



OTTO VON GUERICKE
UNIVERSITÄT
MAGDEBURG

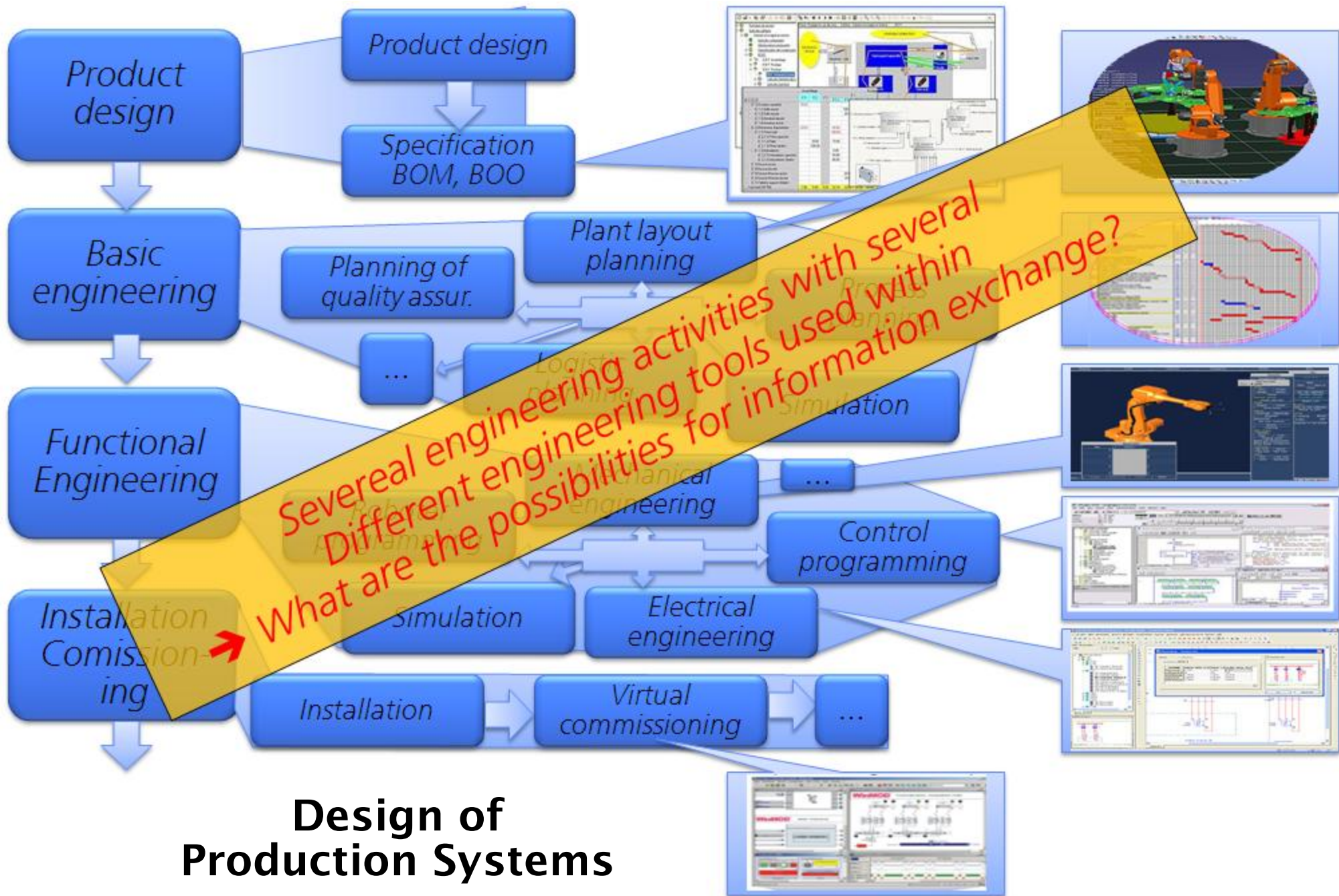
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INSTITUT FÜR ARBEITSWISSENSCHAFT,
FABRIKAUTOMATISIERUNG
UND FABRIKBETRIEB

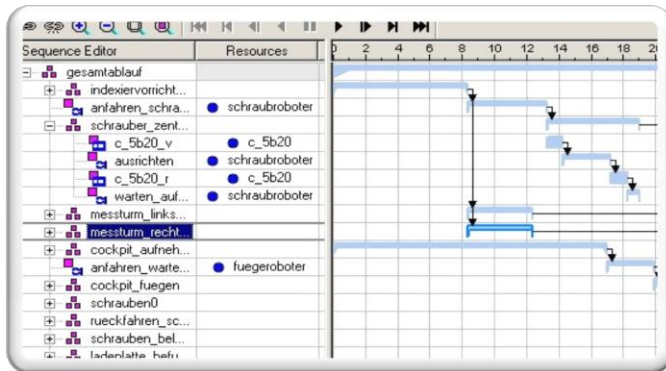
AutomationML

Today, Tomorrow, and After Tomorrow

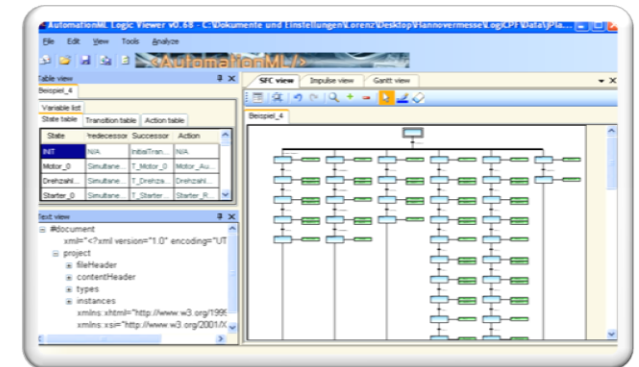


„This is mine it will never be yours stay away, from what I love.“*

Tools consider engineering information as is its own properties, which should not be used by other tools.



Engineering tool 1



Engineering tool 2

*Beatsteaks (2007): Limbo Messiah. Lied 5 - Demons Galore. Audio CD: Warner Music International (Warner)

Problem

- **Exchange of engineering data along engineering phases, engineering tools, persons, ...**
- **Ensure compatibility and interoperability especisly for tools**

- Compatibility between elements of a system is defined by the level of integration assessed with respect to the agreeability of properties of the elements which are in interaction
- Interoperability of elements of a system is defined by the level of integration assessed with respect to the degree of involvement of the interaction of these elements to the fulfillment of the system functionalities

		Koexistenz	Kompati- bilität	Interope- rabilität	Austausch- barkeit
Methode Engineering- prozess	Gleiche Nutzerführung				
	Gleiche Engineeringmethode				
Semantik	Gemeinsame Engineeringrollen				
	Gleiche Modelle				
Abstrakte Syntax	Gleiche Engineeringdisziplinen				
	Gleiche Engineering Artefakte				
Konkrete Syntax	Gemeinsame Datenbasis				
	Gemeinsame Datenschnittstellen				

Aims

- Hierarchies of system structures
- Interfaces of hierarchies
- Device descriptions

- Geometrie of systems and its components
- Kinematik of systems and its components

- Interfaces
- Wiring plans
- Piping plans
- ...

**Information sets are not disjoint and independent
They have interrelations and dependencies**

Topology Information

Mechanical Information

Electrical, Hydraulic, Pneumatical Information

Further Information

Mechatronics Unit

Function Describing Information

- Uncontrolled (physical) behaviour
- Controlled behaviour
- Functional parameters
- Technology descriptions

- Economic data like costs and floor size requirements
- Functional oriented data like weight and energy consumption
- Use related data like handbooks and mounting guides
- Team related data like required knowledge and skills

Control information

- Variable declaration
- Control code
- I/O interfaces
- Fieldbus configuration

Engineering artifacts and information sets

- Hierarchies of system structures
- Interfaces of hierarchies

- Geometrie of systems and its components
- Kinematik of systems and its components

- Interfaces

**Topology
Information**

**Mechanical
Information**

**Electrical,
Hydraulical,
Pneumatical
Information**

- Uncontrolled (physical) behaviour
- Controlled behaviour
- Functional parameters

**Further
Information**

**Mechatronics
Unit**

**Function
Describing
Information**

- Economic data like costs and floor size requirements
- Functional oriented data like weight and energy consumption

**Control
information**

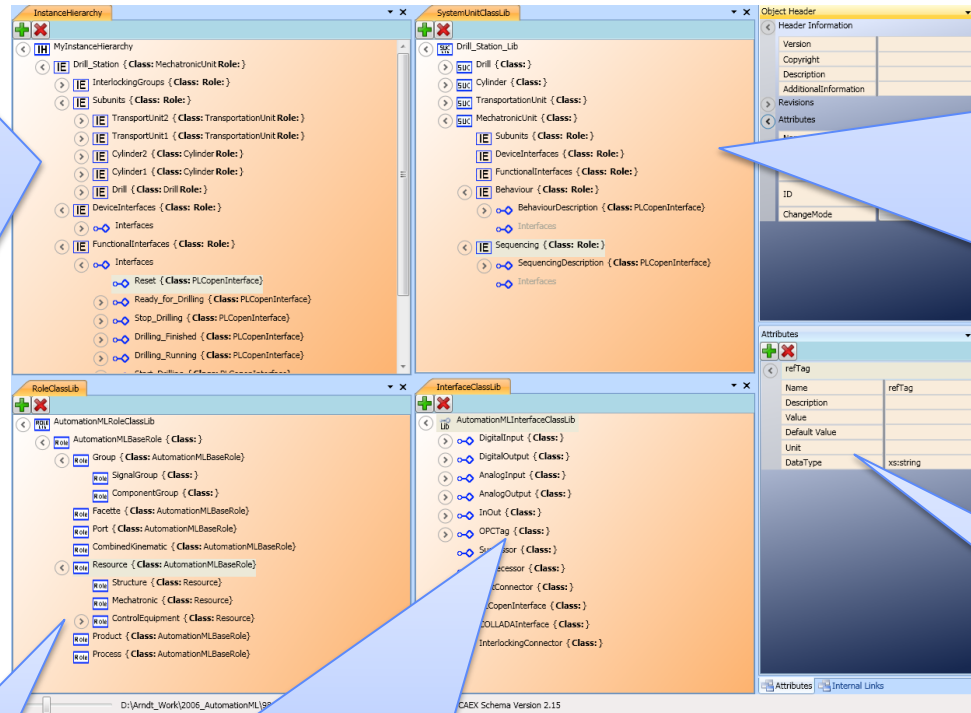
- Variable declaration
- Control code
- I/O interfaces

Engineering artifacts and information sets

- **CAEX (IEC 62424) provides the basis for information modelling**

InstanceHierarchy

- *Description of system structure, representation of different relevant objects and object parts*
- *Hierarchies of elements with properties*
- *Grouping of information sets for the different system objects*
- *Visualization of a project or parts of a project*



SystemUnit ClassLib

- *Description of generic system components*
- *Specification of reusable objects within libraries*

RoleClassLib

- *Specification of object semantics*
- *Specification of expected substructures (including attributes) of objects and its semantics*

InterfaceClassLib

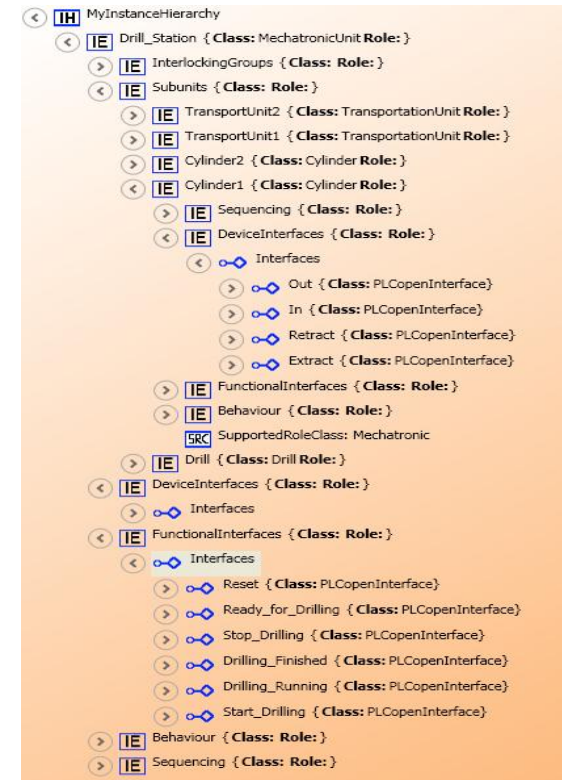
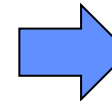
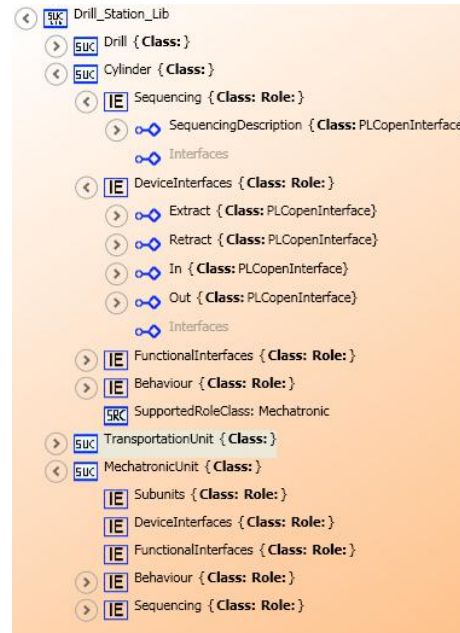
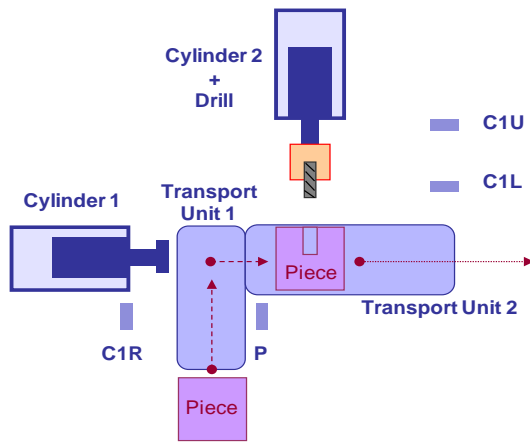
- *Specification of useable interfaces*
- *Interfaces between system objects*
- *References to information stored externally (e.g. in COLLADA and PLCopen)*

Attributes

- *Description of specific properties and conditions of objects*
- **Internal Links**
- *Representation of dependencies of / connections between interfaces*

What provides AutomationML today ?

1. Element breakdown of system to reusable components and devices, Representation of these components and devices by SystemUnitClasses
2. Instantiation, combination and interlinking of System UnitClasses for representation of system topologies within InstanceHierarchy



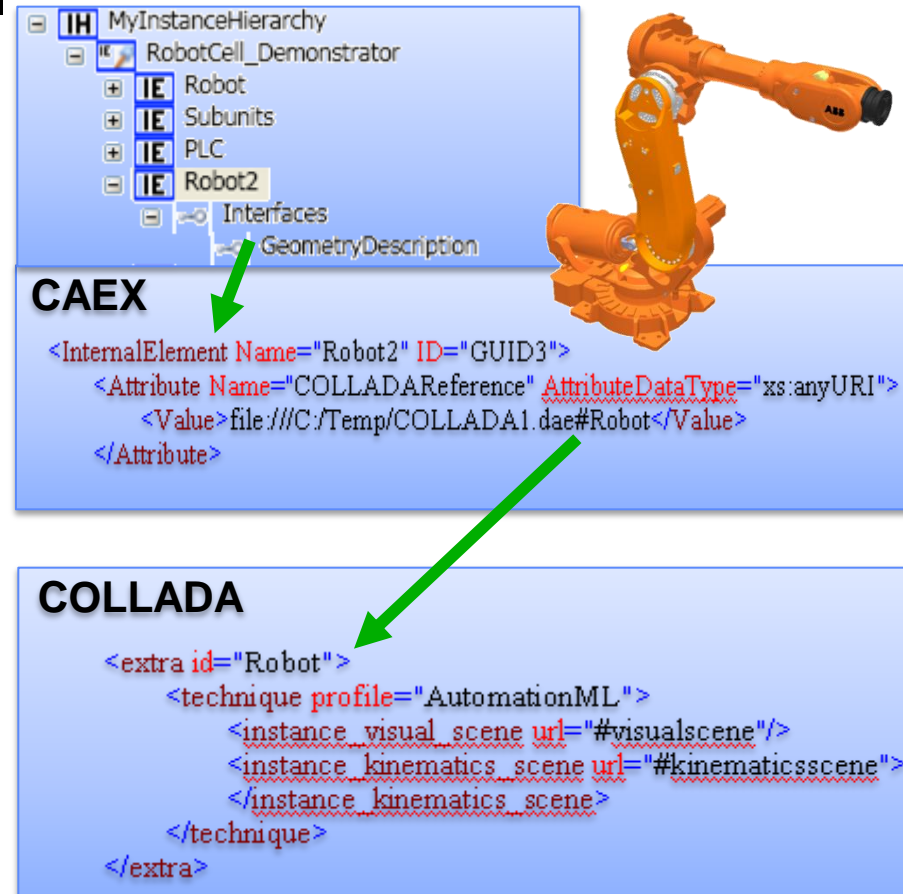
Usable for structured representation of plants, for the collection of reusable elements, for the exchange of structure information, ...

What provides AutomationML today ?

- **Geometry and Kinematic information are represented by COLLADA**

- XML based representation of geometrical and kinematical information as unique referenced object structures
- Integration within topology structures by CAEX reference mechanisms
- Combination of partial models in CAEX exploiting special attributes for position information representation

- **Currently applicable for the modeling of complex CAD information**



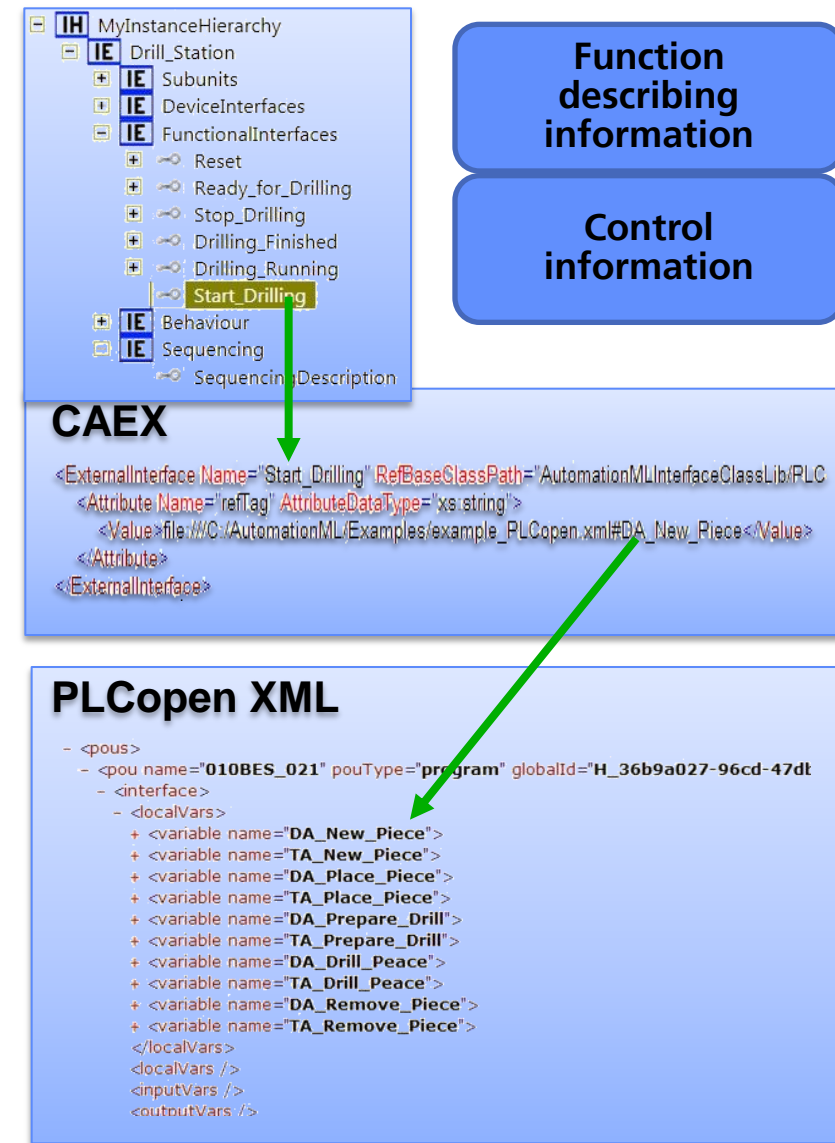
What provides AutomationML
today ?

- **Sequencing and behavior information are represented by PLCopen**

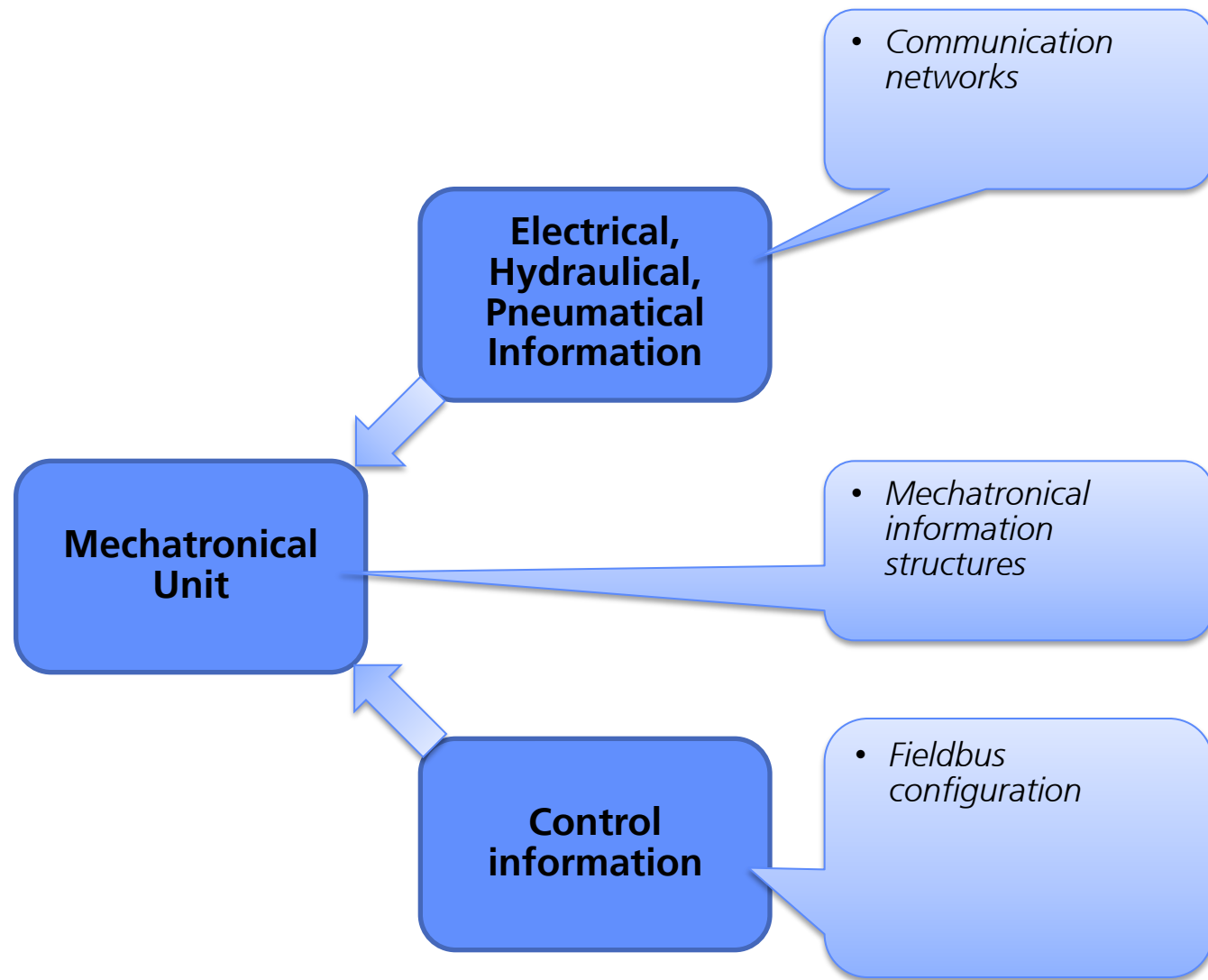
- XML based representation of sequencing and behavior exploiting a unique mapping to SFC and exploitation of unique references to objects
- Integration within topology structures by CAEX reference mechanisms
- Combination of different behavior models in CAEX using variable interlinking

- **Possible behaviors to be described**

- Uncontrolled behavior (Behaviour)
- Controlled behavior (Sequencing)
- Illegal states (Interlocking)

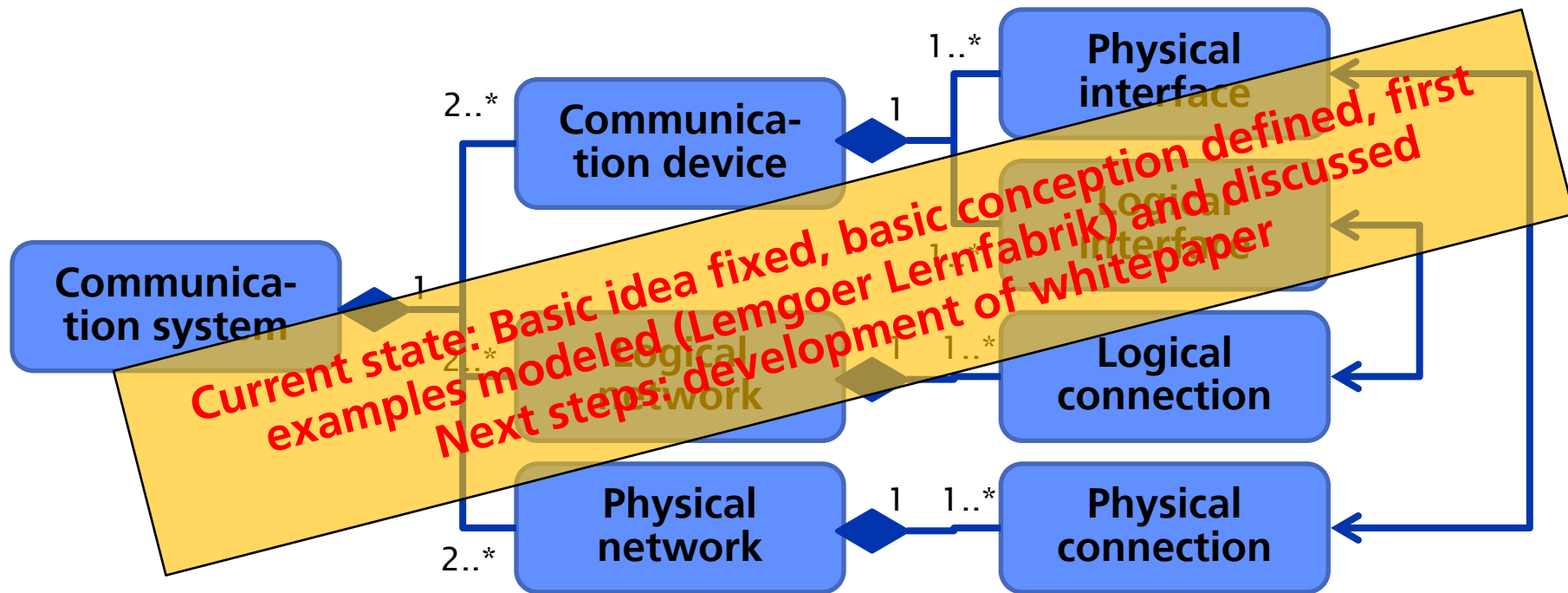


What provides AutomationML today ?



What provides AutomationML tomorrow ?

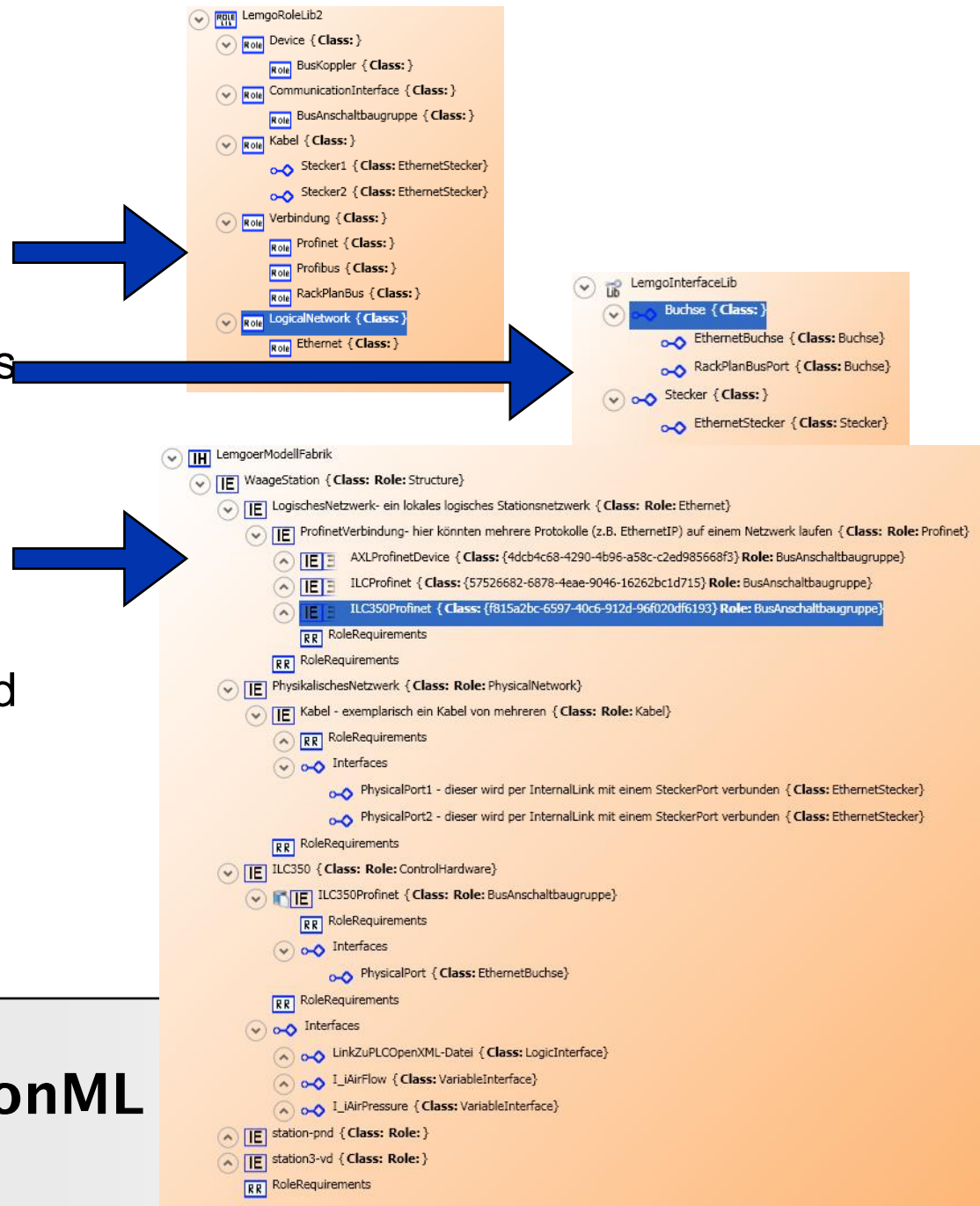
- Communication systems will be described using CAEX
- Basement is the distinction of
 - Devices with logical and physical interfaces
 - Logical networks consisting of interconnections of logical interfaces
 - Physical networks consisting of interconnections of physical interfaces



What provides AutomationML tomorrow ?

• Communication profil defines

- Role classes for the specification of semantics of devices, interfaces, physical and logical connections
- Interface classes for plugs and jacks
- Distinction between physical networks with wires and logical networks with connections consisting of groups or mirror objects
- Properties of devices, networks, and connections are represented by attributes of the relevant InternalElements



What provides AutomationML tomorrow ?

- **Defined description rules**

- Communication is described by devices, physical networks, and logical networks

- Devices

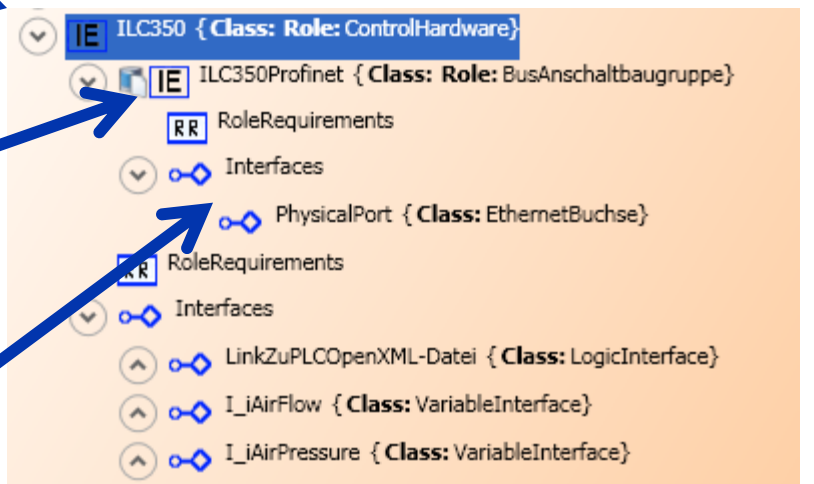
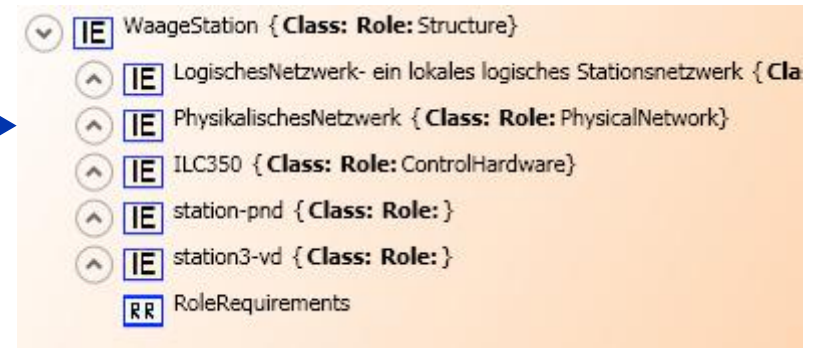
- » Will contain the hardware topology terminating at signals
- » Signals are defined by logic group
- » Communication relevant parameters and properties of signals are attached to signals
- » Communication relevant parameters and properties of devices are attached to devices

- Devices will contain „CommunicationInterfaces“

- » Communication relevant parameters and properties of CommunicationInterfaces are attached to CommunicationInterfaces

- „CommunicationInterfaces“ will contain “Jacks”

- » Jacks will be connected to plugs of wires
- » Communication relevant parameters and properties of jacks are attached to jacks



What provides AutomationML tomorrow ?

- **Defined description rules**

- Physical networks

- » Physical networks will contain wires
 - » Communication relevant parameters and properties of wires are attached to wires

- Wires will contain plugs

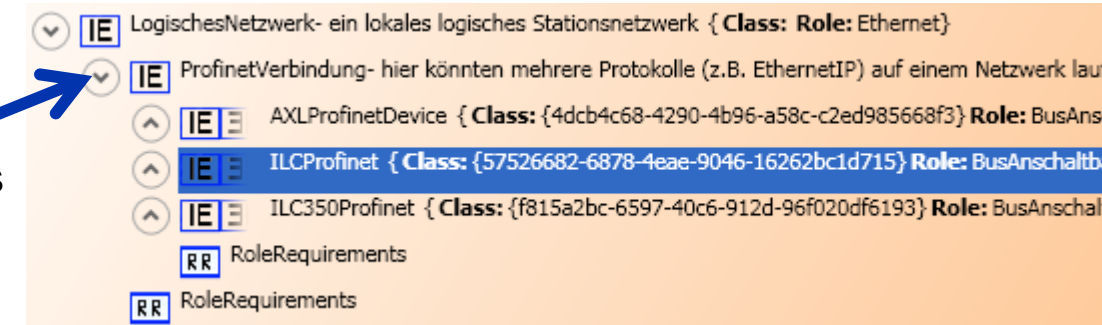
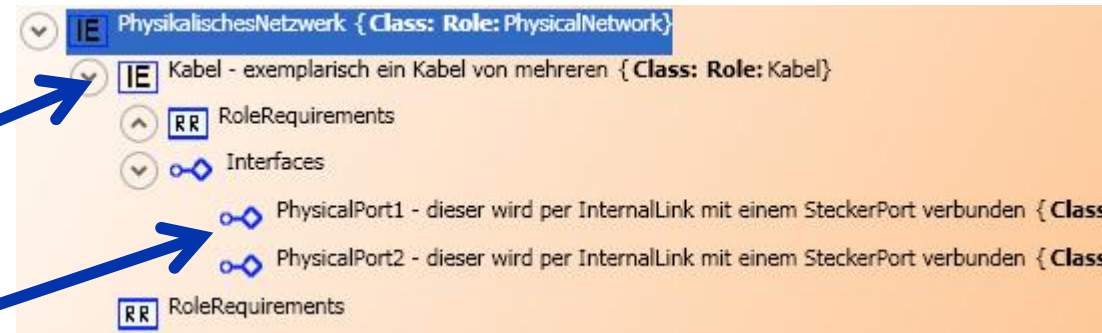
- » Plugs will be connected to jacks by internal links
 - » Communication relevant parameters and properties of plugs are attached to plugs

- Logical networks

- » Logical networks will contain connections
 - » Communication relevant parameters and properties of connections are attached to connections

- „Verbindungen“ enthalten „Mirror-Objekte“ vom Typ „CommunicationInterface“

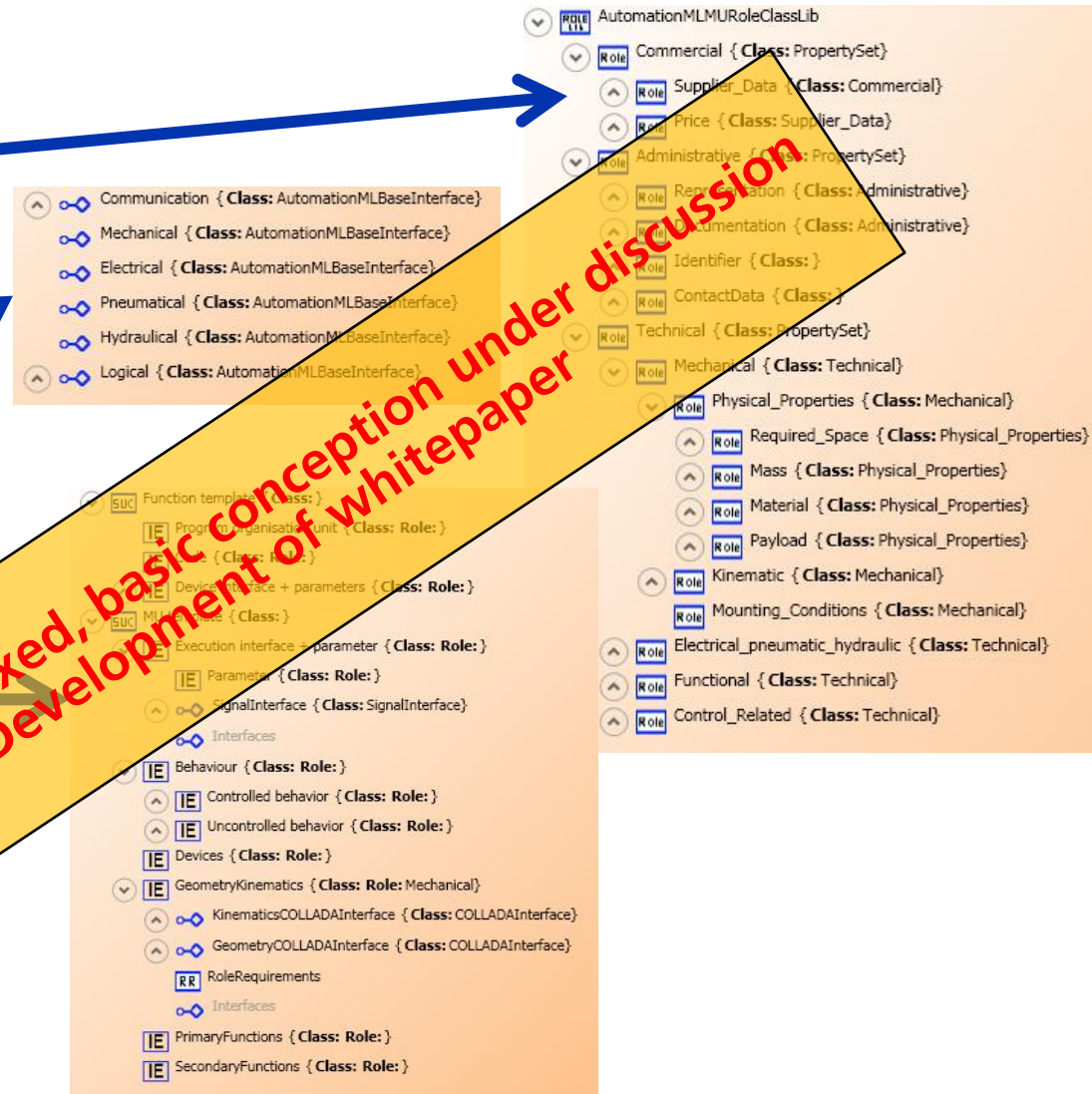
- By integration of plugs in devices and its connections by wires will enable the mapping of logical networks and physical networks



What provides AutomationML tomorrow ?

• Mechantonic profil defines

- RoleClassLibraries are used to define semantics of objects and attributes exploiting the role „PropertySet“
- InterfaceClasses for representation of domain oriented interconnections of objects
- SystemUnitClasses with possibilities of engineering domain related structuring of information sets of mechatronical units simplifying the information retrieval by providing clear semantics



What provides AutomationML tomorrow ?

- *Device descriptions*

- *Consideration of alternative representations of geometric and kinematic information for integration of further standards*

- *Wiring*
- *Piping*

**Topology
Information**

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**Further
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**Mechatronics
Unit**

**Function
Describing
Information**

- *Process description using PPR concepts*

- *Use related data like handbooks and installation guidelines*

- *Extension of volatile data sets to project databases*

What provides AutomationML after tomorrow ?

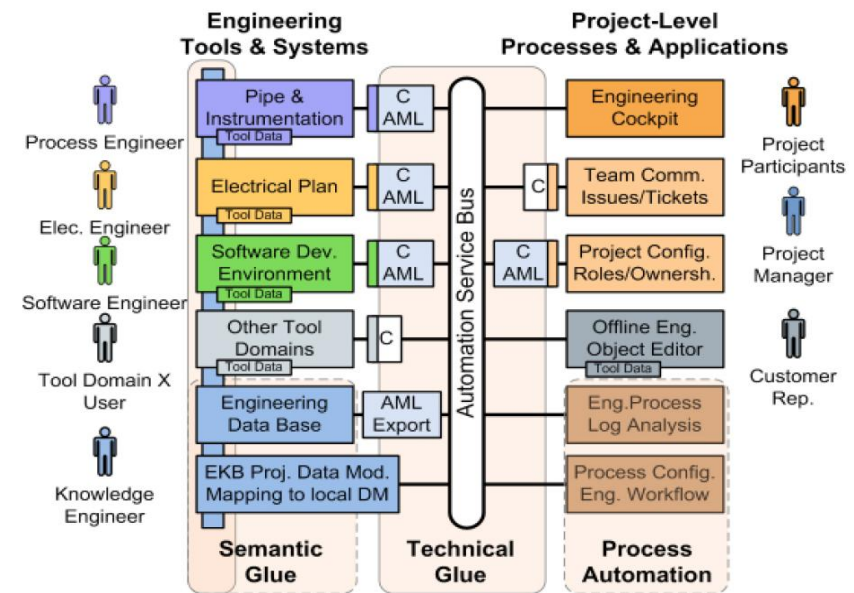
- **Consideration of possibilities for the representation of arbitrary graph based structures of systems and its representation in AutomationML**
 - What are the main similarities of these systems and how can they be mapped to a common meta-model?
 - How will this meta-model be mapped to the XML based dialects of AutomationML?
 - How can this structure be exploited to represent wiring plans, piping plans, etc.?
 - Executed within Logic Working Group
 - First activities started for meta-model definition
- **Consideration of possibilities for the representation of dependencies between products, processes and resources**
 - Which information have to be stored to represent products, processes and resources properly?
 - How are the dependencies between these information?
 - How can they be expressed in AutomationML?
 - Executed within Robotic Working Group
 - First activities started by considering the example of knowledge representation for process engineering in tooling industry

What provides AutomationML
after tomorrow ?

- **Analysis of alternative descriptions for geometry and kinematics information**
 - Which description means / data formats are relevant in practice? Which application potential will they provide to AutomationML?
 - How can these description means / data formats be integrated in AutomationML in completion to COLLADA?
 - Executed within Robotic Working Group
- **Integration of arbitrary pdf-based information carriers for different purposes**
 - Handbooks, installation guidelines, maintenance guidelines, etc. are usually stored in pdf format, they should be exchanged in completion to system information
 - Application fields could be project management, maintenance process management, system documentation, installation process management, ...
 - How can the content of pdf documents be referenced and documented in a semantically unique way?
 - Working group unknown

What provides AutomationML
after tomorrow ?

- **Consideration of possibilities for the extension of the application of AutomationML with respect to project management**
 - Common workshop of logi.cals and University Magdeburg together with Technical University Vienna for tool integration based on Engineering Service Bus and AutomationML
 - Date: 31.05.2012, Location: Frankfurt (Main), Cosmopolitain within main train station
 - Starting point:
 - » How can the data exchange of tool chains be executed efficiently and vendor independent
 - » How can I ensure data consistency along the engineering process chain
 - Content:
 - » Discussion of problem fields within the use of tool chains with respect to data consistency
 - Aim:
 - » Evaluation of the possibility to establish a new AutomationML working group



What provides AutomationML after tomorrow ?

Thanks for your attention!