FACTORY-X

Factory-X

Customer Sounding Board
February 13, 2025

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

Agenda
Topics and Presenters

Topic	Time	Presenter
Welcome, Introduction & Moderation	5 min	Silke Huesmann Roland Rosen 
Factory-X Use Case Overview	5 min	Ulrich Löwen 
TP 2.04 Condition Monitoring led Services	15 + 10 min	Fernando Martinez Calderon 
TP 2.09 Energy-Consumption and Load Management	15 + 10 min	Marc-André Dittrich 
TP 2.10 Carbon Footprint Management	15 + 10 min	Lucas Fochler 
Discussion & Closing	5 min	All

After each part of presentation, we have time for questions

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Factory-X

The Digital Ecosystem for Factory Outfitters and Operators

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
- BASF
- Berger Holding
- Catena-X e.V.
- Codewerk
- DMG MORI
- Empolis
- EPLAN
- Estainium
- Eviden
- 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 AG
- TRUMPF
- T-Systems
- TÜV SÜD Chemie Service
- Uhlmann Group
- VDMA e.V.
- WITTENSTEIN
- ZVEI e.V. (FE)

Factory-X Associated Partners

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

Factory-X goes public
Registration over https://factory-x.org/

Manufacturing-X Technical Council

What is the Manufacturing-X Technical Council?

- Factory-X aims to create an IT/SW technical basis (the „Factory-X Kernel“) for software solutions in Manufacturing-X using results from Catena-X.
- In the M-X Technical Council, the approaches are presented – depending on the project progress – and feedback is invited.

Who is it for?

- The Manufacturing-X Technical Council is aimed at anyone who is interested in the application of the IT/SW technical “Factory-X Kernel”, e.g., for the implementation of their own software solutions within the framework of Manufacturing-X.

When? #3 is on February 18, 2025

Customer Sounding Board

What is the Customer Sounding Board?

- In Factory-X, various so-called business applications (software solutions) are designed, developed as prototypes and validated for 11 use cases.
- In the Customer Sounding Board, these are presented – depending on the project progress – and feedback is invited.

Who is it for?

- The Customer Sounding Board is aimed at anyone who is interested in using, e.g. validation, the business applications of the use cases or who wants to create their own software applications that are interoperable with Factory-X.

When? #3 Now!

What‘s next?

Further MX TC und CSB will follow and we aim for direct exchange! If necessary, via NDAs.

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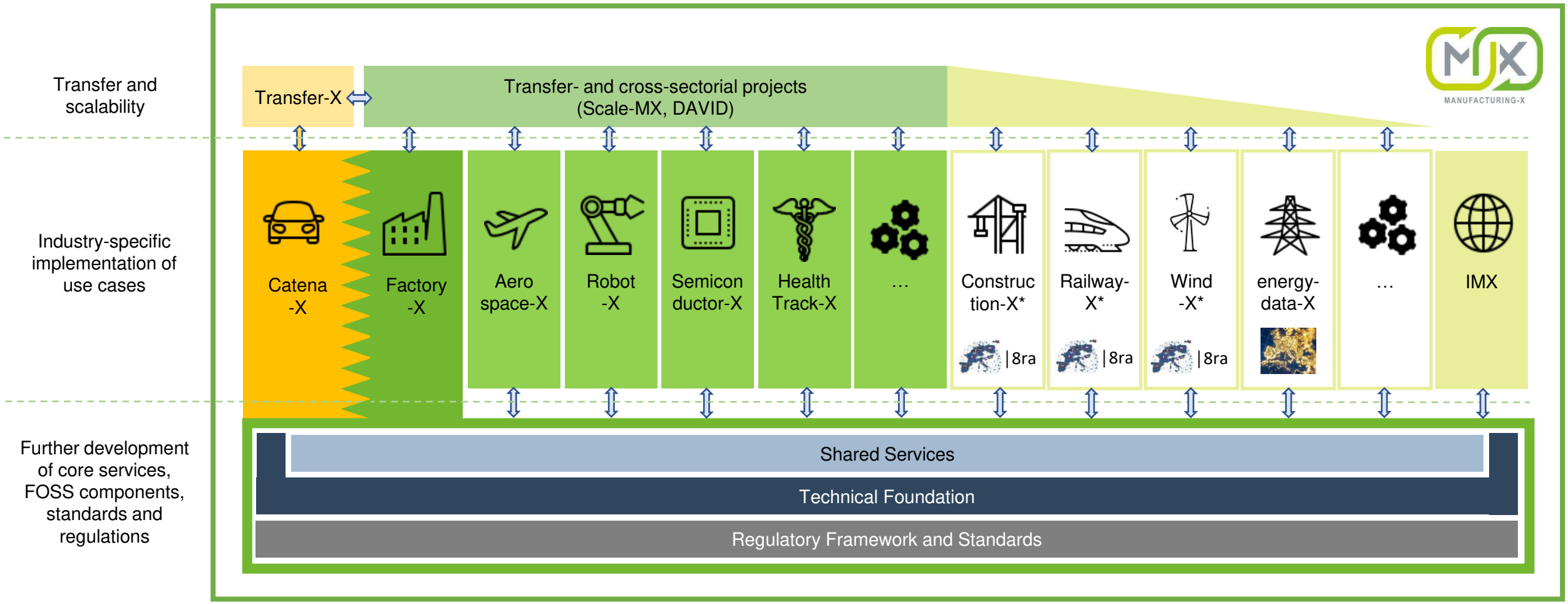
Use Case Overview

Germany
Cooperation between the projects

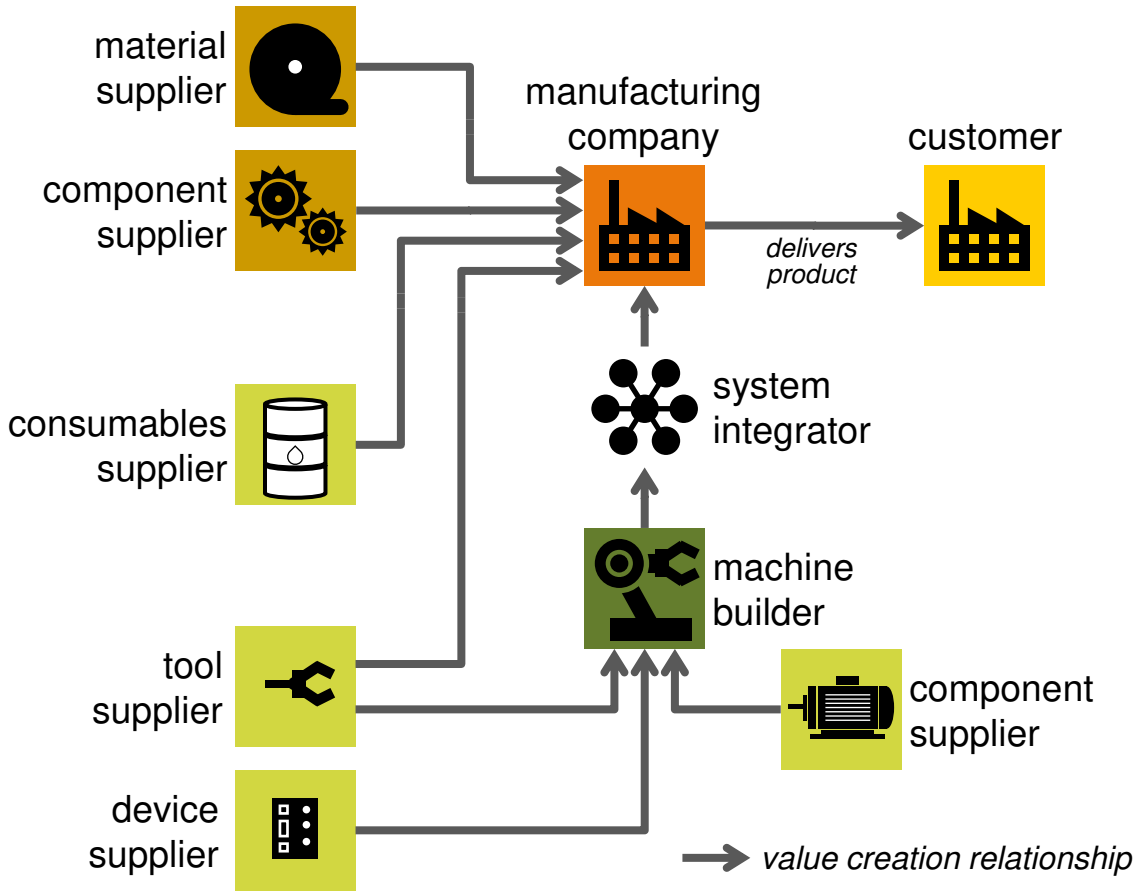


*Project in preparation

All icons by icons8

Supply Chains in Manufacturing Industries

Illustration

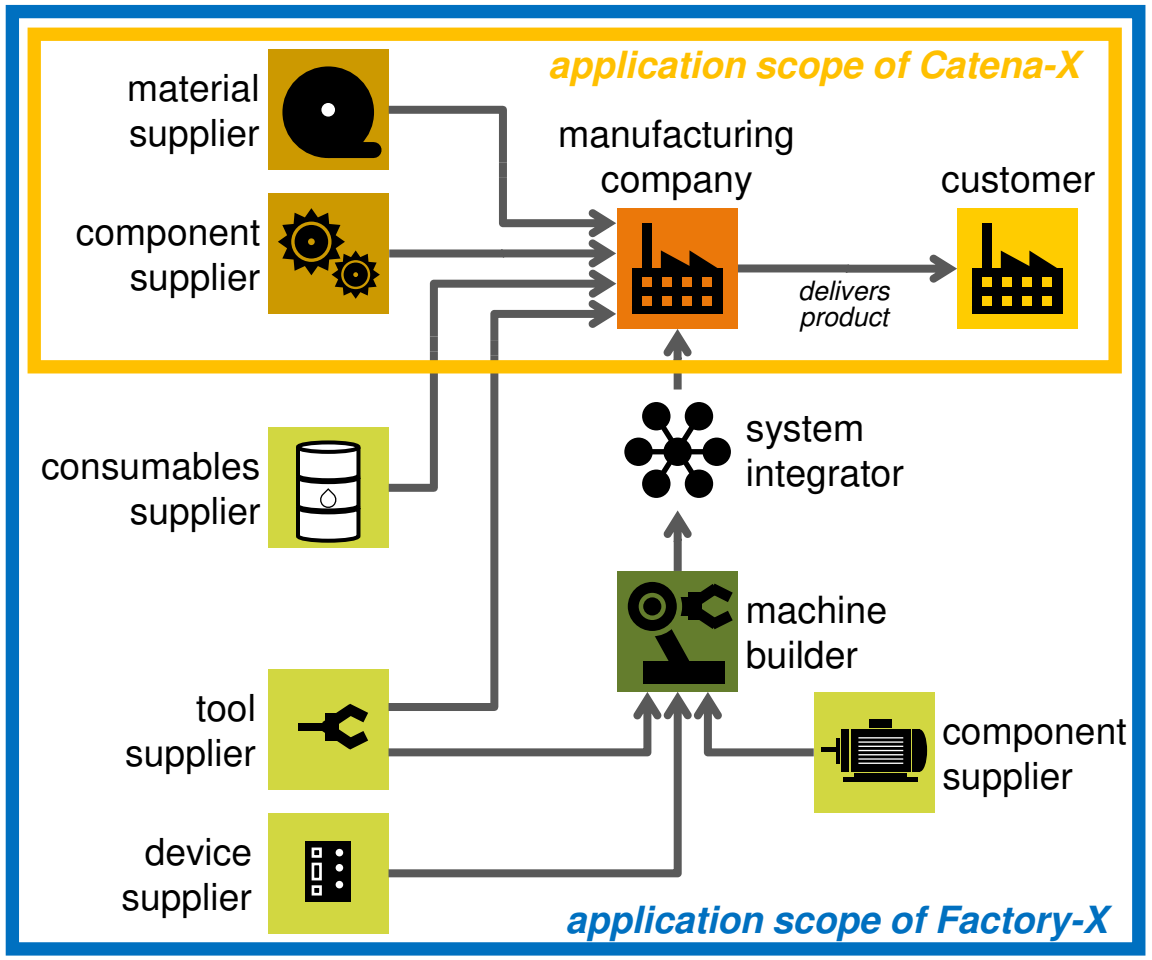


From the perspective of a manufacturing company, there are two different supply chains:

- 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

Supply Chains in Manufacturing Industries

Illustration



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

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

TP 2.04
Condition Monitoring led Services

Frequently Encountered Pain Points in Service and Maintenance

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Factory Operators

Costly production losses
- Unplanned downtimes
- Limited performance of equipment
- Quality problems

High maintenance costs
- Under-maintenance leads to emergency situations and extra costs
- Over-maintenance represents a waste of resources

Unnecessary prolongation of repairments
- Repairments follows a lengthy escalation chain (machine operator → in-house maintenance → machine builder → component supplier)

Expertise is scarce
- Increasing complexity of equipment reduces the amount of machines / machine types a maintenance team can be responsible for

Machine Builders and Component Suppliers

High service and support costs
- Significant amount of “uncompensated“ work, such as questions, warranty cases, and minor issues
- Multiple visits required by technicians for diagnosis and repair

Need to improve and modernize service offering
- Service quality is an increasingly important criteria when purchasing a machine
- Excellent service is a differentiator against competitors
- Service is an increasingly interesting revenue source

Risk of customer loss
- Dissatisfaction due to long time to repair
- Downtime and service penalties

High employee attrition
- Dissatisfaction due to unpredictable and frequent travel, often in emergency mode

Condition Monitoring Led Services

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

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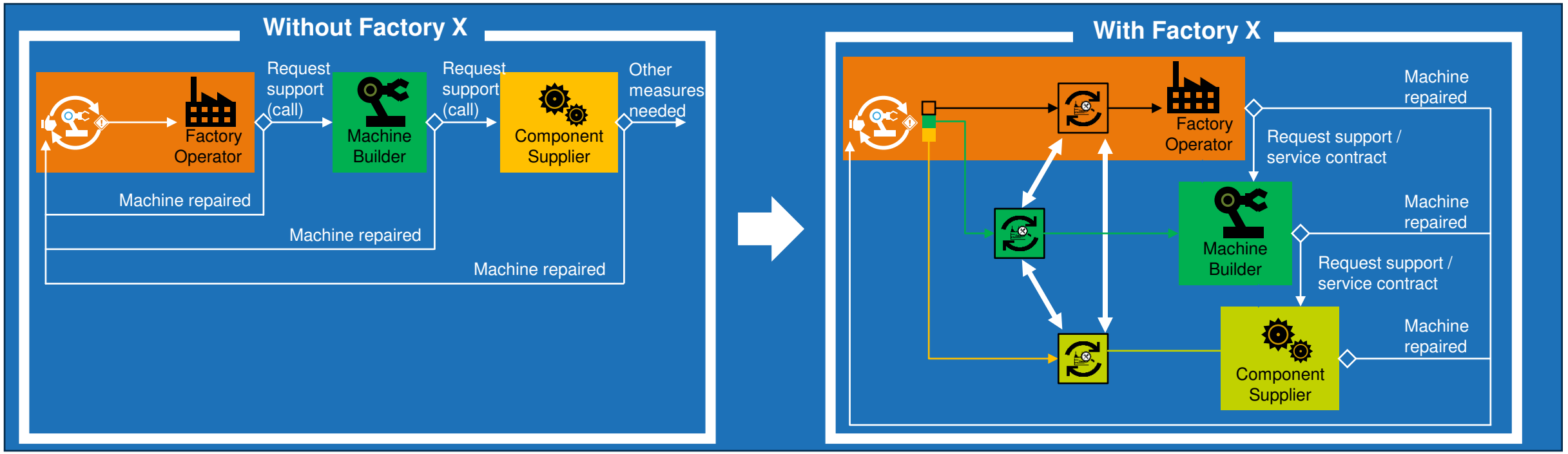
The Goal

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 data sharing due to standardized mechanisms and data models
- Integration efforts are minimized by employing standardized protocols, standards, and mechanisms, in accordance with industry norms



Condition Monitoring Led Services

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

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Your Benefits

- Increased machine availability - work can be planned before problems affect production (improving service value and experience, while keeping costs at check)
- Faster and accurate decisions - are made based on data-driven insights that can be accessed immediately incl. from other parties
- Efficient work - Parties are supported with Business Applications for Digital, Remote and Field, and Crowd Services
- Efficient realization - Standardized data sharing mechanisms and data models make implementation and operation easier, faster, more secure, and cost-efficient

Portfolio of Business Apps Relevant for the Use Case

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Condition Monitoring

Tracks health of equipment to detect potential issues before they lead to failures

Reliability Analysis

Evaluates the consistency and dependability of equipment of time

Process Optimization

Analyzes stability and compliance of processes to detect non-conformances

Device Connectivity

Enables seamless communication and exchange of data between devices

Data model centered connectivity framework

Enables seamless data exchange and integration by focusing on a unified data structure

Digital Service

Digitalizes domain expertise and workflows to facilitate self-service or automated support

Product Optimization

Collects operational and health information equipment to identify systematic improvement potentials

Remote Service (Management)

Supports, maintains, or troubleshoots equipment from distance, without needing on-site presence

Field Service (Management)

Coordinates on-site work, such as maintenance, repairs, or installations, performed by technicians

Enterprise Service Management

Streamlines service business processes to improve efficiency and service delivery

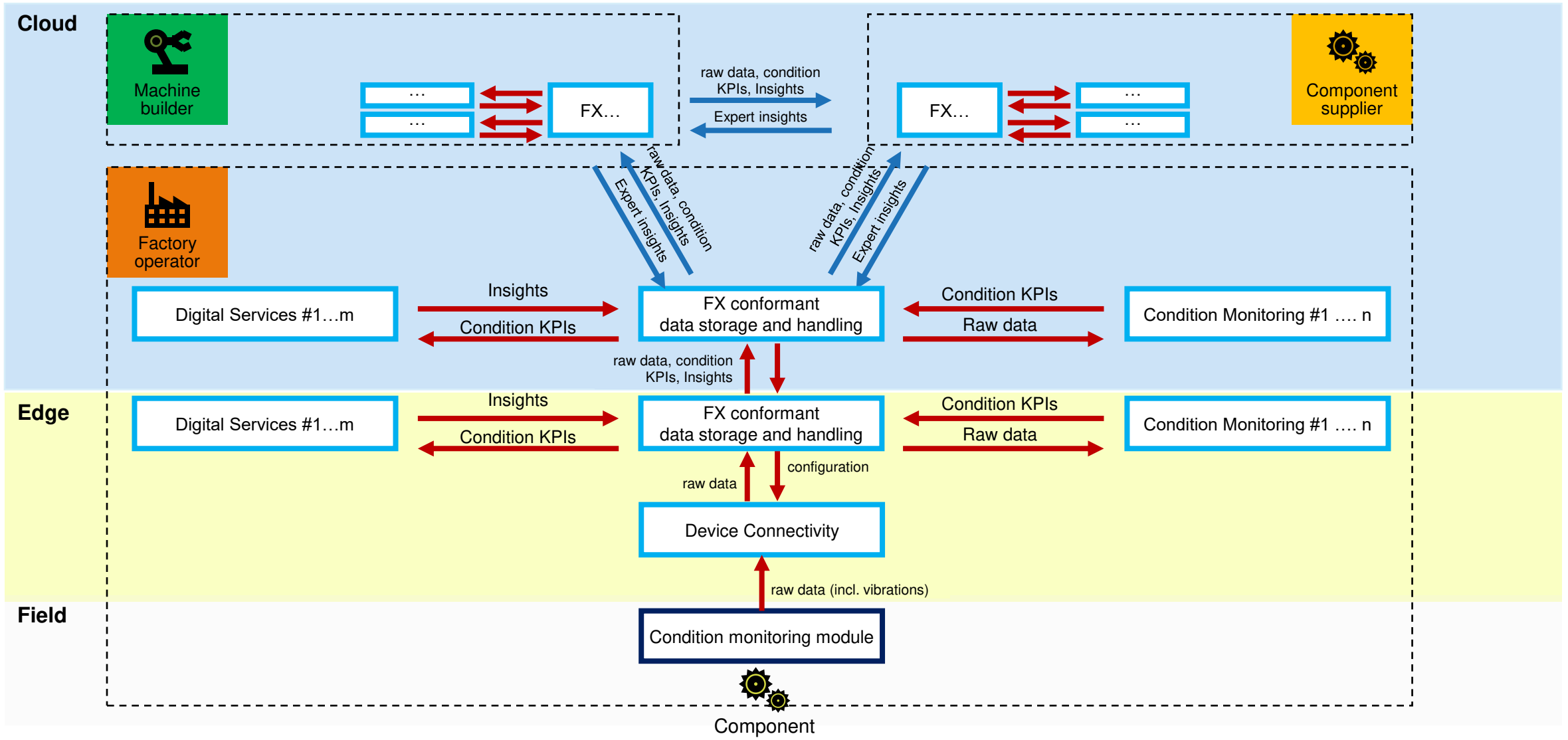
Crowd Service (Management)

Provides a list of service partners who can provide services

Customer Services Front Office

Handles direct customer interactions addressing inquiries, and providing support

Simplified Usage-View: Condition Monitoring & Digital Service



Example Scenario – “Spindle needs to be replaced”
FX will facilitate the exchange of data between companies

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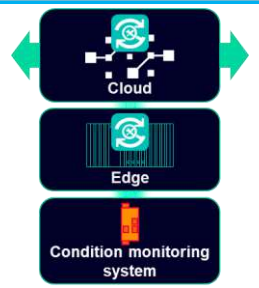
Machine Builder

Factory Operator

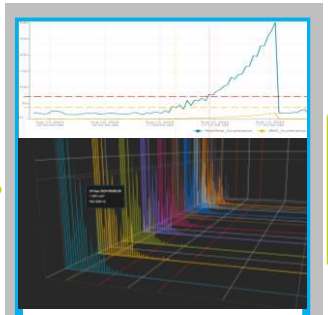
Enabled by FX

Machine Builder

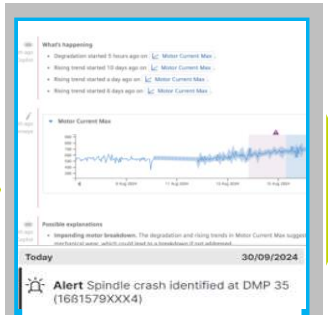
Condition Monitoring



Condition Monitoring



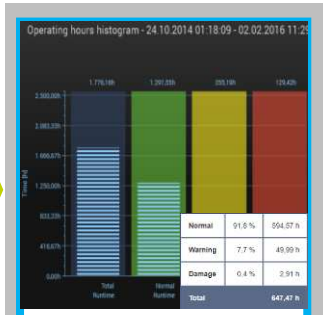
Condition Monitoring



Digital Service

Condition Monitoring + Digital Service

Condition Monitoring + Digital Service



Condition Monitoring + Digital Services

Component Supplier

Enabled by FX

Machine Builder

Enabled by FX

Factory Operator

Enabled by FX

Machine Builder

Enabled by FX

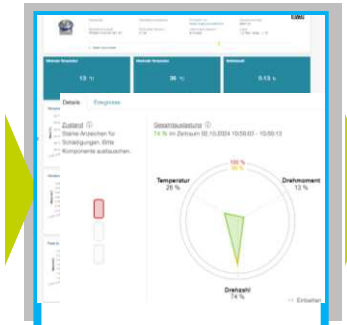
Factory Operator

Enabled by FX

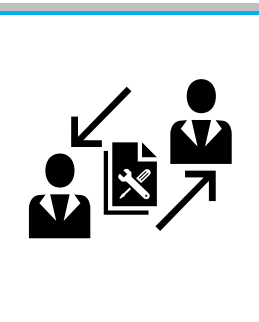
Machine Builder

Enabled by FX

Component Supplier



Condition Monitoring



Ent. Service Mgmt.

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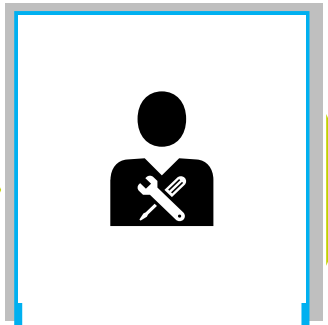
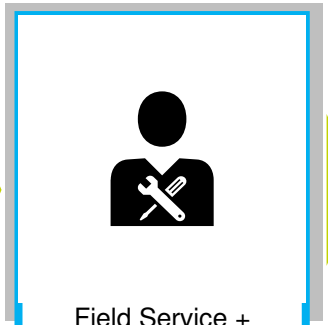
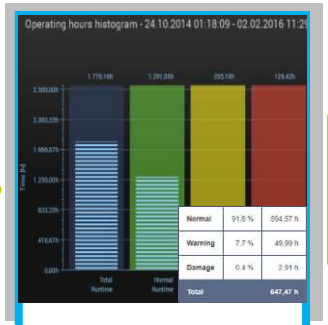


Field Service



Field Service + Condition monitoring + Digital Service



Condition Monitoring + Digital Service

Condition Monitoring + Digital Service

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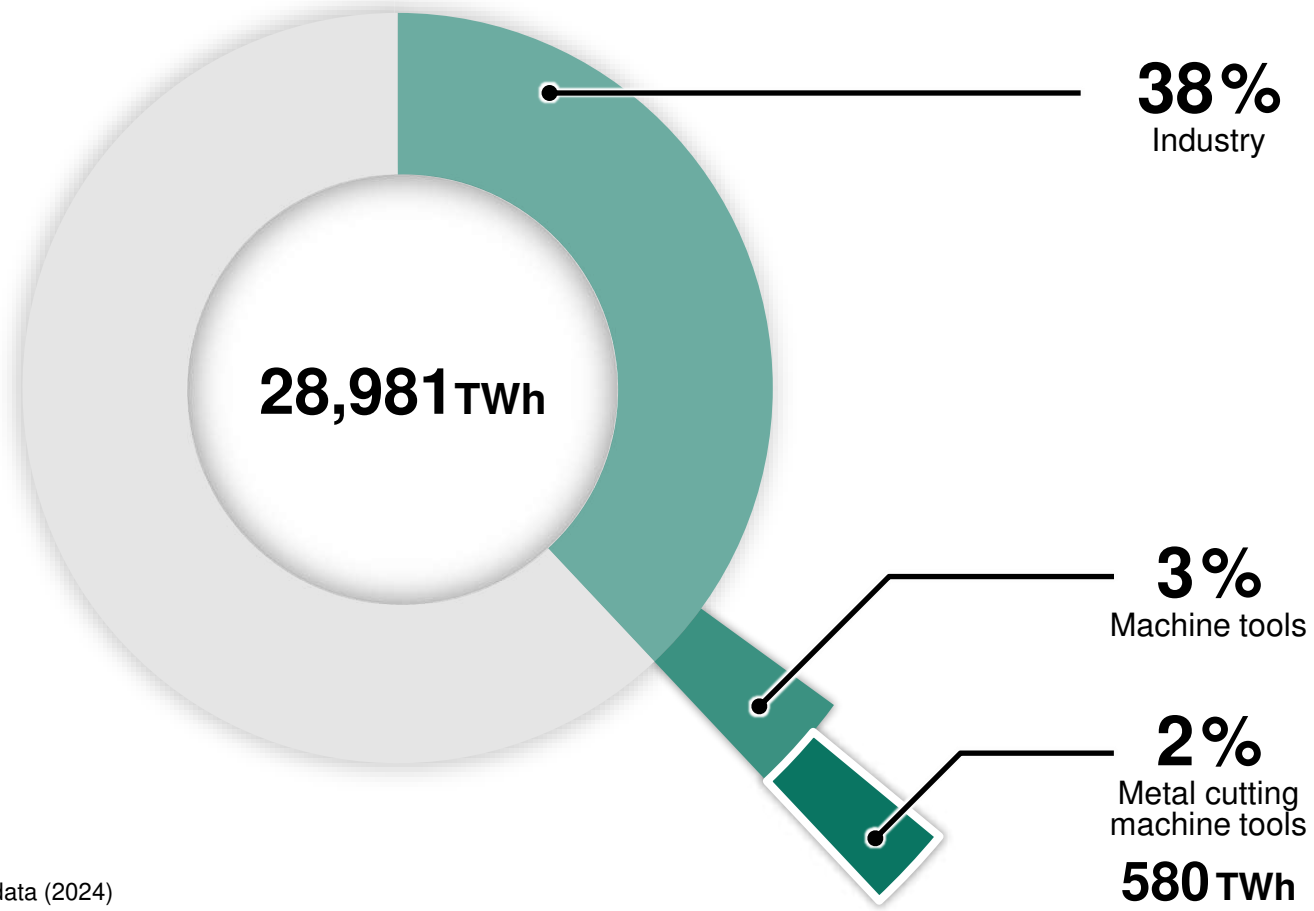
TP 2.09
Energy-Consumption and Load Management

Wikimedia, US-State Department, public domain

Global Electricity Demand

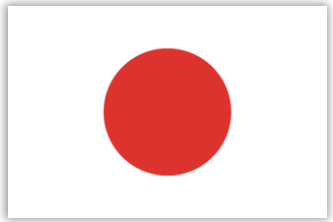
Global electricity demand (2023)



Electricity demand

by countries (2023)

517 TWh
Germany

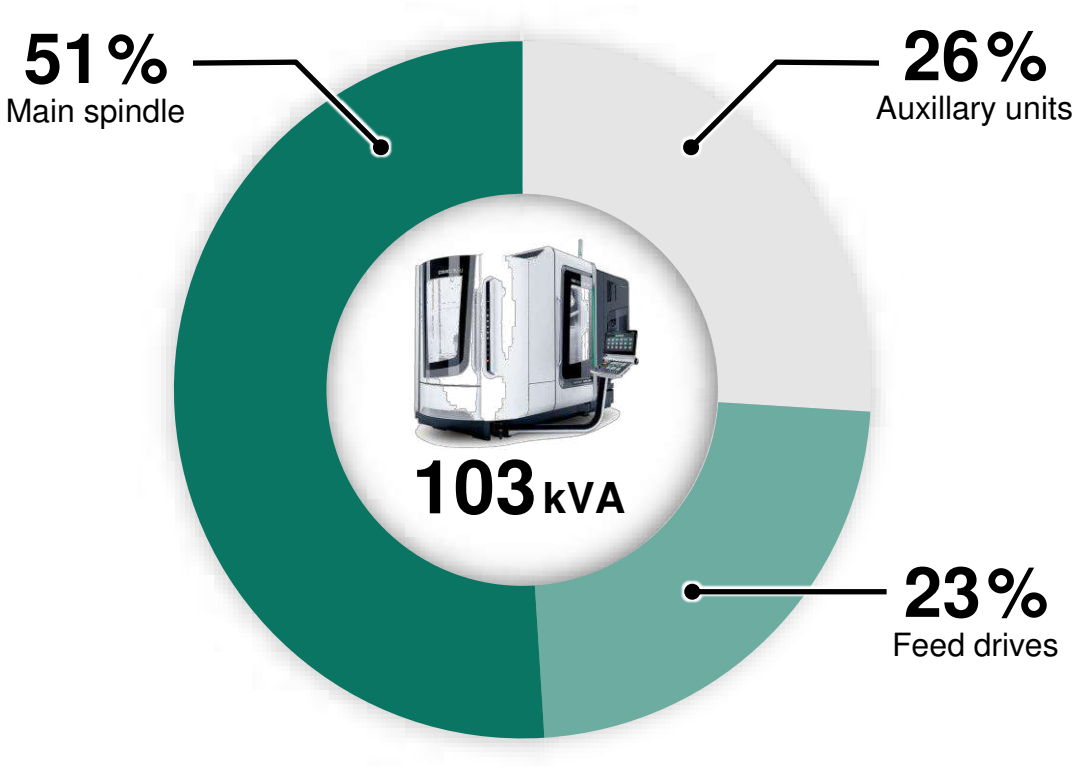


939 TWh
Japan

Enerdata (2024)
Statista, Bruttostromverbrauch in Deutschland bis 2023 (2024)
Statista, Größte Länder weltweit nach Stromverbrauch 2022 (2024)
Denkena B et al. (2020) Energy Efficient Machine Tools

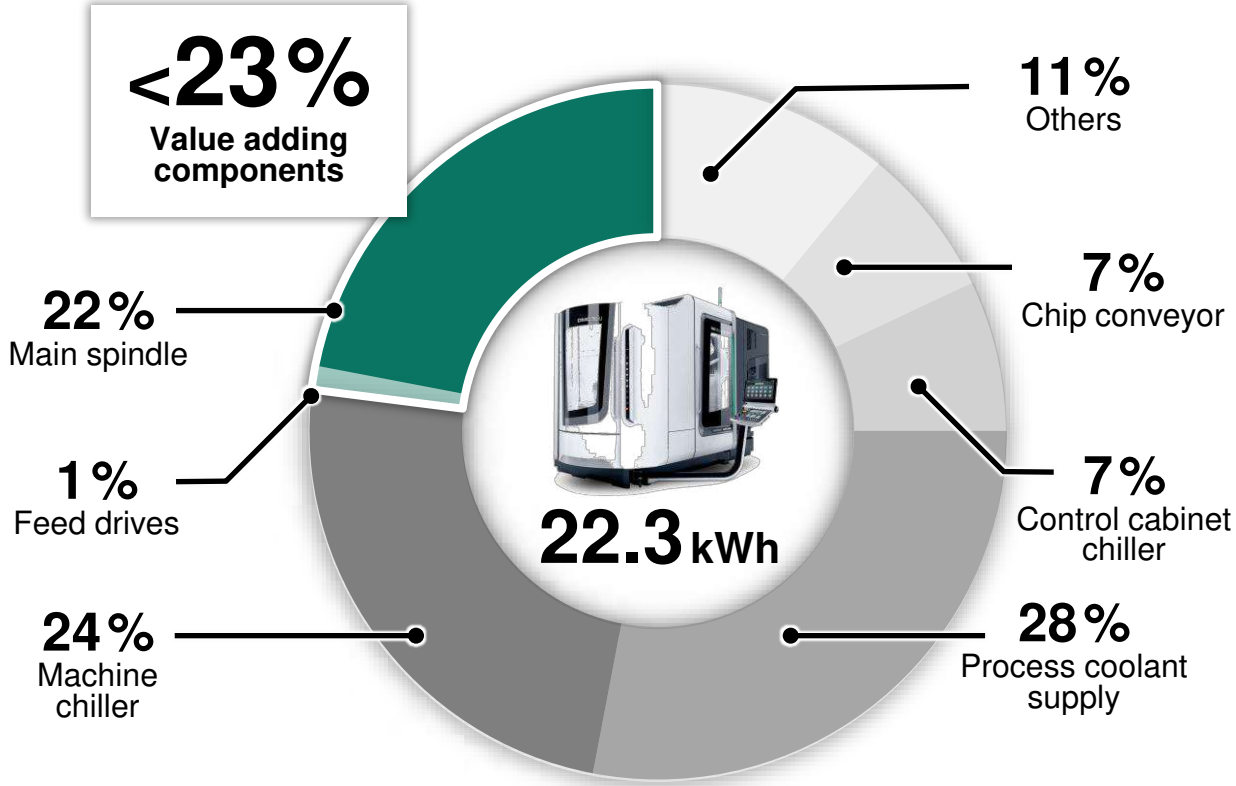
Energy Demand of Machine Tools

Power rating of machine tools…



… and actual energy demand in machining

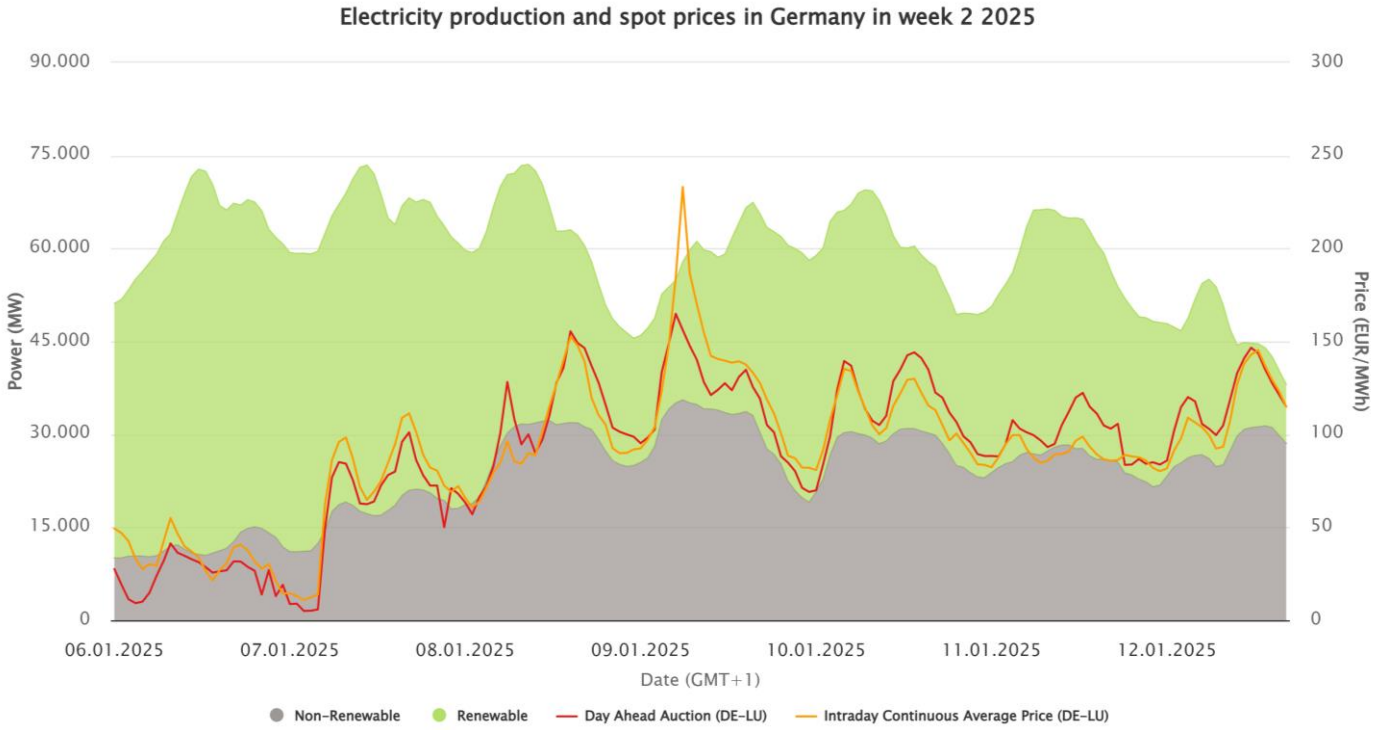
Drilling, milling (roughing & finishing) of cast iron for 140 min.



Challenge 1: Actual energy demand and its distribution often unknown to factory operators.

Hülsemeyer L (2016) Energieeffizienz spanender Werkzeugmaschinen und bedarfsgerechter Betrieb am Beispiel der inneren Kühlschmierstoffzufuhr. Dissertation, Leibniz Universität Hannover

Volatile Spot Prices and On-Site Renewables



- Day-ahead price on electricity exchange is increasingly determined by the availability of renewable energy

- Increasing on-site installations of renewables
- Leveling and adapting the load profile to availability opens cost-saving potential

Challenge 2: Volatile energy prices and on-site renewable offer opportunities to lower energy costs and establish new business models.

Energy-Charts.info, data source: ENTSO-E, Netztransparenz, EPEX SPOT, 14.01.2025

Use-Case: Energy Consumption and Load Management

Two workstreams for data-driven solutions

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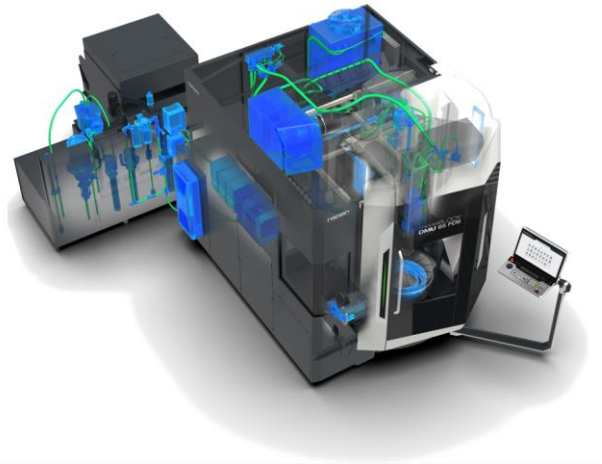
Workstream 1: Energy Consumption



- **Energy monitoring**
- **Energetic digital twin** of machine tools (eDT-X)
- **Data-driven standby** and **demand-oriented** operation of machine tool components

Workstream 2: Load Management

- Prognosis of **workpiece-specific energy demand**
- Energy-optimized **production scheduling & factory infrastructure**
- **Load management** with power authorities

Approach: Data-driven solutions for seamless monitoring and optimization of energy demand and flexibility management in manufacturing.

Energy Monitoring & Optimization

Data fusion for enhanced monitoring & intelligent components

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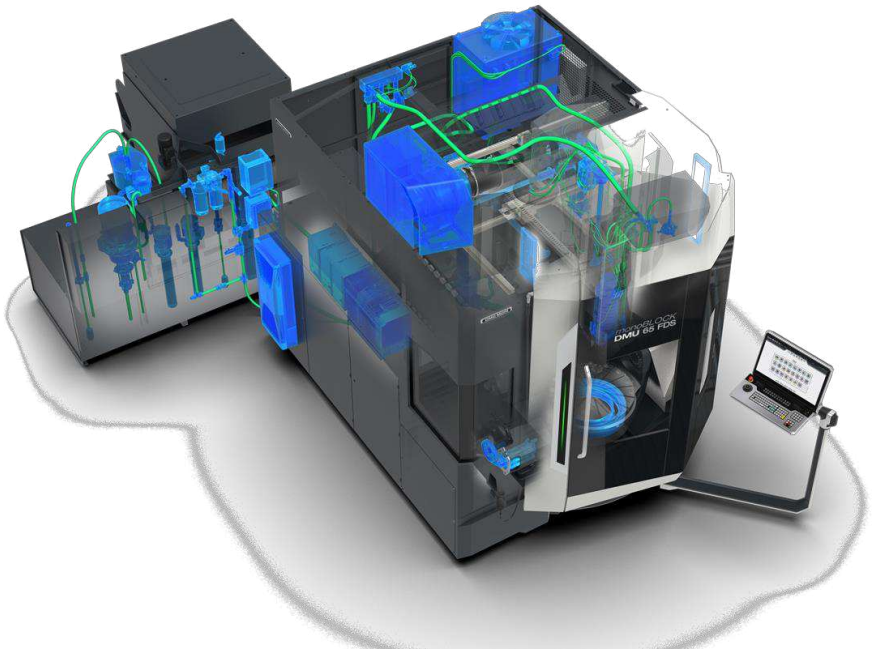
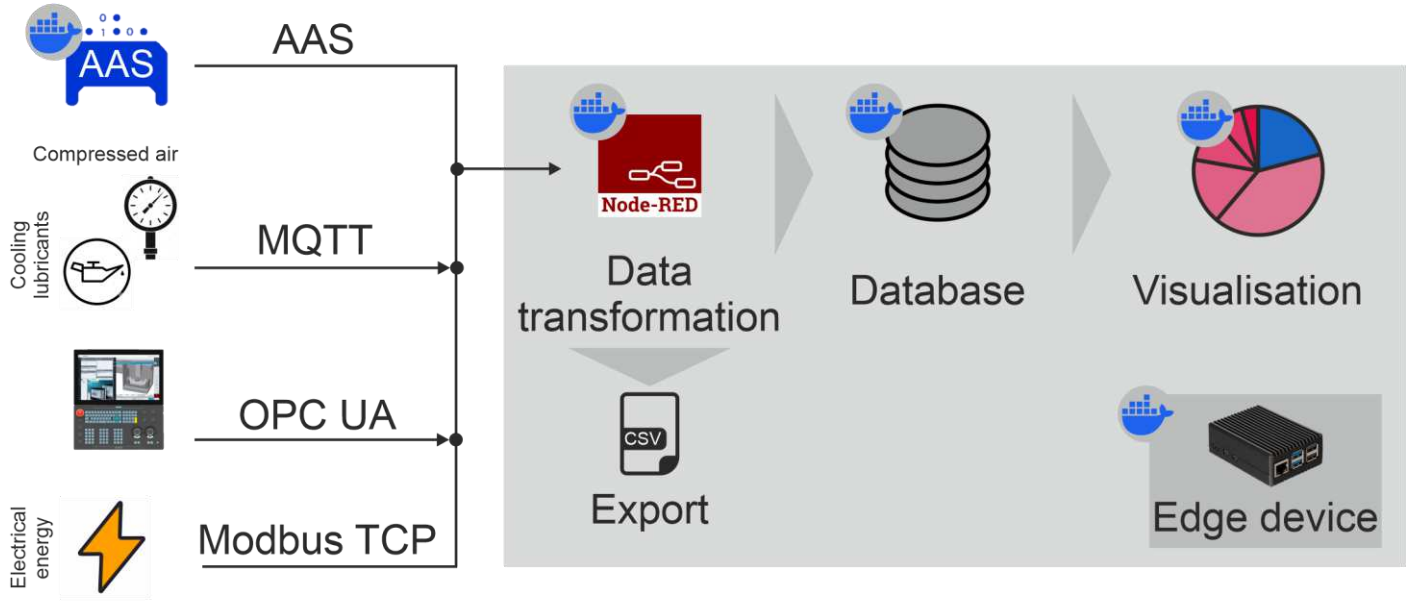
Energy Monitoring

- Component- & workpiece specific energy data
- Fusion of different data energy data sources & synchronization
- Substitution of sensor with digital twins





Intelligent Components

- Data-driven standby of control systems
- Demand-oriented use of support units (process coolant & mist extraction)

Energetic Digital Twin (eDT-X)

eDT-X as enabler for data-driven services

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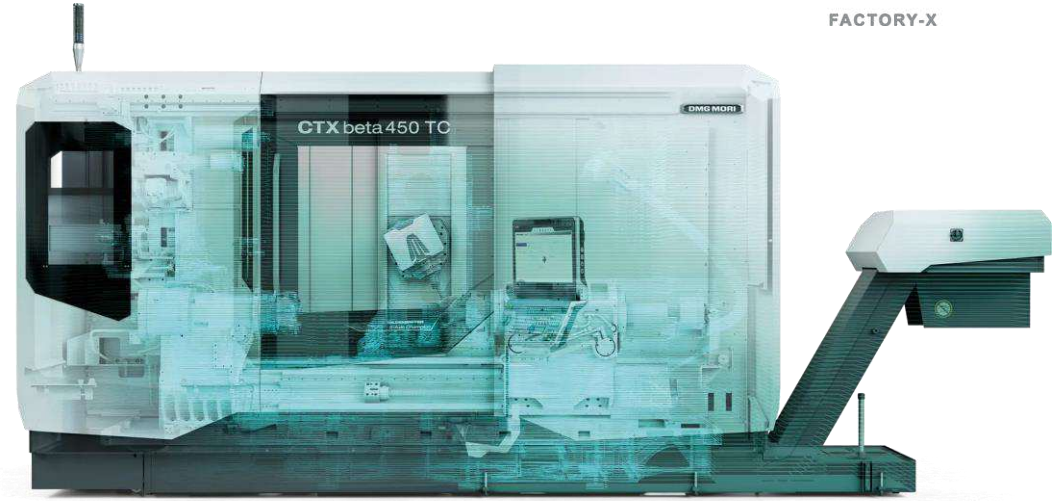
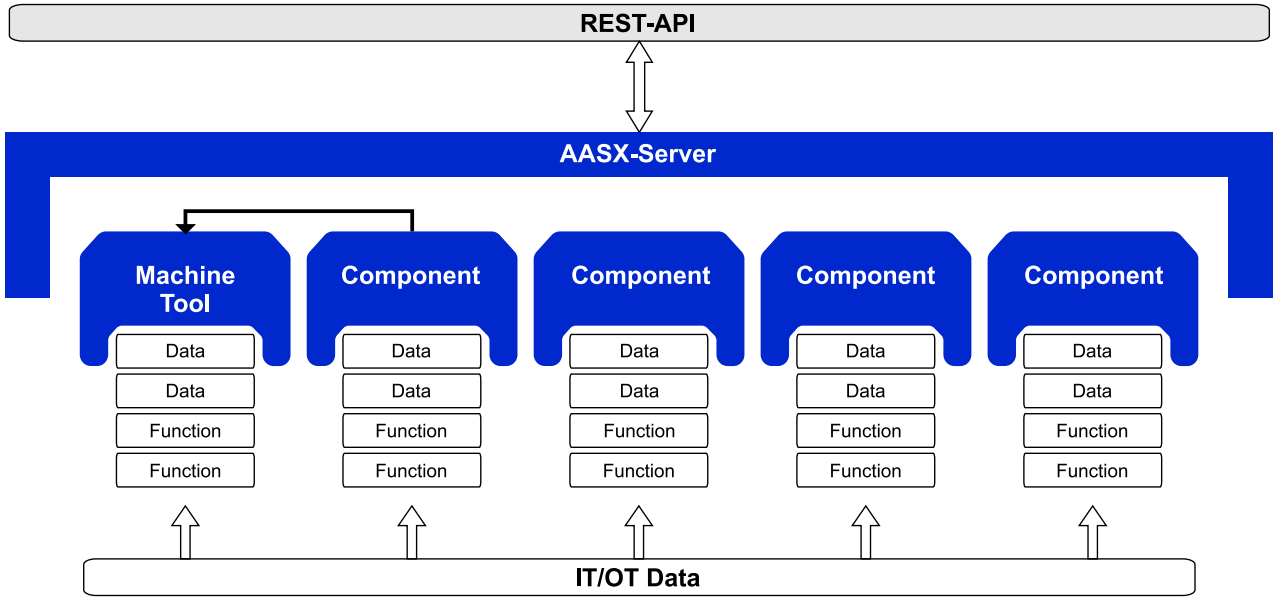
Enabling Technology

- Virtual representation of machine tools at component level
- Base for **virtual measurements**, **energy prognosis** of operating states & **workpiece-specific energy demand**





The FX Solution in Detail

- Structured information with semantic description
- Implemented via Asset Administration Shell (AAS)
- Contains condition-based models for the energy behavior of individual components

Energy-Optimized Production Scheduling

Aligning the production with electricity generation

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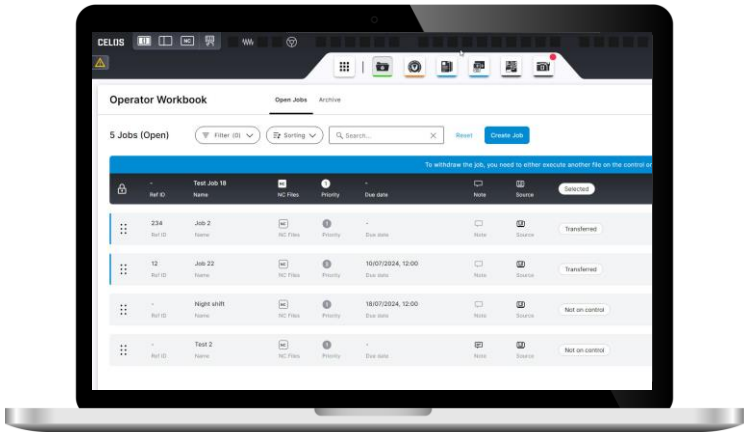
Prognosis of Energy Demand

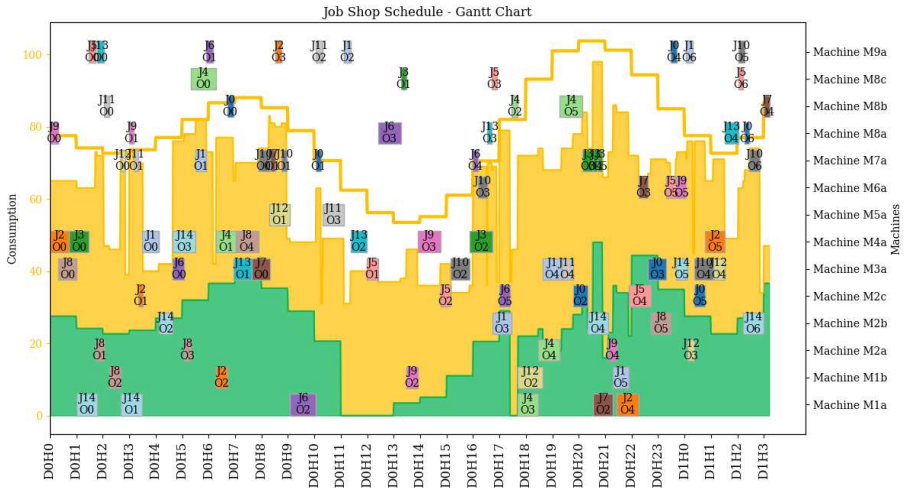


	Name	Machine tool	Energy demand [kWh] Finishing	Medium machining	Set up	Total
1	Ring	DMC 210 FD	21.76	11.35	2.77	**35.88**
2	Base plate	DMU 40 eVo	5.95	1.48	0.71	**8.13**
3	Fixture	DMU 40 eVo	3.57	1.97	0.49	**6.03**
4	Structural part	DMF 300|8	18.45	7.46	1.98	**27.89**
5	Shaft 1	CTX beta 450 TC	1.10	0.83	0.13	**2.05**
6	Shaft 2	CTX beta 450 TC	2.20	1.10	0.22	**3.52**
7	Shaft 3	CTX beta 450 TC	4.62	2.20	0.45	**7.27**

- Modelling the required energy based on planning data with the eDT-X

Energy-Optimized Production Scheduling & Load Management

- Optimize and execute production schedule with respect to day-ahead energy prices & on-site electricity generation
- Interfaces to Manufacturing Execution System (internal) & electricity spot prices (external)
- Optimized utilization of dynamic electricity tariffs and local generation



Factory-X – Collaborative Innovation

Make energy data work across factories

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Seamless acquisition and interoperable usage of data across stakeholders requires **innovations at interfaces** and **industry standards**!

Interdisciplinary Project Team

The Team

DMG MORI	TRUMPF	SIEMENS	ifm	VDMA	IFW
Fraunhofer	Berger Holding	Uhlmann			

Competencies from **machine tool builders**, **factory operators**, **software providers**, **research** & **networks united**

Focus on domain-specific challenges possible due to **backend development in TP4**

Usage and development **standards** (OPC-UA, AAS, FX-port) ensure transfer to application

Summary and Benefits

Data-driven solutions for energy-efficient manufacturing

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Summary

- Urgent need for increased transparency and optimization of energy demand in manufacturing
- Data-driven solutions will support transformation towards green production
- Use-case „Energy Demand and Load Management“ in Factory-X provides solutions for seamless acquisition and usage of energy data

Your Benefits

- Solutions for **interoperable energy monitoring & reduced energy demand** of machines
- Innovative approach to administrate and use energy data via the **Energetic Digital Twin**
- **Energy-optimized production scheduling** for reduced energy costs
- **Load management** offers new business opportunities in collaboration with power authorities
- Defining **standards for interoperable energy data**

Energie-Monitoring im Werkzeugmaschinenbau

Become a front-runner in energy-efficient manufacturing of the future with us!

TP 2.10
Carbon Footprint Management

Challenge

- Reduce CO2-footprint and become CO2-neutral

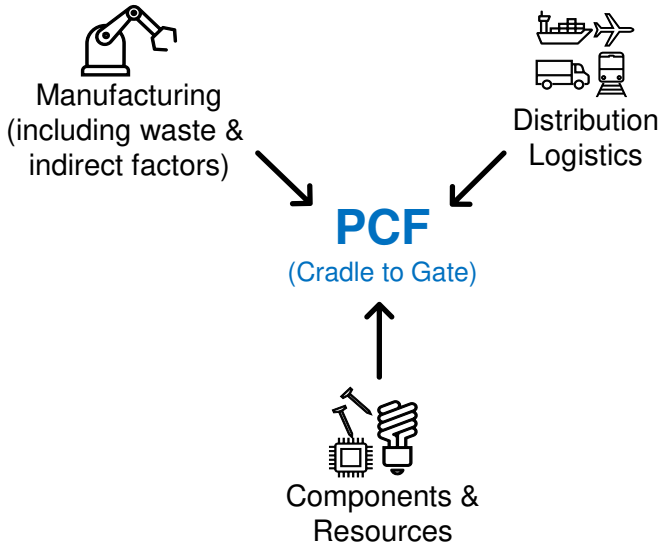
Goal

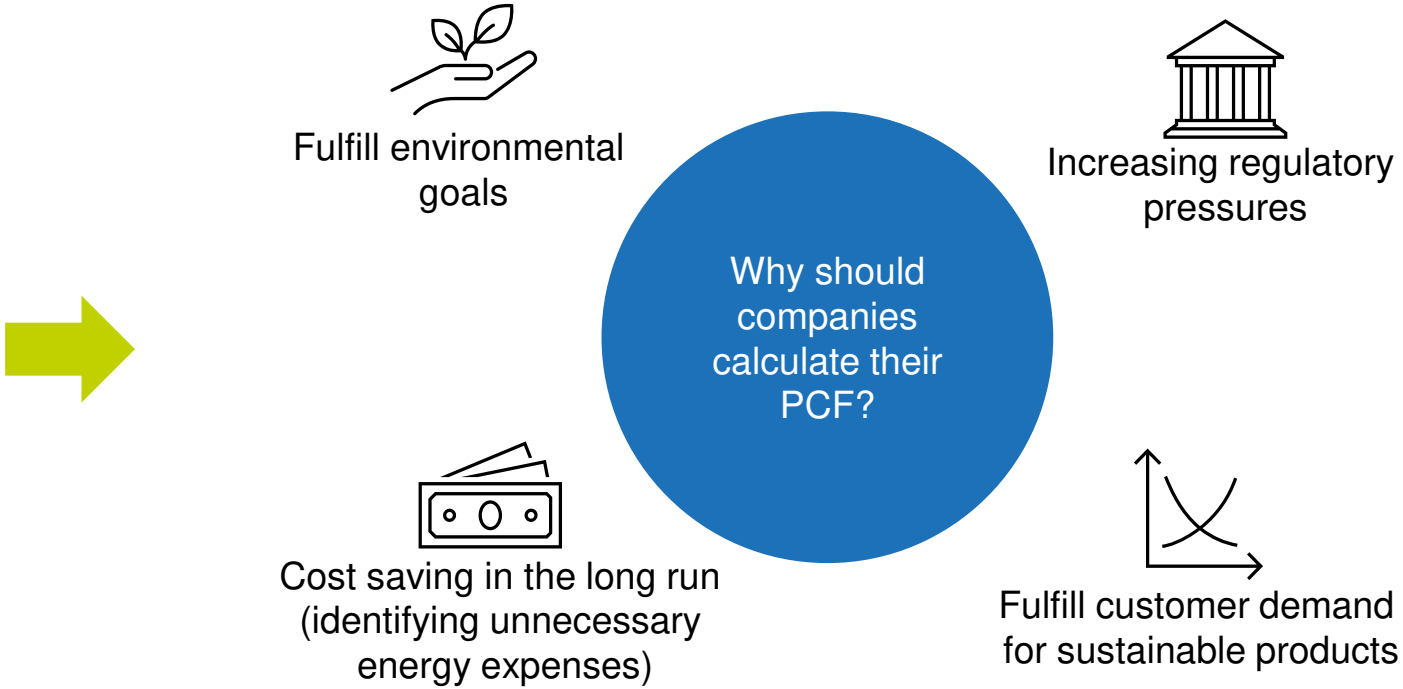
- Solutions for CO2-transparancy along entire supply chain

What is the product carbon footprint (PCF), and why should companies calculate it?

What is the PCF? (According to ISO 14067):

„sum of GHG emissions [ ] and GHG removals [ ] in a product system [ ] , expressed as CO2 equivalents [ ] and based on a life cycle assessment [ ] using the single impact category [ ] of climate change"





Challenges we want to address

Comparability & missing guidance

- Many companies miss guidance on which factors from their production need to be considered in the PCF
- Uncertainty exists regarding the need to consider indirect contributions (like factory lighting & heating etc.)
- PCF values from different companies are currently not comparable due to different calculation procedures

Huge complexity & necessary resources

- Large number of measurement points necessary, that then need to be broken down to product level
- High amount of personnel to collect data from manufacturing & logistics
- Need for the exchange of information with a multitude of suppliers across the supply chain
- Need for representative secondary data

Factory-X PCF Guidance

Gives Guidance for a comparable PCF calculation and to lower the entry hurdle for SMEs

Factory-X PCF Business Applications

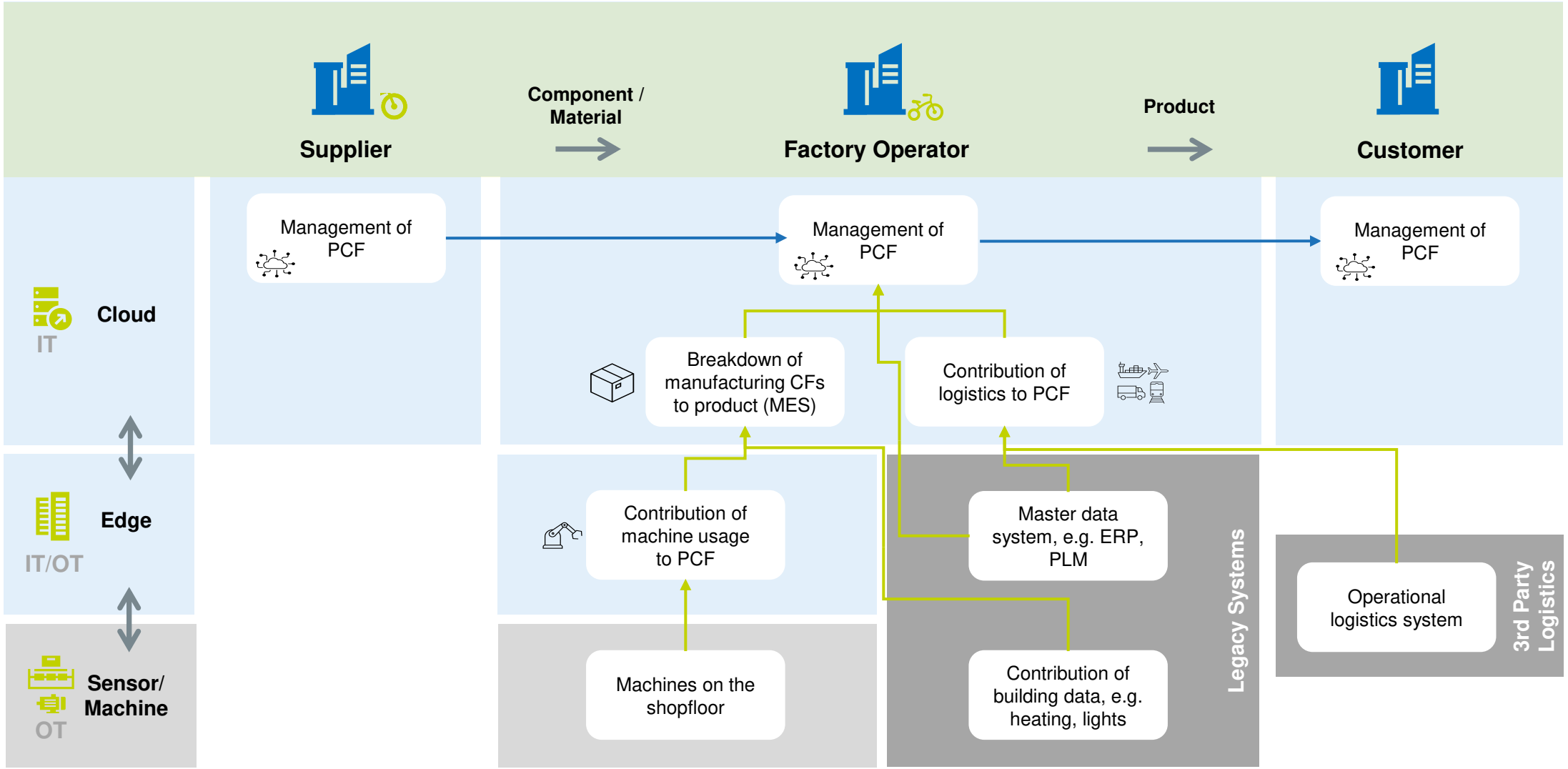
Tools to enable companies to measure and calculate their PCF with less effort

- 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 seamless and reliable sharing of comparable PCF data between participating companies along the whole supply chain

Our usage view shows the interactions between the business applications and legacy systems



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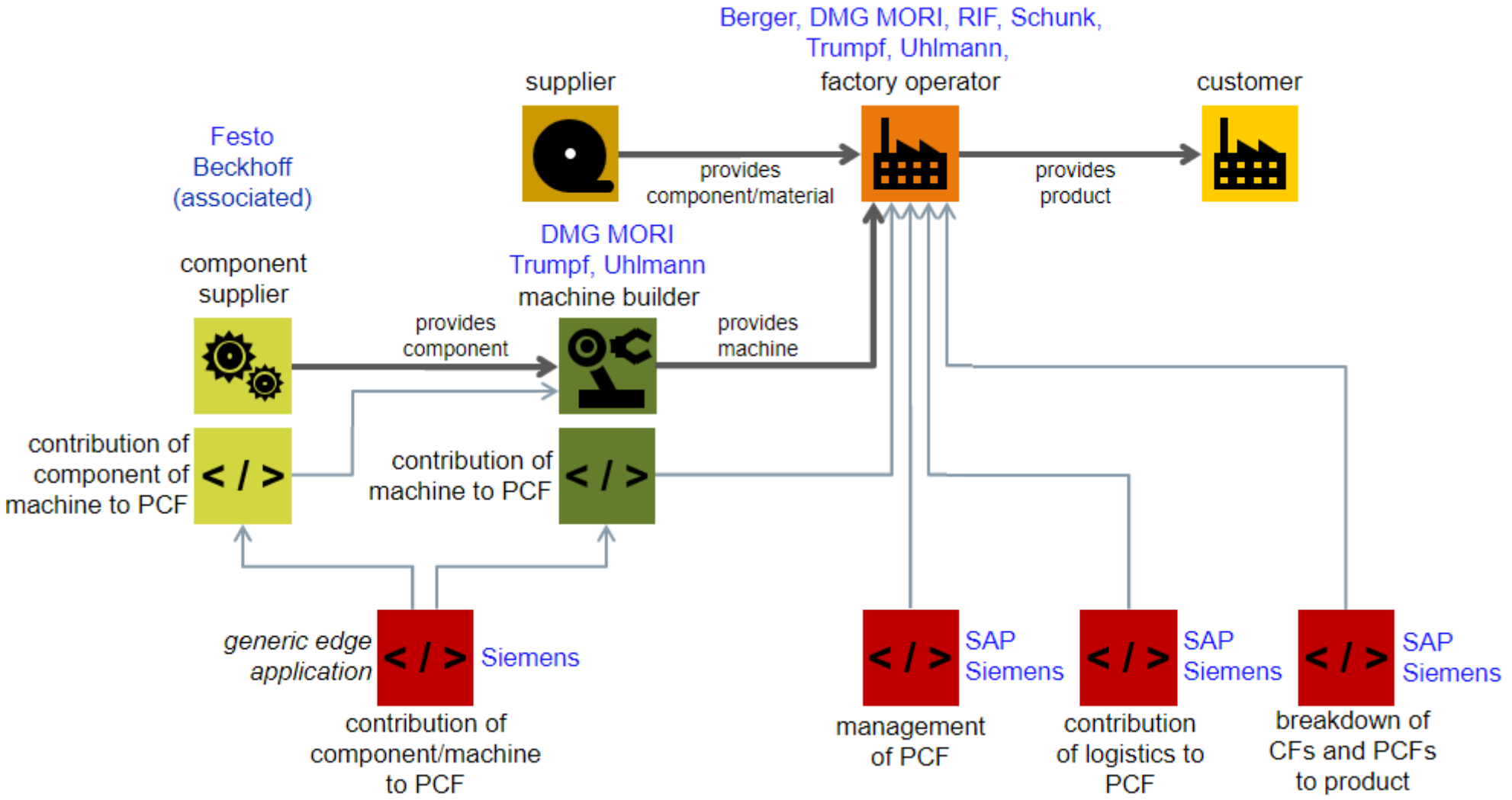
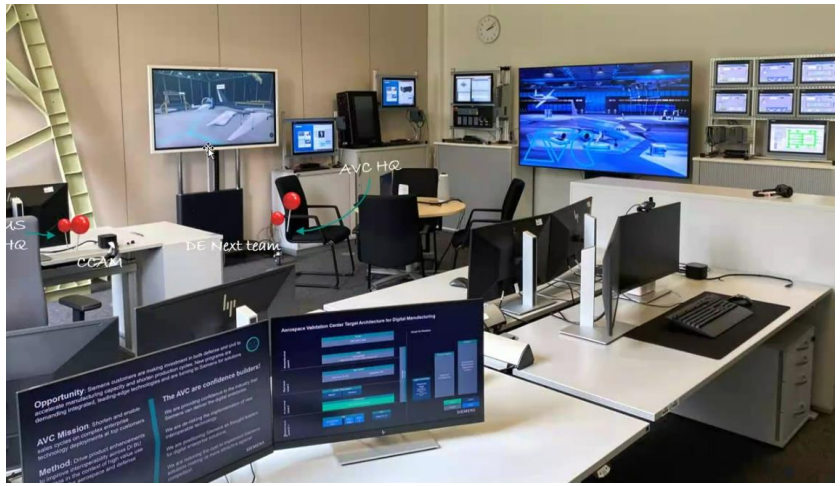


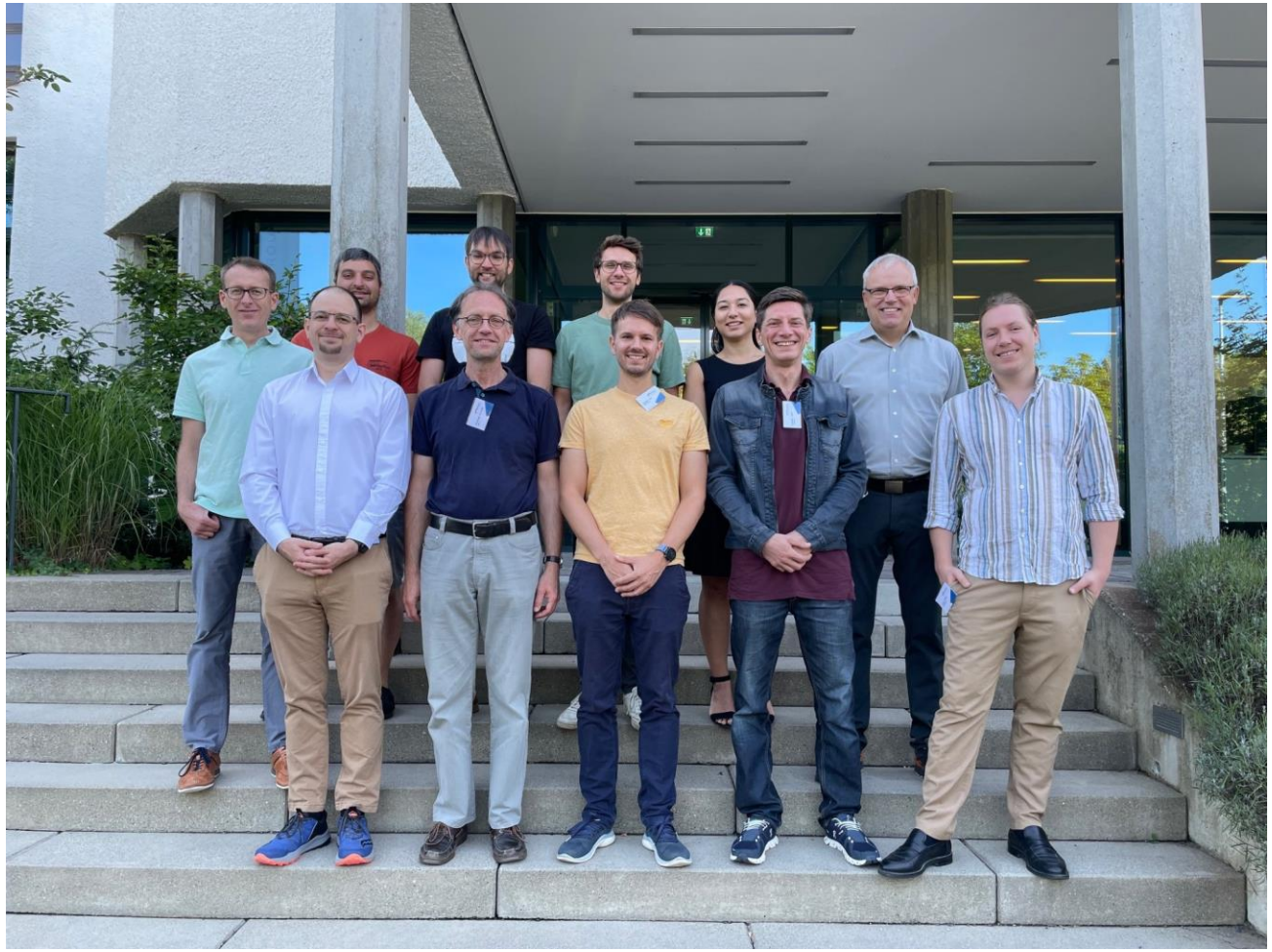
Our next step: Developing a Test- and Demonstrator framework

We are currently developing a Test-and Demonstrator framework at the Siemens Aerospace Lab in Nuremberg to:

- Validate the business processes we have defined.
- Be able to hands-on develop the business applications.
- Test the interactions between the applications that are developed/adapted in Factory-X.
- Ensure, that the ecosystem can be rolled out without major changes at other factories.



The TP2.10 Team



Uhlmann	Schunk	SAP
Festo	Siemens	DMG Mori
Berger	Fraunhofer	RIF GmbH
TRUMPF	Beckhoff	ESTAINIUM

FACTORY-X

Q & A

Thank you

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