Christian Doppler Laboratory

Simulations & SCADA Integration and Model Design

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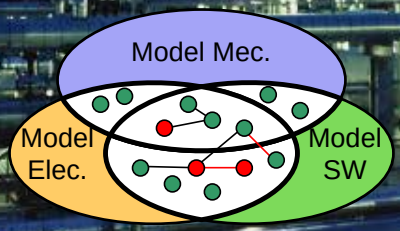
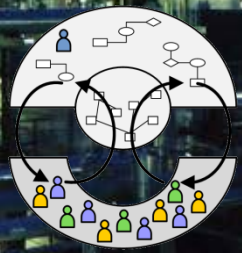
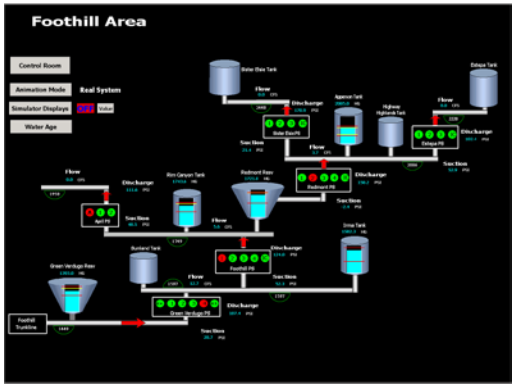


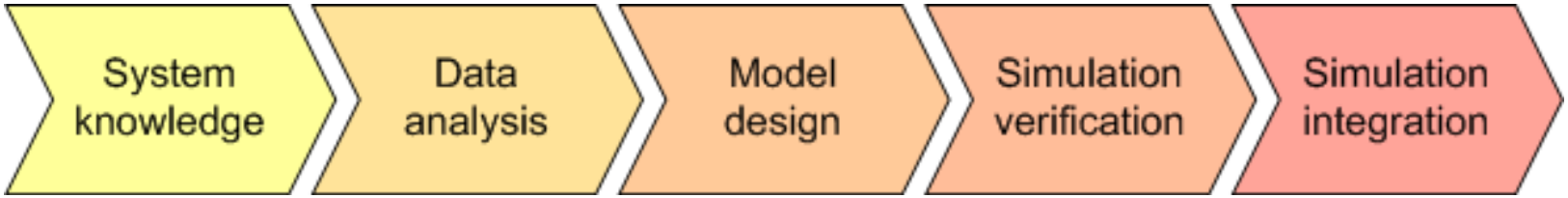


Motivation

Typical tasks and research issues

- goal: simulation framework for handling complex simulations for following tasks:
  - estimate unmeasured variables
  - optimal control
  - operation planning and analysis
  - failure detection



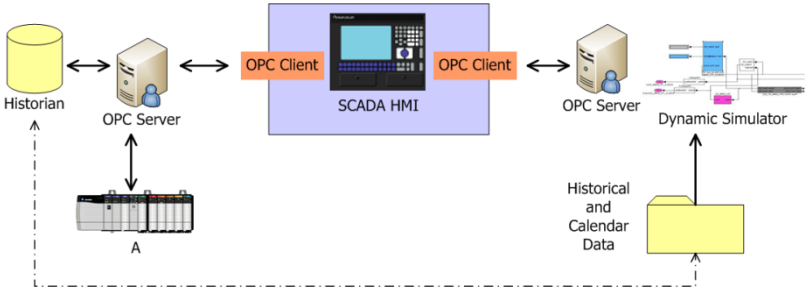


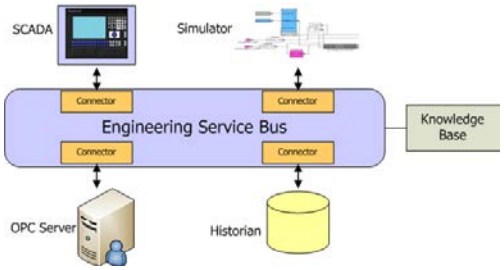
- Model-driven simulation integration

  (model-driven: based on formalized knowledge on the real world)
- Simulations and models – ontology based design

Foundation for simulation integration

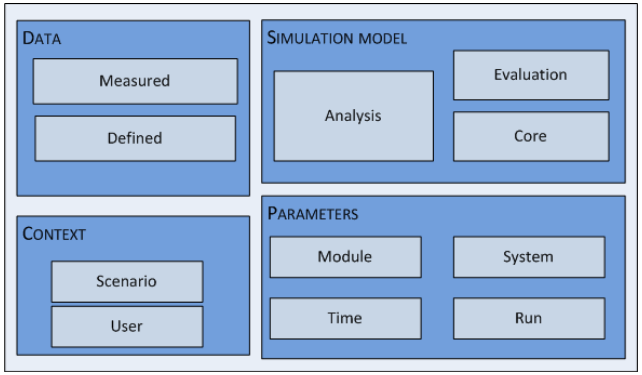
Simulation framework





- based on Engineering Service Bus (EngSB)
- unified access to data, limited number of interfaces
- journaling and other managements (source code, tasks)
- flexibility and easy reconfiguration

- complex architecture including input data, parameters and context
- main domains of simulation task:
  - simulation model/code/simulator
  - input data
  - context – goal, user, time features



Simulation life-cycle

Simulation life-cycle

- extracted from formalized knowledge (Knowledge Base)
- flexibility and design efficiency
- easy reconfiguration
- user oriented

- connector configuration
- simulation workflow
- handling of results

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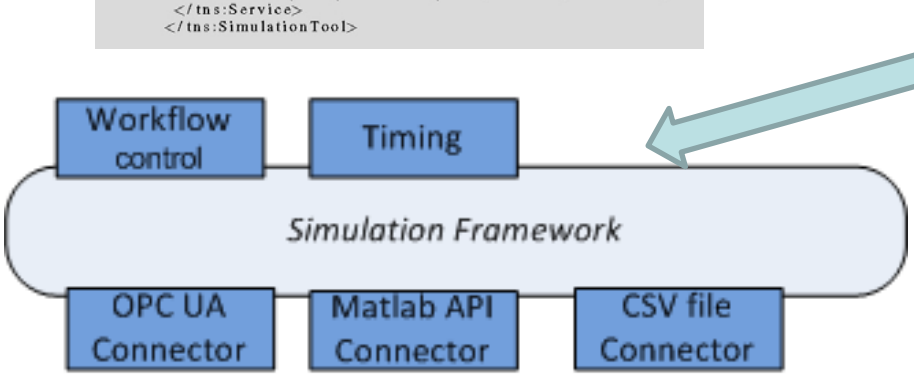
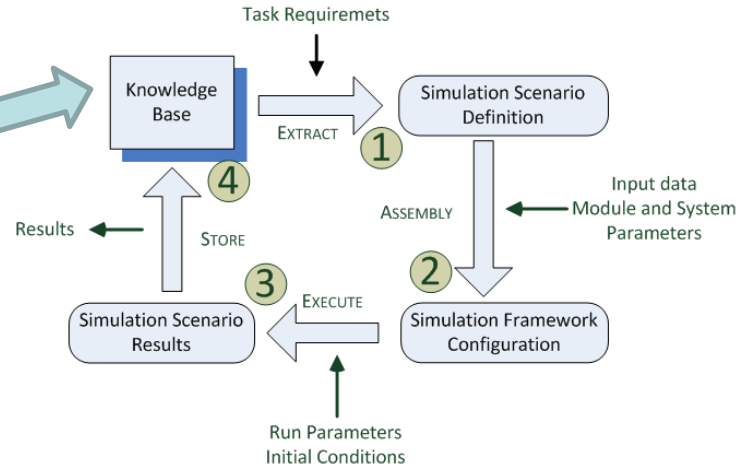
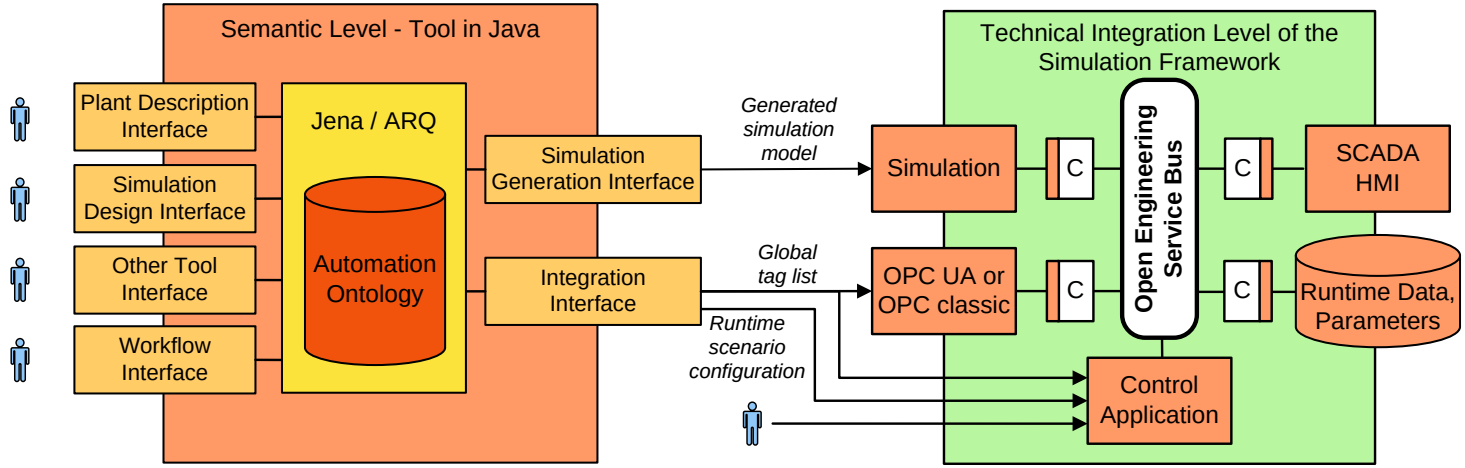




Automation Ontology

Structure

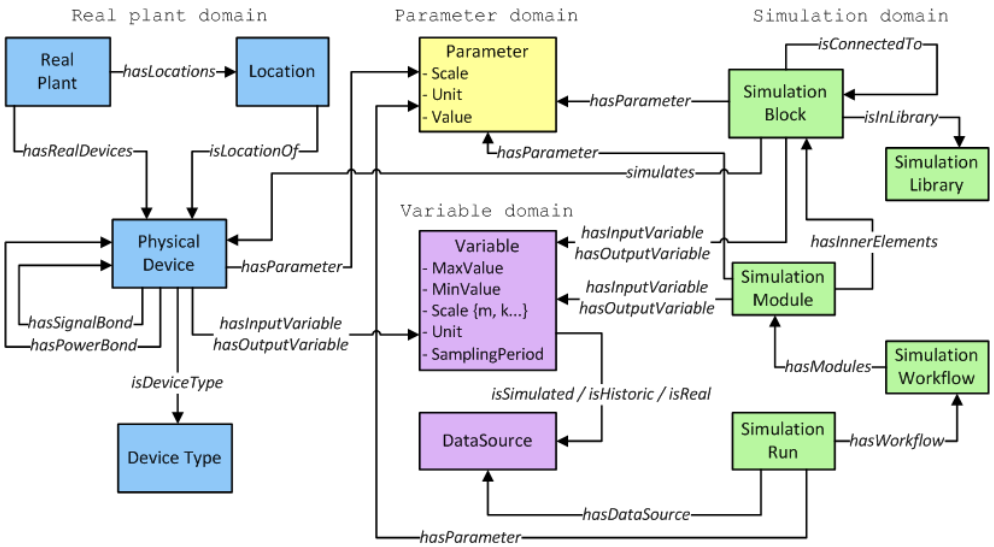


- machine-understandable form
  - contain object definitions, mappings, links, structures, parameters
  - no measured or calculated data
  - real plant structure -> automation ontology

- automation ontology interfaces:
  - input interface for populating ontology
  - output interface supporting simulation model design and simulation integration

Automation Ontology

Details



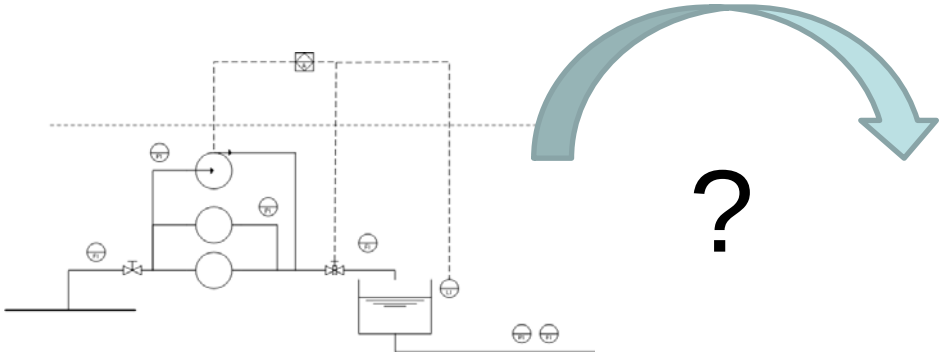
Domains: real plant, simulation, bond-graphs, parameters, variables

- automation ontology
  - most of upper objects are project-dependent and evolving
  - easy reconfiguration and changes
  - knowledge transfer between projects
  - several intermapped sub-ontologies

Bond-graphs

Simulation model design

- problem: path from engineering view to mathematical description



?

$$Q_i - C_{db}a_b\sqrt{2g(H_1 - H_2)} = A\frac{dH_1}{dt}$$

$$C_{db}a_b\sqrt{2g(H_1 - H_2)} - C_{dc}a_c\sqrt{2gH_2} = A\frac{dH_2}{dt}$$

  - Bond-graphs: human-oriented approach, introduced in already in 50‘s
  - modeling of power flows and energy transfers between physical subsystems
  - all types of engineering systems can be described using analogies
  - non-computer based design but very formal approach

Certicon

Overview

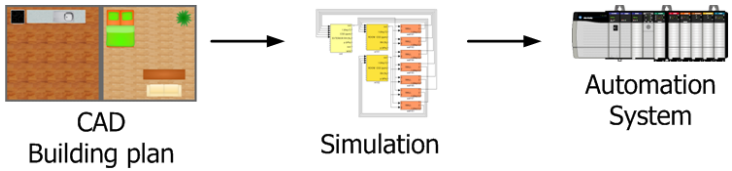
- founded 1996
- 220+ employee
- business focus in R&D, technology transfer and software development:
  - SW solution for production planning
  - medical systems
  - embedded systems
  - diagnostic systems

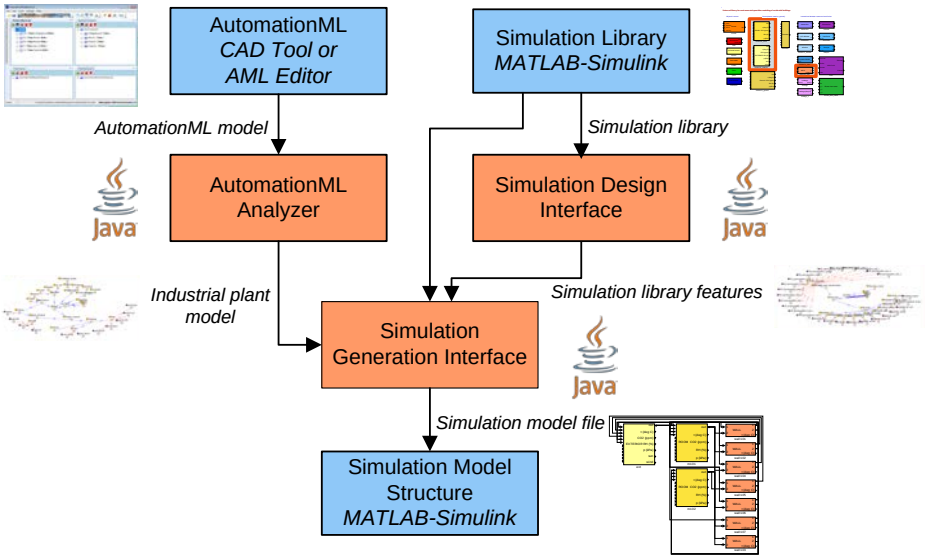
- University cooperation
  - Czech Technical University (CIIRK, Faculty of Electrical Enginering)
  - West Bohemia University
  - Center of Applied Cybernetics

Real applications

Passive houses

- in co-operation with CTU Faculty of Electrical Engineering
- temperature and humudity control
- semi-automatic simulation design
- **goal:** exclude control engineer from the engineering process
- direct way from CAD to simulation
- a real house in Úvaly (cca 20 km east of Prague)
- small measurement system + TECO PLC

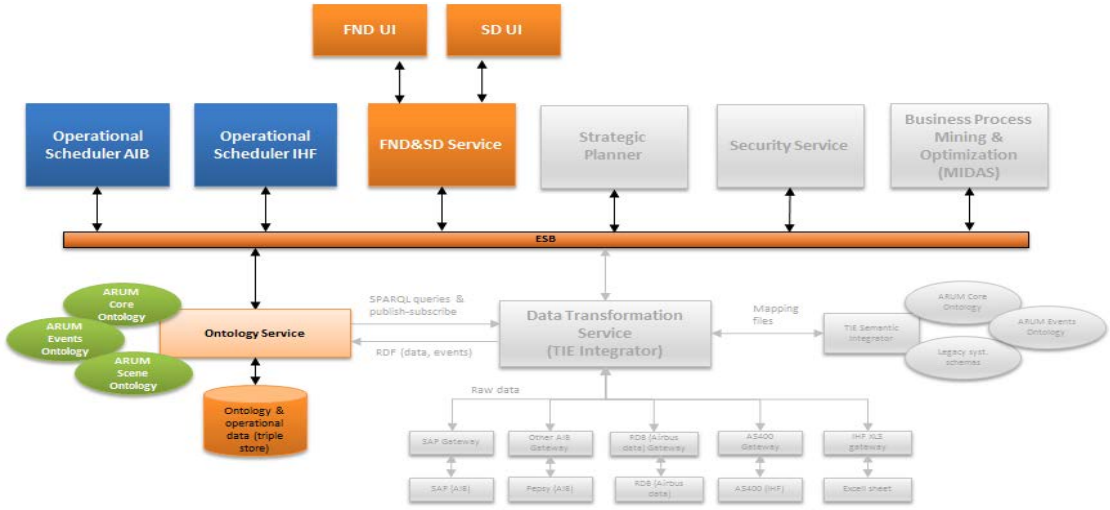




Real applications

Production systems

- ARUM (Adaptive Production Management)
- technical lead and main SW contributor
- production scheduling and optimization
  - agent-based technologies
  - knowledge-based multi-agent system
- simulations needed
  - simulation for real-time operation
  - predictive simulations



Summary

Results

- simulations: background for modern prodution systems
- no optimization, schedulling or predictive system can work withou them

- faster simulation integration
- knowledge based -> common repository for all engineers
- avoid error-prone methods
- easy reconfiguration and handling changes in the projects
- complex view of a task (simulation + data + parameter + scenario)
- semi-automatic simulation design for repeated tasks

- future work
  - hierarchical task definition (use only what needed)
  - complex optimizations
  - simulations for predictive tasks