FACTORY-X

Organizational, economic & technical benefits
of the Factory-X digital ecosystem

Exemplified by 11 Use Cases in Factory-X

PART OF MANUFACTURING-X

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Organizational, economic, & technical benefits of the Factory-X digital ecosystem

The solutions provided by the Factory-X use cases generate enormous potential for industry 4.0 in Germany and beyond. They can be divided into organizational, economic, and technical benefits, and touch on the following important aspects:

Organizational benefits

- Management and operational integrity
- Governance
- Collaboration and partnerships
- Compliance and regulations

Economic benefits

- Monetization
- Cost-benefit analysis
- New business models
- New opportunities for cost saving and profit

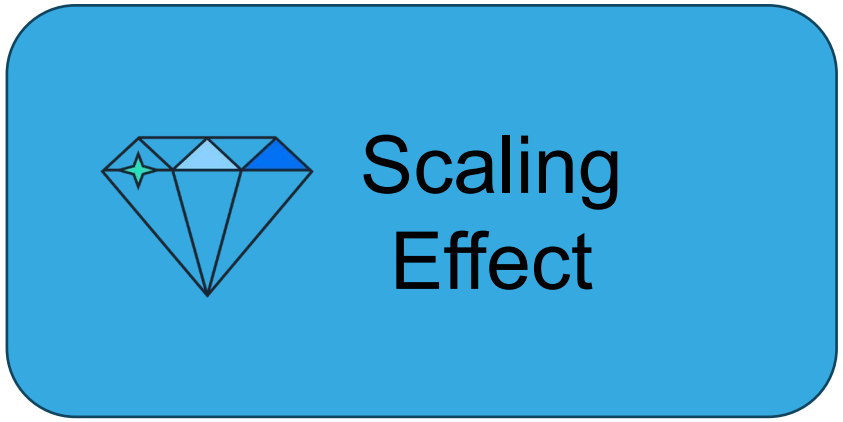
Technical benefits

- Interoperability
- Standardization
- Data sovereignty
- Real time exchange of data
- Data integrity

All use cases in Factory-X provide organizational, economic, and technical benefits!

Potential to scale for the different stakeholders in the Factory-X digital ecosystem

*The key promise of the Factory-X data ecosystem is the **scaling effect** within organizations and along the entire supply chain.*



Scaling potential:

- *Enabling automated and interoperable information exchange*
- *Enabling more diverse and complex relationships along supply chains*
- *Enabling new business models and services*

Stakeholders in the Factory-X digital ecosystem include:

Factory operators, machine builders, component suppliers, integrators, service providers

And more…

11 Use Cases of Factory-X

11 Use Cases for horizontal and vertical data transfer

Integrated Toolchains and Collaborative Engineering

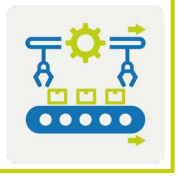
Information Update and Change Service

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

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UC2.1
Integrated Toolchains and Collaborative Engineering

TP2.1 - Integrated Toolchains and Collaborative Engineering

Unite Tools, Unite Minds: Revolutionize Manufacturing

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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

High scalability for the component supplier thanks to data integrity, user management, effort reduction, better governance, and new business models; plus, scalability for the software provider thanks to new marketplaces and new services

TP2.1 - Integrated Toolchains and Collaborative Engineering

Unite Tools, Unite Minds: Revolutionize Manufacturing

	Organizational Benefit	Economic Benefit	Technical Benefit
Factory operator	• Product / Solution Search • Populating Databases • Update management • Collaborative use of engineering data based on a trusted framework • Interchangeability	• Productivity in Engineering - faster - easier - better (fewer errors) - cheaper • Facilitate & accelerate collaborative engineering • Data sovereignty ensures a competitive advantage	• 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.
Component supplier	• Collaborative use of engineering data based on a trusted framework • Digital twins for simulating and optimizing production processes and systems during life cycle	• New marketplaces (for applications) • Data Integrity (current, complete, versioned) • User management (data) • Effort reduction • Governance • New business models	• 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.
Software application provider		• Interchangeability • New marketplaces (for applications) • New services (e.g., validation of data models)	

UC2.2
Information Update and Change Service

Information Update and Change Service

Instant Updates, Automated Changes!

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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

Information Update and Change Service

Instant Updates, Automated Changes!

	Organizational Benefit	Economic Benefit	Technical Benefit
Factory operator	• Standardized information transfer means that manual integration of information is no longer necessary (= saves times) • Easier software update of assets on the shopfloor saves time (=efficiency) • Better overview of status of assets means quicker attention to breakdowns (=resilience)	• Efficiency in software updates saves human resources (=reduced costs) • Quicker attention to production problems saves money, because more orders can be fulfilled (=more revenue)	• Automated software updates improve cyber security of the entire factory as well as individual machines (=security)
Component supplier	• Secure provision of information to users (Cyber Resilience Act, functional enhancements and improvements) and a better overview of where and how components are used (e.g. through feedback on whether updates are carried out by the factory operator) (=increased transparency)	• Higher satisfaction among customers because information is sent seamlessly to the asset management system of customers (= more customers, more stable customer relationships = more revenue)	
Software application provider		• More customers thanks to a need in support for information sending and receiving services (=more revenue)	

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UC2.3 Collaborative Information Logistics

Use Case Collaborative Information Logistics

Standardize Smart, Document Fast!

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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 parsing of information in a way that makes it economically feasible

Scaling Effect

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

Use Case Collaborative Information Logistics

Standardize Smart, Document Fast!

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	Organizational Benefit	Economic Benefit	Technical Benefit
Factory operator	• 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	• 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	
Component supplier	• Companies are able to utilize a **scaling and branching** solution to accommodate their information logistical demands with ease	• Companies face **low entrance barriers** when trying to exchange information about products, certificates and documentation	
Information system software application provider	• Companies are able to utilize a **scaling and branching** solution to accommodate their information logistical demands with ease		• Implementation efforts are greatly reduced thanks to **uniform standards** that ease parsing of information in a way that makes it economically feasible

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UC2.4
Condition Monitoring led Services

Condition Monitoring Led Services

Enable new digital services to increase equipment availability in a cost-efficient way

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Economic benefits

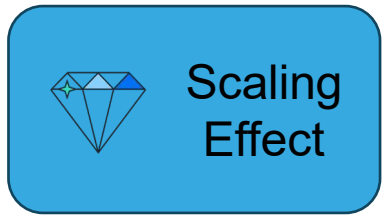
- Factory operator has **maximum availability** of the production equipment at **minimum TCO** (total cost of ownership)
- Machine builder can **increase service turnover** based on a new and **scalable service offering**
- **Reduced service cost** due to efficient processes and usage of standardized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

Condition Monitoring Led Services

Enable new digital services to increase equipment availability in a cost-efficient way

FACTORY-X

	Organizational Benefit	Economic Benefit	Technical Benefit
Factory operator	• Building trusting collaboration in the supply chain with a willingness to share data • Seamless process integration of providers' services into the company's own systems (interoperability)	• Higher availability of production equipment • Increased efficiency of internal processes • Reduced total cost of ownership thanks to needs-based and rapid maintenance / servicing • Saving resources in the in-house maintenance and IT team	• Reduced complexity of data connectivity through standardized connectors and one or a few central IT systems involved • Central governance of data exchange with all providers, central control of all information via a dashboard • Enabling the use of AI-supported optimizations / services
Machine builder	• Trusting collaboration in the supply chain with a willingness to share data • Building long-term customer relationships and customer loyalty throughout the machine's life cycle • Designing a sustainable long-term service strategy (field service < remote service < digital service)	• Increase in service revenue by scaling the service on the basis of standards • Design of new services / continuous improvement and expansion of the offering • Design of new, data-driven business models • Increase in service efficiency / reduced service costs	• Reduced complexity of data connectivity through standardized connectors and one or a few central IT systems involved • Availability of data on machines from the installed base / from production • Integration of the expertise / algorithms of the components installed by the manufacturer into the company's own services
Component supplier	• Trusting cooperation in the supply chain with a willingness to share data	• Increase in service sales through integration into the machine manufacturer's service offerings • Increased service efficiency / reduced service costs	• Reduced complexity of data connectivity through standardized connectors and one or a few central IT systems involved • Availability of data on components of the installed base / from production
Software application provider		• Expansion of the functional scope of existing solutions • Expansion of the customer base • Design of new business models	

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UC2.5
Modular Production

Modular Production

Build Smart. Adapt Fast!

FACTORY-X

Economic benefits

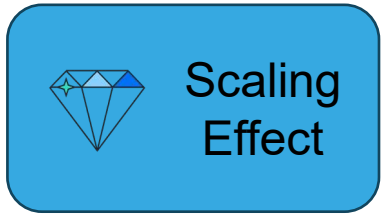
- Reduced **machine setup time**
- Use the existing system more flexibly
- **Fast response** to market demands (through adaptive production planning)
- Standardized capability descriptions enable **interoperability**

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

Modular Production

Build Smart. Adapt Fast!

FACTORY-X

	Organizational Benefit	Economic Benefit	Technical Benefit
Factory operator	• Reduced machine setup time • Use the existing system more flexibly	• Reduced machine setup time • Use the existing system more flexibly • Fast response to market demands (through adaptive production planning)	• Standardized interfaces for orders and resources • Semantic mapping, automated integration process • Fast response to market demands (through adaptive production planning)
(Component) supplier		• Standardized capability descriptions enable interoperability	• Standardized interfaces for orders and resources • Semantic mapping, automated integration process
Software application provider	• Preliminary stage for cross-company demand and capacity planning • Standardized capability descriptions enable interoperability	• Standardized capability descriptions enable interoperability	• Semantic mapping, automated integration process • Preliminary stage for cross-company demand and capacity planning

UC2.6
Manufacturing as a Service - On Demand Manufacturing

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

Manufacturing as a Service – On-Demand Manufacturing

Shared skills – matching orders

	Organizational Benefit	Economic Benefit	Technical Benefit
Factory operators	• Gains easy access to platforms • Benefits from efficient processing	• New customers and more orders, resulting in better capacity utilization	• Interoperability between enterprises, standardized data model
Customer	• Gains access to new manufacturing capabilities	• Customers receive efficient, diverse manufacturing solutions	• Interoperability between enterprises, standardized data model
On-demand manufacturing service provider	• The F-X ecosystem facilitates diversification, resilience, and scalability	• The F-X ecosystem increases the market size and offers diversification	• Interoperability between enterprises, standardized data model

FACTORY-X

UC2.7
Autonomous Operation-as-a-Service

Autonomous Operation as a Service

Remote Shopfloor automated – Service improved!

FACTORY-X

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

Autonomous Operation as a Service

Remote Shopfloor automated – Service improved!

FACTORY-X

	Organizational Benefit	Economic Benefit	Technical Benefit
Machine builder (standardization allows others to take this role)	Remote Operation Center improves reliability and reduces workload	Remote Operation Center reduces operational costs through automation	F-X enables remote/autonomous machine management
Manufacturing companies	Physical operator benefits from reduced workload, improved efficiency, and resilience	Manufacturing companies achieve reduced downtime and costs	Remote operators gain standardized access via digital twins
Software application provider	F-X data space enables flexible software integration and operational redundancy	F-X simplifies software-service integration economically	Digital twins and autonomous systems enhance operational continuity

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UC2.8 Traceability

TP2.8 - Traceability

Trace Today, Trust Tomorrow

FACTORY-X

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

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

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

Scaling Effect

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

TP2.8 - Traceability

Trace Today, Trust Tomorrow

	Organizational Benefit	Economic Benefit	Technical Benefit
Factory Operator	• 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	• Cost reduction • Causality, conclusions enable efficient troubleshooting • Minimize production risk costs • Countermeasures to prevent future errors • Improve customer satisfaction	• Automated search in the data space of production data (time, similar parameters) • One and only data transformation towards any data space
Component supplier		• Discount • User data / customer data about the product enables new business models	• Secure exchange • Delegate authentication, authorization enforcement and communication negotiation to MX-Port
Software application provider		• Sell scalable applications • Visualize traceability benefits • Demonstrate efficiency gains	• Data standard

FACTORY-X

UC2.9
Energy-Consumption and Load Management

Energy-Consumption and Load Management

Optimize Your Power, Elevate Your Savings!

FACTORY-X

Economic benefits

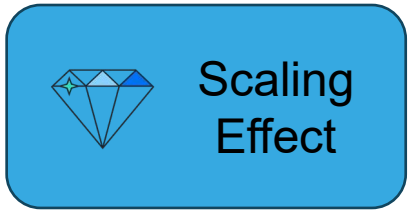
- Component supplier: **Optimizing the energy efficiency** of own components or across components
- Component supplier, machine builder, and factory operator: **lower energy and CO^2** consumption, cost savings
- Energy operator can **balance load peaks**, offer higher grid quality and possibly lower 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



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

Energy-Consumption and Load Management

Optimize Your Power, Elevate Your Savings!

FACTORY-X

	Organizational Benefit	Economic Benefit	Technical Benefit
Factory operator Machine builder	• Standardized transfer of energy data • Improved transparency of energy demand • Pre-condition for automatic PCF reporting	• Reduced power demand at machine tool level (=lower energy costs) • Reduced power peaks & improved usage of renewables (=lower energy costs) • Reduced energy costs due to better predictability	• Automatic energy saving functions • Simulation of energy demand with eDT-X • Consideration of flexible energy prices in planning • Higher assurance of grid stability
Net operator	• Standardized communication of energy flexibility	• Reduced costs for balancing due to utilization of flexibility at consumer side	• Levelling of grid loads • Improved grid quality due to better planning • Better forecasts due to better knowledge of consumption
Software application provider	• Easier offering of digital service due to marketplace of data space	• Additional digital products increase customer benefit and enable new services (=more revenue)	• Software application providers are also component suppliers or machine tool builders. Suppliers can access actual performance of components and machine tools in the field (better data for product development)

FACTORY-X

UC2.10
Carbon Footprint Management

Carbon Footprint Management

Transparency in Emissions – Easy PCF Calculation

FACTORY-X

Economic benefits

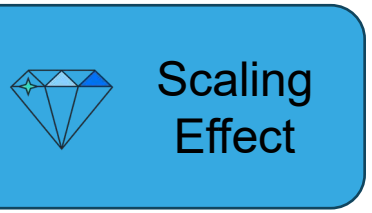
- **Reduction of manual tasks** calculating the PCF
- Competitive differentiation through PCF
- Enabling of **R-strategies**

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

Carbon Footprint Management

Transparency in Emissions – Easy PCF Calculation

FACTORY-X

	Organizational Benefit	Economic Benefit	Technical Benefit
Factory operator	• Transparency through guidance on calculation • Comparable PCF values	• Reduction of manual tasks calculating the PCF • Competitive differentiation through PCF • Enabling of R-strategies	• Standardized PCF calculation (share of logistics and manufacturing) • PCF management and sharing • Standardized approach model for PCF data collection
Component supplier Supplier		• Competitive differentiation through PCF • Enabling of R-strategies • Portfolio expansion	• PCF management and sharing
Software application provider		• Portfolio expansion	

UC2.11
Circular Economy

TP2.11 - Circular Economy

Close the Loop – for a Second Life!

FACTORY-X

Economic benefits

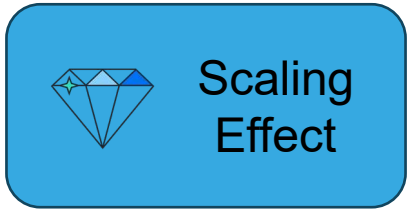
- Since the lifecycle of the machine is known, a **decision on the reuse 'R' strategy** can be made directly.
- **Resource conservation** (of expensive resources)
- **Reusage of expensive machines**
- New business cases

Technical benefits

- **Interoperability** through standardization
- Data based **condition recording** possible
- Quality of data increases with structure

Organizational benefits

- Data entry is simplified
- No retours of unknown products
- Support for service workers increases their efficiency



Scaling potential due to sharing of data between factory owner and component supplier + every participant can use the data; Resource conservation is enabled through scale, which means that machines and materials can be reused

TP2.11 - Circular Economy

Close the Loop – for a Second Life!

	Organizational Benefit	Economic Benefit	Technical Benefit
Factory Owner	• The product does not need to be returned to the manufacturer to assess its condition • Anyone who participates can use the data	• Buy-back offers for high-quality components • Material savings / multiple use • Resource conservation through reuse • PCF decreases through resource conservation • Higher machine availability	• Data-based assessment of condition is possible • Quality improvement (of the data) because the required data is already defined
Component supplier	• Data entry is simplified • No retours of unknown products • Anyone who participates can use the data	• Since the lifecycle of the machine is known, a decision on the reuse 'R' strategy can be made directly. • Upselling for runtime warranties • Cost reduction because no technical personnel need to go on-site	• Data-based assessment of condition is possible • Quality improvement (of the data) because the required data is already defined
Software provider		• Sale of software licenses in maintenance contracts	

FACTORY-X

Thank you!