BALLUFF innovating automation

HS PF

MITSUBISHI ELECTRIC Changes for the Better

Vendor-Independent modeling and exchange of Fieldbus Topologies with AutomationML

Markus Rentschler, Balluff GmbH, Germany

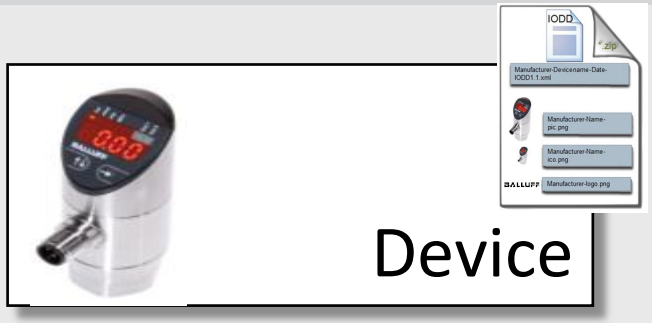
Prof. Dr. Rainer Drath, University of Applied Sciences Pforzheim, Germany

Matthias Mueller, Mitsubishi Electric Europe B.V., Germany

Outline

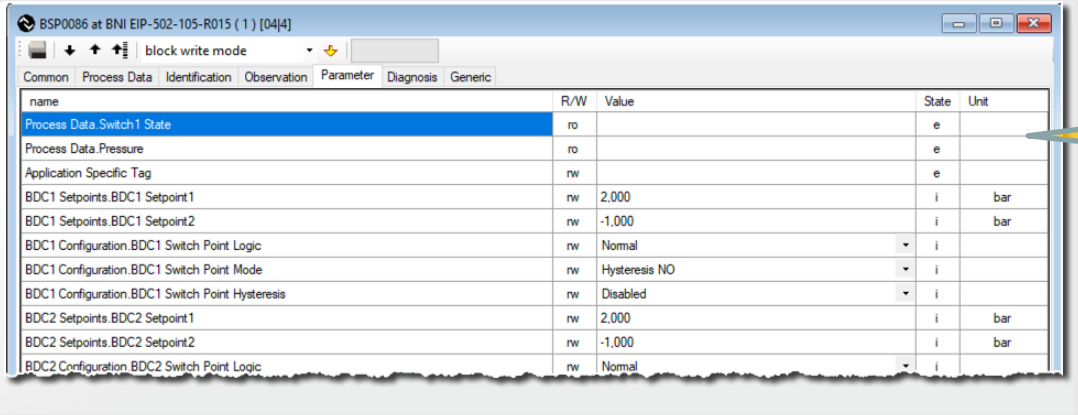
1. **Problem Statement**
   - Device Engineering & Lifecycle
   - Lack of instance data handling
   - Lack of modelling capabilities
   - The standardization deadlock
2. **Proposed Solution**
   - AML-Device Descriptions (AML-DDs)
   - AML-DD File Packages
   - Topology Descriptions
3. **Practical Example**
4. **Conclusion**

Device Engineering



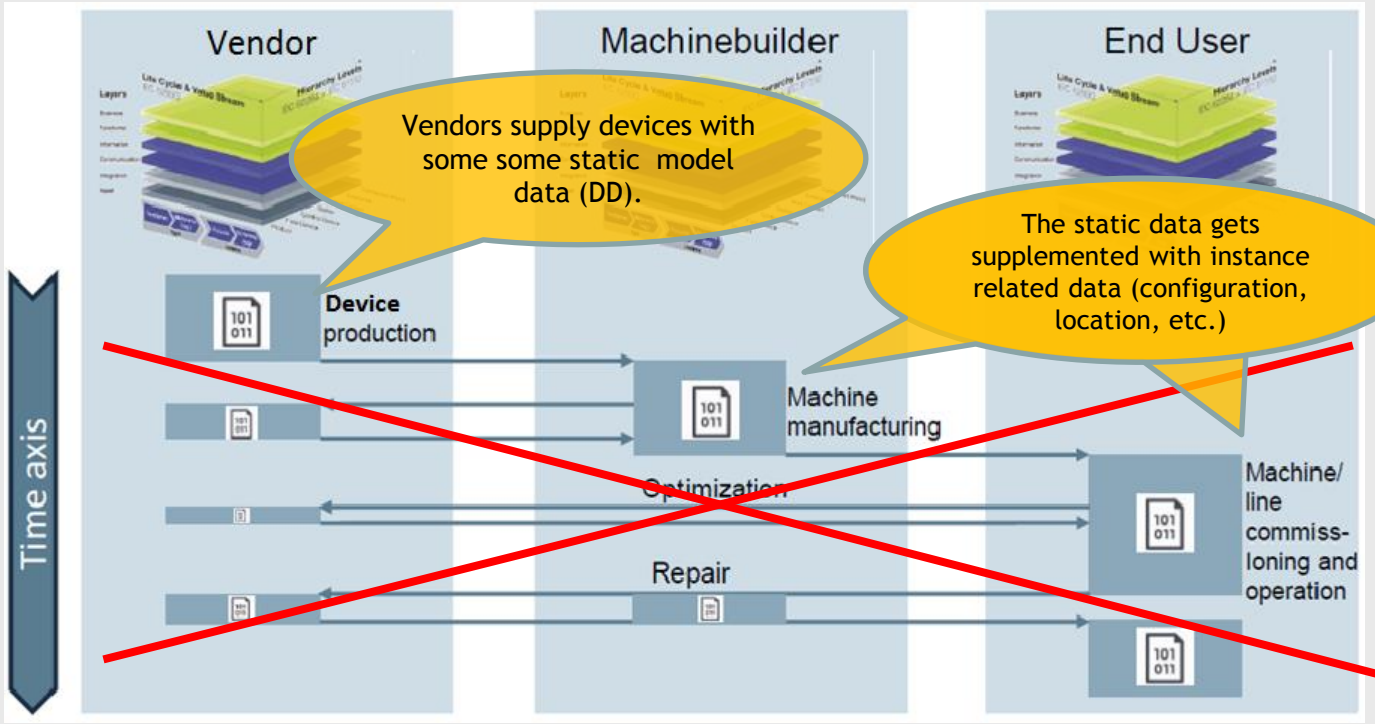
The **Device description (DD)** models a static device type with its properties and parameters

- e.g. ESD (Ethernet/IP), ESI (EtherCAT), GSD (Profinet), XDD (Powerlink), CSP+ (CC-Link), IODD (IO-Link)



DD‘s allow representation of the device properties in a proprietary engineering tool

Lack of instance data handling over the device lifecycle



Source: ZVEI

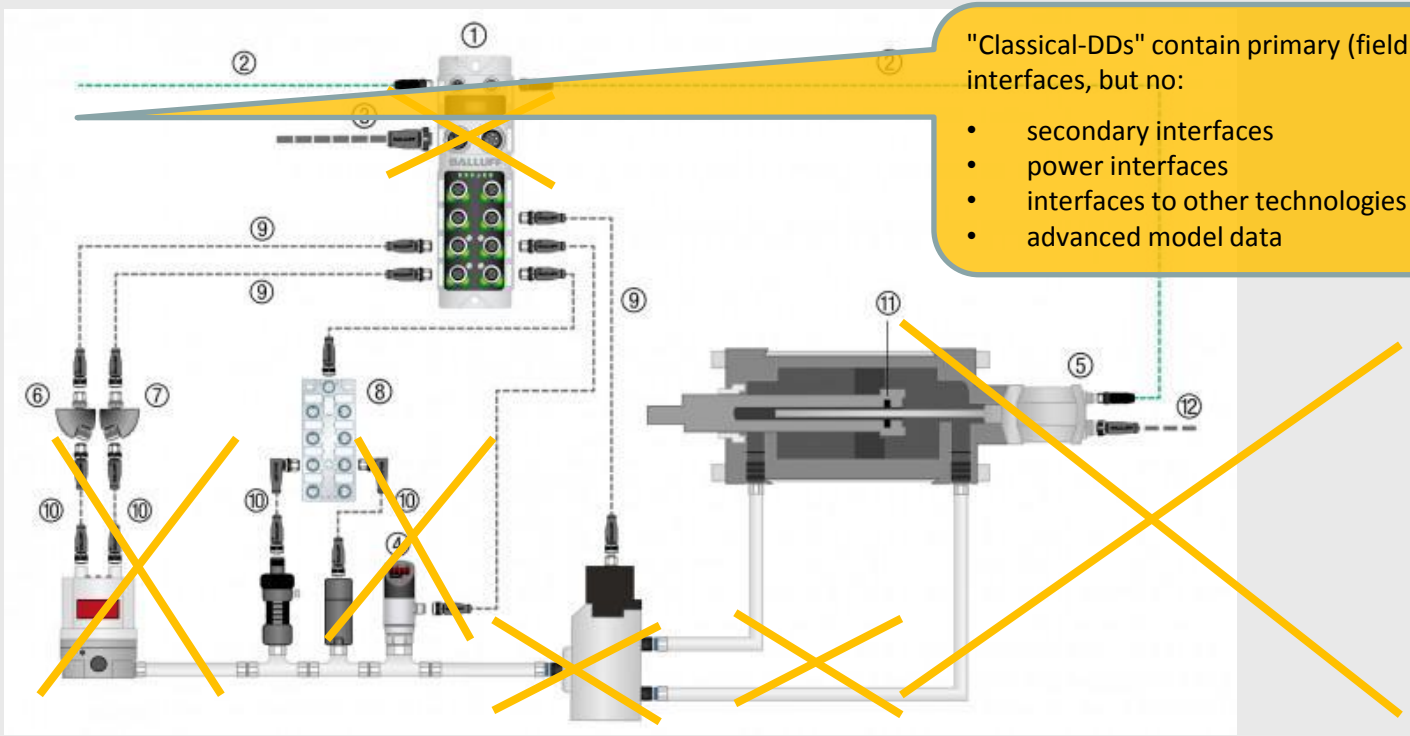
Does not really work today

M.Rentschler, R.Drath, M. Mueller „Vendor-Independent modeling and exchange of Fieldbus Topologies “

Lack of modelling capabilities for mixed technology systems

GSDML

IODD

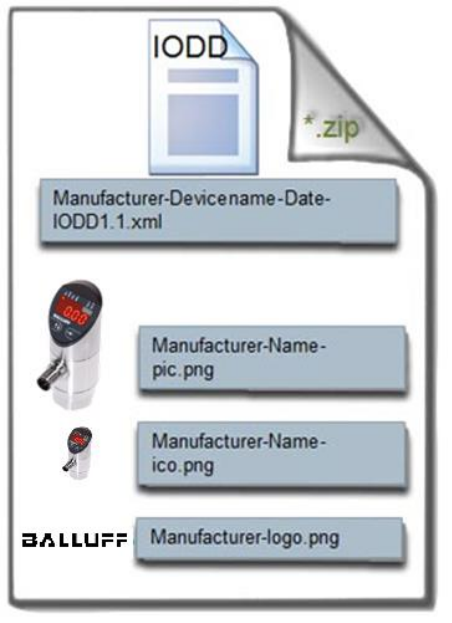


"Classical-DDs" contain primary (fieldbus) interfaces, but no:

- secondary interfaces
- power interfaces
- interfaces to other technologies
- advanced model data

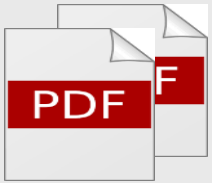
Source: Balluff

Lack of Modelling Capabilities for Devices

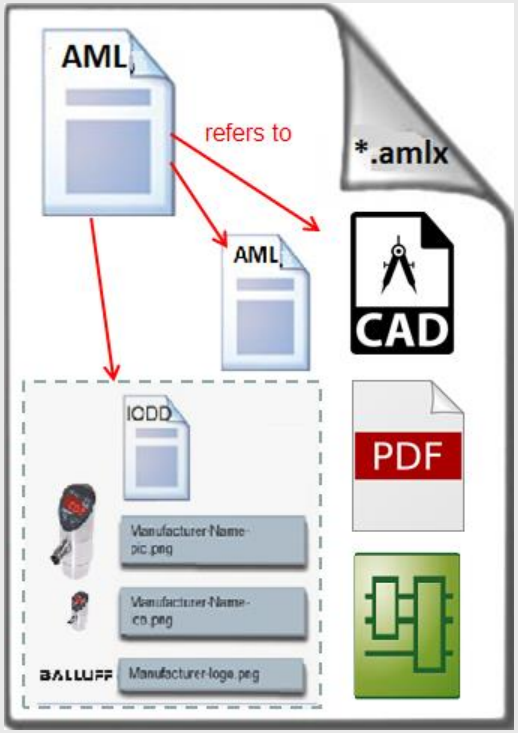


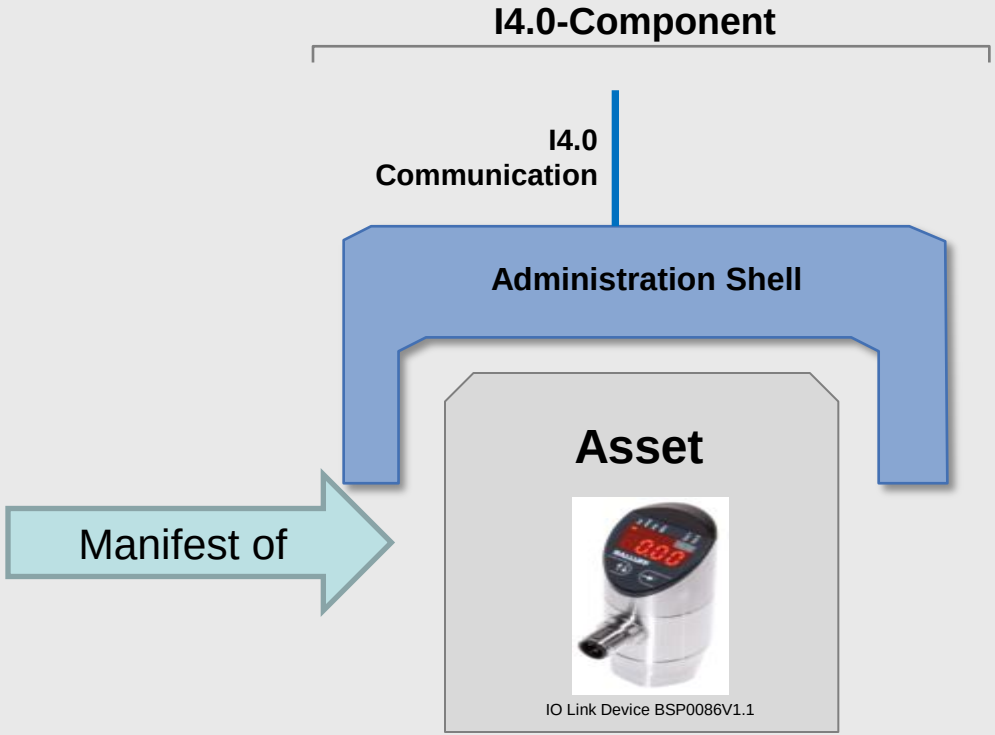
- Container (ZIP)
- Description File (here: IODD)
- Device Picture
- Device Icon
- Logo

Additional model data is often available in separate files, in distributed locations and different versions



Goal: DD with full model for the Digital Twin, "Asset Manifest" for I4.0-Component





Initial Idea

DD Standard today

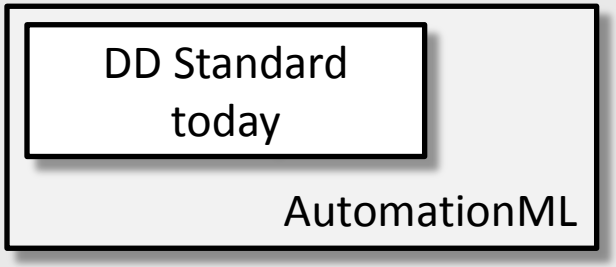
DD Standard tomorrow

Let‘s extend the DD standard!

- **requires a new version of the legacy DD standard**
- **requires extensive standardization cycles within the fieldbus communities**
- **breaks compatibility with the existing tool landscape**

How can we extend a DD standard without changing it?

New Idea: Extend the classical DDs with AML

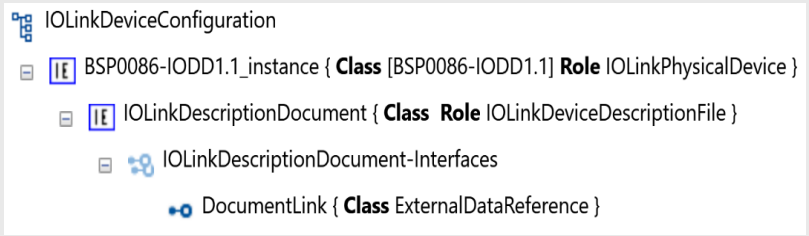


Embedding the existing DD standard into the AutomationML standard

- **The legacy DD remains unchanged**
- **The existing tool landscape can remain unchanged.**
- **Extended features can be added stepwise into the tool landscape.**
- **The DD standard elegantly inherits all object oriented capabilities of AutomationML.**

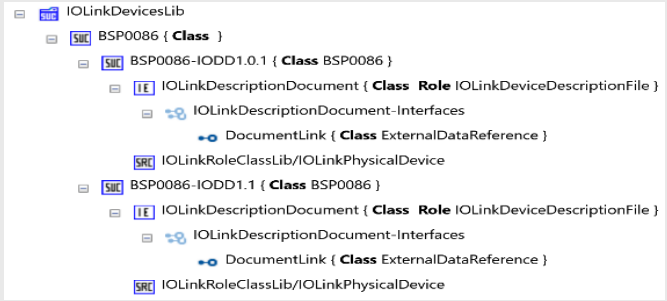
AML-DD: How it works

AutomationML Instance Hierarchy



Additional
instance information

AutomationML Library

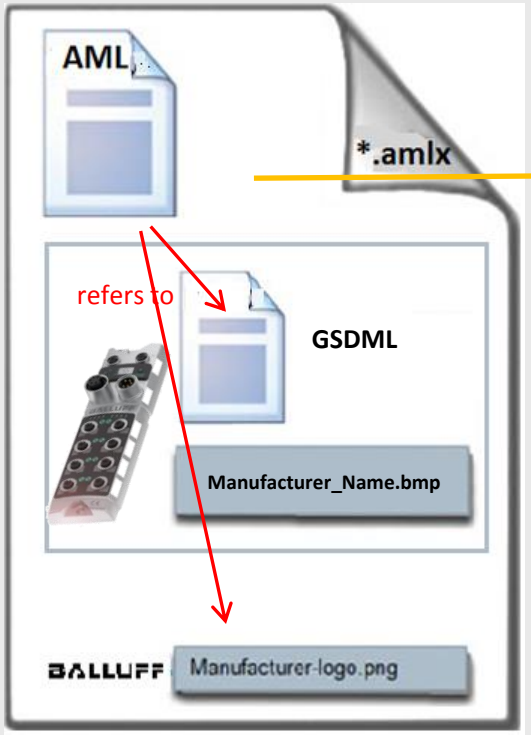


Additional
type information

Unchanged legacy
DD file

„Technology DD“

AML-DD File Package



AMLX or ZIP
File Container

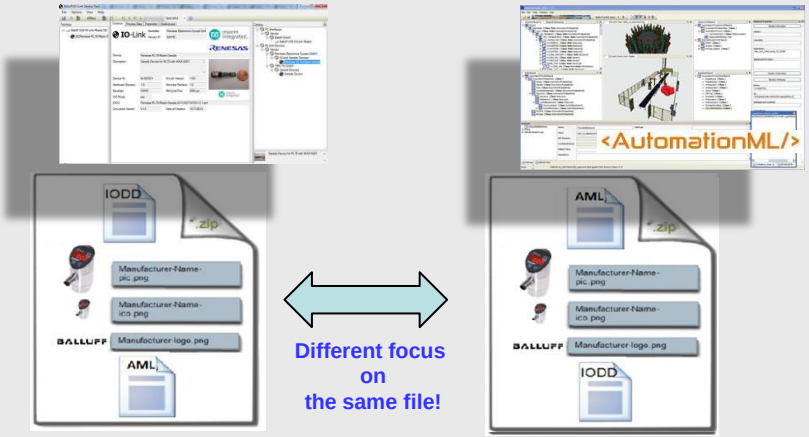
AML Root File with type, instance and additional model information

Technology DD File (here: GSD)

Device Picture

i.e. Additional Logo

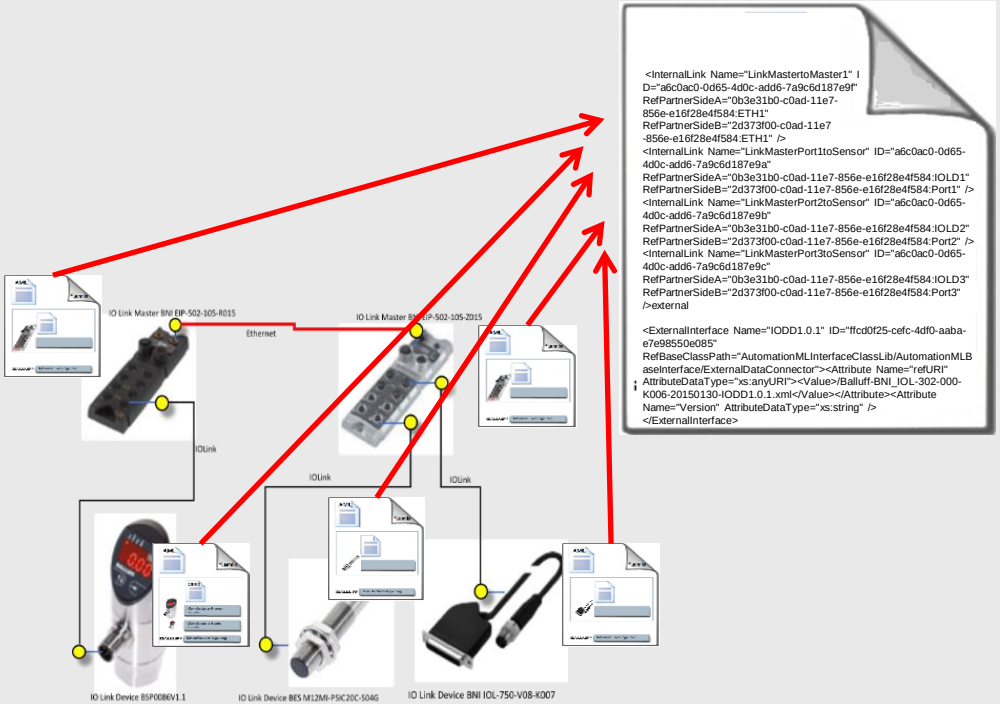
Summary on AML-DDs



The AML-DD concept is generic

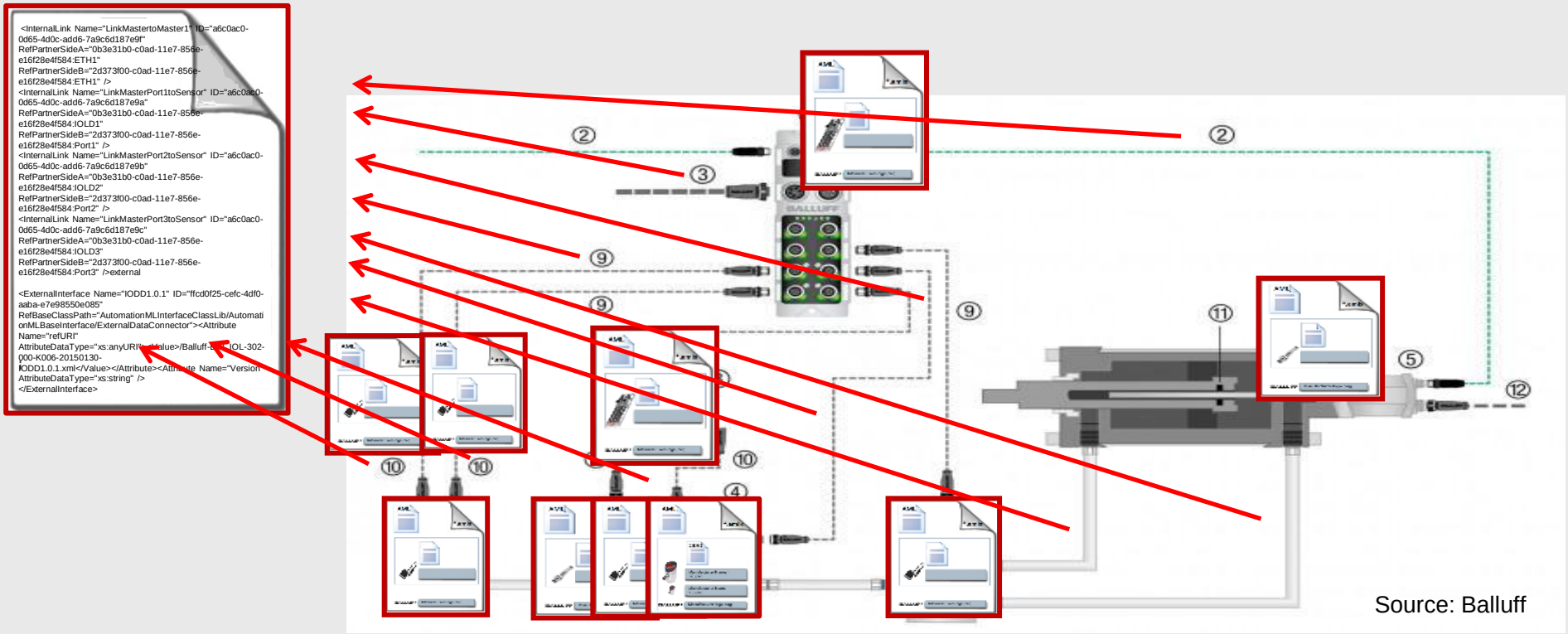
- thus a truly next generation device description
- able to model type and instance information
- starting point for exchangeable 360°models of devices with documents, icons, 3D models, function blocks, faceplates etc.
- Provides a migration path!

Description of topology information

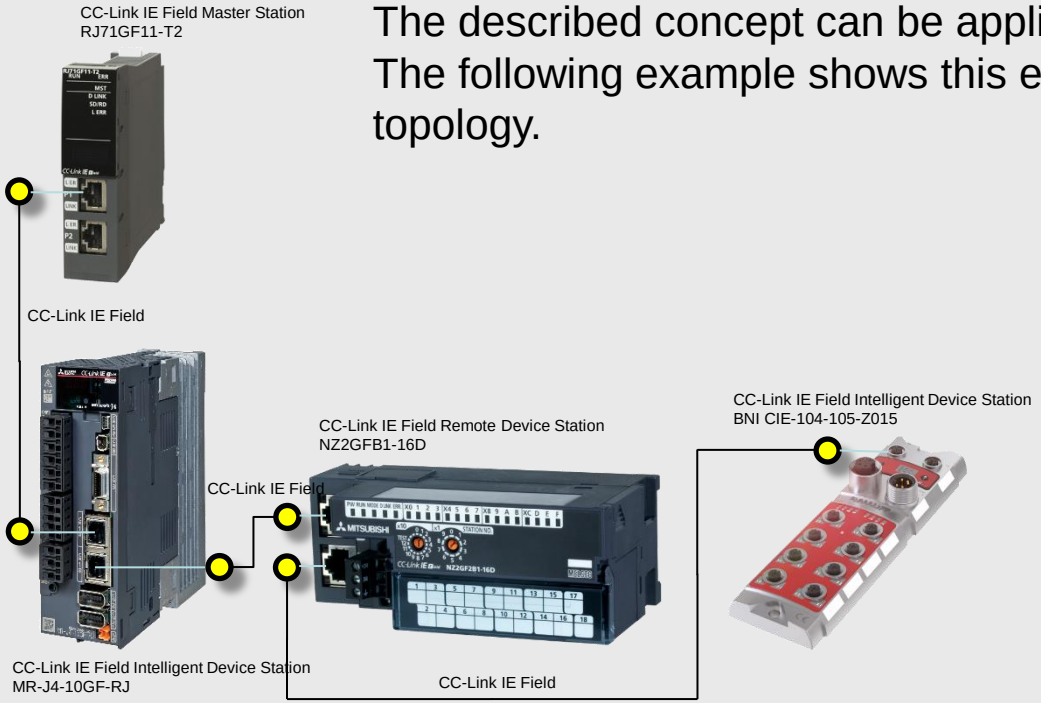


1. A given topology of devices exists.
2. Each device comes with an AML-DD that describes the physical (and logical) device interfaces
3. CAEX provides the “InternalLink” element to connect interfaces, even between different AML files.
4. The links between the interfaces in the AML-DDs are described in an AML-Topology file.
5. The AML-DDs are referenced from the AML-Topology file via the “ExternalInterface”-Element.

Description of mixed technology systems



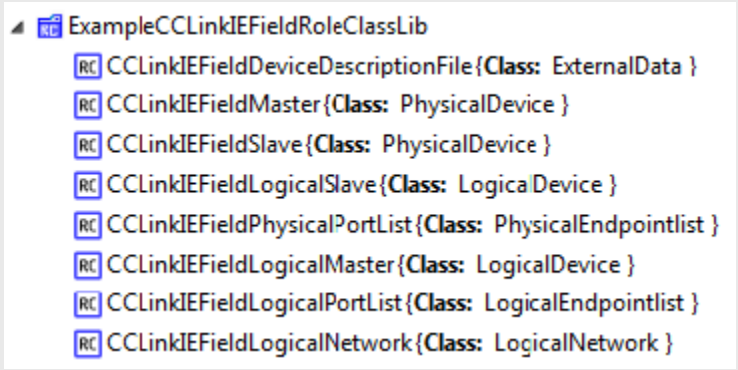
CC-Link IE Field Sample Description



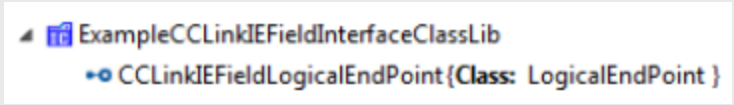
The described concept can be applied to any field bus technology.
The following example shows this exemplary for CC-Link IE Field network topology.

- **Step 1:**
  Developing technology specific role classes
- **Step 2:**
  Modelling of CC-Link IE Field devices and masters in AutomationML
- **Step 3:**
  Modelling the CC-Link IE Field topology

Developing technology specific role classes



Defining technology specific role classes which are derived from role classes of the CommunicationRoleClassLib



Defining technology specific interface class which are derived from a interface class of the CommunicationInterfaceClassLib

Modelling of CC-Link IE Field devices and masters in AutomationML

SystemUnitClass for a Mitsubishi Electric CC-Link IE Field compatible Servo Amplifier

- MR-J4-10GF-RJ
  - CC-LinkIEFieldSlaveDeviceDescriptionFile {**Role:** CCLinkIEFieldDeviceDescriptionFile}
    - CC-LinkIEFieldSlaveDeviceDescriptionFile-Interfaces
      - DocumentLink {**Class:** ExternalDataReference }
  - LogicalCCLinkIEFieldNode {**Role:** CCLinkIEFieldLogicalSlave}
    - EndPoints {**Role:** CCLinkIEFieldLogicalPortList}
      - EndPoints-Interfaces
        - LogicalPort1 {**Class:** CCLinkIEFieldLogicalEndPoint }
  - PortList {**Role:** CCLinkIEFieldPhysicalPortList}
    - PortList-Interfaces
      - CH1A {**Class:** EthernetSocket }
      - CH1B {**Class:** EthernetSocket }
  - PowerPort {**Role:** PhysicalPowerPortList}
  - ExampleCCLinkIEFieldRoleClassLib/CCLinkIEFieldSlave

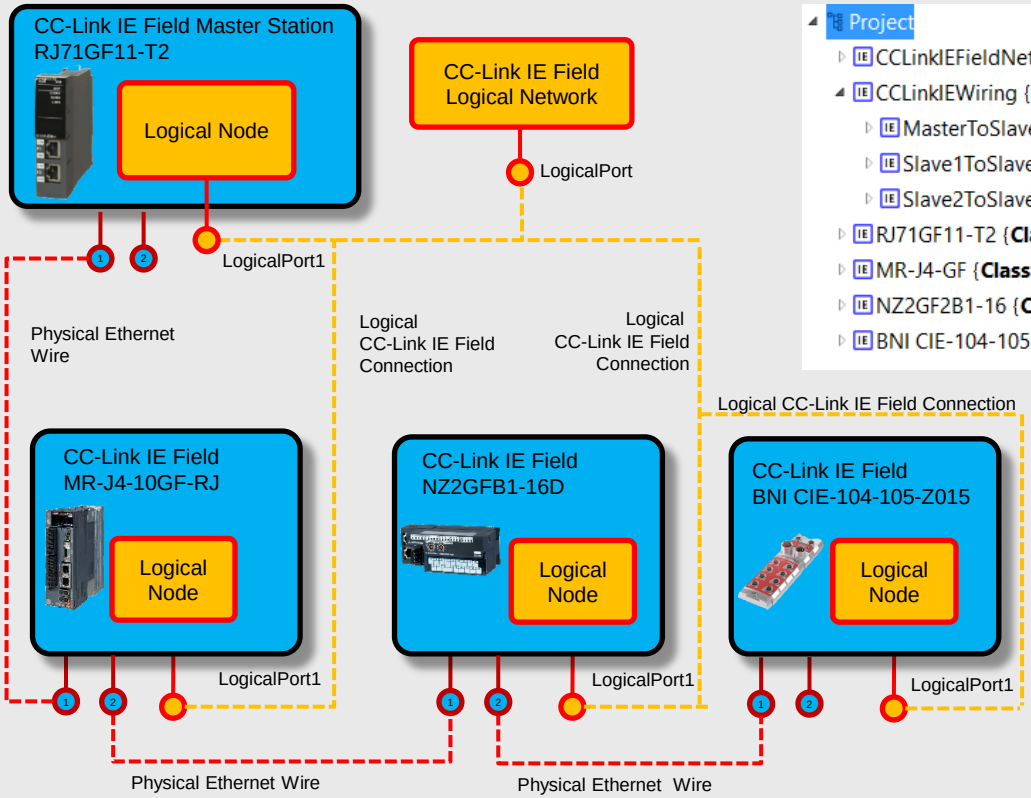
CC-Link IE Field device class

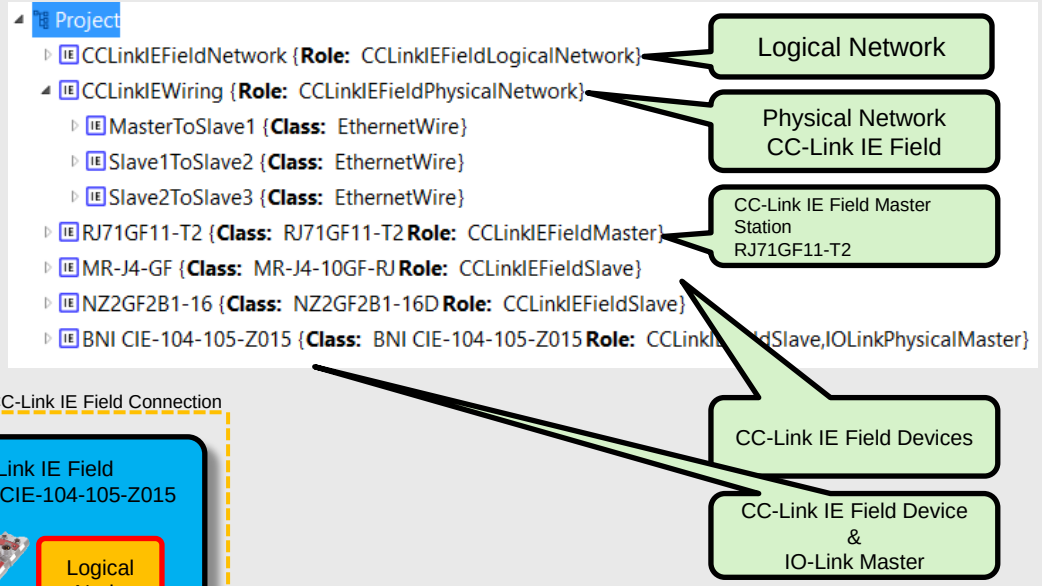
Reference to the CSP+ File

Logical port list containing one logical port

Physical port list with two physical ports

Modelling the CC-Link IE Field topology





Conclusion

- **Engineering of Automation Systems is traditionally based on proprietary Device Description Languages and associated software tools, usually defined by fieldbus organizations.**
- **These systems lack of many capabilities and extending them is difficult, because the fieldbus organizations are very restrictive.**
- **AutomationML based on CAEX is a simple but powerful means to “extend” and finally even replace these legacy Device Descriptions without changing them.**
- **The way to get acceptance for such a method within the industry is standardization by an accepted body within the automation community and a migration path for the legacy systems because of investment protection!**
- **In a cooperation between the IO-Link-Consortium and the AutomationML association currently the first standard is defined for the IO-Link infrastructure.**
- **Because the underlying concept is generic, it can easily be adapted by any fieldbus organization.**

DD standards can be extended without changing them! ☺

Thanks for your attention!