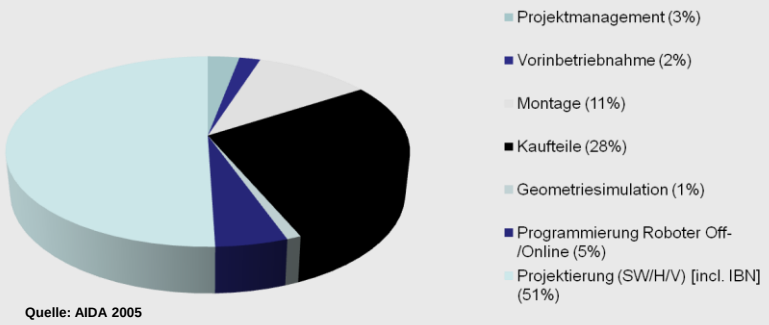
<AutomationML/>

The Glue for Seamless Automation Engineering

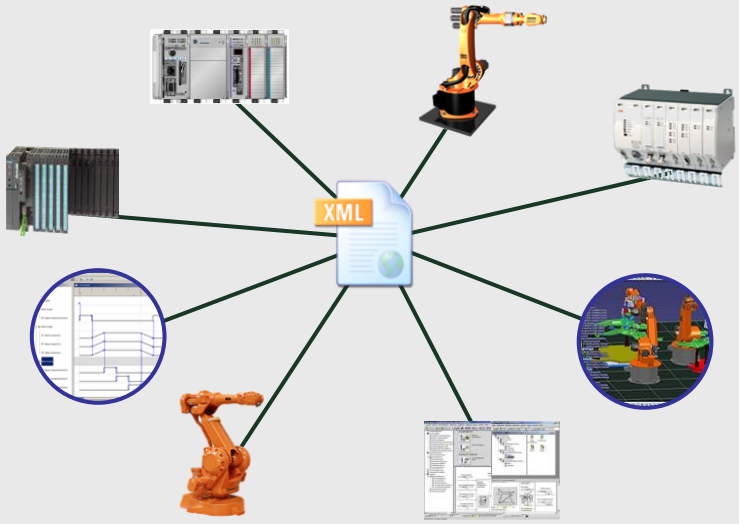
AutomationML Timeline

2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016

- **Various companies and communities of interest have recognized the importance of improvements within the engineering process of production systems**
- **Based on an initiative of Daimler AG 9 companies and research entities convened to discuss improvement related to the data exchange along the tool chain of plant planning**



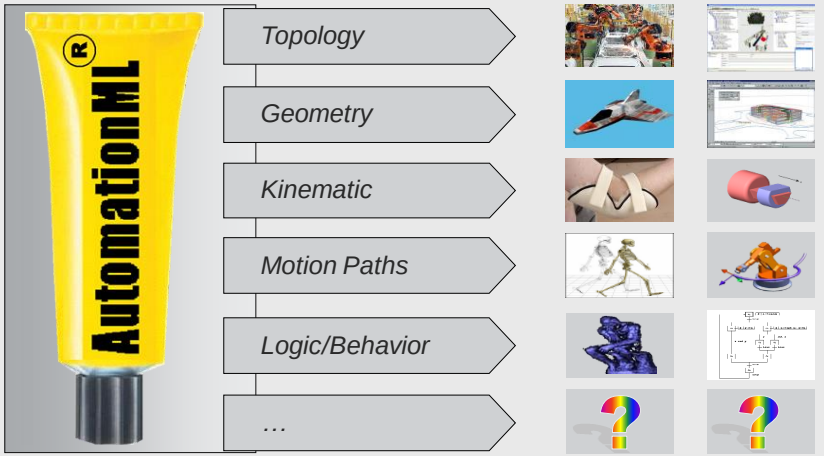
Quelle: AIDA 2005

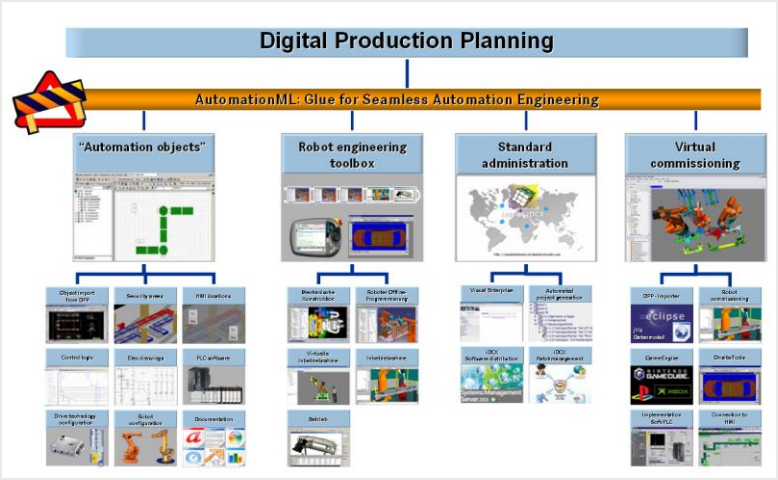


AutomationML Timeline

2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016

- **Focal point of work:**
  - Representation of production system structure
  - Representation of geometry and kinematics of robot cells to enable an improved planning of robot based systems
  - Representation of controlled and uncontrolled behavior of production systems
- **First steps:**
  - Definition of requirements
  - Analysis of existing formats

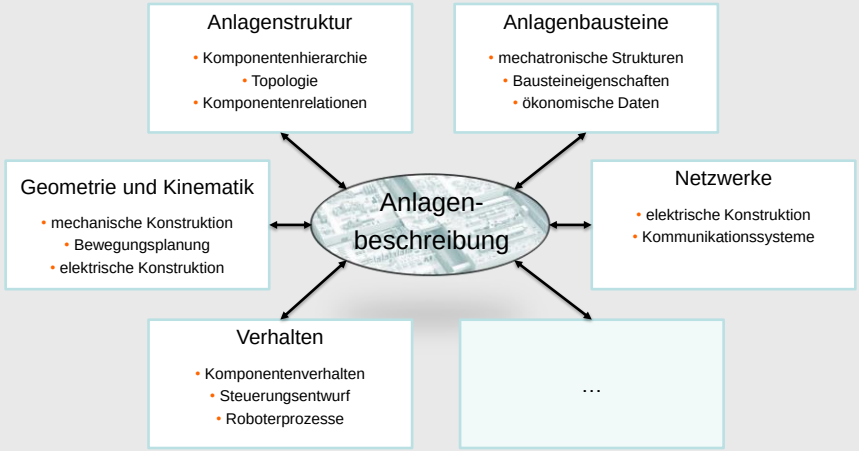


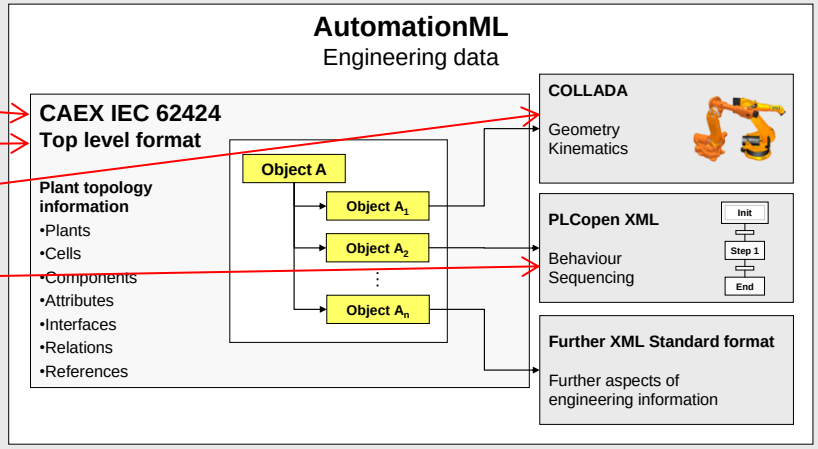


AutomationML Timeline

2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016

- **Concentration on a mechanical view on the production system**
- **Detailing of relevant use cases for the application of AutomationML**
- **Development and publication of the first white papers**
  - Architecture
  - Libraries
  - Geometry and kinematics
  - Logic

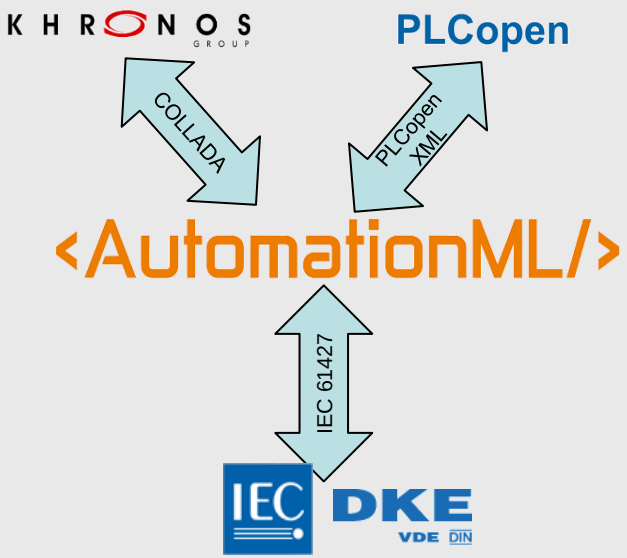




AutomationML Timeline

2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016

- **Start of cooperation with further organizations**
  - KHRONOS Group for the adaptation of COLLADA to the needs of plant planning
  - PLCopen for the adaptation of PLCopen XML to the needs of plant planning
  - IEC und DKE to start international standardization of AutomationML in IEC 62714



AutomationML Timeline

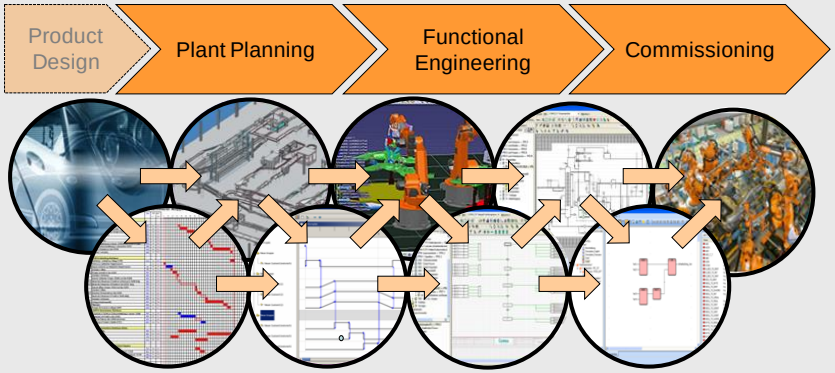
2006 2007 2008 **2009** 2010 2011 2012 2013 2014 2015 2016

- **Formation of AutomationML association**
  - Opening of cooperation to new partners
  - Extension of marketing
- **Publication of improved versions of AutomationML white papers**
  - Integration of first user experiences
  - Commitment to an application background of AutomationML

KUKA DAIMLER ABB

NETALLIED SYSTEMS SIEMENS zühlke empowering ideas

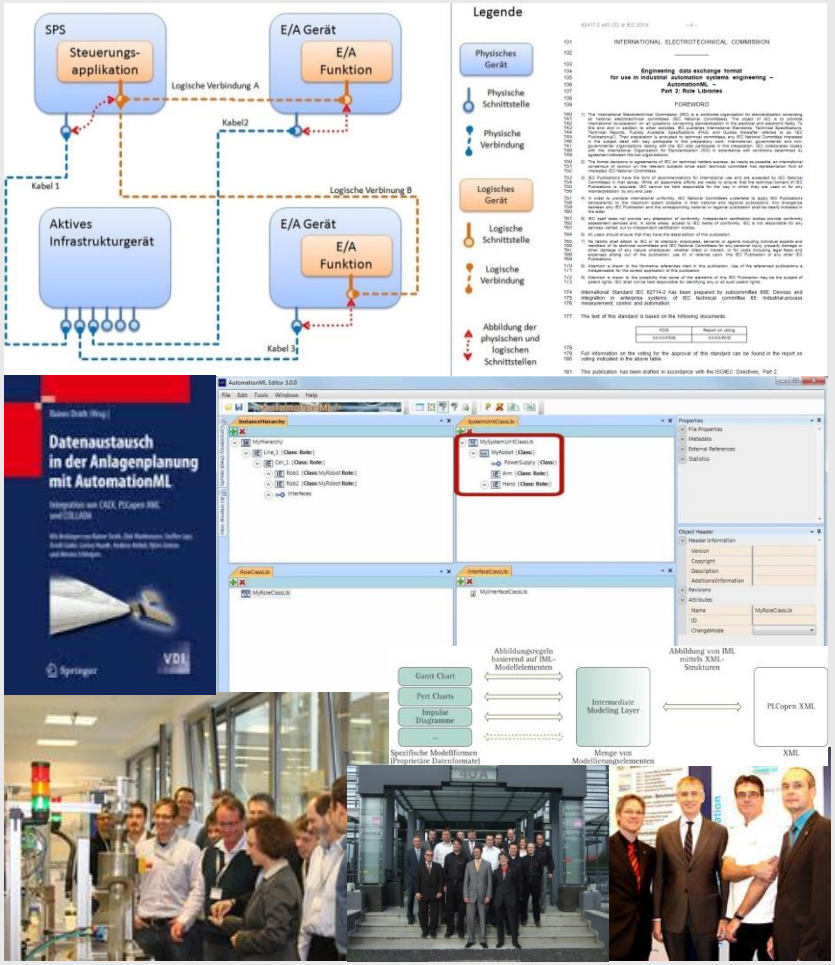
Fraunhofer IITB Universität Karlsruhe (TH) Forschungsuniversität · gegründet 1825 Otto von Guericke Universität Magdeburg



AutomationML Timeline

2006 2007 2008 2009 **2010** **2011** **2012** 2013 2014 2015 2016

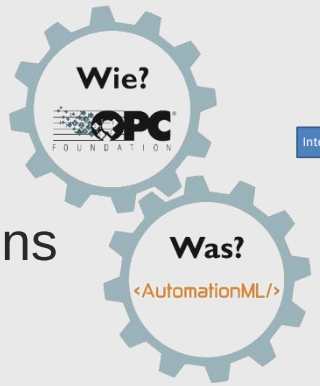
- **Further development of the content of specification documents**
  - Extension of standardized libraries
  - Consideration of networks and their representation
- **Development of free available software provided by the association**
  - AutomationML Engine
  - AutomationML Editor
  - AutomationML Test Center
- **Marketing at fairs, conferences, …**

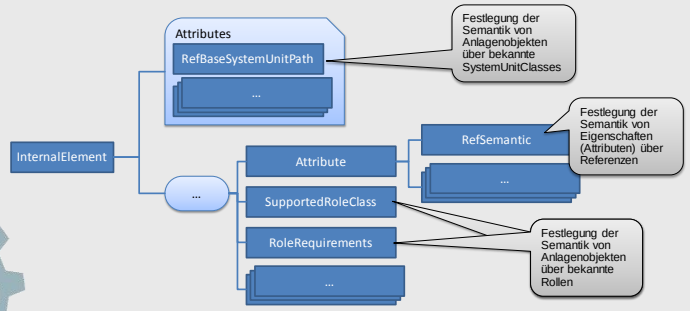


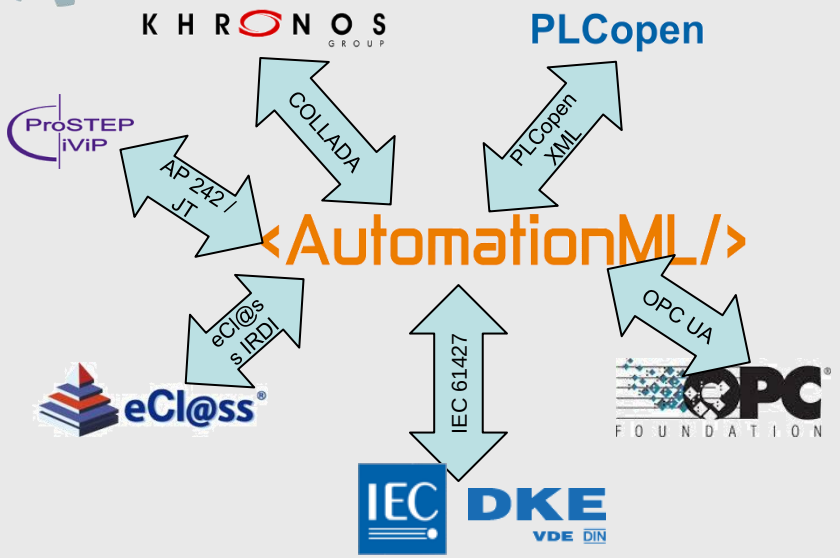
AutomationML Timeline

2006 2007 2008 2009 2010 2011 2012 **2013** **2014** 2015 2016

- **Extension of the field of work**
  - Establishing of new types of documents: Best Practice Recommendations, Application Recommendations
  - Discussion of new topics
    - OPC UA Integration
    - Semantic Integration
- **Extension of cooperation**
  - OPC Foundation
  - eCl@ss e.V.
  - ProSTEP iViP
- **Part 1 has reached status international standard at June 26th 2014**



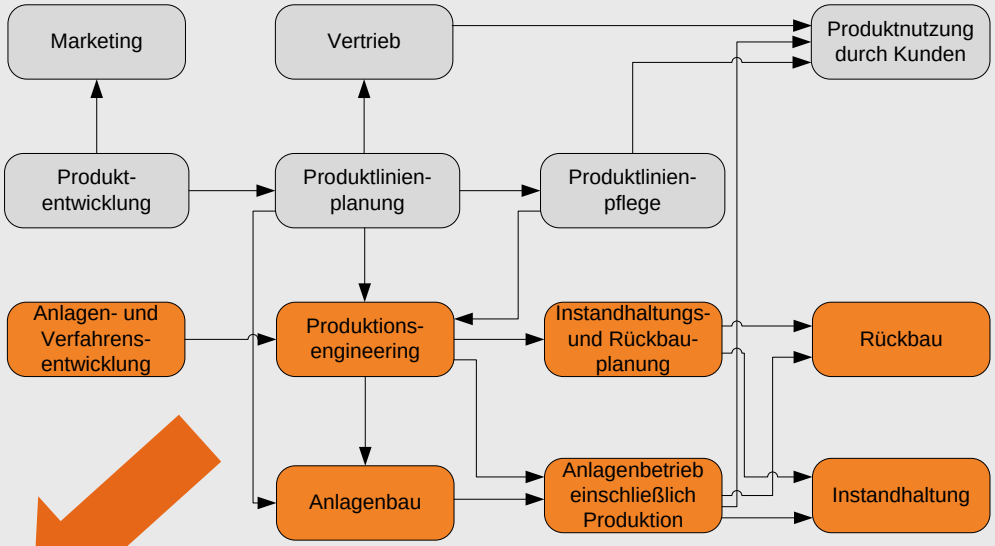


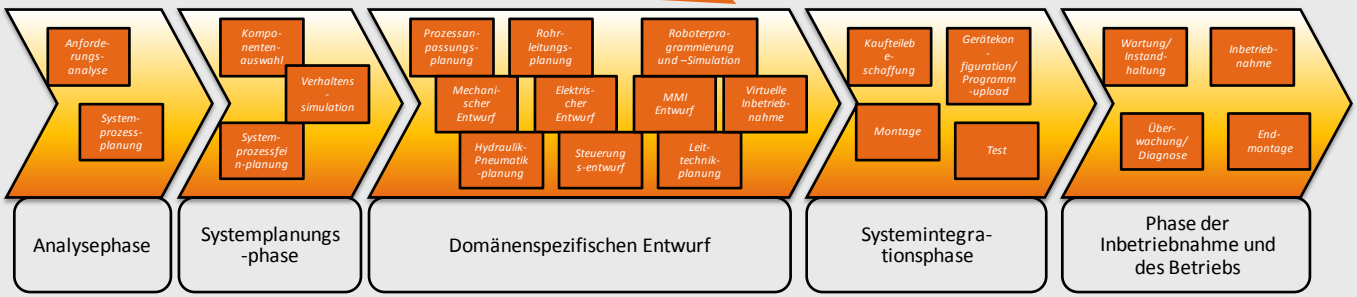


AutomationML Timeline

2006 2007 2008 2009 2010 2011 2012 **2013** **2014** 2015 2016

- **„Stroke of luck“ Industrie 4.0**
  - Consideration of the complete life cycle of a production system requires an integrated data management structure
  - In combination with eCl@ss, OPC UA and other technologies AutomationML can provide a good basis

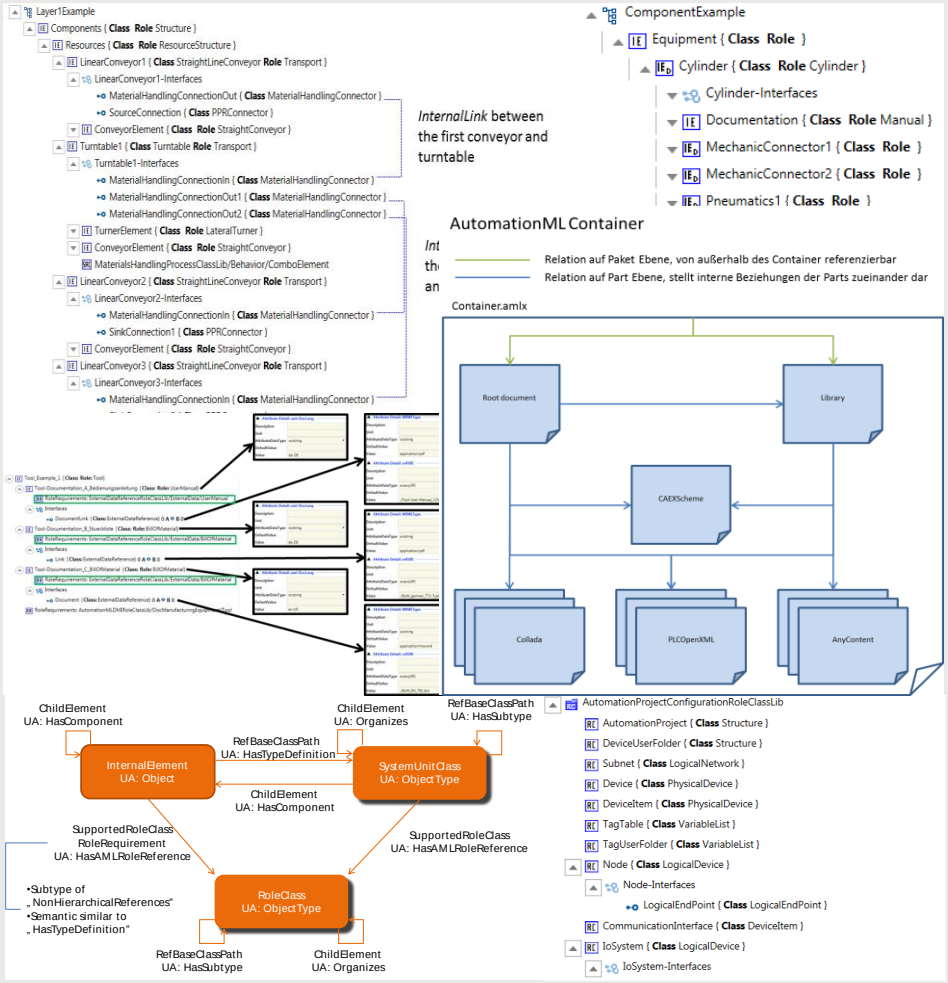




AutomationML Timeline

2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016

- **Standardization is continued successfully**
  - Part 2 reach status international standard at March 30th 2015
  - Parts 3 and 4 are currently in development at IEC
- **Further fields of interest are addressed**
  - Components
  - Transport systems
  - Automation projects
  - Referencing of external data like pdf, xls, jt, bmp, svg, …
  - Storing of projects



AutomationML Timeline

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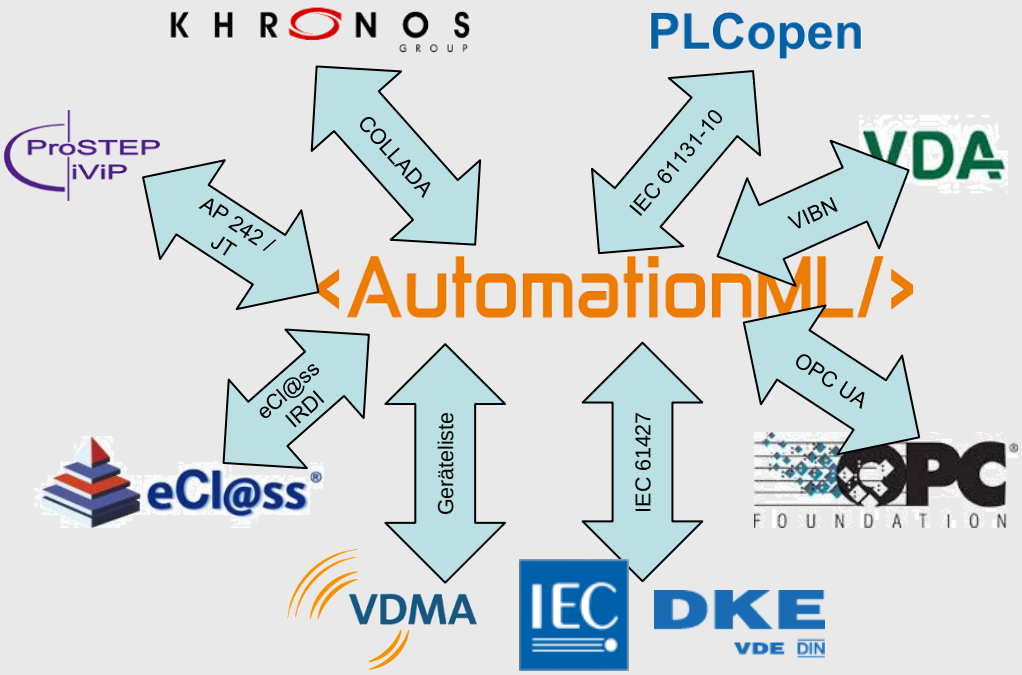
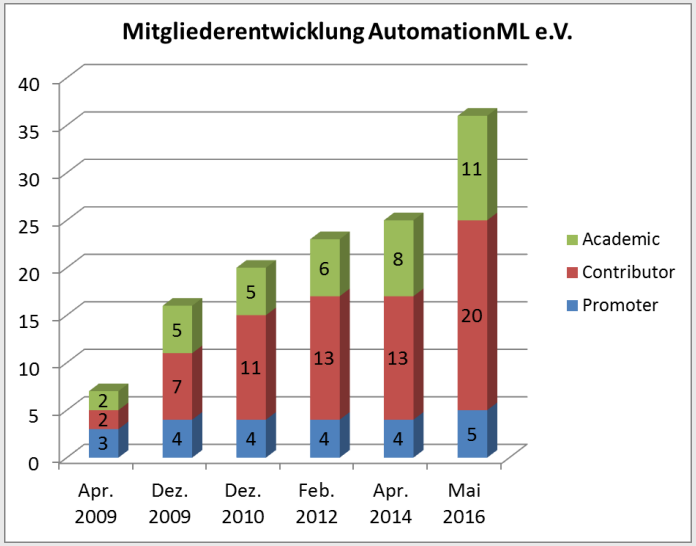
- Increase of membership to 36
- Extension of cooperations





AutomationML is …

- XML based data format (storage format), enabling the vendor neutral exchange of engineering data of production systems
- Link between engineering tools of different engineering disciplines and, therefore, applicable within the complete engineering chain
- Object oriented and enabler for modelling of plant components as data objects combining different facets/aspects of engineering
- Combination and adaptation of existing industry proven data formats, developed for the exchange and storing of different aspects of engineering
- Coherent, distributed document architecture facilitating the handling of large data sets and the handling of libraries in external files

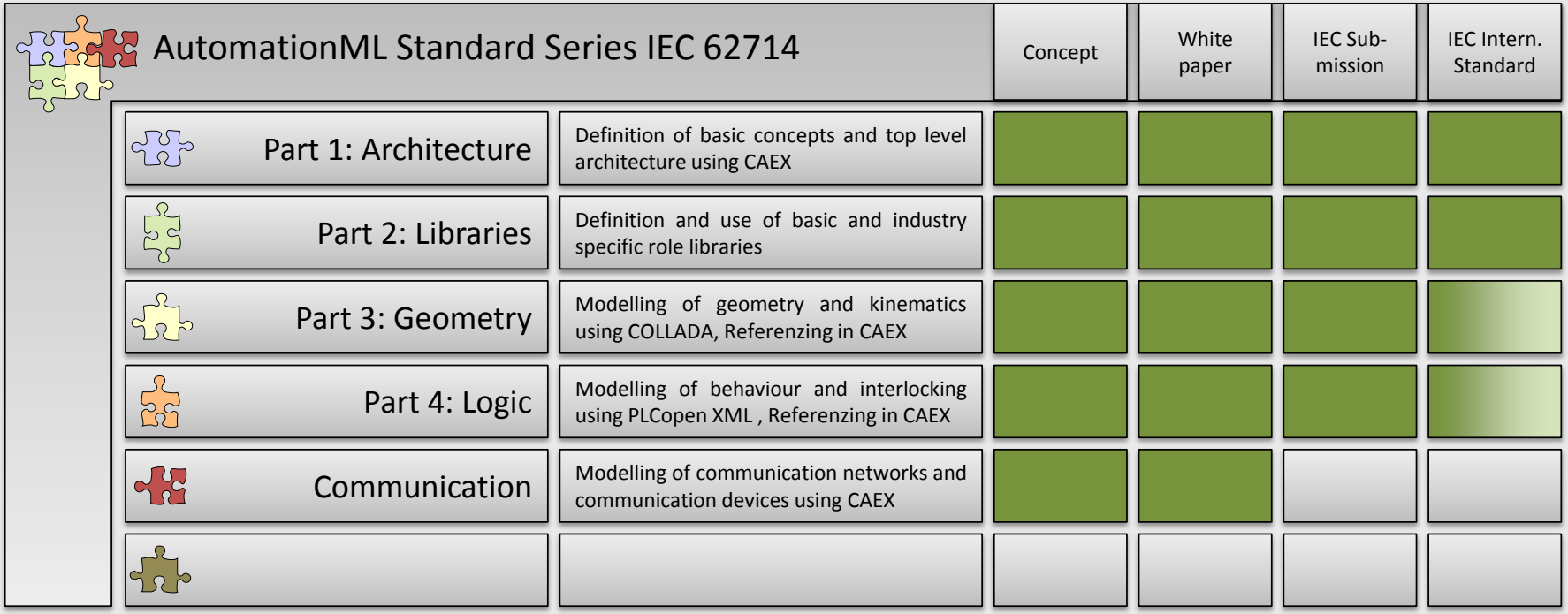
AutomationML is NOT …

- Tool functionality
- Verification of conditions, attribute values, relations, references or semantic correctness of data objects
- Verification and adaptation of consistency and versioning of data objects
- Automatic standardization of user specific information
- Automatic library development
- Automatic version and variant management
- Project management tool
- Project management data base

➔ BUT enables storing all information / data enabling such tool functionalities

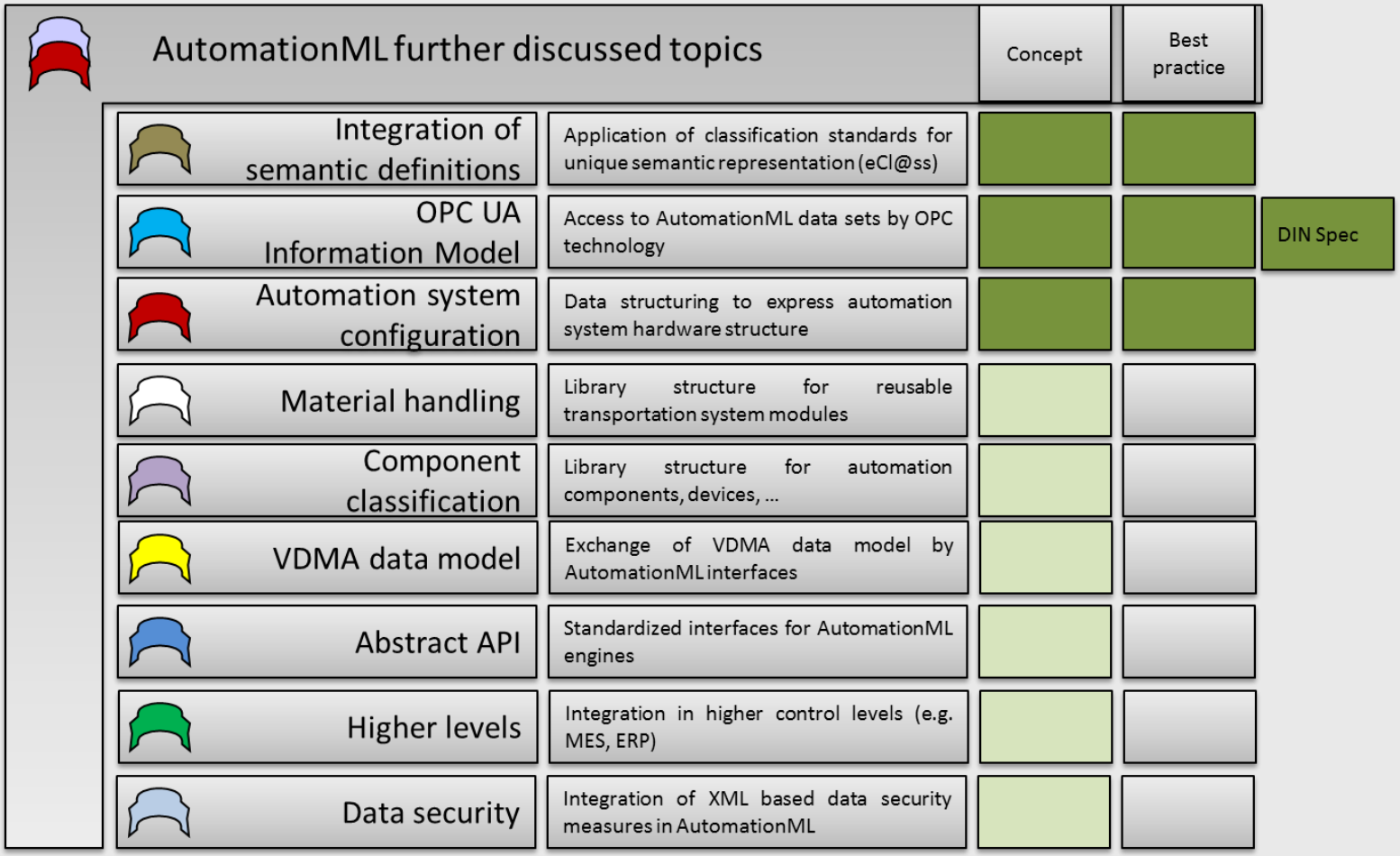
AutomationML now

- **Standardization in IEC**



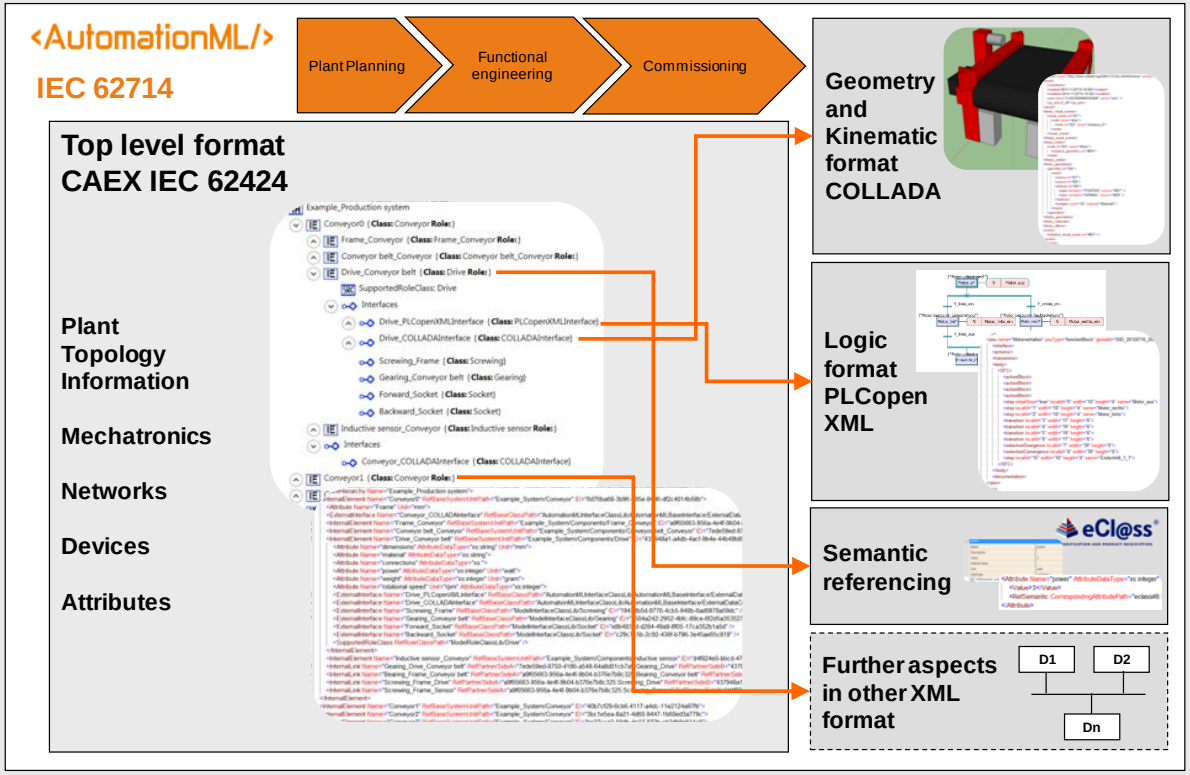
AutomationML now

- **Further topics**



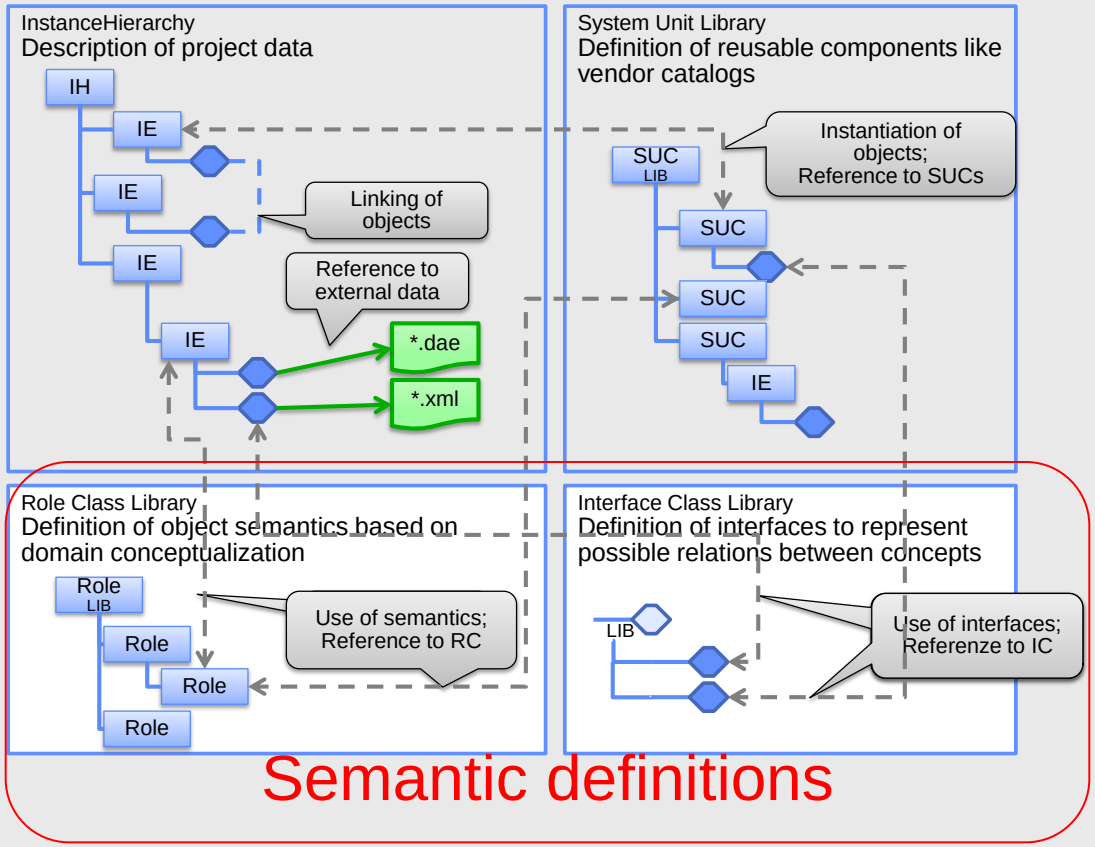
AutomationML Architecture

- **Based on the application of existing XML data formats**
  - CAEX - Structure/Relation of plant objects
  - COLLADA - Geometry und kinematics
  - PLCopen XML - Behavior



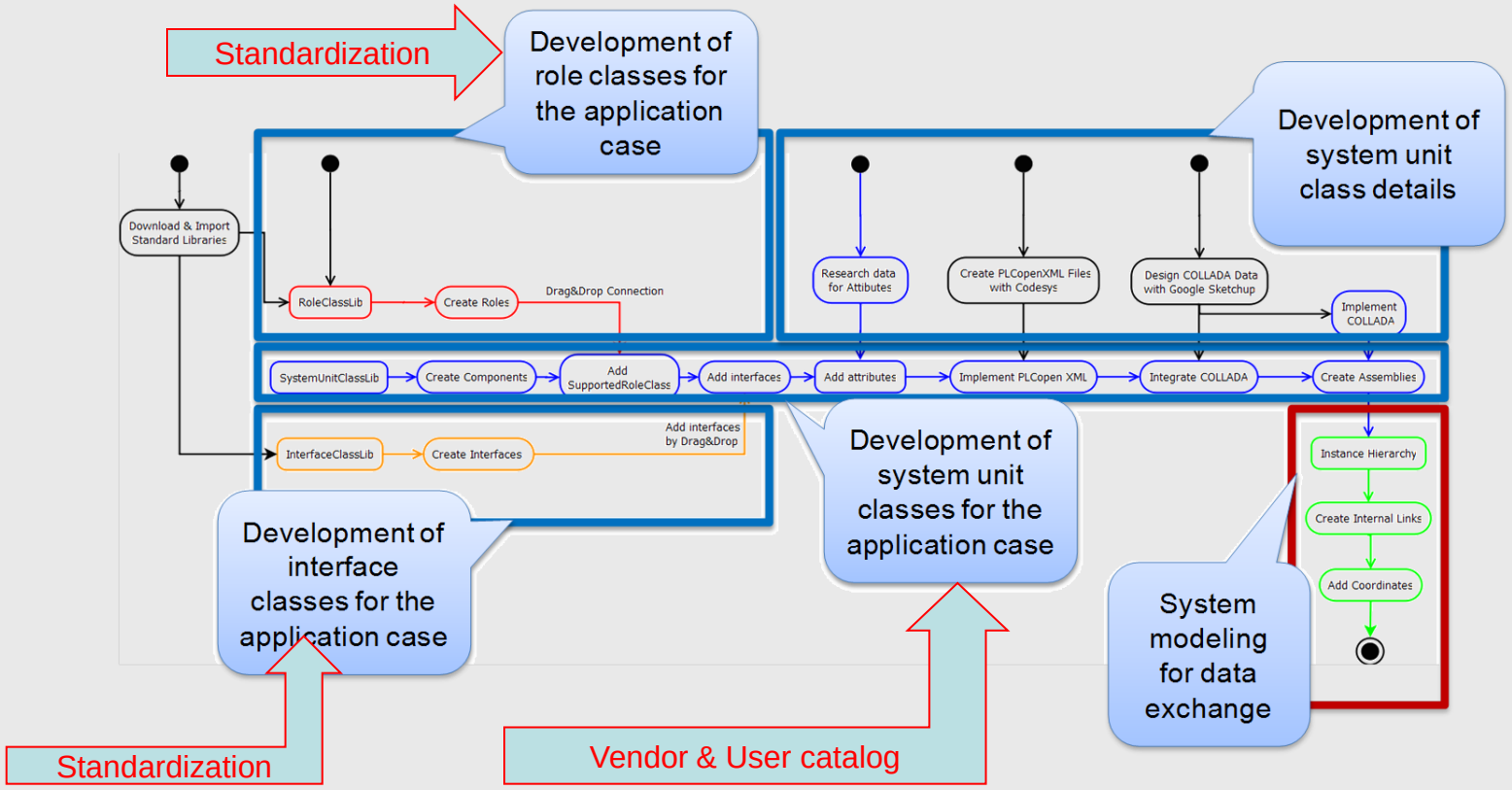
AutomationML Architecture

- Determination of object semantics using role and interface classes
- Definition of reusable objects for plant engineering
- Representation of project data as project tree
- Integration of object details as attributes
- Relations between objects
- Referencing to externally stored information



AutomationML Architecture

- **Important feature: inherent distinction between syntax and semantics**
- **Use process accordingly**

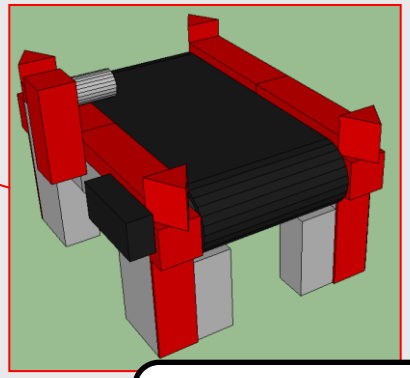


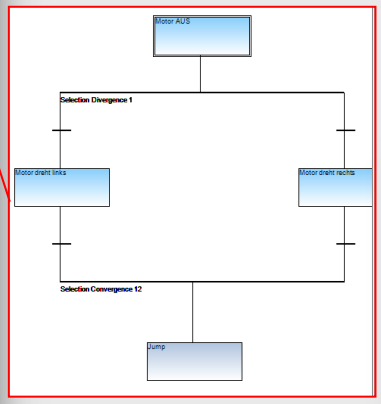
AutomationML Architecture

Project

- Produktionsmodell
  - Conveyer0 {Class: Conveyer Role:}
    - Motor_Band_Conveyer {Class: Motor Role:}
      - SupportedRoleClass: Motor
      - Interfaces
        - Verzahnung_Band {Class: Verzahnung}
        - Verschraubung_Gestell {Class: Verschraubung}
        - Vorlauf_Stromanschlussbuchse {Class: Stromanschlussbuchse}
        - Motor_COLLADAInterface {Class: COLLADAInterface}
        - Rücklauf_Stromanschlussbuchse {Class: Stromanschlussbuchse}
        - Motor_PLCopen_LogicInterface {Class: LogicInterface}
    - Induktivsensor_Conveyer {Class: Induktivsensor Role:}
      - SupportedRoleClass: Sensor
      - Interfaces
        - Sensor_COLLADAInterface {Class: COLLADAInterface}
        - Induktivsensor_PLCopen_LogicInterface {Class: LogicInterface}
        - Verschraubung_Gestell {Class: Verschraubung}
        - Signal_Stromanschlussbuchse {Class: Stromanschlussbuchse}
    - Band_Conveyer {Class: Band_Conveyer Role:}
    - Gestell_Conveyer {Class: Gestell Role:}
  - Conveyer1 {Class: Conveyer Role:}
  - Conveyer2 {Class: Conveyer Role:}
  - Conveyer3 {Class: Conveyer Role:}
  - Conveyer4 {Class: Conveyer Role:}
  - Conveyer5 {Class: Conveyer Role:}
  - Conveyer6 {Class: Conveyer Role:}
  - Conveyer7 {Class: Conveyer Role:}
  - Conveyer8 {Class: Conveyer Role:}
  - Conveyer9 {Class: Conveyer Role:}
  - Turntable0 {Class: Turntable Role:}
  - Turntable1 {Class: Turntable Role:}
  - Turntable2 {Class: Turntable Role:}
  - Turntable3 {Class: Turntable Role:}
  - Turntable4 {Class: Turntable Role:}
  - Turntable5 {Class: Turntable Role:}
  - Turntable6 {Class: Turntable Role:}
  - Turntable7 {Class: Turntable Role:}
  - Maschine1 {Class: Maschine Role:}
  - Maschine2 {Class: Maschine Role:}
  - Maschine3 {Class: Maschine Role:}
  - FL_IL_24_BK_BusKoppler {Class: FL_IL_24_BK_BusKoppler Role:}
  - WAGO_750_342_BusKoppler1 {Class: WAGO_750_342_BusKoppler Role:}
  - WAGO_750_342_BusKoppler2 {Class: WAGO_750_342_BusKoppler Role:}
  - Verkabelung {Class: Role:}

Geometrie	
Material	
Anschlüsse	
Leistung	
Name	Leistung
Description	
Value	3
Default Value	
Unit	Watt
DataType	xs:integer
Gewicht	
Name	Gewicht
Description	
Value	140
Default Value	
Unit	Gramm
DataType	xs:integer
Drehzahl	





Defined roles and interfaces as semantic representation

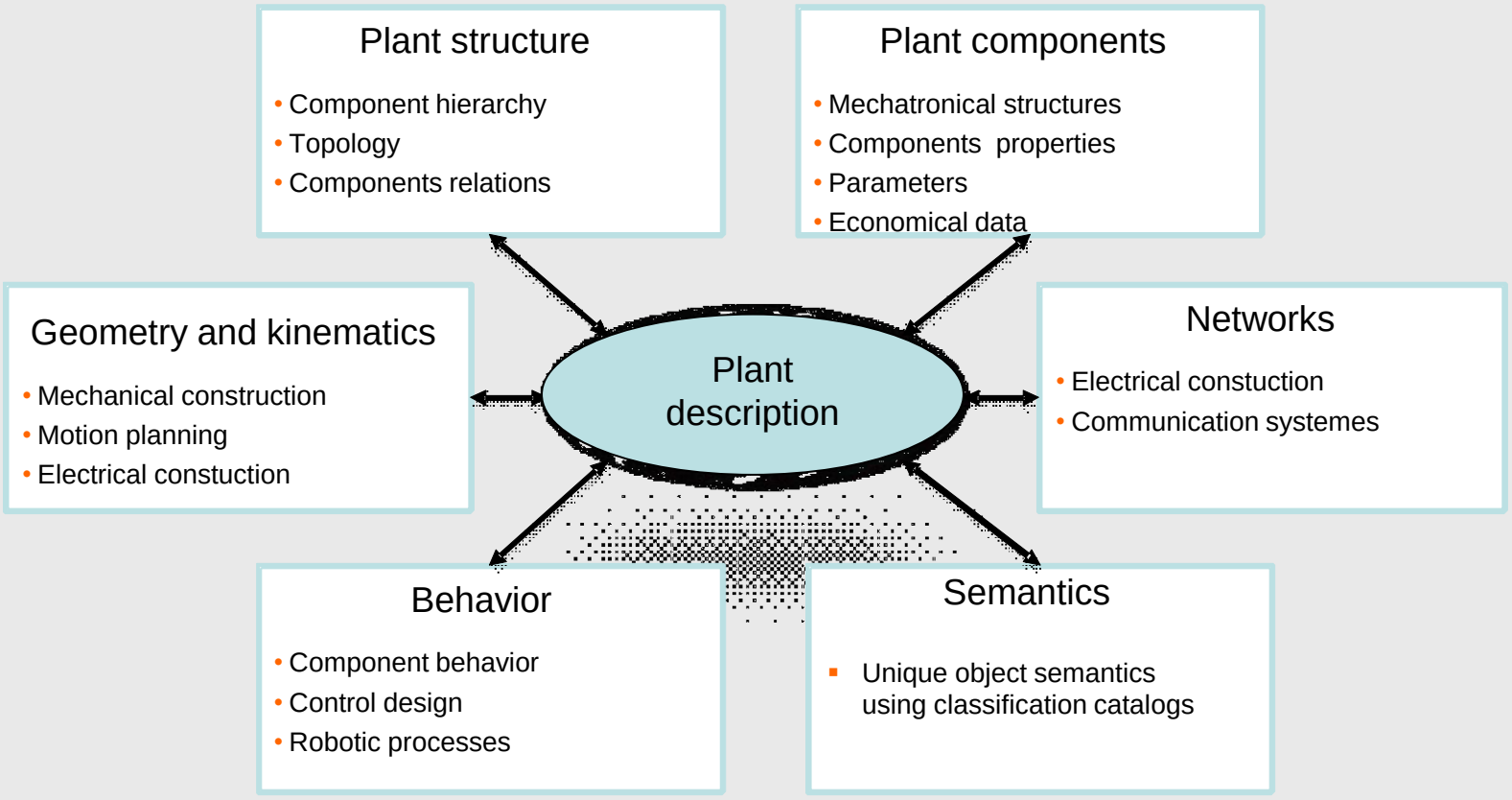
- Modell RoleClassLib
  - Motor {Class: MechatronicAssembly}
  - Sensor {Class: Sensor}
  - Band {Class: BeltConveyor}
  - Gestell {Class: MechanicalAssembly}
  - Untergestell_Turntable {Class: MechanicalAssembly}
  - Obergestell_Turntable {Class: MechanicalAssembly}
  - Ständer {Class: MechanicalPart}
  - Bearbeitungswerkzeug {Class: Tool}
  - Werkzeugträger {Class: MechanicalPart}
  - SPS_Steuerung {Class: PLC}
  - BusKoppler {Class: Communication}
  - Kabel {Class: Communication}
- AutomationMLBaseRoleClassLib
- AutomationMLCSRoleClassLib
- AutomationMLDMIRoleClassLib
- AutomationMLExtendedRoleClassLib

Component libraries

- FabrikModell
  - Bauteile {Class:}
    - Motor {Class:}
    - Sensor {Class:}
      - Verschraubung_Gestell {Class: Verschraubung}
      - Signal_Stromanschlussbuchse {Class: Stromanschlussbuchse}
      - SupportedRoleClass: Sensor
    - Endlagenschalter {Class: Sensor}
    - Induktivsensor {Class: Sensor}
      - Induktivsensor_PLCopen_LogicInterface {Class: LogicInterface}
      - Sensor_COLLADAInterface {Class: COLLADAInterface}
    - Band_Conveyer {Class:}
    - Gestell {Class:}
    - Untergestell_Turntable {Class:}
    - Obergestell_Turntable {Class:}
    - Ständer {Class:}
    - Bearbeitungswerkzeug {Class:}
    - Werkzeugträger {Class:}
    - SPS_Steuerung {Class:}
    - Kabel {Class: Port}
    - Drehkranz {Class:}
    - WZT_Halterung {Class:}
    - Band_Turntable {Class:}
    - WAGO_750_342_BusKoppler {Class:}
    - FL_IL_24_BK_BusKoppler {Class:}
  - Conveyer {Class:}
  - Turntable {Class:}
  - Maschine {Class:}

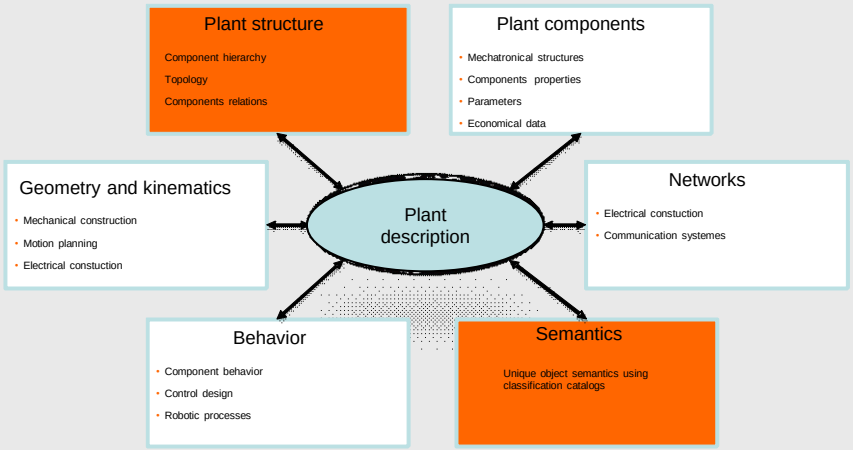
AutomationML now

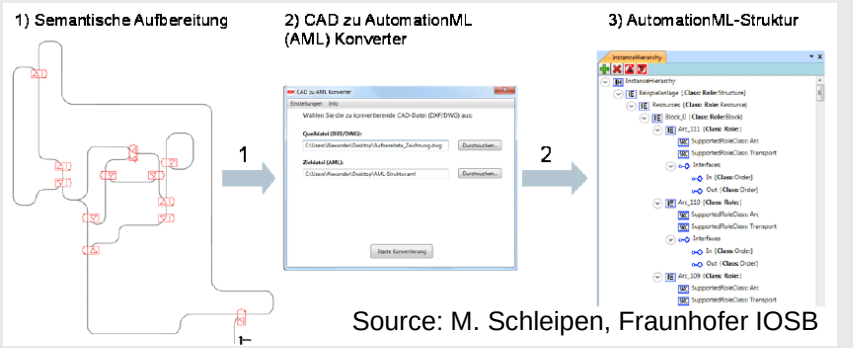
- **Which information can be transferred using AutomationML?**



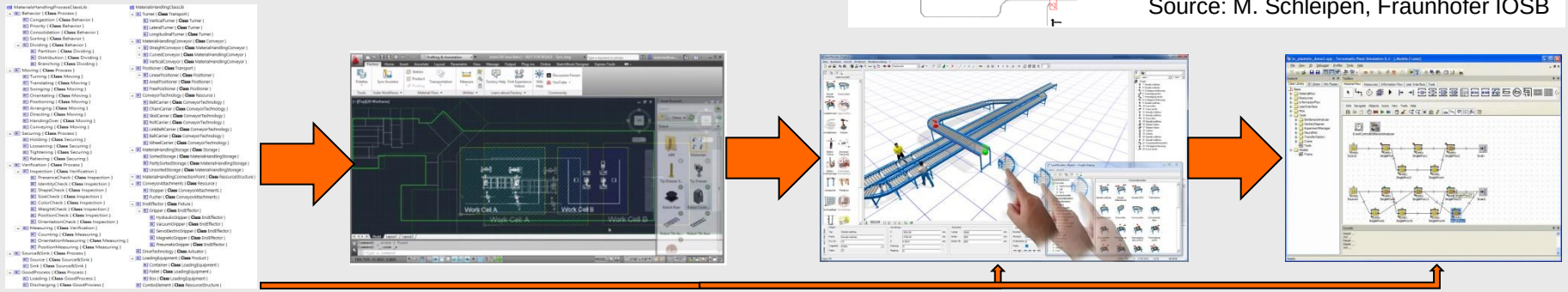
Application examples

- **Exchange of plant structure**
  - Structure of transport systems within plant engineering
    - Example method: Translate CAD structures in AutomationML structures and use them
    - Example tool chain: AutoCAD (Autodesk) → taraVRbuilder (tarakos) → PlantSimulation (Siemens)
    - Preconditions: Transport system role class library



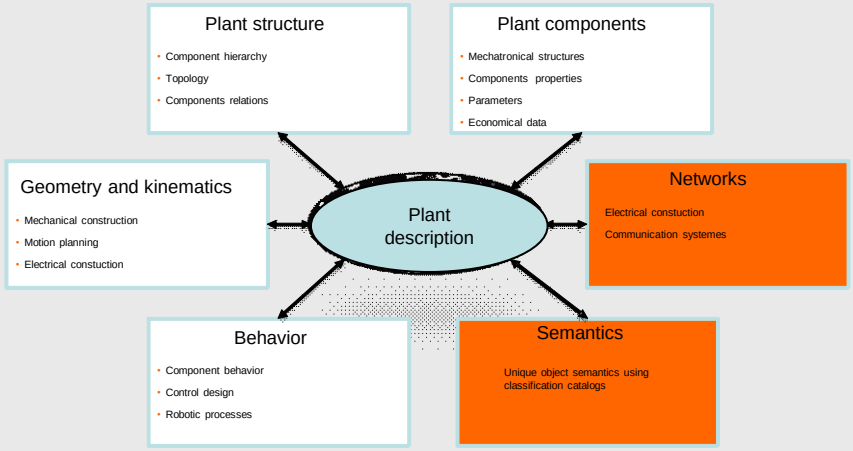


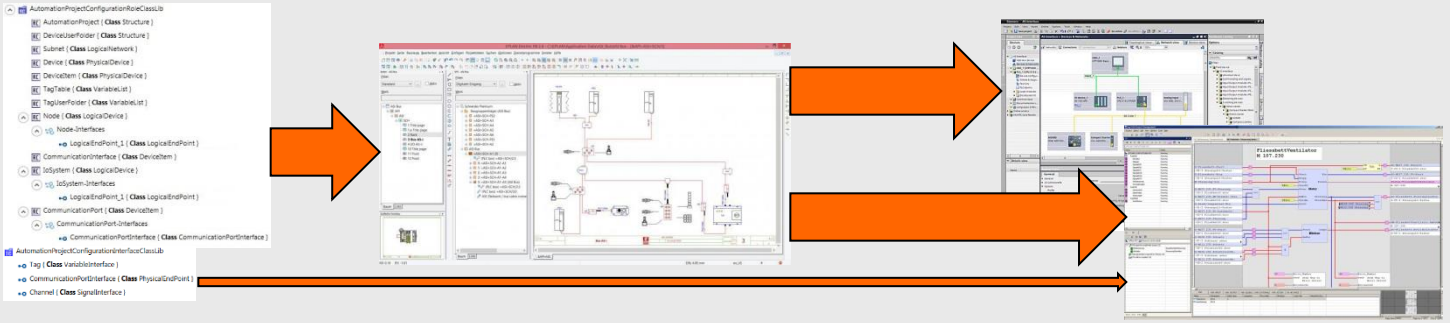
Source: M. Schleipen, Fraunhofer IOSB



Application examples

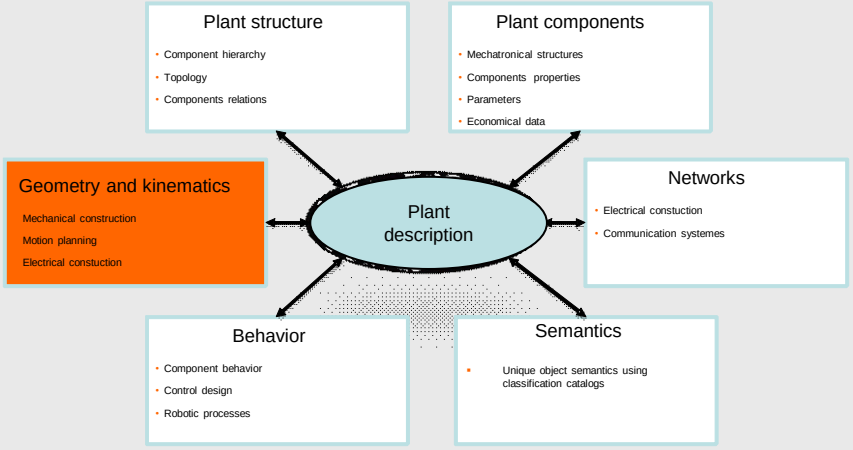
- **Exchange of network structures**
  - Device structure and wiring structure within automation systems
    - Example method: Translate network structures to AutomationML structures and use them
    - Example tool chain:
      EPlan Electric (Eplan)→ TIA Portal (Siemens) / logi.CAD (logi.cals)
    - Preconditions: Automation system element role class library

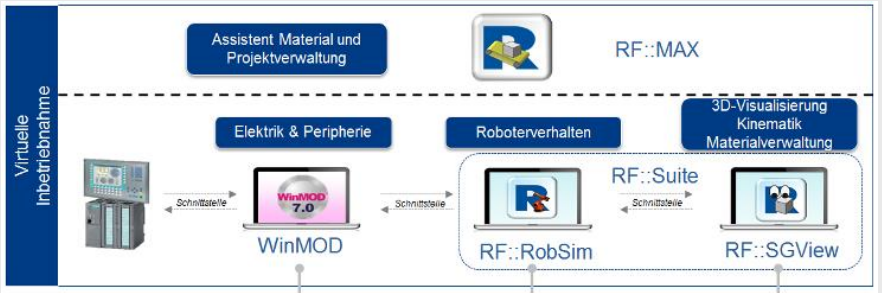


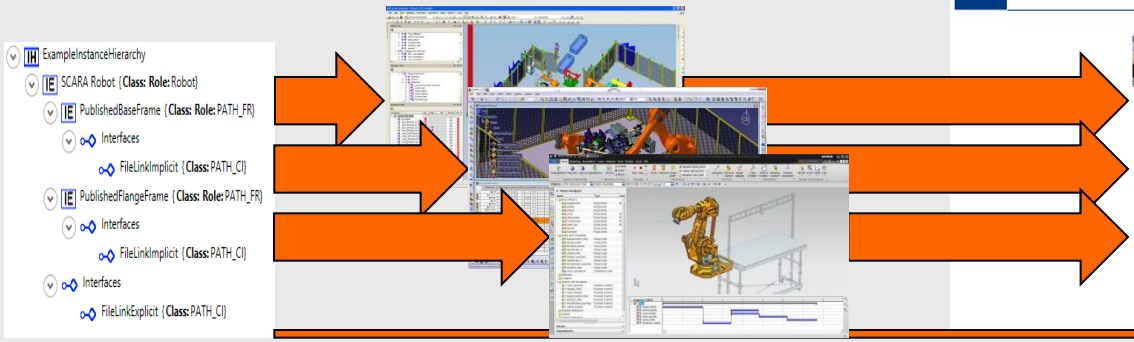


Application examples

- **Exchange of robot kinematics**
  - Exchange of structure, geometry, and kinematics data towards virtual commissioning
    - Integration of structure models with geometry and kinematic models
    - Example tool chain: Process simulate (Siemens), Delmia (Dassault), NX MCD (Siemens) → RF::Suite (EKS Intec)
    - Preconditions: VIBN specific role classes and COLLADA

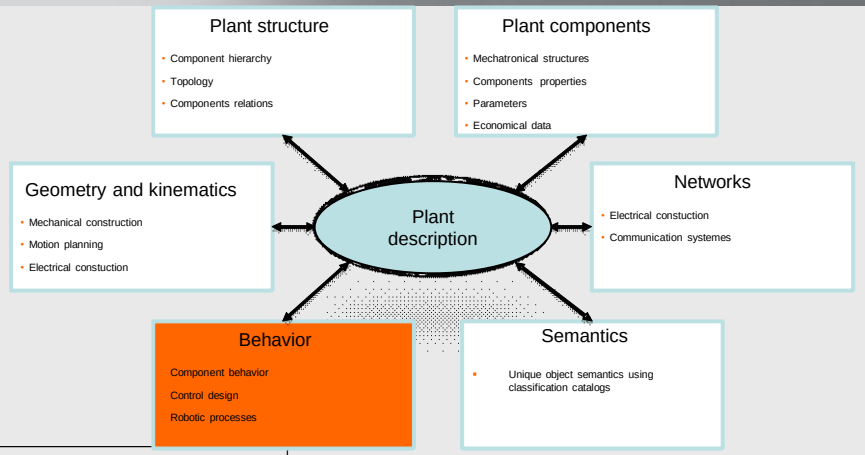


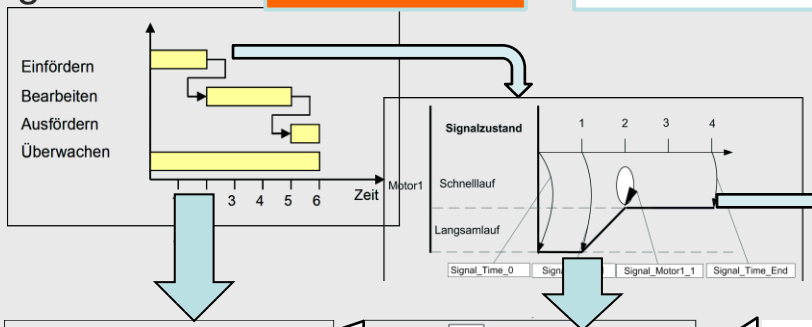


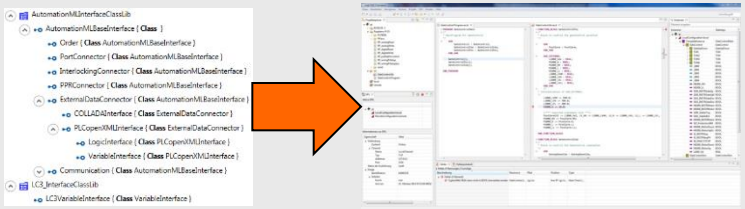


Application examples

- **Generation of control projects**
  - Model based engineering of positive part of control code
    - Integration of SFC networks in different POUs
    - Generation of POU hierarchies by calling of sub-networks exploiting activities and standard function blocks
    - Example tools: logi.CAD (logi.cals)
    - Preconditions: control specific role classes, PLCopen XML

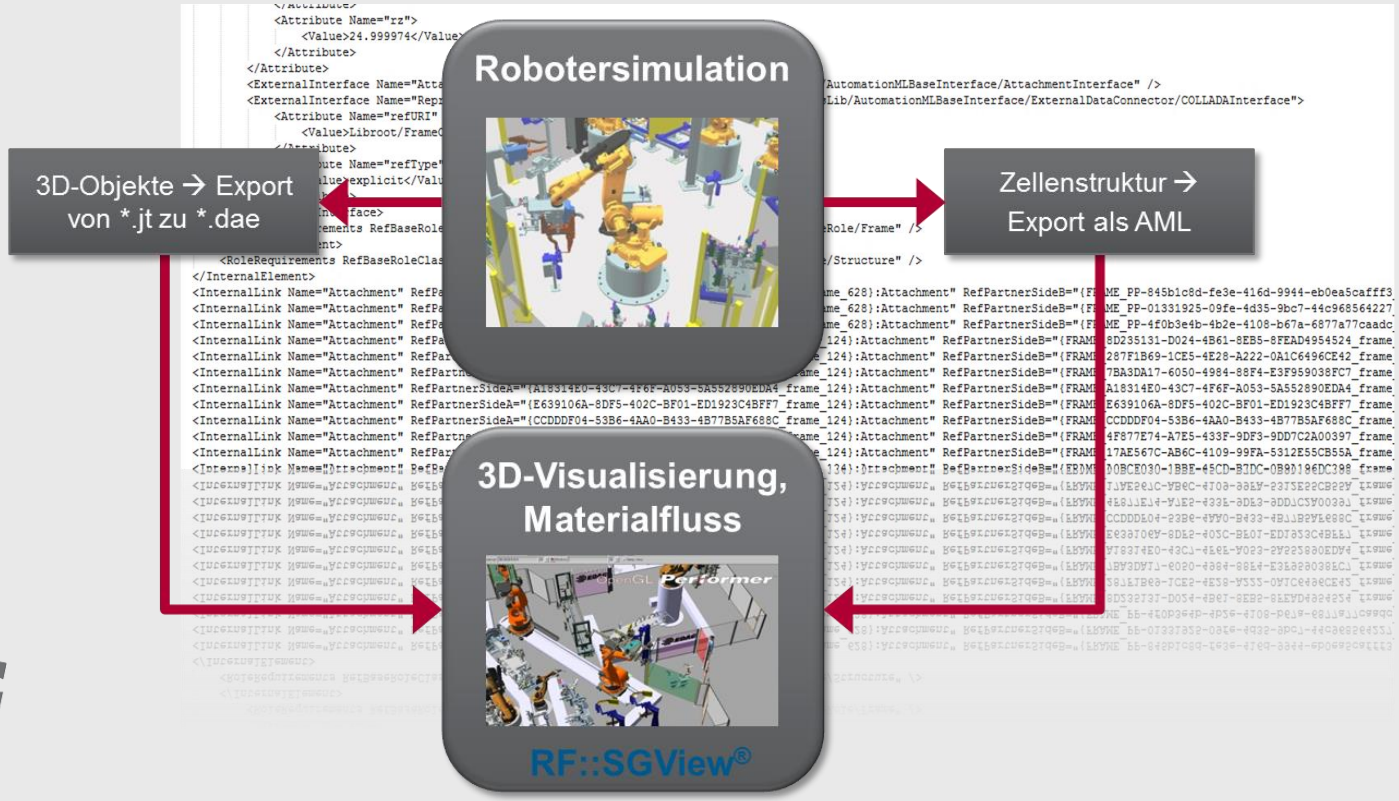






Further available tools with AutomationML interfaces

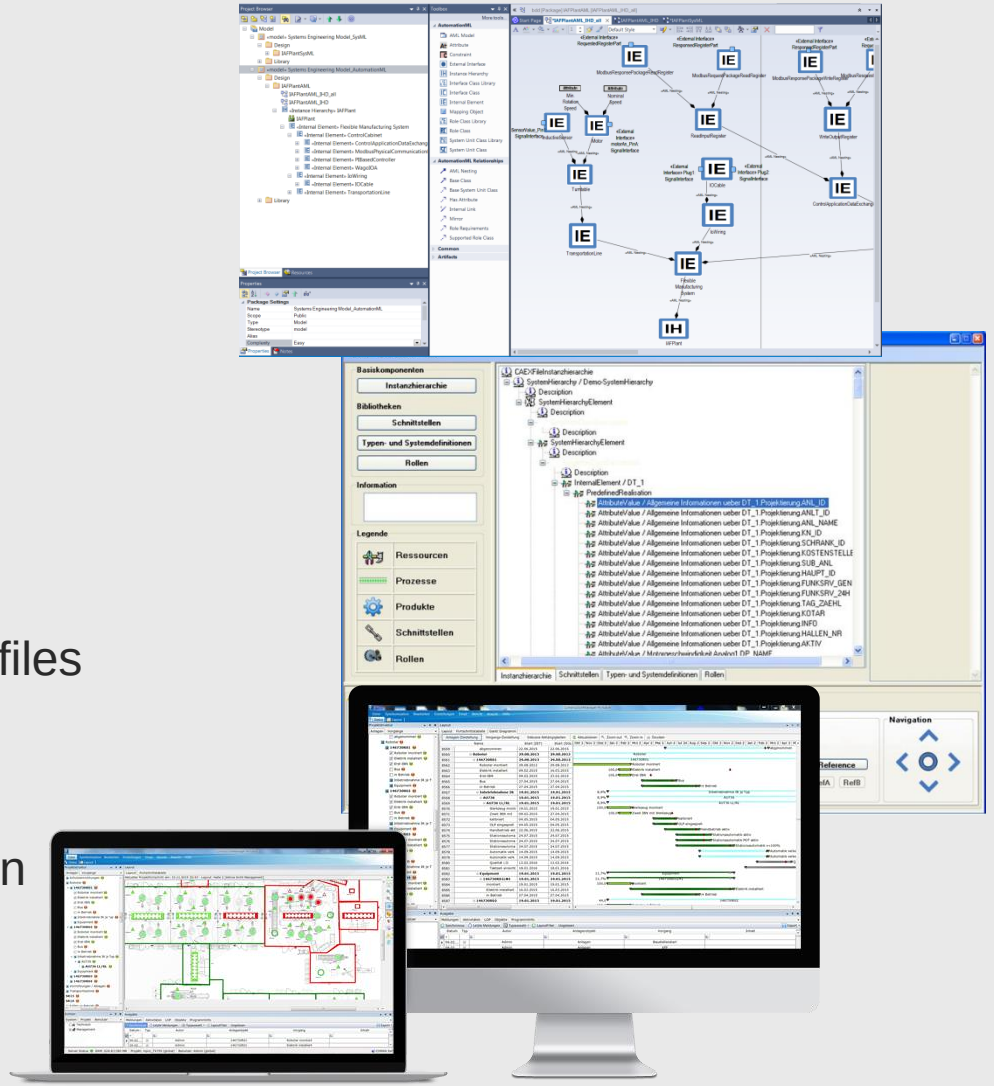
- **Use of AutomationML in EDAG Production Solutions**
  - Data conversion as basement for virtual commissioning
  - Consulting and application development in the field of AutomationML for internal and external projects



EDAG PRODUCTION SOLUTIONS

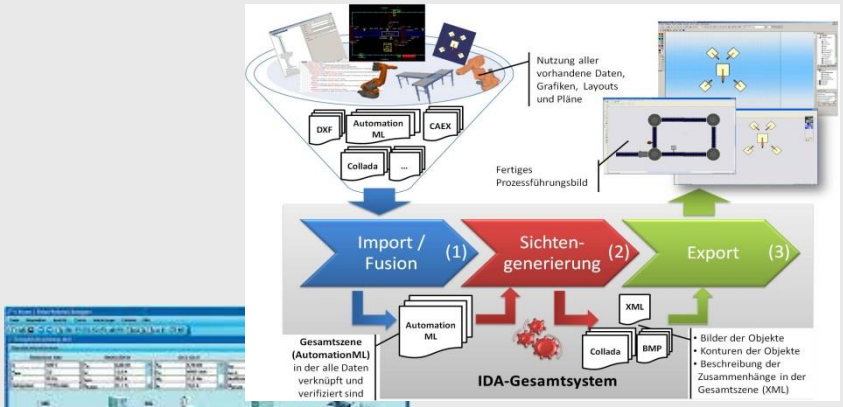
Further available tools with AutomationML interfaces

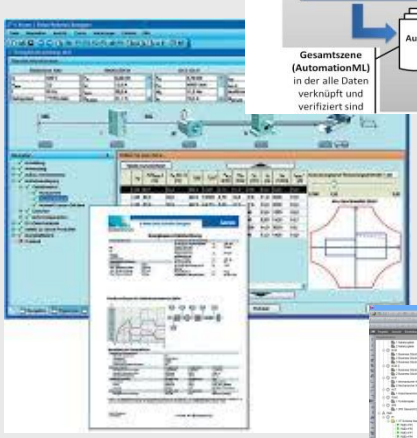
- **AutomationML module for Enterprise Architect**
  - Extension towards SysML
  - LieberLieber
- **AutomationML Export Import Mapper**
  - Mapping of SystemUnitClasses
  - inpro
- **CAEXEditor**
  - Creation of AutomationML test files
  - Fraunhofer IOSB
- **COMAN**
  - Management of plant installation projects
  - inpro

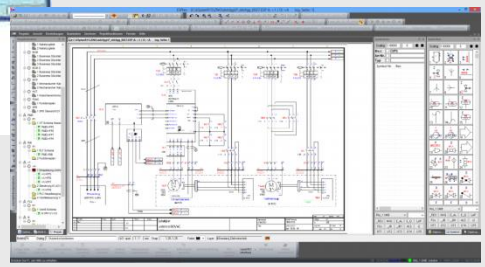


Further available tools with AutomationML interfaces

- **IDA System**
  - Fusion and view generation of/in engineering data
  - cjt Systemsoftware AG & Fraunhofer IOSB
- **Drive Solution Designer**
  - Engineering of drive chains
  - Lenze
- **ESP**
  - CAEX export and import (NAMUR container)
  - ESPlan
- **Automatic Process Data Manager (APDM)**
  - Intelligent data quality and integration platform
  - W.E.S.T.

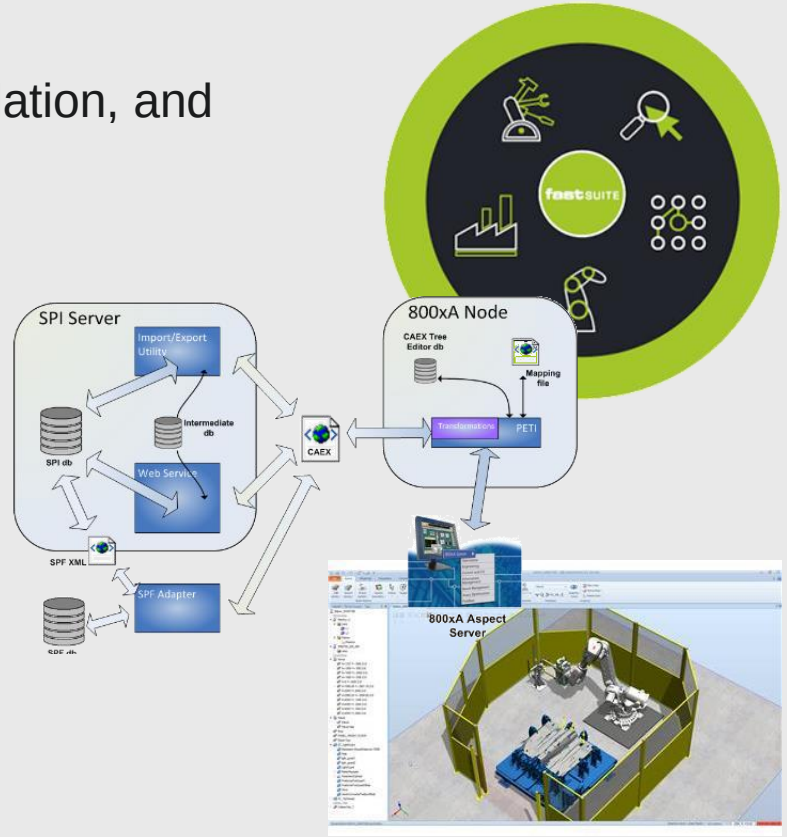






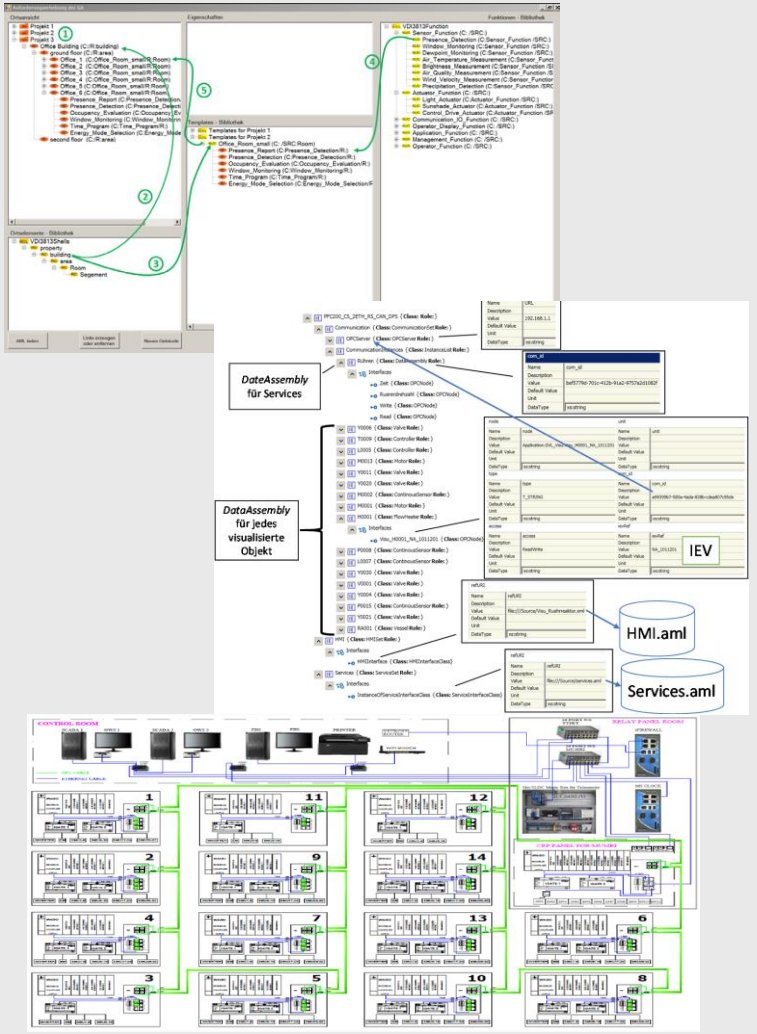
Further available tools with AutomationML interfaces

- **Fast SUITE Edition 2**
  - Definition, planning, programming, simulation, and optimization of production problems
  - Cenit
- **Process Engineering Tool Integration**
  - Provision of consistent engineering information along the complete plant life cycle
  - ABB
- **RobotStudio**
  - Roboter offline programming
  - ABB



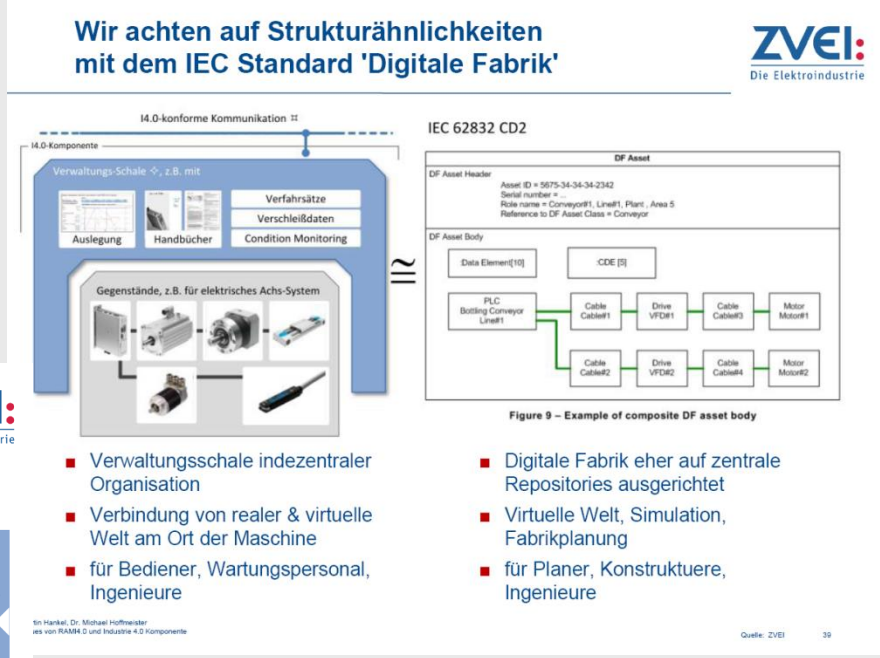
Further interesting application fields of AutomationML

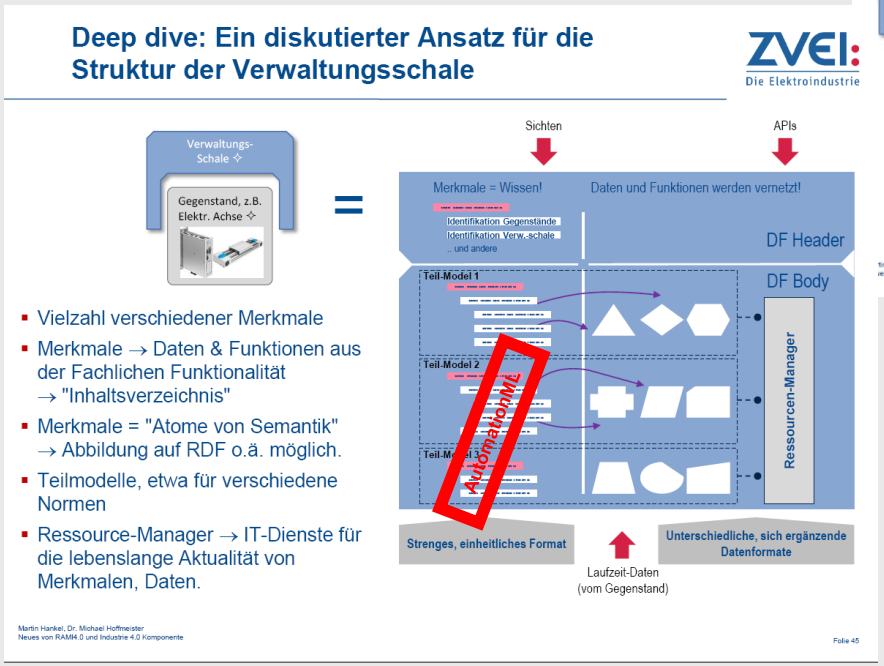
- **Automation generation within building automation**
  - Modelling of building automation systems and automatic control code generation
  - HSU Hamburg
- **Engineering of process industry systems**
  - Representation of process plant modules following the Module Type Package approach
  - Namur
- **Engineering of communication systems in solar industry**
  - Network modelling and device configuration description
  - OvGU Magdeburg



AutomationML tomorrow

- **Were AutomationML can be of importance within future?**
  - Use as basic format for the management shell of Industry 4.0 component

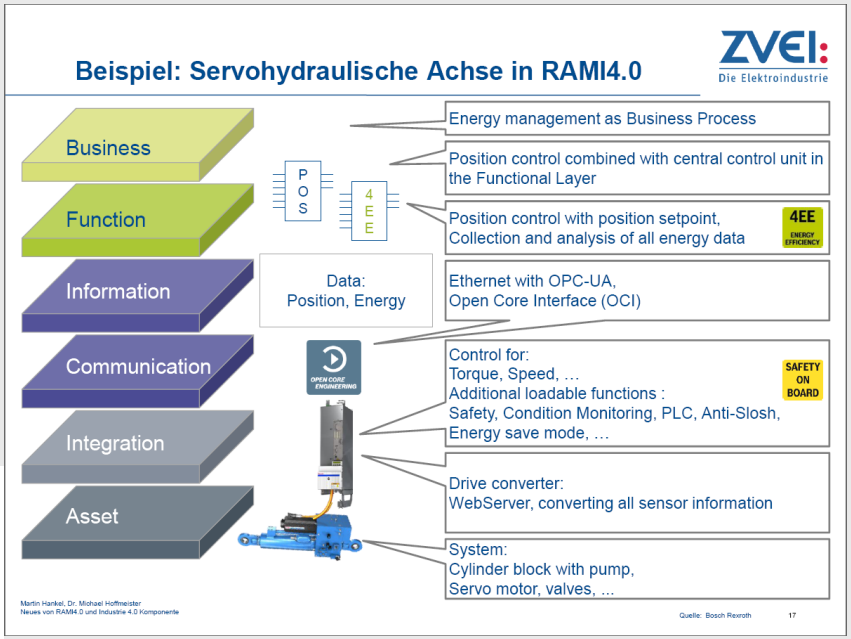


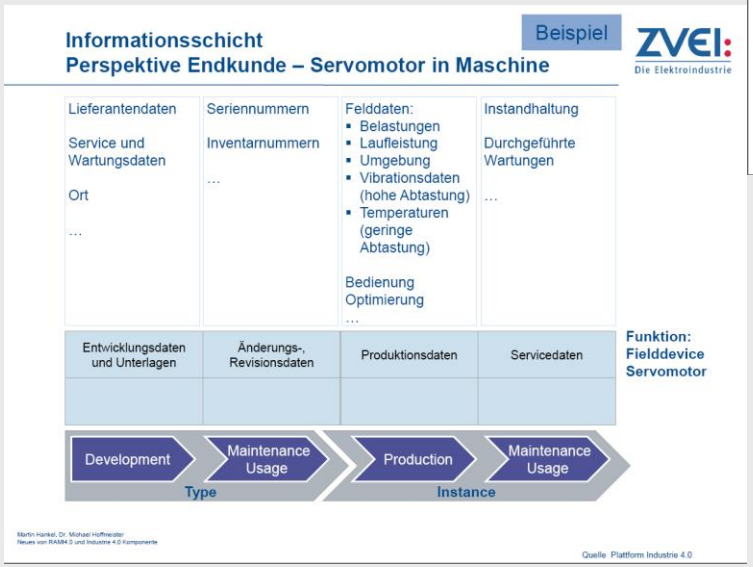


Source: M. Hankel, M. Hoffmeister, Neues von RAMI4.0 und der Industrie 4.0 Komponente, Referenzmodelle für Industrie 4.0

AutomationML tomorrow

- **Were AutomationML can be of importance within future?**
  - For the efficient combination of engineering and runtime data of an Industry 4.0 component

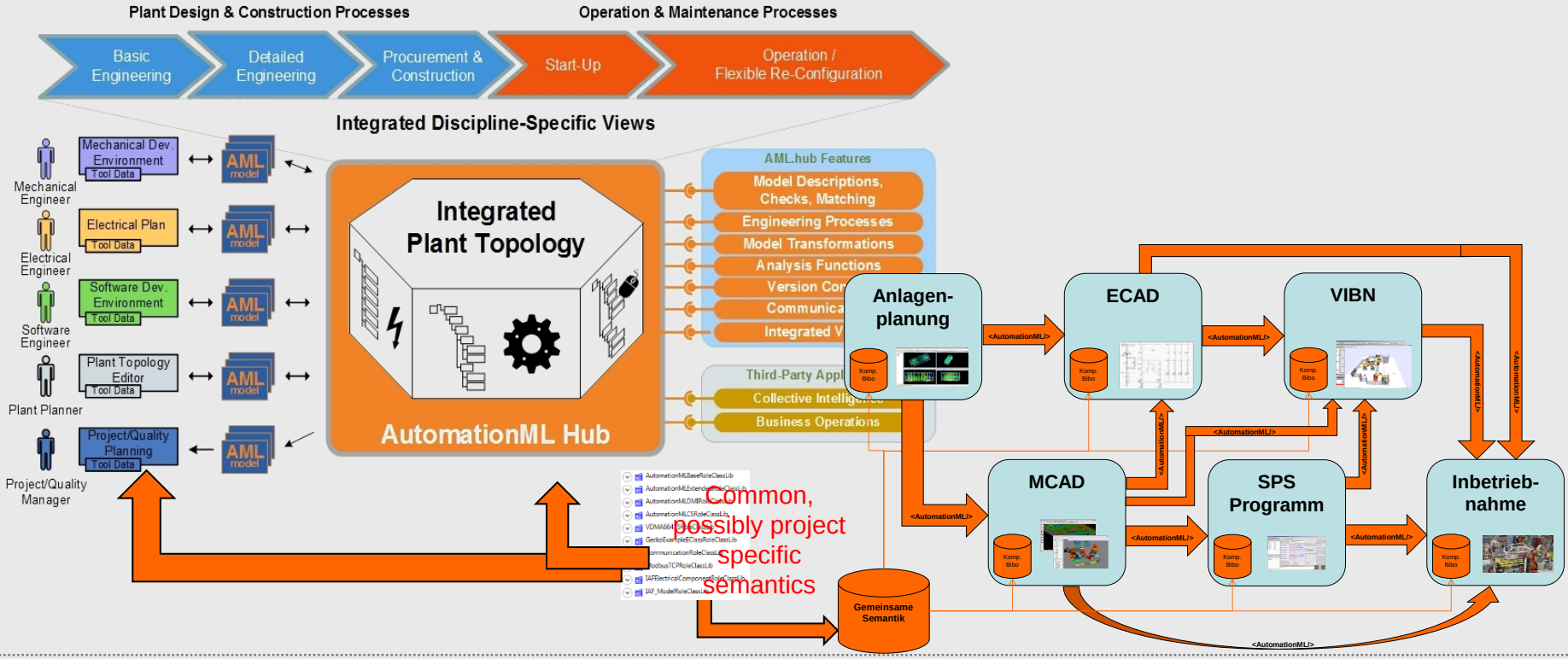




Source: M. Hankel, M. Hoffmeister, Neues von RAMI4.0 und der Industrie 4.0 Komponente, Referenzmodelle für Industrie 4.0

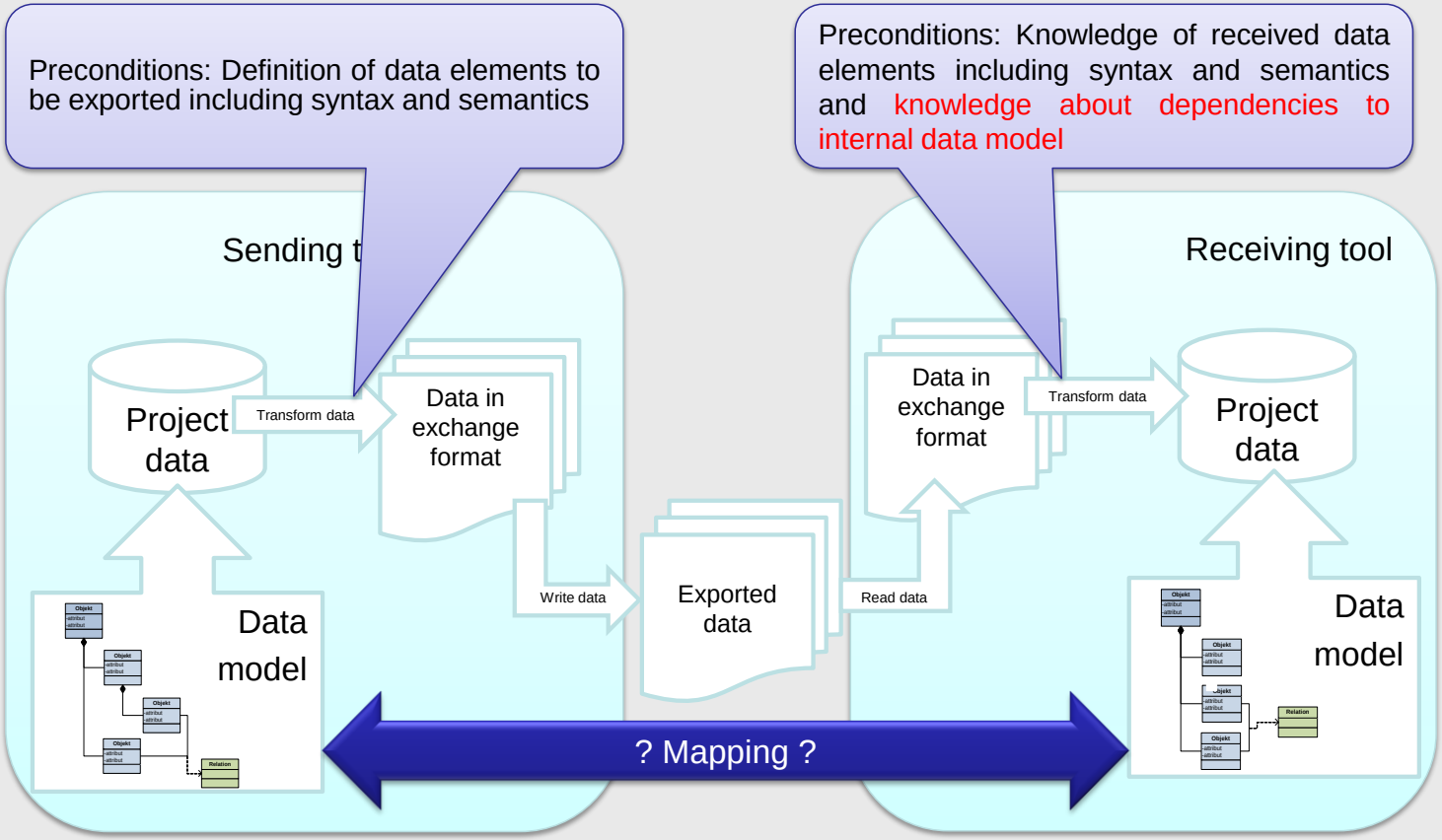
AutomationML tomorrow

- **Were AutomationML can be of importance within future?**
  - Ensuring of discipline and tool crossing integration of engineering data with the purpose of data exchange, project management, consistency generation, …



Value of AutomationML

1. Realization of standardized, lossless, and efficient data exchange between engineering tools based on standardized interfaces and an appropriate use methodology



Value of AutomationML

2. **Enables**
   - Modelling and revision of content of individual data objects as well as the relations between several data objects enabling consistency guarantees
   - Automatic version and variant management
   - Vendor crossing / independent library development / management for engineering data
3. **Provides the technology basis for the integration of domain specific semantics**
   - E.g. use of eCl@ss
4. **Stepwise standardization of semantics**
   - Step-by-step integration of new capabilities in consistent version steps
   - Possibility of combination of standardized and not-standardized parts
   - Possibility of development and consistent combination of domain standards

Value of AutomationML

5. **Enabler for the automatic execution of currently manually executed engineering steps**
   - Examples for engineering steps possibly executed automatically are:
     - Naming of variables
     - Integration of connection structures (Communication, wiring, piping, …)
     - Generation of device and order lists
     - Offer generation
     - Consistency checks
     - …

AutomationML Information

- **Were can further information to AutomationML be found?**

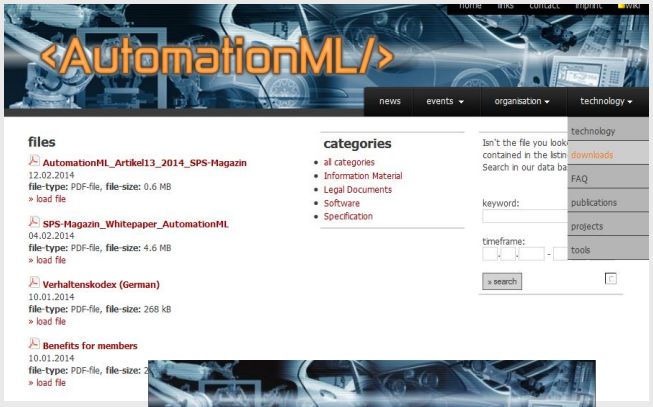
➔ **AutomationML Homepage under www.automationml.org**

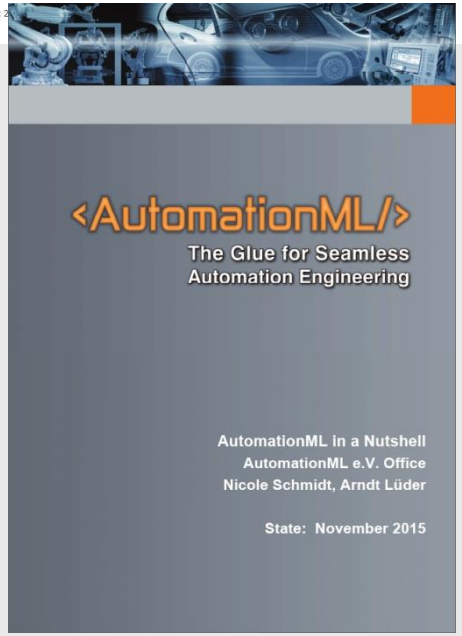
- ➔ Download area with all white papers, software, developer examples, …
- ➔ Research projects, tools, publications, …

➔ **AutomationML Newsletter**

- ➔ To subscribe check the AutomationML Homepage

➔ **AutomationML in a Nutshell**





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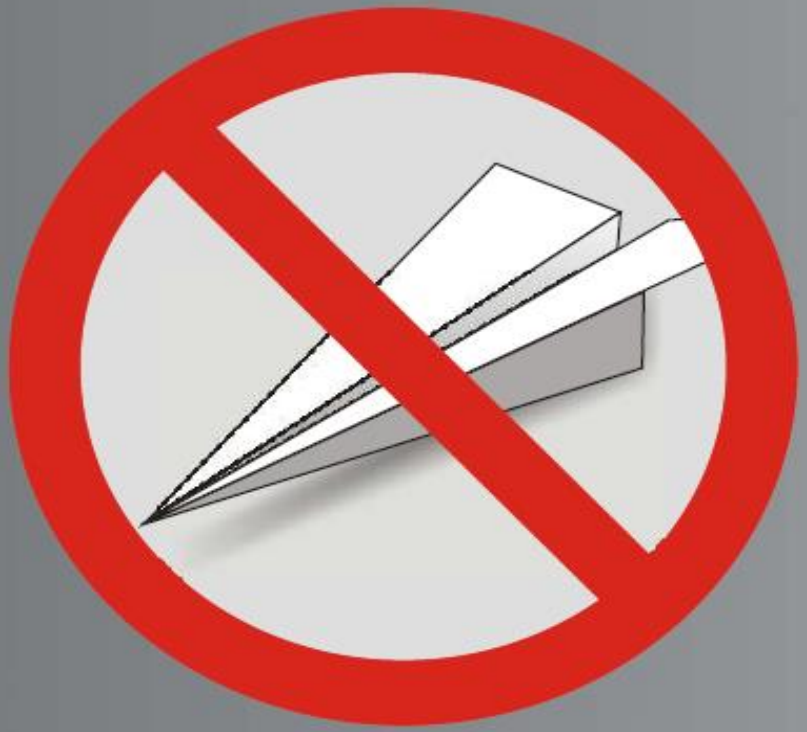
    Web: http://www.iaf-bg.ovgu.de/cvs.html

Join AutomationML!



Get rid of the paper interface!

www.automationml.org