Combining AutomationML and OPC UA

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Agenda

- Motivation
- Plug-and-work principles
- Goals
  - Mapping of AutomationML and OPC UA
  - Access to the AutomationML model in OPC UA
- Examples
- Conclusion and Outlook
Motivation - Changes

• Continuous changes of production systems → reconfiguration of hardware and software components
• Objects to change within a manufacturing enterprise
  • Products
  • Technological or logistical processes
  • Parts of the manufacturing facilities
  • Software systems
  • Company’s organization

• interoperability and seamless semantic integration necessary
Initial situation - 'Babylon' on the shopfloor

Visualization / SCADA
Production Monitoring & Control

Ωασχηµοδυ
Τροχκενµοδυλ
Τεµπερατυρ
Γεσχηωινδιγκειτ

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Bbc_24-xy_Tist

Image sources: MOC Danner, KUKA, MAG, Schunk
Plug-and-work

- Term definition:
  - setting up, modification or termination of interoperation between two or more involved parties with minimal effort
  - **Note 1:** The interoperability of those involved is assumed.
  - **Note 2:** The minimum effort can vary depending on the state of the art.
  - **Note 3:** Plug & play and plug & produce are synonyms or similar terms.

Source: I4.0 Glossary of the VDI GMA technical committee 7.21 »Industrie 4.0«
Unique Datamodels (yesterday-Level 1, today-Level 2, tomorrow-Industrie 4.0)

- Visualisation/Control
- Evaluation
- New Application

Function
- Semantic Models

Knowhow/meaning („Industry 4.0“)
- Resource Objects

Information
- Signals

Data
- (Level 1)
- (Level 2)
Plug-and-work

Simplified access + Unified comprehension = Less engineering costs + Simplified process optimization

Image sources: MOC Danner, KUKA, Schunk, Festo, Siemens, Gebhardt, ROMAI, MAG
Requirements for plug-and-work

- Component description
- Component selection
- Component access
- Component control

Plug-and-work principles

- (Self-)Description via AutomationML (IEC 62714)
- Assistant-Functions and Accumulation/Fusion
- Communication/ Data-Management/ Identification/ Validation via OPC UA (IEC 62541)
- Combination with Middleware, Fieldbus-Technologies, IT-Security-Components, Hardware
- Test/Realization of Components/Systems of industrial partners and accordingly inhouse demo systems
(Self-)Description of Components, Machines and Plants

1. Production system components and their skills (function-oriented descriptions)
2. Function-oriented descriptions of production tasks
3. Methods for an automatic matching/comparison
4. Description of the access path to the functions
Communication, Data Exchange of Components, Machines, Plants and IT-Systems

1. Standardized interfaces for the access to components
2. Universal combination of components to production systems
3. Modular and self-adapting information and control structures
4. Self-parametrisation of the structures possible

OPC UA
Communication and management of data models including security
How?
Start of cooperation at SPS/IPC/Drives 2013
(AutomationML e.V. and OPC Foundation)
Work group members
Communication and management of data models including security

How?

What?

Semantic description of production plant

Companion Specification „AutomationML for OPC UA“ 02/2016

DIN SPEC 16592 „Combining AML and OPC Unified Architecture“ Coming soon (2016)
Relations between use cases over the lifecycle

<table>
<thead>
<tr>
<th>Use Case 1: Information life-cycle management</th>
<th>Use Case 2: Up-to-date description of the system as-is</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use Case 3: Information exchange with MES/SCADA for system operation</td>
<td>Use Case 4: Lossless exchange of OPC Unified Architecture system configuration</td>
</tr>
<tr>
<td>Use Case 5: Communicate/Operationalize AML by means of OPC Unified Architecture</td>
<td>Use Case 6: Mixed simulation environments</td>
</tr>
<tr>
<td>Use Case 7: Lossless storage &amp; retrieval for MRO</td>
<td>Use Case 8: Manufacturing Change Management</td>
</tr>
<tr>
<td>Use Case 9: Lossless storage &amp; retrieval for reconfiguration</td>
<td></td>
</tr>
</tbody>
</table>

Actors and related use cases:

- Mechanical engineer
- Electrical engineer
- Software developer (PLC, HMI, Robot, distributed control system (DCS), network, etc.)
- Plant operator
- SCADA system/MES provider, IT integrator
- Maintenance personnel
- Commissioner
- Plant/Factory Planner

DIN SPEC 16592 Annex A – Industrial application
Goals and benefits (1)

- AutomationML integration in OPC UA
  - Goal: Communicate and operationalize AutomationML by means of OPC UA
- OPC UA server includes functional view on production ➔ information model
  - Result: AutomationML models can be exchanged via OPC UA
  - Benefit: simplify the creation of OPC UA information models based on existing AutomationML data
- Application: re-engineering and maintenance use cases where the AutomationML model evolves over time
Use Cases

- Information life-cycle management
- Up-to-date description of the system as-is
- Information exchange (e.g. asset information, quality information, diagnostic data, etc.) with MES or SCADA system for system operation
- Communicate/Operationalize AML by means of OPC Unified Architecture
- Lossless storage and retrieval of system engineering information for system maintenance, repair, overhaul (MRO)
- Lossless storage and retrieval of system engineering information for manufacturing system reconfiguration
PLUG & WORK –
Online/Operation: Data usage of operation phase

- Use Case „Lossless storage and retrieval of system engineering information for system maintenance, repair, overhaul (MRO)”
- Benefits and usage
  - More exact failure forecast (based on operational data)
  - Predictive maintenance (based on operational data)
  - Easy and safe maintenance and connection (at customer site → network)
  - Longer guarantee/warranty of components (based on operational data)
  - Log/history for components (persistent storage)
Goals and benefits (2)

• OPC UA integration in AutomationML
• Goal: Lossless exchange of OPC UA system configuration within AutomationML models
• Result: Parameters to set up OPC UA communication between tools can be exchanged using AutomationML
• Benefit: simplify the configuration of OPC UA client connections to an OPC UA server (reduce manual configuration effort)
• Application: configuration of communication networks based on description of network configuration and structure (including communication components of sensors and actuators with respect to communication system parameters, network structure and wiring, quality of service, etc.)
Use Case

• Lossless exchange of OPC Unified Architecture system configuration
• Mixed simulation environments
• Manufacturing change management
PLUG & WORK – Offline/Engineering: Data usage for configuration

- Use case „Lossless exchange of OPC Unified Architecture system configuration”
  - Benefits and usage
    - Faster startup
    - Integrated documentation for components
    - Usage of existing data for engineering of MES and visu
Example: Demo available in Karlsruhe

- Demo plant: each module/controller equipped with OPC UA server
- Aggregating OPC UA server based on Unified Automation C++ SDK
- AutomationML model of plant
- Trafo tool: AML2UA
- AML model = information model of aggregating server with connection to OPC UA server of controllers
- View on aggregating server with AML-UA-information model via different clients
Past and present research in this area


• EU, SkillPro - Skill-based Propagation of "Plug&Produce"-Devices in Reconfigurable Production Systems by AML, FP7-2012-NMP-ICT-FoF (Grant 314247), 2012-2015, http://www.skillpro-project.eu

DIN SPEC 91345 – RAMI4.0

DIN SPEC 91345 describes ...

... are structured and ...

Human world

<table>
<thead>
<tr>
<th>Model world</th>
<th>State world</th>
<th>Archive world</th>
<th>Physical world</th>
</tr>
</thead>
</table>

Information world Physical world

... how technical assets ...

... made available for the information world!

Reference architecture model Industrie 4.0

Industrie 4.0 component

© 2016, DIN e. V.
Plug-and-work embedded in „Layer“
Relation to I4.0 component

<AutomationML/>

OPC UA

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Conclusion and Outlook

• Plug-and-work based on standards for I4.0 components
• February 2016: Companion Specification „AutomationML for OPC UA“: general explanation, mapping rules, and definition of organizing nodes and AutomationML standard libraries
• Coming soon (2016): DIN SPEC 16592 – Combining AML and OPC Unified Architecture
  • Extended mapping rules, integration of OPC UA configuration data in AutomationML, relation to other standards and specifications, and use cases for industrial application
• Current work of joint working group
  • AML BPR - DataVariable concept: Integration of OPC UA configuration data in AutomationML
  • Harmonization with other companion specs: OPC UA for devices, OPC UA for IEC62264 (ISA95), OPC UA for FDI, OPC UA for IEC61131-3 (PLCOpen)
• Current status via AutomationML/OPC-F website or http://www.iosb.fraunhofer.de/?opcuaamll
Thank you!
Combining AutomationML and OPC UA
Finland, October 2016

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