FACTORY-X

Factory-X

The Digital Ecosystem for Factory Outfitters and Operators

View our LinkedIn Profile

PART OF MANUFACTURING-X

Supported by:
Federal Ministry for Economic Affairs and Energy
Funded by the European Union
NextGenerationEU
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

M-X Port

FACTORY-X

Manufacturing-X

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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

International Manufacturing-X (IMX): Make Data Work

IMX 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.

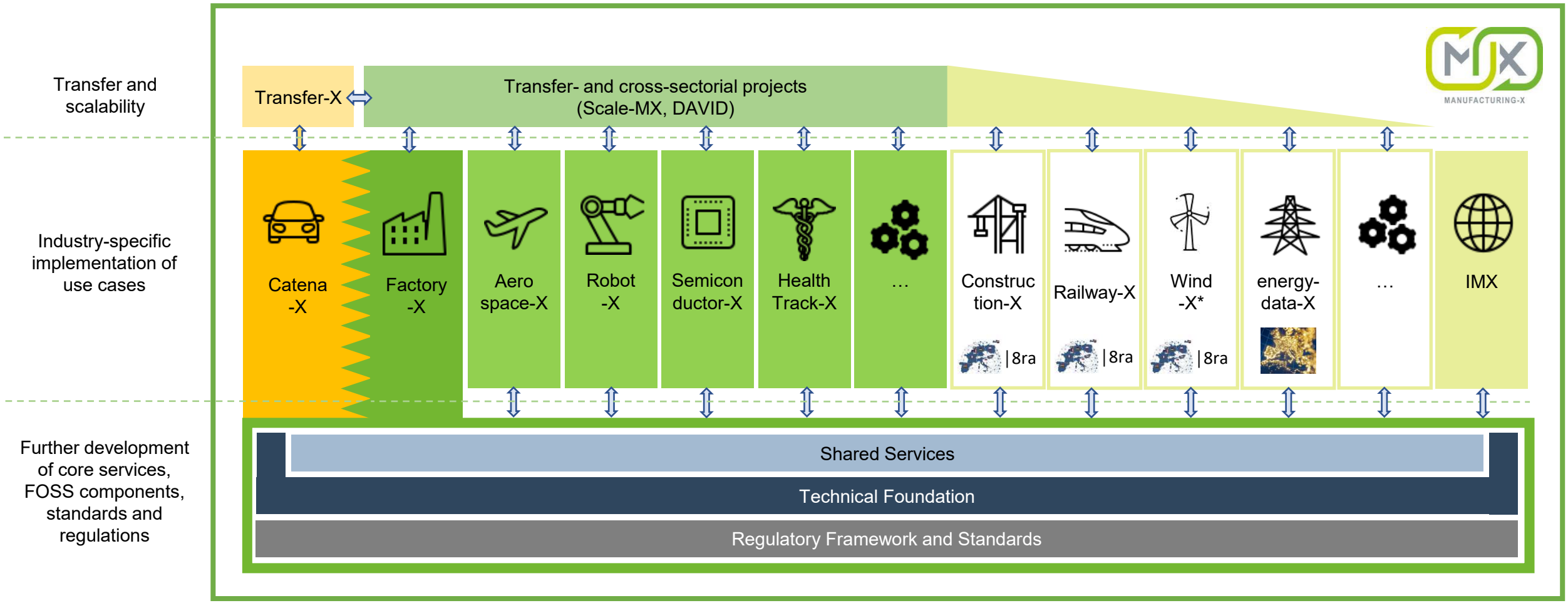
Sustainability

Accelerate digital innovations and enable new data-driven business models to create new value for manufacturing

Competitiveness

Projects

Landscape of Manufacturing-X projects in Germany



*Project in preparation

Source: Manufacturing-X initiative

Motivation & Big Picture

Foundational Framework for IMX

A common guideline for IMX activities and international stakeholders.

Strategic Goals

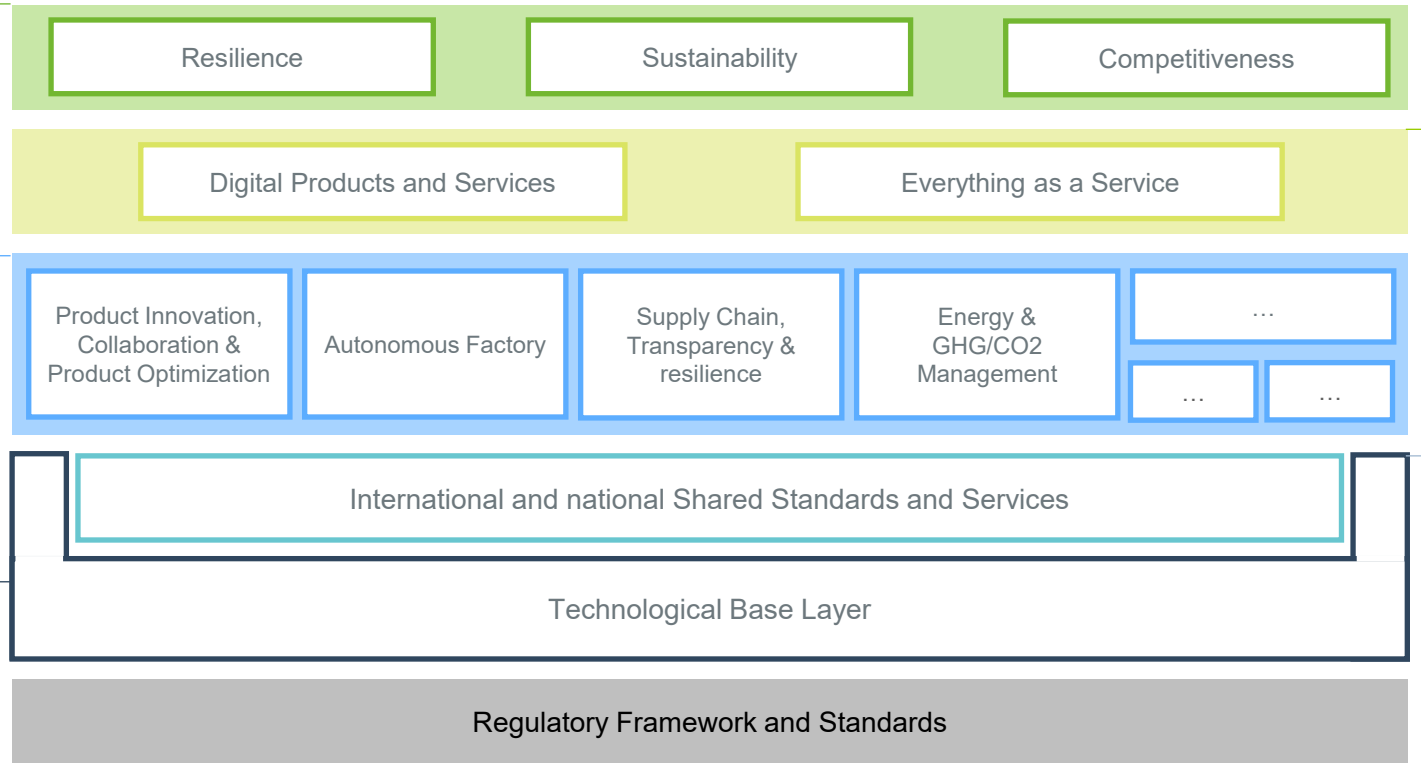
International Manufacturing-X develops the foundations for a resilient and competitive industry in a sustainable society.

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.

International Alignment: International MX Council

What has happened so far:

2023 July Initiation Brussels, Belgium

2023 October Inauguration Tokio, Japan

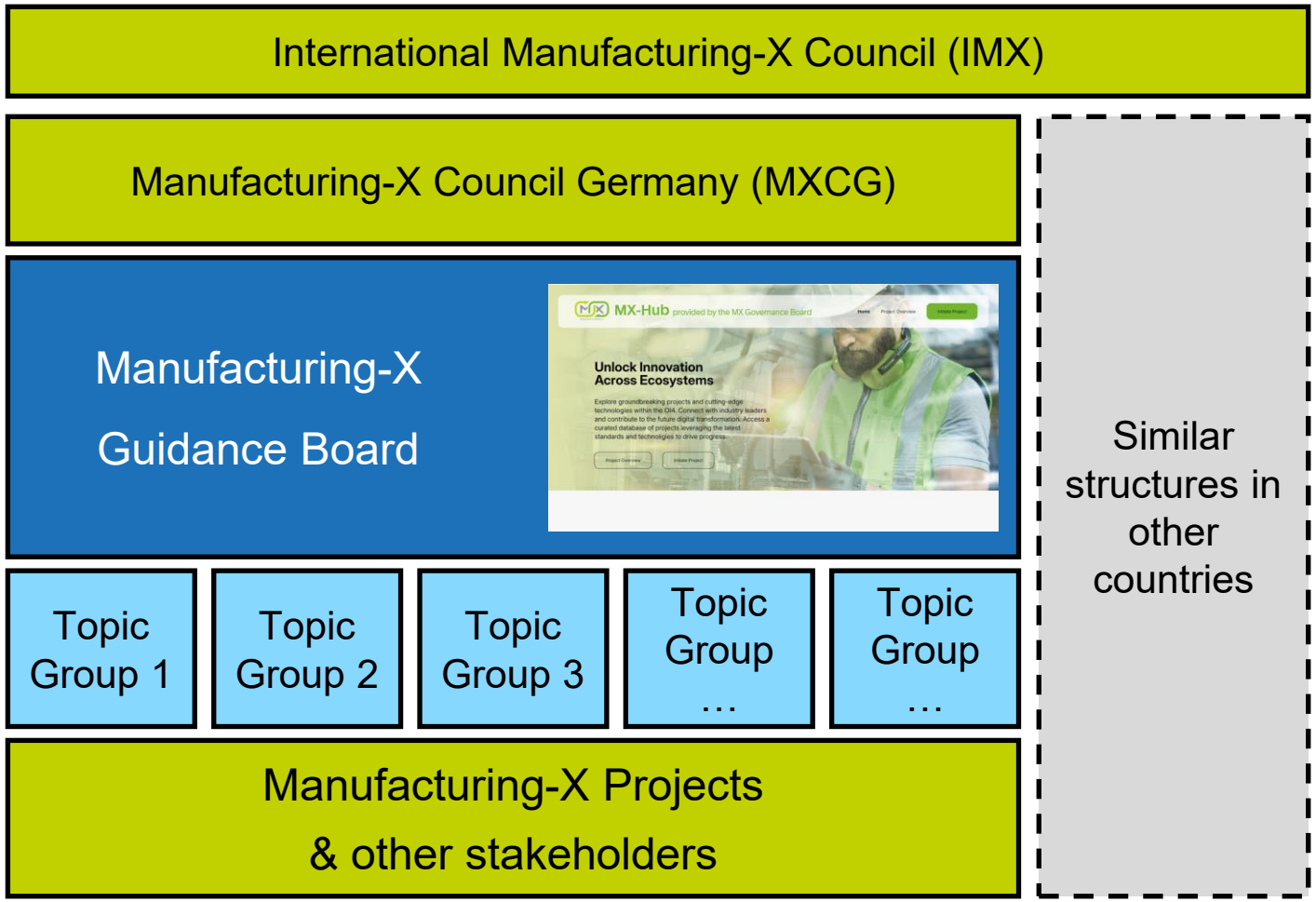
2024 February Kick-off Paris, France

2024 Novem. USA/ CESMII

2025 May Athens/ Greece

2025 Nov. Copenhagen/ Denmark

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

FACTORY-X

Factory-X
Project Overview

The Digital Ecosystem for
Factory Outfitters and Operators

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NextGenerationEU

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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

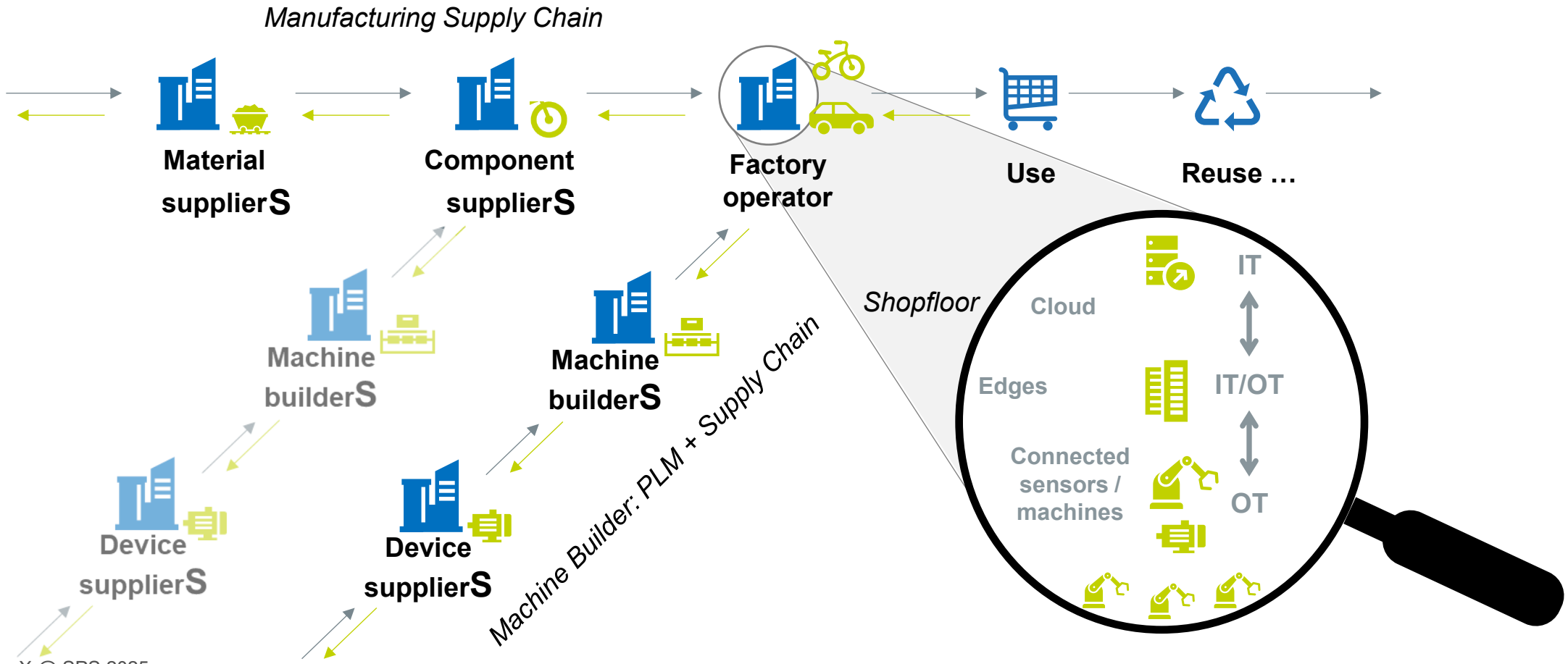
August-Wilhelm Scheer Institut Digital Research, Fraunhofer, IFW Institut für Fertigungstechnik und Werkzeugmaschinen, ISW, RUHR UNIVERSITÄT BOCHUM RUB, smartFactory, Catena-X, ESTAINIUM Association, LNI4.0, VDMA, zvei electrifying ideas

Associated Partners

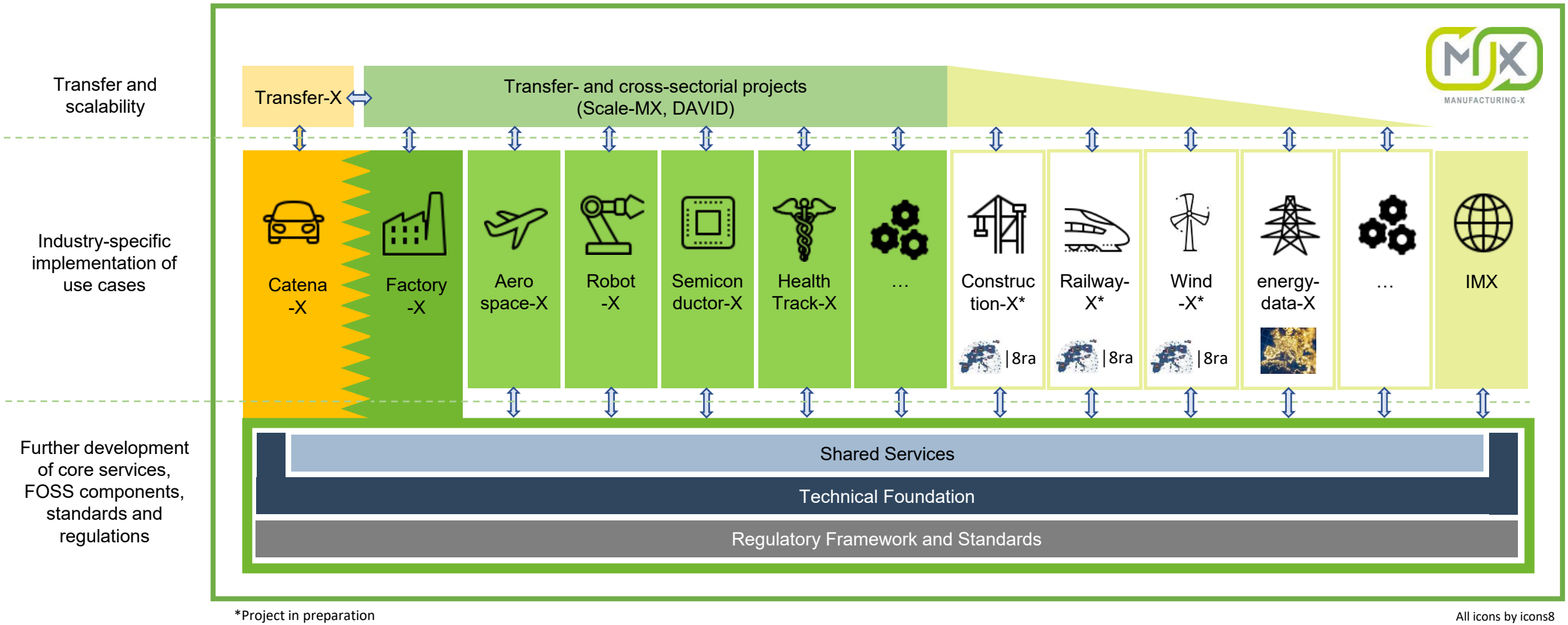
ARENA2036, bayern innovativ Innovation leben, BECKHOFF, BOSCH, Digital Data Chain Consortium, EVIDEN, IDTA, Sharecat, STANDARDIZATION COUNCIL INDUSTRIE 4.0, zvei electrifying ideas

Factory-X
Our Scope and claim

Building the foundation of an open and collaborative digital ecosystem for factory outfitters and operators!



Germany
Cooperation between the projects



*Project in preparation

All icons by icons8

Way forward to M-X DATA ECOSYSTEM

MX-Port via Factory-X
- MX-Port Hercules
- MX-Port Leo
- MX-Port Orion

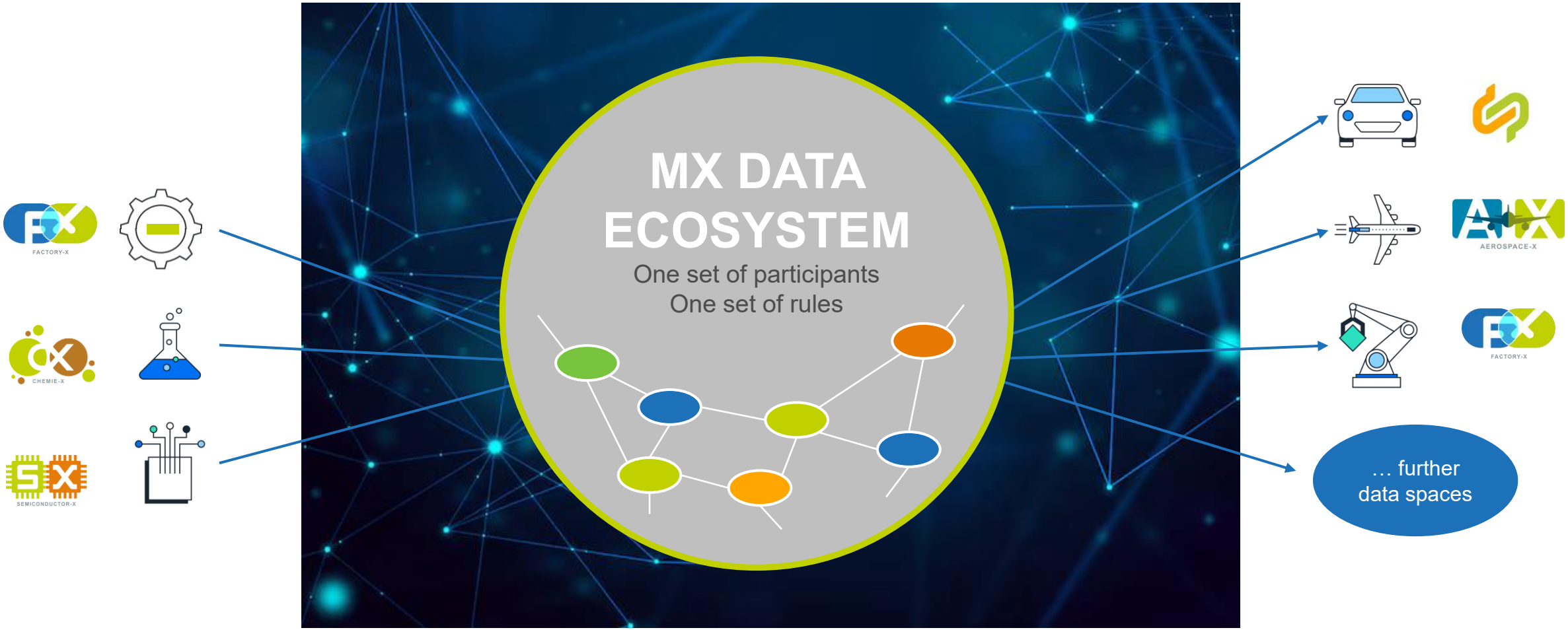
Factory-X proposal for
- Governance „M-X Verstetigung“
- Operating Model
- Set of common rules

M-X Governance Organization

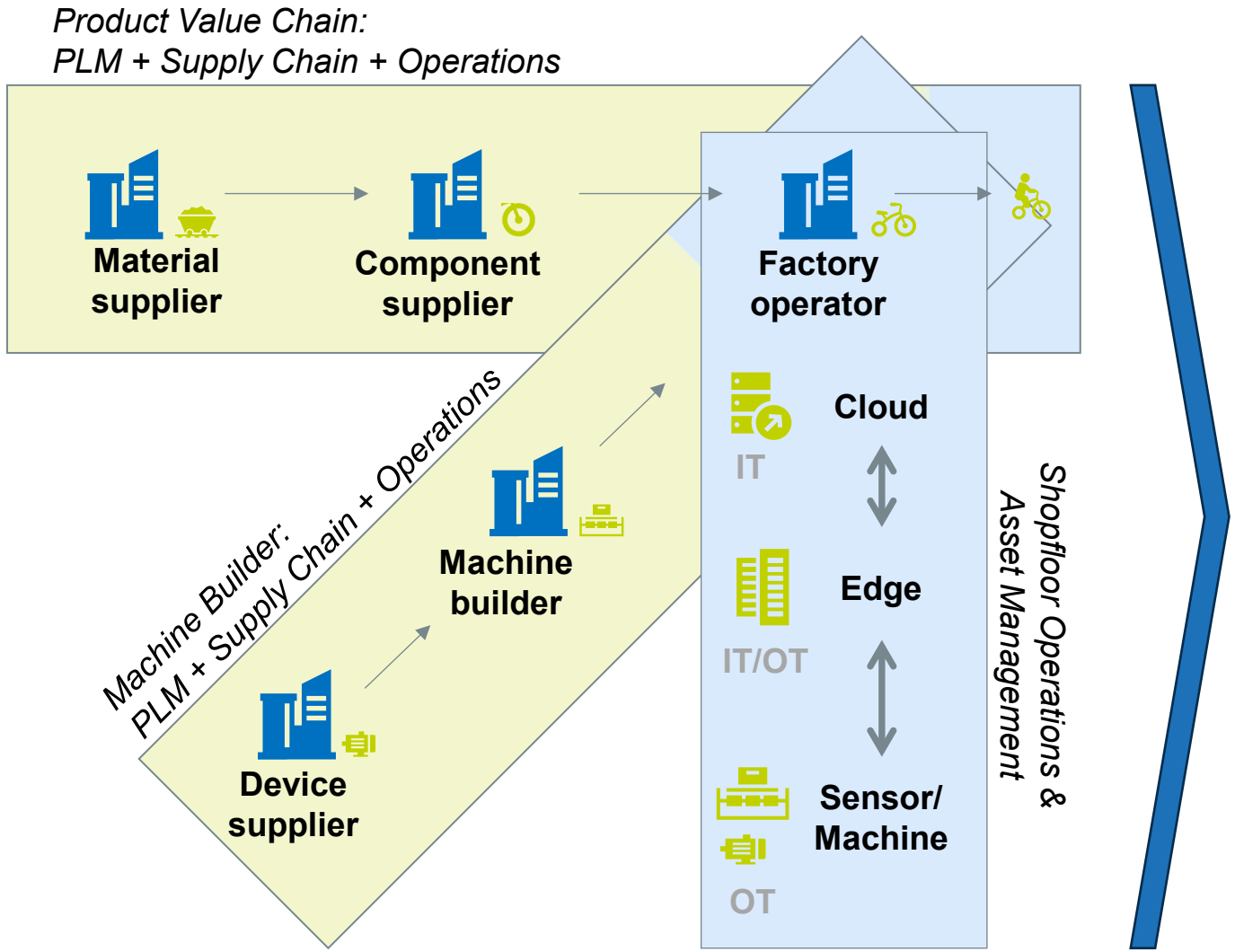
M-X DATA ECOSYSTEM

One set of participants
One set of rules

. . . And that creates the foundation of Europe's leadership in industrial AI



Technical Foundation:
MX-Port with focus on different scenarios



Foci of MX-Port Configurations

Supply Chain oriented
"HERCULES"

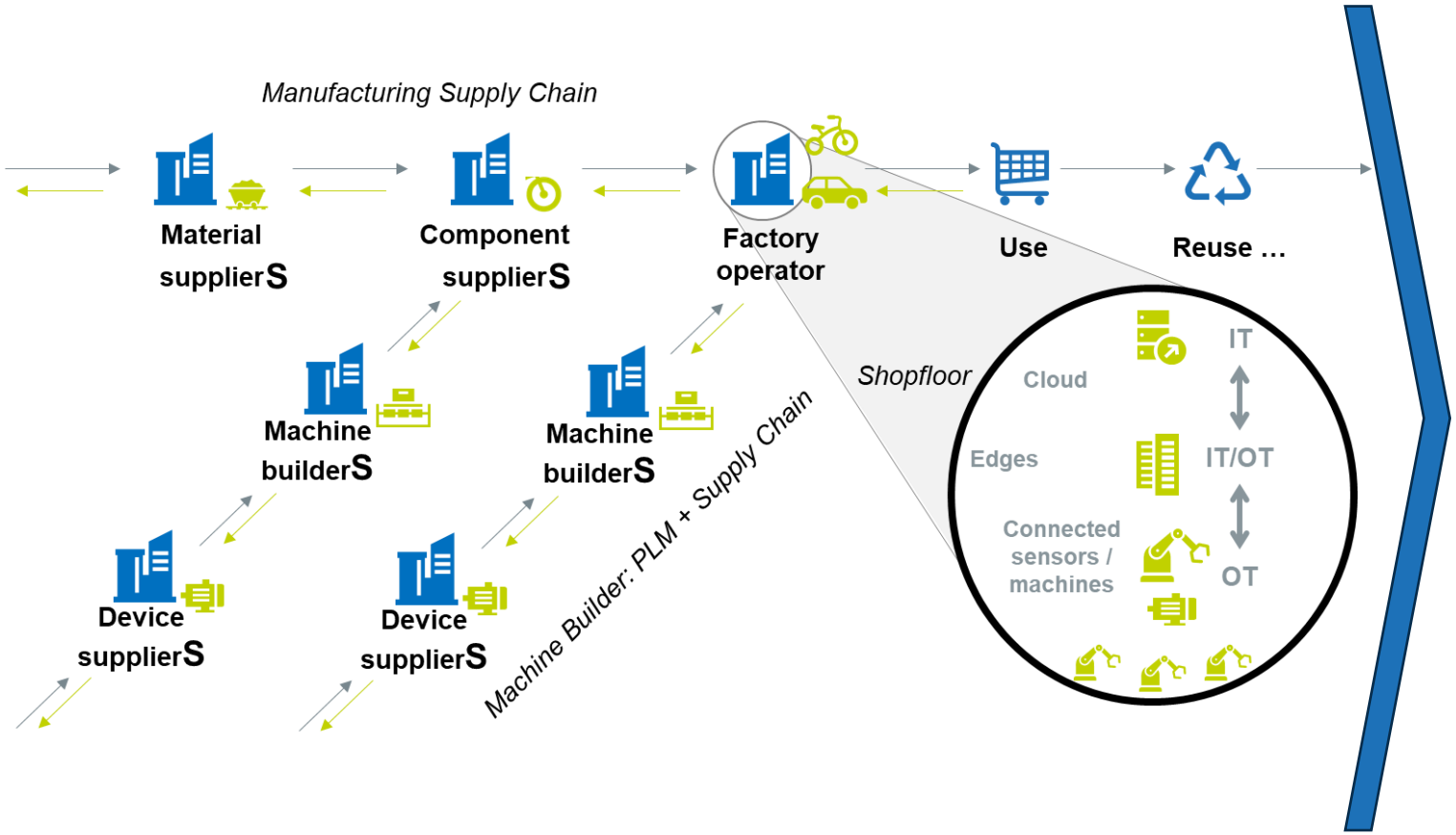
PLM +
Operations Mgmt. for Production Equipment
"LEO"

Operations Mgmt. for Production Equipment
"ORION"

Cross company Intra company

“One size fits all” does not work. We need a modular approach to achieve interoperable data spaces

The Factory-X Continuum



Generic structure of MX-Port

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

MX-Port 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

“One size fits all” does not work. We need a modular approach to achieve interoperable data spaces

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.

Generic structure of MX-Port

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options

Using the MX-Port, Factory-X realizes the following MX-Port configurations

Configuration “Leo”

- IEC 63278 / IDTA compliant; AAS as integration technology for cross-company data sharing

layer	MX-Port “Leo”
MX Discovery	Company Lookup, ID-Link
MX Access & Usage Ctrl.	Trusted Partner List, AAS Security
MX Gate	AAS-REST, AAS-MQTT
MX Converter	AAS Submodels
MX Adapter	application specific

Configuration “Hercules”

- Using DSP/DCP for cross-company data sharing

layer	MX-Port “Hercules”
MX Discovery	Dataspace Protocol
MX Access & Usage Ctrl.	Decentralized Claims Protocol
MX Gate	HTTPS (like AAS), MQTT (like OPC UA), BlobStorage
MX Converter	AAS Submodels, AAS Events, …
MX Adapter	application specific

Configuration “Orion”

- OPC compliant; synchronous/asynchronous cross-company data sharing

layer	MX-Port “Orion”
MX Discovery	Dataspace Protocol
MX Access & Usage Ctrl.	Decentralized Claims Protocol (OPC UA Security)
MX Gate	OPC UA Binary, OPC UA MQTT (JSON)
MX Converter	OPC UA Information Model (w. Companion Spec.)
MX Adapter	application specific

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

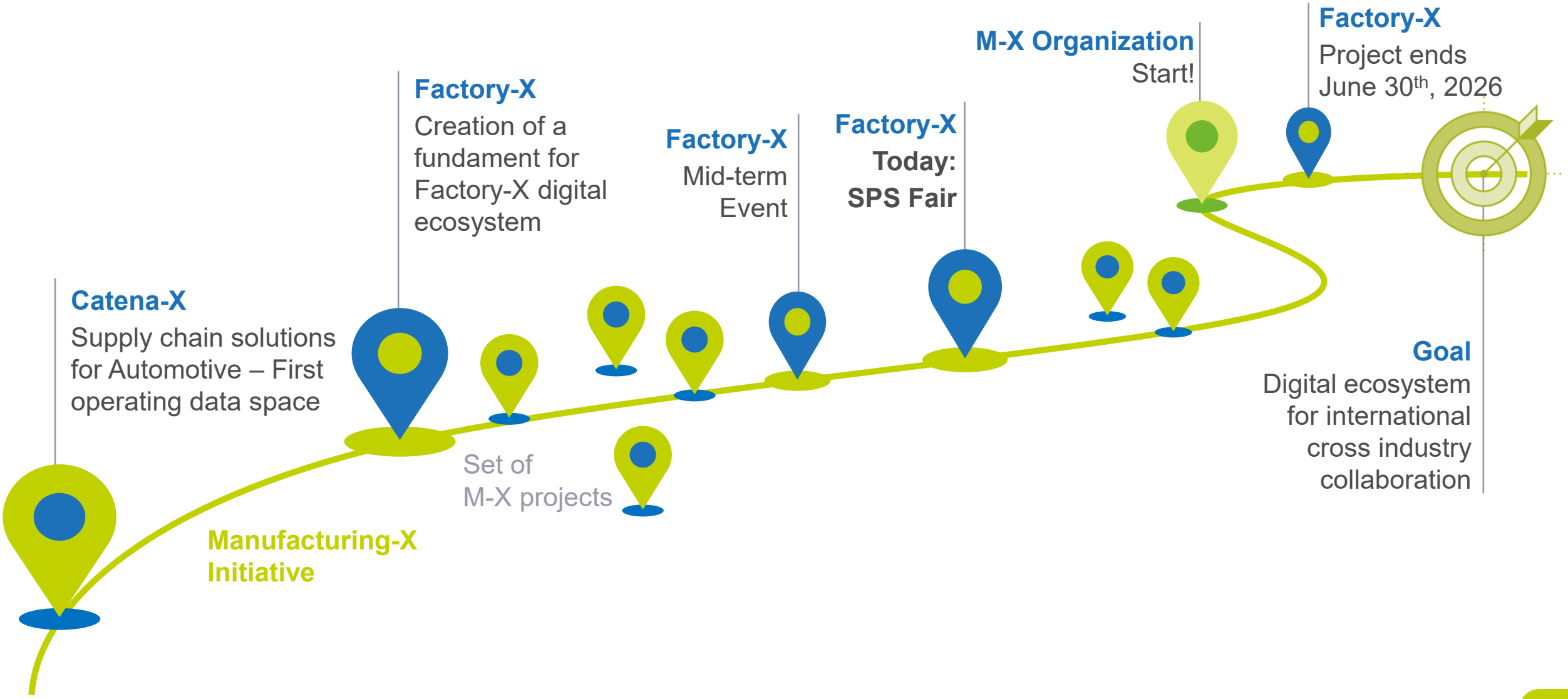
Energy-Consumption and Load Management

Carbon Footprint Management

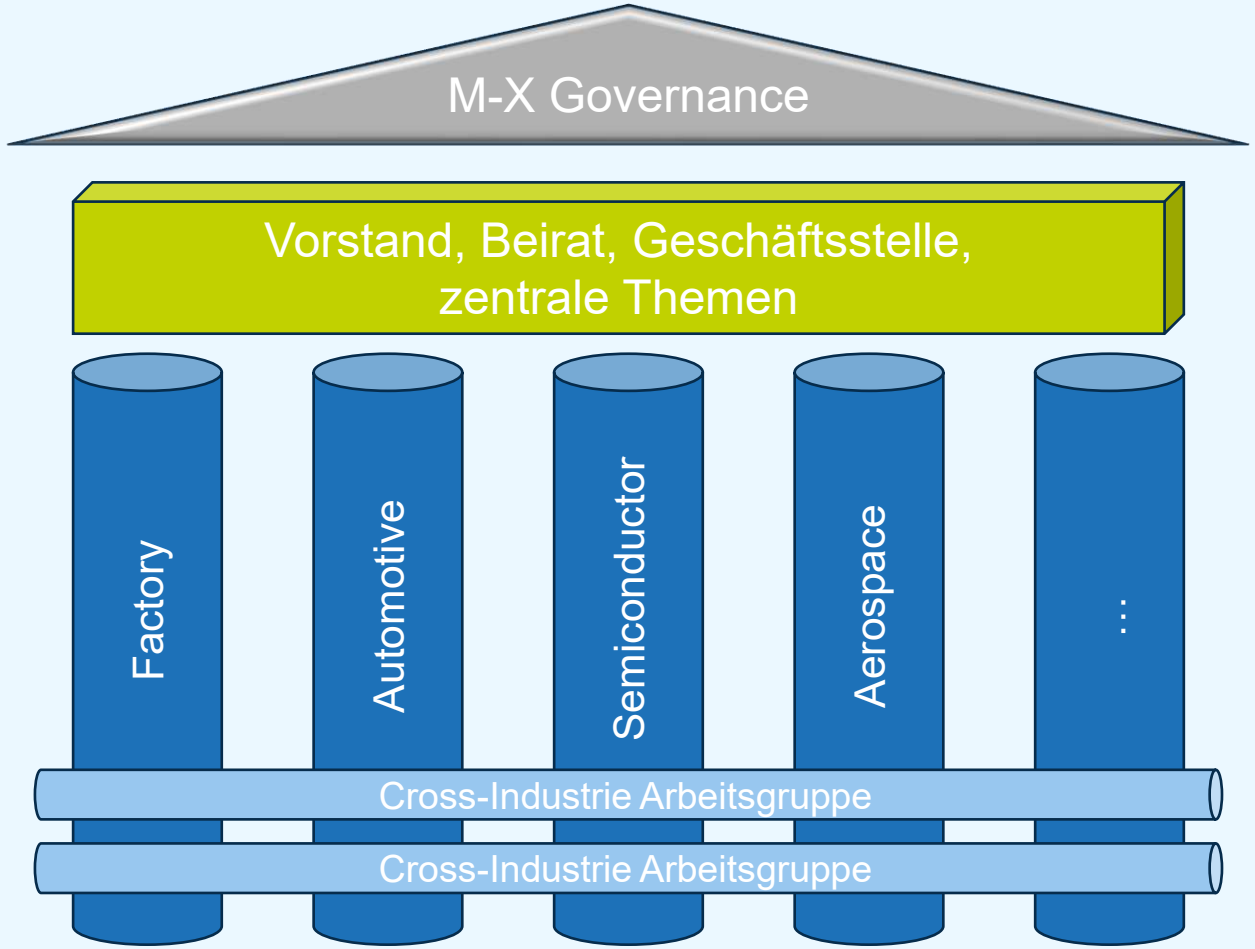
Circular Economy

Factory-X Kernel & Basis Services

Factory-X
Open collaboration of factory outfitters and operators



Longterm Governance: MX-Lastenheft



Zentrale Vereins-„Infrastruktur“
„Keep it small, focused, effective and efficient“

Industriespezifische Arbeitsgruppen bzw.bevorzugt Nutzung existierender Intiativen
„Not reinventing the wheel again“

Arbeitsgruppen für übergreifende Themen
„must be done when needed“

FACTORY-X

Business Models

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

Funded by the European Union
NextGenerationEU

Business Models

Our focus

- Gather and analyze existing business model from various sources
- Select F-X relevant use case candidates for business models
- Develop a procedure to enable participants of the ecosystem adapt their business model
- Build implementation tools e.g. for workshops
- Build demonstrators 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 "do it yourself logic for a small number of use cases

FACTORY-X

Operating Model

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

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

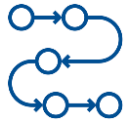
Key Results

- 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.

What is an Operating Model?

Key Components:

Fundamental principles to assure the quality characteristics



Processes and procedures that are required for the effective and efficient operation of the Data Space.

Technologies and fundamental enablers (e.g. MX-Port) required to ensure compliance with the fundamental principles.

Role definitions and the associated **rights and responsibilities** within the Factory-X Data Space.

Objectives:

- **Establish shared principles** as the foundation for mutual understanding
- **Establish a collaborative framework** that ensures alignment among participants
- **Establish structured processes** to enhance efficiency and assure legal compliance
- **Establish clear compliance guidelines** for all roles and services to maintain transparency and trust

Why do we need an Operating Model?

Key Benefits:

Establish a legally binding and accepted ground for all participants of the data ecosystem

Agreement on common guidelines and rules to share data between different vertical industries

Avoidance of lock-in effects by enabling **barrier- and -discrimination-free business models** for all participants

Enable scalable & interoperable solution offerings by integrating Hercules, Leo and Orion

Enable Co-Evolution and Co-Innovation over time without losing **compatibility and interoperability** within Factory-X and Manufacturing-X and with other data ecosystems

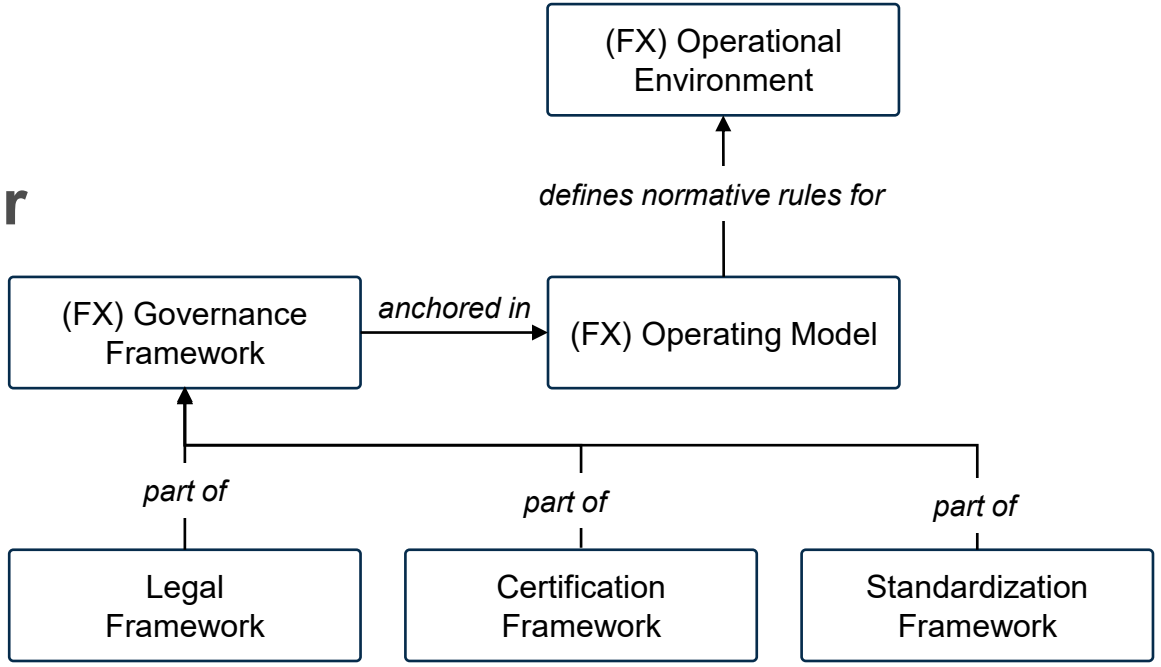
Concrete Building Blocks of an Operating Model

The Operating Model anchores the Governance Framework of a given Dataspace and its compliance mechanisms with the

- Legal Framework
- Certification Framework
- Standardization Framework

as its foundation and extends it with clear

- overall organizational structure
- roles and responsibilities,
- their collaboration mechanisms,
- their mandatory services and
- the lifefycle / release management



Brief overview of the responsibility of the standardization, certification and legal framework

	Standardization Framework	Certification Framework	Legal Framework
Main responsibility	• **Technical specifications**	• **Technical compliance**	• **Legal compliance**
Main objective	• Provide a collaborative environment to jointly create technical specification / standards while assuring legal compliance (e.g. anti trust and intellectual property) • Enable interoperability and compatibility between independent implementations	• Proof and assure interoperability and compatibility between independent implementations • Proof and assure compliance with the value proposition and quality requirements of Factory-X	• Ensure compliance with relevant legislation (such as data protection) • Provide contractual frameworks to assure (e.g.) legal accountability and data sovereignty accepted by all participants
Main challenge	• Achieve and maintain interoperability over time while enabling technological evolution	• Minimize certification costs while assuring compliance and reliability	• Establish clear, predictable liability rules and data usage conditions to mitigate risk and encourage data sharing

Technical Compliance

Legal Compliance

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Transfer Measures

Supported by:
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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

FACTORY-X

MX-Port

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NextGenerationEU

Supported by:
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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

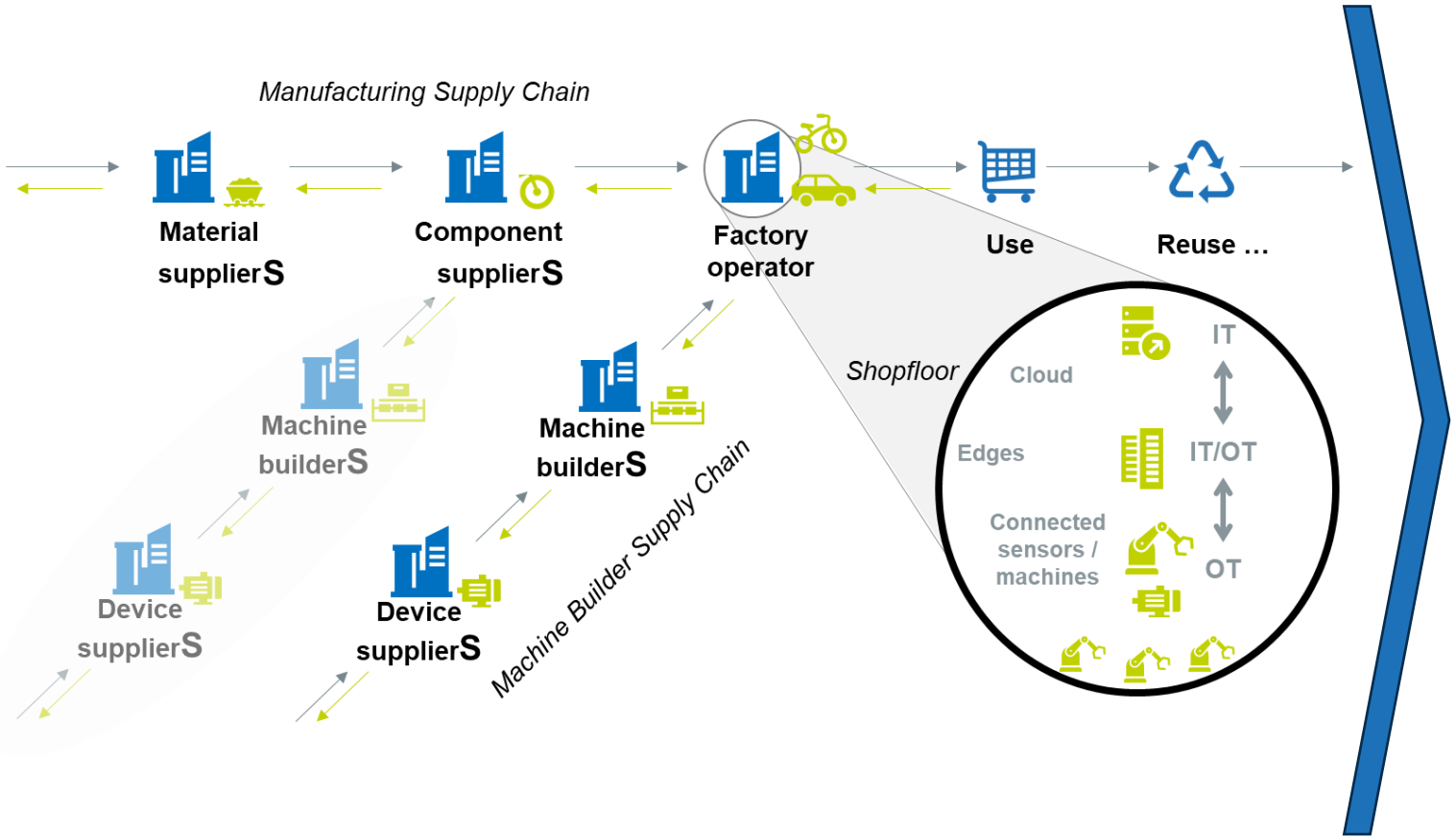
Lay the technical foundation for interoperability of all projects under the Manufacturing-X umbrella based on requirements of MX- Use Cases and general MX- consortia qualities.

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 the specification of the MX-Port components interfaces.

“One size fits all” does not work. We need a modular approach to achieve interoperable data spaces

The Factory-X Continuum



Generic structure of MX-Port

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MX-Port 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

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Layer	Purpose
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options

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

FACTORY-X

Challenges

To cover different domain needs
- Regulated/non-regulated industries
- 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, AAS, 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 north star 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	Company Lookup	ID-Link
MX Access & Usage Ctrl.	Trusted Partner List	AAS Security
MX Gate	AAS-REST	AAS-MQTT
MX Converter	AAS Submodels	
MX Adapter	application specific	

layer	MX-Port "Hercules"		
MX Discovery	Dataspace Protocol		
MX Access & Usage Ctrl.	Decentralized Claims Protocol		
MX Gate	HTTPS (like AAS)	MQTT (like OPC UA)	BlobStorage
MX Converter	AAS Submodels	AAS Events	…
MX Adapter	application specific		

layer	MX-Port "Orion"	
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- OPC compliant; synchronous/asynchronous cross-company data sharing

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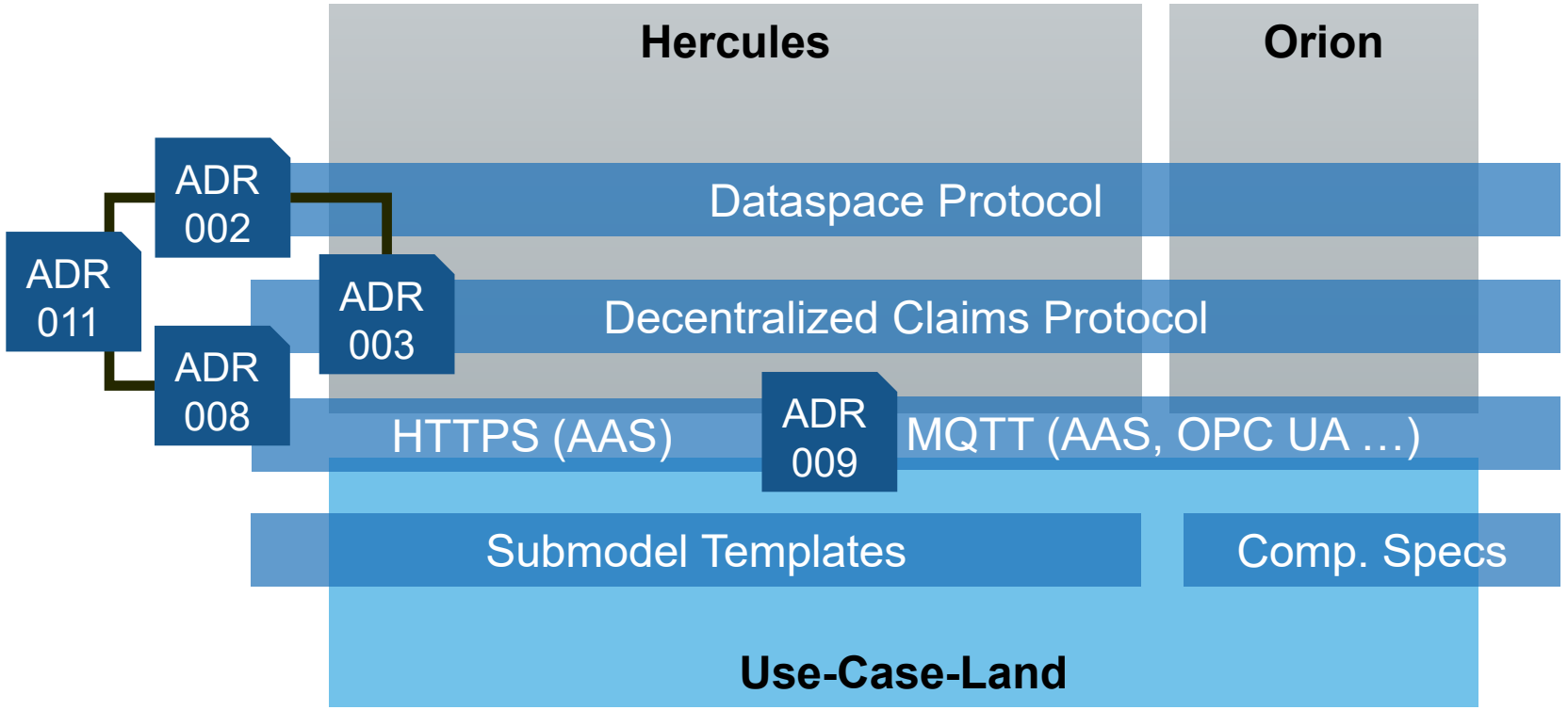
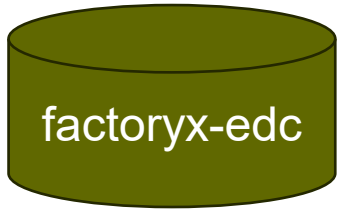
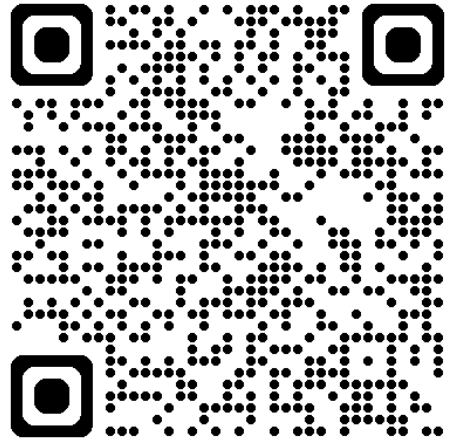
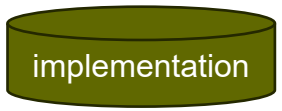
“Hercules” delivers Open-Source software to participate in End-to-End data exchange already today.





Check out our github repositories!





MX-Port Orion - Summary

What is it?

- MX-Port configuration based on OPC UA
- Uses OPC UA Companion Specification and DSP / DCP

What can it do?

- Cross-company exchange of live shopfloor information

What is it for?

- Cross-company exchange of existing OPC UA information
- (continuous) provision of machine-level data
- External condition monitoring / analysis
- Authorized and secure bidirectional communication with industrial equipment (e.g., remote control, remote maintenance)

	Layer	MX-Port “Orion”
L5	MX Discovery	Data Space Protocol
L4	MX Access & Usage Ctrl.	Decentralized Claims Protocol => OPC UA Security
L3	MX Gate	OPC UA Binary / OPC UA MQTT (JSON)
L2	MX Converter	OPC UA Information Model (with Companion Specification)
L1	MX Adapter	application specific

Benefits

- OPC UA is an established and widely used technology
- Semantic models / OPC UA Companion Specifications are available as freely accessible resources
- Information models are developed and harmonized together with experts from machine and plant manufacturers
- No additional effort caused by technology mismatches (conversion of information models)

MX-Port Leo: Think Big, Start Small, Scale Up!*

FACTORY-X

Immediate entry possible for data providers and data consumers

- A data provider only needs to provide an AAS server in accordance with IDTA / IEC 63278
- No further requirements need to be met to provide data
- Data consumer can access data in accordance with IDTA / IEC 63278

Operation possible without 3rd party operating company

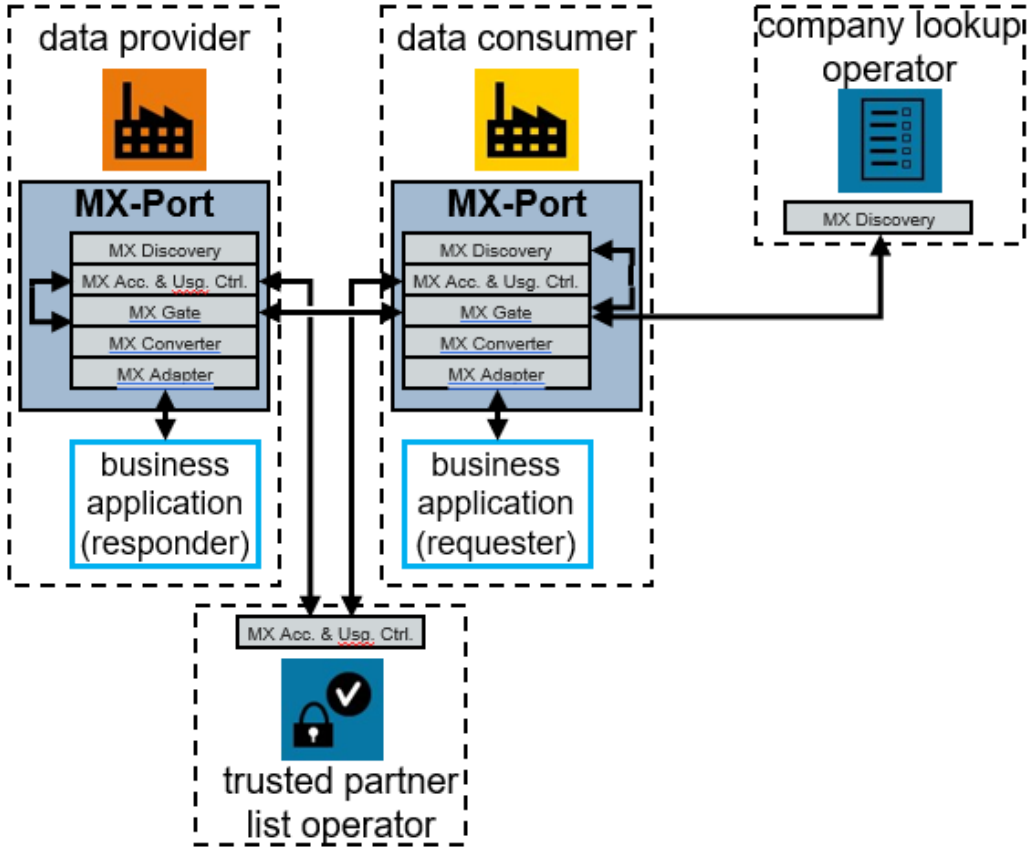
- Neither a data provider nor a data consumer needs to register at any 3rd party

Each company operates its own system to manage its identities

- Identities currently managed by a company do not need to be duplicated
- Identities extend down to the device/service and user level, not just the company level

Scalable regarding many partners for data exchange

- Gradually expandable following to business needs and opportunities of a company



*) Asset Administration Shell – Quick Start Guide

FACTORY-X

Factory-X Use Cases

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

Funded by the European Union
NextGenerationEU

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

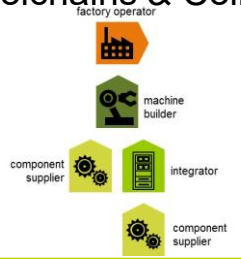
Circular Economy

Factory-X Kernel & Basis Services

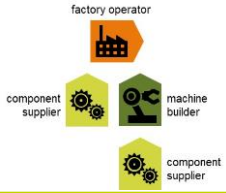
11 Use Cases of Factory-X

11 Use Cases for horizontal and vertical data transfer

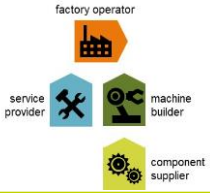
Int. Toolchains & Collab. Eng.



Inf. Update and Change Service

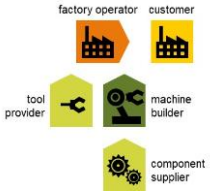


Collaborative Information Logistics



Condition Monitoring led Services

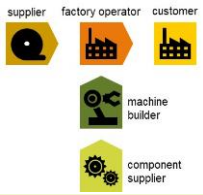
Modular Production



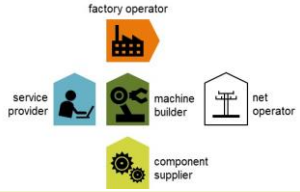
Manufacturing aaS

Autonomous Operation aaS

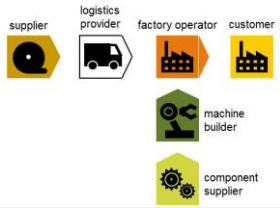
Traceability



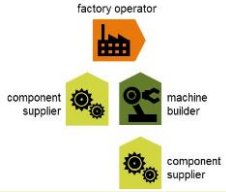
Energy-Consump. & Load Management



Carbon Footprint Mgmnt.



Circular Economy



FACTORY-X

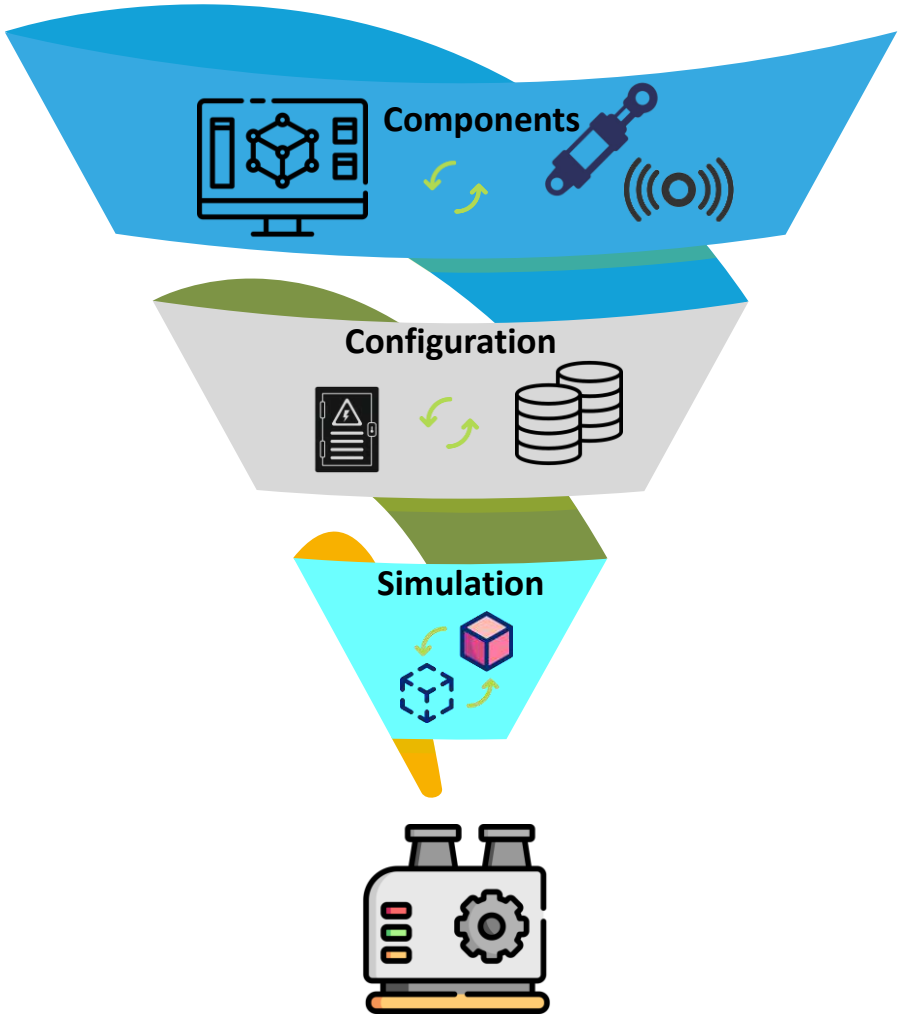
TP2.1
Integrated Toolchains and Collaborative Engineering

Funded by the European Union
NextGenerationEU

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

Integrated Toolchains and 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 and Collaborative Engineering

Unite Tools, Unite Minds: Revolutionize Manufacturing

FACTORY-X

Economic benefits

- **Increase productivity** of engineering processes
- Facilitate & **accelerate** collaborative engineering
- **Data sovereignty** ensures a competitive advantage

Organizational benefits

- **Collaborative use of engineering data** based on a trusted framework
- **Digital twins** for simulating and optimizing production processes and systems during life cycle

Technical benefits

- **Integrated toolchains** for digital engineering from virtual solution finding and configuration to simulation
- **Data continuity** along integrated vendor-independent toolchains based on common standards
- Standardized interfaces & data models for **seamless data exchange**
- Virtual modeling of factory facilities as basis for **simulating, forecasting and optimizing** manufacturing processes and systems over entire life cycle

Scaling effect due to standardized data interfaces and seamless data continuity across engineering tools, disciplines, and partners involved in the digital engineering ecosystem. New engineering performance thanks to MX-Port!

FACTORY-X

TP2.2
Information Update and Change Service

Funded by the European Union
NextGenerationEU

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

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

Economic benefits

- Factory operators **save human resources** from automating processes and making the management of the shopfloor more efficient
- Customers (such as factories that rely on component suppliers and machine builders) are **more satisfied** because of easy cooperation

Organizational benefits

- Thanks to **standardized interfaces**, factory operators and component suppliers can **easily access information** from each other and about their assets in the shopfloor
- Factory operators no longer have to study and understand different complicated **semantics** for data transfer; can rely on the same standardized solution, which **saves time and resources**

Technical benefits

- **Cybersecurity** in a factory is improved due to standardized and fast updates. Manual updates are no longer necessary and thus factory operators save time and resources
- Automated software updates ensure **technical interoperability** of machines and components in a factory. This increases resilience of the production system, because the technology is up to date and working seamlessly

Scaling effect due to availability of interoperable software updates! Component suppliers providing/sending and factory operators receiving/retrieving automated software updates

FACTORY-X

TP2.3
Collaborative Information Logistics

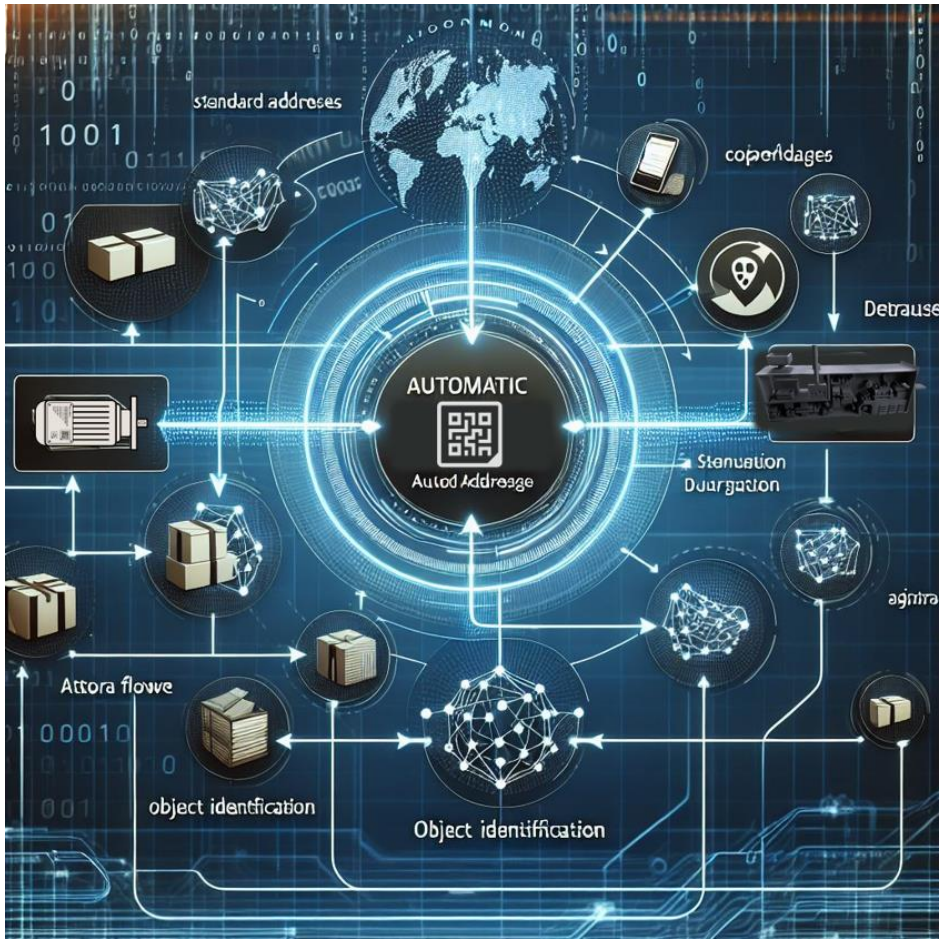
Funded by the European Union
NextGenerationEU

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

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, Document Fast!

FACTORY-X

Economic benefits

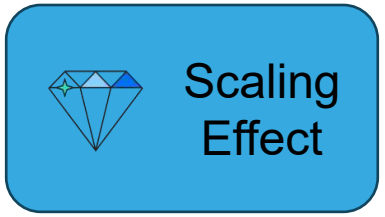
- Companies face **low entrance barriers** when trying to exchange information about products, certificates and documentation
- Users of Collaborative Information Logistics experience significant **time-saving** in accessing desired information

Organizational benefits

- Companies are able to utilize a **scaling and branching** solution to accommodate their information logistical demands with ease
- Users of Collaborative Information Logistics experience significant **time-saving** in accessing desired information

Technical benefits

- Implementation efforts are greatly reduced thanks to **uniform standards** that ease transferring of information in a way that makes it economically feasible



Most potential to scale lies in the uniform standards for information representation and access; this is the technical foundation for the economic and organizational savings that make data spaces scale with regards to unified Information Logistics approaches

FACTORY-X

TP2.4
Condition Monitoring led Services

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

Funded by the European Union
NextGenerationEU

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 in a cost-efficient way

Economic benefits

- Factory operator has **maximum availability** of the production equipment at **minimum TCO** (total cost of ownership)
- Machine builder can **increase service turnover** based on a new and **scalable service offering**
- Reduced service cost due to efficient processes and usage of standardized infrastructure

Organizational benefits

- Building **trustful collaboration** in the supply chain with the willingness to share data
- Long-term **customer relationships over the lifecycle** of the machines

Technical benefits

- **Reduced complexity** of data connectivity through standardized connectors and one or few central IT systems involved
- **Central governance** of data exchange with all providers, central control of all information via a dashboard
- **Availability of machine / component data** from the installed base / from production for advanced analytics / AI

Scaling effect due to the possibility to enact multiple parallel and complex relationships with various partners (across factories, component suppliers, machine builders, start-ups offering new services, software firms, etc.), all based on data sharing

FACTORY-X

TP2.5
Modular Production

Supported by:
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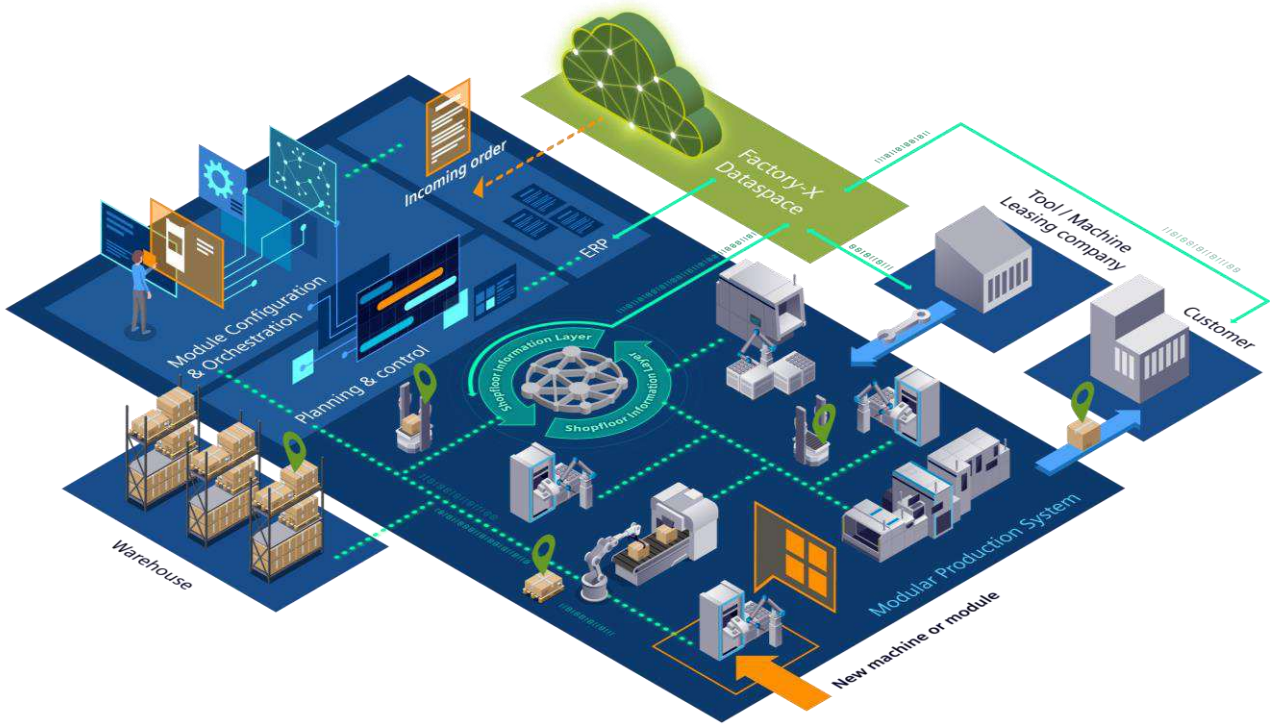
on the basis of a decision by the German Bundestag

Funded by the European Union
NextGenerationEU

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

Economic benefits

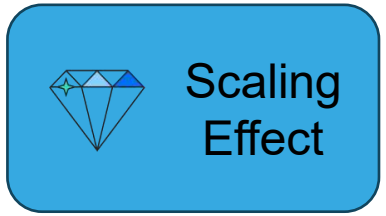
- Reduced **machine setup time**
- Use the existing system more flexibly
- **Fast response** to market demands (through adaptive production planning)
- Standardized capability descriptions enable **interoperability**

Organizational benefits

- Reduce machine setup time
- Use the existing system more flexibly
- Preliminary stage for **cross-company demand and capacity planning**
- Standardized capability descriptions enable interoperability

Technical benefits

- **Standardized interfaces** for orders and resources
- Semantic mapping, automated integration process
- **Fast response** to market demands (through adaptive production planning)



Scaling effect due to overall increased production capacity and flexibility

FACTORY-X

TP2.6
Manufacturing as a Service – On Demand Manufacturing

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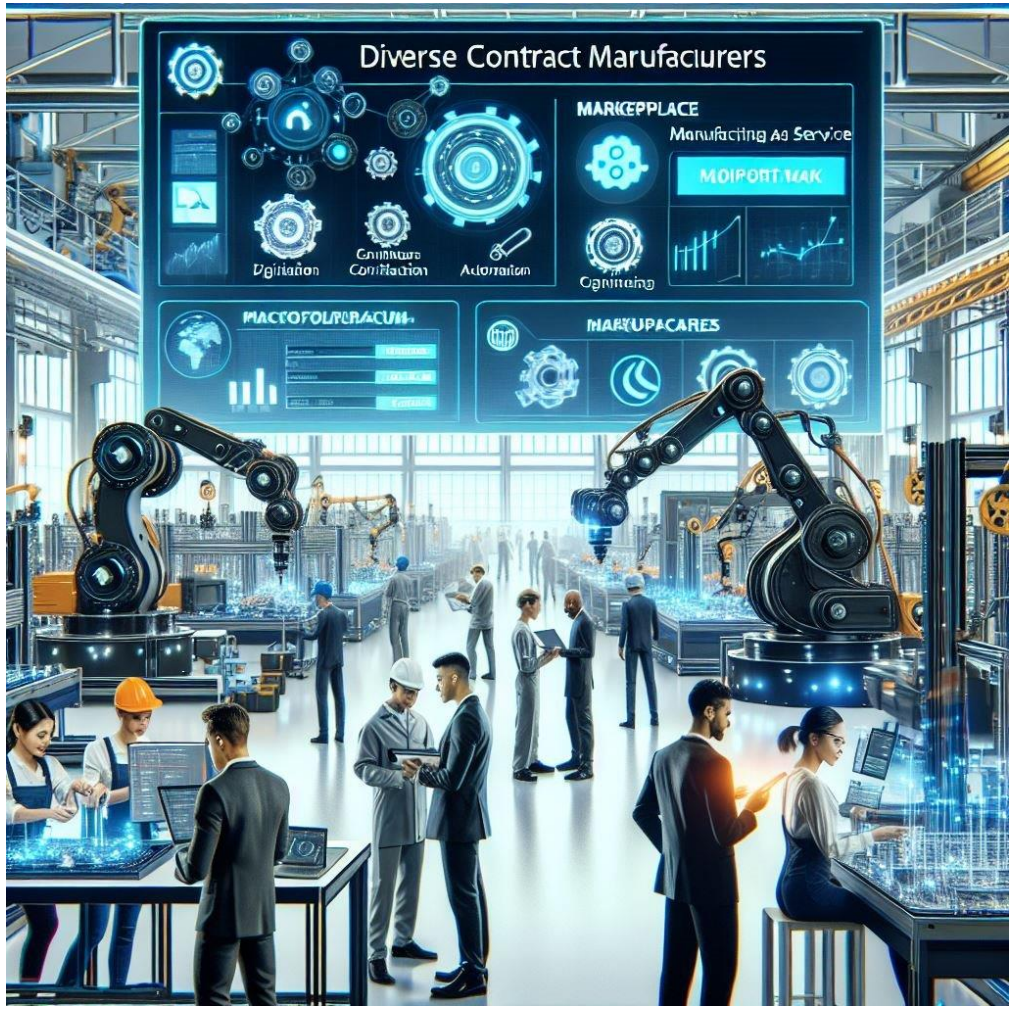
on the basis of a decision by the German Bundestag

Funded by the European Union
NextGenerationEU

Manufacturing as a Service – On Demand Manufacturing

Shared skills – matching orders!



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 quality control for machining ensuring low-lot-size 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

Economic benefits

- **New orders** through digital platforms, driving revenue
- **Capability** to produce diverse product ranges leading to **new market opportunities**.
- Enhanced market position through diversification and scalability

Technical benefits

- **Seamless scalability** of manufacturing capabilities via digital data spaces

Organizational benefits

- Increased **adaptability** in manufacturing operations
- Increased **utilization of free manufacturing capacities** (machines kept productive)
- **Efficient distribution and management** of production orders through platforms

Scaling Effect

F-X allows to scale the number of contract manufacturers on platforms to make the business case work

FACTORY-X

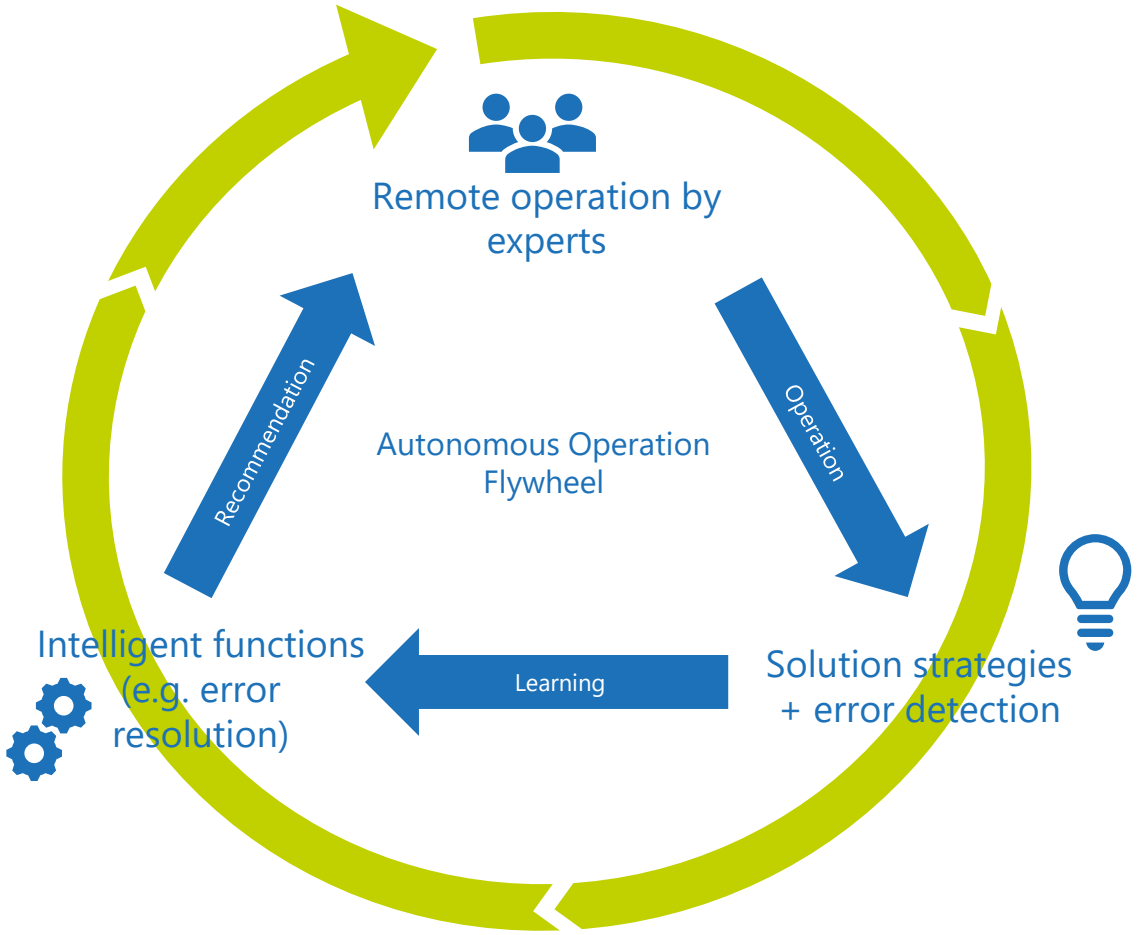
TP2.7
Autonomous Operation as a Service

Funded by the European Union
NextGenerationEU

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

Autonomous Operation as a Service

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!

Economic benefits

- **Reduced operational downtime** through continuous remote or autonomous operation
- **Lower operational costs** by minimizing the necessity for on-site personnel
- Efficiency through **flexible selection and integration** of software services

Technical benefits

- Remote and autonomous operation of machinery enabled via **standardized digital twins**
- **Simplified connectivity** among multiple software providers using the F-X Orbs and data spaces
- Ability to **autonomously solve operational issues** through AI-driven autonomous systems

Organizational benefits

- Higher operational **reliability** through redundancy (remote/autonomous/physical operation)
- **Increased productivity** per physical operator due to workload reduction via remote/autonomous solutions
- Enhanced **operational flexibility** through modular selection and integration of software providers

Scaling Effect

Enables efficient scaling by integrating multiple machines and diverse software providers, streamlining operational management through central data spaces

FACTORY-X

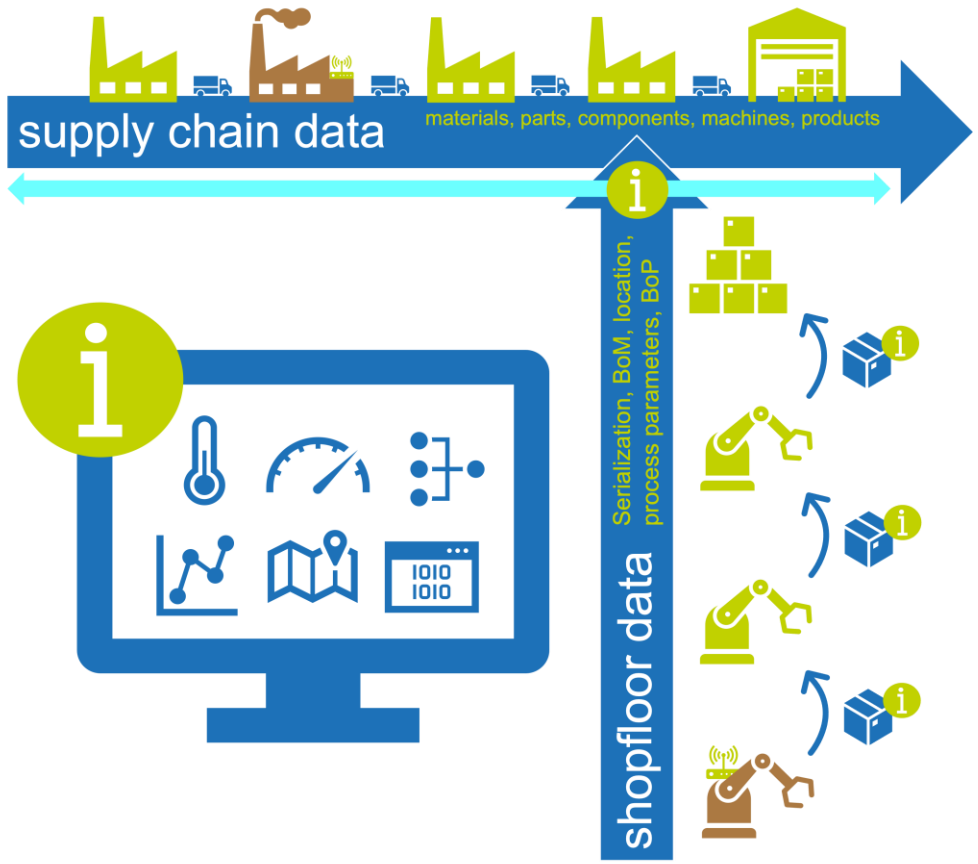
TP2.8
Traceability

Funded by the European Union
NextGenerationEU

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

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

Traceability

Trace Today, Trust Tomorrow

Economic benefits

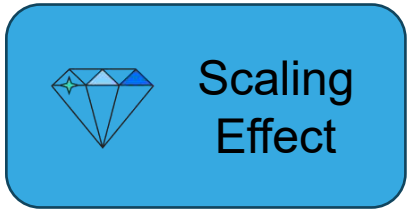
- Cost reduction
- Causality, conclusions enable efficient troubleshooting
- Allows to minimize production risk costs
- Countermeasures to prevent future errors
- User data / customer data about the product enables new business models

Organizational benefits

- Efficient analysis
- Time-to-fix reduction
- Focus on key traceability use case specifics
- Meet regulatory compliance based on the efficient, standardized and cost-effective access to all necessary and relevant data

Technical benefits

- Automated search in the data space of production data (time, similar parameters)
- Secure exchange
- One and only data transformation towards any data space



Software providers can scale their products and services within the ecosystem to support every system with traceable production.

FACTORY-X

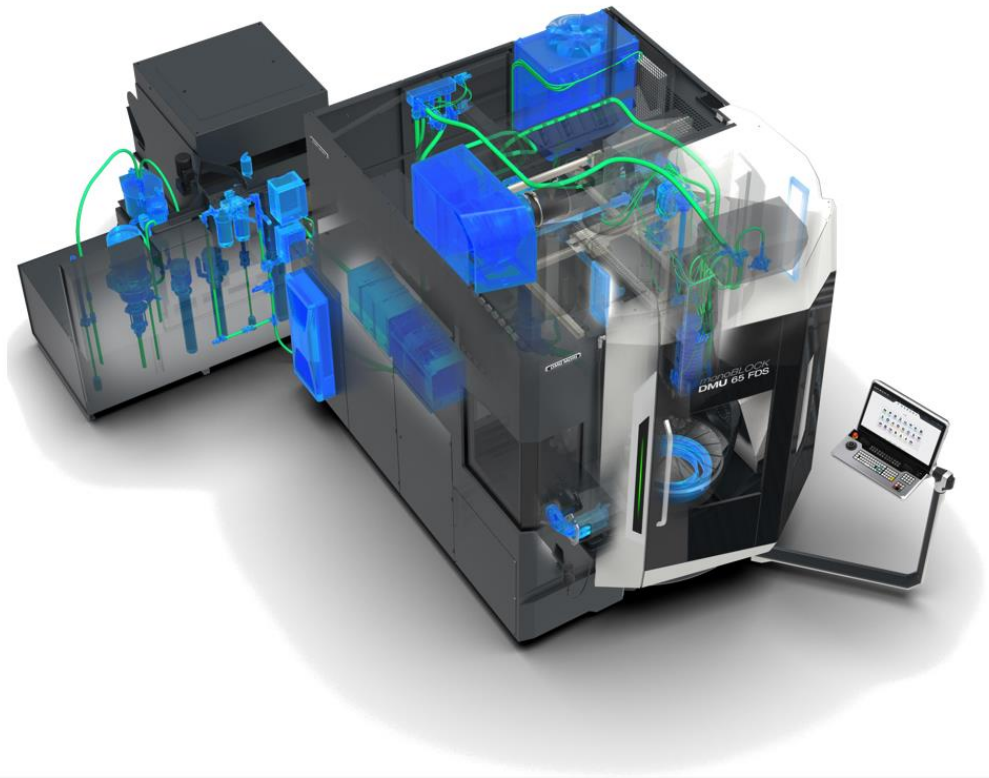
TP2.9
Energy Demand and Load Management

Funded by the European Union
NextGenerationEU

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

Energy-Consumption and Load Management

Data-driven solutions for energy-efficient manufacturing



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-Consumption and Load Management

Optimize Your Power, Elevate Your Savings!

Economic benefits

- Component supplier: **Optimizing the energy efficiency** of own components or across components
- Component supplier, machine builder, and factory operator: **lower energy consumption, less CO_2 emissions** and cost savings
- Energy operator can **balance load peaks**, offer higher grid quality and possibly lower prices

Organizational benefits

- Factory operator, machine builder, and component supplier: utilizing **local resources**
- **Benefit from favorable energy prices** from grid operators in line with own order situation

Technical benefits

- Machines and components become more energy efficient
- **Standardized mechanism** exchanges information on energy demand and supply across all levels: Components, machines, factories, grid operators

Scaling Effect

Standardized communication about energy load and availability across stakeholders and with the grid operator enables automated energy management

FACTORY-X

TP2.10
Carbon Footprint Management

Funded by the European Union
NextGenerationEU

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

Carbon Footprint Management

Comparable & Automated Product Carbon Footprint Calculation

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

Transparency in Emissions – Easy PCF Calculation

Economic benefits

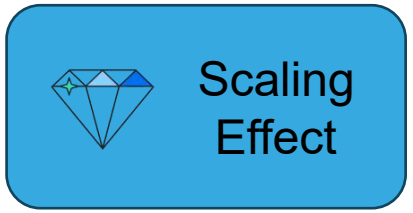
- **Reduction of manual tasks** calculating the PCF
- Competitive differentiation through PCF

Technical benefits

- **Standardized PCF calculation** (share of logistics and manufacturing)
- **PCF management** and sharing
- Standardized approach model for PCF data collection

Organizational benefits

- **Transparency** through guidance on calculation
- Comparable PCF values



Scaling effect due to automated provision and easy sharing of Product Cardon Footprint of individual products or processes along the supply chain with customers

FACTORY-X

TP2.11
Circular Economy

Funded by the European Union
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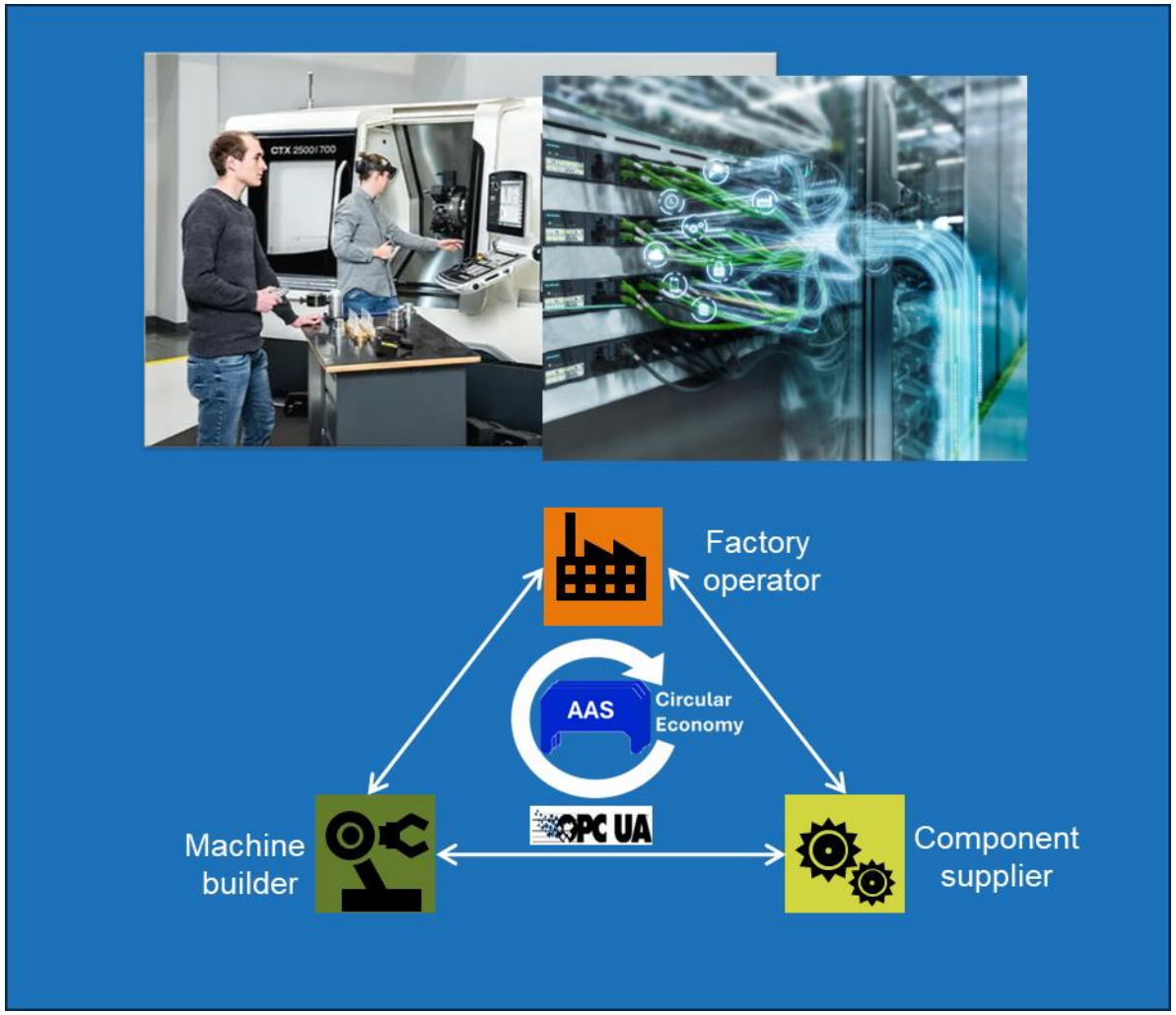
Circular Economy

Close the Loop – for a Second Life!



The Goal

- **Shift** from reactive, experience-based assessments **to proactive, data-driven strategies** that **extend the operational lifetime** of machines and components.
- The **AAS-based MX-Port** and the **R-Grading Workflow App** form the foundation for a **data-driven circular economy**.
- **Avoiding silo thinking** means **sharing all available machine data** in a holistic and cross-company manner. The data are bundled and anonymized to enable the grading of **intelligent and non-intelligent components.**

The FX Solution in Detail

Interoperable data transmission based on **MX-Port Leo** and standardized **AAS sub models for Circular Economy**

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

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

Assess the **situation of the machine** and its **components** for derivation of further **R-strategies** (**R**efurbishing / **R**emanu-facturing / **R**ecycling)

Circular Economy

Close the Loop – for a Second Life!

FACTORY-X

Economic benefits

- **Data-based situation assessment** of the machine and its main components directly at the machine's location.
- **Transition from an experience-based to a data-based condition assessment** of machines/components.
- **Waste reduction** by ensuring multiple lives for machines/components through Remanufacturing, Refurbishing and Recycling

Technical benefits

- **Interoperability** through standardization based on AAS and MX Port
- **Advancing new technical possibilities** for company-specific, data-based grading of machines and their main components.

Scaling potential due to low entry barriers and sharing of anonymized and bundled data between all relevant players but with approval of the data owner.

Organizational benefits

- **Avoiding silo thinking by sharing all available data** in a holistic and cross-company manner for relevant components (intelligent and non-intelligent)
- **Plannable reconditioning** of machines and components through refurbishing and remanufacturing

Factory-X @ SPS 2025

Organization	Hall	Booth
Factory-X Booth @ VDMA	**3**	**329**
LNI 4.0	3	321
ZVEI	3	321
Codewerk	5	358
Hilscher	5	130
IDTA	5	358
OI4	5	160
umati	5	238
Bayern Innovativ	6	240
ISW Universität Stuttgart	6	340
Festo	9	305
SmartFactory-KL	10	210
Siemens AG	11	76

Thank you

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