Semantic Mapping Support for Mechatronic Objects in AutomationML

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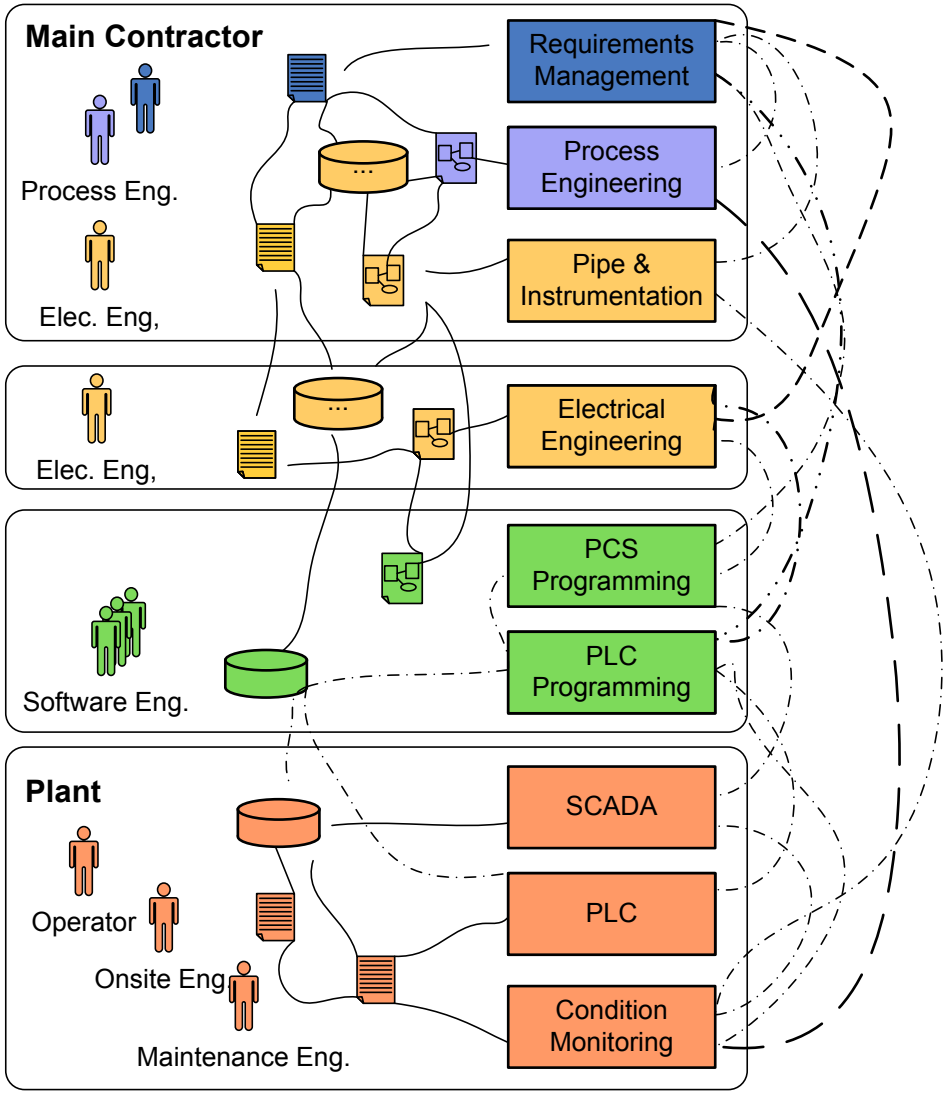
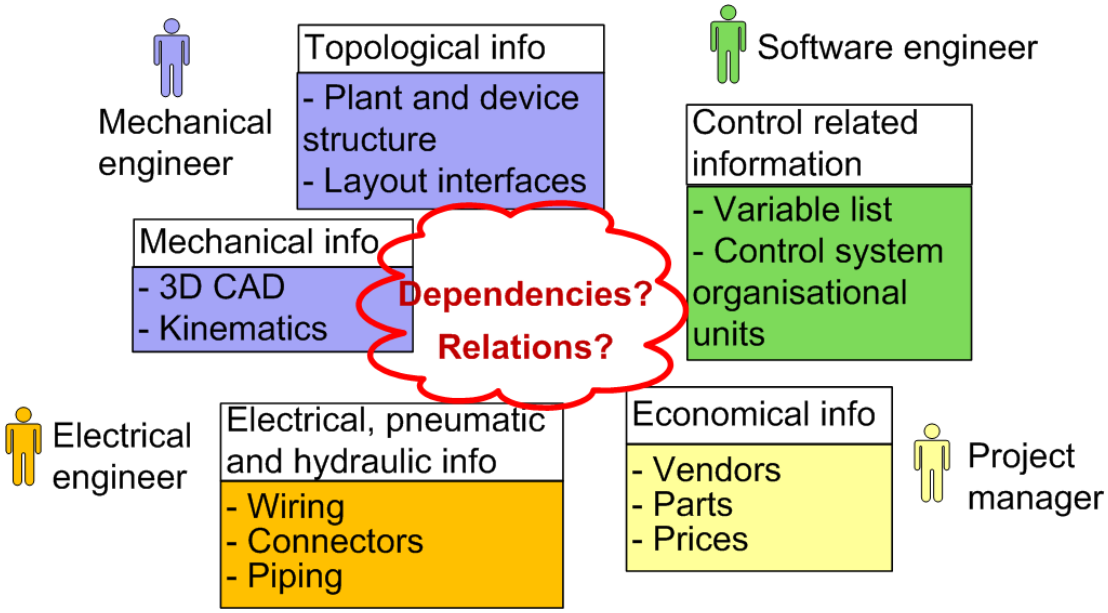
Production Systems Engineering Environments



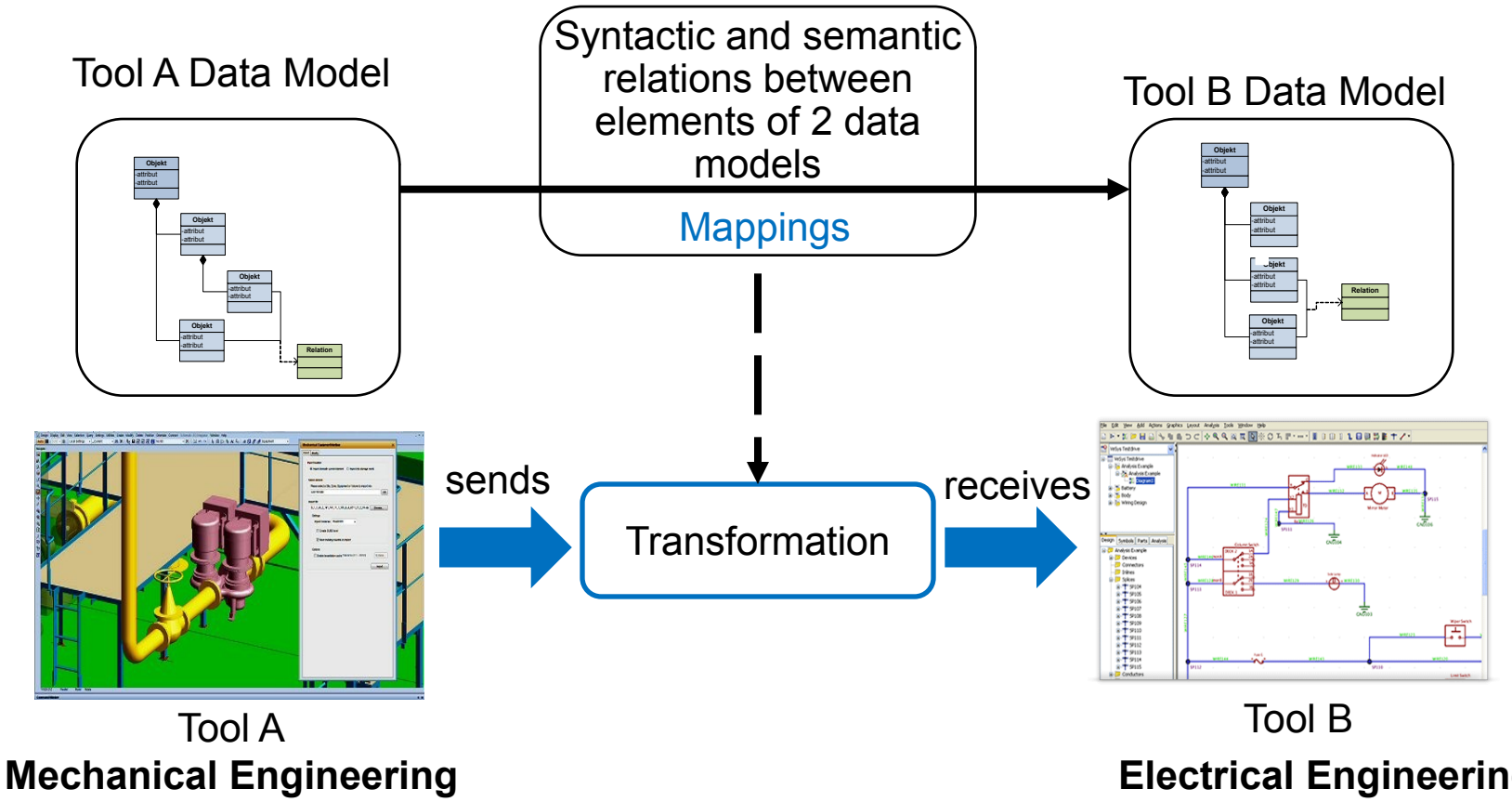
- **Multi-disciplinary engineering**
  - Cooperation of different engineering disciplines
- **Various Heterogeneities**
  - Technical: different eng. tools
  - Semantic: dissimilar data models and data formats
  - Process: tailored engineering processes
- **Needs**
  - Data exchange and data analysis across discipline and tool boundaries
  - Explicit specification of dependencies and relations between heterogeneous data models

Information Exchange in Production Systems Engineering

- Machine-understandable definition of relations between engineering views
  - E.g., to automate consistency checking, change management
- No standardized means to represent relations and dependencies
- **Goal**
  - Investigate capabilities of AutomationML to represent semantic mappings, i.e. Relations and dependencies between eng. models



Interaction Scenario across Discipline and Tool Boundaries in Mechatronic Environments



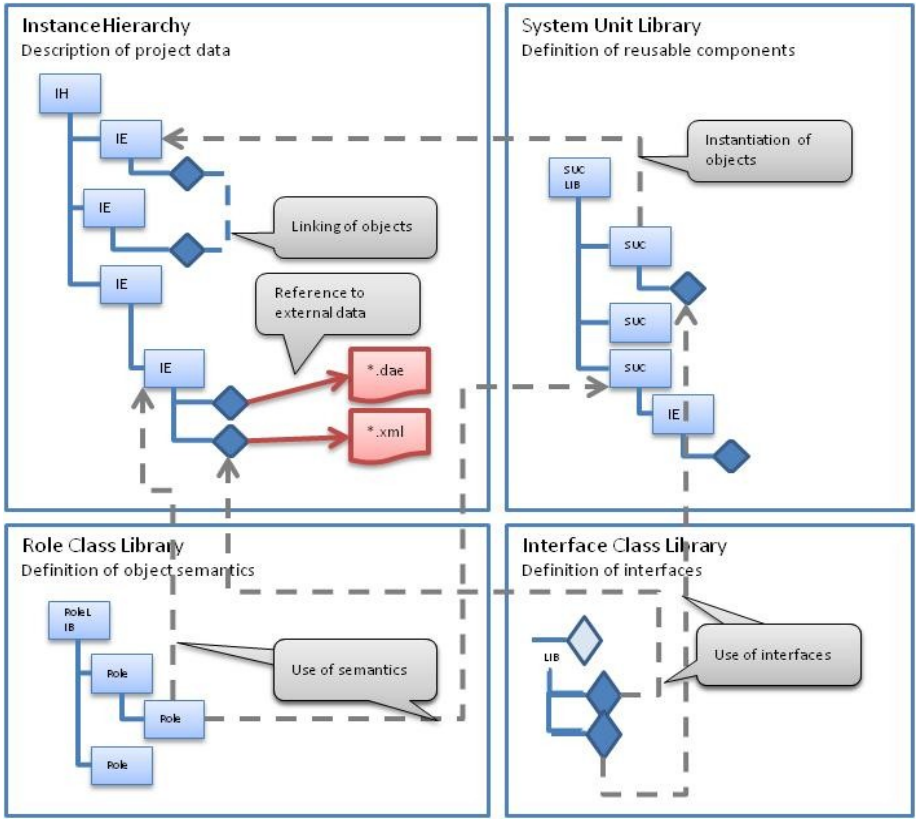
Semantic Mapping Types

- ***Mapping*** – captures the semantic and structural relationships between the entities of two data models, i.e.
  - Formally and explicitly defined
  - In enough detail to allow data interpretation

- **Identified mapping types**:
  - M1: Value processing
    - M1.1: String processing
    - M1.2: Data type transformation
    - M1.3: Math functions
    - M1.4: External functions call
  - M2: Granularity
  - M3: Schematic differences
  - M4: Conditional mappings
  - M5: Bidirectional mappings
  - M6: Grouping and aggregation
  - M7: Restrictions on values

Modeling Mappings in AutomationML

- **Major modeling means**
  - *Role Class Libraries* modeling object semantics
  - *Interface Class Libraries* modeling object relations and references to external information
  - *System Unit Class Libraries* modeling production system component libraries
  - *Instance Hierarchies* with internal elements modeling the hierarchy of production system components in a recent project or setting



Modeling Mappings in AutomationML (cnd)

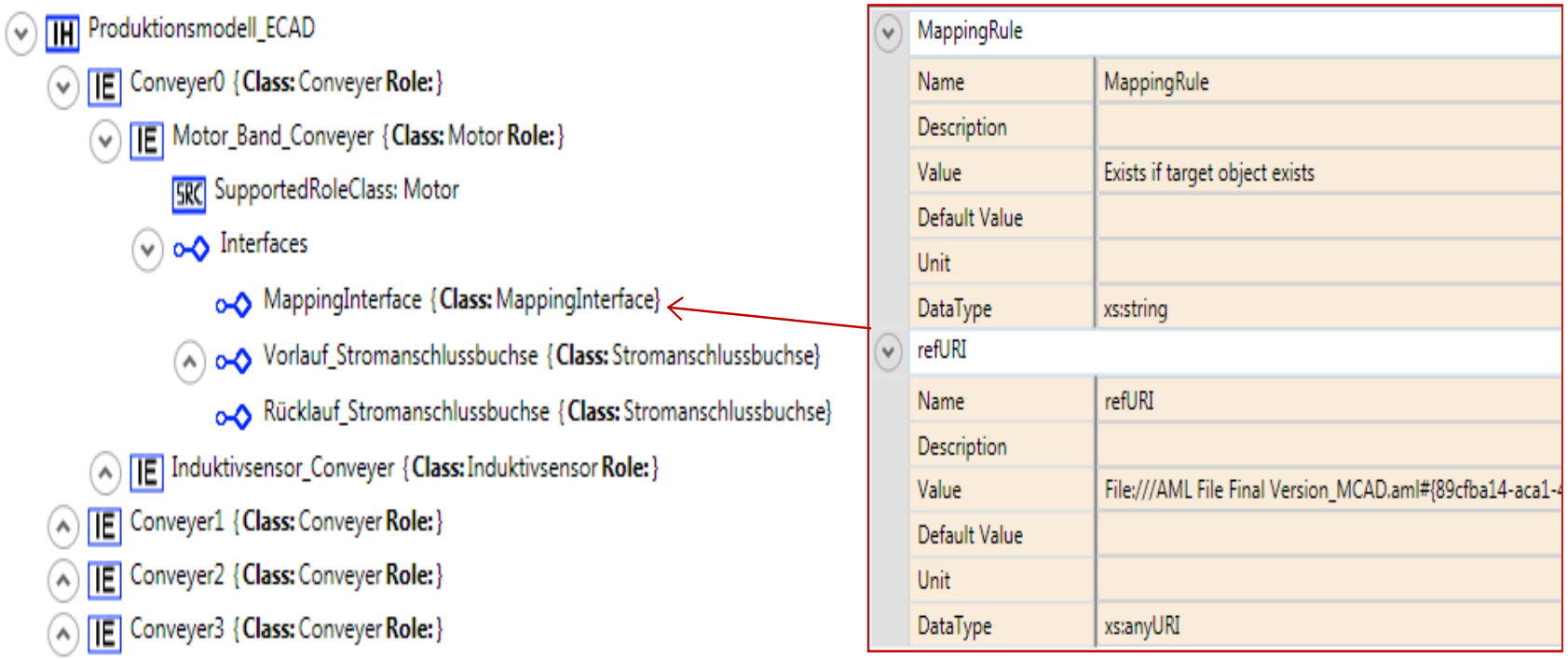
- **Modeling capabilities**
  - A1: Part – Subpart relation in InstanceHierarchy
  - A2: Mirror objects
  - A3: Interfaces
  - A4: Interface – InternalLink combination
  - A5: Interface - InternalLink – InternalElement combination
  - A6: Semantic reference attribute
  - A7: RefBaseSystemUnitClassPath attribute
  - A8: RoleRequirement and SupportedRoleClass Attribute

		Mappings									
		M1.1	M1.2	M1.3	M1.4	M2	M3	M4	M5	M6	M7
AutomationML	A1	-	-	-	-	+	-	-	-	+	-
	A2	-	-	-	-	+	+	-	-	-	-
	A3	+	+	+	+	+	+	+	+	-	+
	A4	-	-	-	-	-	-	-	+	-	-
	A5	+	+	+	-	-	-	+	+	-	+
	A6	+	+	-	-	+	+	-	-	-	-
	A7	-	-	-	-	+	-	-	-	-	-
	A8	-	-	-	-	+	+	-	-	-	-

Different modeling possibilities have different capabilities for mapping representation

AML Example 1: Mappings crossing File Borders

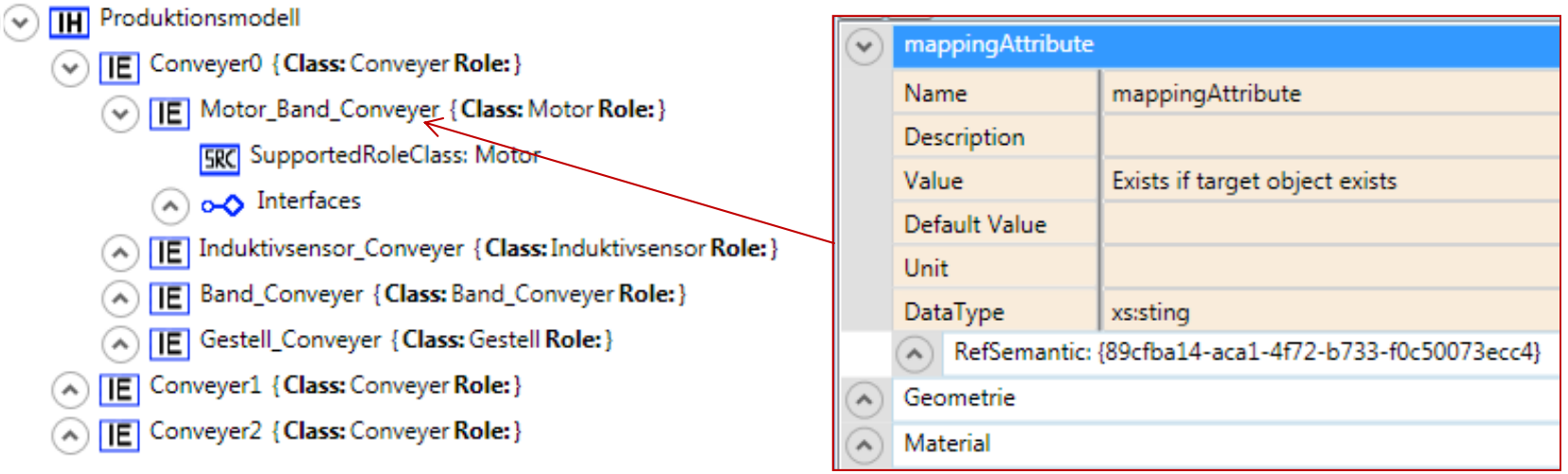
- Different AutomationML files for the mechanical, the electrical and the control engineering parts
  - Only the external interfaces (Modelling type A3) is applicable



AML Example 2: Mappings crossing Domain-Specific Hierarchy Borders

- One CAEX file
- Two or more instance hierarchies for different engineering disciplines

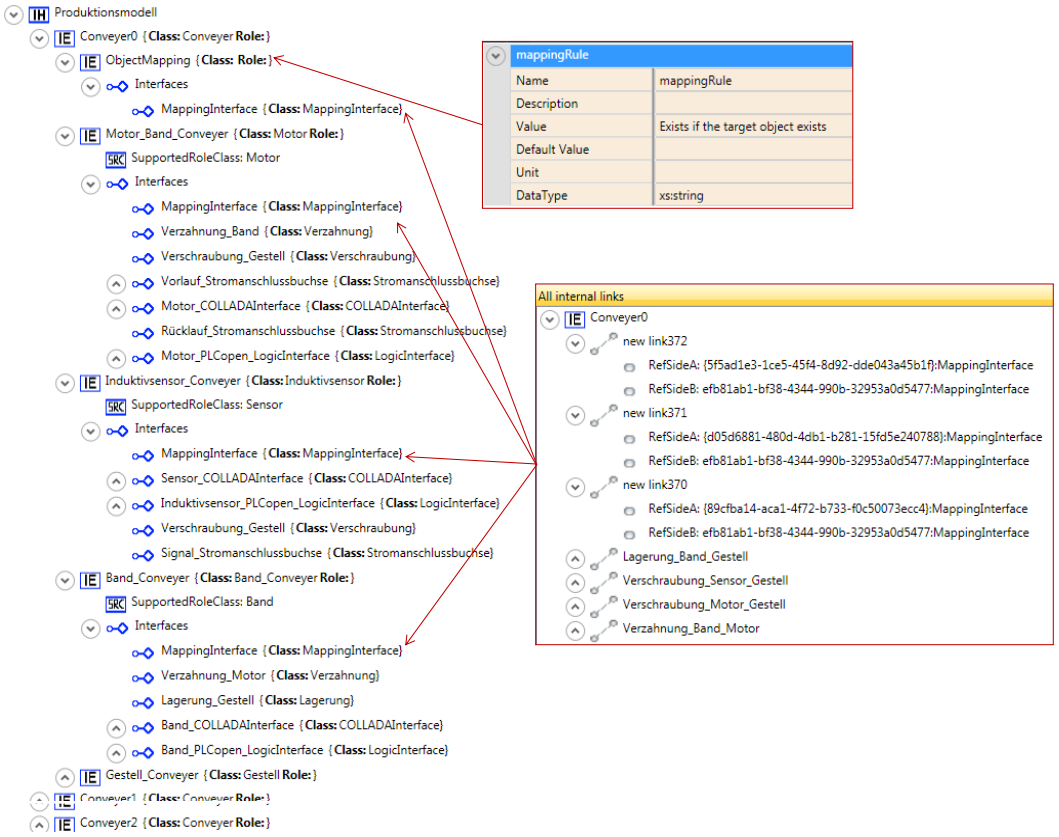
- RefSemantic within attributes (Modelling type A6) is best applicable in this case
  - Can carry an identifier enabling the identification of other objects
  - Attribute hosting the reference can carry the description of the mapping



AML Example 3: Mappings within one Instance Hierarchy

- One CEAX file with one instance hierarchy to model all relevant engineering data

- All modeling types can be applied, except for
  - External interfaces (modelling type A3)
  - Common semantic representations (modelling types A7 and A8)



Summary

- We investigated how semantic mappings between engineering models can be represented in the data exchange standard AutomationML.
- All required mapping types can be represented in AutomationML.
- But there is no clear guideline in the AutomationML context on how to represent relations and dependencies between model views.
- Such a guideline depends on the application case, i.e. whether
  - the mapping connecting objects of different files or in the same file, and
  - different instance hierarchies or
  - the same hierarchy.
- Future work will investigate guidelines for engineers and tools on best practices for representing links between engineering models extending current practice.