

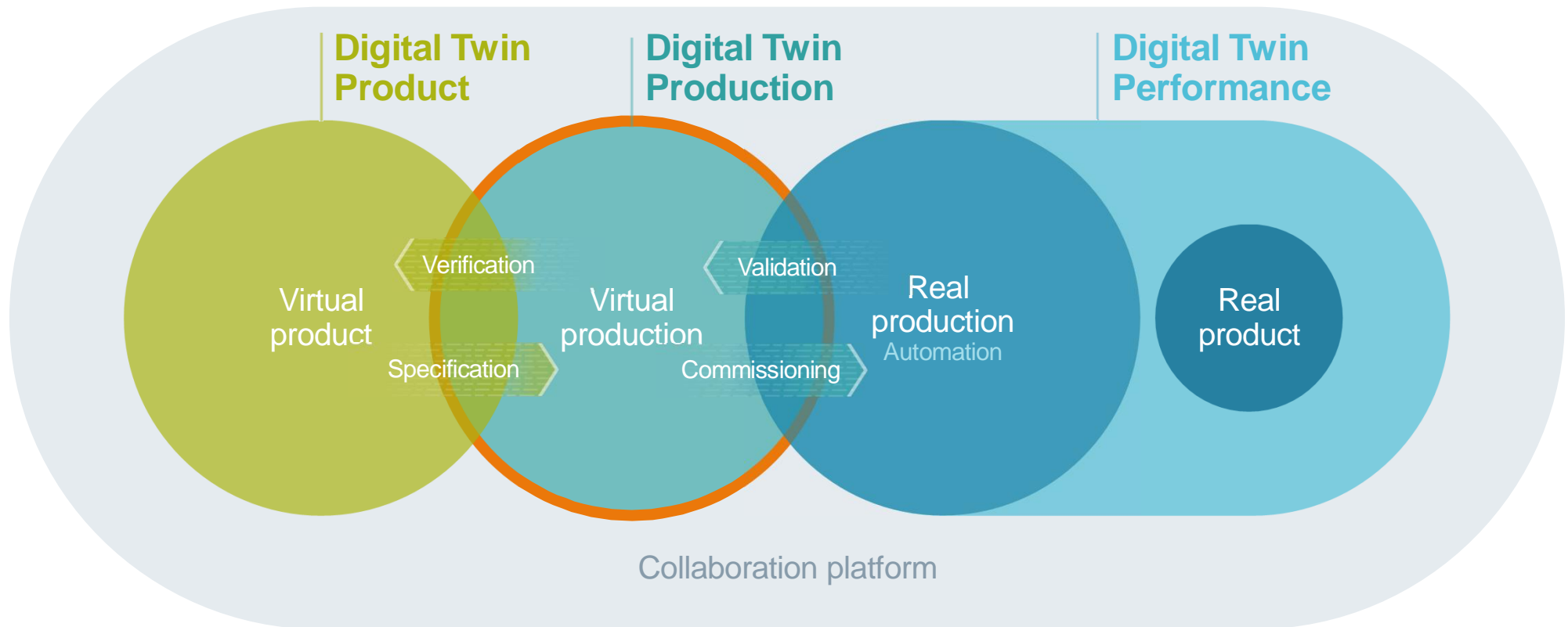


The background image shows a complex industrial manufacturing environment. A digital twin overlay is visible, consisting of a semi-transparent blue wireframe model of a machine or assembly line. This model is positioned over the physical machinery, which includes various pipes, cables, and structural frames. The overlay highlights specific components and their spatial relationships, illustrating the concept of virtual commissioning. The overall scene is dimly lit, with the primary light source being the digital overlay itself.

AutomationML describing Components for Virtual Commissioning

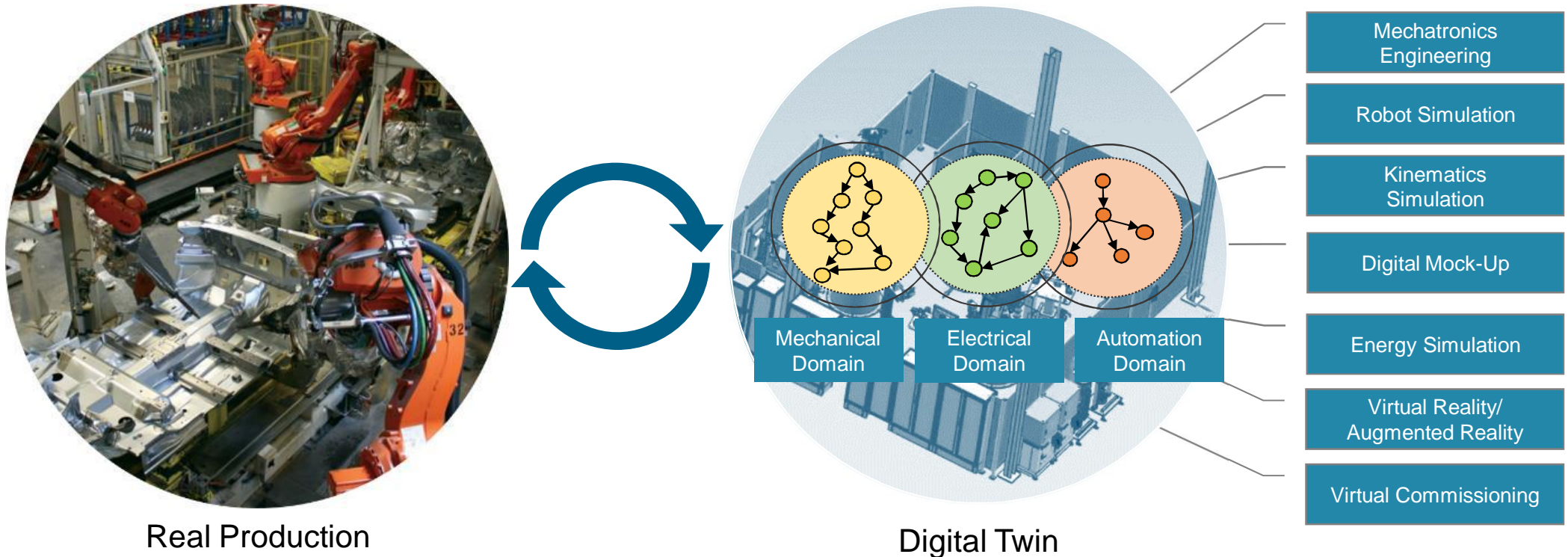
Dr. Wolfgang Schloegl
Head of Digital Engineering
Siemens AG, Nuremberg, Germany

Holistic Digital Twin for Manufacturing

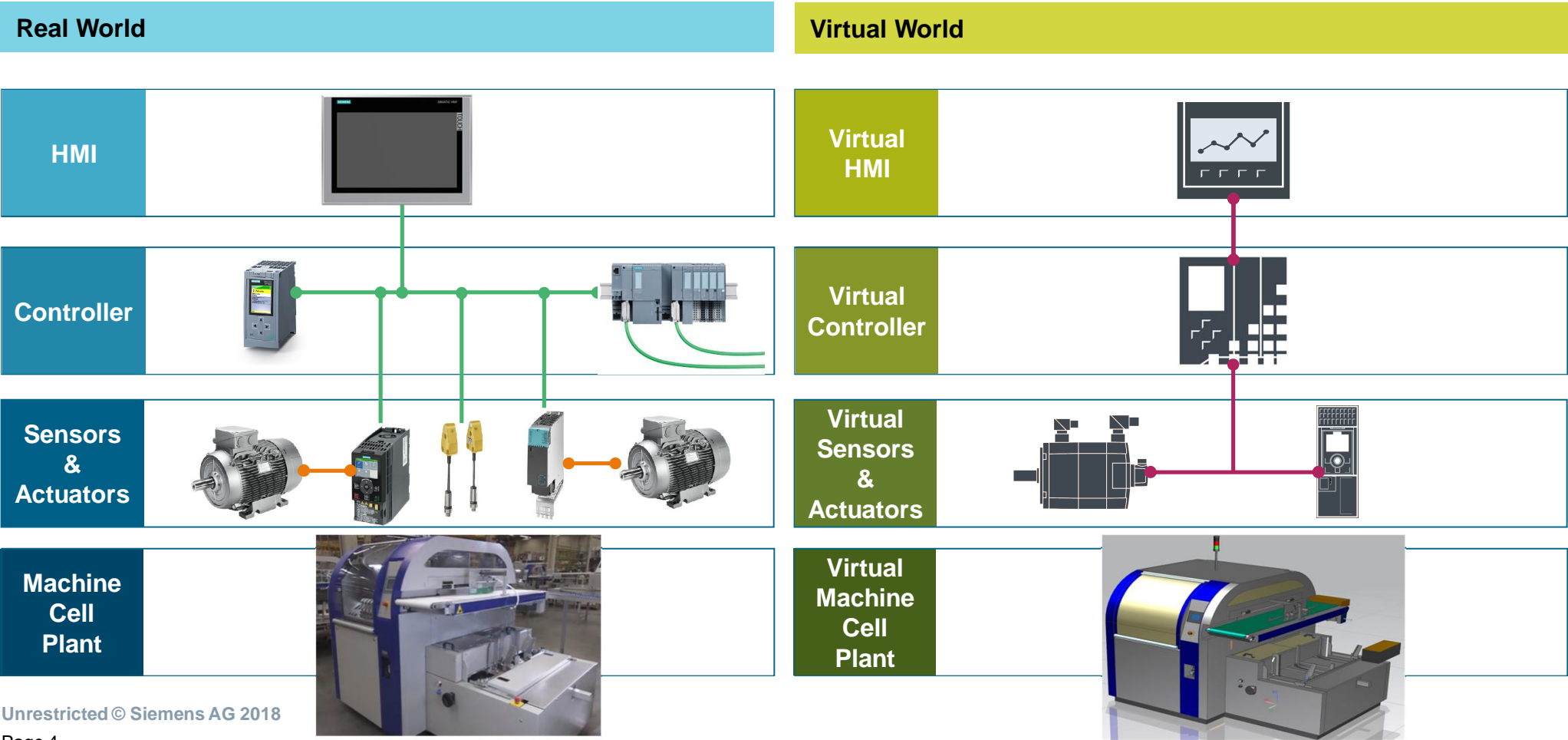


Engineering and Simulation based on the Digital Twin

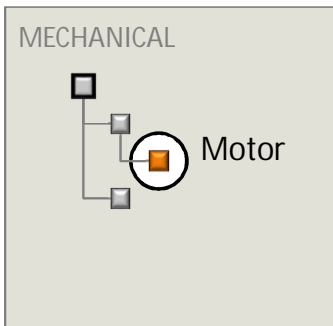
Multi-Domain-Engineering and Simulation



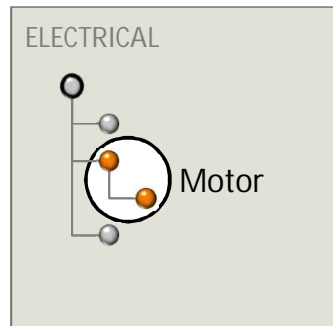
Simulation at every Level



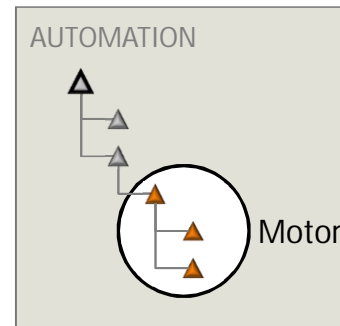
Data needed for Simulation and Virtual Commissioning – Availability of automatically interpretable Data



e.g.: JT file

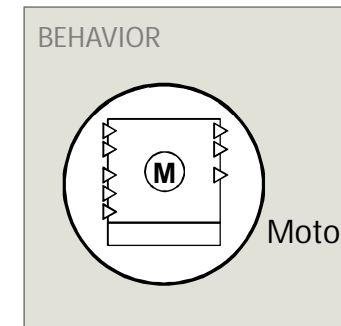


e.g.: E-CAD template



e.g.: PLC function block

Crucial for Virtual Commissioning



No tool independent
automatically interpretable
data available



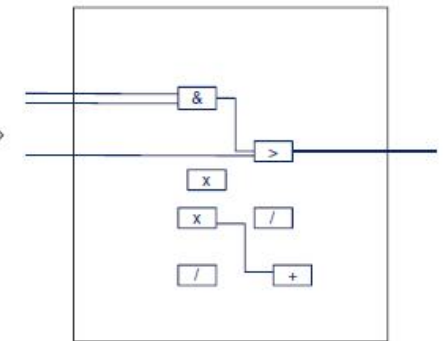
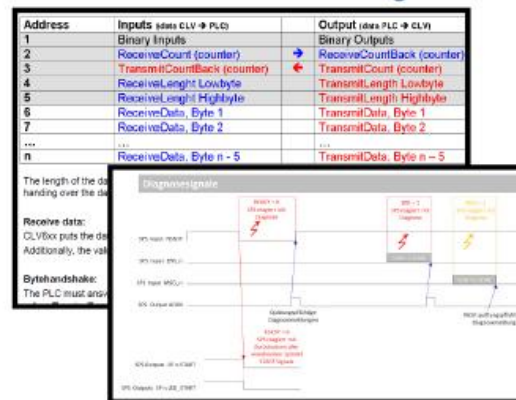
Library Content for Virtual Commissioning

Example Library of Behavior Models:

Cluster	Components	Complexity
Operator panels	6	Low
Safety devices	9	Low
Drives	55	High
Conveyors	11	High
Robot interfaces	7	Very high
Circuit breakers	10	Low
Part presence controls	11	Low
Special functions	11	High
Total	120	

Challenge today:

Manual modelling based on written device documentation (interface documentation, function diagrams, ...) or reverse engineering.



Goal: Definition of a neutral format describing the behavior of electrical devices containing function elements that can be interpreted automatically.

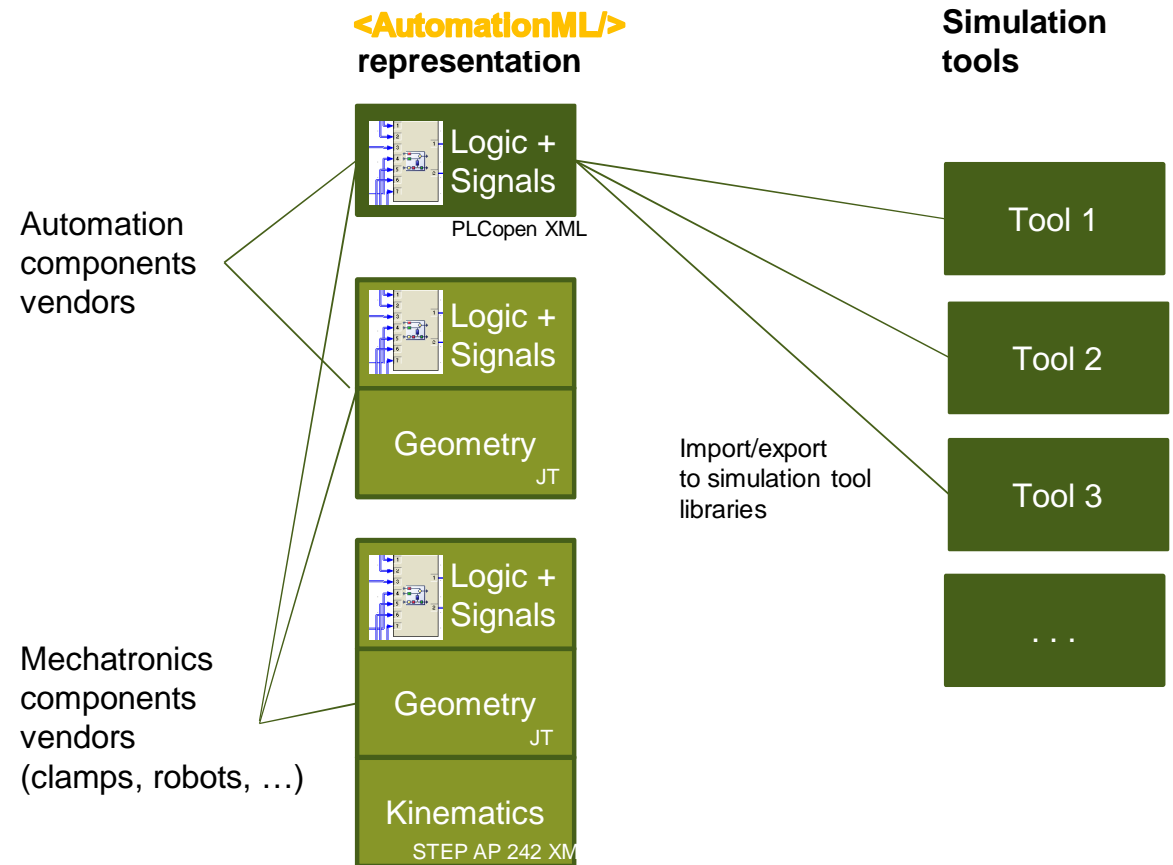
AutomationML for describing Mechatronics Components for Virtual Commissioning

Initial Situation

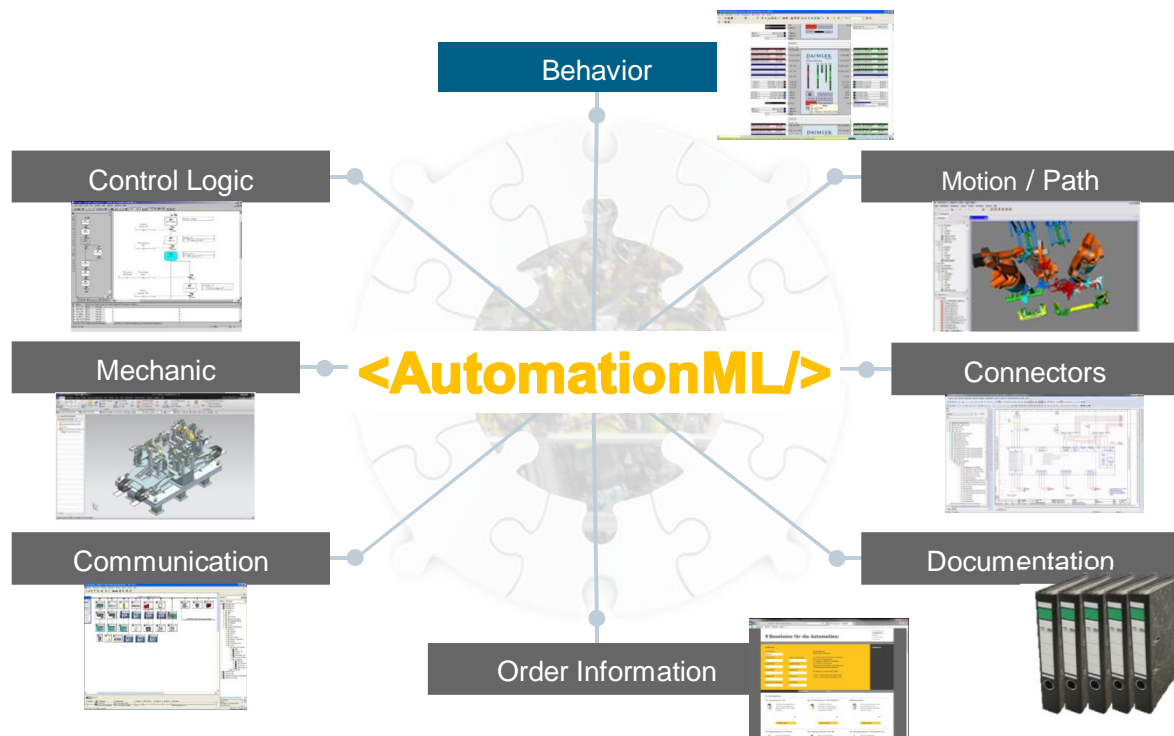
- High effort to create libraries of behavior models for every device for every simulation system at every user based on paper documentation
- The component manufacturers have the knowledge about their component's behavior
- The behavior models are developed differently by each user based on its knowledge,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

Goal

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



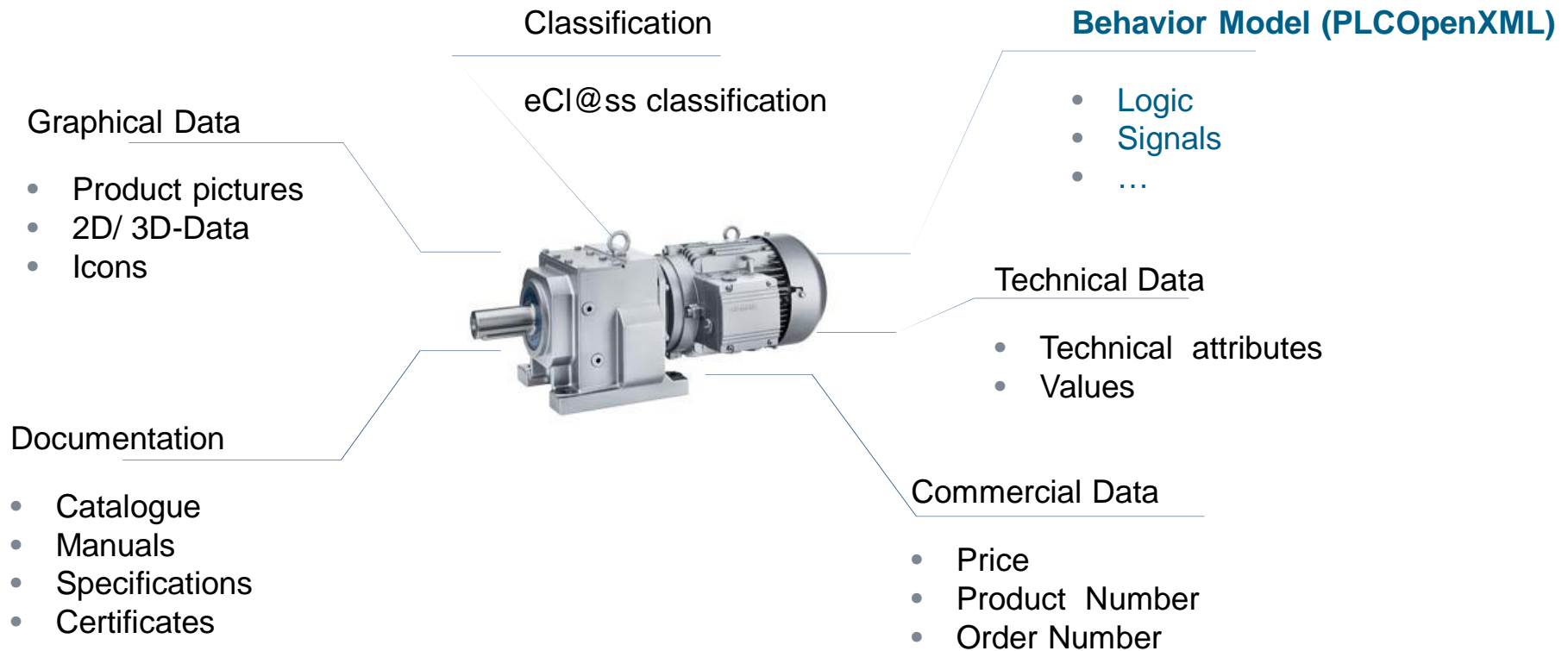
Aspects of Automation Components



Automation components combine different aspects of information

- General data
 - Ordering information
 - Technical information
 - Documentation of the automation component
 - Symbols and pictures.
- Functional data
 - Information to describe the functional behavior of the automation component.
 - Function blocks to control the component
 - Internal interlocking of the automation component
- Model information
 - Simulation Model
 - 2D and 3D models
 - Kinematic models
- Connectors to all logic, electric, pneumatic and hydraulic interfaces of the component

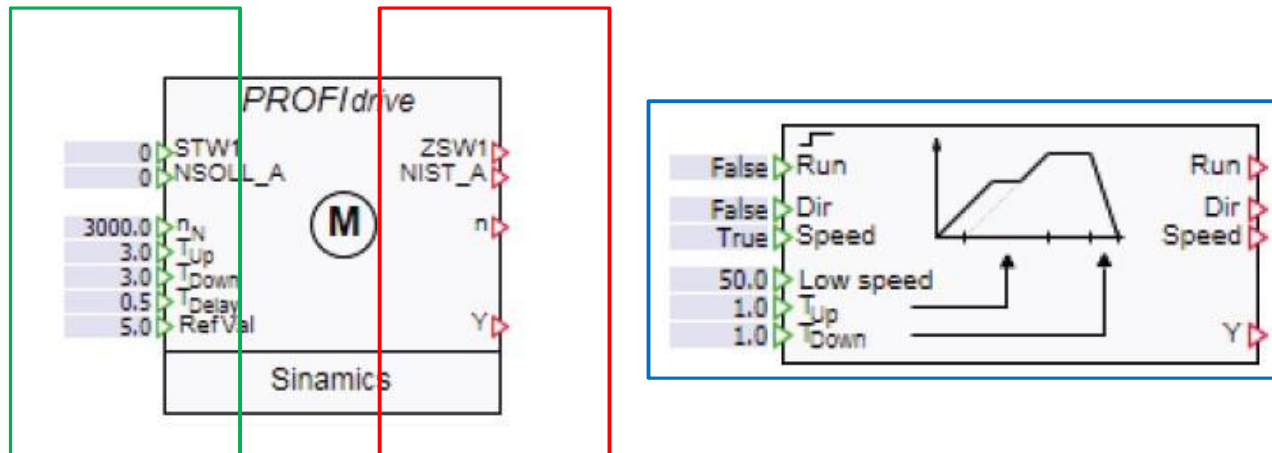
Example: Motor



Example: Motor

The behavior model of a motor

Input Connectors
Output Connectors
Model (PLCOpen XML)



Automation Components in AutomationML: Example Motor

The screenshot displays the Siemens AutomationML software interface, specifically the Instance Hierarchy and Attribute details panels.

Instance Hierarchy:

- Motor 1LM1222-4BC13-3AA0 {Role: BASIC_27-02-21-01 Low-voltage three-phase current asynchronous motor, squirrel-cage rotor (IEC)}
 - ElectricalConnectors {Role: ElectricConnector}
 - ElectricalConnectors-Interfaces
 - U1 {Class: ElectricInterface}
 - V1 {Class: ElectricInterface}
 - W1 {Class: ElectricInterface}
 - PE {Class: ElectricInterface}
 - Simulation Models {Role: AutomationMLBaseRole}
 - PLCopenModels
 - Motor {Role: PLCopenModel}
 - Motor Interfaces
 - Motor Behaviour {Class: LogicInterface} (highlighted with a blue box)
 - Run In {Class: VariableInterface}
 - Dir In {Class: VariableInterface}
 - Speed In {Class: VariableInterface} (highlighted with a green box)
 - Low Speed In {Class: VariableInterface}
 - Up In {Class: VariableInterface}
 - Down In {Class: VariableInterface}
 - Run Out {Class: VariableInterface}
 - Dir Out {Class: VariableInterface}
 - Speed Out {Class: VariableInterface}
 - Y Out {Class: VariableInterface}

Attributes: Motor Behaviour

Attribute detail: refURI

Value
file:///MotorBehaviour.xml#UUID_B36292AF-6311-4070-B232-84A1A6436F85

Attributes: Speed In

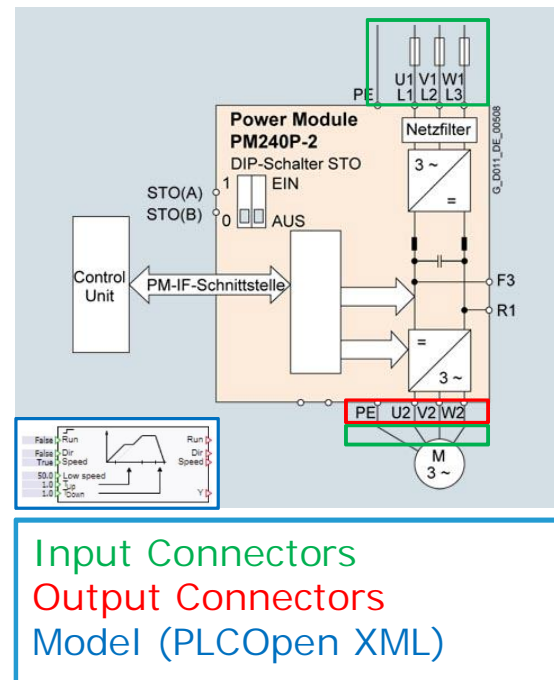
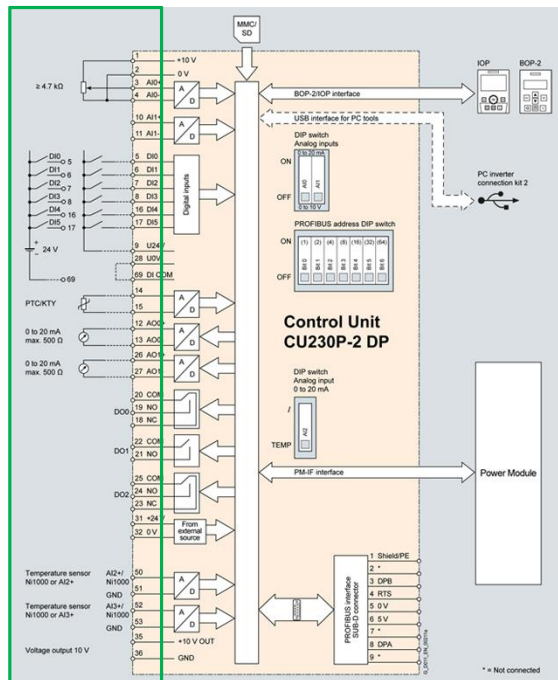
Attribute detail: refURI

Value
file:///MotorLib_RS.xml#530CCDC9-D892-48F9-B7B8-4B44817E4AC1

Arrows indicate the mapping from the 'Motor Behaviour' and 'Speed In' attributes in the Instance Hierarchy to their respective attribute detail panels.

Example: Frequency Converter

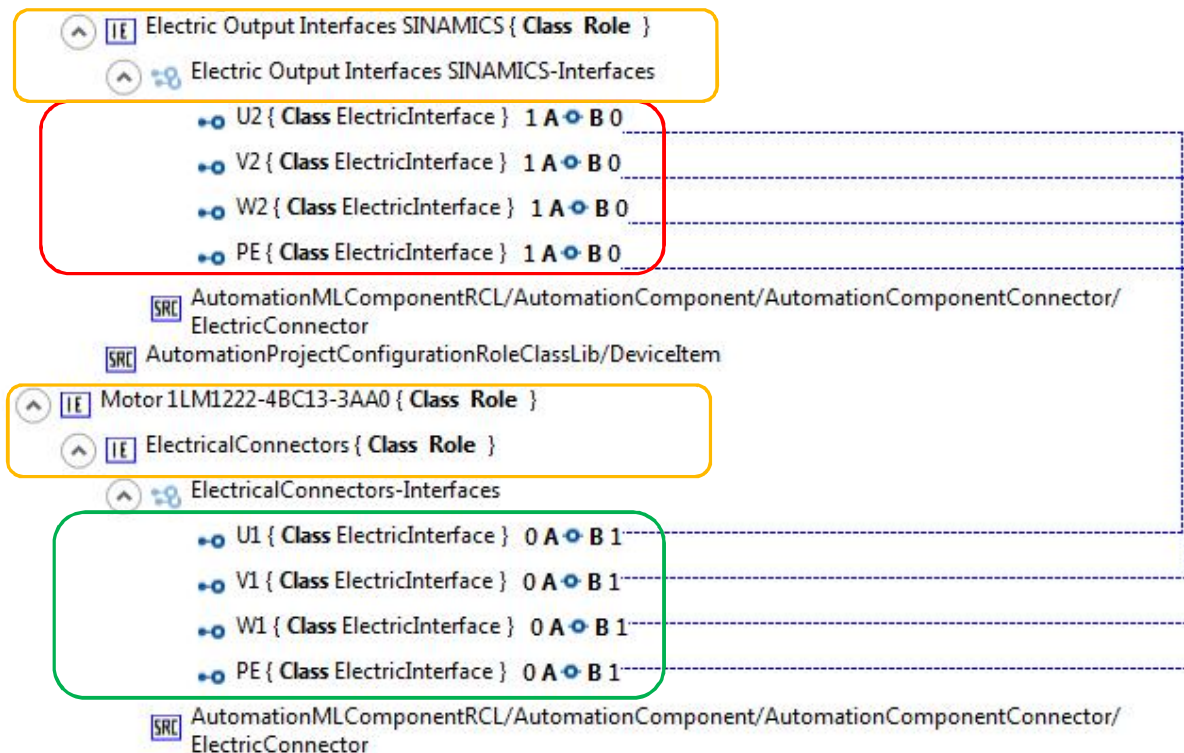
The motor in combination with a frequency converter



Input Connectors
Output Connectors
Model (PLCOpen XML)

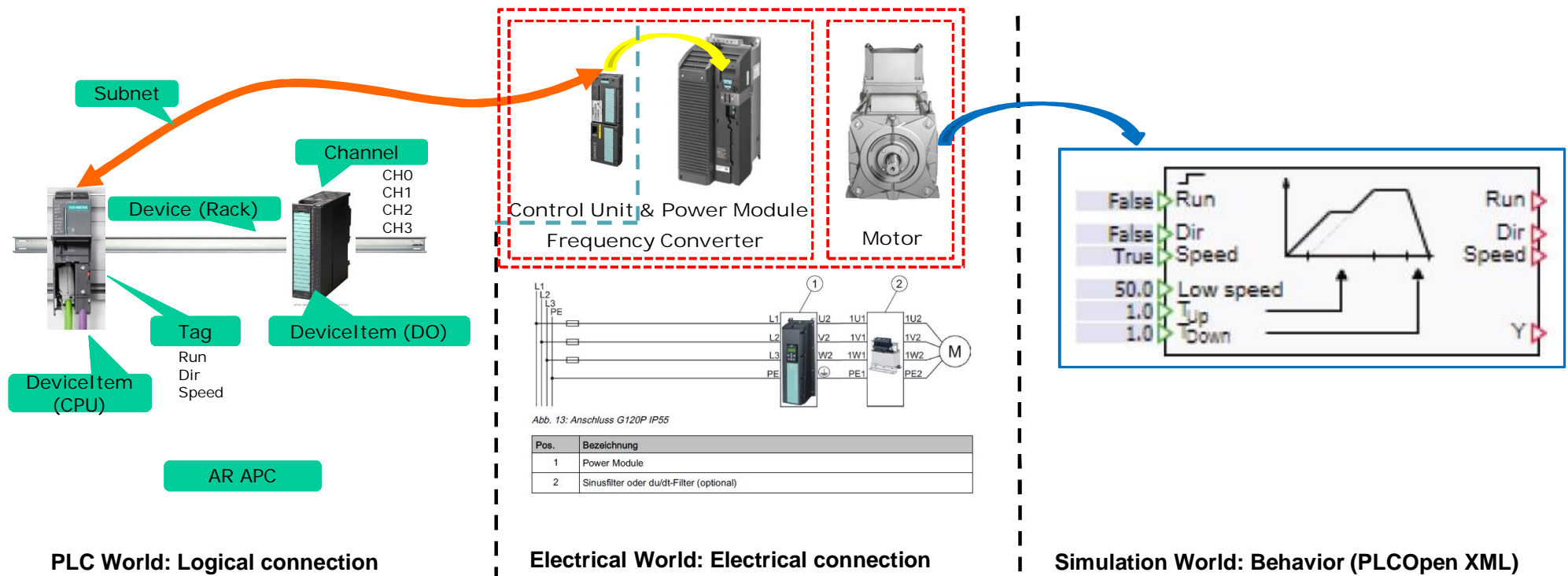
Example Motor and Frequency Converter: Electrical connection

The electric output connectors of the frequency converter are connected to the input connectors of the motor



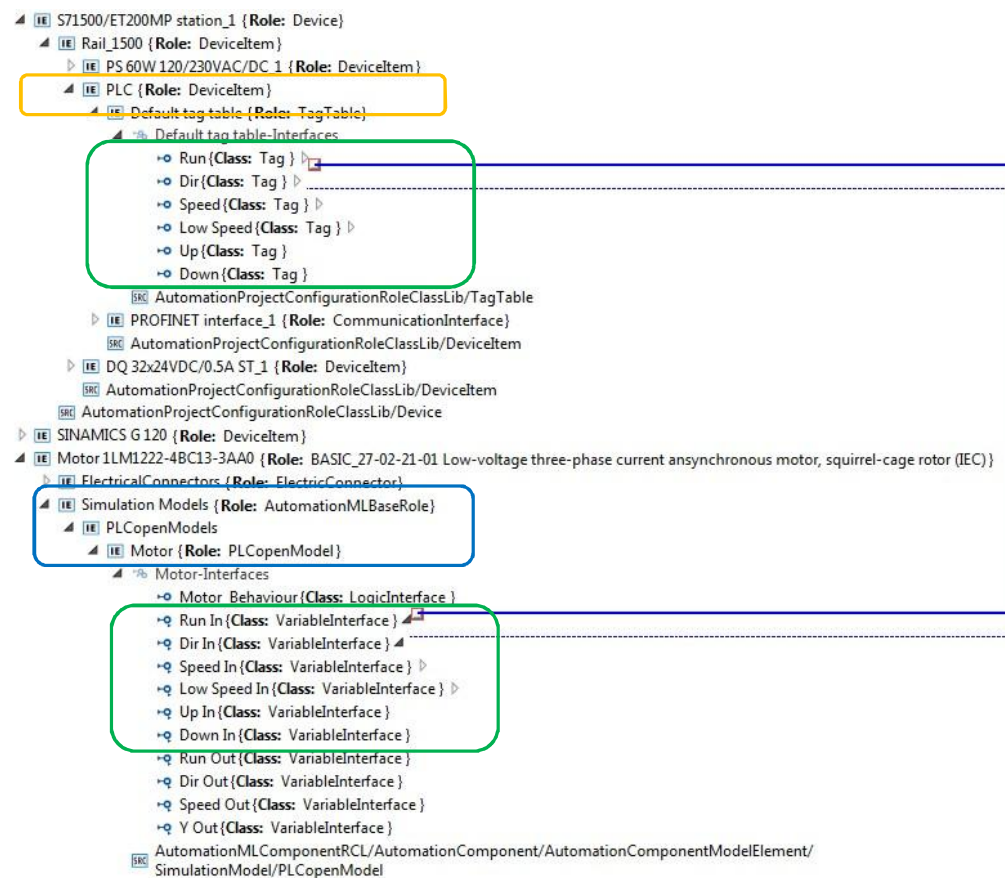
Example Motor and Frequency Converter: Connection to PLC

Connect the PLC to the motor and to the frequency converter according AR APC



Example Motor and Frequency Converter: Connection to PLC

The connection of the simulation to the PLC according AR APC in AutomationML



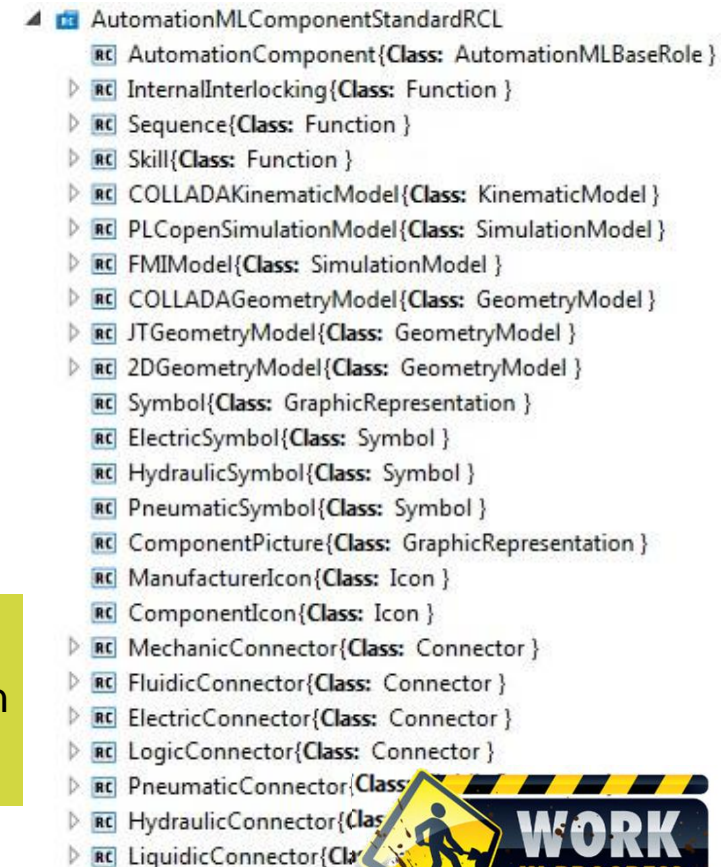
AutomationML describing Components for Virtual Commissioning - Outlook



Beside the shown AutomationML behavior description based on PLCOpen XML further aspects of components are about to be defined:

- FMI models (higher accuracy, knowledge protection)
- Vendor specific simulation models
- Collada Kinematic Models
- JT Geometry
- 2DGeometry Models
- Electric, fluidic, hydraulic
- . . .

Together with 3D, kinematics and electrical data the shown concept allows the definition of mechatronics building blocks for the digital twin of production in an AutomationML-based standardized component model.



The background image shows a complex industrial pharmaceutical production line. It features various machines, conveyor belts, and storage tanks. A semi-transparent digital overlay is applied to the image, showing a 3D wireframe model of the machinery and several bright green pills floating in the air, suggesting a focus on precision and innovation in manufacturing.

SIEMENS
Ingenuity for life

Make AutomationML yours!
Thank you.

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