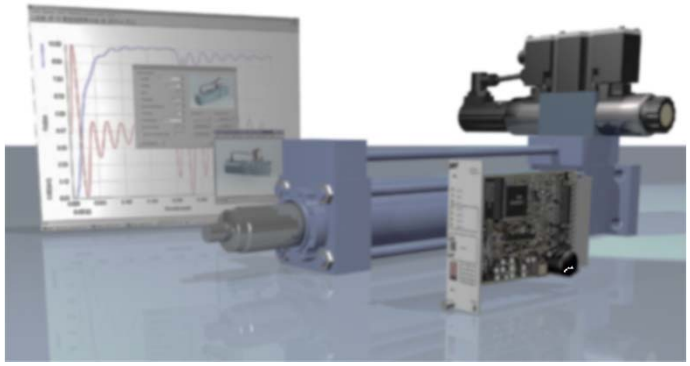

4th OpenModelica Workshop,
February 6, 2012
Linköping

Lars Mikelsons

Virtual Comissioning in DCE
A Roadmap

Rexroth
Bosch Group

Bosch – Three Business Sectors

Bosch Group overall

- €47.3B in sales
- 283,500 associates
  34,500 of those associates in research and development

Automotive Technology

- 59% share of sales
- World and technological leader as an automotive technology supplier

Industrial Technology

- 14% share of sales
- Drive & Control Technology [1], Packaging Technology, Solar Energy

[1] Bosch Rexroth AG (100 % Bosch)

Consumer Goods and Building Technology

- 27% share of sales[2]
- World's largest power tool manufacturer, leading in household appliances, thermotechnology, and safety engineering

[2] including other segments

Rexroth
Bosch Group

2010 - Figures

Total revenue:
€5,063M

Germany:
€1,253M

Europe without Germany:
€1,623M

Asia / Africa / Australia:
€1,358M

Americas:
€829M

Total associates:
34,896

Germany:
18,226

Europe without Germany:
8,505

Asia / Africa / Australia:
5,122

Americas:
3,043

Total research and development:
€267M

Cost share of revenue:
5.3%

Total investments:
€131M

Cost share of revenue:
2.6%

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Drive and Control Company

Rexroth
Bosch Group

Complete: Technologies and Services

Linear Motion Technology
Industrial Hydraulic Controls
Assembly Technology
Electric Drives and Controls
Industrial Hydraulic Cylinders

Product Groups

Transmission Units
Power Units, Manifolds, and Hydraulic Accessories
Pneumatics
Mobile Controls
Compact Hydraulics
Mobile Electronics
Pumps and Motors
Large Hydraulic Drives
Wind Turbine Gearboxes

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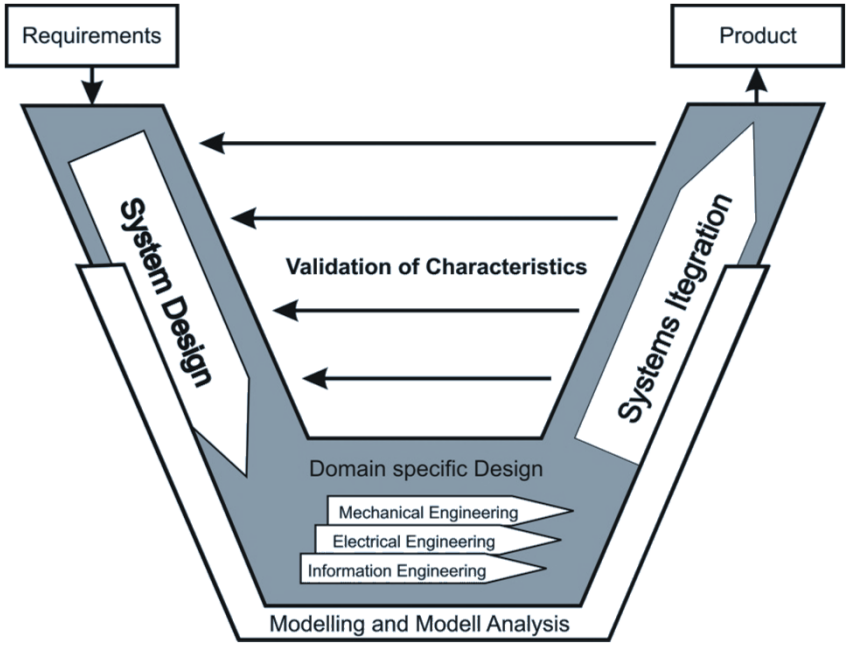
Bosch Group

Simulation as a Development-Tool

- Verification
- Optimization
- Comissioning



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Bosch Group

Outline

- Motivation
- **Vision**
- Starting Point
- Future Work

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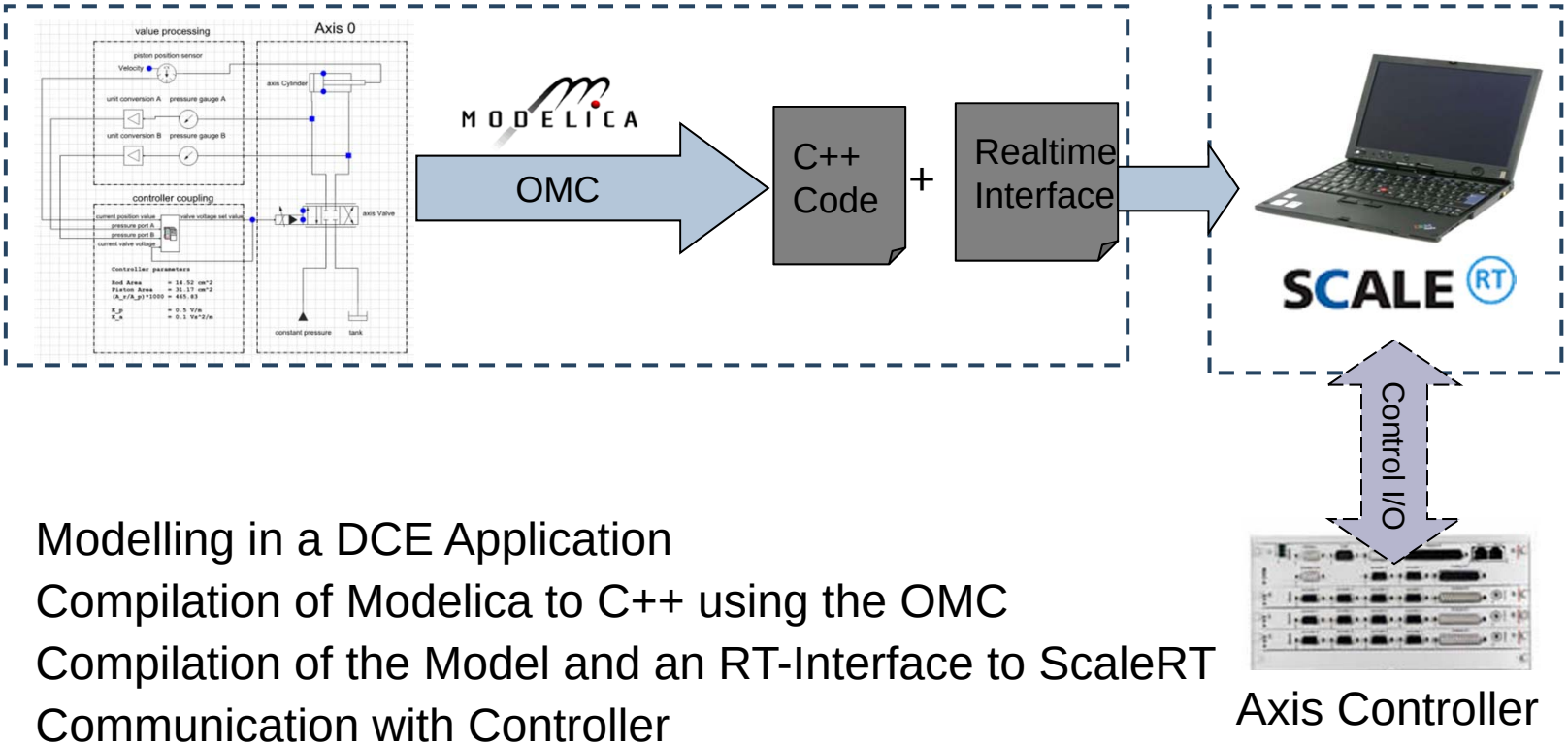
Automated Toolchain for Virtual Comissioning



- Modelling in a DCE Application
- Compilation of Modelica to C++ using the OMC
- Compilation of the Model and an RT-Interface to ScaleRT
- Communication with Controller

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Application Example

- Pieter Schelte
  - Installation and removal oil platforms
  - 382 m length, 117 m width
  - Installation power 95 MW
  - Topside: weight >10.000 t
  - Ready for operation end 2014

- Topside Lifting System (TLS)
  - TLS divides into:
    - Y-Drive
    - Z-Drive
  - Simulation phases:
    - Active Motion Compensation (AMC)
    - Constant Pushing (CP)

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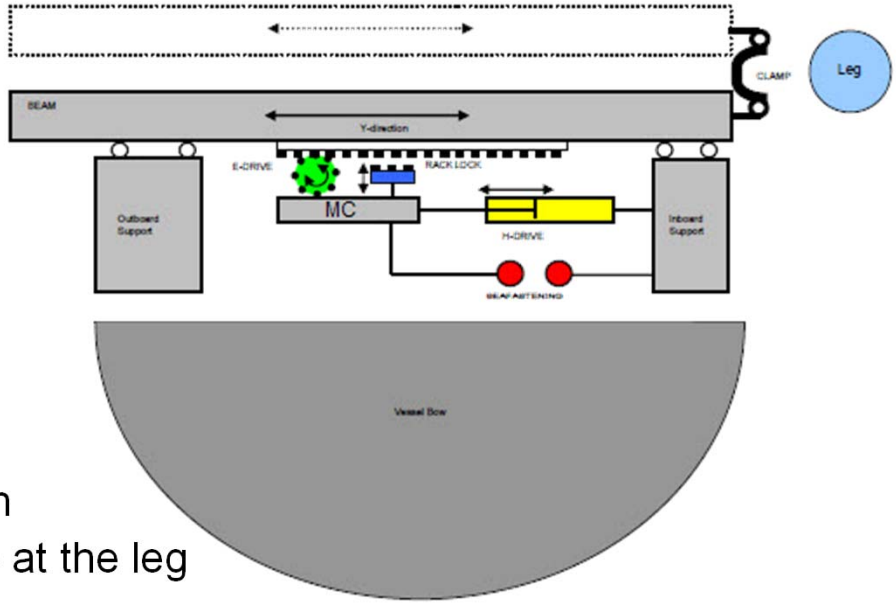
Topside Lifting System

- Components
  - Hydraulic unit
    - 3-Chamber active heave compensation cylinder
    - 3-Way valve
    - Tank and pressure source
    - Accumulator
  - Electrical drive
  - Rack-pinion and ideal gears
  - Beam and motor carriage mass
  - Force controller



- Functions
  - AMC for sea and parasitic motion
  - Appling a constant pushing force at the leg

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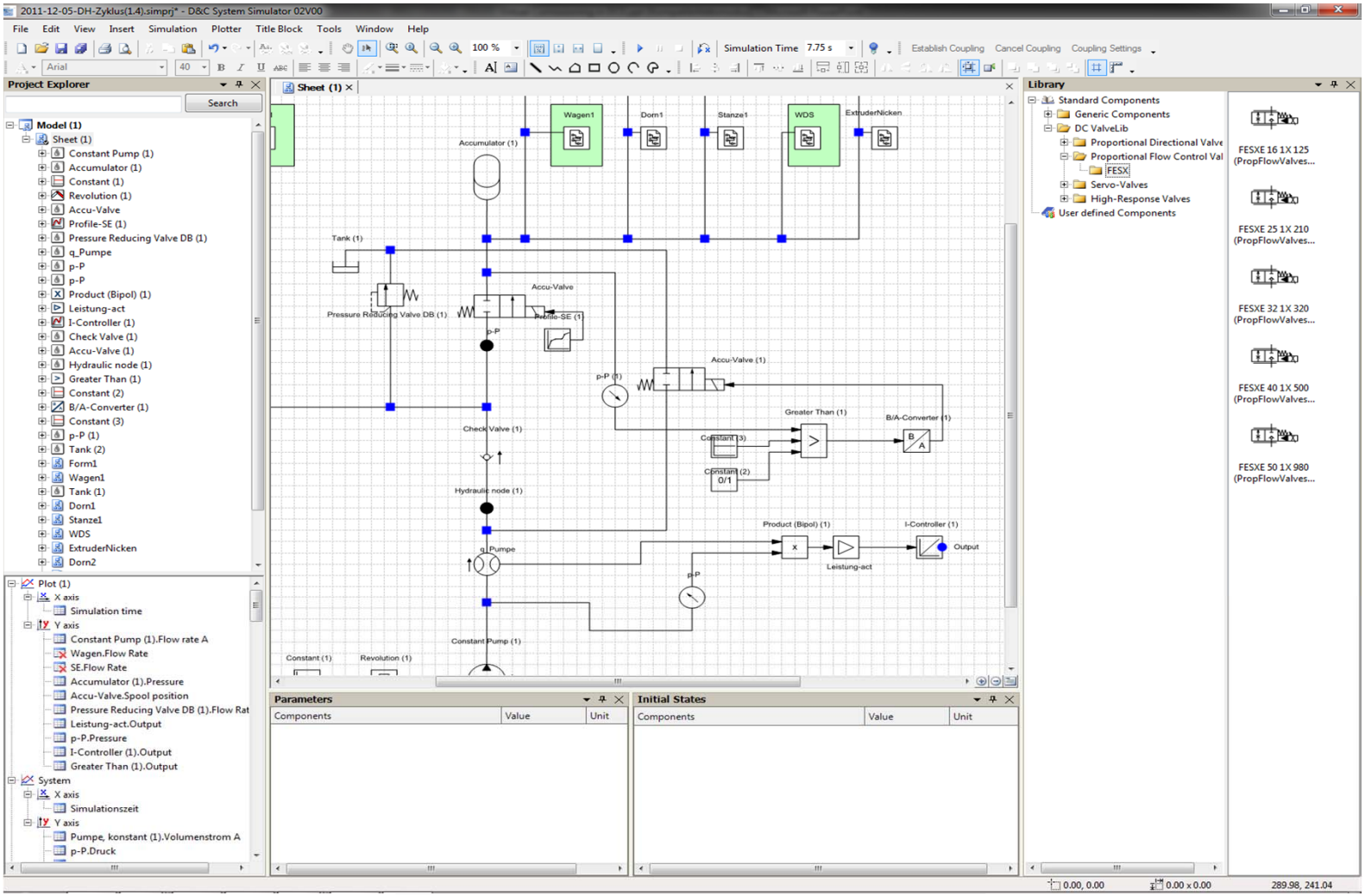
Modelica-Based Modelling Application



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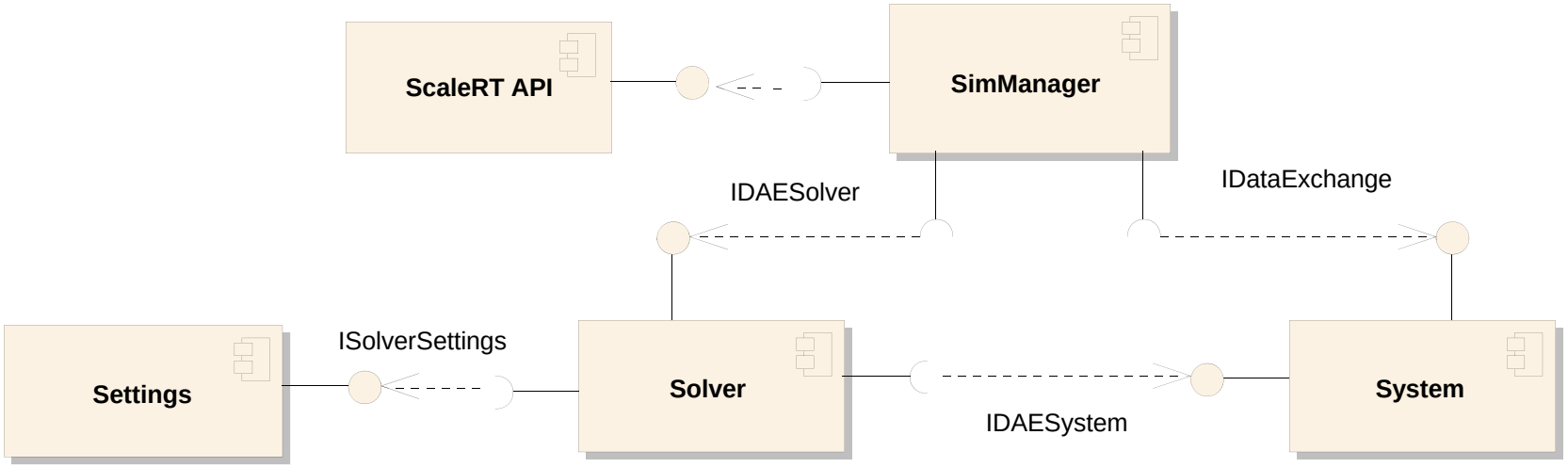
C++ Runtime



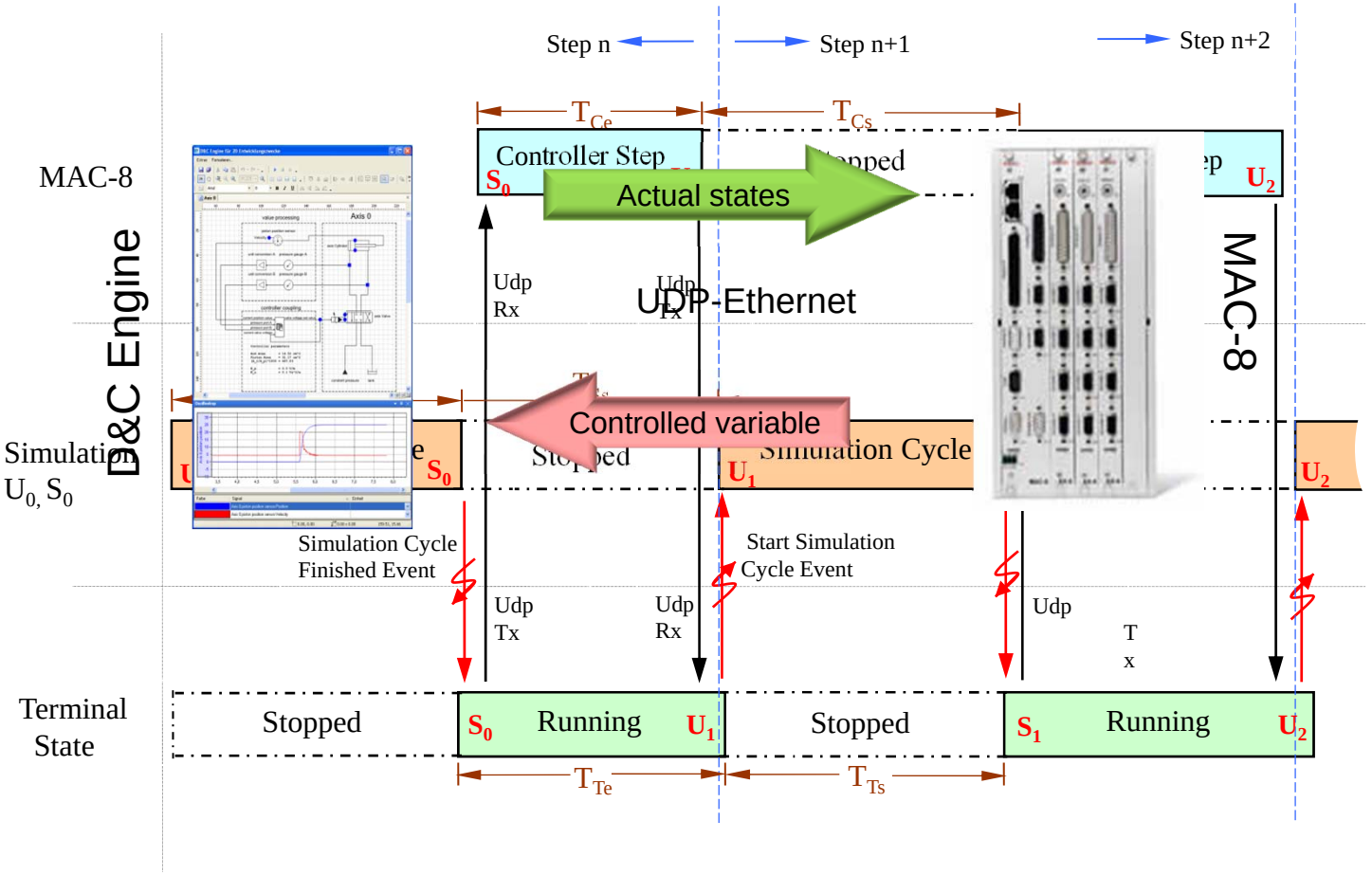
`SimManager` - Controls the simulation (Main Loop)

`System` - Holds the DAE equations

`Solver` - Encapsulates the numerical time integration method

`Settings` - Configuration of the solver

Communication via Handshake



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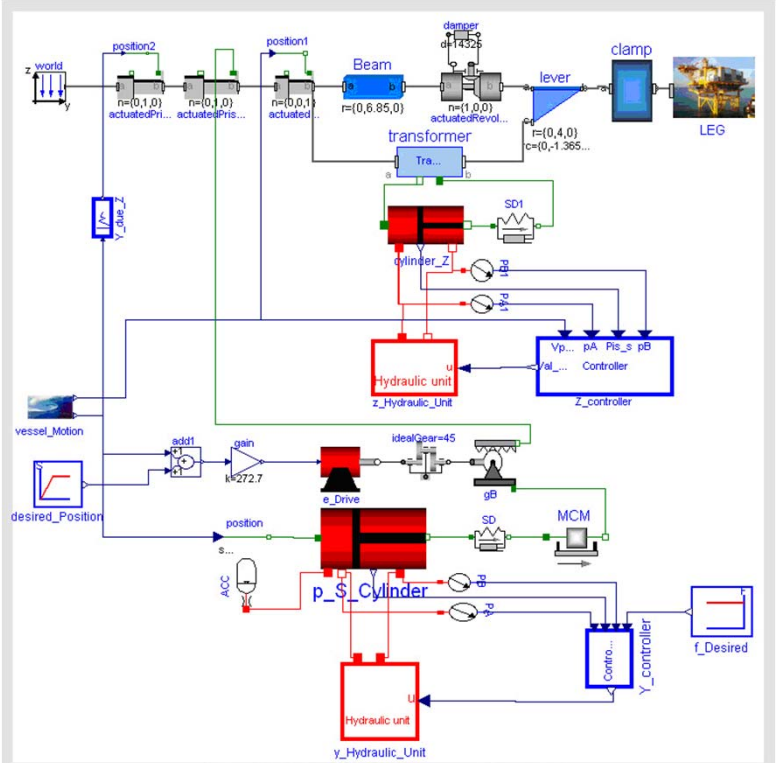
Modelica Model

- Built in Dymola
- Validated with other models
- Model can be (partly) compiled and simulated with OMC

- Problem: Simulation Time



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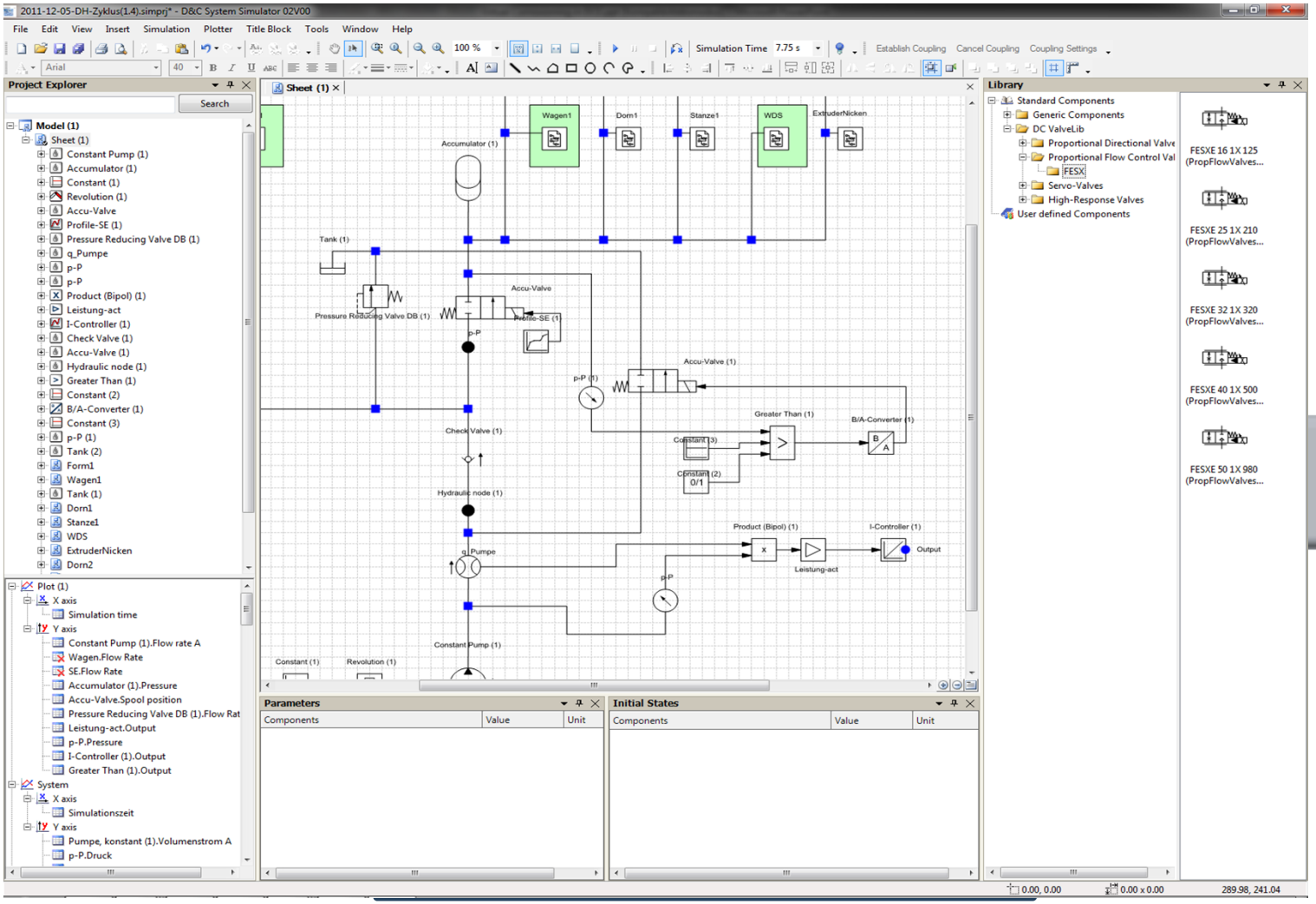
Modelica-Based Modelling Application



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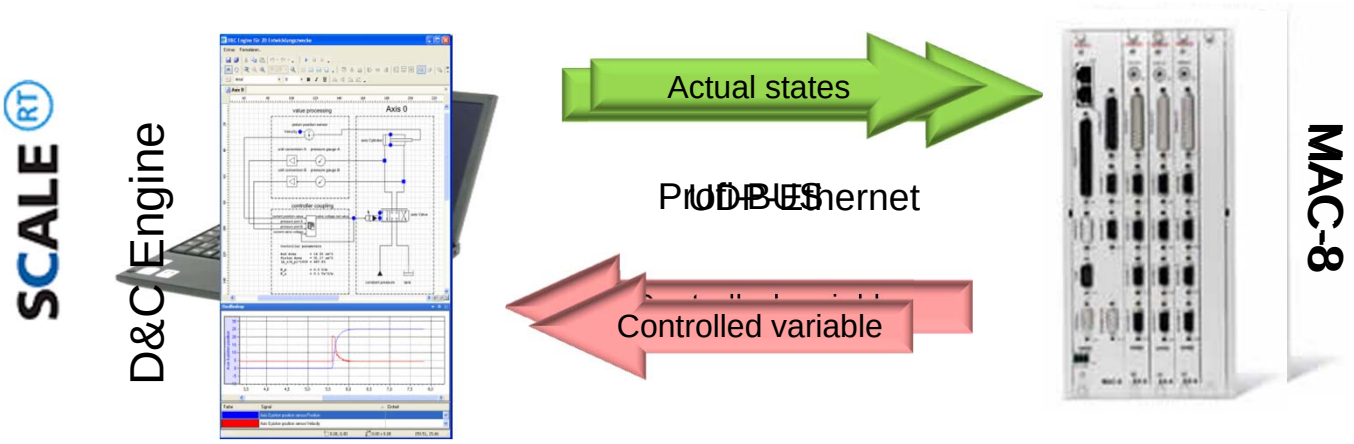
Communication in Real-Time



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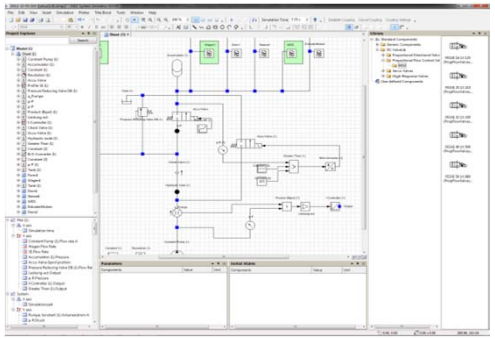
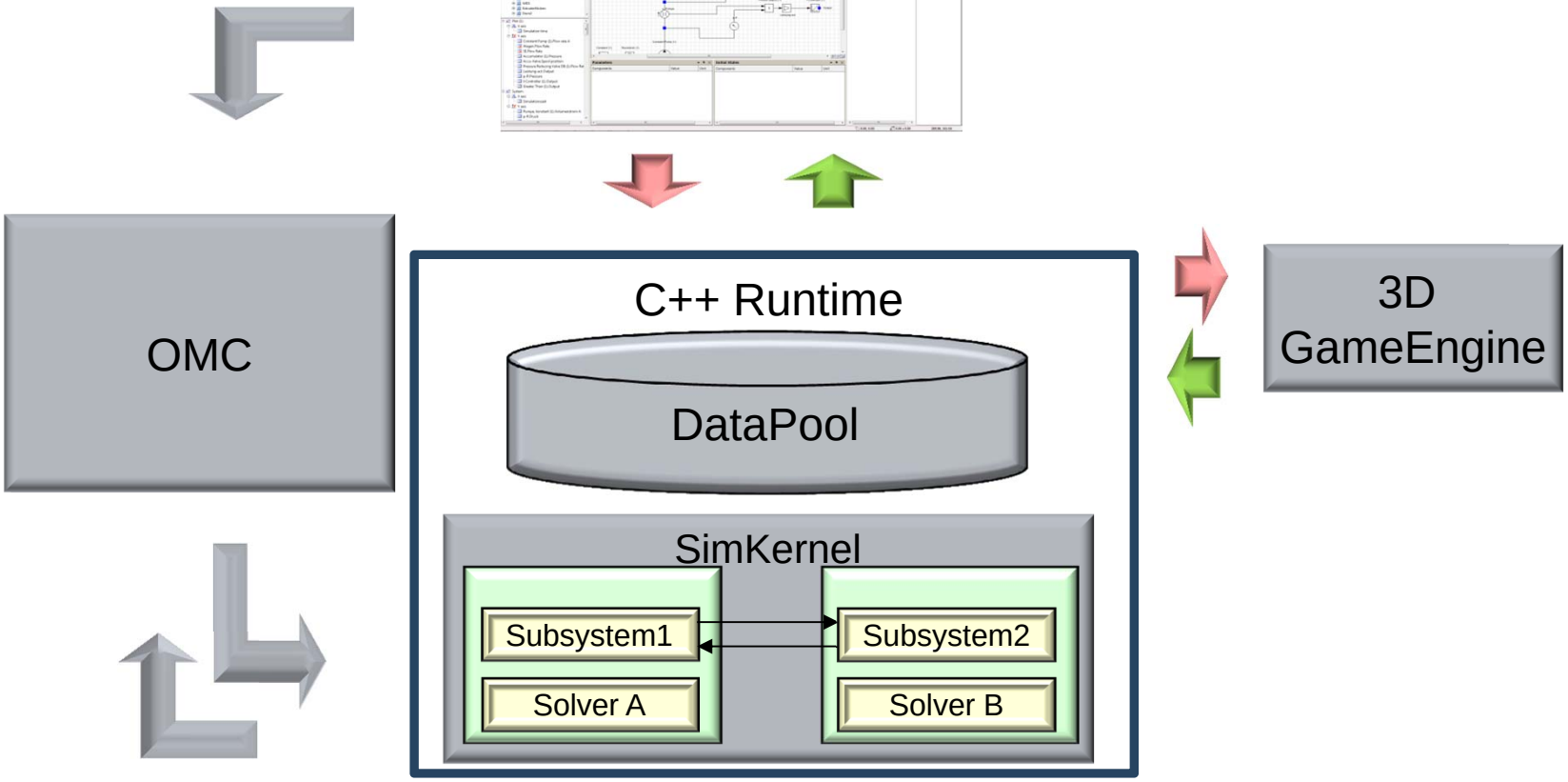
D&C Engine





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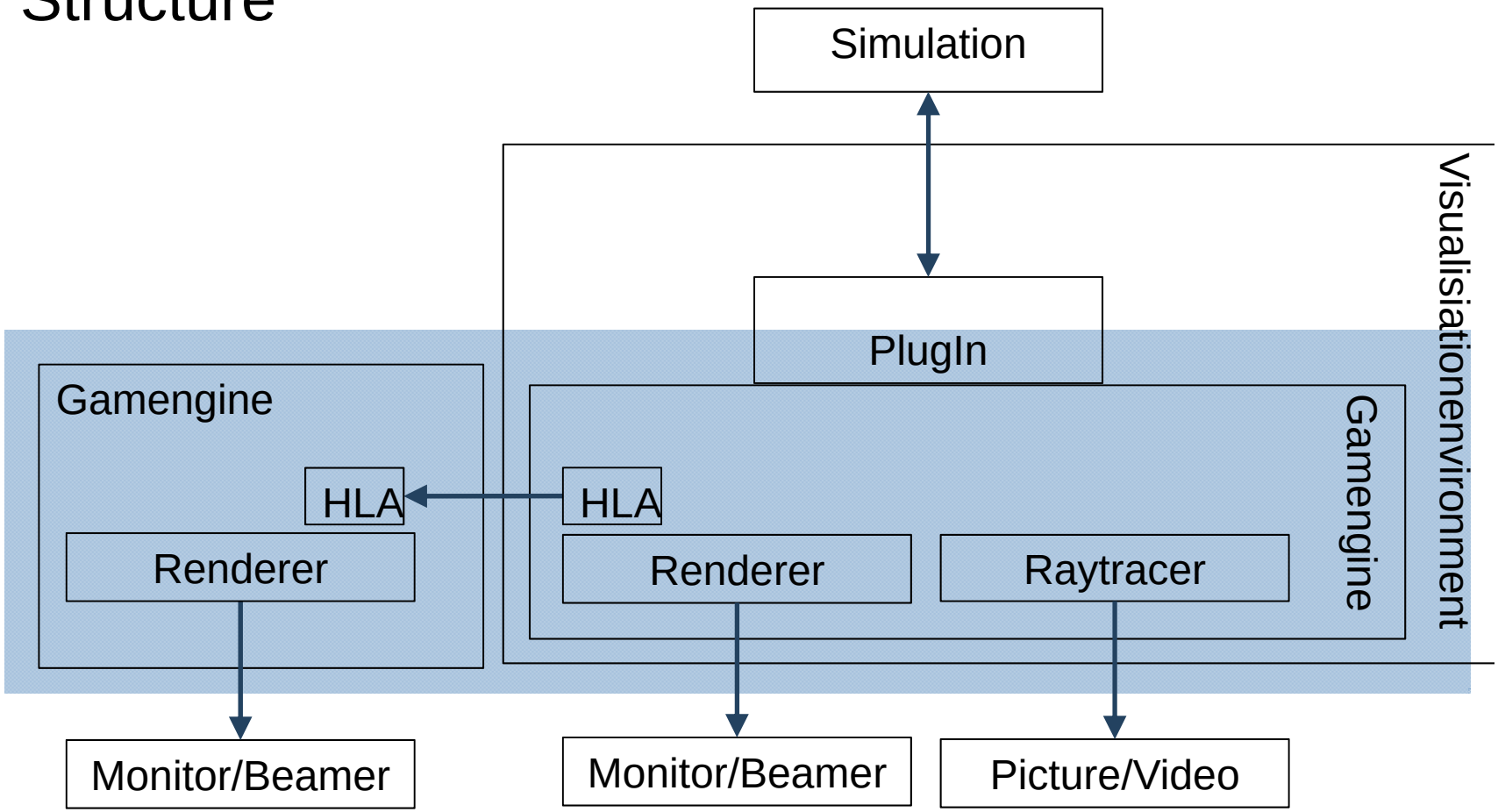
Structure



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Torque3D

- Commercial Game-Engine
- DirectX 10
- WYSIWYP Editor

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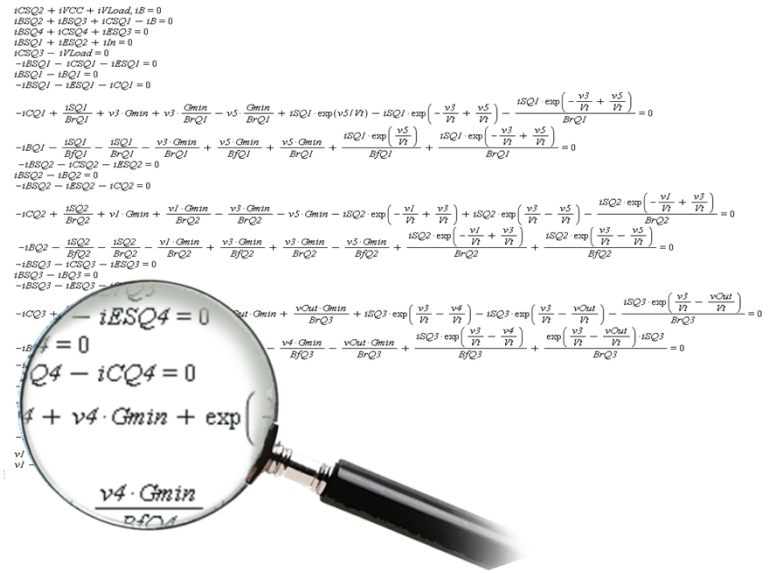
Race against Time

- Model Reduction
  - Equation-Based Reduction Techniques
  - Manual simplification
- Choice of appropriate solution method
  - Real-Time Cycle
  - Multi-rate integration



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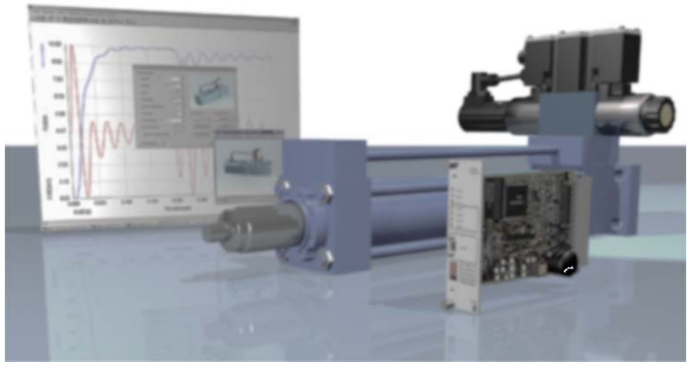

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