

The background of the top banner features a collage of industrial automation elements. On the left, a robotic arm is visible. In the center, there's a semi-transparent image of a car. On the right, a control panel with a screen and various buttons is shown. The overall color scheme is blue and grey, with an orange accent bar on the right side.

<AutomationML/>

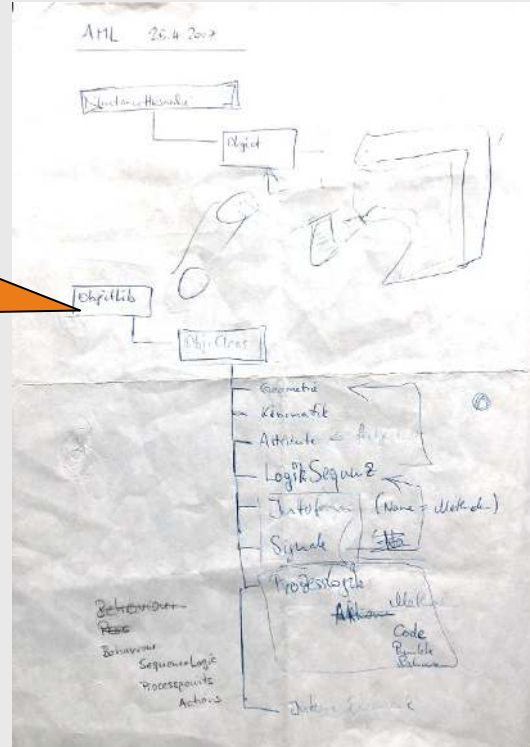
The Glue for Seamless
Automation Engineering

20 Years of AutomationML

Much thinks reached
BUT
Still much (new) things open

Before October 18th & 19th 2006

First idea on
a piece of paper
(preserved
by Rainer)



The AutomationML Tour dates



October 18th & 19th 2006 - Kick off

- Based on an invitation of DaimlerChrysler the “Fantastic 9” have met a first time
 - Intention has been to initiate the development process of AutomationML

Discussion of
aims and
vision



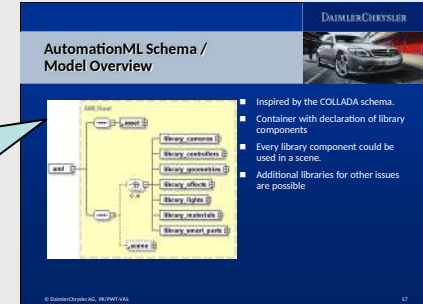
Collection of purposes,
technologies, development
directions, etc.



Hard
discussions



First ideas
based on
Collada



Process
expectations
at OvGU

1. Definition of target space (today & tomorrow ???)
2. Analysis of abilities of UML/SysML/IEC 61499 to model relevant information of target space
3. Definition of used description technologies / models
4. Aggregation of overall AutomationML objects
 - Definition of structure
 - Definition of contained information
 - Definition of information consistency rules
5. Development of mapping / transformation technologies
6. Definition of AutomationML compliance
7. Development of consistency check

2007 – Basic definitions

Decision matrix: Base format for graphics/kinematics

DAIMLERCHRYSLER

	Weight	COLLADA	X3D	STEP	JT	3DXML
Open Standard (Yes/no?)	10	100%	100%	80%	68%	53%
Community	2	93%	93%	87%	27%	13%
Documentation	8	93%	93%	80%	53%	20%
Validation	8	90%	80%	100%	0%	40%
Toolintegration	10	45%	28%	41%	40%	14%
Developer Support	6	100%	100%	80%	80%	60%
Market	7	69%	71%	71%	87%	
Units	5	60%	60%	100%	40%	
Geometry	10	58%	58%	85%	76%	
Kinematics	9	80%	0%	80%	0%	
Structure	9	78%	74%	43%	51%	
Sequencing	10	0%	0%	20%	0%	
Physics	7	100%	80%	80%	80%	
Convex Bodies	2	100%	0%	40%	0%	
Primitives	2	100%	100%	100%	20%	
Format	8	51%	48%	29%	26%	
Mix with XML standards possible?	10	100%	100%	38%	24%	
Weighted Average		73%	62%	63%	40%	

Decision matrix: Base format for sequencing/behaviour

DAIML

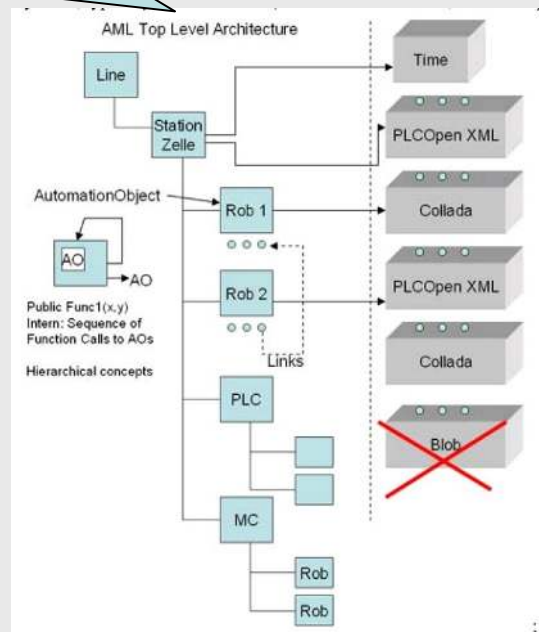
	Weight	PLCOpen (61131)	IEC 61149	SysML
Open Standard (Yes/no?)	10	100%	95%	100
Validation	6	100%	70%	80
Community	8	68%	43%	65
Developer Support	6	86%	43%	53
Market	7	94%	34%	58
Modeling Power, Description	10	62%	74%	80
Formality	6	44%	44%	40
Design Process Support	9	63%	62%	75
Technical Criteria	7	94%	22%	64
Format	9	78%	70%	82
Mix with XML standards possible?	7	50%	50%	50
Weighted Average		76%	58%	70%

March 2007 - Technology selection by
alternatives evaluation

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March 2007 - Technology selection by alternatives evaluation

August 2007 – Our vision on AutomationML architecture



Here we are – Press conference at HMI 2007



Groß Sub-Criteria	Subcriteria	Weight	CAEX	Val. W. SUM	%	AD XML	Val. W. SUM	%	Remarks
SUM		122,0	DKE	90,2	73,9%	Siemens	91,6	75,1%	
Information									
Guidelines									
Open Data Format (Yes/No?)			8,8	80,0%		8,8	80,0%		
Community		9,6	9,6	100,0%		9,6	100,0%		
Developer Support		6,0	5,4	90,0%		5,4	90,0%		
Market									
Window of Opportunity		10,0	9,0	90,0%		9,0	90,0%		
Barriers		2,0	2,0	100,0%		2,0	100,0%		Increased from 1
Correlating Adapters		2,0	2,0	100,0%		2,0	100,0%		
Popularity		1,0	1,0	100,0%		1,0	100,0%		
Acceptance		2,0	2,0	100,0%		2,0	100,0%		
Operational acceptance and diffusion rate		2,0	2,0	100,0%		2,0	100,0%		Increased from 2
Stability		2,0	2,0	100,0%		2,0	100,0%		
Tool developer		2,0	2,0	100,0%		2,0	100,0%		
Experience in use (Control)		2,0	2,0	100,0%		2,0	100,0%		New Item!
Coverage of AM relevant workpieces		2,0	2,0	100,0%		2,0	100,0%		
Meaning		2,0	2,0	100,0%		2,0	100,0%		
Modeling power									
Description range		10,0	9,0	90,0%		9,0	90,0%		Increased from 1
Colour Requirements		2,0	2,0	100,0%		2,0	100,0%		
Core Concepts		2,0	2,0	100,0%		2,0	100,0%		
Further research concepts		2,0	2,0	100,0%		2,0	100,0%		
Design process									
Design process support		10,0	9,0	90,0%		9,0	90,0%		
Summary									
CAEX		90,2	90,2	100,0%		91,6	101,7%		
AD XML		91,6	91,6	101,7%		91,6	101,7%		

December 2007 – We use CAEX

2008 – Development of first details

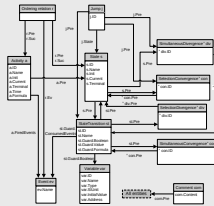
<AutomationML/>

The Glue for Seamless Automation Engineering

The Intermediate Modeling Layer IML

<AutomationML/>
The Glue for Seamless Automation Engineering

- Decouples the target format PLCopen XML from various input and output data formats
- Is quite comparable to SFCs of IEC 61131-3
- Extended to support further models and diagrams
- Additionally two simplified IML systems are defined for easy, but still powerful behavior descriptions



Hannover Messe, 21-25 April 2008

AutomationML

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Term setting – we are the glue

Inventing IML

AutomationML is the glue for seamless automation engineering

<AutomationML/>
The Glue for Seamless Automation Engineering

- Interoperability between tools
- For all engineering phases
- Lossless and scalable
- Open data format



Hannover Messe, 21-25 April 2008

AutomationML

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Back-up: Suggested new work items and milestones

<AutomationML/>
The Glue for Seamless Automation Engineering

- Top-level architecture**
 - Philipp: Simulation relevant data, interlinking of all AML parts
 - Exchange of AML documents together with logics, geometry and kinematics „in real life“
 - Role library
 - Interface library
 - Signal parameters
 - Material information (?)
 - Economical view (?)
- Geometry / Kinematics**
 - Motion
 - CSGs
 - Physics, material information (?)
- Logics**
 - Validate impulse charts
 - State charts
 - Interlocking
 - Safety (SIL)
 - Check application of B2MML
- Communication and Devices**
 - Network view
 - Device view
 - Application view
- Cabling**
 - new, 2D (?)
- Process**
 - (s. Keibel slides)

Three work directions – Architecture, Geometry & Kinematics, Logic

The top level architecture contains the topology and links to further information

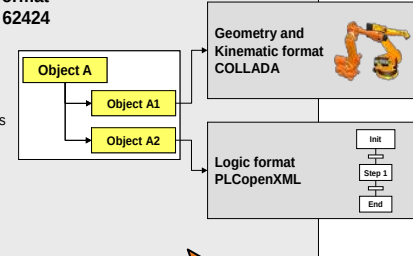
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The Glue for Seamless Automation Engineering

AutomationML

Top level format CAEX IEC 62424

Topology of

- Plants
- Cells
- Components
- Attributes
- Interfaces
- Relations
- References



Hannover Messe, 21-25 April 2008

AutomationML

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14th International Conference on Concurrent Enterprising – we show the architecture the first time

<AutomationML/>

The Glue for Seamless
Automation Engineering

[illegible]

AutomationML Congress 2026

May 5th & 6th 2010 – 1st AutomationML Conference Ladenburg

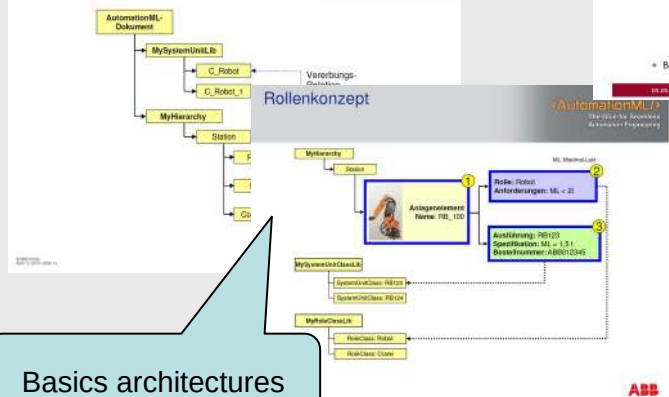
<AutomationML/>
The Glue for Seamless
Automation Engineering

- Focus on AutomationML architecture with all its flavours, applied technologies, use cases and more

Book
No.1



AutomationML
CAEX - Dateistruktur



Anwendungsfall:
Von der Simulation zum Roboterherstellertool

- Beteiligte: Roboterprogrammierer
- Quelltools: CATIA V5, MicroStation, DELMIA DS B V5
- Zieltools: KUKA Sim, ABB RobotStudio
- Informationen:
 - Prozessbahn
 - Festlegung des kinematischen Profils (gespeiste Achsen, Achslimits)
 - Festlegung des Bewegungsprofils (Geschwindigkeiten, Beschleunigungen)
- Bisheriger Austausch: Video, Powerpoint

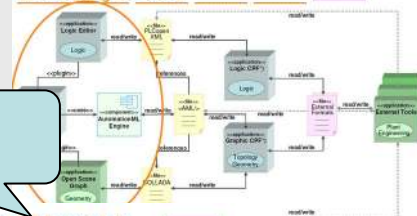
Use case collections

Tooling

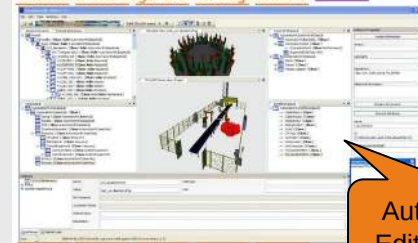
Anwendungsfall:
Von der Simulation zum Roboterherstellertool



Die AutomationML-Werkzeuge helfen bei der Nutzung des Formats und der Visualisierung der Daten



Mit dem AutomationML Editor wird die Anlagentopologie detailliert beschrieben, Geometrie und Logik werden eingebunden



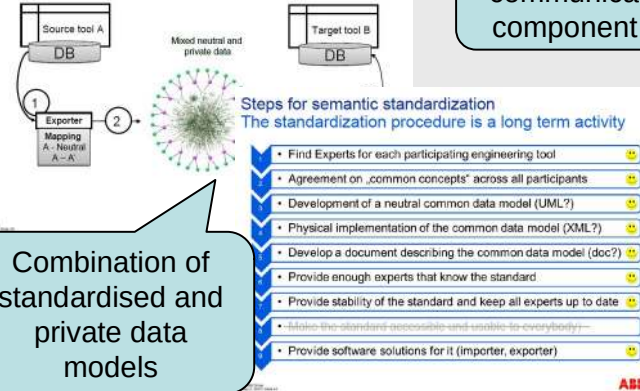
AutomationML
Editor was born

- Focus on implementation and application strategies as well as future developments

The idea
We actively allow mixed neutral/private data models

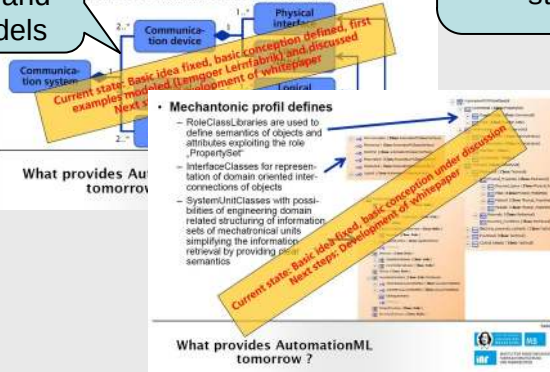
Advances towards
communication and
component models

Importer
implementation
strategies



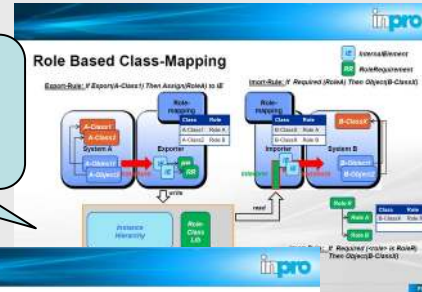
Combination of
standardised and
private data
models

Communication systems will be described using CAEX
the distinction of
logical and physical interfaces
networks consisting of interconnections of logical interfaces
networks consisting of interconnections of physical interfaces



What provides Automation tomorrow?

What provides AutomationML tomorrow?



AutomationML – Fachexperten erklären das Format

First major journal publication

Liaison with OPC
Foundation started
end of 2013

Ontology based evaluation of AutomationML

Standardization needs and paths

Actual status

- Evaluation by means of examples
 - Research examples
 - ExampleTopology.aml
 - SimpleExamplePart2_reduced.aml
 - Practice examples
 - Festo
 - Siemens

OPC UA integration

October 18th & 19th 2016 – 4th AutomationML Conference Esslingen

<AutomationML/>
The Glue for Seamless
Automation Engineering

Focus on engineering project support



Further topics

AutomationML further discussed topics	Timeline	Not started
Integration of semantic definitions	Integration of configuration variables for manufacturing automation (CNC)	
OPC UA information model	Process data exchange (data sets to PLC)	
Automotive system configuration	Data modelling for digital automation (order to production)	
Material handling	Robotics - assembly line models	
Component classification	Object structure (component classification)	
YDMA data model	Change of state (component classification)	
Abstract API	Industrial interfaces (APIs)	
Higher levels	Integration in higher levels (ERP)	
Data security	Integration of data security (Access control)	

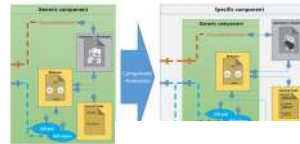
AutomationML now

Standardization in IEC

AutomationML Standard Series IEC 62734	Control	White space	Not started	Not started
Part 1: Architecture	Influence of order concepts and has been published (IEC 62734-1)			
Part 2: Libraries	Definition and use of basic and industry standard data types			
Part 3: Geometry	Modeling of geometry and dimension using IEC 62734-3 (IEC 62734-3)			
Part 4: Logic	Modeling of hardware and interconnect using IEC 62734-4 (IEC 62734-4)			
Communication	Modeling of communication capabilities and interconnect using IEC 62734-5 (IEC 62734-5)			

Standardization progress

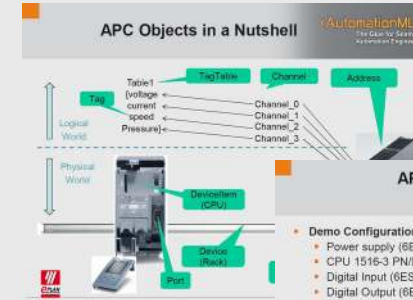
Tool OPAK AML-ComponentGenerator Concept



OPAK Engineering: 1. Import Components and Compose a Static Model of a System



Component model and their use



Start of AR APC development

APC Demonstration Configuration

Demo Configuration

- Power supply (6ES7 507-0RA00-0AB0)
- CPU 1516-3 PN/DP (6ES7 516-3AN01-0AB0)
- Digital Input (6ES7 521-1BL10-0AA0)
- Digital Output (6ES7 522-1BL00-0AB0)



AML Hub Data Management

- Open integration and communication platform
- Versioned AutomationML model repository for plant topology and class libraries
- File-based version management system
- Allows managing and reporting changes and consistency of AML-models and -libraries and connections to incorporated models.

Model Management in AML.hub



- File Format Analysis
- File-to-Model Transformation
 - Requires model description
- Model-to-AML Transformation
 - Models with cross-discipline information
- Merge with Integrated Plant Topology

AutomationML Hub



October 24th & 25th 2018 – 5th AutomationML Conference

Gothenburg

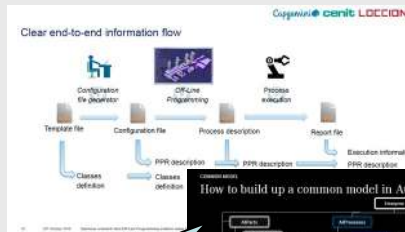
<AutomationML/>

The Glue for Seamless Automation Engineering

Focus on data integration within an engineering workflow

Tool chain integration technologies

AutomationML in the Oil&Gas Industry
Automated code generation by means of the IEC PAS 61311



AutomationML for describing Mechanisms Components for Virtual Commissioning

Initial Situation

- High effort to create libraries of behavior models for every device for every simulation system at every user based on paper documentation
- The component manufacturers have the knowledge about their component's behavior
- The behavior models are developed differently by each user based on its knowledge, the target systems and the use cases
- Reverse-engineering needed occasionally because of insufficient documentation

Goal

Usage of AutomationML, to create a standard for describing mechanisms components for virtual commissioning



System structure descriptions

Migration to AutomationML based Tool Chains incrementally overcoming Engineering Network Challenges

AutoML: Modern Tool Chains for Incremental Migration to AutomationML based Tool Chains

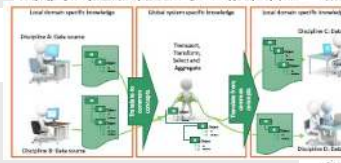
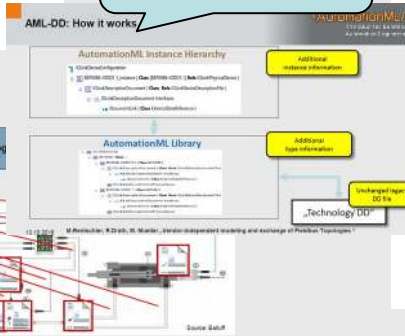
AutoML: Modern Tool Chains for Incremental Migration to AutomationML based Tool Chains



Requirements of individual tool chains



Description of mixed technology



AutomationML in a continuous products life cycle: a technical implementation of RAMI 4.0

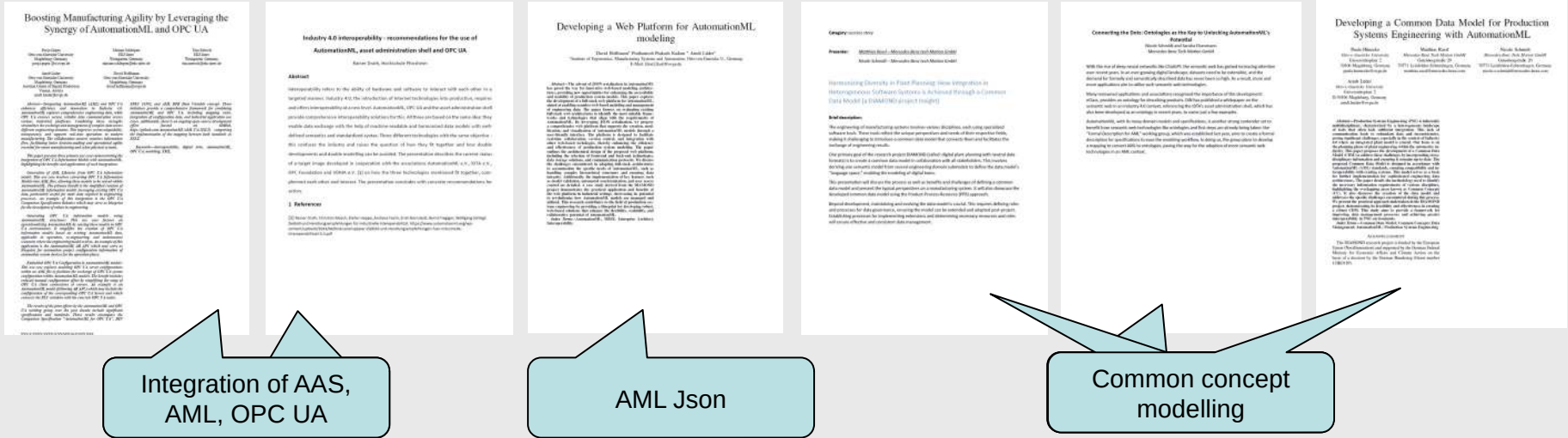
AutomationML in a continuous products life cycle: a technical implementation of RAMI 4.0

AutomationML in a continuous products life cycle: a technical implementation of RAMI 4.0

AutomationML in a continuous products life cycle: a technical implementation of RAMI 4.0

AutomationML in a continuous products life cycle: a technical implementation of RAMI 4.0

- Focus on information modelling in an integrated engineering network and the production system life cycle



No Photos → Has been cancelled due to limited participation

Wissenschaftlicher Hauptbeitrag atp magazin | Formatvorlage 2023

Synergien durch Standards im Anlagenentstehungsprozess

DIAMOND - AML und AAS im Engineering

Lars Dörner, Lorenz Haindl - Murtelektronik
Tina Mersch, Miriam Schläpfer - EKS InTec
Matthias Freund, Manuel Paul - Festo
Arndt Linder - OVGU
Kian Kase - sapo

Die Autoren stellen die praktische Umsetzung einer Integrationsmethode von AutomationML (AML) und der Asset Administration Shell (AAS) im Rahmen des Forschungsprojekts DIAMOND vor. Das Projekt fokussiert auf den Lebenszyklus einer Produktionsanlage von der Integration der Komponentenbeschreibungen in der Engineering-Phase der Anlage bis hin zur Vernetzung der Engineering-Daten in die Betriebsphase. Der kombinierte Einsatz von AAS und AML wird für den Übergang zwischen Komponentenentwicklung und Engineering sowie zwischen Engineering und Betrieb beschrieben, wobei der Schwerpunkt auf der Integration und Vernetzung vorhandener Informationen ausstelle einer Neumodellierung liegt. Konkrete Konzepte, die in AML und AAS verwendet werden können, werden beschrieben, z.B. die Verwendung eines SemanticID. Die praktische Umsetzung dieser Methode im Rahmen des DIAMOND-Projekts wird anhand einer Motorkomponente inklusive Zylinderkopf wie z.B. Antriebs oder Antriebskonfiguration dargestellt, die in eine Produktionslinie integriert, projektiert und anschließend in Betrieb genommen wird. Die Autoren zeigen, wie mit dieser Methode die Lücke zwischen Engineering-Daten und lauffähigen Informationen durch Nutzung und Integration von AAS in AML-Modelle und umgekehrt geschlossen werden kann.

DIAMOND / AutomationML / Verwaltungsschale / AAS / AML / Integration

DIAMOND – AML and AAS in engineering

The authors present the practical implementation of an integration method of AutomationML (AML) and the Asset Administration Shell (AAS) in the context of the DIAMOND research project. The project focuses on the transition between component development and engineering, and between engineering and operation focusing on the integration and interlinking of existing information instead of re-modelling. Concrete concepts to be used in AML and AAS are described, e.g. the usage of a SemanticID. The practical implementation of this method within the DIAMOND project is presented by means of a motor component including corresponding parts like, e.g. a drive or a drive train configuration. These are integrated into a production cell which is engineered and then put into operation. The authors demonstrate how this method can be used to bridge the gap between engineering data and runtime-

Wissenschaftlicher Hauptbeitrag atp magazin | Formatvorlage 2023

Datendurchgängigkeit im Anlagenentstehungsprozess

DIAMOND – Modell und Realisierung

Tina Mersch, Miriam Schläpfer, EKS InTec

Bernd Köhnenkötter, Alfred Hyppik, Lehrstuhl für Produktionssysteme, Ruhr-Universität Bochum

Joachim Burklein, Mercedes-Benz

Michael Ach, BMW

Christian Göbel, tarakos

Matthias Freund, Manuel Paul, Festo

Arndt Linder, Paula Hiescke, OVGU

Lars Dörner, Murtelektronik

Wolfgang Schölgl, Siemens

Im DIAMOND-Projekt wird ein domänenübergreifendes, gemeinsames Informations- und Datenmodell (Common Data Model - CDM) für den gesamten Engineering-Prozess (im Beispiel der Automobilindustrie) entwickelt, mit dem Ziel die Effizienz der Anlagenentstehung messbar zu steigern. Dieser Prozess ist derzeit fragmentiert und basiert auf verschiedenen Software-Tools und Datenformaten. DIAMOND nutzt AutomationML und die Verwaltungsschale als Standards für den Datenaustausch und die Datenintegration. Für eine erweiterte Nutzung des CDM bedarf es auch das Projekt auch mit der Realisierung eines Backbones, der das CDM verwaltet und einen kontrollierten Zugriff auf Engineering-Daten ermöglichen kann. Das Ziel ist es, einen flexiblen und effizienten Engineering-Prozess mit minimaler Datenredundanz und maximaler Interoperabilität zu schaffen. Der Ansatz soll individuelle Schnittstellen reduzieren, Flexibilität und Erweiterbarkeit ermöglichen. DIAMOND umfasst alle Disziplinen von der frühen Planungsphase bis zur finalen virtuellen Inbetriebnahme.

nur zur Dokumentation der
Interoperabilität / Common Data Model / Standards / AutomationML / AAS
Veröffentlichungen für den

Projekträger

Wissenschaftlicher Hauptbeitrag atp magazin | Formatvorlage 2023

Common Data Model für den Anlagenentstehungsprozess

DIAMOND - Anforderungen und Umsetzung

Paula Hiescke, Arndt Linder, Otto-von-Guericke-Universität Magdeburg

Sandra Eisenmann, Matthias Rasel, Mercedes-Benz Tech Innovation

Tina Mersch, Miriam Schläpfer, EKS InTec

Alexander Große-Kretz, Bernd Köhnenkötter, Lehrstuhl für Produktionssysteme

Lorenz Haindl, Murtelektronik

Ulrich Burger, SinPlan

Vanessa Kraus, La-ATX

Die Datenbereitstellung und -verarbeitung im Anlagenentstehungsprozess wird häufig durch zersplitterte Aufbereitungsprozesse und inkompatible Informationsformate gehindert. Das DIAMOND-Projekt adressiert diese Herausforderung mit einem Common Data Model (CDM), das domänenübergreifende Interoperabilität ermöglicht. Das Vorhaben umfasst zunächst eine Anforderungsanalyse. Daran schließt sich die Entwicklung der Modelle entwickelt und in einer gemeinsamen Ontologie zusammengefasst. Der vorliegende Ansatz folgt dem Model-View-Controller-Prinzip. Das CDM bildet das Modell und spezifische Sichten erlauben den fokussierten Datenaustausch über einen zentralen Backbone. Die herstellereigene Serialisierung erfolgt über AutomationML und die Verwaltungsschale. Erste Praxiserprobungen im Projekt bestätigen das Potential für verteilte Planungsszenarien und ein geringeres Fehlerrisiko. Somit leistet das CDM einen Beitrag für effizientere und flexiblere Lösungen im Anlagenengineering.

Common Data Model / Anlagenengineering / AutomationML

Common Data Model for Factory Engineering

The last engineering process is often slowed down by data-creating preparation processes and inconsistent information. Project engineering project addresses this challenge by employing a Common Data Model (CDM) that enables cross-domain interoperability. The process starts with a requirements analysis. Domain-specific models are then developed and brought together in a common ontology. This approach aligns with the model-view-controller principle: the CDM forms the model and specific views enable targeted data exchange via a central backbone. Vendor-independent serialization is facilitated through the use of AutomationML and the Asset Administration Shell. Initial practical tests in the project confirm the potential for shorter planning times and a

Wissenschaftlicher Hauptbeitrag atp magazin | Formatvorlage 2023

Prozess- und Verschwendungsanalyse in Engineering und Inbetriebnahme

DIAMOND – Grundlage einer effizienten Digitalisierung des Gesamtprozesses

Tina Mersch, Miriam Schläpfer, EKS InTec

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Arndt Linder, Paula Hiescke, OVGU

Lars Dörner, Murtelektronik

Wolfgang Schölgl, Siemens

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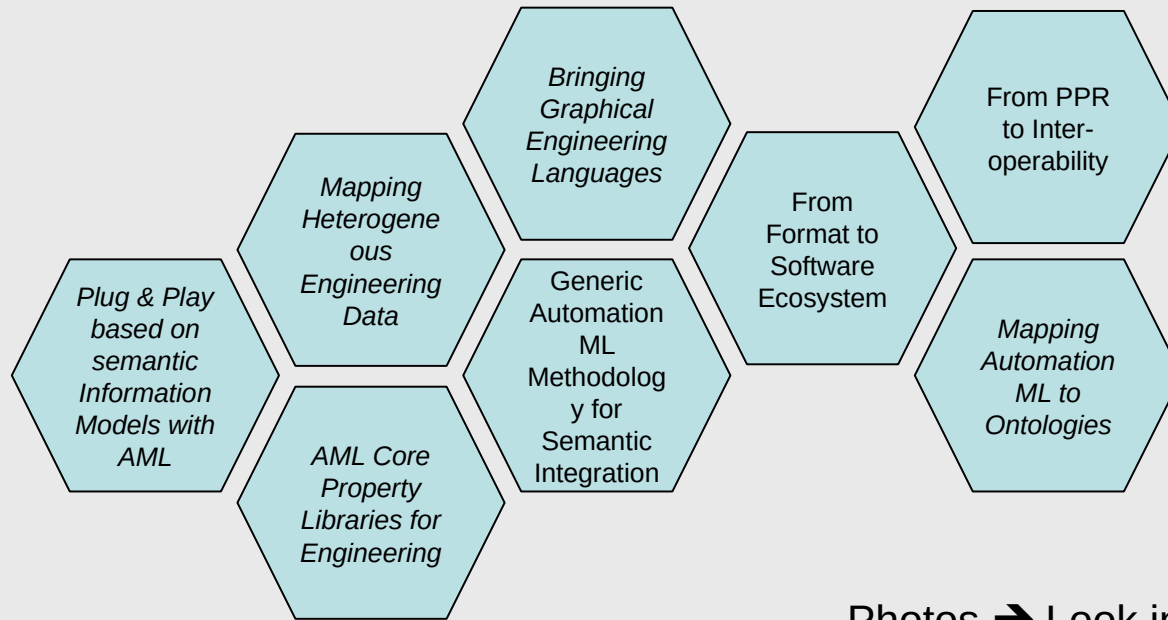
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We are here now! And we focus on modelling and applying semantic within AutomationML Models



Photos ➔ Look into the mirror

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3 book publications on AutomationML:

- “AutomationML – A Practical Guide”
- “AutomationML – The Industrial Cookbook”
- “AutomationML – Das Lehrbuch für Studium und Praxis”

Where do we stand ?

When have the current standard documents arrived ?

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The Glue for Seamless
Automation Engineering

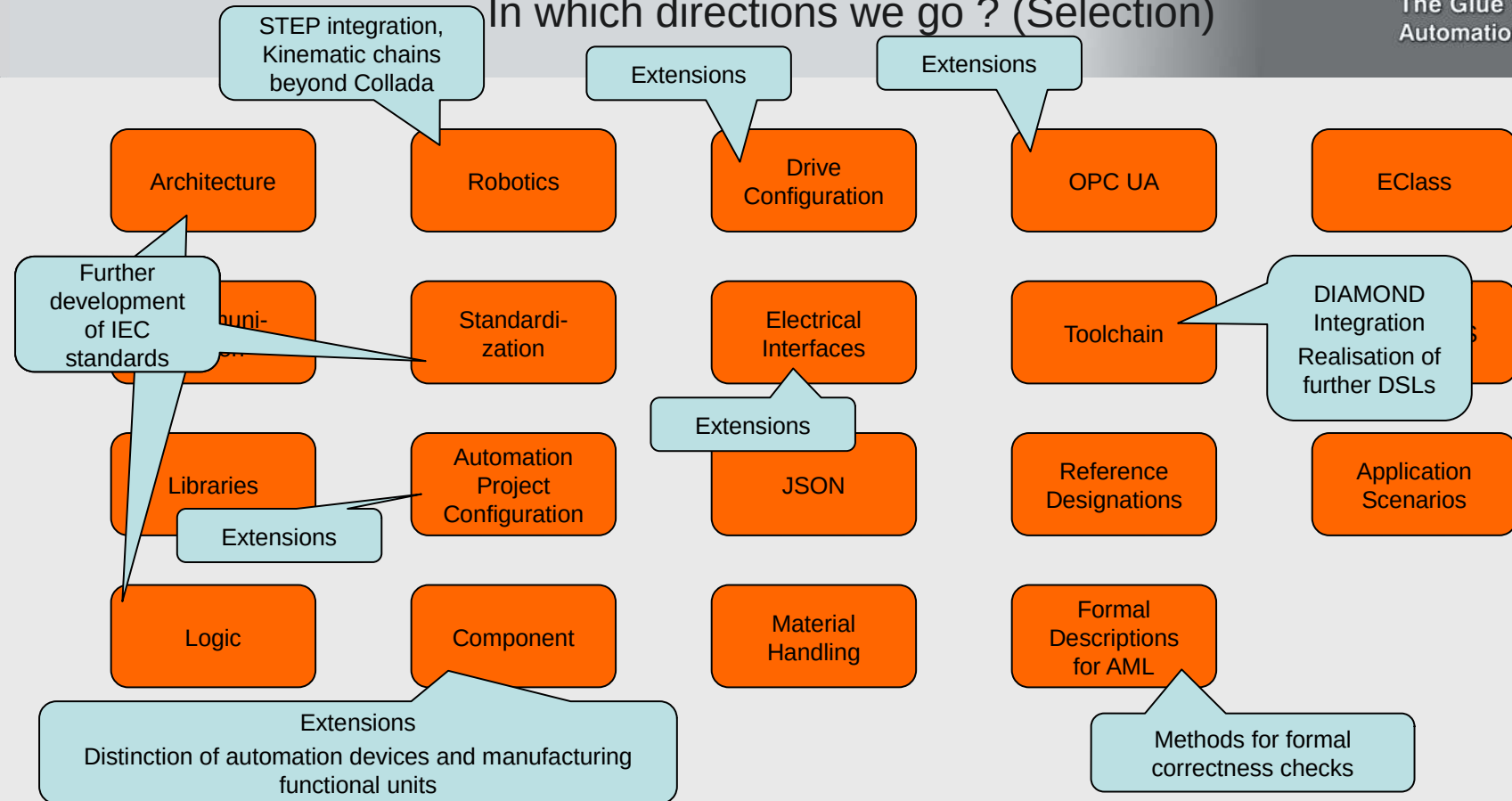


Where do we stand ?

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In which directions we go ? (Selection)



Where do we go ?

