FACTORY-X

MX-Port Concept

Enable data sharing across industries

Factory-X

The Digital Ecosystem

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Version History

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1 The Goal: Enable data sharing across industries

The project Factory-X has been tasked to define a common base for exchanging data (see green rectangle in the lower part of figure 1) as the foundation for all projects under the Manufacturing-X umbrella and potentially beyond. This common base includes heterogenous technical and non-technical elements like regulations, standards and software services. In this summary we introduce the **MX-Port as a configurable and open concept** for the "shared-service-box" in figure 1. Factory-X will define and prototypically implement at least two configurations of the MX-Port serving the requirements from Factory-X use cases.

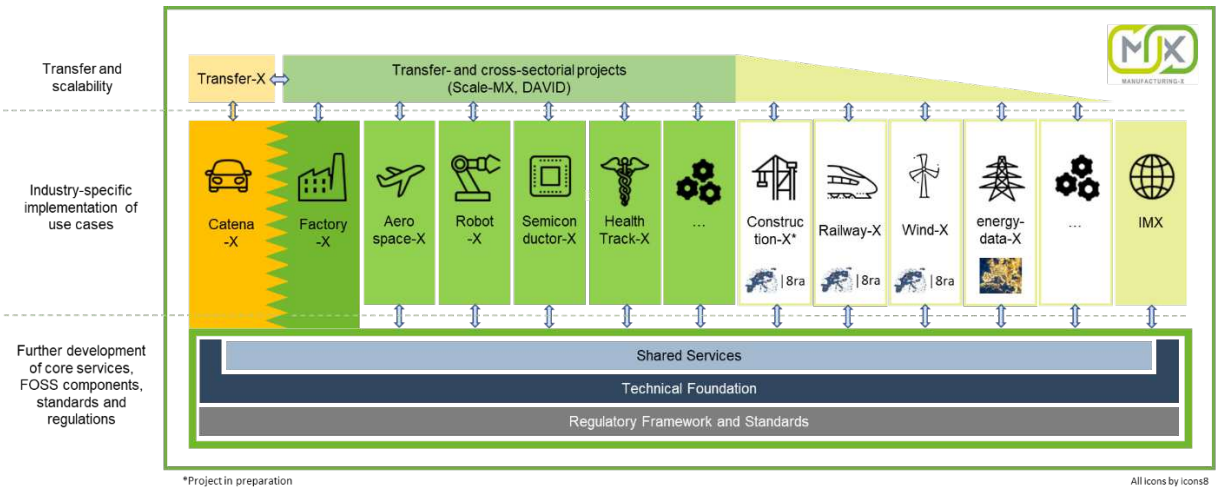

Figure 1: Systemic approach to Manufacturing-X (Source BMWK)

2 Motivations and requirements to the MX-Port concept

Today and even more in the future companies - SMEs as well as large corporations - will exchange and share data with partners from different industries to improve their own business, generate value out of the data or meet regulatory requirements. To illustrate the requirements for the MX-Port, we use the fictitious company "Small Motor Inc.". It develops, manufactures and supplies electric motors to customers in different industries. For this purpose, the company sources raw materials and parts from suppliers in various industries. "Small Motor Inc." is involved in various lifecycle processes (e.g., Product Lifecycle Management, Production System Lifecycle Management) and value chains (e.g., product supply chain), see figure 2.

The MX-Port concept offers an approach for a decentralized, trusted and secure data exchange as well as interoperability and economic scaling. Particularly interoperability is a strategic goal for Manufacturing-X and a core technical element of the MX-Port concept. A technical and scientific analysis of interoperability can be found at DSSC (Source: https://dssc.eu/space/SK/812286015/3+-+Interoperability+and+Data+Quality).

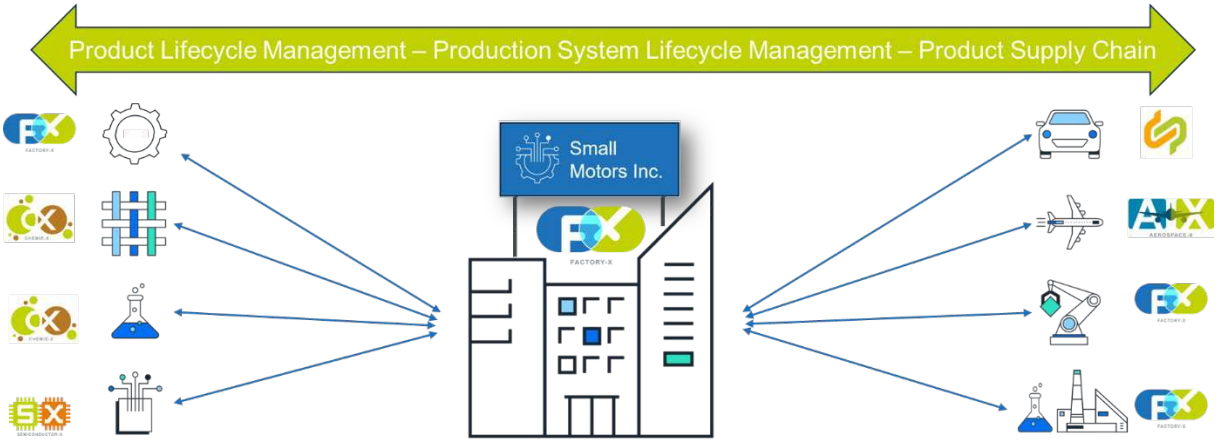

Figure 2: Value chains of "Small Motors Inc." (source Factory-X)

In a pragmatic way the Factory-X project has described goals for **interoperability** from an ecosystem participant and application provider perspective:

As a digital ecosystem participant, I want to

- collaborate with all other data ecosystem participants (also from other data spaces and business spaces),
- model data, that I exchange, only once for use by all my business partners (independent of their industry or geography),
- use uniform processes with all other data ecosystem participants for comparable tasks,
- be neither locked-in by a specific business application provider,
- nor locked-in by a specific operating company.

As a provider of applications to the digital ecosystem, I want to

- set and use the standards that are relevant for me (as defined within the FX-Project),
- be able to choose the level of interoperability that is right for me and
- be able to exchange my service provider independently of my IT.

This would ideally mean for "Small Motor Inc." that they will have

- to register, identify and authenticate themselves only once to be able to collaborate with companies from different industries,
- to model its data only once for a given use case,
- to use only one technology stack (MX-port configuration, see below) to realize the "Shared-Service-Box" that allows the use of the required protocols, connectors etc.,
- the free choice in selecting a business application for a use case from several providers.

However, in the real world we will not be able to achieve all goals at the same time. Our objective is to realize a cost-efficient solution approach to increase the benefit for all ecosystem participants.

3 The MX-Port Concept

The MX-Port concept shall accomplish the following:

1. Enable the following business oriented Factory-X qualities[1] (based on the technical building blocks defined by Dataspace Support Center, source https://dssc.eu/space/bv15e/766066850/Technical+Building+Blocks):
   - Interoperability,
   - Trust & Security,
   - Scalability,
   - Data Sovereignty.
2. Build on the standards from entities such as Gaia-X, Catena-X, Plattform Industrie 4.0, IDTA, SCI 4.0, OPC Foundation and the IPCEI-CIS.
3. Extend and expand these standards and results where necessary to provide a technological basis for the Factory-X use cases, for example:
   - accommodate connectivity down to the shop floor, which was not part of the Catena-X scope.
   - accommodate industry specific requirements.
     In Factory-X, for example, these are new offers and business models that have not been adequately addressed in Catena-X, such as offering firmware updates for machines and components on the shopfloor or ‘as-a-service’ business models in return for sharing data.
4. Deliver an integration architecture, i.e. the MX-Port concept presented here, that enables all Manufacturing-X projects to realize their use cases.

Due to the different market conditions, different perspectives and roles of data space participants, a large set of standards, communication technologies and others must be considered. DSP/DCP, AAS and OPC UA are only some examples for the data exchange between companies and within a company.

To be able to structure these requirements logically and to find a way to understand, where exactly they are affecting the existing architecture, we have decided to define a concept which we call the „ MX-Port concept“. The MX-Port concept enables that

- business applications are integrated in a uniform manner,
- existing software applications can be integrated without having to change them on the use-case-function-level.

[1] Term „quality“ is used within the Factory-X project without claim to technical-scientific validity.

The MX-Port concept structures the complete technical data exchange stack, from the data source to the exchange within or between companies in the following 5 layers:

	Layer	Purpose
L5	Discovery	. . . is used to find business partners, data assets (e.g. devices) or business applications.
L4	Access & Usage Control	. . . 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.
L3	Gate	. . . is used to exchange data in a uniform way.
L2	Converter	. . . provides the semantic model for the data to be exchanged.
L1	Adapter	. . . enables any business application to use the MX-Port.

Figure 3: Five layers of the MX-Port concept (Source Factory-X)

The five levels do not have to be used in all applications. However, all software components (existing and newly proposed) for implementing the concept should be able to be assigned to one of these five layers. This will allow us to clearly understand

- which purpose a proposed component will serve,
- which options and alternatives exist per layer.

A clear consequence of this concept is that going forward there will be multiple configurations of the MX-Port concept, consisting of different software components. However, they will be structured identically and therefore enable interoperability according to the interoperability levels

- Data Interoperability,
- Intra-Data Space Interoperability,
- Cross-Data Space Interoperability,

as recommended by the Dataspace Support Center (https://dssc.eu/space/SK/812286015/3+-+Interoperability+and+Data+Quality).

4 Creation of MX-Port configurations, in scope of Factory-X

To create concrete configurations, we must assign possible components to the different layers of the MX-Port. This is done in a two-step process (figure 4):

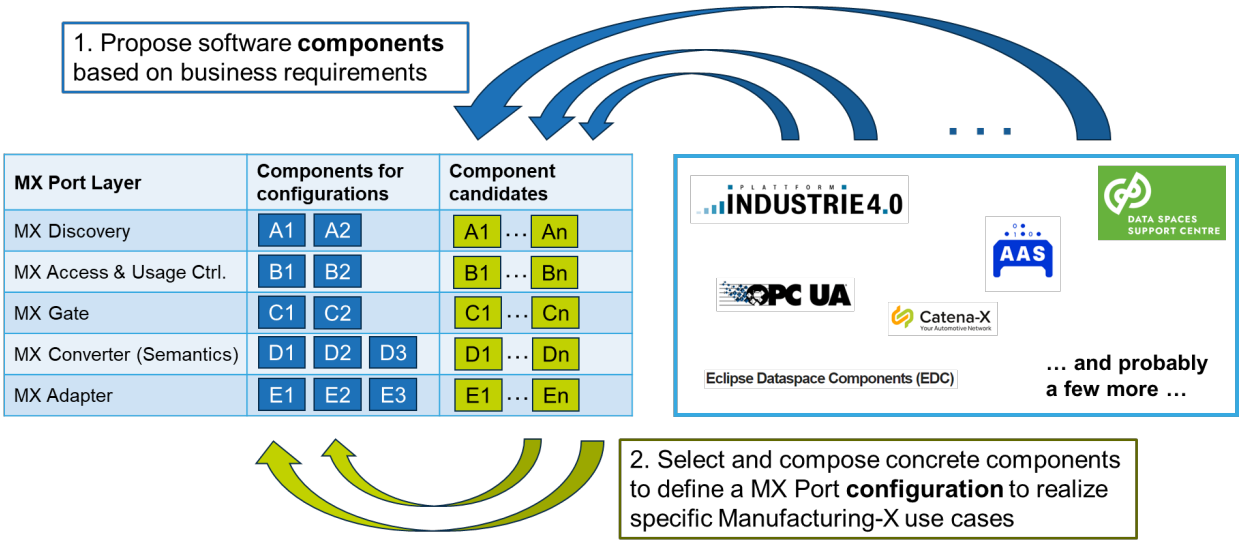

Figure 4: Creation of MX-Port configurations (Source Factory-X)

In Step 1, proposals for software components are typically made by use case owners based on concrete business, functional, commercial or other requirements. These solutions are most likely coming from a set of existing industry standards.

In Step 2, the proposals with the best fit to the aforementioned qualities will be selected as an MX-Port configuration and prototypically implemented to realize the business application in the use cases. Going forward and as more projects start using the MX-Port, the validation will move to the MX-level.

The MX-Port concept is an open approach. This means that further configurations can be added to fulfil needs from other Manufacturing-X projects (especially use cases) and thus to upscale the Manufacturing-X data space.

5 Two preselected MX-Port configurations for Factory-X purposes

We present here the first two concrete configurations[2], which are currently under development in the Factory-X project. **The open MX-Port concept is not limited to these two special configurations. Further configurations are possible and/or further components on each layer can be proposed and provided (wherever feasible).**

[2] Factory-X is using constellation names for MX-Port configurations

The first configuration is an adaptation (realized in Factory-X) of the current “Catena-X Architecture” to the MX-Port, which is briefly described in figure 5. Main element is the implementation of the DSP/DCP protocols for cross-company data sharing. We call this configuration “Hercules”.

	Layer	**MX-Port “Hercules”[3]**
L5	Discovery	Data Space Protocol / Decentral Claims Protocol[4]
L4	Access & Usage Control	
L3	Gate	AAS - REST
L2	Converter	AAS Submodels[5]
L1	Adapter	Application specific

Figure 5: MX-Port configuration "Hercules" (Source Factory-X)

The second configuration provided by Factory-X, is “Leo” (see figure 6). In the Factory-X project, many use cases focus on the exchange of asset data. Based on the installed base of existing standards, the required trust level and the necessity to reach firms of all sizes, the requirement has been made to build a version of the MX-Port based on AAS integration technology, compliant to IEC 63278 / IDTA for cross-company data sharing:

	Layer	**MX-Port “Leo”[3]**
L5	Discovery	ID-Link[6]
L4	Access & Usage Control	AAS Security[7]
L3	Gate	AAS - REST
L2	Converter	AAS Submodels[5]
L1	Adapter	Application specific

Figure 6: MX-Port configuration "Leo" (Source Factory-X)

This configuration of the MX-Port is interoperable with the “Hercules” configuration according to the scenario in figure 7: The factory operator uses ”Leo” for cross-company data sharing with the machine builder and “Hercules” for cross-company data sharing with the supplier. Technically, this is made possible by the fact that business application 3 can support both configurations.

[3] Other configurations can use different technologies / standards like OPC UA, OPC object model or Automation ML

[4] Concrete implementation by Factory-X will be an EDC adaptation (realized as open source)

[5] Includes harmonization of AAS Submodel templates and OPC-UA companion specifications

[6] Related to IEC 61406 Part 1-2

[7] For example, reference to IDTA-01004-3-0 and IEC 63278 Part 3

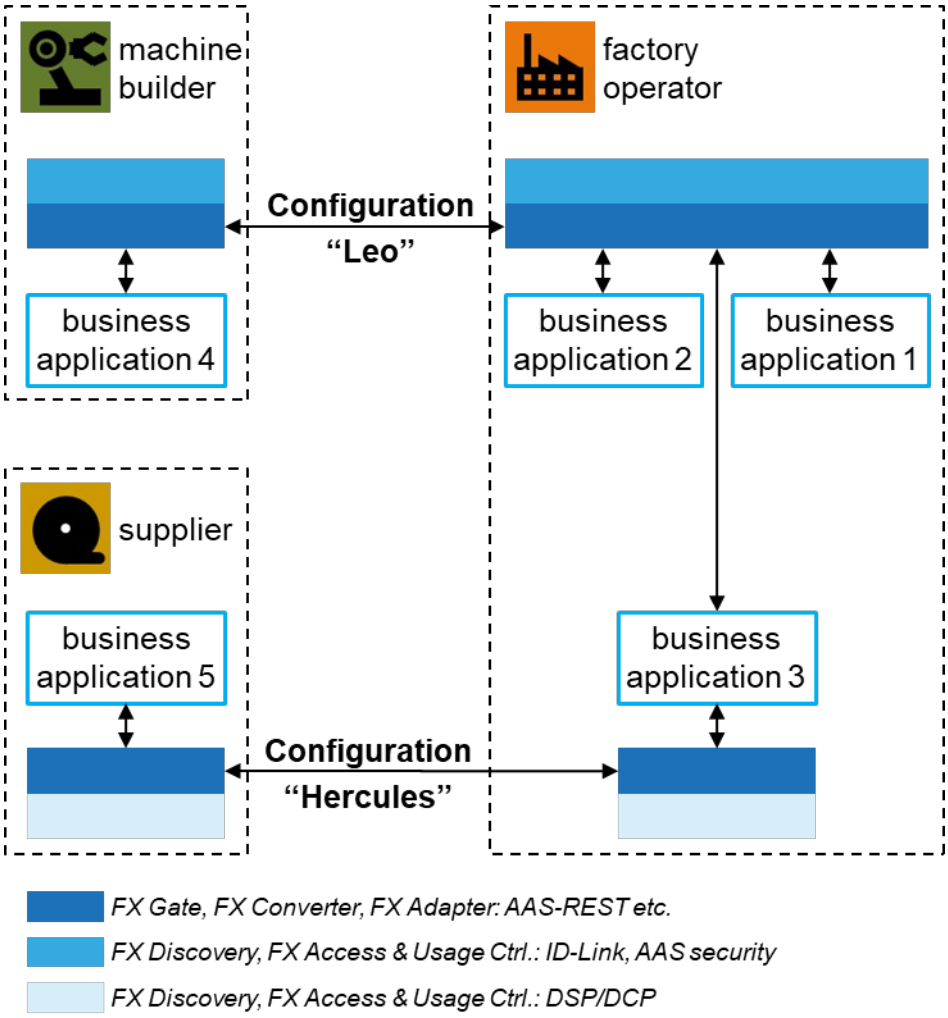

Figure 7: Combining different configurations of the MX-Port (Source: Factory-X)

6 Conclusion

Federated dataspaces for multilateral cooperation and data sharing across locations, companies, industries and national borders offer a powerful support to strengthen competitiveness, resource efficiency and resilience. The MX-Port concept with its five layers enables seamless interoperability of MX-data ecosystems.