

Christian Doppler Laboratory

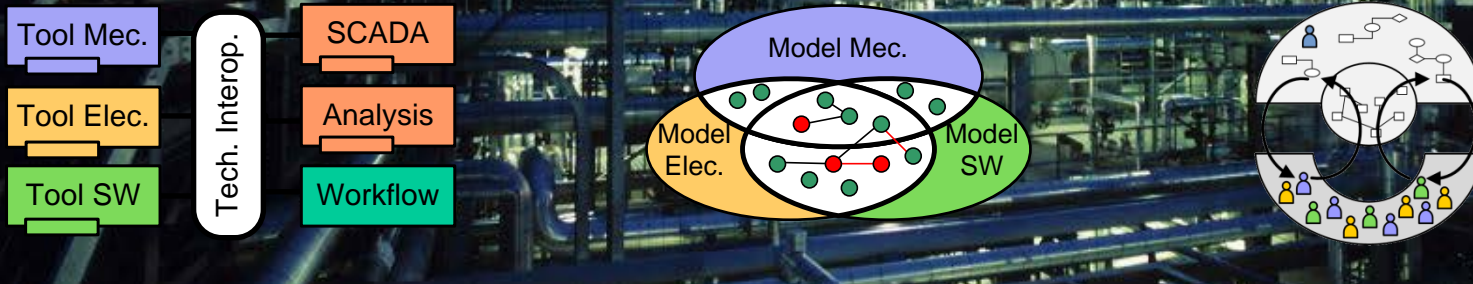
Simulations & SCADA Integration and Model Design

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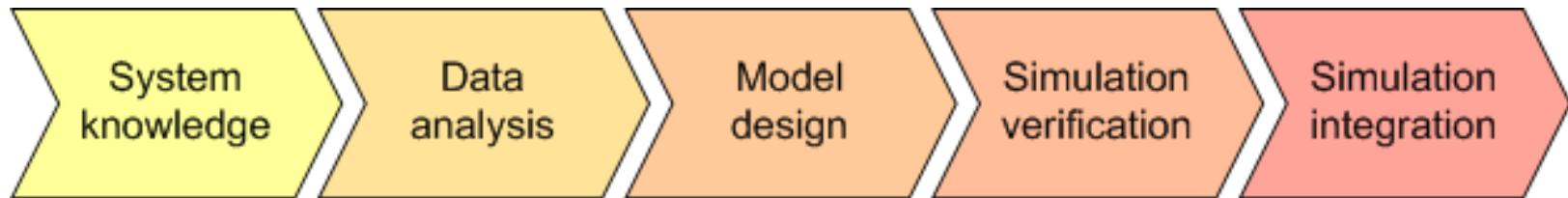
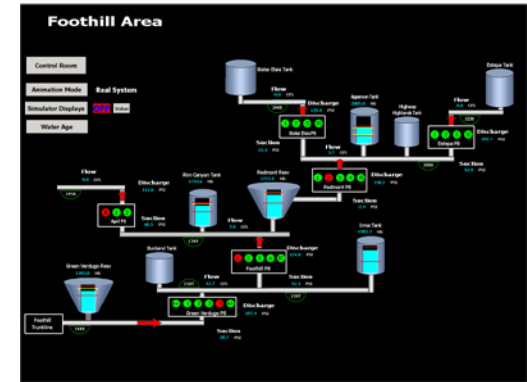
<http://cdl.ifs.tuwien.ac.at>



Motivation

Typical tasks and research issues

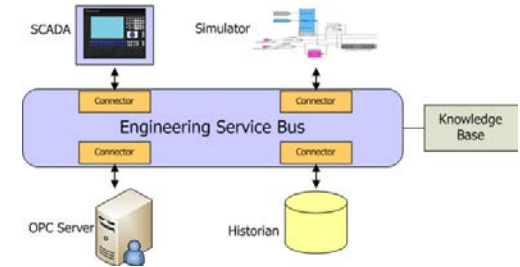
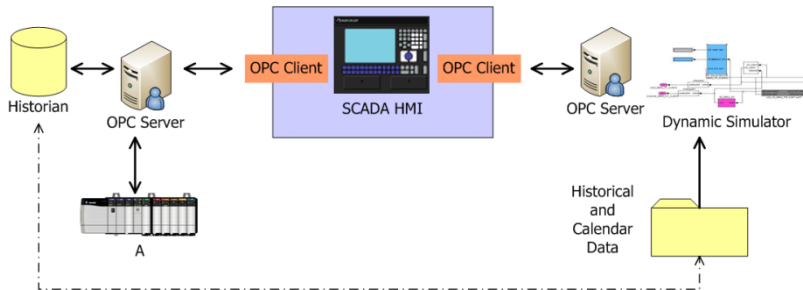
- goal: simulation framework for handling complex simulations for following tasks:
 - estimate unmeasured variables
 - optimal control
 - operation planning and analysis
 - failure detection



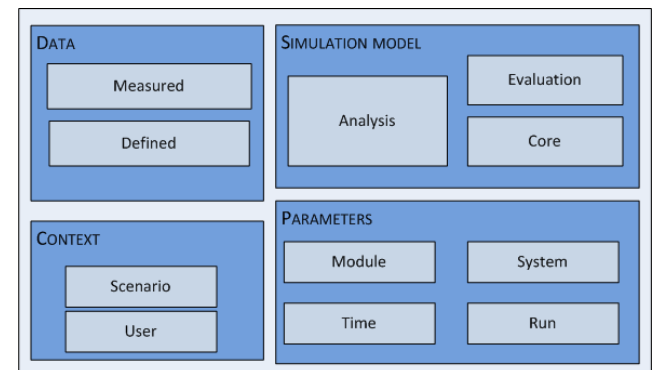
- Model-driven simulation integration
(model-driven: based on formalized knowledge on the real world)
- Simulations and models – ontology based design

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

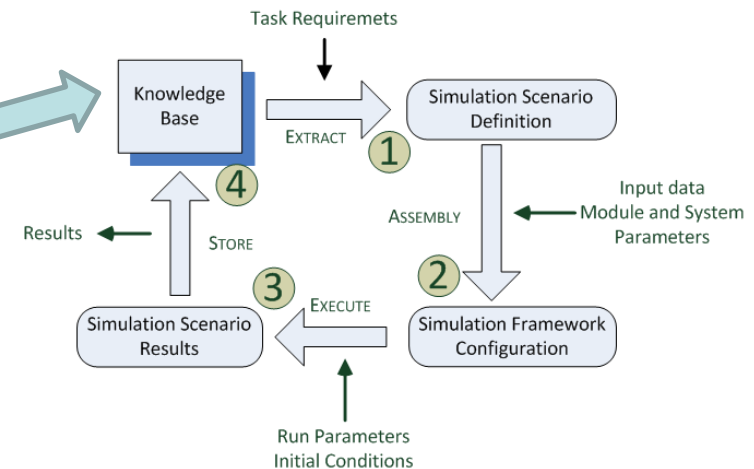
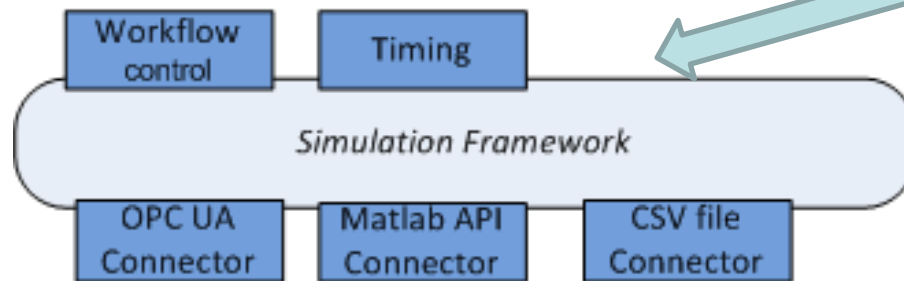
- extracted from formalized knowledge (Knowledge Base)
- flexibility and design efficiency
- easy reconfiguration
- user oriented

```

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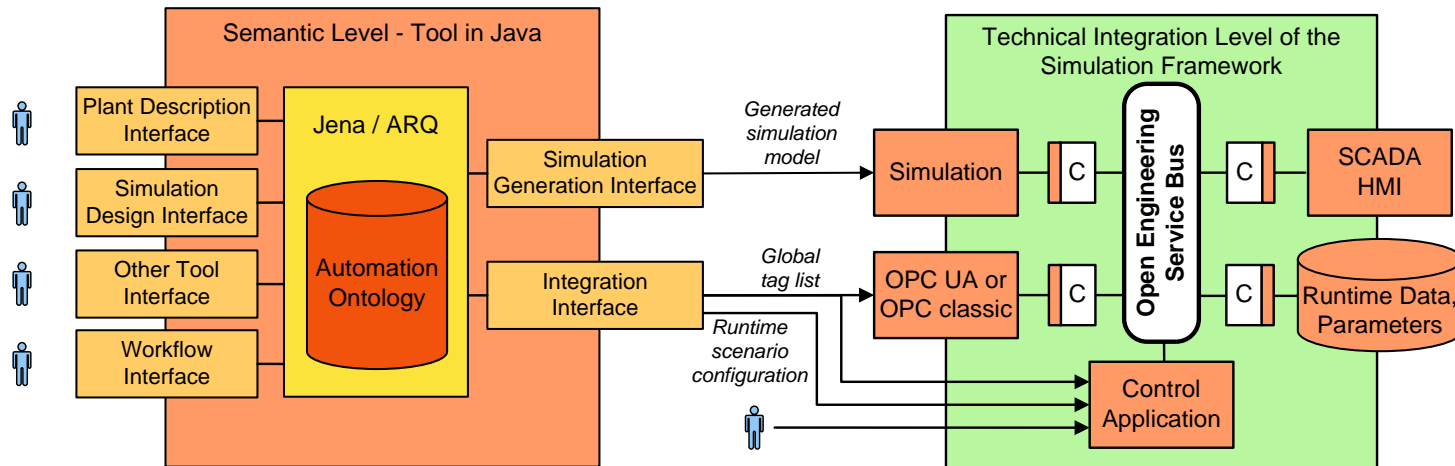
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- connector configuration
- simulation workflow
- handling of results



Automation Ontology

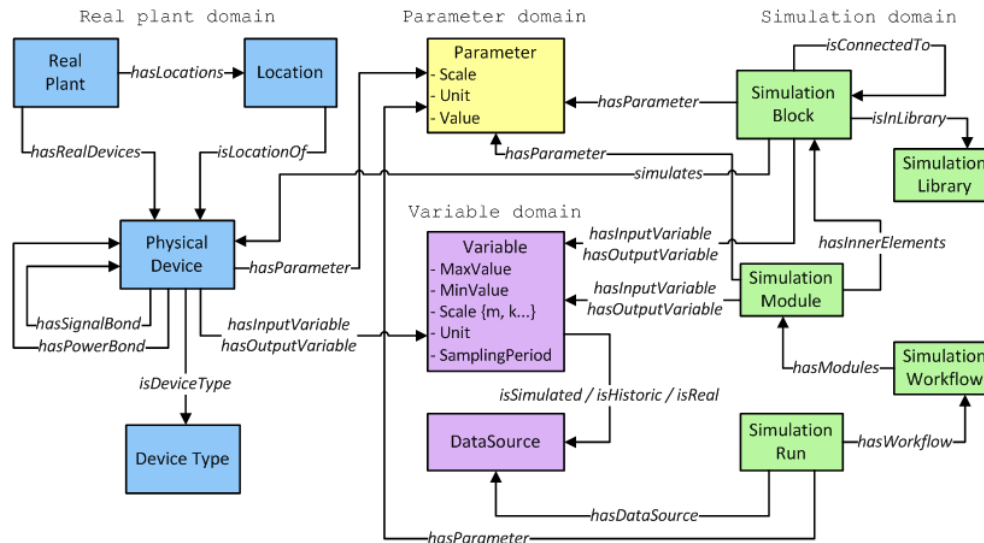
Structure



- 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



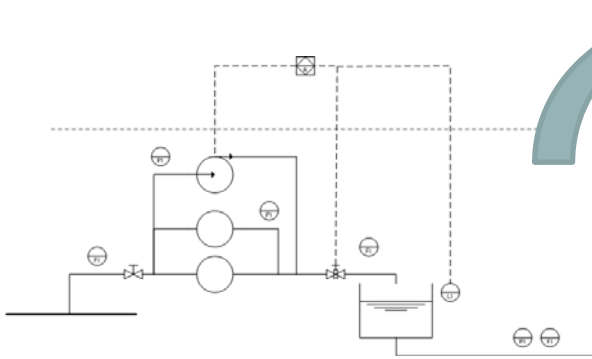
Domains: real plant, simulation, bond-graphs, parameters, variables

- 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



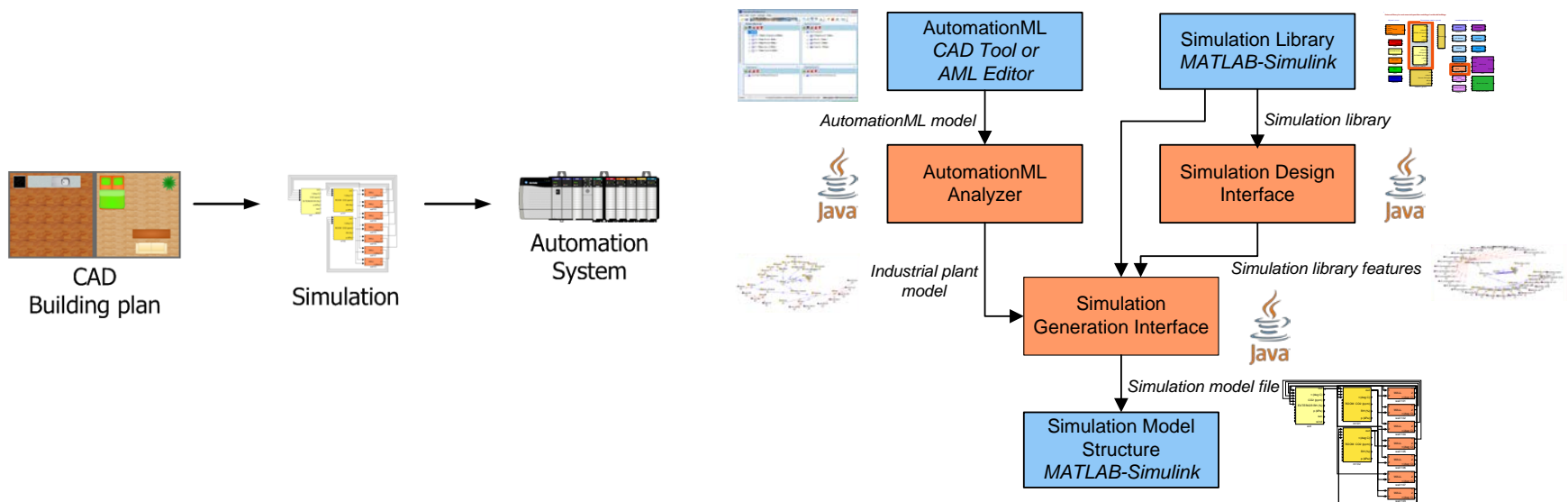
- founded 1996
- 220+ employee
- business focus in R&D, technology transfer and software development:
 - SW solution for production planning
 - medical systems
 - embedded systems
 - diagnostic systems
- University cooperation
 - Czech Technical University (CIIRK, Faculty of Electrical Engineering)
 - West Bohemia University
 - Center of Applied Cybernetics



Real applications

Passive houses

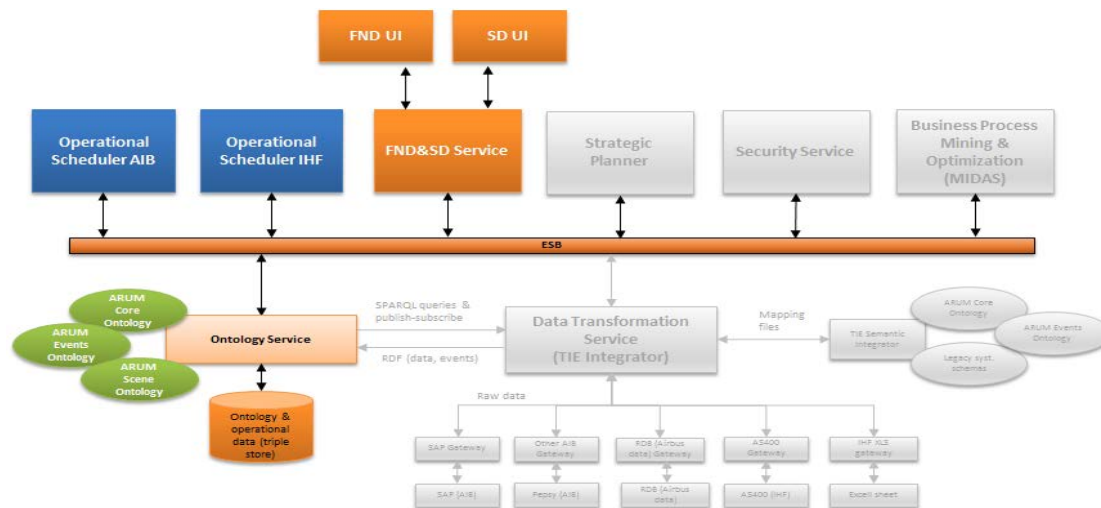
- in co-operation with CTU Faculty of Electrical Engineering
- temperature and humidity control
- semi-automatic simulation design
- **goal:** exclude control engineer from the engineering process
- direct way from CAD to simulation
- a real house in Úvaly (cca 20 km east of Prague)
- small measurement 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 production systems
- no optimization, scheduling or predictive system can work without 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