



# Factory-X

Manufacturing-X Technical Council  
October 24, 2024

PART OF



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by the German Bundestag

# Agenda

## Topics and Presenters



Topic	Presenter
Welcome, Introduction & Moderation	Silke Huesmann Roland Rosen  
<p>Factory-X TP-4 “The Factory-X Kernel”</p> <ul style="list-style-type: none"><li>• Recap of MX TC at July 10, 2024</li><li>• FX Integration Architecture</li><li>• The concept of FX-Port in more detail</li><li>• I4.0 / AAS</li><li>• Outlook</li></ul>	Guido Stephan 
Discussion & Closing	All

*After each part of presentation, we have time for questions*

# Factory-X

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**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 1<sup>st</sup>, 2024
- Completion of Project by June 2026

## Factory-X Partners

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

## Factory-X Associated Partners

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

# Overall Architecture of Factory-X: The Digital Ecosystem for Factory Outfitters and Operators



**Resilience**

**Sustainability**

**Competitiveness**

**Digital Products and Services**

**Everything as a Service**

**Product Innovation  
Collaboration**

**Production Optimiz. /  
Autonomous Factory**

**Supply Chain  
Transparency**

**Energy & CO<sub>2</sub>-  
Management**

**Shared services**

**Shared technological base layer**

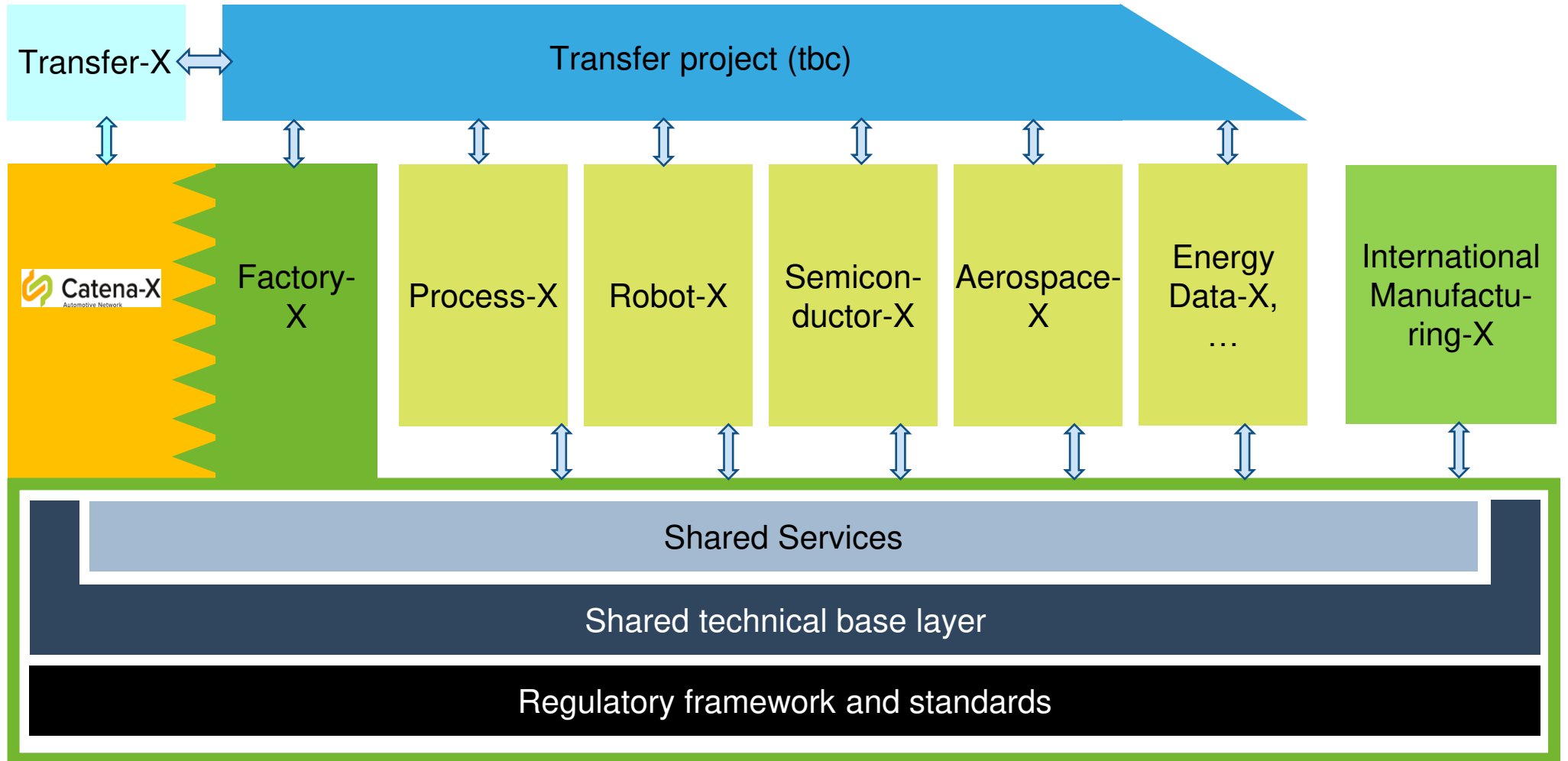
**Regulatory Framework and Standards**

# Factory-X Kernel

## Systemic approach to „Manufacturing-X“



Including SME and additional sectors



# Factory-X goes public

Registrierung über <https://factory-x.org/>



## Manufacturing-X Technical Council

### *Was ist das Manufacturing-X Technical Council?*

- Factory-X verfolgt die Zielsetzung unter Verwendung von Ergebnissen von Catena-X eine IT/SW-technische Basis (den „Factory-X Kernel“) für Software-Lösungen in Manufacturing-X zu schaffen.
- Im M-X Technical Council werden die Ansätze – entsprechend des Projektfortschrittes – vorgestellt und zu Feedback eingeladen.

### *Für wen ist es?*

- Das Manufacturing-X Technical Council richtet sich an alle, die Interesse an der Anwendung des IT/SW-technischen „Factory-X Kernels“ haben, z.B. für die Realisierung eigener Software-Lösungen im Rahmen Manufacturing-X.

***Wann? 2. MX TC Jetzt!***

## Customer Sounding Board

### *Was ist das Customer Sounding Board?*

- In Factory-X werden für 11 Use Cases verschiedene sogenannte Business Applikationen (Software-Lösungen) konzipiert, prototypisch entwickelt und validiert.
- Im Rahmen des Sounding Board werden diese – entsprechend des Projektfortschrittes – vorgestellt und zu Feedback eingeladen.

### *Für wen ist es?*

- Das Customer Sounding Board richtet sich an alle, die Interesse an der Anwendung, z.B. Erprobung, der Business Applikationen haben oder eigene, zu Factory-X interoperable Software-Lösungen erstellen wollen.

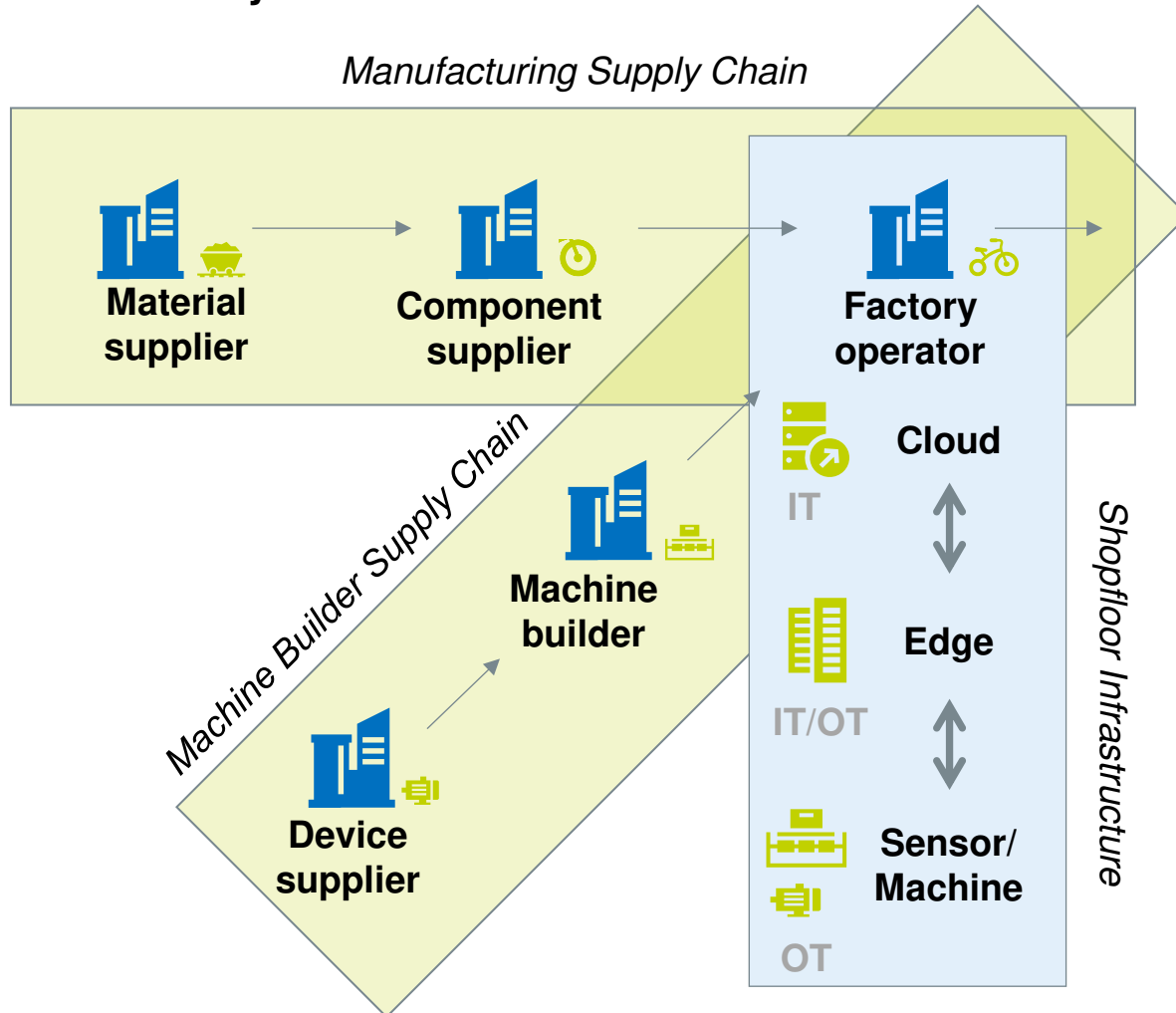
***Wann? 2. CSB war gestern.***

## Wie geht es weiter?

**Weitere MX TC und CSB werden folgen und wir streben direkten Austausch an! Ggf. über NDAs.**

# Strategic goals from the Factory-X project world

## The Factory-X Continuum














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



# 11 Use Cases of Factory-X

<p><b>11 Use Cases for horizontal and vertical data transfer</b></p>	<p>Integrated Toolchains and Collaborative Engineering</p> 	<p>Information Update and Change Service</p> 	<p>Collaborative Information Logistics</p> 
<p>Condition Monitoring led Services</p> 	<p>Modular Production</p> 	<p>Manufacturing as a Service - On Demand Manufacturing</p> 	<p>Autonomous Operation-as-a-Service</p> 
<p>Traceability</p> 	<p>Energy-Consumption and Load Management</p> 	<p>Carbon Footprint Management</p> 	<p>Circular Economy</p> 

Factory-X Kernel & Basis Services

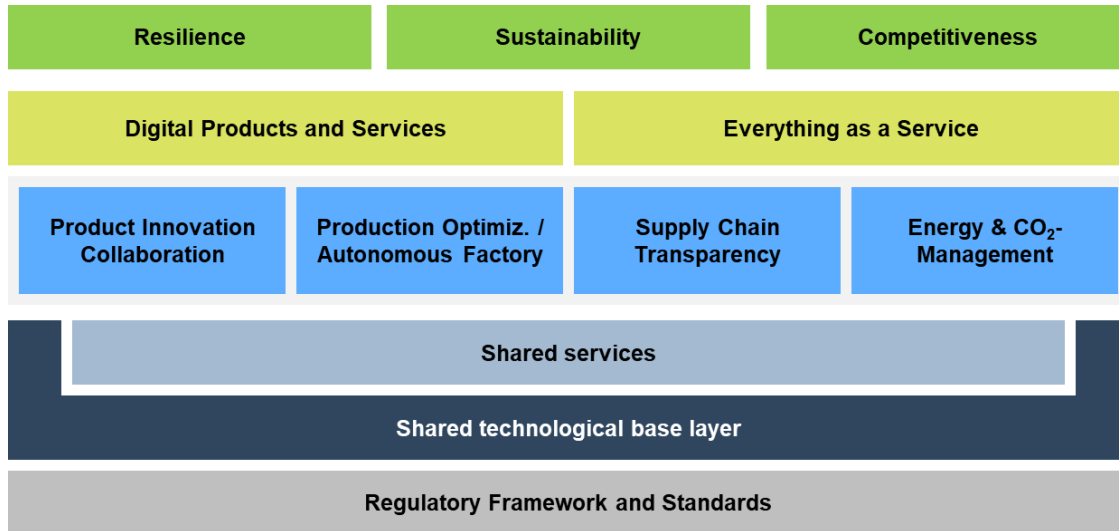
# Factory-X

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## TP 4: “The Factory-X Kernel”

# Shared Services

## Standardized Common Base to integrate IT and OT



### Problem Statement

- Integration of IT and OT is technical possible but faces several hurdles.
- The standardized application of technology can solve this.

### Solution Approach

- Standardized vertical integration (intra-shopfloor) and horizontal integration (e.g. IEC, Catena-X)

### Goals and Benefit

- Standardized Integration of IT and OT enhances technical capabilities and commercial offerings.
- Using the installed base unchanged protects investments and IP.

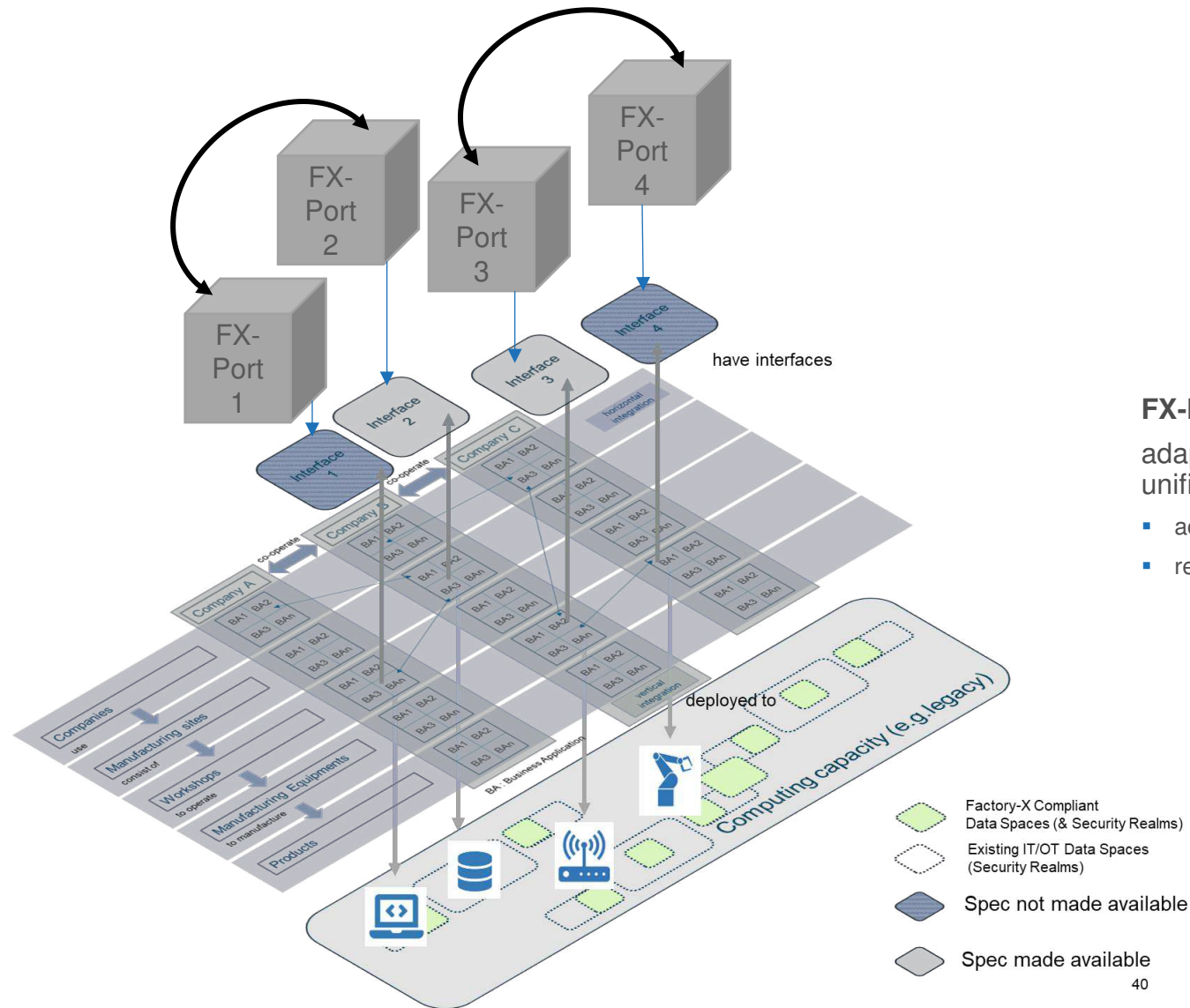
### Basic assumptions

- Industrial Applications are developed and will be developed to fulfill a defined business purpose.
- They define the therefore appropriate interfaces and information structures on their own discretions.
- This enables flexible and fast development of various business cases beyond FX.
- FX needs to support the integration of existing and future Industrial Applications if necessary to implement FX use cases.

### FX Integration architecture

- The FX-Integration Architecture defines a finite and well-defined set of architectural building blocks which enable the integration of Industrial Applications without the need to change their interfaces and / or information structures. A adapter might be required by an application to connect to the Factory-X port.
- In addition, it supports the discovery of Industrial Applications according to defined criteria as well as their application driven composition according to business purposes.
- Therefore, the FX Integration Architecture provides a set of shared services with standardizes Interfaces.

# FX-Port generic concept for vertical and horizontal integration

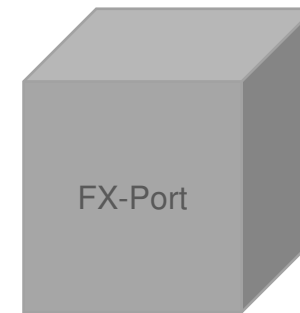


**FX-Port is a concept to enable interactions of industrial applications in a uniform way**

## FX-Port

adapts to BA – interfaces and unifies

- access to information
- representation of information



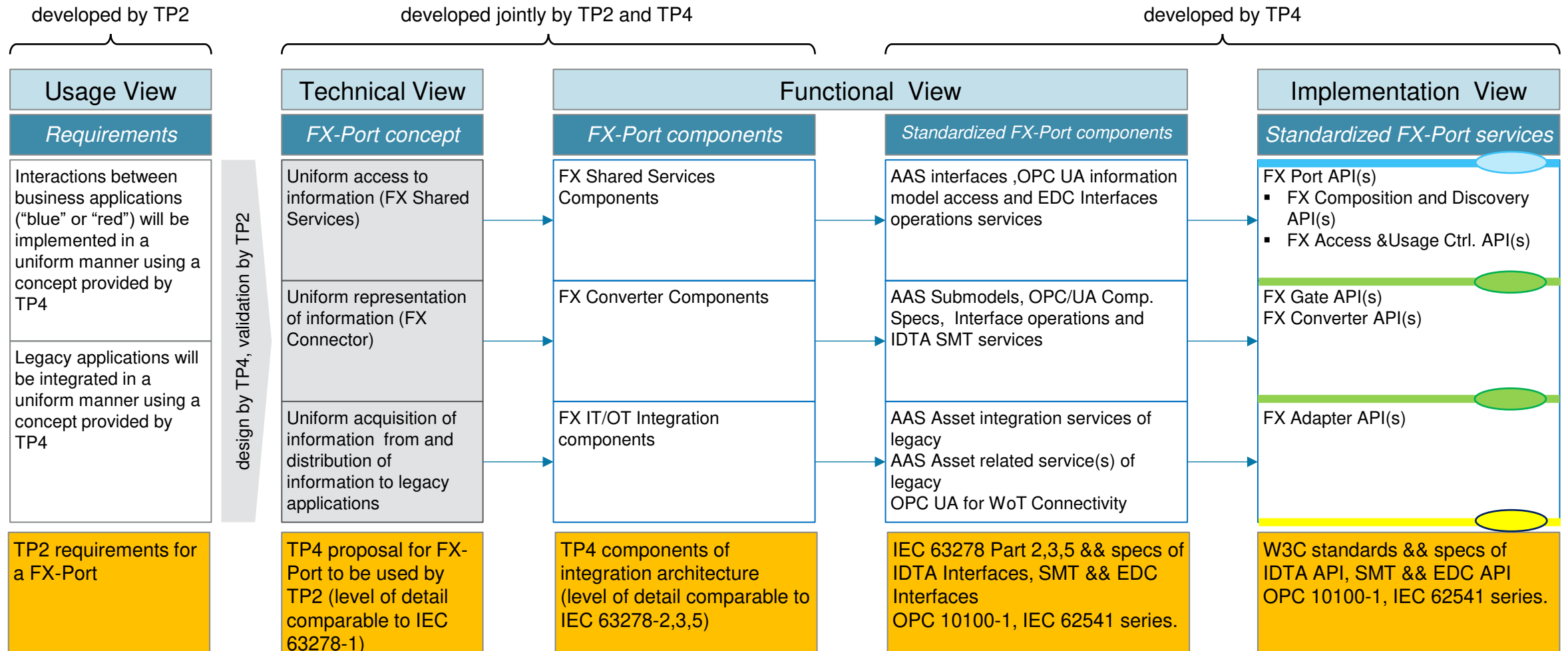
## FX-Port

unifies configuration for

- Access Control and Usage Control of FX-Ports
- Composition and Discovery of FX- Ports

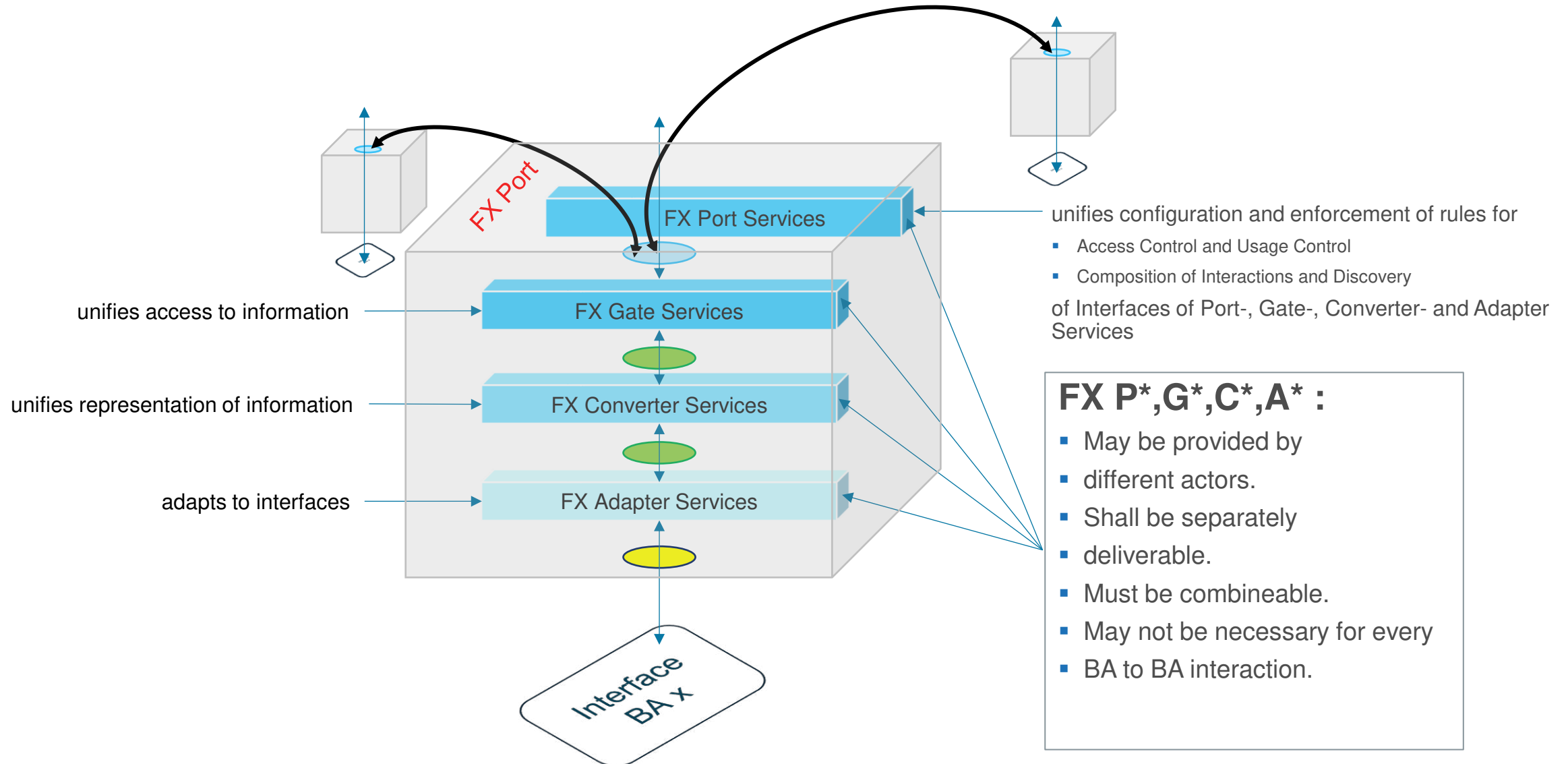
**The FX Integration Architecture will provide a set of shared services with standardized Interfaces of FX-Ports**

# FX-Port generic concept for vertical and horizontal integration



Legacy APIs    
    
 Standardized APIs

# FX-Port generic concept for vertical and horizontal integration

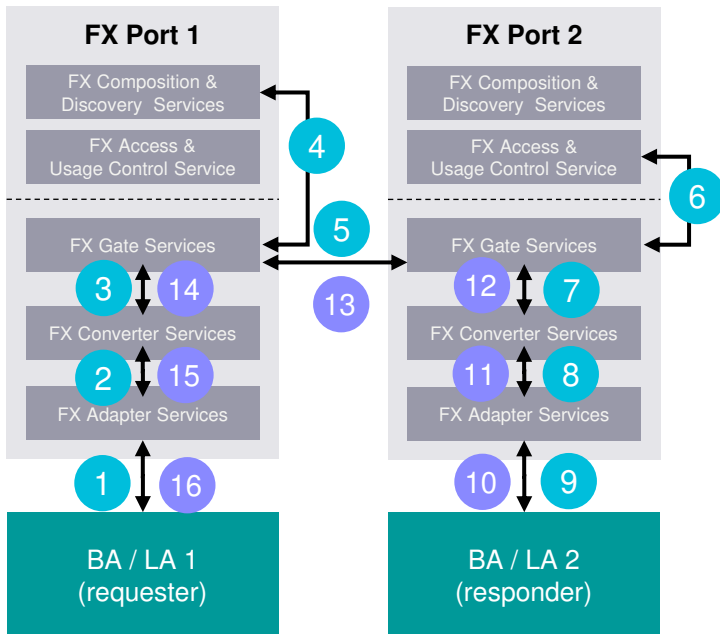


# FX-Port – requester / responder interaction sequence

## Use of one FX Port per BA / LA interface



The sequence looks complex but this is what is done in one or the other way when integrating applications which have different information models and interfaces!



**x** Request Sequence  
**y** Response Sequence

**Example operation :** BA / LA 1 requests generic operation kind X (e.g., read, write, execute, delete) from BA / LA 2

- 1 BA / LA 1 transfers information and requests operation X to Adapter 1. BA / LA 1 interface is used as specified
- 2 Adapter 1 transfers information of BA / LA 1 to interface of Converter 1 and invokes operation X to Converter 1
- 3 Converter 1 converts information of BA / LA 1 to information for exchange and invokes operation X' to Gate 1
- 4 Gate 1 requests destination of Gate 2 of BA / LA 2 (e.g., via EDC Discovery Service)
- 5 If 4 succeeds Gate 1 transfers information for exchange and invokes operation X' of Gate 2
- 6 Gate 2 enforces access & usage control of operation X',
- 7 If 6 succeeds Gate 2 transfers information for exchange via Ports and invokes operation X' of Converter 2
- 8 Converter 2 converts information for exchange to information model of BA / LA 2 and invokes operation X'' to Adapter 2
- 9 Adapter 2 transfers information and indicates operation X'' to BA / LA 2. Therefore BA / LA 2 interface is used as specified

**Information =** operation kind (e.g., read, write, execute, delete) and parameters

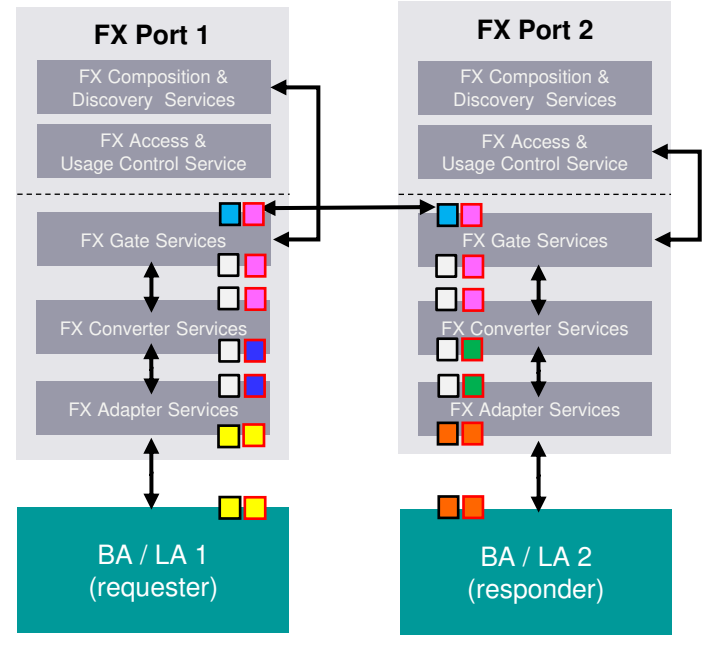
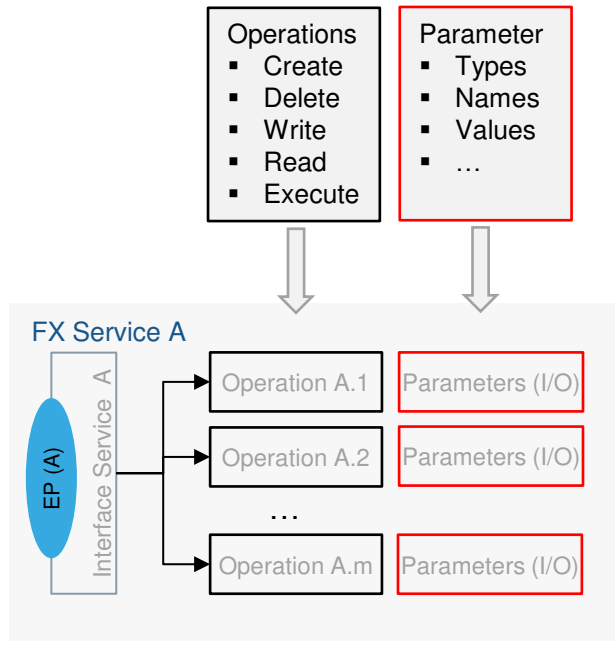
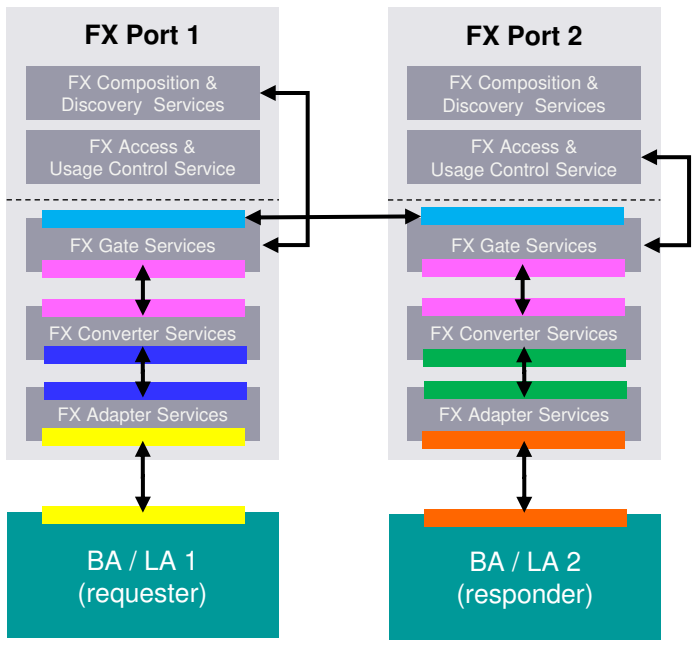
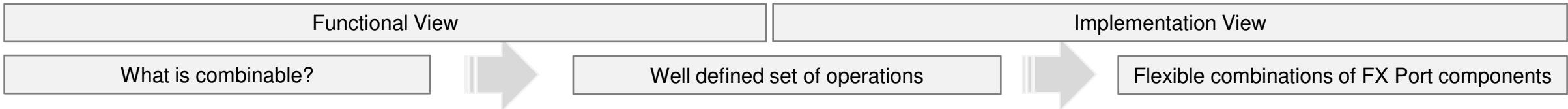
**X, X', X'' =** same kind but different information model of X

- 10 BA / LA 2 processes operation X'' and responds information to Adapter 2. BA / LA 2 interface is used as specified.
- 11 Adapter 2 transfers information of BA / LA 2 to Converter 2 and invokes operation X'' to Converter 2
- 12 Converter 2 converts information of BA / LA 2 to information for exchange and invokes operation X' to Gate 2
- 13 Gate 2 transfers information for exchange and invokes operation X' of Gate 1
- 14 Gate 1 transfers information for exchange and invokes operation X' of Converter 1
- 15 Converter 1 converts information for exchange to information model of BA / LA 1 and invokes operation X to Adapter 1
- 16 Adapter 1 transfers information and confirms operation X to BA / LA 1. Therefore BA / LA 1 interface is used as specified



# FX-Port concept – combinable components by standardized interfaces

## Well defined set of Operations between interfaces of FX Port Services



**Interfaces:** Colour Code indicates same specification (Operation & Parameter)  
**EP:** Endpoint of interface (address where to find an interface of a service)

**Interface Operations**  





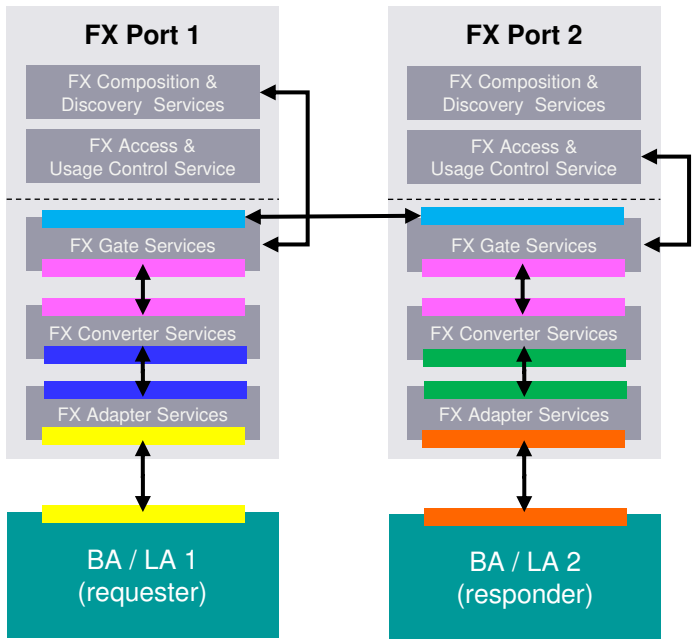

**Interface Parameter**

# FX-Port concept - combinable components by standardized interfaces

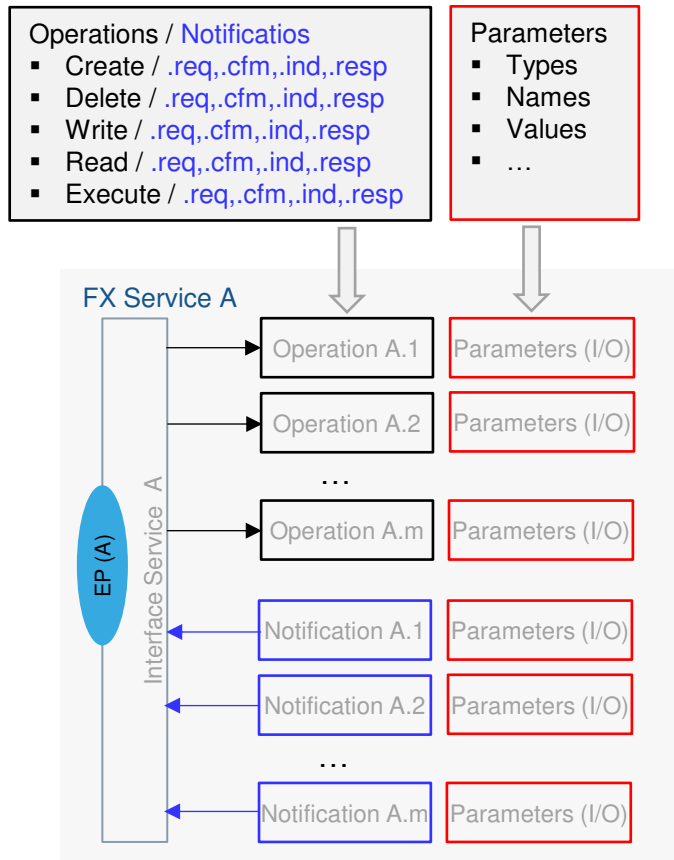
## Well defined set of notifications to enable asynchronous scenarios



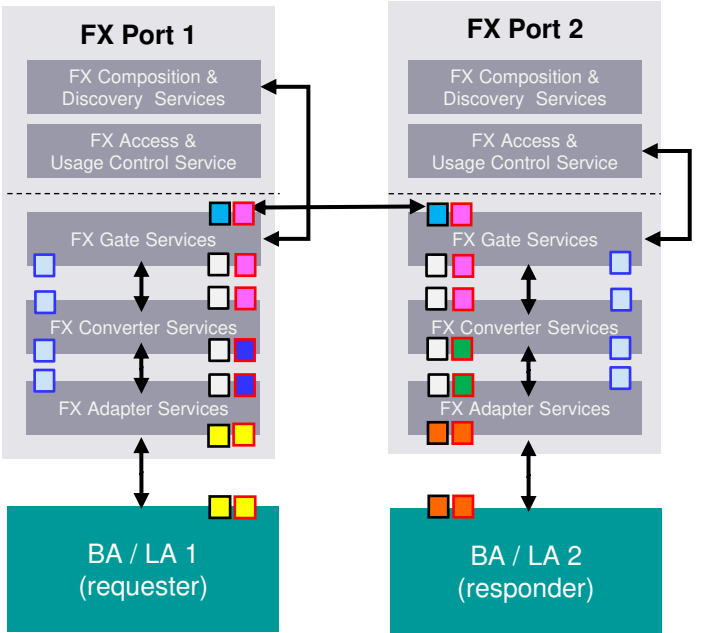
What is combinable?



Well defined set of operations / Notifications



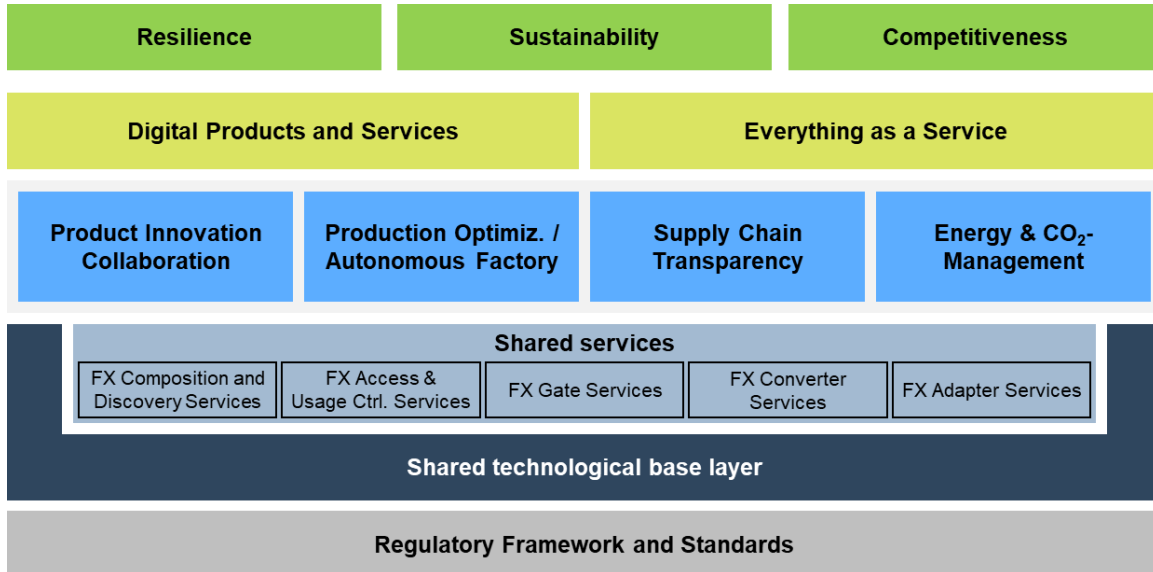
Flexible combinations of FX Port components



Interfaces: Colour Code indicates same specification (Operation & Parameter)  
 EP: Endpoint of interface (address where to find an interface of a service)

Interface Operations  
 Interface Parameters  
 Interface Notifications

# Shared Services of FX Port Standardized Common Base to integrate IT and OT



## Problem Statement

- Integration of IT and OT is technical possible but faces several hurdles.
- The standardized application of technology can solve this.

## Solution Approach

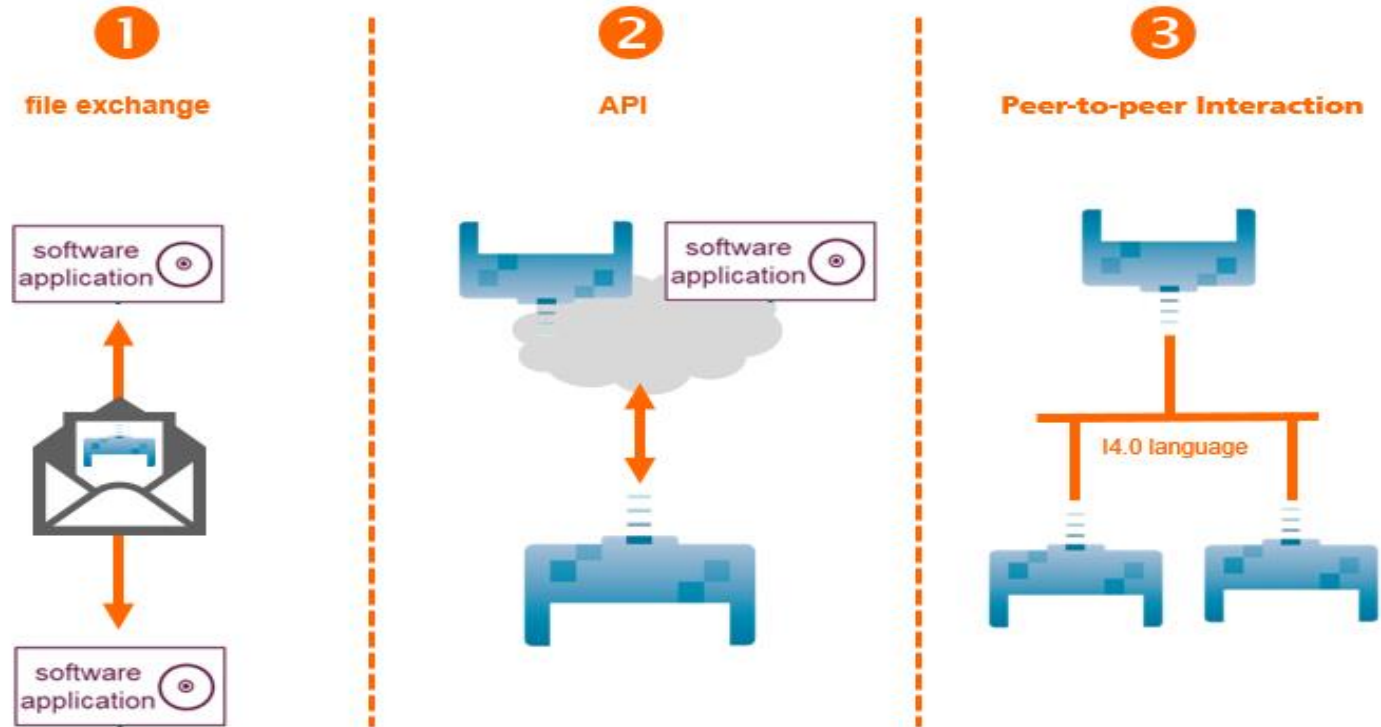
- Standardized vertical integration (intra-shopfloor) and horizontal integration (eg. IEC, Catena-X)

## Goals and Benefit

- Standardized Integration of IT and OT enhances technical capabilities and commercial offerings.
- Using the installed base unchanged protects investments and IP.

# Relation FX Port / I4.0 / AAS

## Three AAS types serve different needs



Main characteristics

Type 1:  
(Passive)

Type 2: Re-active  
(Client / Server)

Type 3 : Pro-active  
(Servient)

Main added value

**Standardized Information**

**Standardized Access**

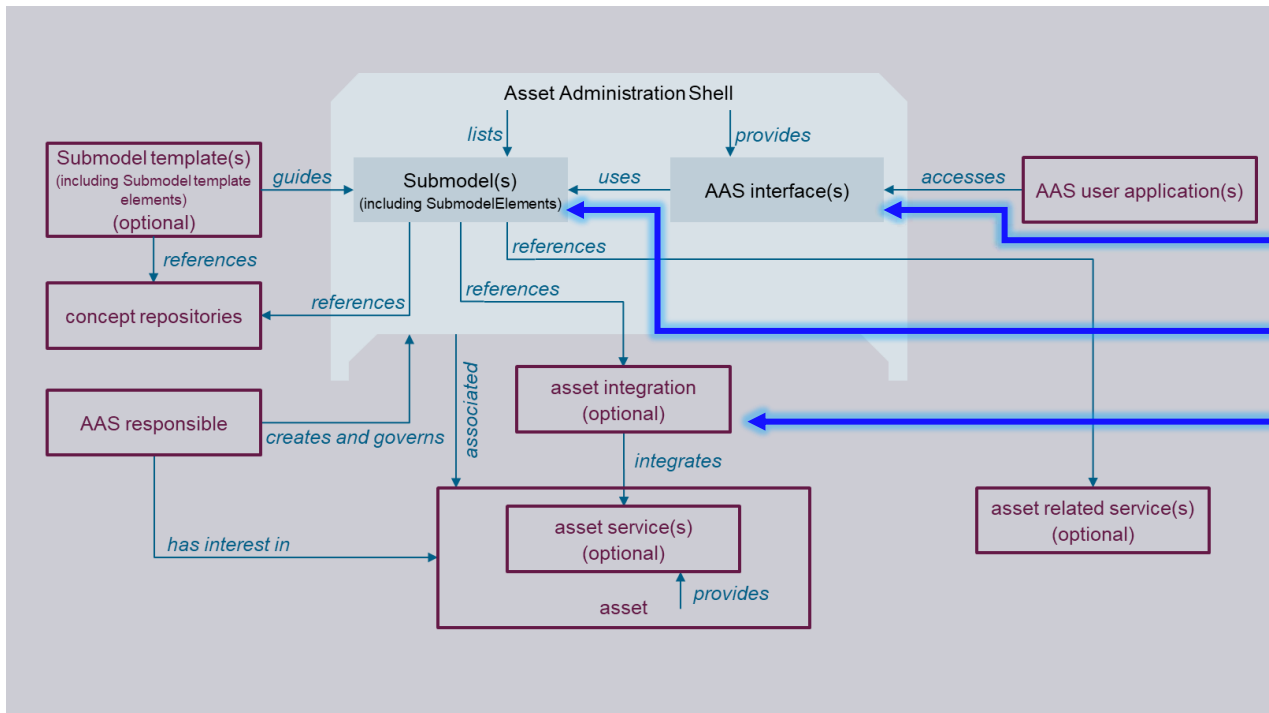
**Standardized Interaction**

# Relation FX Port / I4.0 / AAS

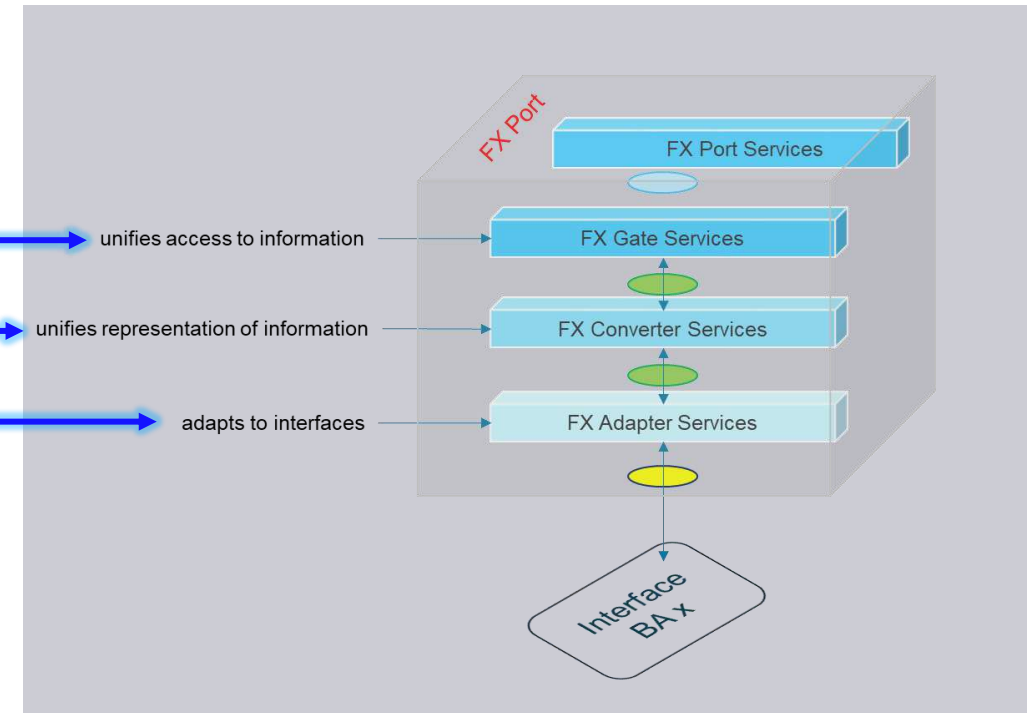
## AAS Type 3 may become a promising candidate for a standardized and Industrie4.0 conformant implementation of the FX-Port concept



### IEC 63278 Part 1



### FX Port



AAS specifications and standards therefore need to be enhanced by necessary content for AAS Type 3. This topic is under discussion in FX.

- Stay curious
- Will presented at the next Technical Council

# Q & A

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# Thank you

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