

AutomationML as basis of the Module Type Package for Modular Process Plants

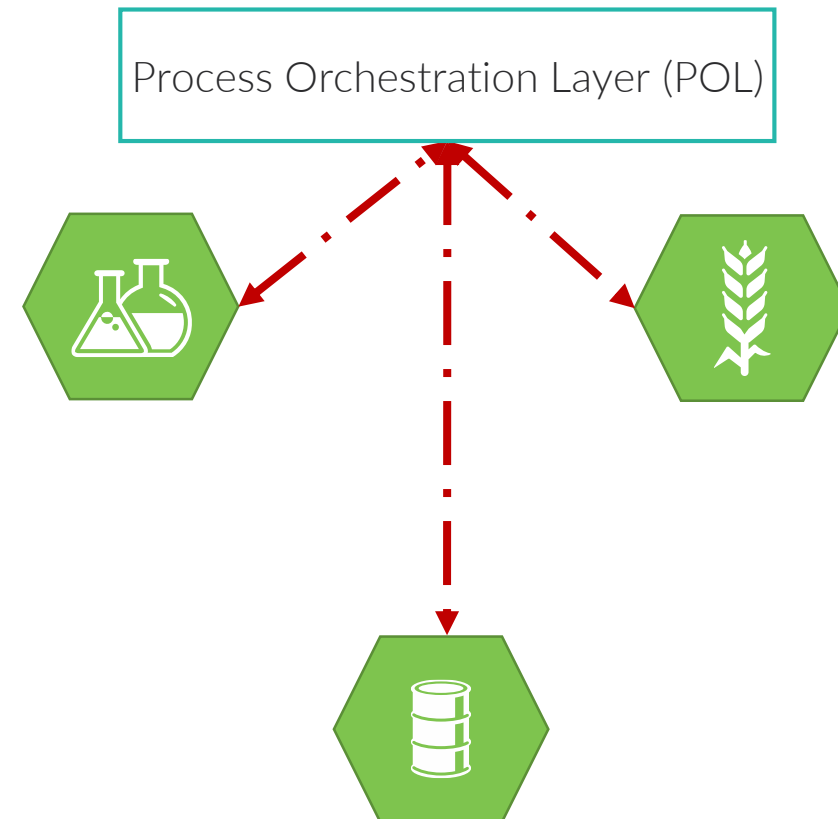
Henry Bloch, Semodia GmbH

AutomationML Plugfest 2019, Hamburg



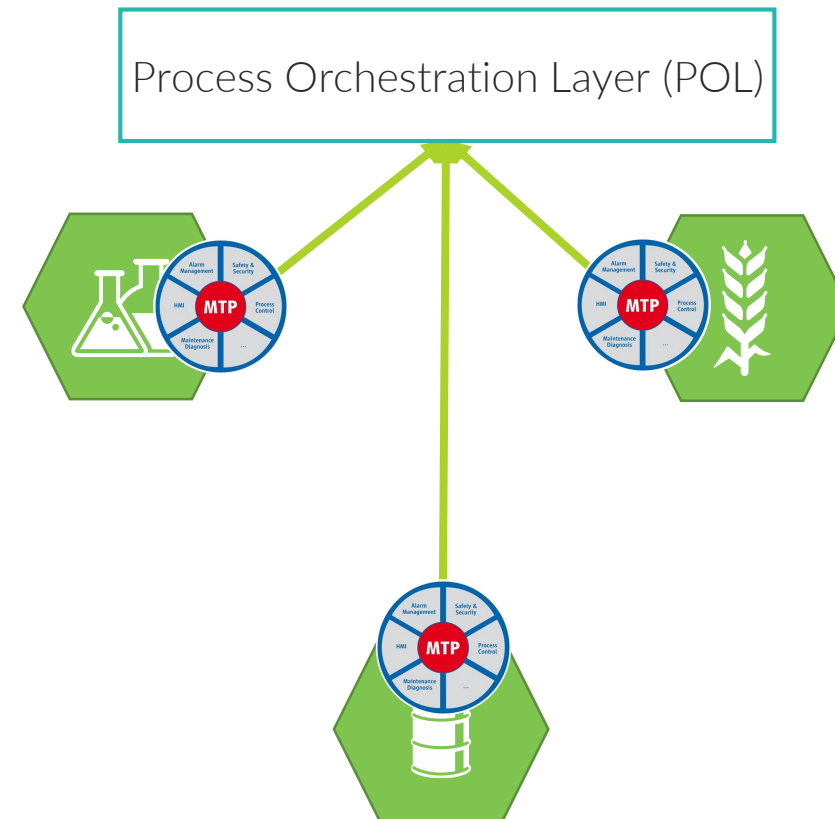
Motivation of Modularization

- Current challenges:
 - Short product lifecycles
 - Highly volatile markets
- New requirements get important
 - Shorter time-to-market
 - Increased flexibility
- Modularization as approach to fulfil these requirements
- Communication among different controllers required

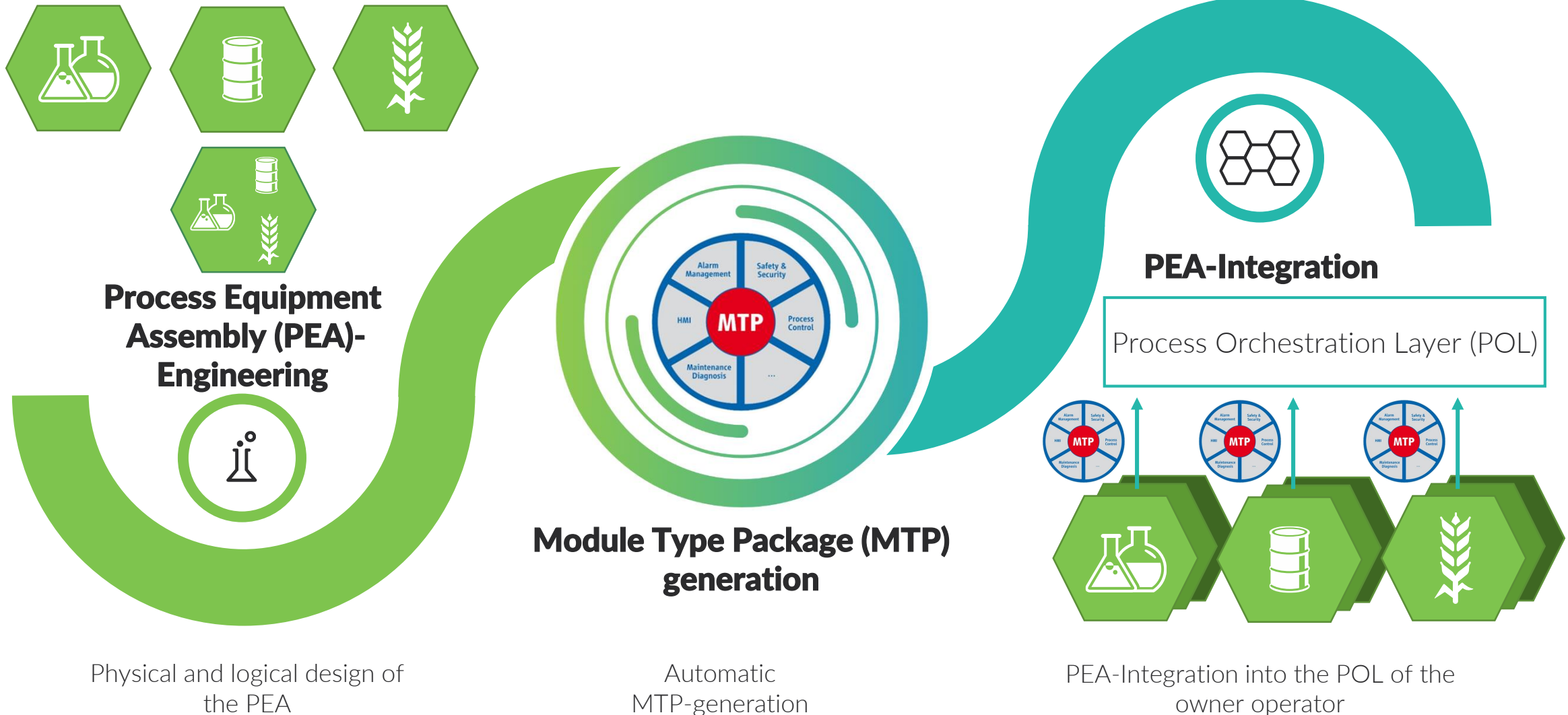


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- To overcome the challenge of different communication of different controllers, the Module Type Package was designed

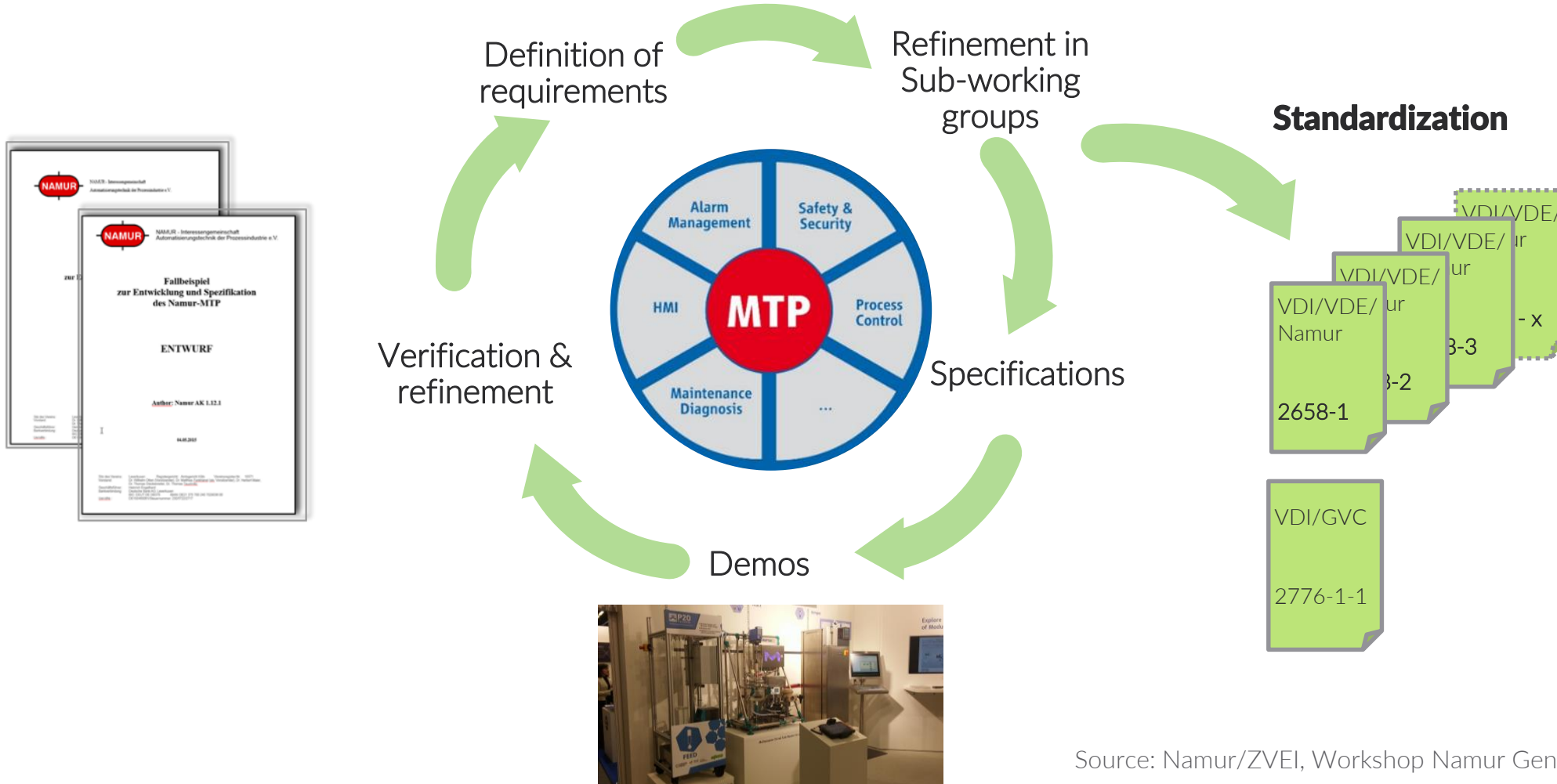


Modular Plants and MTP



Standardization effort

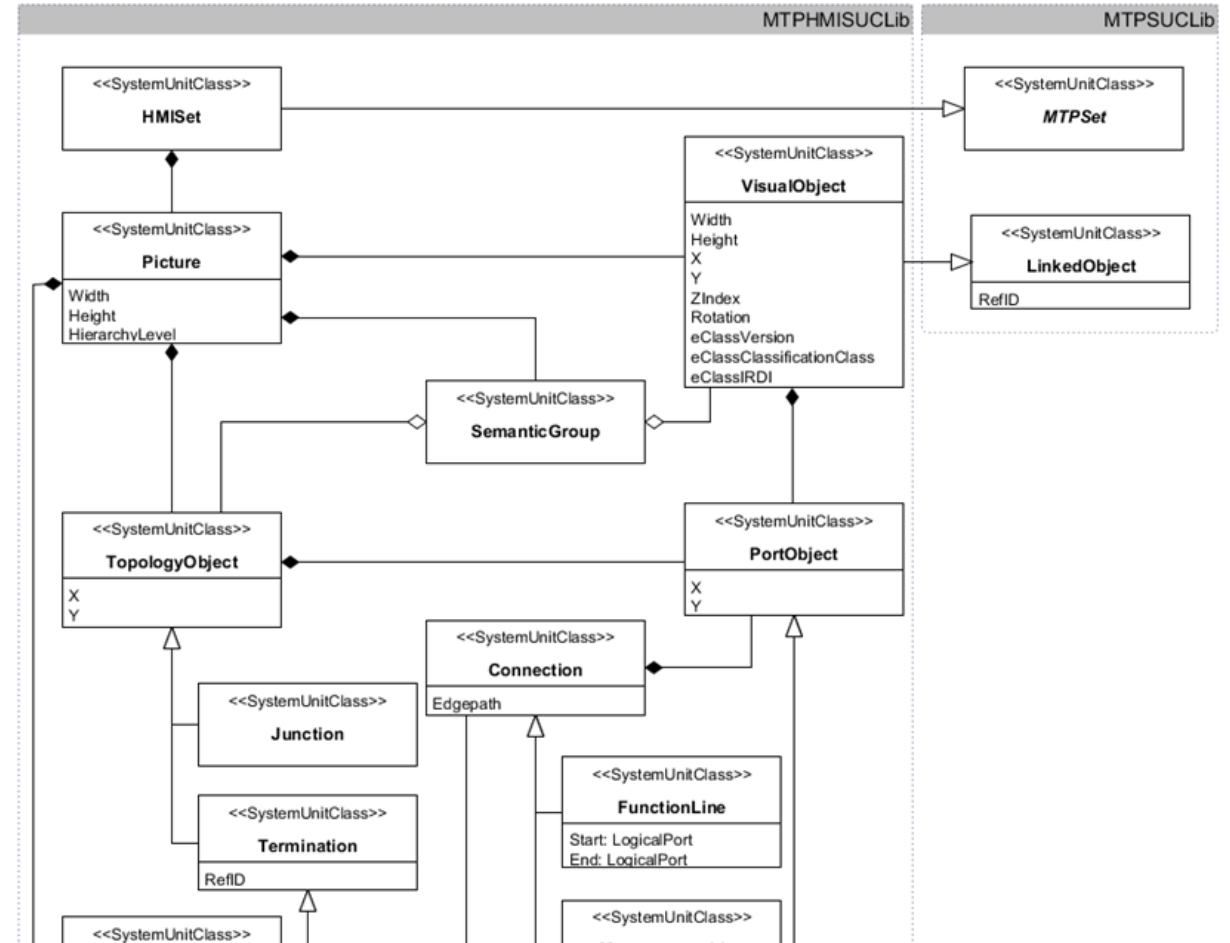
Agile procedure of NAMUR, ZVEI and VDI for high quality standards



Source: Namur/ZVEI, Workshop Namur General Meeting 2017

Standardization effort

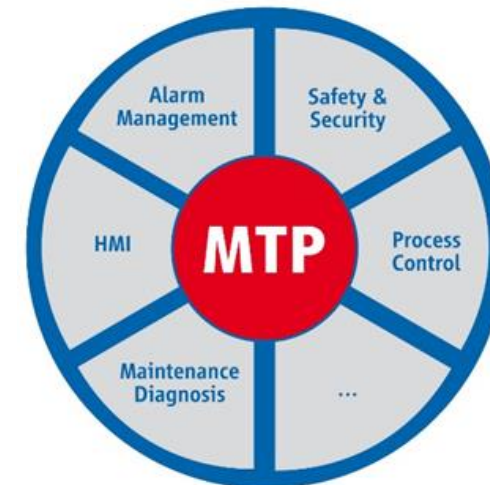
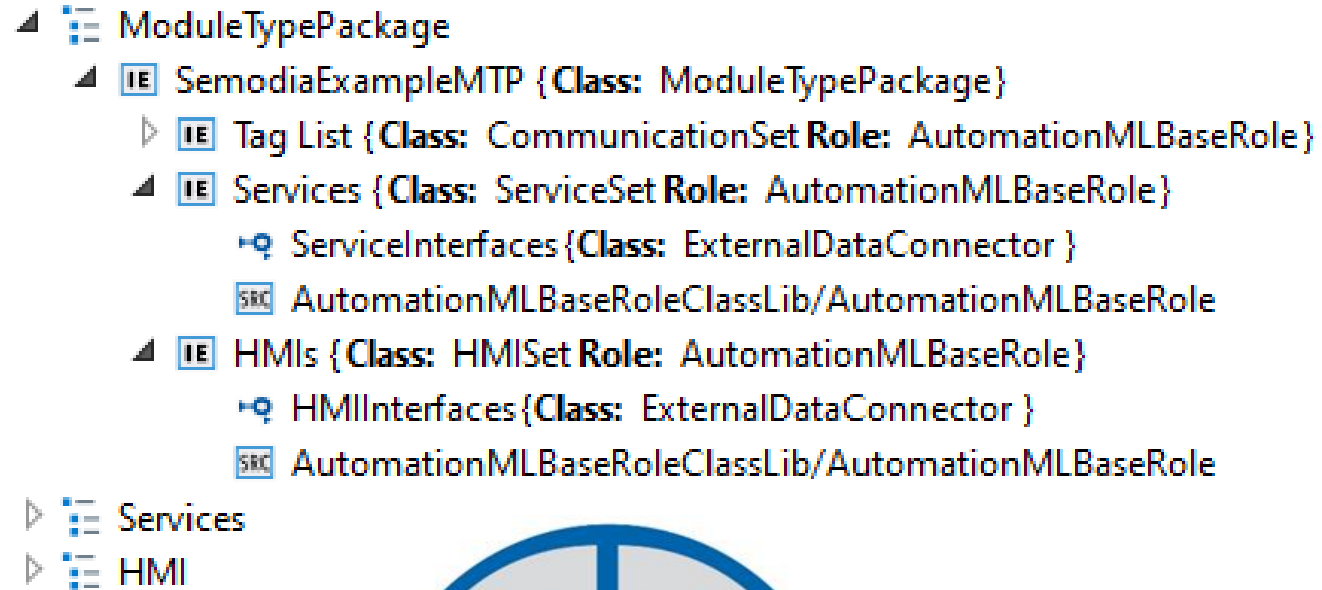
- Structure of the standard VDI/VDE/NAMUR 2658:
 - Separated parts per aspect
 - UML class diagrams
 - Detailed modelling guidelines for the *InstanceHierarchy*
 - *SUCLib* and *ICLib* as part of the standard



Excerpt of VDI/VDE/NAMUR 2658-2, 2018

Structure of the MTP

- The MTP is structured in different aspects
 - Manifest as root *InstanceHierarchy*
 - Communication as part of the manifest
 - As *InstanceHierarchy* by itself:
 - HMI
 - Services
 - Further aspects
- By historical development no *Roles* are used, except for the *AutomationMLBaseRole*

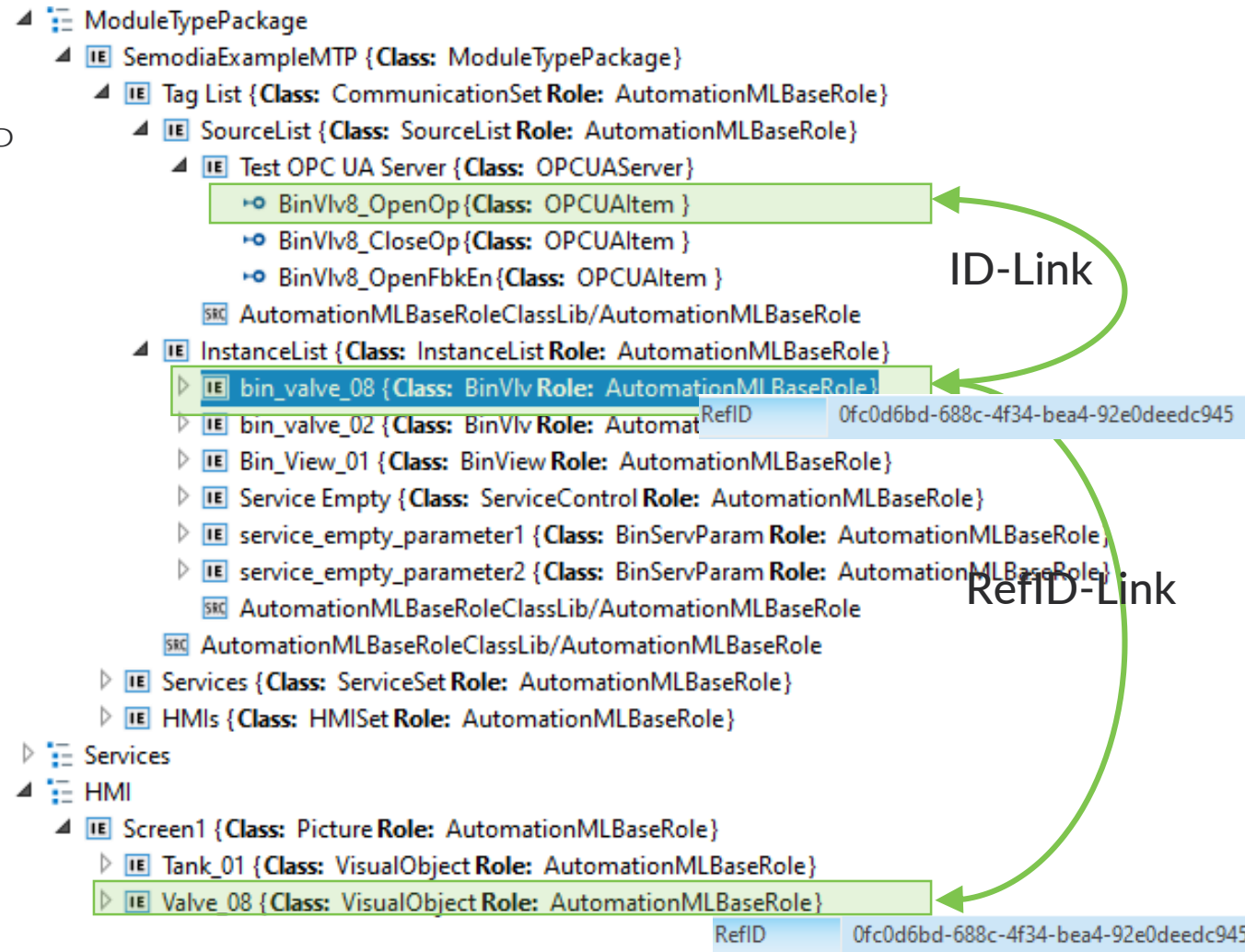


Source: VDI/VDE/NAMUR 2658-1

References within the MTP

The concept of LinkedObjects allows references between aspects

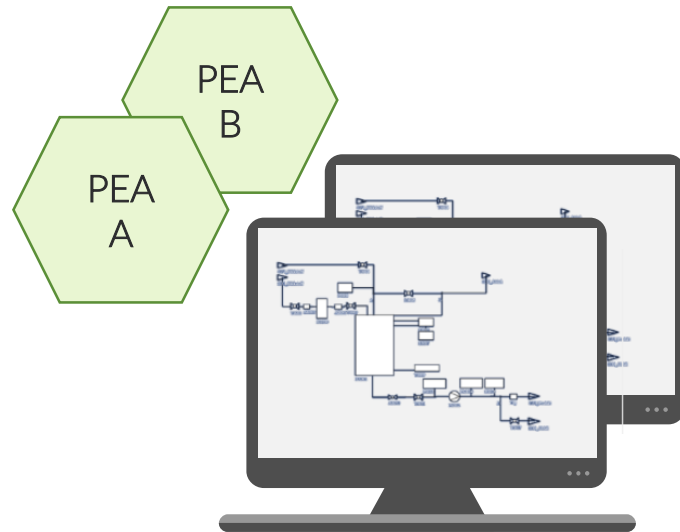
- The CommunicationSet:
 - InstanceList:
contains all DataAssemblies of the MTP
 - SourceList:
contains all communication nodes, e.g. OPC UA nodes.
- To refer between the InstanceList and the SourceList the *AutomationML-ID* of the *InternalElement* is used = ID-Link
- To refer between the InstanceList and other MTP-aspects, each *InternalElement* has the *RefID-attribute* (xs:ID).
- By a RefID-Link, a data dynamisation is provided to other aspects



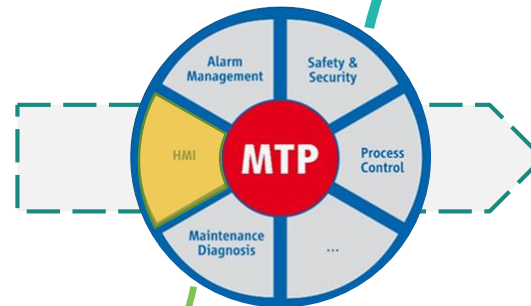
HMI aspect of the MTP

Overview of the automatic HMI-generation by MTP

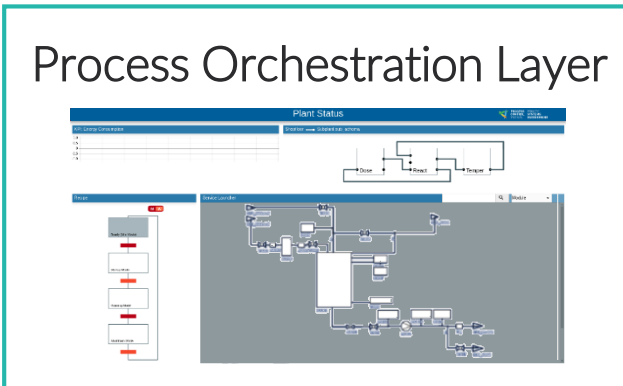
Proprietary visualization of
static and dynamic objects



PEA-Engineering



POL-Engineering



PEA
A

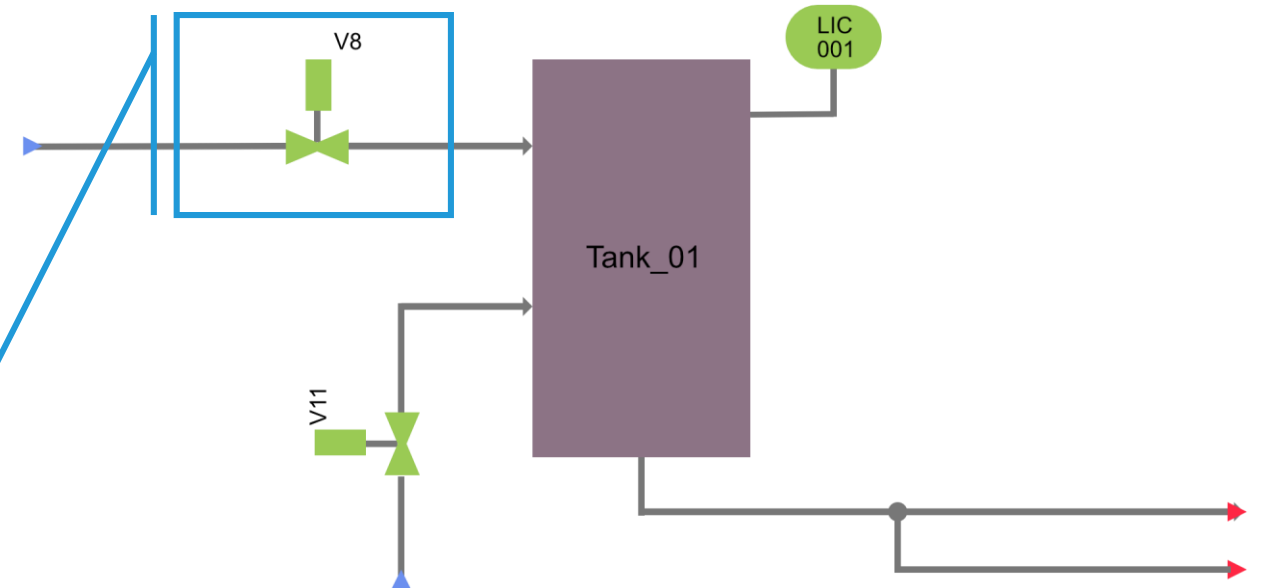
PEA
B

HMI aspect of the HMI

Modelling of VisualObjects

- Each VisualObject is defined as *InternalElement* including the *attributes*:
 - Reference to the InstanceList:
RefID
 - Visual information:
X, Y, Width, Height, Rotation, eClass-reference

Name	Value	DataType
Width	98	xs:double
Height	164	xs:double
X	415	xs:double
Y	250	xs:double
Rotation	0	xs:double
RefID	0fc0d6bd-688c-4f34-bea4-92e0deedc94	xs:ID
ZIndex		xs:integer
eClassVersion	10.1	xs:string
eClassClassificationC	27220601	xs:string
eClassIRDI		xs:string



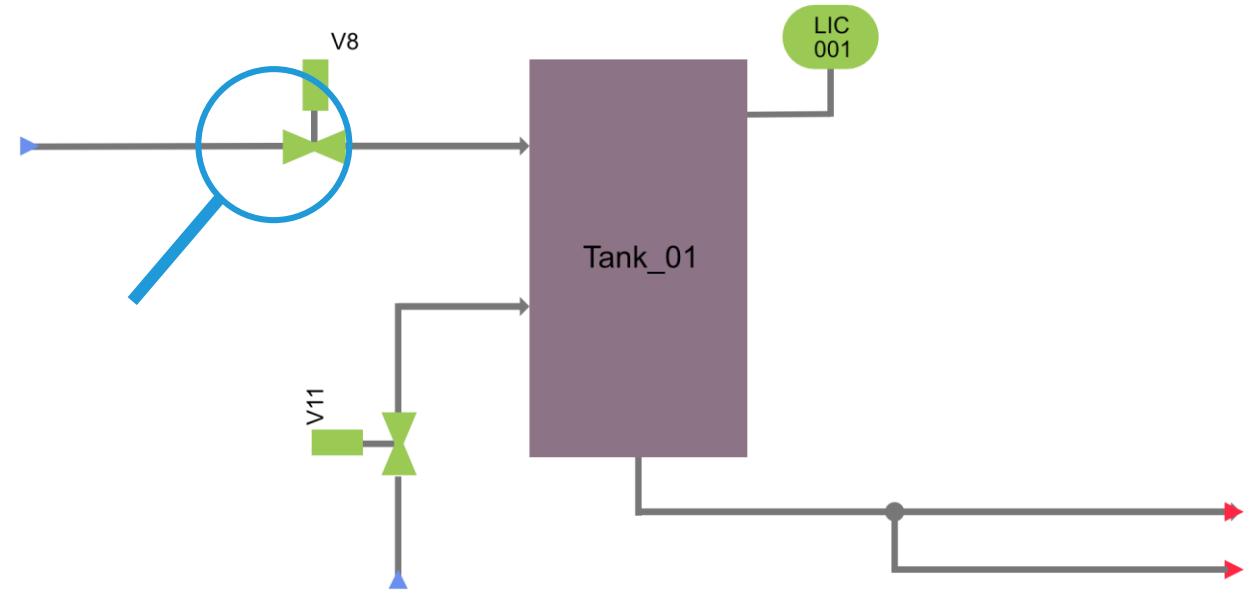
Simple example of an HMI within the PEA-Engineering

HMI aspect of the HMI

Modelling of connections

- Connections are modelled by PortObjects, *Interfaces* and *InternalLinks*
- The PortObjects and *Interfaces* differ by the type of connection

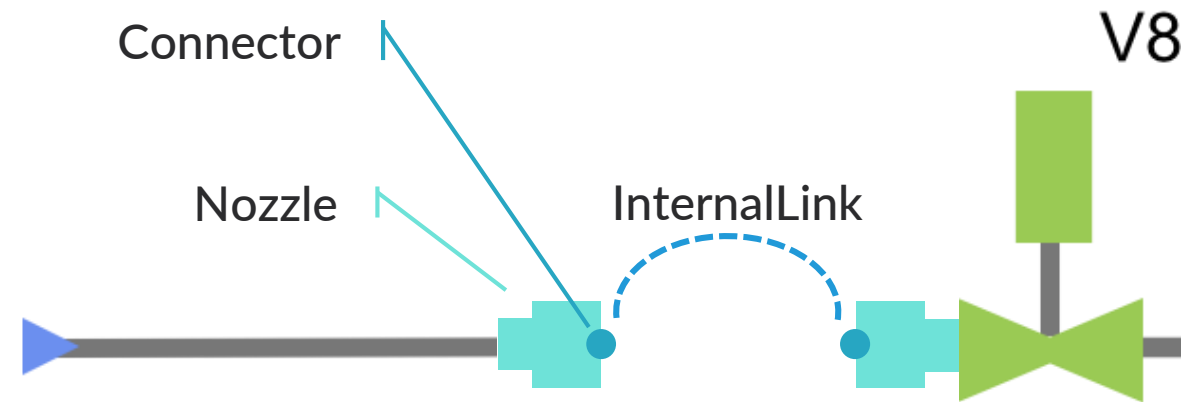
Type of connection	PortObject-SUC	InterfaceClass
MassFlow	Nozzle	MassFlow Connector
InformationFlow	MeasurementPoint /LogicalPort	InformationFlow Connector



Simple example of an HMI within the PEA-Engineering

HMI aspect of the HMI

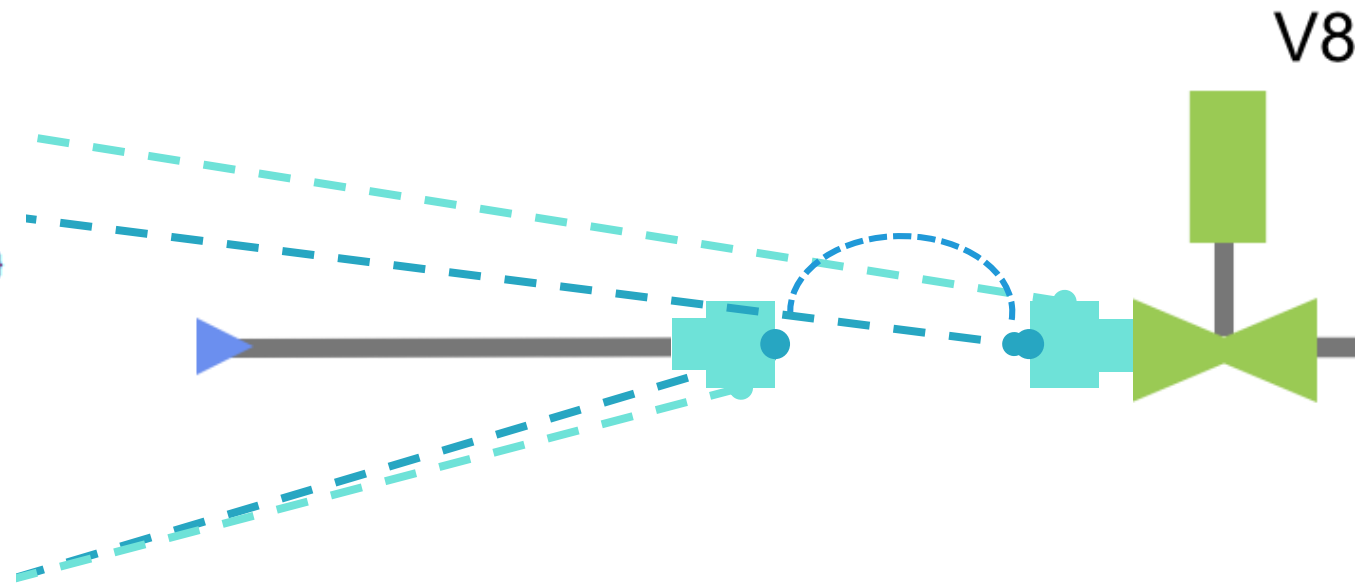
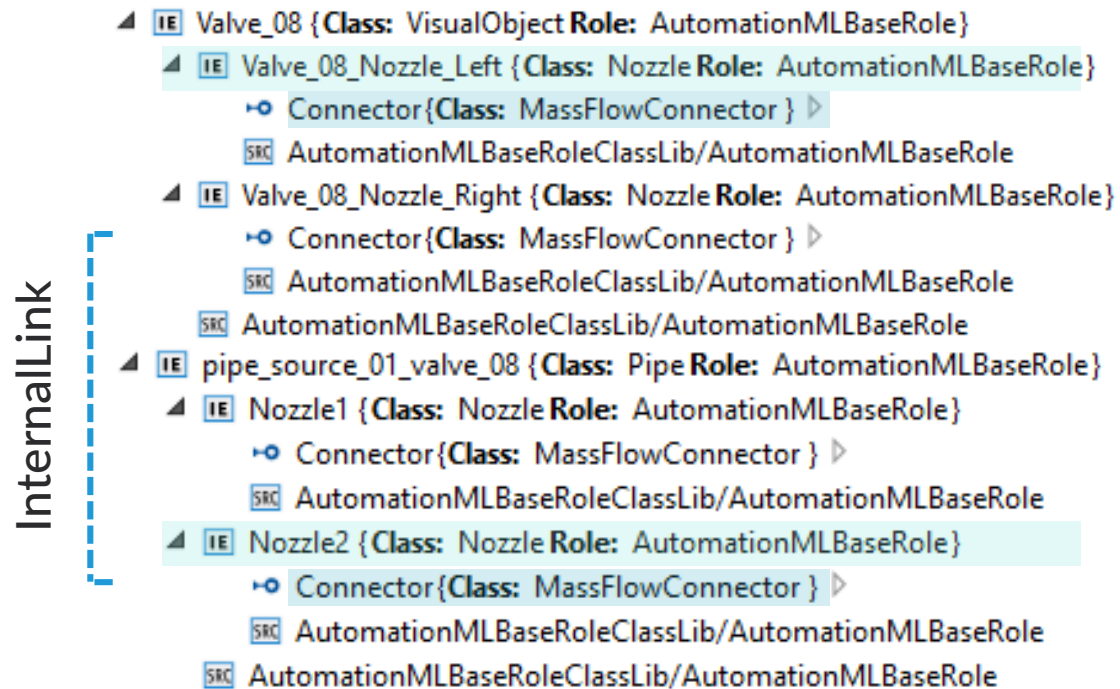
Modelling of connections



HMI aspect of the HMI

Modelling of connections

- Also Pipes, FunctionLines and MeasurementLines are modelled as *InternalElements*

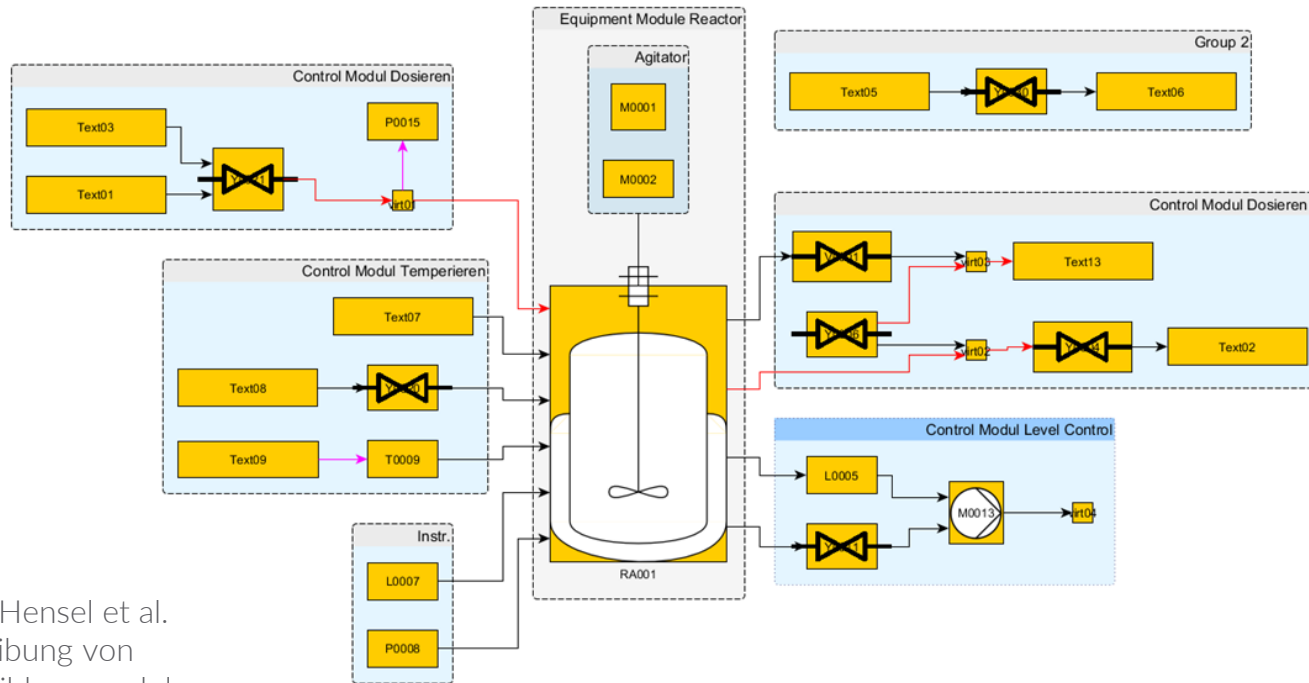


- Pixel and connection-driven relation is required
- Coordinates of PortObjects have to be identical

HMI aspect of the HMI

HMISUCLib

- To group objects, the *SUC* SemanticGroup shall be used.



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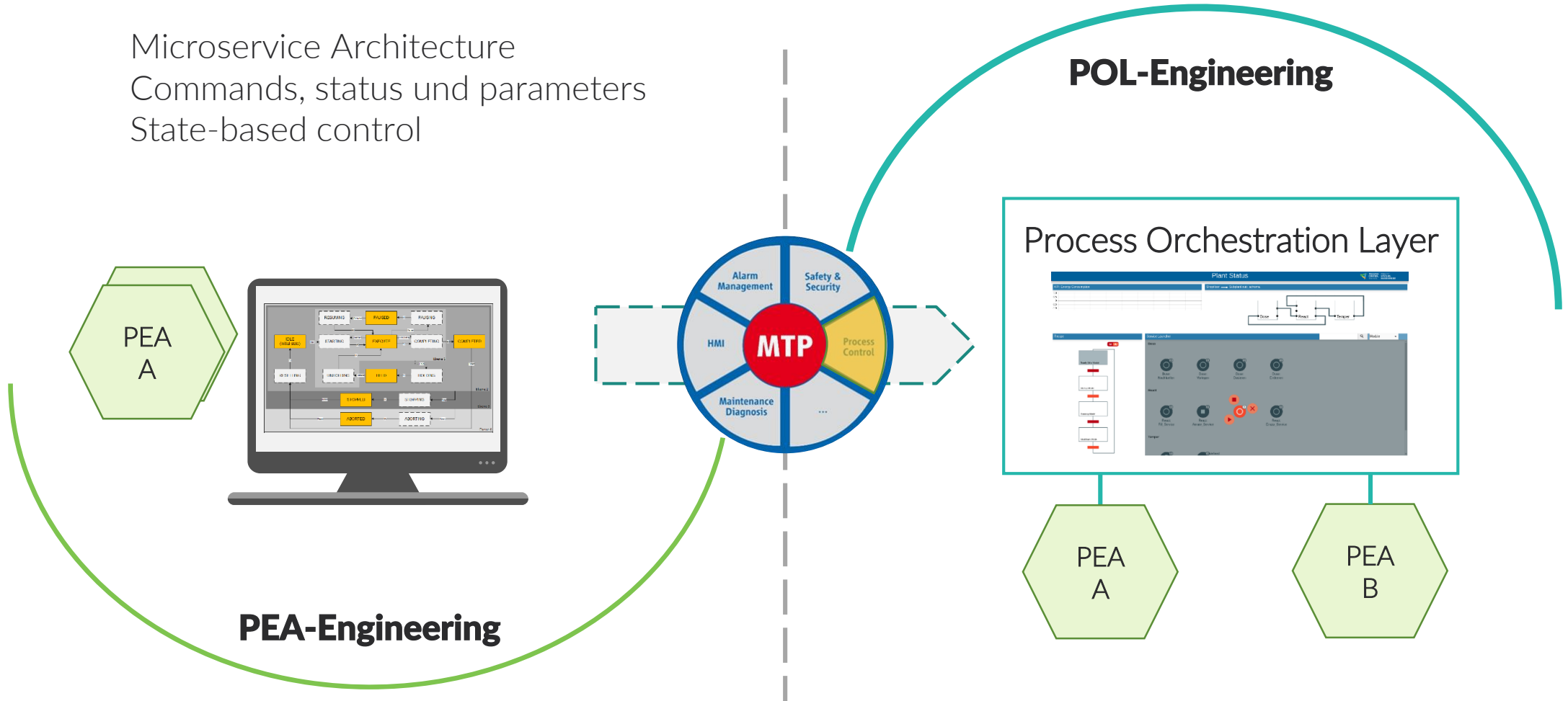
    ▲ SUC HMISet {Class: MTPSet}
        ↳ HMIReference{Class: ExternalDataConnector }
    ▲ SUC Picture {Role: AutomationMLBaseRole}
        SRC AutomationMLBaseRoleClassLib/AutomationMLBaseRole
    ▲ SUC SemanticGroup {Role: AutomationMLBaseRole}
        SRC AutomationMLBaseRoleClassLib/AutomationMLBaseRole
    SUC VisualObject {Class: LinkedObject}
    ▲ SUC PortObject {Role: AutomationMLBaseRole}
        SRC AutomationMLBaseRoleClassLib/AutomationMLBaseRole
    ▲ SUC LogicalPort {Class: PortObject}
        ↳ Connector{Class: InformationFlowConnector }
    ▲ SUC MeasurementPoint {Class: PortObject}
        ↳ Connector{Class: InformationFlowConnector }
    ▲ SUC Nozzle {Class: PortObject}
        ↳ Connector{Class: MassFlowConnector }
    ▲ SUC TopologyObject {Role: AutomationMLBaseRole}
        SRC AutomationMLBaseRoleClassLib/AutomationMLBaseRole
    ▲ SUC Junction {Class: TopologyObject}
        ▷ IE Nozzle3 {Class: Nozzle Role: AutomationMLBaseRole}
        ▷ IE Nozzle2 {Class: Nozzle Role: AutomationMLBaseRole}
        ▷ IE Nozzle1 {Class: Nozzle Role: AutomationMLBaseRole}
    ▲ SUC Termination {Class: TopologyObject}
        ▷ IE Nozzle {Class: Nozzle Role: AutomationMLBaseRole}
        SUC Sink {Class: Termination}
        SUC Source {Class: Termination}
    ▲ SUC Connection {Role: AutomationMLBaseRole}
        SRC AutomationMLBaseRoleClassLib/AutomationMLBaseRole
        ▷ SUC Pipe {Class: Connection}
        ▷ SUC FunctionLine {Class: Connection}
        ▷ SUC MeasurementLine {Class: Connection}
  
```

Source: Hensel et al.
Beschreibung von
Bedienbildern modularer
Anlagen. Automationskongress.
2017. Baden-Baden.

Service-aspect of the MTP

The service aspect is similar modelled to the HMI aspect

Microservice Architecture
Commands, status und parameters
State-based control



Summary and Outlook

MTP as vendor-independent model for PEAs

- The MTP is divided into different aspects
- Each aspect is standardized in separated parts of VDI/VDE/NAMUR 2658
- The agile standardization results in a high quality standard, which is on its way to become an IEC standard
- Further aspects which will be standardized are:
 - Alarm Management
 - OPC UA Communication
 - Maintenance
 - Pharma Requirements
 - Safety Requirements
- The MTP market is continuously growing
- Solutions to generate MTPs based on engineering tools are soon accessible



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