Integrated simulation-based process and automation engineering

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Introduction

• Plant design performed using computer aided design tools (CAD/CAE) in managed workflow
• Process simulation not used as an integrated part of the workflow
  - High effort needed for exploiting simulation [1]
  - Integration with process and automation design tools required
• Integration of dynamic process simulation and automation design
  - Standard engineering data format for automatic integration
• Apros dynamic process simulation software [2]
Process plant engineering workflow

- Design in different engineering disciplines
  - Focus on process and automation design in basic and detailed design
- Process simulation usually utilised in late design phases when problems occur – area of improvement
- Benefits of dynamic process simulation
  - Mitigate risks
  - Reduce costs
  - Improve safety
Integrated simulation-based process and automation engineering workflow

Basic design  Detailed design

Process engineering
- Basic process design
  - Dynamic process model
    - Basic automation functionality
      - Basic design tests
        - Detailed process design
          - Updated dynamic process model
            - Detailed design tests
              - Automation detailed design

Dynamic process simulation

Automation engineering

Feedback

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Apros

• Apros – dynamic process simulation
  - Fortum and VTT, developed since 1986
  - Modelling and simulation of dynamic processes
  - Nuclear and combustion power plants
  - Process, automation and electrical modelling

• Apros 6 is based on Simantics integration platform [3]
  - Semantic data model
  - Eclipse plug-in technology
  - Simantics Constraint Language (SCL)
    • Simantics Transformation Language (STL)
Standard engineering data

• No universal data model or format widely accepted in industry [4]
• Several standards and data formats available
  - Generally applicable or specific for a discipline
• IEC 61131 widely adopted in automation industry
  - IEC 61131-3 defines a software model and PLC programming languages [5]
  - Function Block Diagram (FBD) resembles Apros automation diagrams
  - Allows definition of user defined blocks
  - PLCopen XML offers XML format for IEC 61131-3 [6]
Implementation

- Requirements
  - Main requirement: Standard representation of Apros automation data

- Mapping of data models
  - IEC 61131-3/PLCopen XML and Apros

- Model transformation using STL
  - Transformation rules

- Tests
  - Automatic testing environment for future development
  - Separate tests performed
Rule FouRule where

@when
FouMapping ?composite ?fbdElement

@from
Component ?composite ?component ?name ?componentType ?location
L0.HasName ?componentType ?typeName
?typeName != "BINARY_SIGNAL" //Exclude binary signals
?typeName != "ANALOG_SIGNAL" //Exclude analog signals
?componentId = resourceId ?component

isUserComponent ?component == False &
isAutomationComponent ?component == True

@to
Element ?fbdElement "block" ?blockElement
Attribute ?blockElement "localId" (show ?componentId)
Attribute ?blockElement "width" (show (calculateBlockWidth ?component))
Attribute ?blockElement "height" (show (calculateBlockHeight ?component))
Attribute ?blockElement "typeName" (getComponentType ?component ?typeName)
Attribute ?blockElement "instanceName" ?name

Element ?blockElement "position" ?positionElement
Attribute ?positionElement "x" "(floor (componentAnchorX ?component ((?location!4))))"
Attribute ?positionElement "y" "(floor (componentAnchorY ?component ((?location!5))))"

Element ?blockElement "inputVariables" ?inputVariablesElement
Element ?blockElement "inputVariables" ?inputVariablesElement
Element ?blockElement "outputVariables" ?outputVariablesElement

@where
// not included in this example
Apros

CODESYS
Conclusions

• Successful integration of dynamic process simulation and automation design using standards demonstrated
  - Enables integrated simulation-based engineering workflow
  - Apros used for basic automation design
  - Standard support in automation design tools restricted

• Model transformation using STL effective
  - STL usable for future transformation needs in Simantics
References


