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GI

A Generic FMU Interface for Modelica

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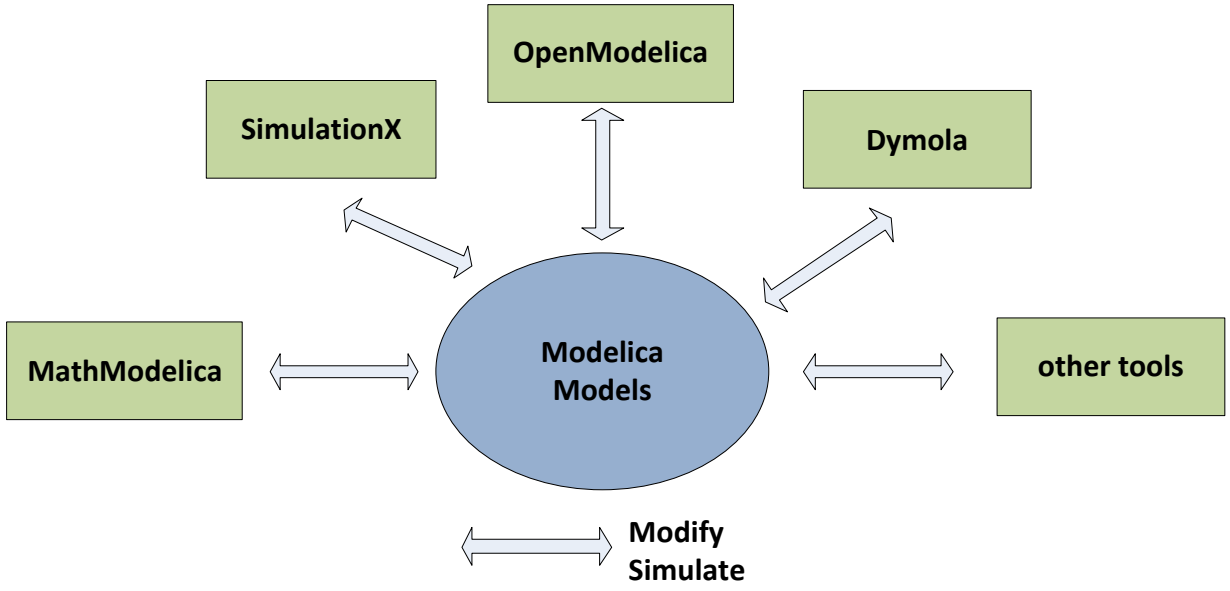
Overview

1. Introduction to Modelica & FMI
2. Approaches for FMU Import
3. Prototype Implementation
4. Case Study
5. Conclusion

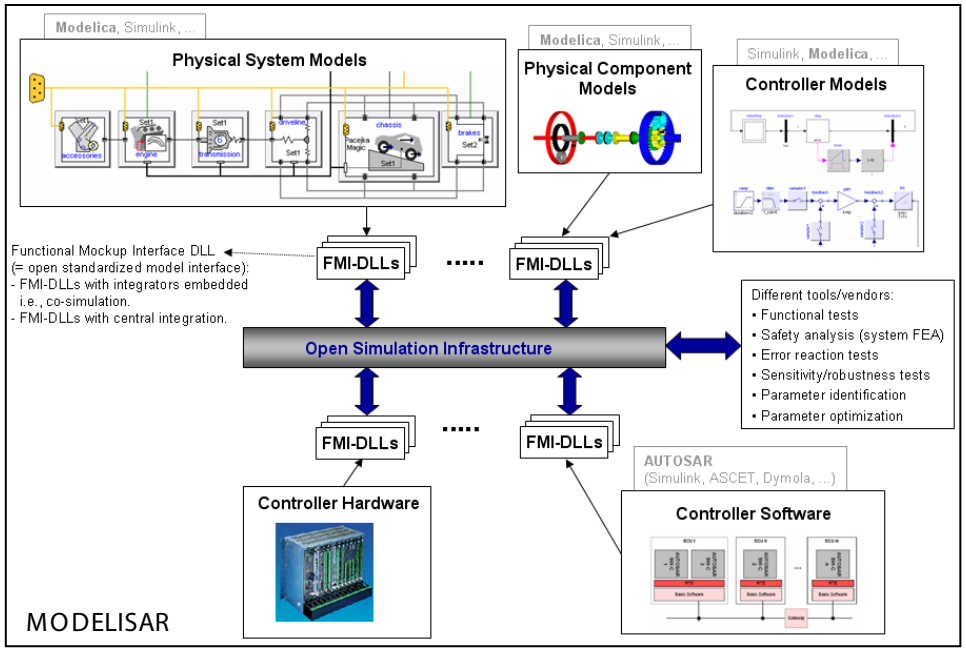
Introduction 1

- **Model Exchange in Modelica**
  - Modelica is an EOOL for modeling and simulation
  - A bunch of modeling and simulation tools based on Modelica
  - Generally no problem for model exchange btw. these tools



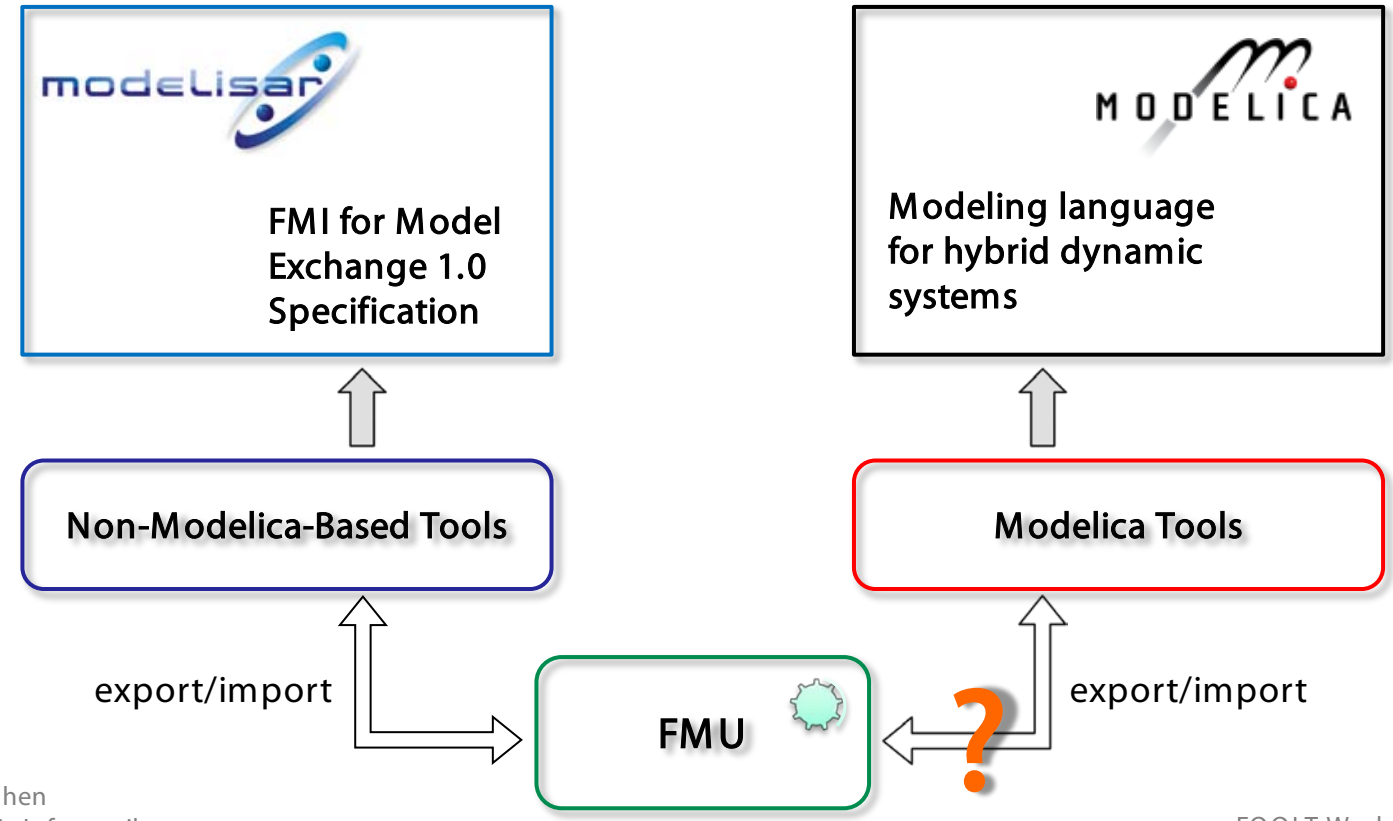
Introduction 2

- **Functional Mock-up Interface (FMI) 1.0 for Model Exchange**
  - Specification of a C interface for models (FMUs)
  - An FMU instance presents the model attributes and behavior
  - FMUs are distributed in a compressed form
  - FMUs may be exchanged btw. any tools for variant purposes



Introduction 3

- **Enhance Model Reusability and Interoperability in Modelica**
  - Functionality for FMU export to non-Modelica-based tools
  - Functionality to import generated FMUs



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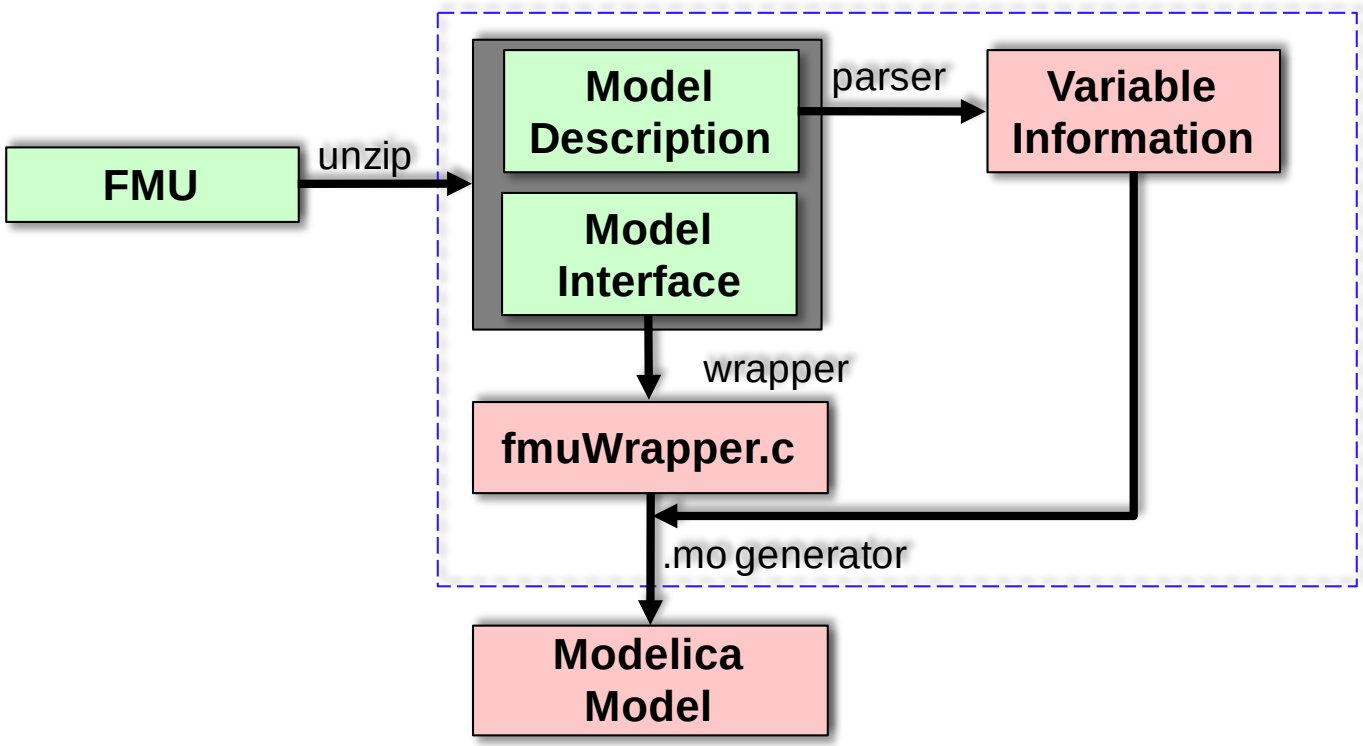
Approaches for FMU Import 1

- **Stand-alone FMU Import**
  - Decompression of the archived .fmu file
  - Parsing model description XML file
  - Wrapper around interface functions
  - Connection with solver
  - Result analysis and presentation
- **FMU Import in Modelica**
  - Decompression of the archived .fmu file
  - Parsing model description XML file
  - Mapping interface functions onto Modelica external functions
  - Mapping FMI structures onto Modelica constructs
  - Integration of model attributes and behaviors

Approaches for FMU Import 2

- **Workflow of FMU Import in Modelica**



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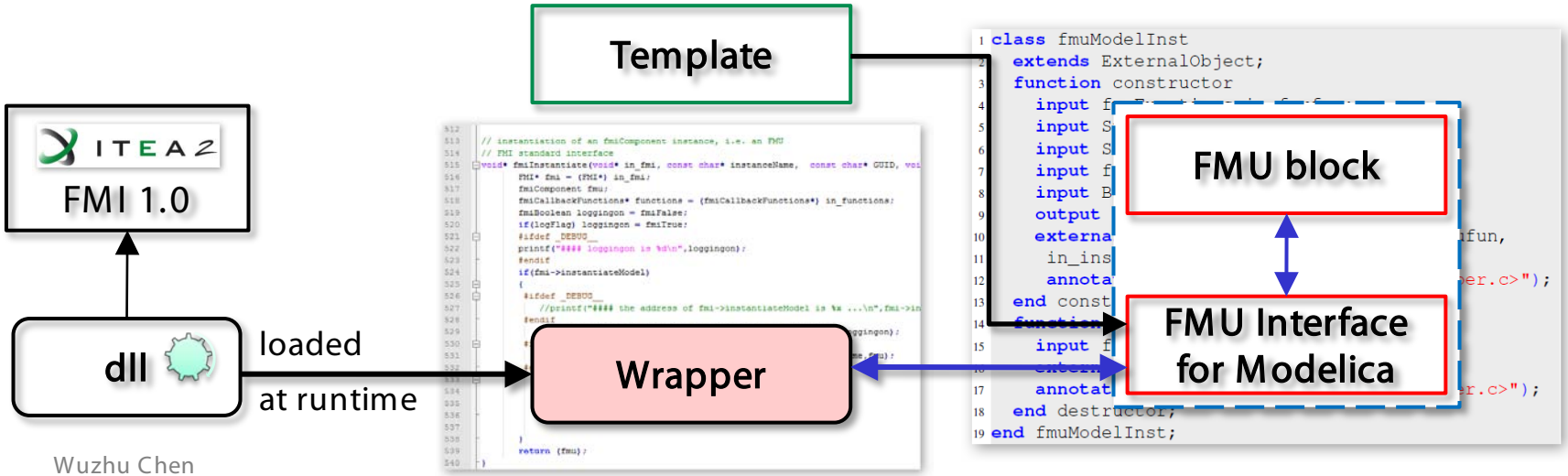
Prototype Implementation 1

- **1. Decompression of FMUs**
  - *7-zip* is used to decompress FMUs
  - Decompressed files stored in a sub-directory in OpenModelica
  - Temporary files may be deleted after code generation
- **2. Parsing modelDescription.xml**
  - Model variables and their attributes are stored in this xml file
  - Open-source library *Expat* is used
  - Result is a tree-like structure with nodes attached on it
  - Variable attributes can be queried by traversing the structure
  - Validation of the xml file not yet implemented

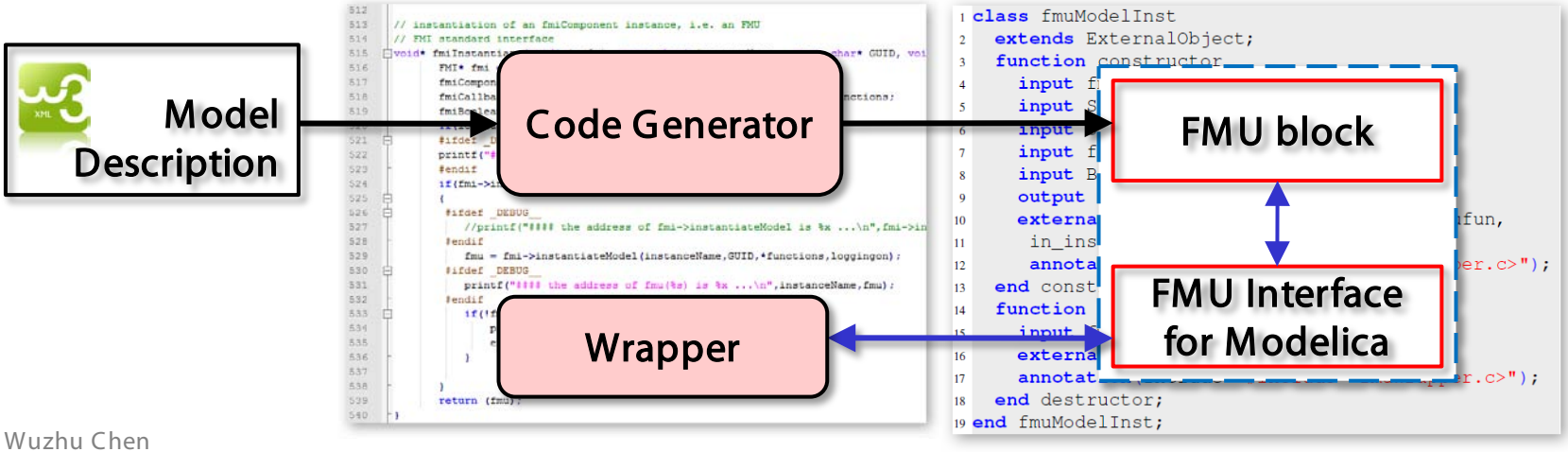
Prototype Implementation 2

- **3. Generic Interface Generation**
  - FMI interface functions in a dynamic link library (dll)
  - Load the library via information from the xml file
  - Wrapper functions are then created around FMI functions
  - Some extra helper functions
  - FMI interface is represented as Modelica external function constrcuts
  - Code generation from a template file



Prototype Implementation 2

- **4. Modelica Models Generation**
  - Calling sequence guaranteed by Modelica *algorithm* constructs
  - Specific data-flows ensured by the restricted class *block*
  - Internal variables defined based on the information from the xml file
  - The FMU block body generated by incorporating variable information and interact with the model via interface functions



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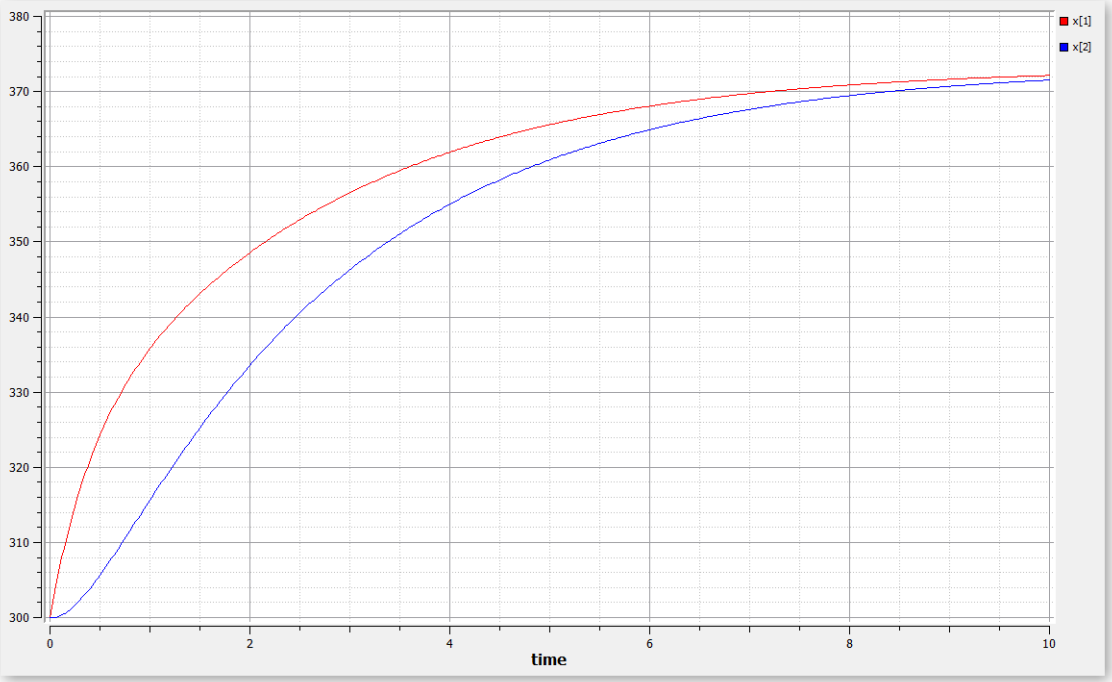
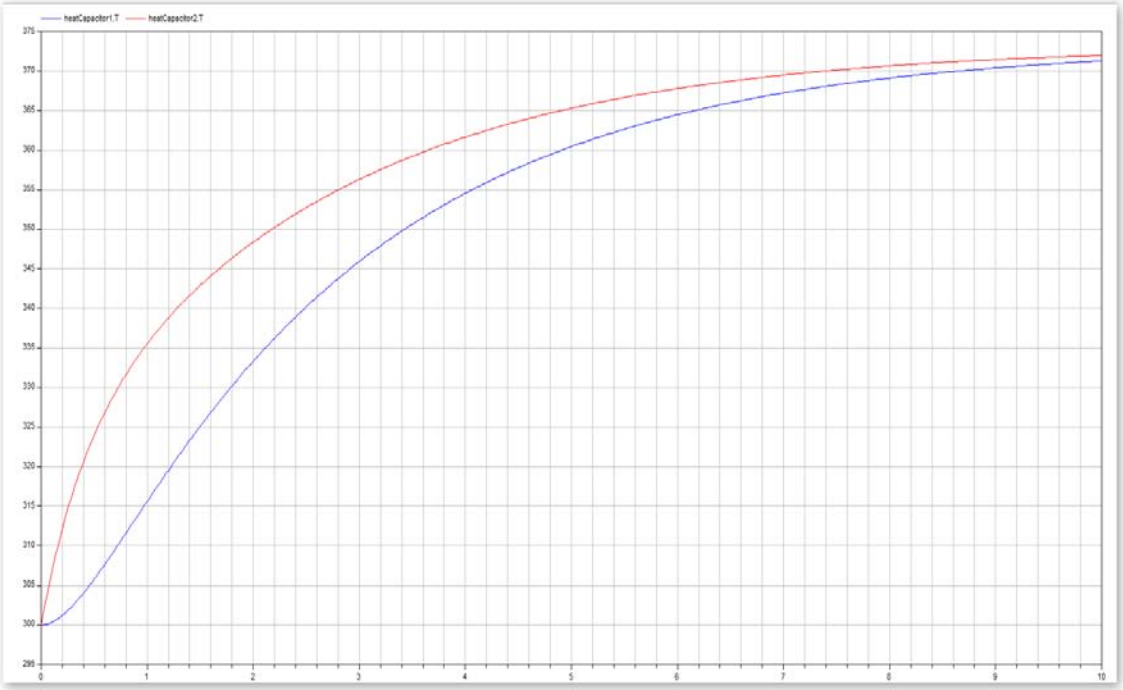
Case Study 1: Heat Transfer Equation

- **Imported CPU Cooling Model (Dymola 7.4)**
  - Continuous dynamic system
  - FMU import functionality of the prototype from other simulator in OpenModelica



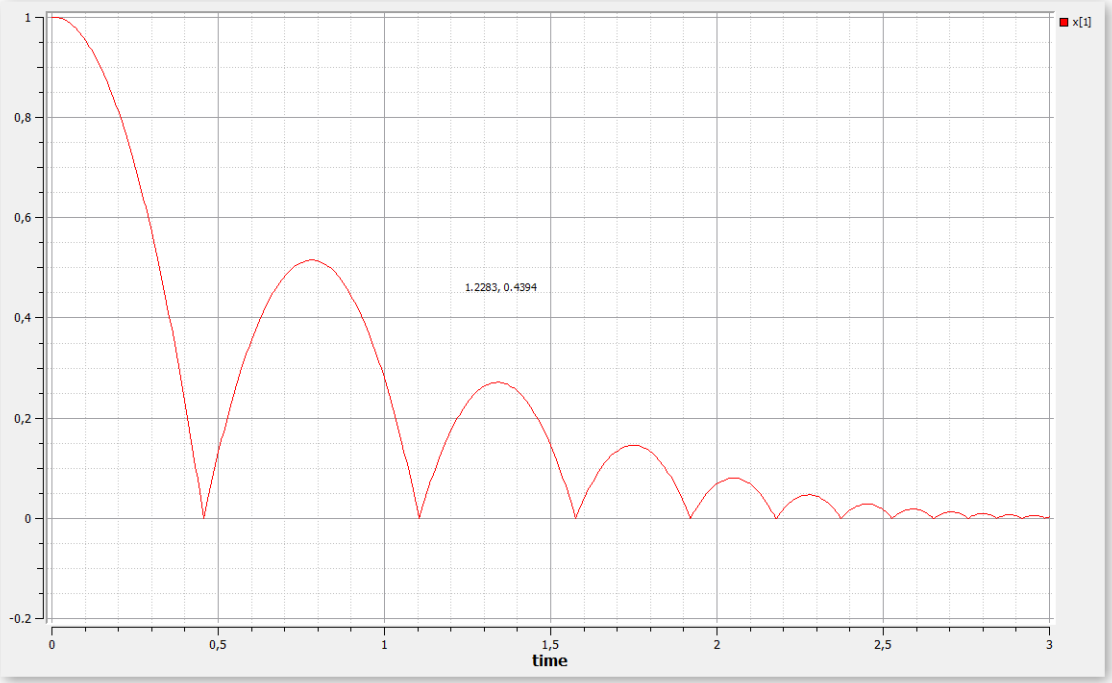
Case Study 1: Heat Transfer Equation

- **Original Modelica CPU Cooling Model (Dymola)**



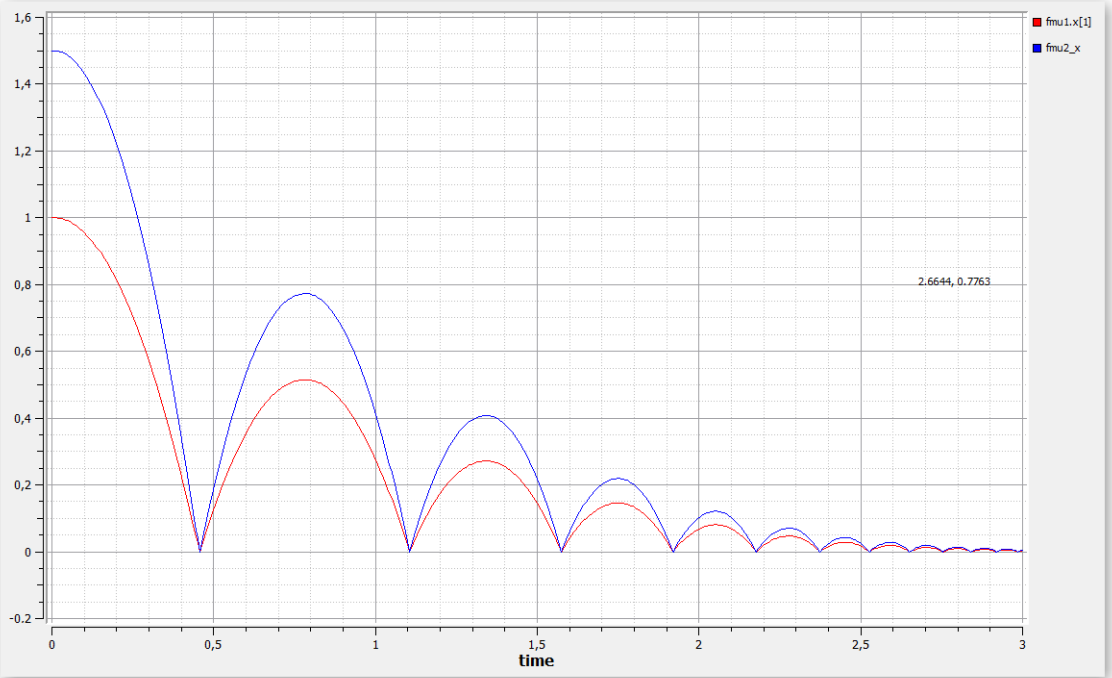
Case Study 2: Hybrid DAE System

- **Bouncing Ball Model (fmusdk)**
  - Hybrid dynamic system
  - Testing FMU import functionality of the prototype



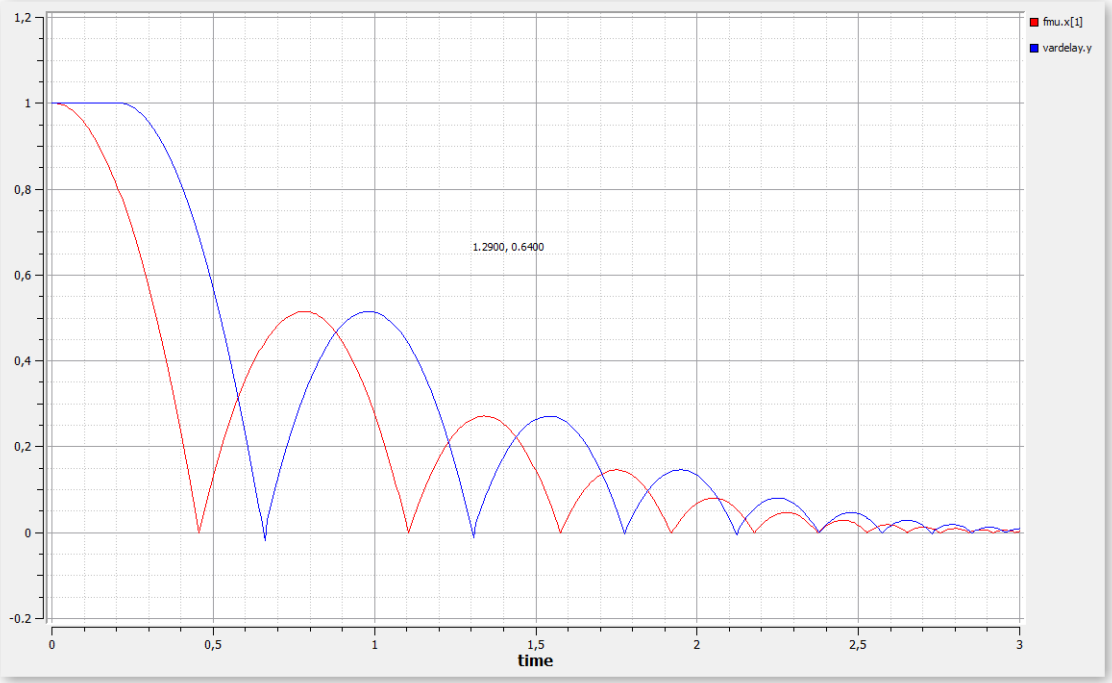
Case Study 2: Hybrid DAE System

- **Bouncing Ball Model (fmusdk)**
  - Testing capability of multiple instances of an FMU



Case Study 2: Hybrid DAE System

- **Bouncing Ball Model (fmusdk)**
  - Testing capability of native-connection btw. the imported FMU and pure Modelica model



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Conclusion

- We realized
  - FMU Import
  - multiple FMU instances
  - native-connections between imported FMU and pure Modelica model
- The interface is vendor-neutral and open-source
- Automatic code-generation fully compliant with Modelica language specification is achieved as well

Thanks for your attention!
Questions are welcomed