improving service value and experience). Parties are additionally empowered with Digital Services
- Efficient implementation - Standardized data sharing mechanisms and data models make implementation and operation easier, faster, more secure, and cost-efficient

Modular Production

Build smart, adapt fast!



The Goal

- Fast adaption of production resources to new requirements or changes in the production process
- Ensure flexibility and adaptability of production resources to increase resilience and competitiveness
- Maintain stable and high-performing production even during a shortage of workers or machine downtimes

The FX Solution in Detail

- Modular solutions at machine level with semantic self-description and interfaces to the shopfloor
- Analysis of the current machine configuration and proposals for optimized reconfiguration
- Modular and adaptive production control to ensure an optimized orchestration of process steps and (re-)scheduling based on feedback from the shopfloor

Modular Production

Build smart, adapt fast!

FACTORY-X

Your Benefit

Enhance your competitiveness and resilience through flexible and adaptable production processes. With digital solutions, production resources can be quickly adjusted to meet new requirements, making your production more efficient and future-proof.

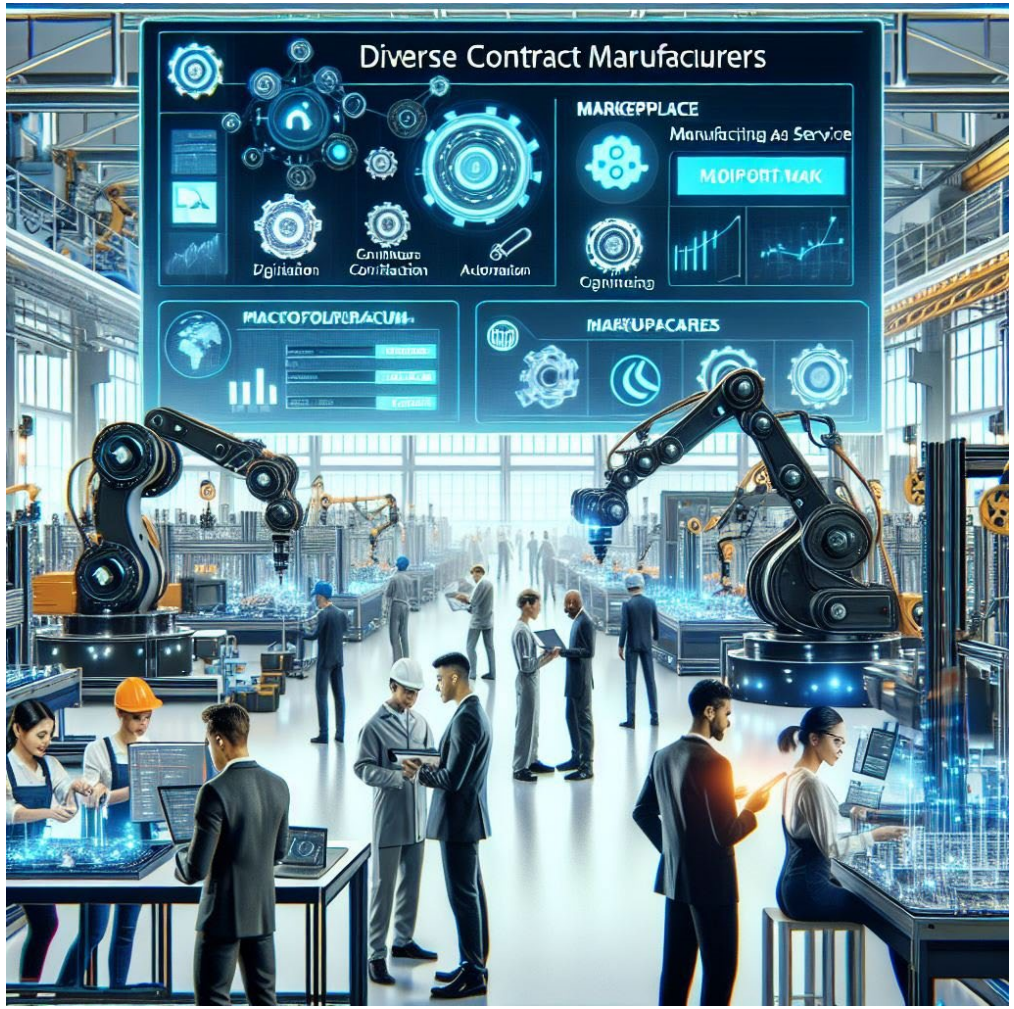
Independence from Skilled Labor: Maintain stable and high-performing production even during a shortage of skilled workers, enabling greater flexibility and adaptability.

Efficient Order Changes: Optimize your production with automated configuration of machines and workstations. Reduce setup and downtime while minimizing potential sources of errors.

Manufacturing as a Service – On-Demand Manufacturing

Shared skills – matching orders!

FACTORY-X



The Goal

- **Visibility** and transparency on digital manufacturing marketplaces with shared skills
- **Efficiency** with automated processes in bidding and execution
- **Competitiveness** with matching orders and manufacturing quality ensuring even for lot-size-one production

The FX Solution in Detail

- Inter-company connectivity
- Using standardized data formats for
  - Manufacturing capabilities
  - Quotation
  - Quality control

Manufacturing as a Service – On-Demand Manufacturing

Shared skills – matching orders!

FACTORY-X

Your Benefit

New business potential and increase of order income

With access to digital manufacturing marketplaces, you increase your market reach and receive manufacturing orders that fit your capabilities and current conditions without the need for extensive sales activities. This enables you to make optimal use of available capacities.

Reduced effort in entering these marketplaces, in quoting, planning and processing

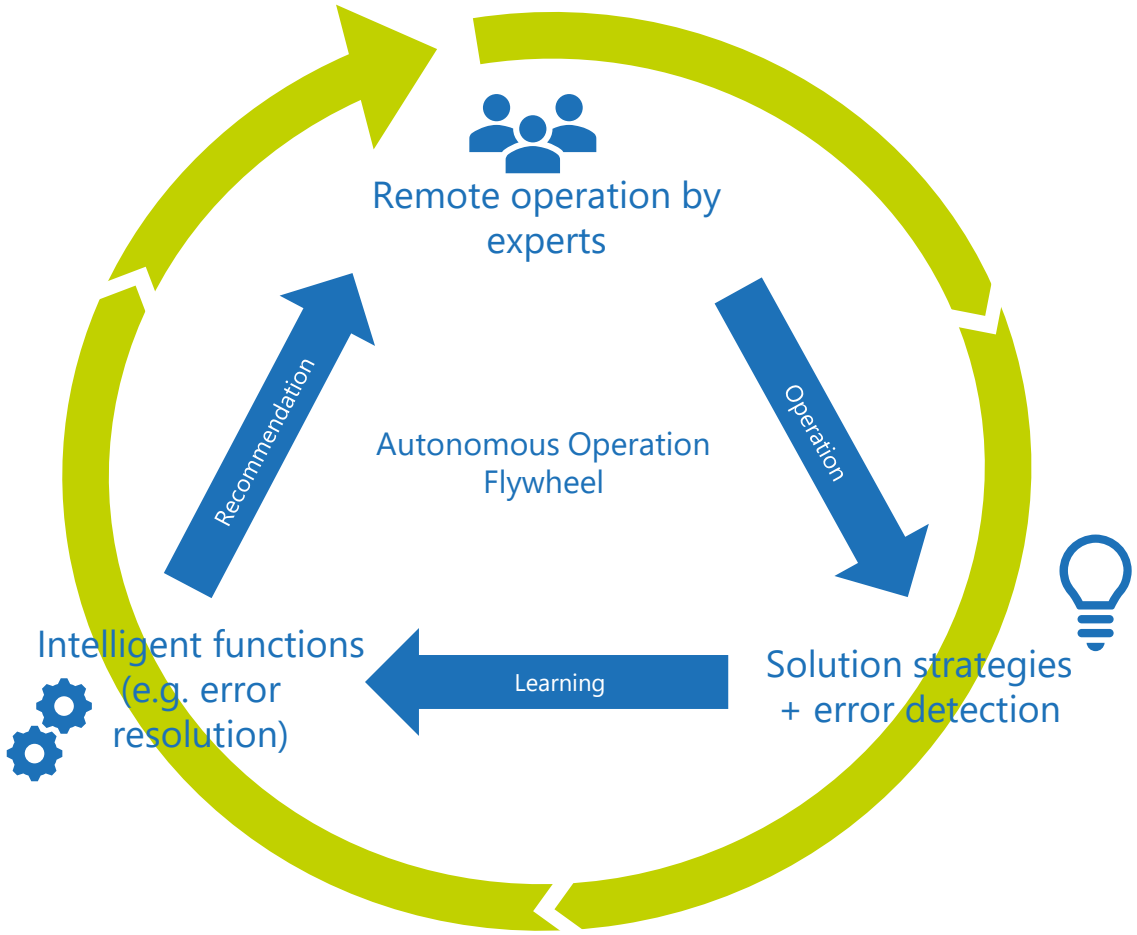
Through automated order processing and cost calculation, while simultaneously meeting quality requirements, you optimize the time and effort required for quote preparation and order execution to a minimum. This significantly enhances your efficiency and provides a competitive advantage.

Customer satisfaction with best company's reputation

With the FX quality monitoring solution, you ensure adherence to the required processing quality continuously across multiple levels, even for small batch sizes down to lot-size-one. This guarantees that customer expectations are met, enhancing your company's reputation.

Autonomous Operation as a Service - AOaaS

Remote Shopfloor automated – Service improved!



The Goal

To provide a remote monitoring and operations platform that allows manufacturers to maintain high productivity and efficiency without relying on on-site specialists.

The FX Solution in Detail

Through a shared data space, multiple service partners from different organizations can seamlessly collaborate to resolve machine issues with minimal disruption. This real-time, cross-company collaboration ensures scalable and efficient problem-solving for the machine owner.

Autonomous Operation as a Service

Remote Shopfloor automated – Service improved!

FACTORY-X

Your Benefit

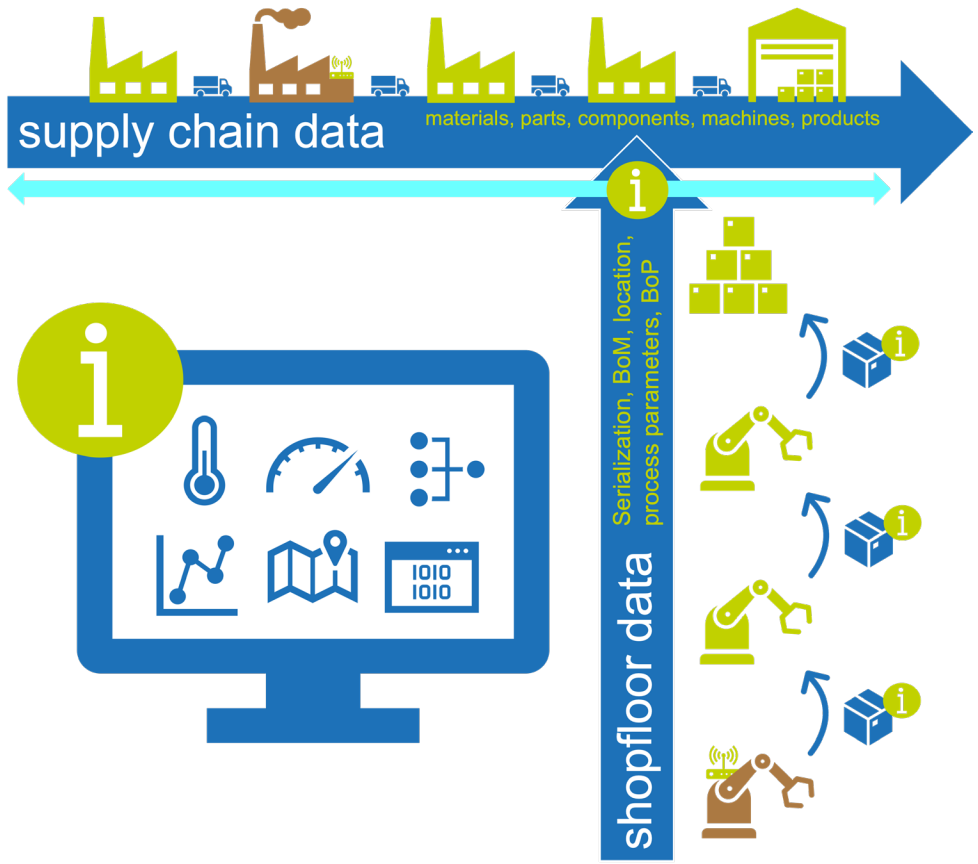
Increased delivery reliability: By the next shift, finished parts are ready for you – with no rescheduling or delivery delays.

Autonomous Manufacturing: Despite a shortage of skilled workers, you can also manufacture productively at the highest level.

Productive unmanned shift: Reduce downtime processing time by a factor of five – for maximum efficiency during the unmanned shift

Traceability

Overview



The Goal

Traceability links all manufacturing information through a standardized system by providing:

- Product & process data over the whole lifecycle
- Bill of material as planned, produced & maintained
- Material provenance and use over the value chain

The FX Solution in Detail

- Two aspects:
  1. Shop floor traceability:
     collects core asset, quality, process and position data
  2. Supply chain traceability:
     leverages data spaces for secure and controlled data exchange among partners

Why Traceability

Trace Today, Trust Tomorrow

FACTORY-X

Your Benefit

Reduce failures and waste by rapid detection of end product defects based on comprehensive documentation of process parameters

Quickly resolve quality problems by precise root-cause analysis and taking appropriate actions avoiding costly recalls and strengthening competitiveness

Optimize value chain based on the secure and policy-controlled information exchange about parts provenance and usage leading to more trust among partners

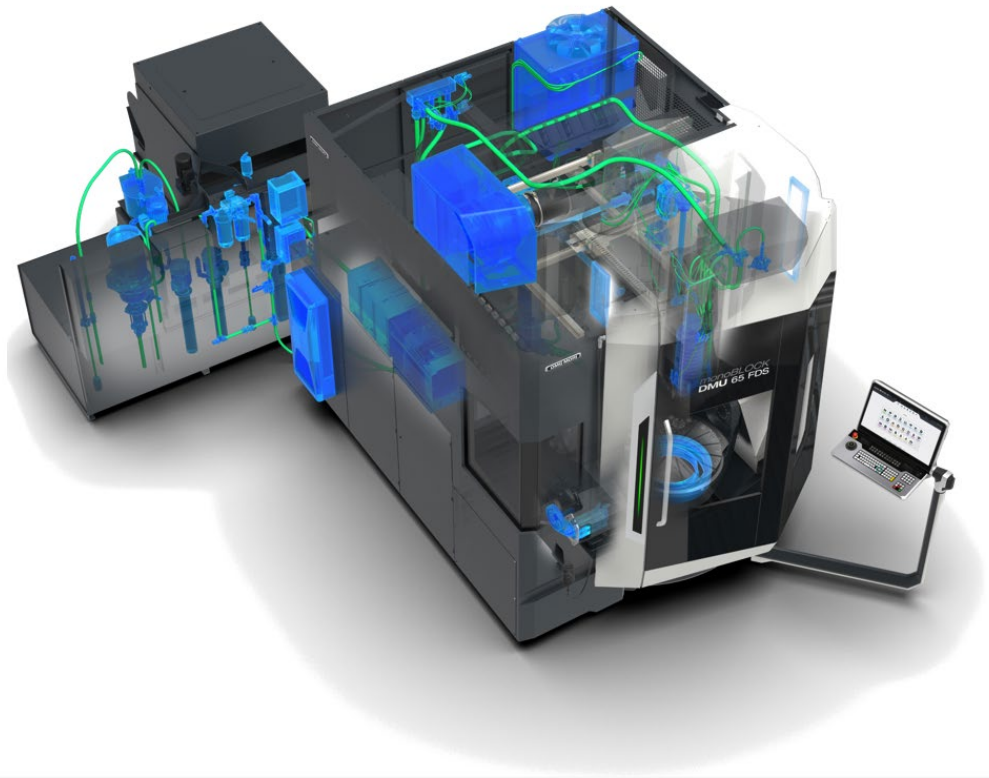
Improve customer satisfaction by consistent process documentation ensuring high product quality and strengthening customer trust

Meet regulatory compliance based on the efficient, standardized and cost-effective access to all necessary and relevant data

Energy Demand and Load Management

Data-driven solutions for energy-efficient manufacturing

FACTORY-X



The Goal

- Solutions for seamless monitoring and optimization of energy demand
- Energy-optimized production scheduling & factory infrastructure
- Management of energy flexibility across companies and to power authorities

The FX Solution in Detail

- Vertical energy data management (machine-to factory-level)
- Data-driven energy optimization of machine tools
- Utilization of existing and new standards like OPC-UA, AAS or MX-Port

Energy Demand and Load Management

Data-driven solutions for energy-efficient manufacturing

FACTORY-X

Your Benefit

- Solutions for interoperable energy monitoring & energy demand reduction of machine tools
- Innovative approach to administrate and utilize energetical characteristics via the Energetic Digital Twin
- Energy-optimized production scheduling for reduced energy costs
- Load management offers new business opportunities in collaboration with power authorities

Carbon Footprint Management

Comparable & Automated Product Carbon Footprint Calculation

FACTORY-X

The Goal

- Factory Operators are missing detailed guidance on Product Carbon Footprint (PCF) calculation
- Calculating PCFs is highly complex and resource-intensive
- Our Goal is to provide calculation guidance and business applications, that enable companies to measure and calculate their PCF with less effort

The FX Solution in Detail

- We will deliver Business Applications for:
  - Calculation of logistics share of PCFs
  - Calculation of manufacturing share of PCFs
  - Management and sharing of PCFs
- The Factory-X ecosystem will enable the reliable sharing of comparable PCF data between companies.

Carbon Footprint Management

Comparable & Automated Product Carbon Footprint Calculation

FACTORY-X

Your Benefit

Factory-X PCF guidance: Gives guidance for a comparable PCF calculation and lowers the entry hurdle for SMEs

Factory-X PCF Business Applications: Tools to enable companies to calculate their PCF with less effort

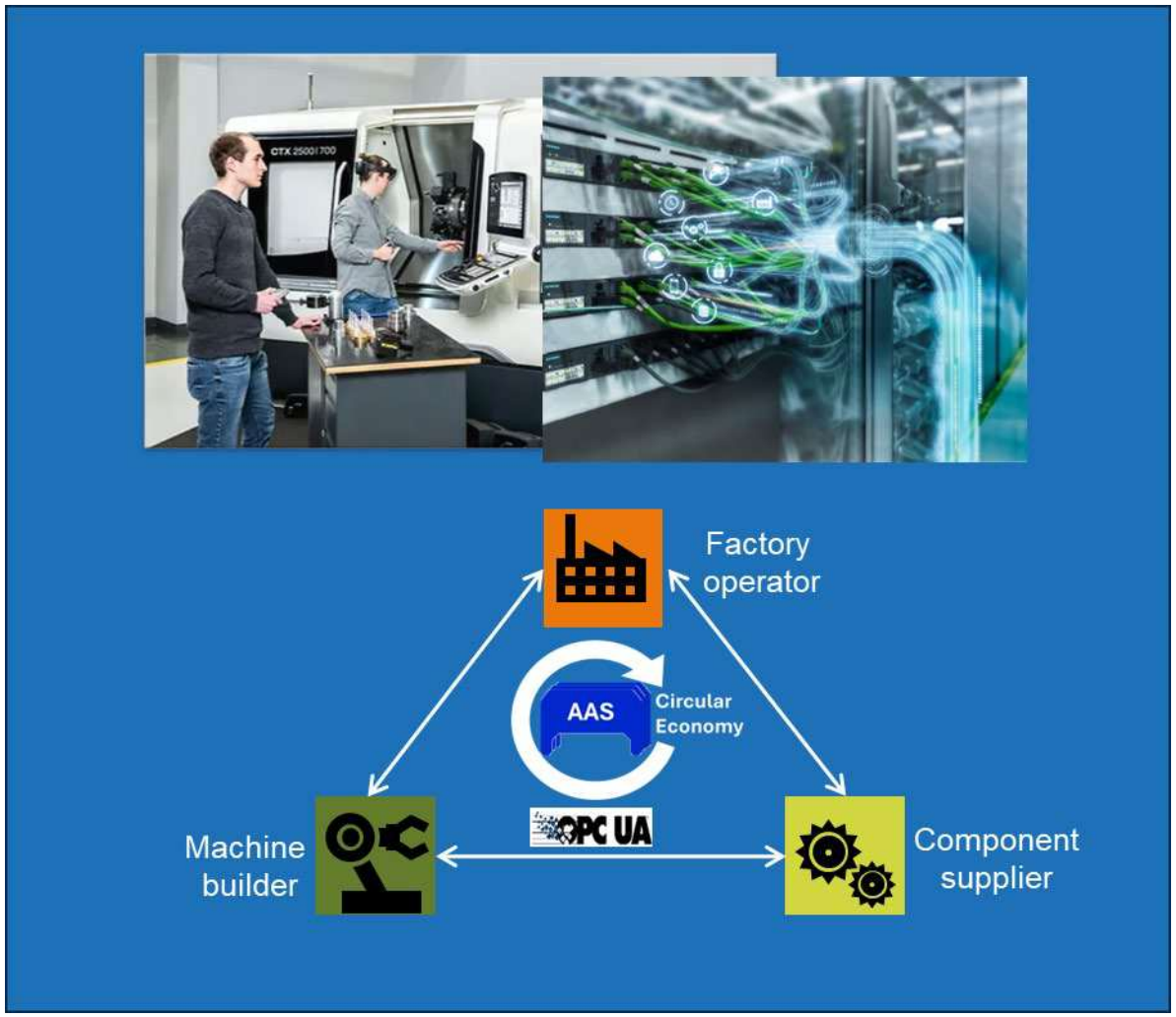
- Calculation of logistics share of PCFs
- Calculation of manufacturing share of PCFs
- Management and sharing of PCFs

Factory-X Ecosystem: The Factory-X Ecosystem will enable reliable sharing of comparable PCF data

Circular Economy

Close the Loop – for multiple lives!

FACTORY-X



The Goal

- Extending the useful life of machines and components by using AAS standard for circular economy. This includes a seamless digital information chain of machines/components as well as relevant operating data to enable R-grading strategies.
- Challenge: Provision of actual AAS data of machines/components and specific operating data
- Goal of the solution leads to added value for machine operator, manufacturer and component supplier.

The FX Solution in Detail

Cross-company workflow from machine operator, machine manufacturer to component supplier and back

In a **protected dataspace** and defined authorization concepts

With **up-to-date machine/component transparency** and **standardized**, **anonymized operating data**

to assess the **situation of the machine** and its **components** for derivation of further **R-strategies/decisions** (refurbishing / remanufacturing / recycling)

Circular Economy

Close the Loop – for multiple lives!

FACTORY-X

Your Benefit Qualified and **data-based decision-making** to **increase the lifetime of machines** and its **components** by using **AAS standard for circular economy**

Improve sustainability: Cross-company data exchange creates transparency across the entire machine/component life cycle and helps you make better, more sustainable decisions. This means that machines and components can be reused or recycled, thereby avoiding waste and saving resources while increasing efficiency.

Optimization: Using standardized, anonymized operating data and up-to-date machine/component data enables you to make optimizations, like suggesting other usage or choosing the best R-strategies. AAS standard for circular economy reduces manual efforts supports maintenance and increases the life of machines and their components.

Easier data usage: It is essential for a digital information chain to integrate all companies into the product life cycle. Improved international standards, simplified data integration, protected dataspace usage help to build broad view of the product life cycle.

Thank you

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