



OPC UA

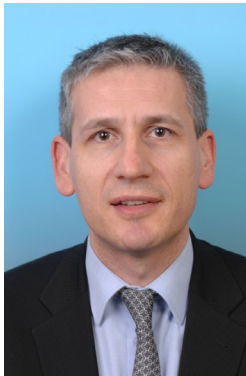
Field Level Communications

OPC UA Field eXchange (FX)

- OPC UA Field eXchange (FX) – Status and Roadmap
- Use Case for Controller-to-Controller (C2C & C2D)
- UAFX Base Facet
- Safety
- Useful Links



P. Lamboley
Chair OPC FLC
Schneider Electric



D. Leduc
Schneider Electric



V. Lacroix
Systerel

Vision for Field Level Communications Initiative

The vision of the initiative is...

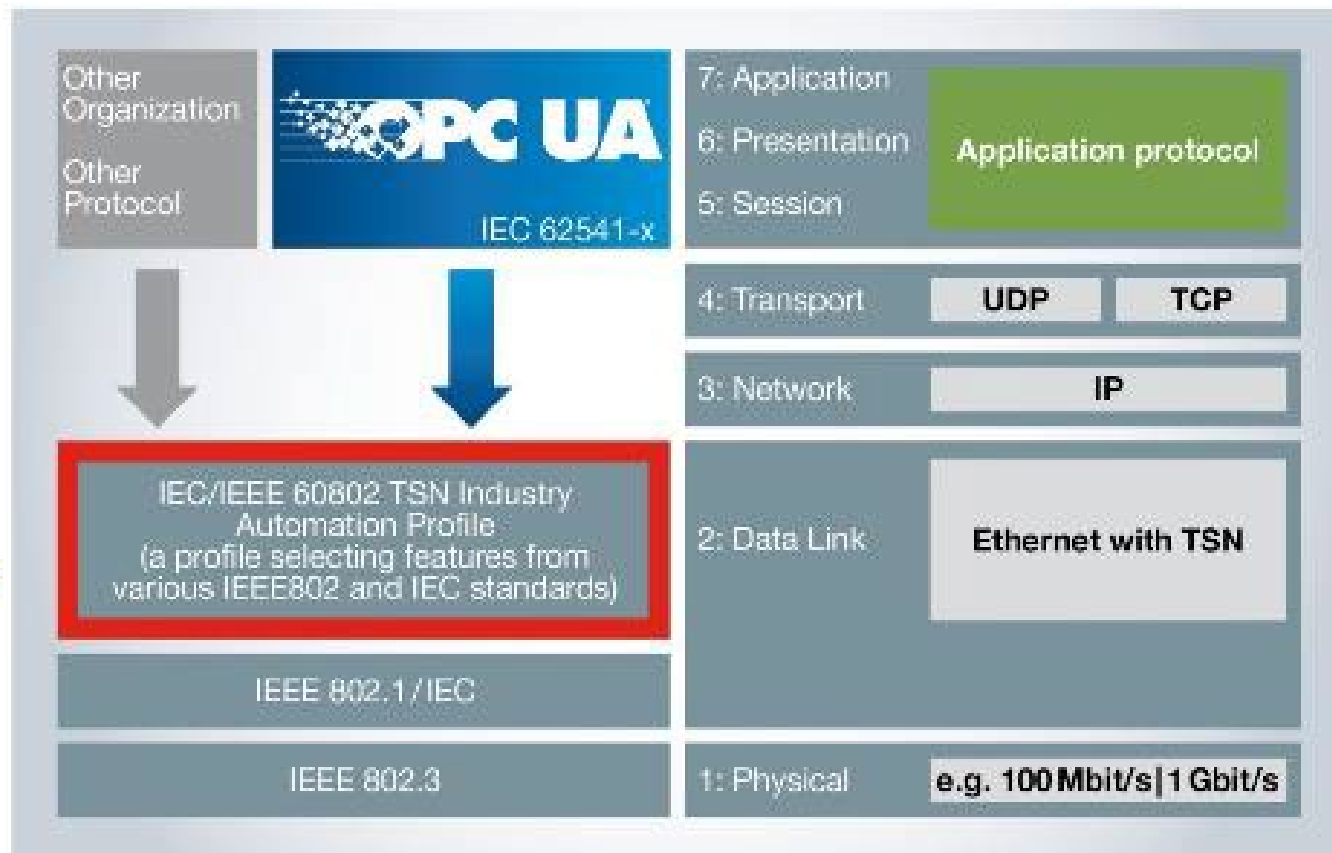
...to aim for an open, unified, standards-based IIoT communication solution between sensors, actuators, controllers and cloud addressing all requirements of industrial automation

Technology base – collaboration with IEC and IEEE

The working groups will closely align with the TSN Profile for Industrial Automation (TSN-IA-Profile) which will be standardized by the IEC/IEEE 60802 standardization group. This will help ensure that a single, converged TSN network approach is maintained so that OPC UA can share one common multi-vendor TSN network infrastructure together with other applications.

Goal of IEC/IEEE 60802

- Converged TSN network: different protocols can share the same TSN network infrastructure
- Use of common HW components



Definition of terms (to avoid confusion)

- ▶ **FLC** stands for Field Level Communications and is used for naming the initiative and the technical working groups of the OPC Foundation to extend OPC UA to the field level in Factory Automation as well as in Process Automation.

FLC Initiative / FLC working groups

- ▶ **FX** stands for Field eXchange and is used for naming the extensions of the OPC UA framework to meet the diverse requirements for field level communications.

OPC UA FX / UAFX

Four Years FLC (Field Level Communications) Initiative (11/2018 - 11/2022)



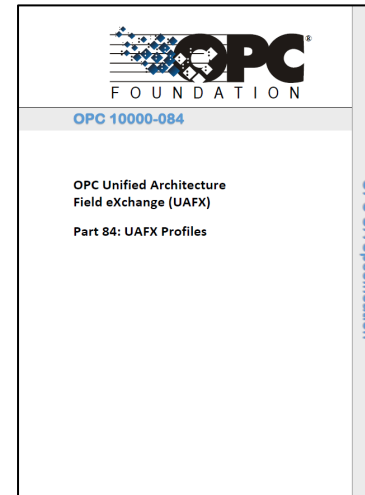
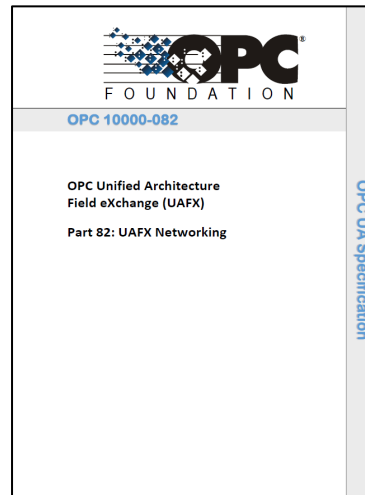
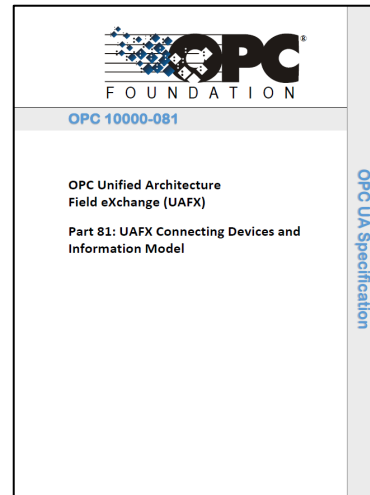
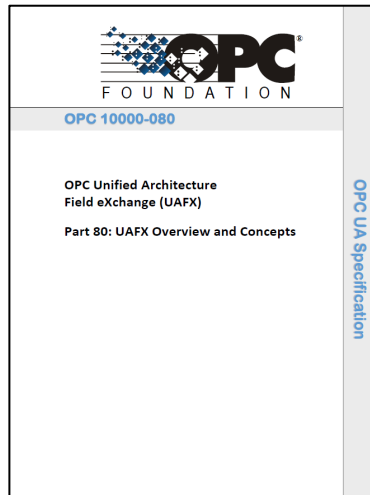
Press Conference November 2018



Members of the Field Level Communication (FLC) Initiative's Steering Committee

OPC UA FX Specifications: Parts 80, 81, 82 & 84

First Release

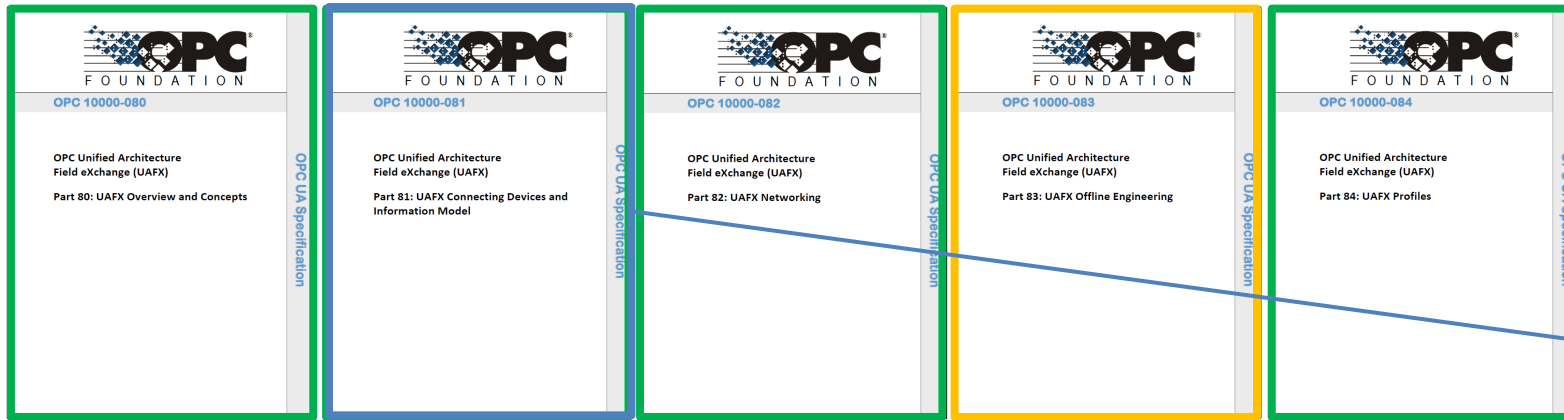


Congrats & Thanks to
more than 320 experts
from more than
65 OPCF member companies!

- ▶ **First Release published** with the focus on Controller-to-Controller (C2C)
 - Consists of 4 Parts (OPC 10000-080, 10000-81, 10000-082, 10000-084)
 - UAFX specifications have passed in-depth OPCF member reviews and extensive prototyping to ensure their implementations maintain cross-vendor interoperability
 - Automation vendors can now start adopting UAFX functionality in their offerings, and end-users can look forward to the advantages UAFX-based field communications offer
- ▶ **Test specifications & Test cases are being developed to provide conformance testing**

OPC UA FX Specification Series: Parts 80-84

Release Status



Released in 11/2022

Revision in 01/2023

RC completed

Part 80: UAFX Overview and Introduction
Part 81: UAFX Connecting Devices and Information Model
Part 82: UAFX Networking
Part 84: UAFX Profiles

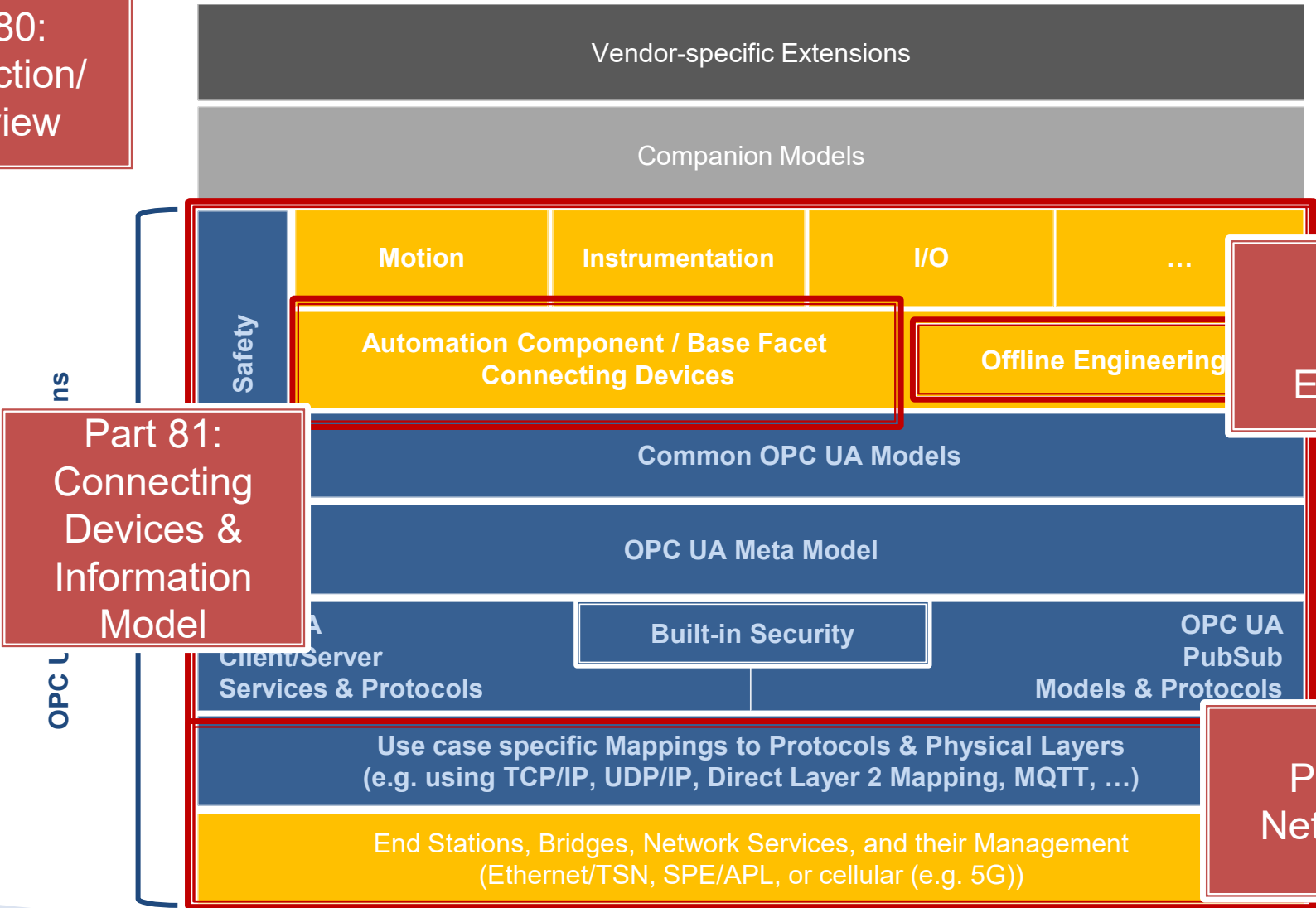
Part 83: UAFX Offline Engineering
Specification finalized –
Open: Conformance Units
for Part 83 in Part 84

**Part 83 + Revision of Part 84 to be
submitted for member review**

OPC UA FX (Field eXchange) - Technical Solution Approach

Part 80:
Introduction/
Overview

Part 84:
Profiles



Part 83:
Offline
Engineering

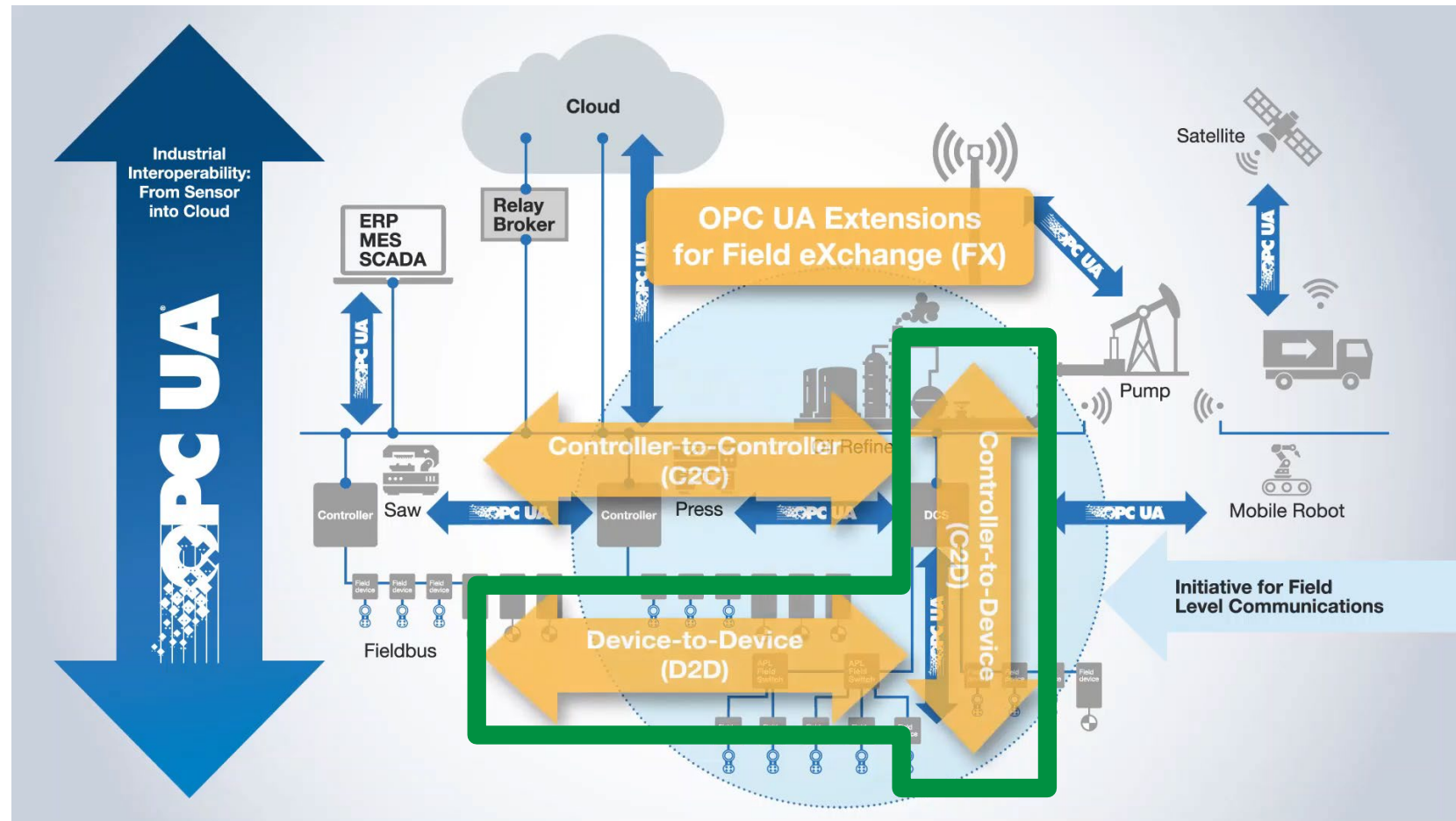
Part 81:
Connecting
Devices &
Information
Model

Part 82:
Networking

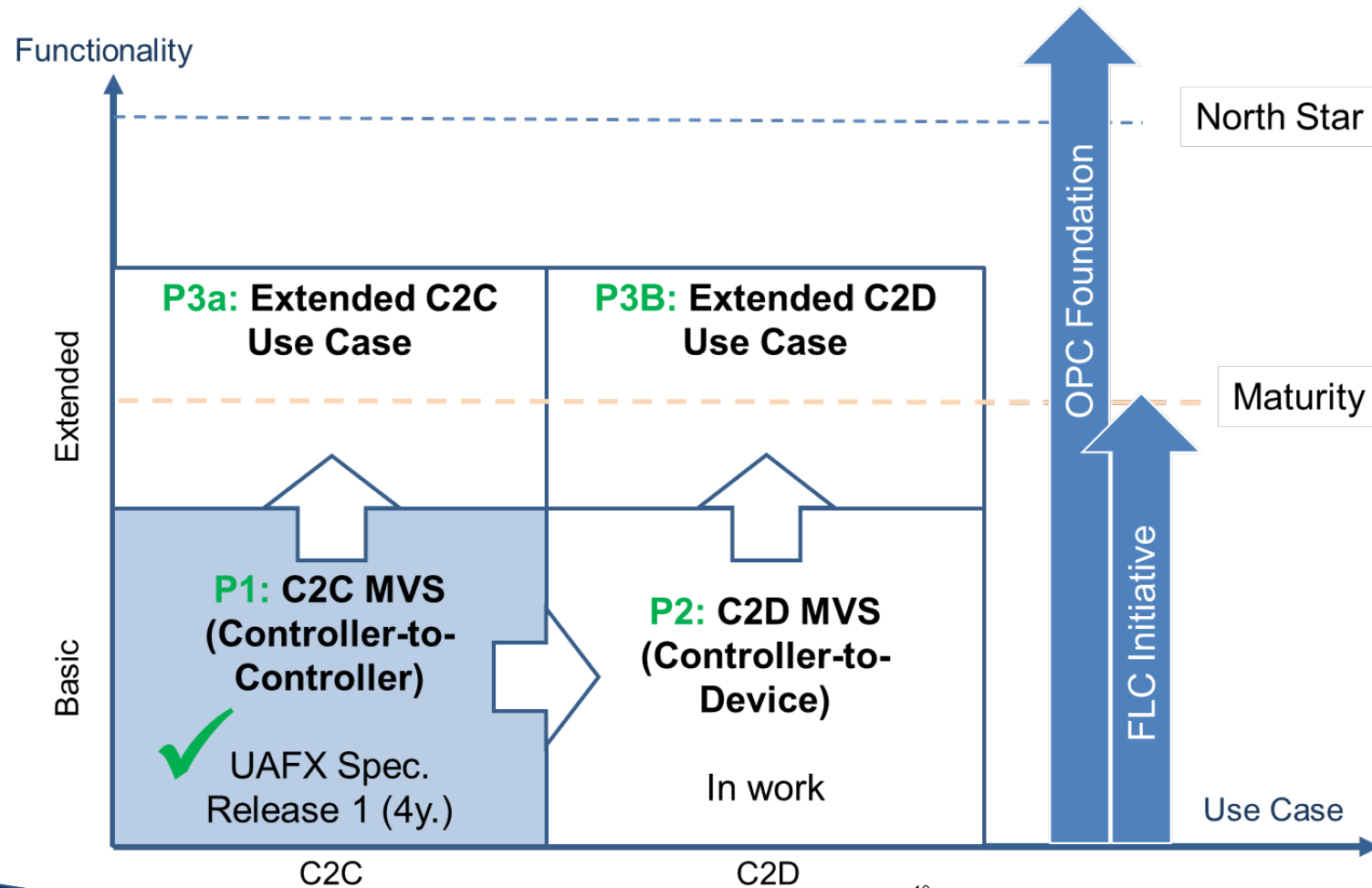


FLC Initiative: Further Roadmap

- ▶ Kick-off Technical Work on **Controller-to-Device (incl. Device-to-Device)** held on July 26-28, 2022
- ▶ Handover of Requirements
- ▶ Working group structure established



FLC/ UAFX Roadmap for C2C & C2D



- Work on C2D started (handing over of requirements, establishment of working group structure, kickoff of WG done)
- FLC Initiative currently runs until end of 2023 and will be extended
- The next phase after 2023 of the initiative will deal with the extensions for C2D & the maintenance of C2C



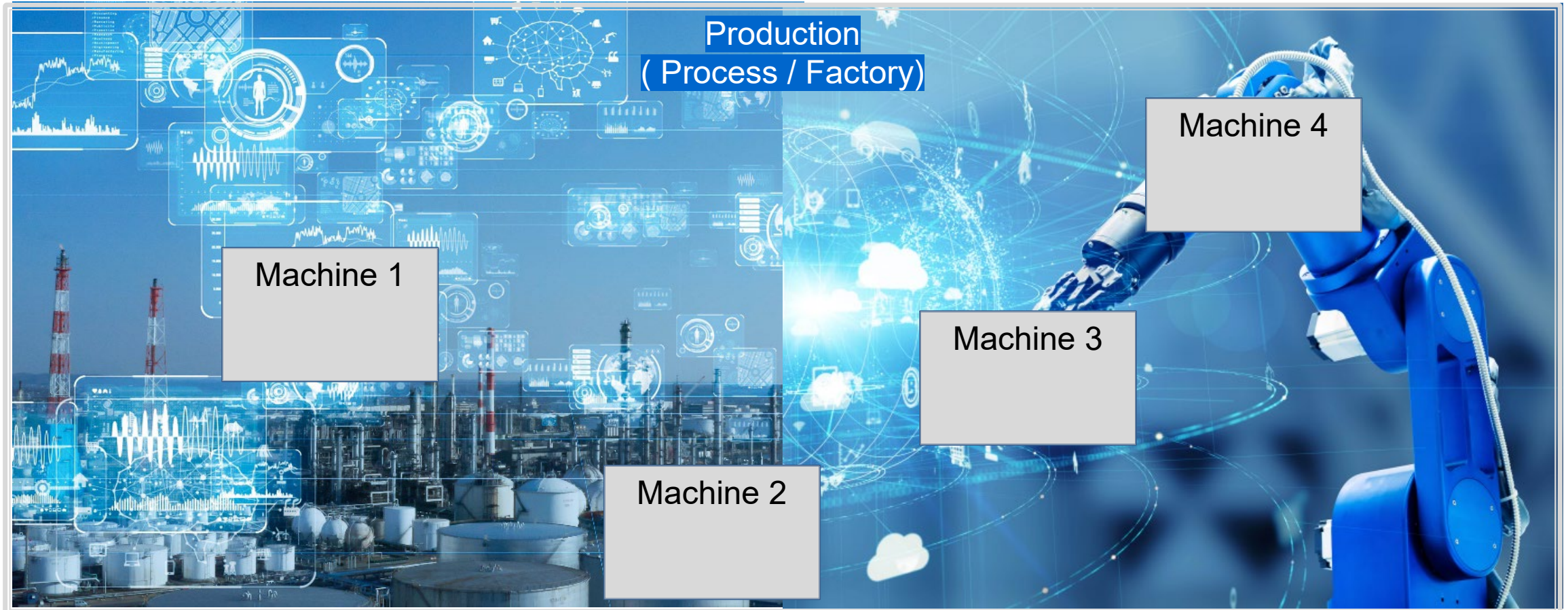
OPC UA Field Exchange – Use Cases for

C2C and C2D

UAFX C2C – Highly flexible automation solutions: Application Areas



Integration of autonomous machine in the digital factory



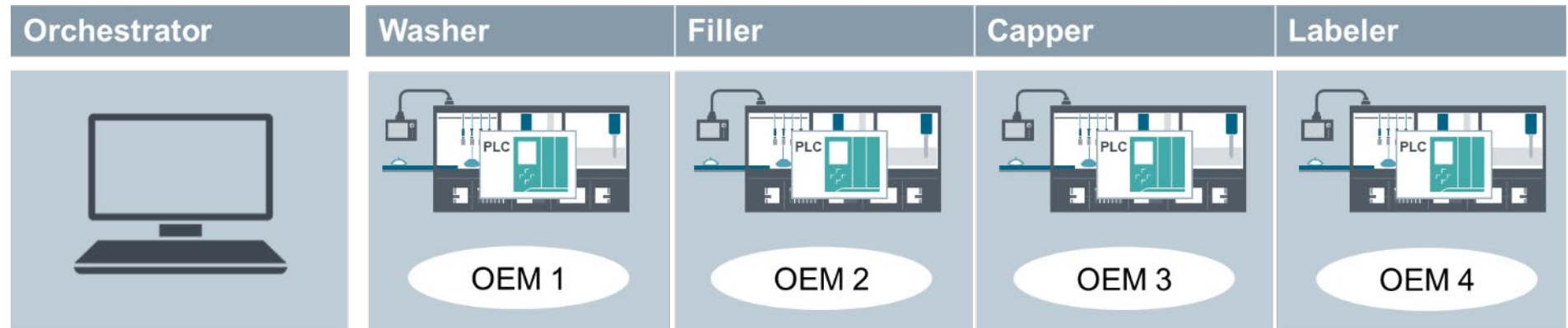
How to integrate autonomous machines in the digital factory?

Example: Bottle filling plant

- Multiple machines with different capabilities
- Different OEMs with different Controller vendors

Modularization

- Machine builder
- Plant owner



How to integrate autonomous machines in the digital factory?

OEMs challenge:

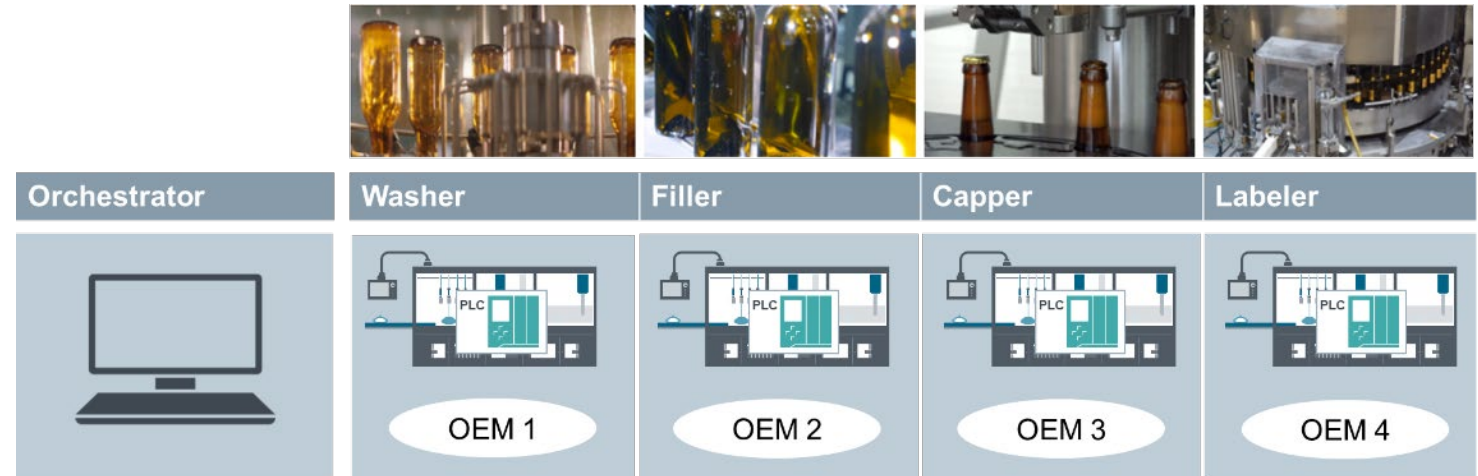
- Same project for all machine instances
- No need to program communication

Plant owner challenge:

- Fast and easy integration
- Vendor independent, interoperable communication

Solution: OPC UA Field eXchange

- Machines has well defined semantic interfaces
- Orchestrated with OPC UA means
- Safety, security and real-time integrated!



Components involved

UAFX capable controller or application

- Application program exposes semantic interfaces
 - Descriptor

→ Machine builder



Capper



OEM 3

Components involved

UAFX capable controller or application

- Application program exposes semantic interfaces
 - Descriptor

→ Machine builder



Capper

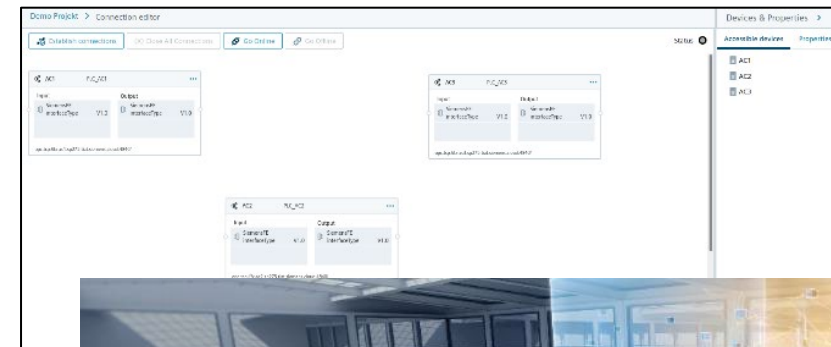


OEM 3

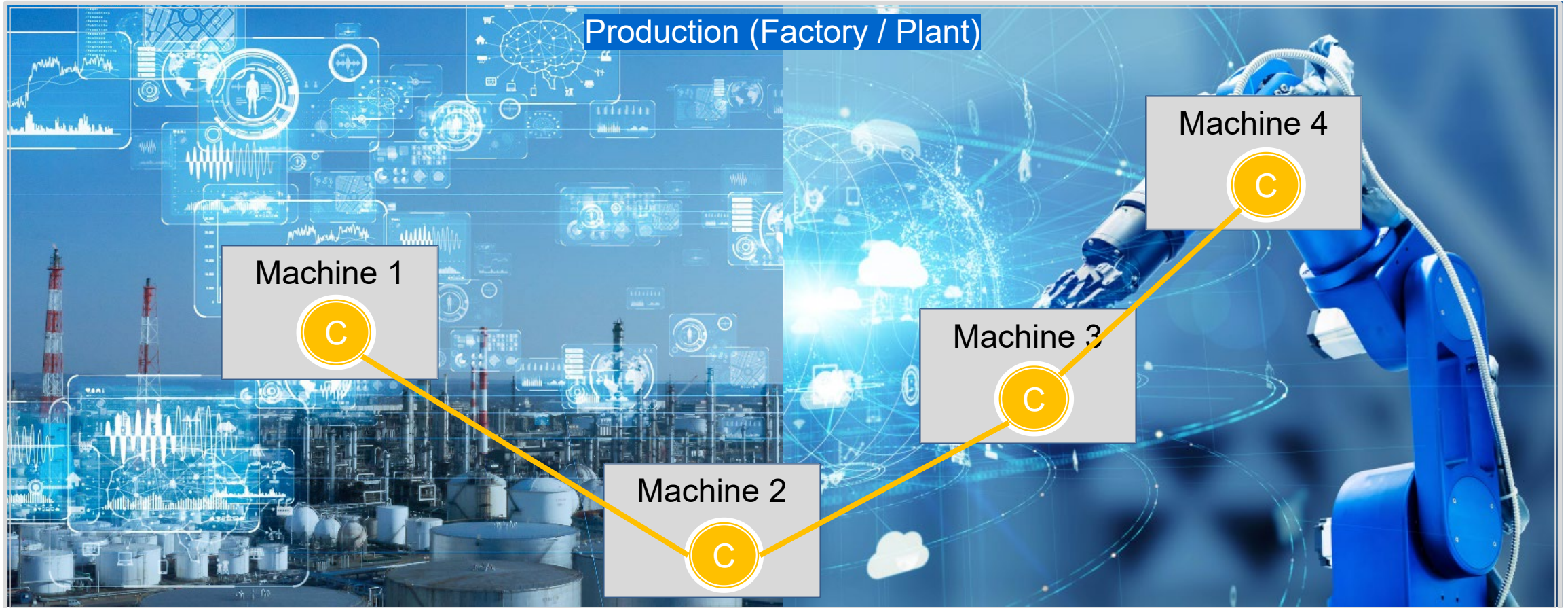
UAFX orchestration



- Provisioning & orchestration of autonomous units
 - Connection Manager

→ Plant Owner



UAFX C2C Connectivity



-  Controller supporting C/S + PubSub + UAFX (Prototype)
-  UAFX Connection

UAFX C2C Multi-Vendor Demo: Application scenario

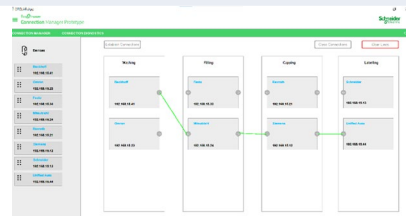
- ▶ Bottling Line using UAFX Connections between UAFX Controller prototypes
- ▶ Controllers acting as publishers, subscribers or publishers/subscribers



- Connection Managers**
- Siemens
 - Unified Automation
 - Mitsubishi
 - Schneider Electric



Washer	Filler	Capper	Labeller
Beckhoff	Festo	Rexroth	Schneider Electric
Omron	Mitsubishi	Siemens	Unified Automation



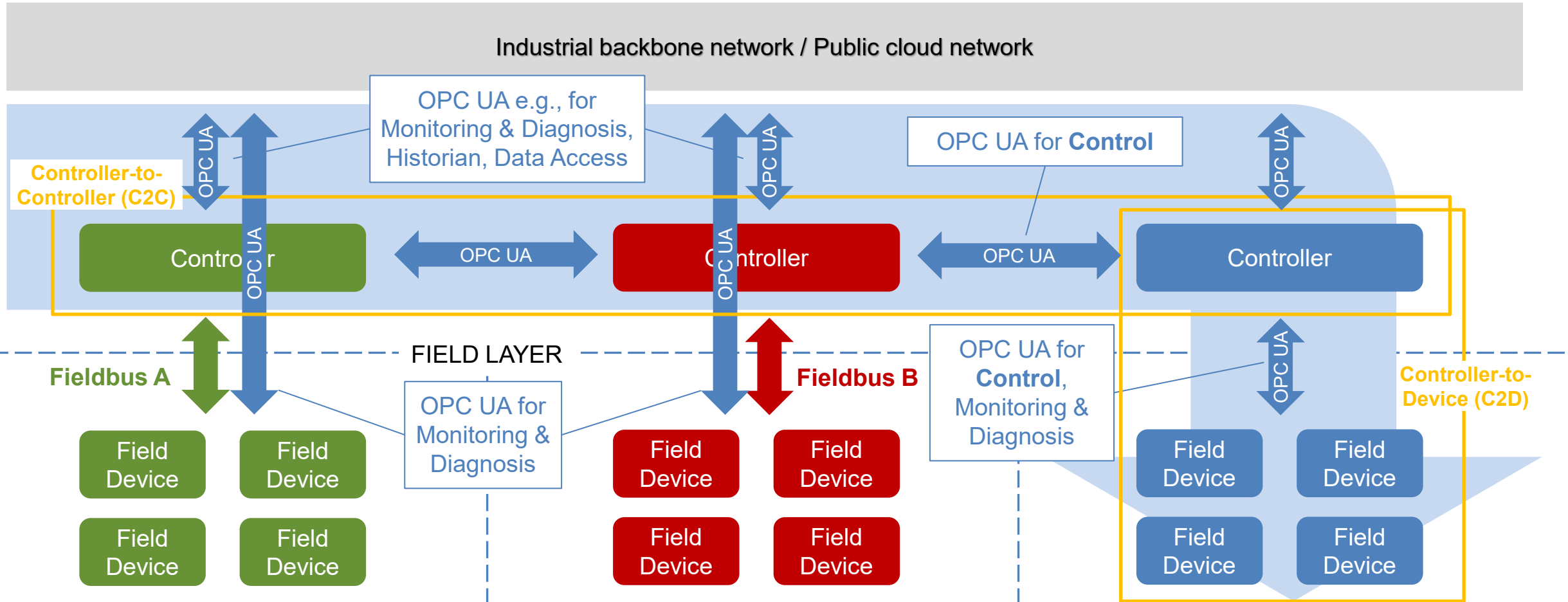
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UAFX Multi-Vendor Demos @ SPS 2022 & @ Smart Factory + Automation World 2023

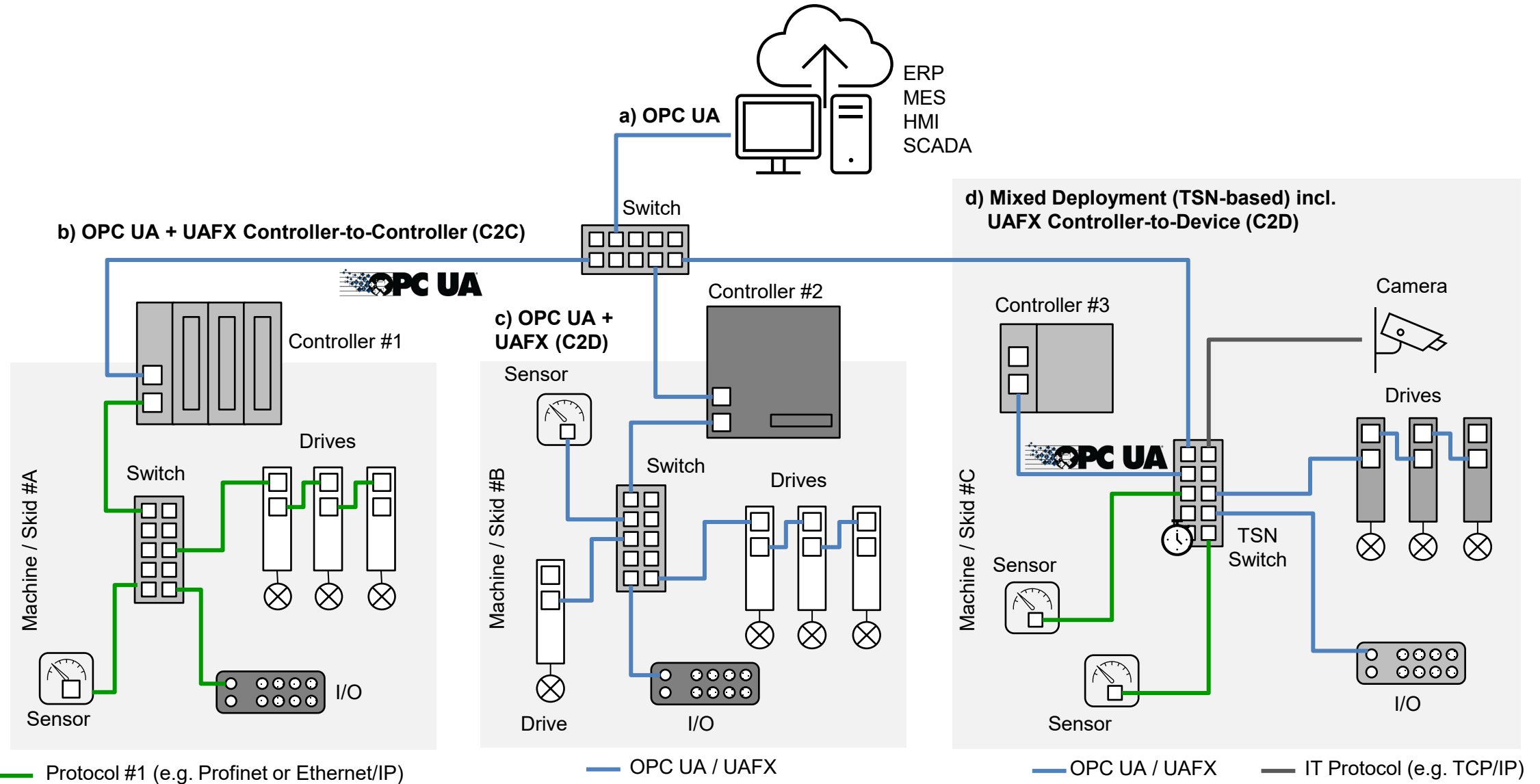


OPC UA + UAFX Extensions From C2C to C2D

OPC UA + UAFX incl. APL + TSN support the convergence of industrial communication for FA & PA & beyond



Compatibility & Coexistence of OPC UA & UAFX

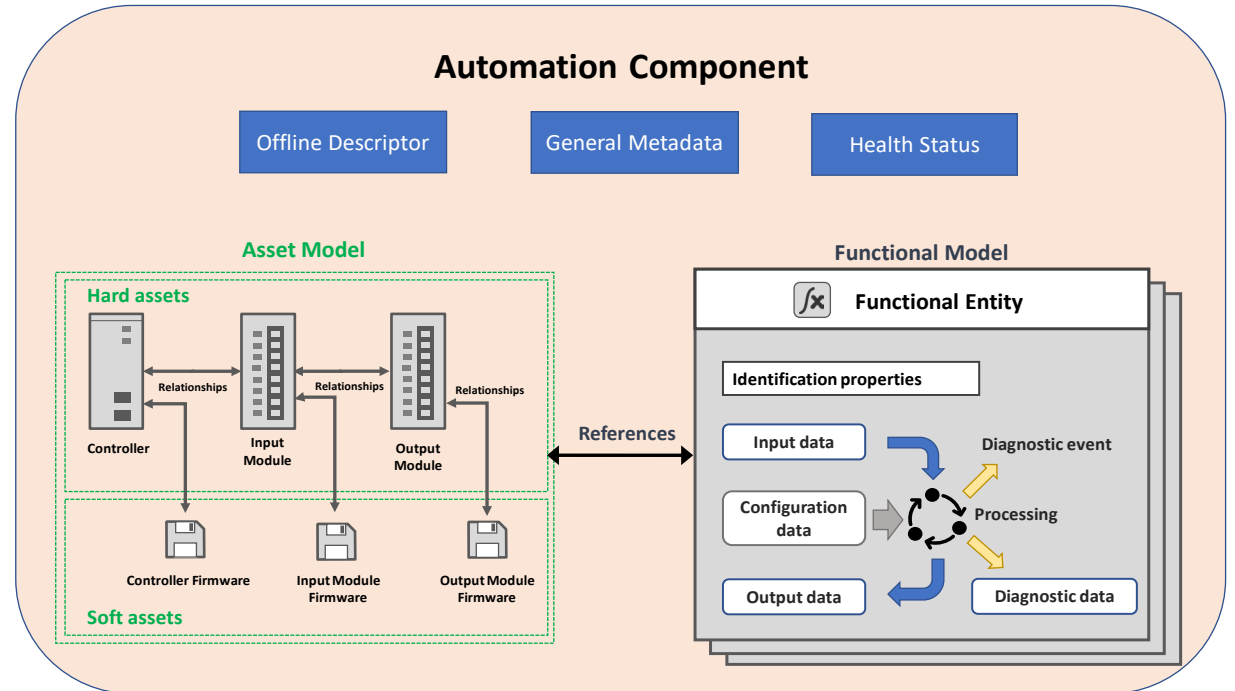




UAFX Base Facet

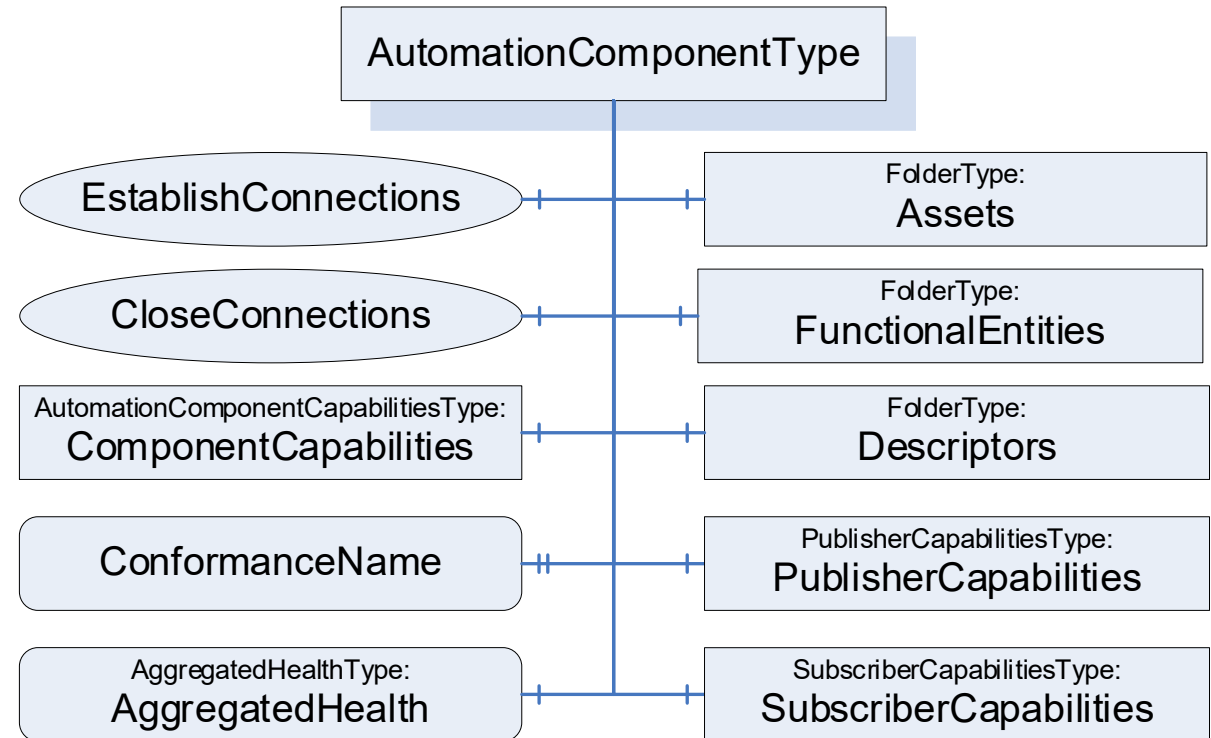
OPC UA FX Information Model

- ▶ Harmonization of asset and functional model for automation components
- ▶ Uniform access to information in automation components, independent of
 - being device or controller
 - being drive, PLC or temperature sensor
 - Factory or Process Automation
- ▶ FxRoot as well-known entry point



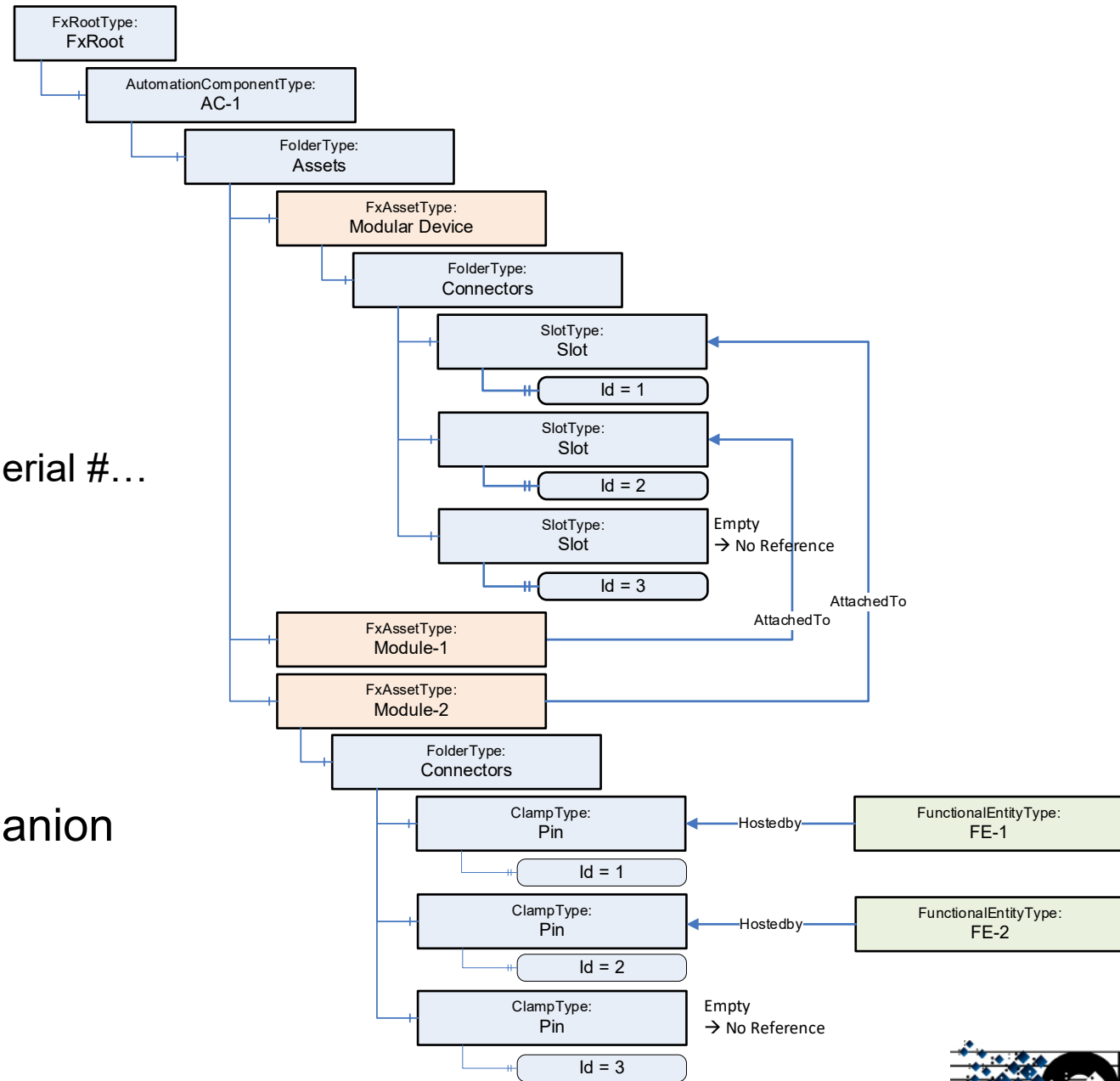
AutomationComponent

- ▶ Certification details
- ▶ General status/health information
- ▶ Capabilities such as:
 - Maximum connections
 - Maximum FunctionalEntities
 - Communication related capabilities
- ▶ Folders to organize Assets and FunctionalEntities
- ▶ Methods to establish and close a set of connections in a single call
- ▶ Descriptor information



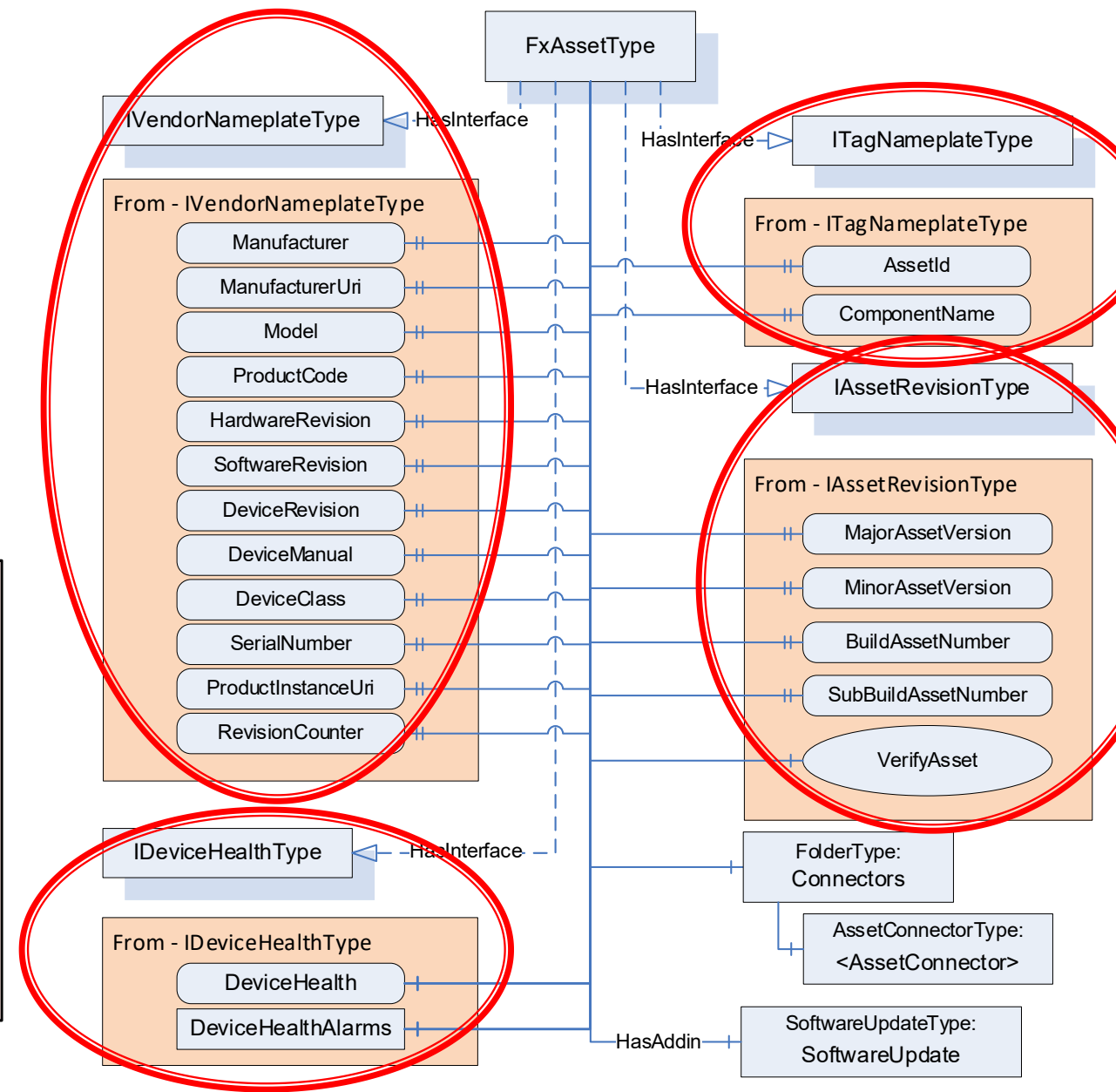
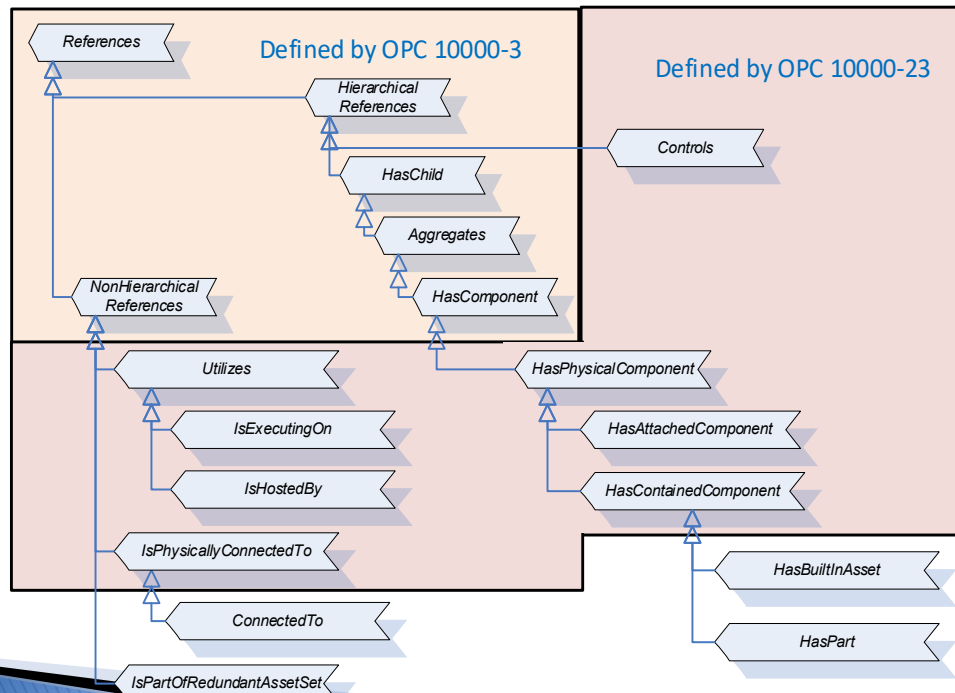
Asset Model

- ▶ Describes world of things
 - Physical things
 - Software, firmware, licenses
- ▶ Offers nameplate information
 - Vendor, Product, Firmware Version, Serial #...
- ▶ Allows to assign tags
 - AKZ, OKZ...
- ▶ Supports compatibility verification
- ▶ Based on OPC UA DI (Part 100)
- ▶ Allows extension of existing companion specs (PA-DIM...)



Asset Model

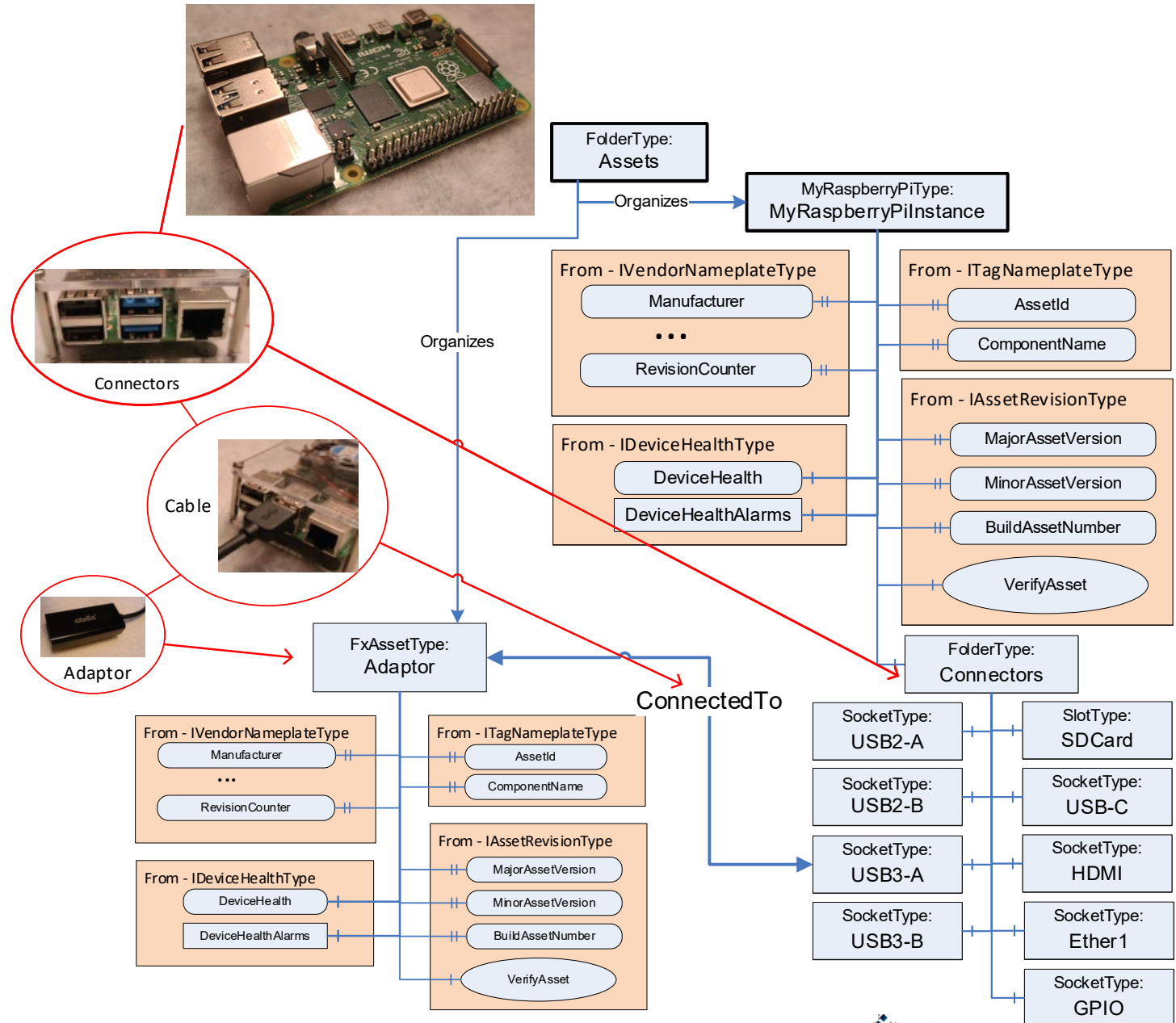
- ▶ Composed of Interfaces
 - IVendorNameplate from DI
 - ITagNameplate from DI
 - IDeviceHealth from DI
 - IAssetRevision from FX
- ▶ Connectors concept
- ▶ SoftwareUpdate as AddIn from DI



Asset illustration

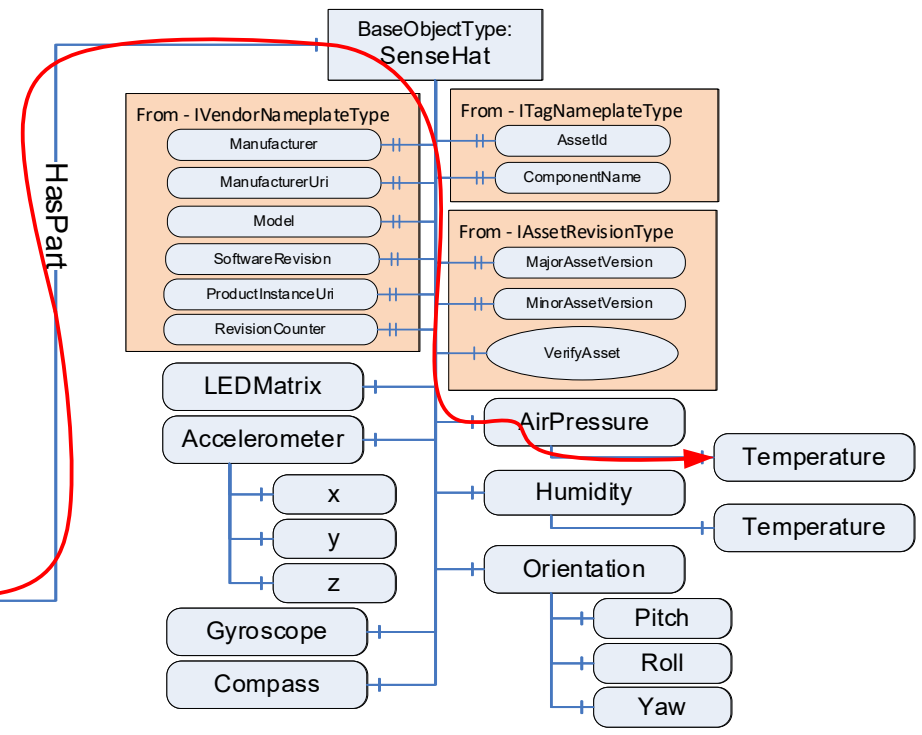
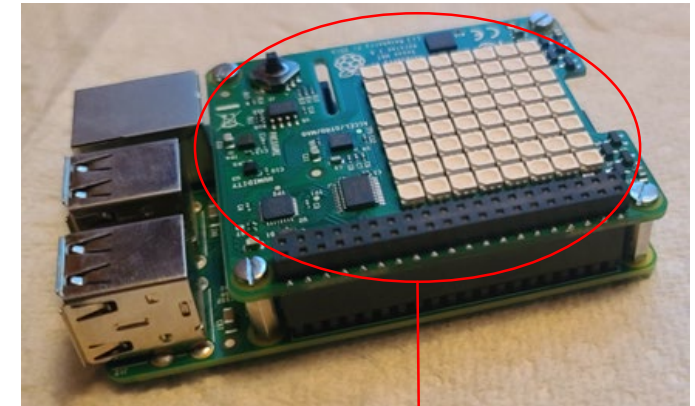
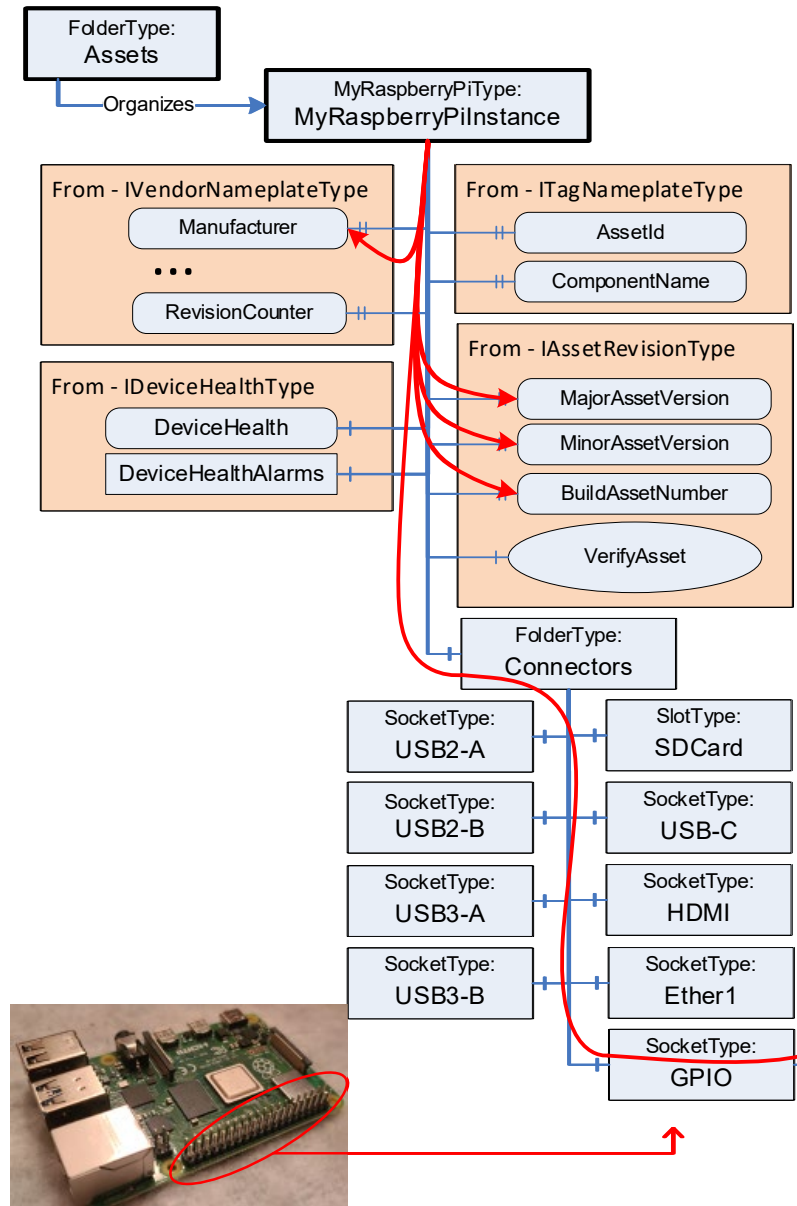
▶ Raspberry Pi Example

- Connectors
- External adaptor



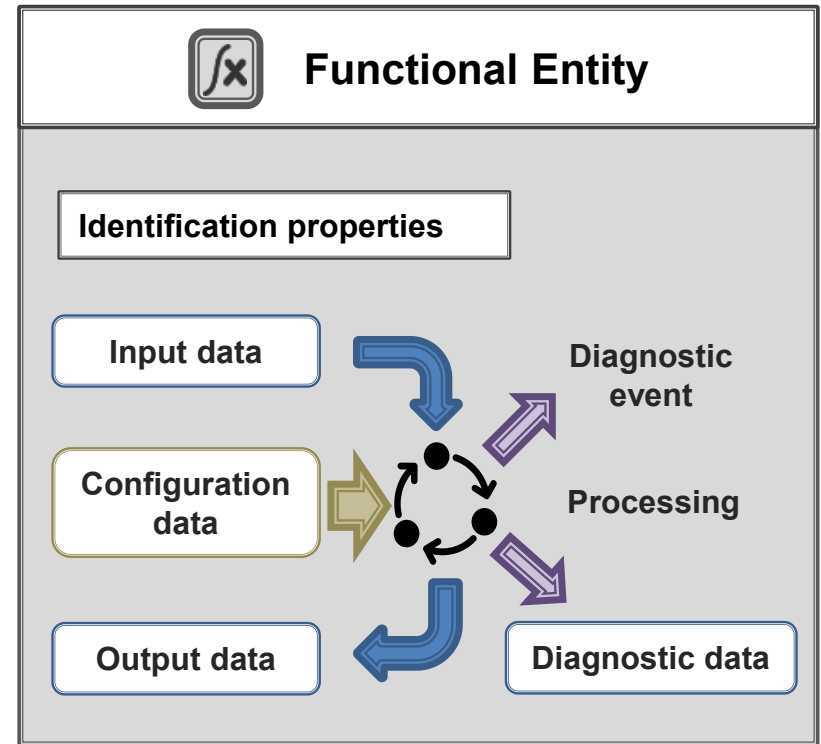
Asset illustration

- ▶ RaspberryPi
- ▶ GPIO
- ▶ SenseHat
- ▶ Verification of Asset
 - Including nested Assets



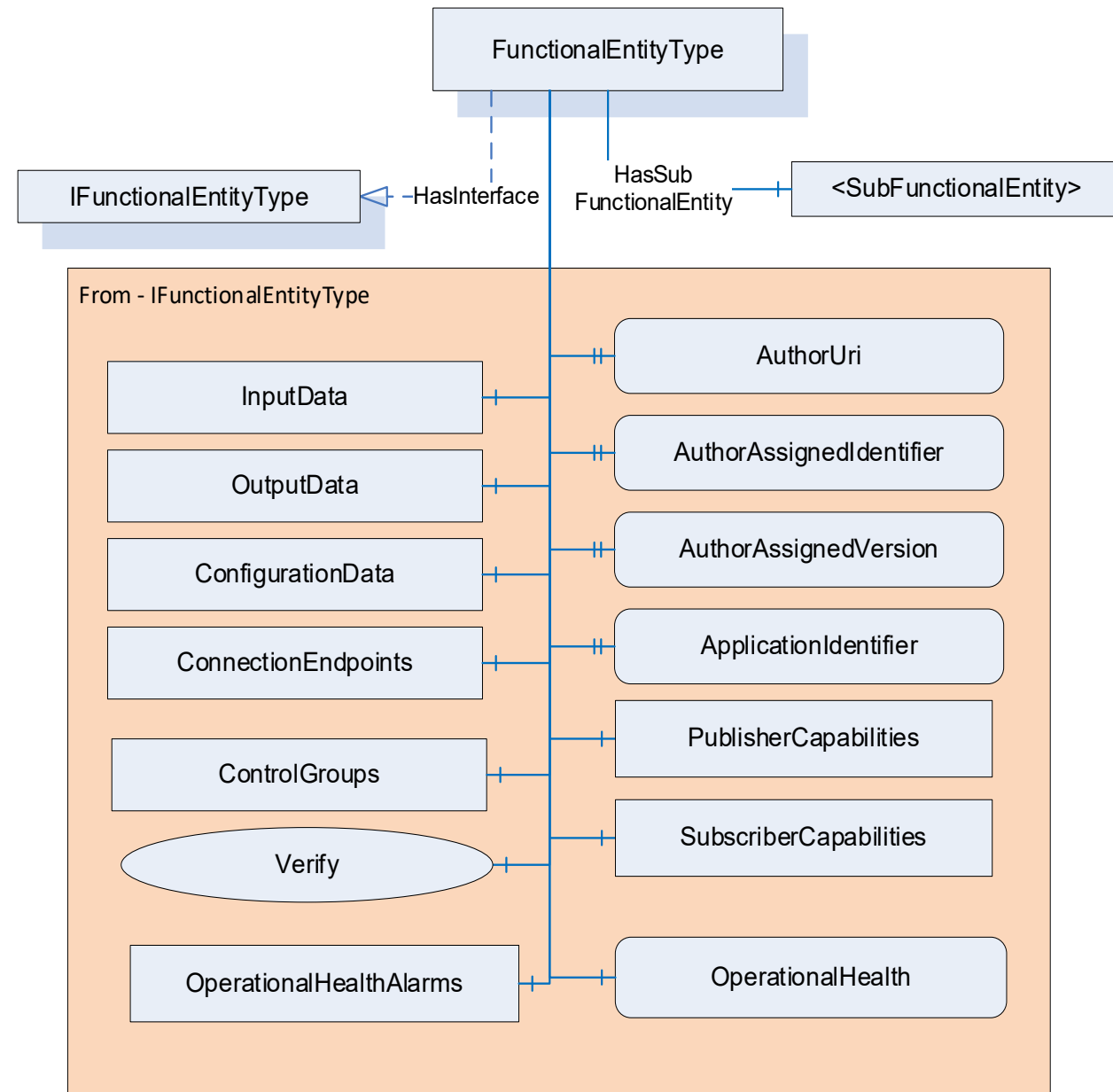
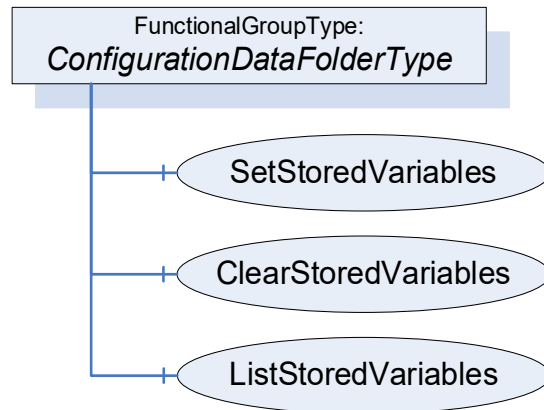
Functional Model

- ▶ Describes world of functionality
 - As simple as a digital input, or a temperature sensor
 - As complex as a drive
- ▶ Supports identity verification
- ▶ Supports semantics, data type, security...
- ▶ Supports real time data exchange
- ▶ Allows extension of existing companion specs (PA-DIM...)



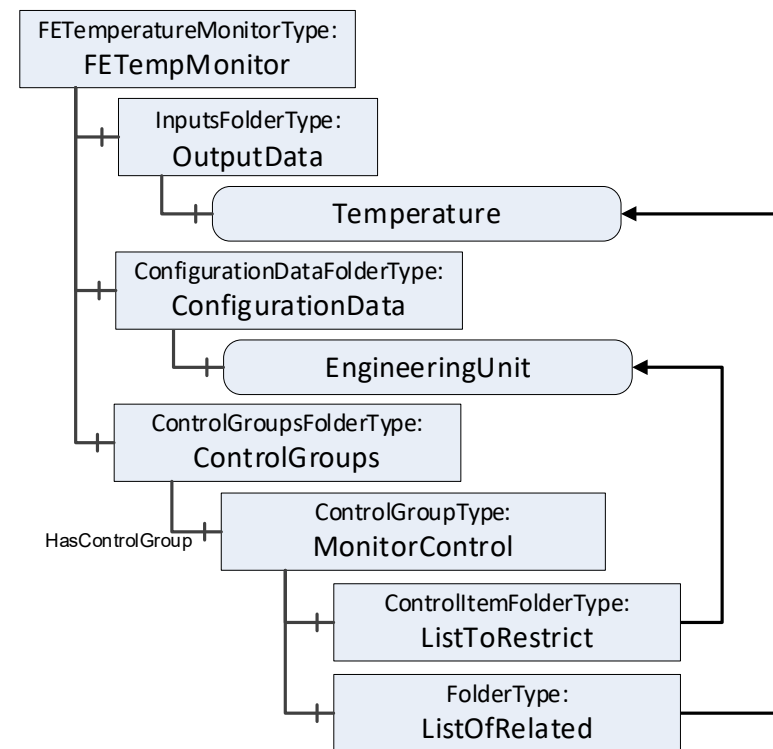
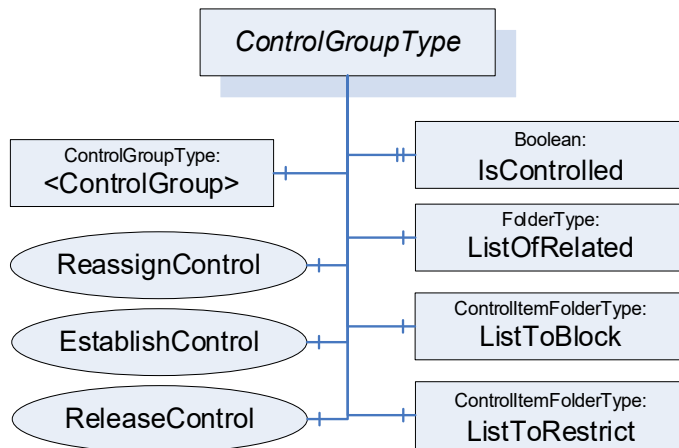
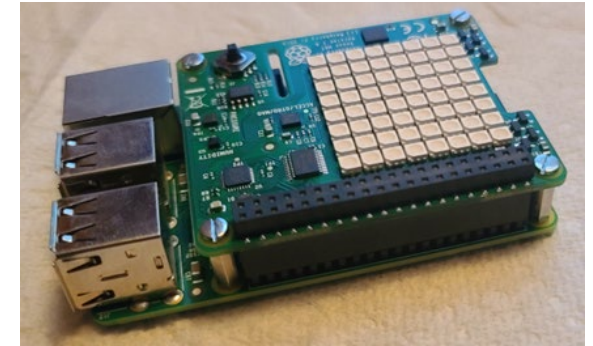
FunctionalEntity

- ▶ Includes identification information
 - Author information
 - Application information
- ▶ Input / Output / Configuration Data
 - Persisted data
- ▶ Verification functionality
- ▶ Control Groups
- ▶ Connections
- ▶ Aggregated health/status information



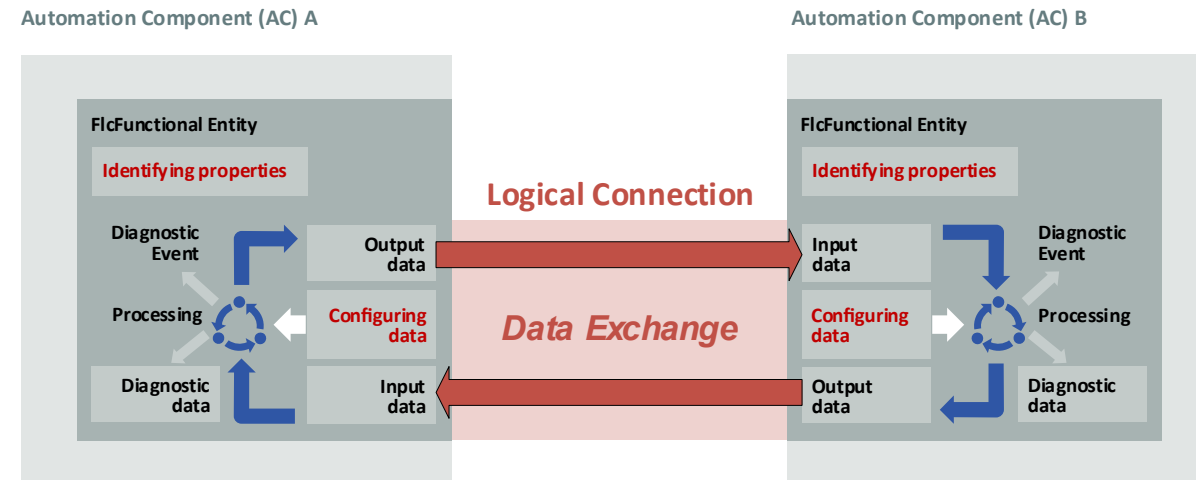
FunctionalEntity illustration

- ▶ Continue with Raspberry Pi example
- ▶ Sub type of FunctionalEntity adds
 - Predefined output and configuration data
- ▶ It also includes ControlGroups
 - Provide functionality related information
 - Provides locking capabilities

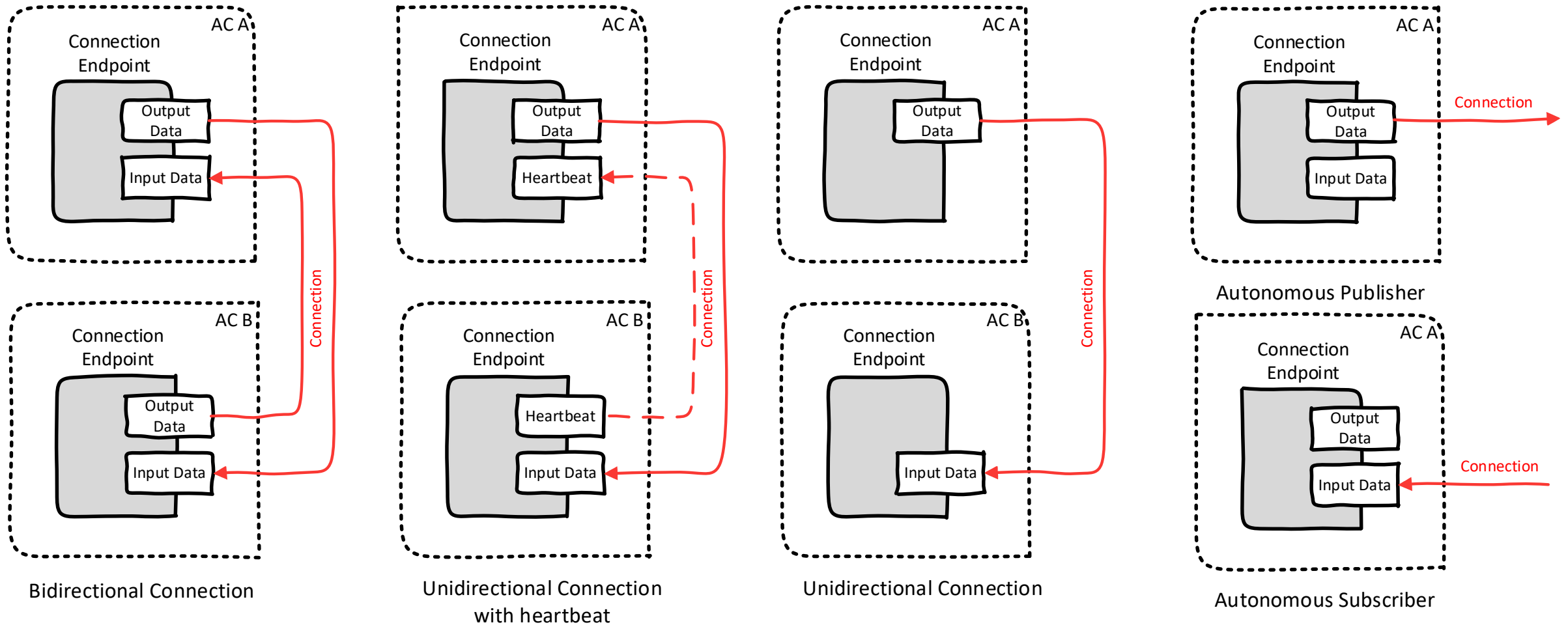


Connections

- ▶ Enables data exchange between functional entities
- ▶ Establishing Connections includes
 - Verification (Assets and Functional Entity)
 - Establish exclusive access to information
 - Set ConfigurationData
 - Establish communication model for data exchange
 - Persistence
- ▶ Data Exchange
 - Based on OPC UA PubSub
 - Mapping to ClientServer supplied with a later version
 - Safety
 - Security (Authentication, Encryption)
 - QualityOfService (Priority, Guaranteed Bandwidth, Latency, Deadline) including TSN
 - Various transports (ETH, UDP, AMQP, MQTT)
 - Monitoring
 - Cleanup

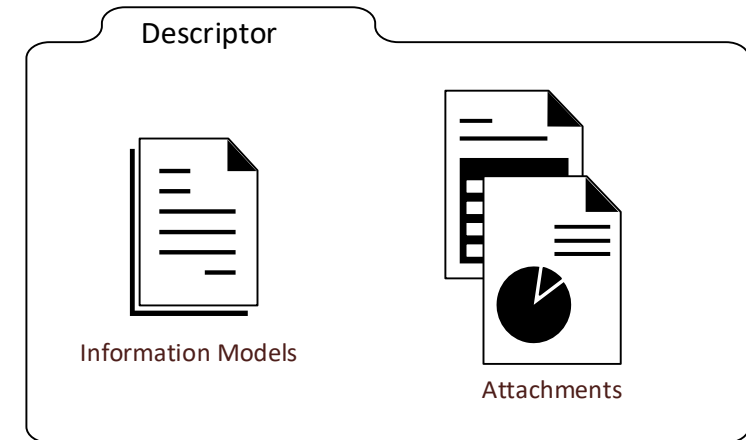


Connection types

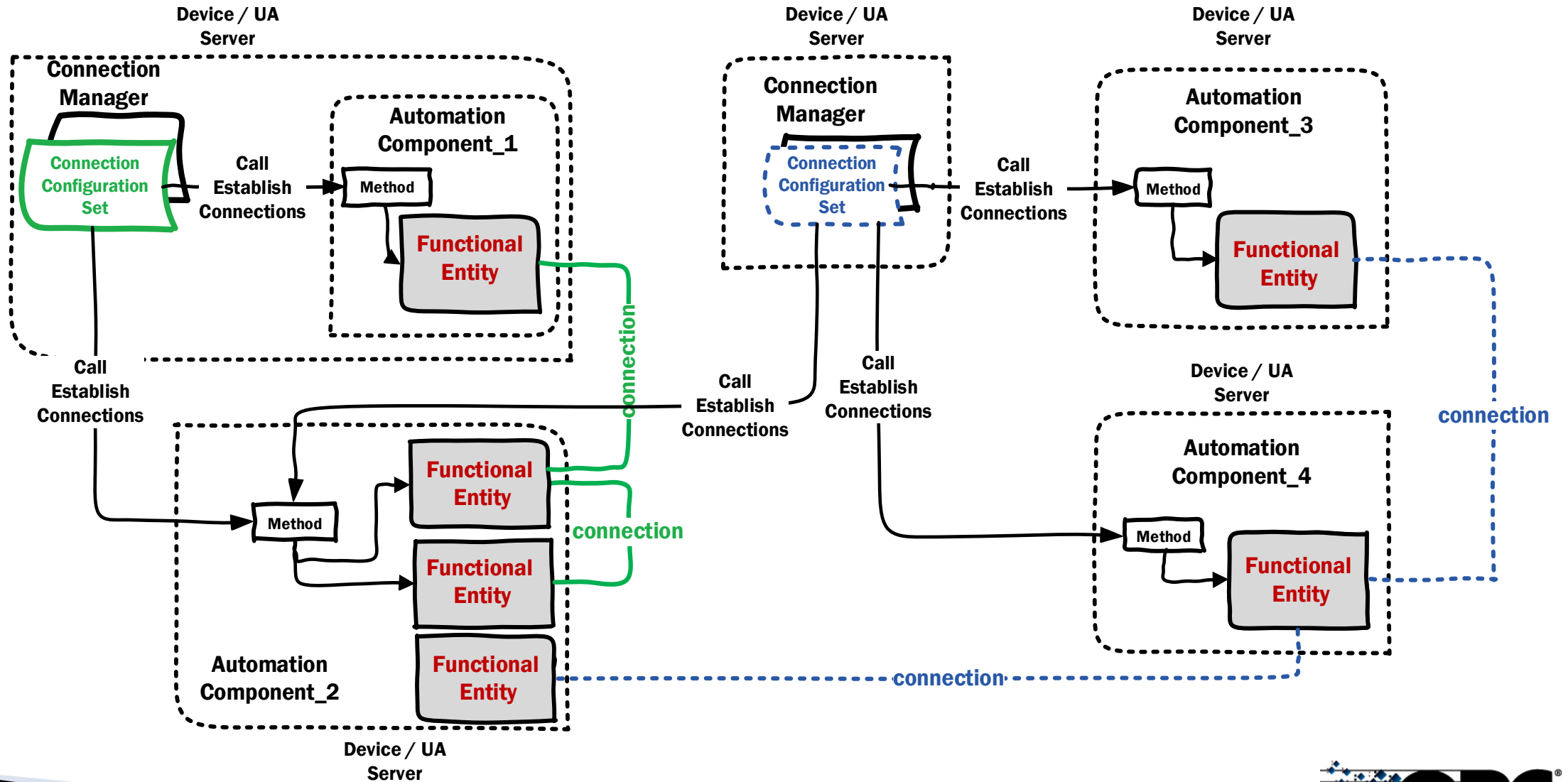


Offline Descriptor

- ▶ Offline Descriptor describes capabilities, functionality, configuration and assets of an automation component
- ▶ Essential part for development, commissioning, operation, and maintenance phases of an automation system
- ▶ Open Packaging Convention document (ECMA-376)
 - Packaging of Modelling and Attachment files
 - Relationships
 - Digital Signature
- ▶ Model files use AutomationML (AML) (IEC 62714)
 - XML-based data exchange format for plant engineering
- ▶ Attachments
 - Integration of “other” Information Models (e.g. PLCOpen, Yang,...)
 - Document, manuals, drawings ...

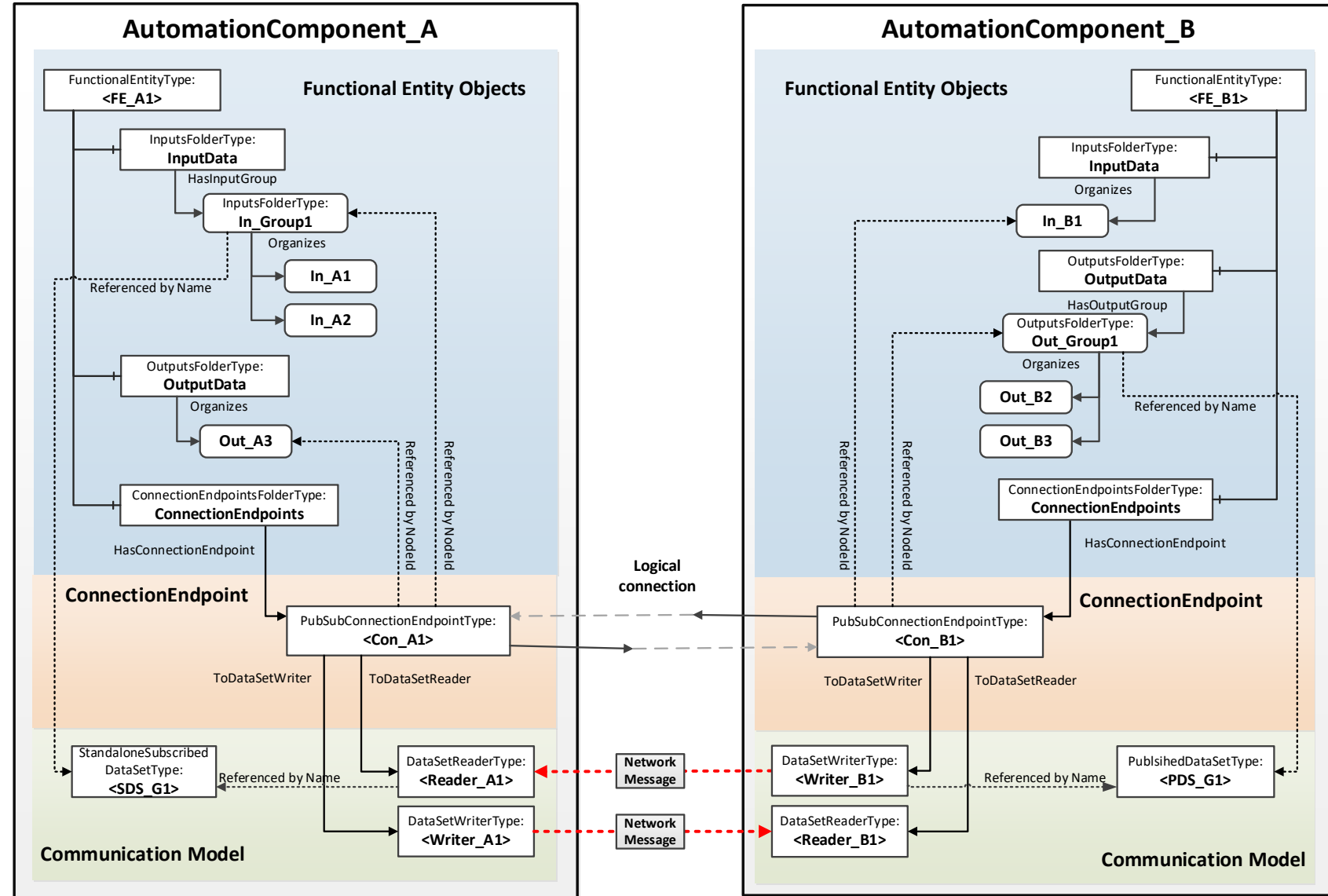
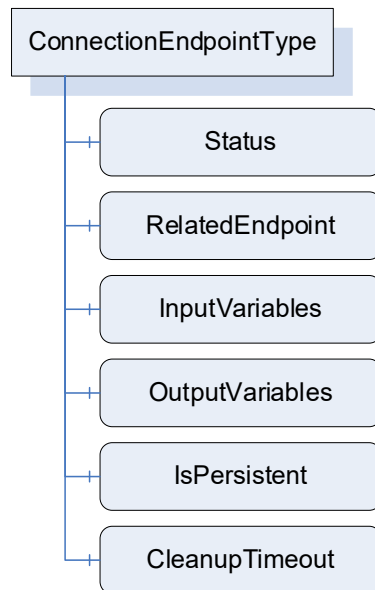


Establishing Connections



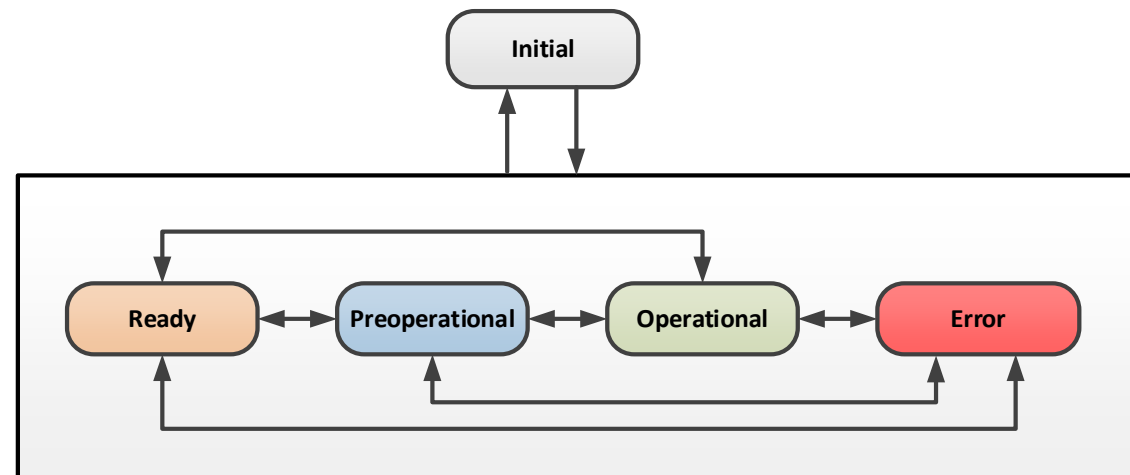
Connections

- ▶ **ConnectionEndpoint**
 - Logical connection between FunctionalEntities
 - Relates data nested in FunctionalEntity
 - Can be persisted
 - Report status information



Connection Behaviour

- ▶ Connections are monitored
- ▶ Persistent Connections are restored after power cycle
- ▶ Non-persistent Connections are deleted
 - when in Error for CleanupTimeout
 - after power cycle

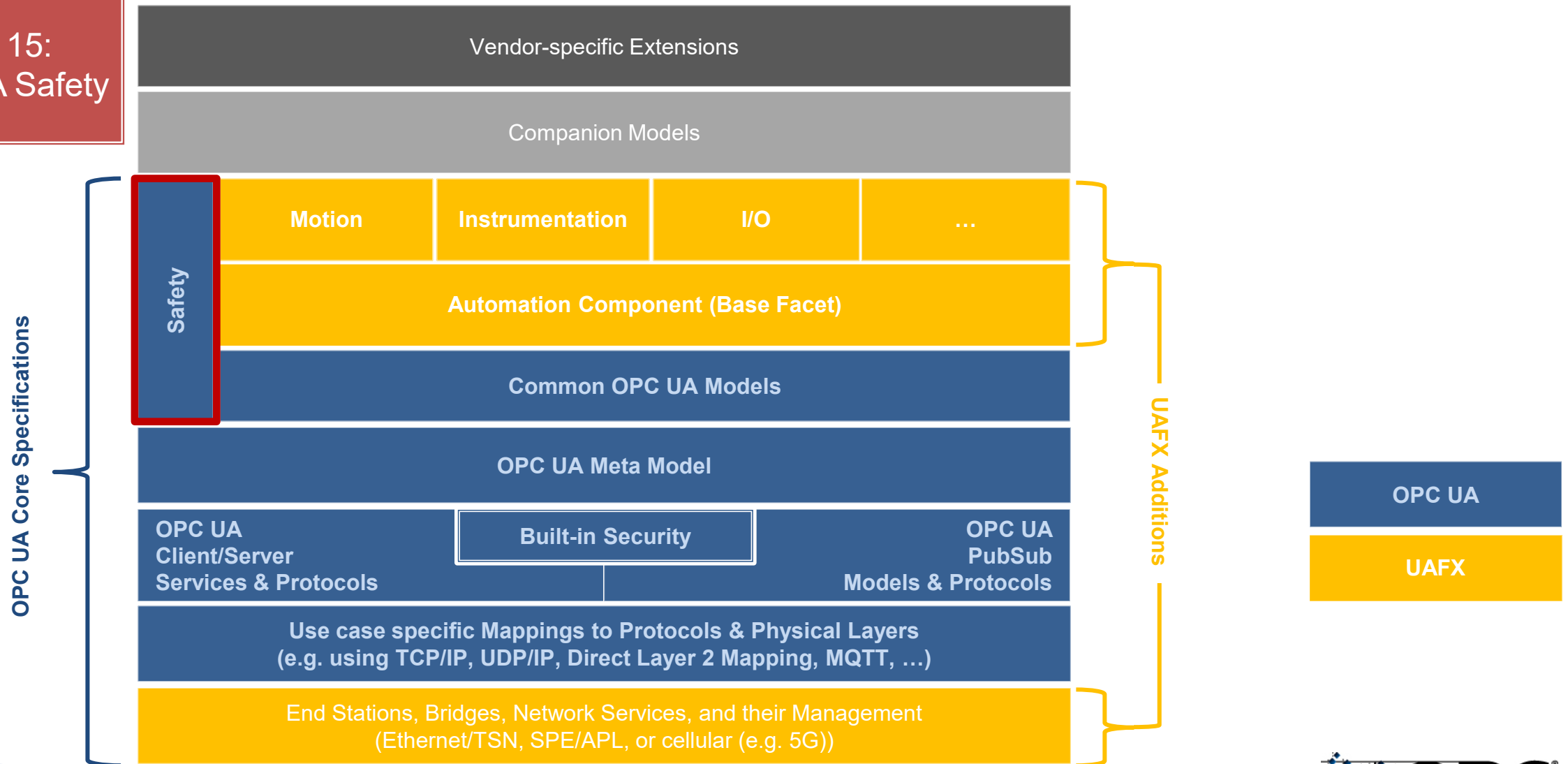




OPC UA Safety

OPC UA + UAFX Communication Stack Architecture

Part 15:
OPC UA Safety



OPC UA Safety Specification: Part 15

New Release

- ▶ OPC UA Safety Specification R 1.05.02 published

History:

- ▶ Cooperation with PROFIBUS & PROFINET International (PI) started in 02/2018
- ▶ Release 1.04: Client/Server support (07/2020)
- ▶ Release 1.05: PubSub support (11/2021)
- ▶ Release 1.05.02: Revisions (11/2022)

Related Activities:

- ▶ Safety Test Tool (UASCTT) and Safety Stack prototypes available
- ▶ TÜV Assessment & Certification planned for Q1-Q2/2023

OPC
FOUNDATION

OPC 10000-15

OPC Unified Architecture
Part 15: Safety

Release 1.05.02
2022-11-01

OPC UA Specification

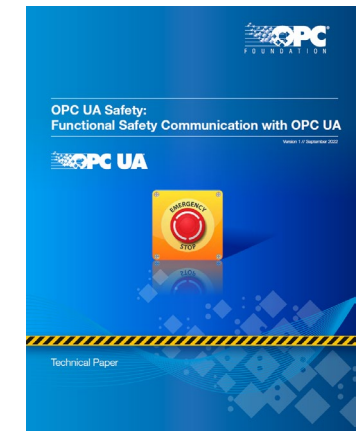
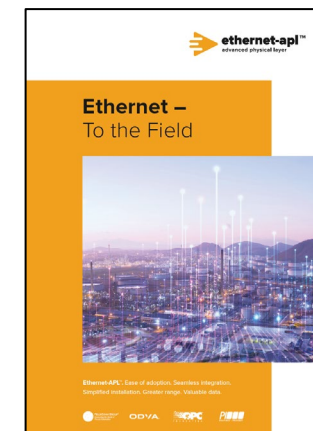
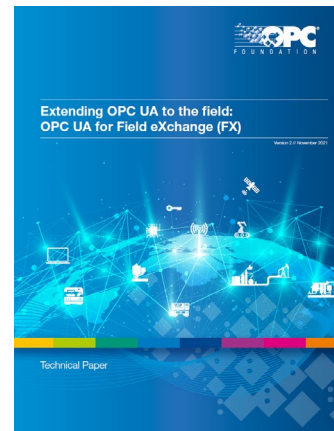
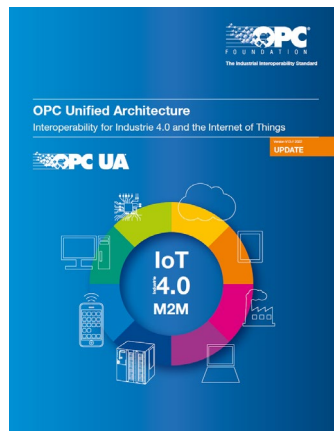


OPC UA FX Useful links

FLC Initiative: Brochures / Technical Papers

<https://opcfoundation.org/flc/>

Title	Remark	
General OPC UA Brochure	Version 14 with Update on FLC/UAFX	Link
FLC Flyer (4 pages)		Link
FLC Technical Paper (40 pages)	Update planned for Q2/2023	Link
APL Brochure (18 pages)		Link
OPC UA Safety – Technical Paper (24 pages)	Released in 09/2022	Link



Useful links

- ▶ C2C Demo
 - https://youtu.be/pZltyMZr_xo?t=6266

- ▶ Looking for more information ? Brochures, Recordings, Slides,...
 - <https://opcfoundation.org/>
 - <https://opcfoundation.org/flc>
 - <https://opcfoundation.org/apl>



Thank you !!!