



# Multibody-System Visualization and Interactive Realtime Simulation of FMUs for OpenModelica based Simulations

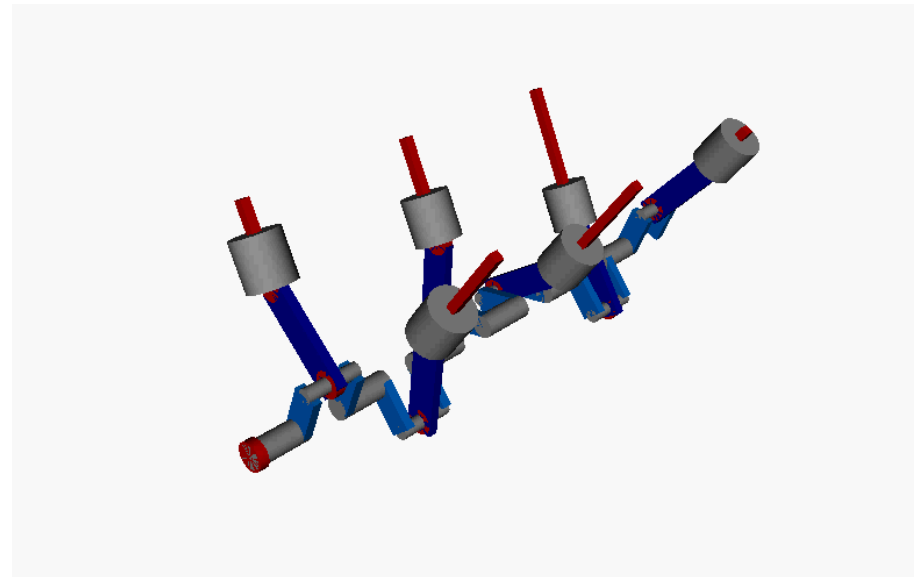
Volker Waurich

Leipzig, 10/02/2016



## Outline

1. Motivation
2. OMVis - Visualization Tool
3. Interactive Simulator
4. Summary and Outlook



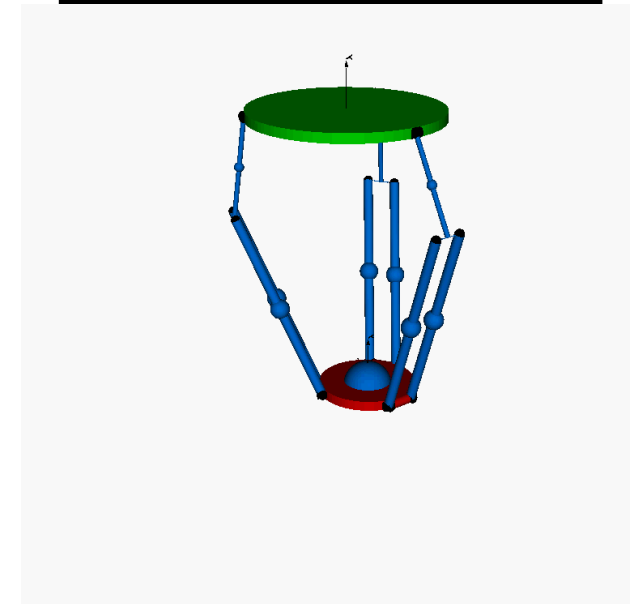
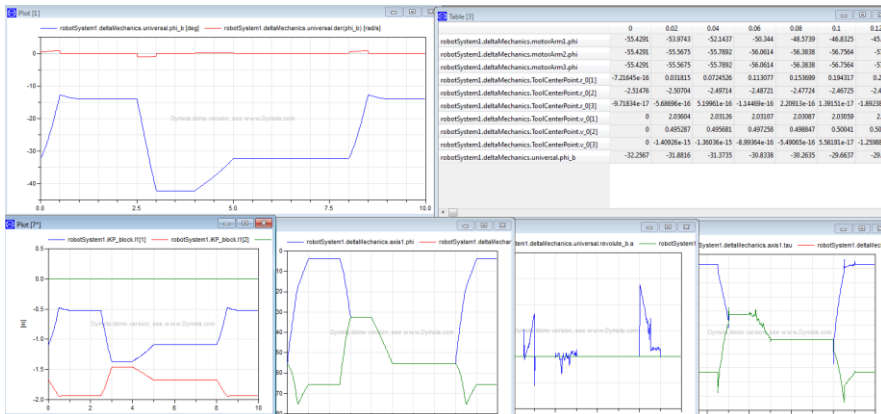
# MOTIVATION

## Presentation of Results

numerical values /  
line plots

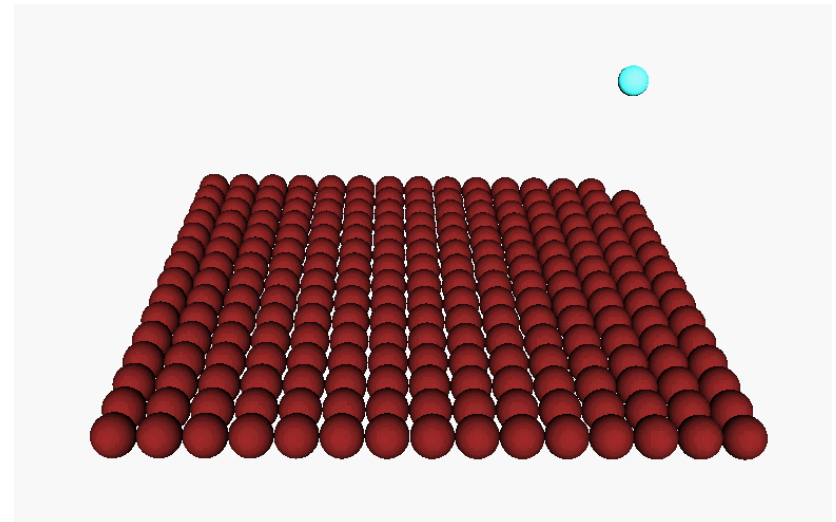


3D animation



## Model Visualization

- get an overall understanding of your model behaviour
- model validation
- communicate more data in a faster, more understandable way
- graphic applications (e.g. simulator)



## Simulator Development

*Get the most realistic behaviour  
that is still realtime capable.*

- evaluation of FMUs for realtime application
- generic simulator setup
- test different FMUs for realtime ability
  - level of detail
  - optimization, compiler settings
  - parallelization



# OMVIS – VISUALIZATION TOOL

## Visualization Base Data

### **Simultaneous animation**

- scene update during simulation run
- state-of-the-art for commercial tools
- network communication during simulation

### **Result file based animation**

- visualization after completed simulation run
- scene description needed

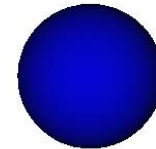
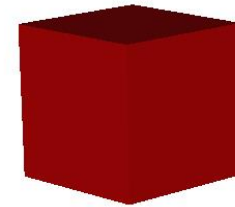
### **FMU based animation**

- scene description needed
- not specified in standard
- currently no public solution available (?)



## Scene Description

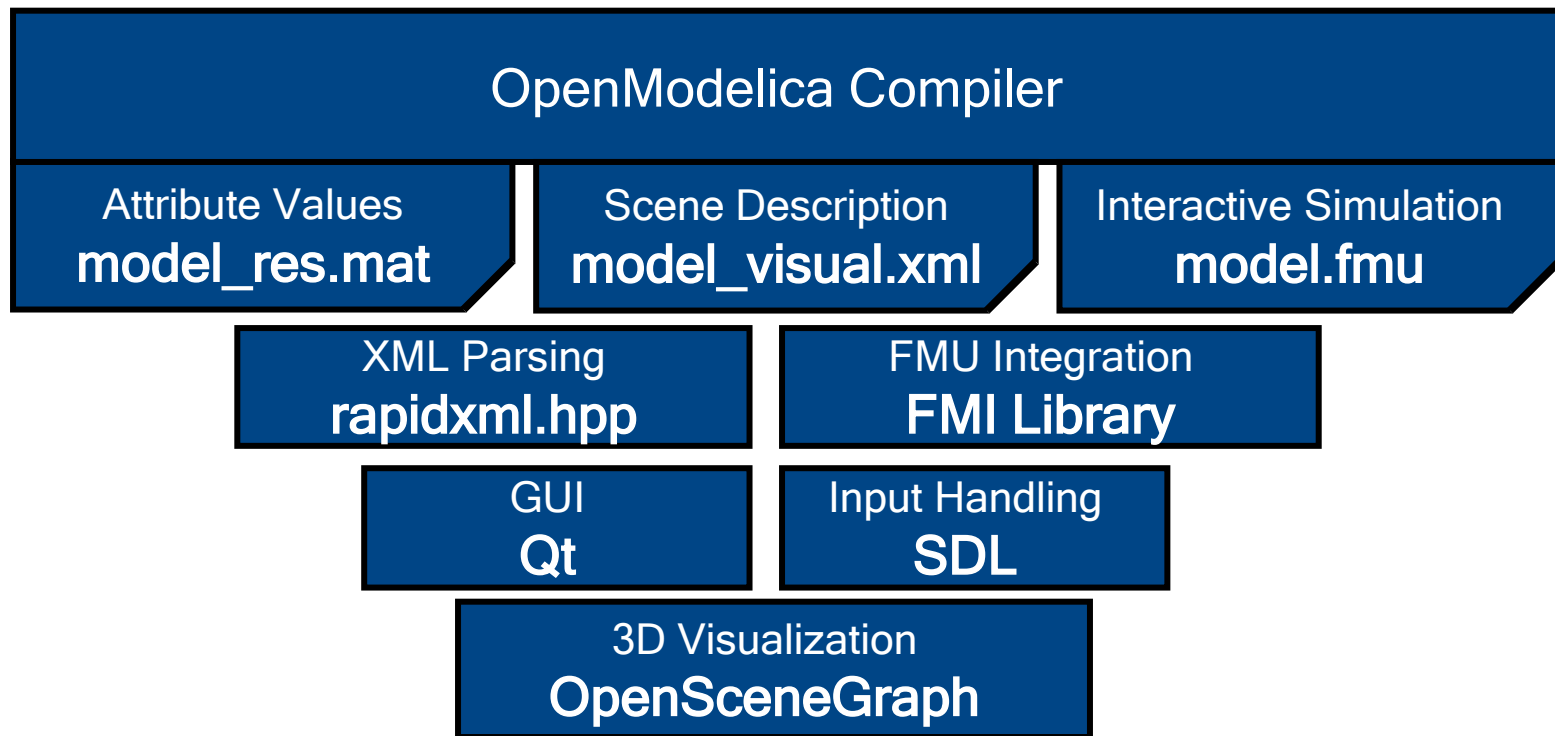
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      <cref>world.x_label.r_abs[2]</cref>
      <cref>world.x_label.r_abs[3]</cref>
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  ...
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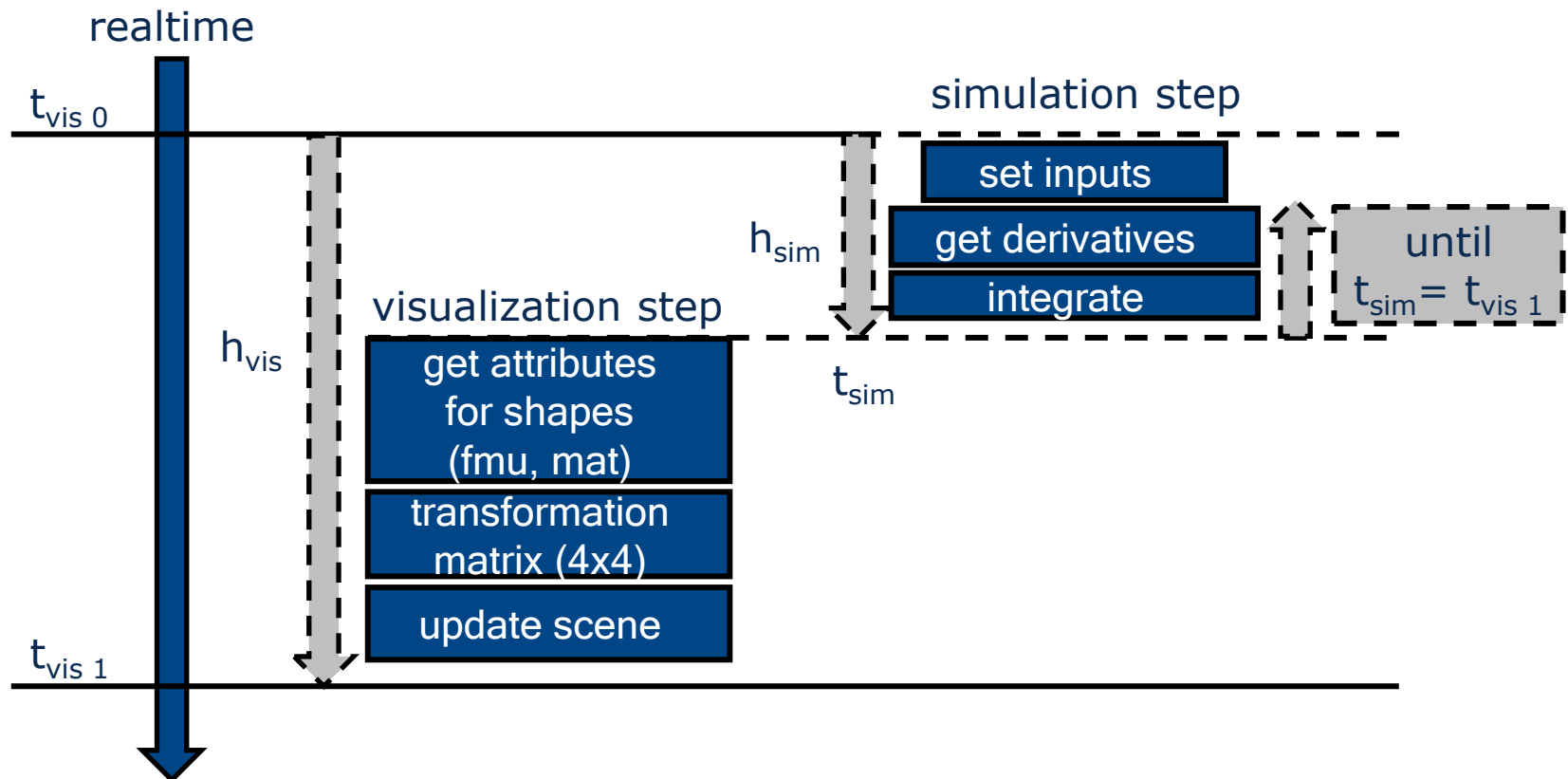
Shapes from:

`Modelica.Mechanics.MultiBody.Visualizers.Advanced.Shape`

## Structure



## Workflow



# INTERACTIVE SIMULATOR

## Realtime Criteria

- simulation of a time range  $\Delta t$  has to be faster than realtime  $\Delta t$

→ deterministic execution time of system computation and time integration:

- no event iteration (or fixed number of iterations)
- no nonlinear systems (or fixed number of iterations)
- no implicit time integration methods (or fixed number of iterations)
- no order or step size control (fixed step size)

In practice:

everything is allowed as long as the real time criteria is fulfilled

## Encounter Realtime Requirements

### **model adaptation:**

- linearization, stiffness, complexity reduction

### **system computation:**

- tearing, reshuffling, partial function evaluation, common-sub-expression-elimination, backend-evaluation of linear torn systems
- evaluation of parameters, compute outputs only
- parallelization

### **time integration:**

- multirate, multimode, inline integration

### **hardware**

## Excavator model



## Summary

- Implementation of a visualization tool
- either result file visualization or fmu-based, interactive visualization
- scene description XML file, generated by OpenModelica Compiler
- generic simulator set up to evaluate FMUs for interactive simulators



## Outlook

- further enhancement of OMC to perform automated realtime optimizations (multirate integration with static partitioning)
- extend OMVis for missing functionalities(missing geometric primitives, modelica visualization lib?)
- FMU visualization standard ?

Thank you for your attention.



**»Wissen schafft Brücken.«**

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