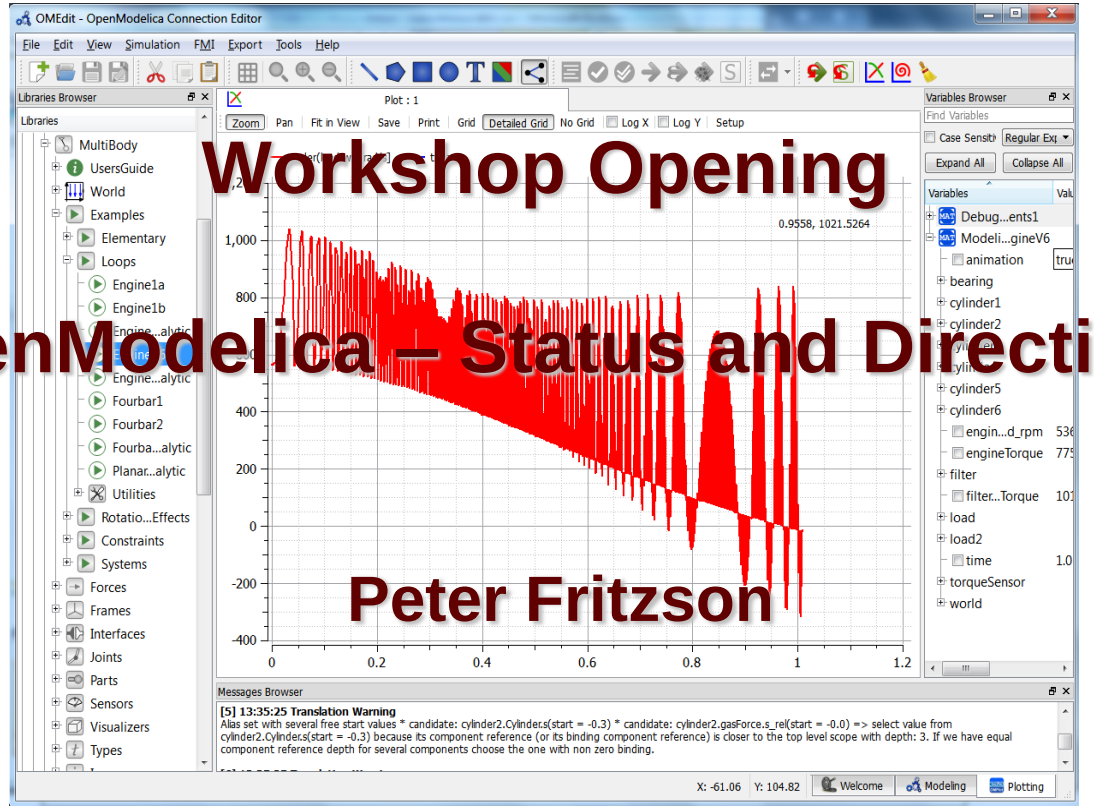
8th Annual OpenModelica Workshop Feb 1, 2016



Workshop Opening

OpenModelica – Status and Directions

Peter Fritzson

To All Participants!

Very Welcome to this Eight Annual OpenModelica Workshop!

Goals for the OpenModelica Effort

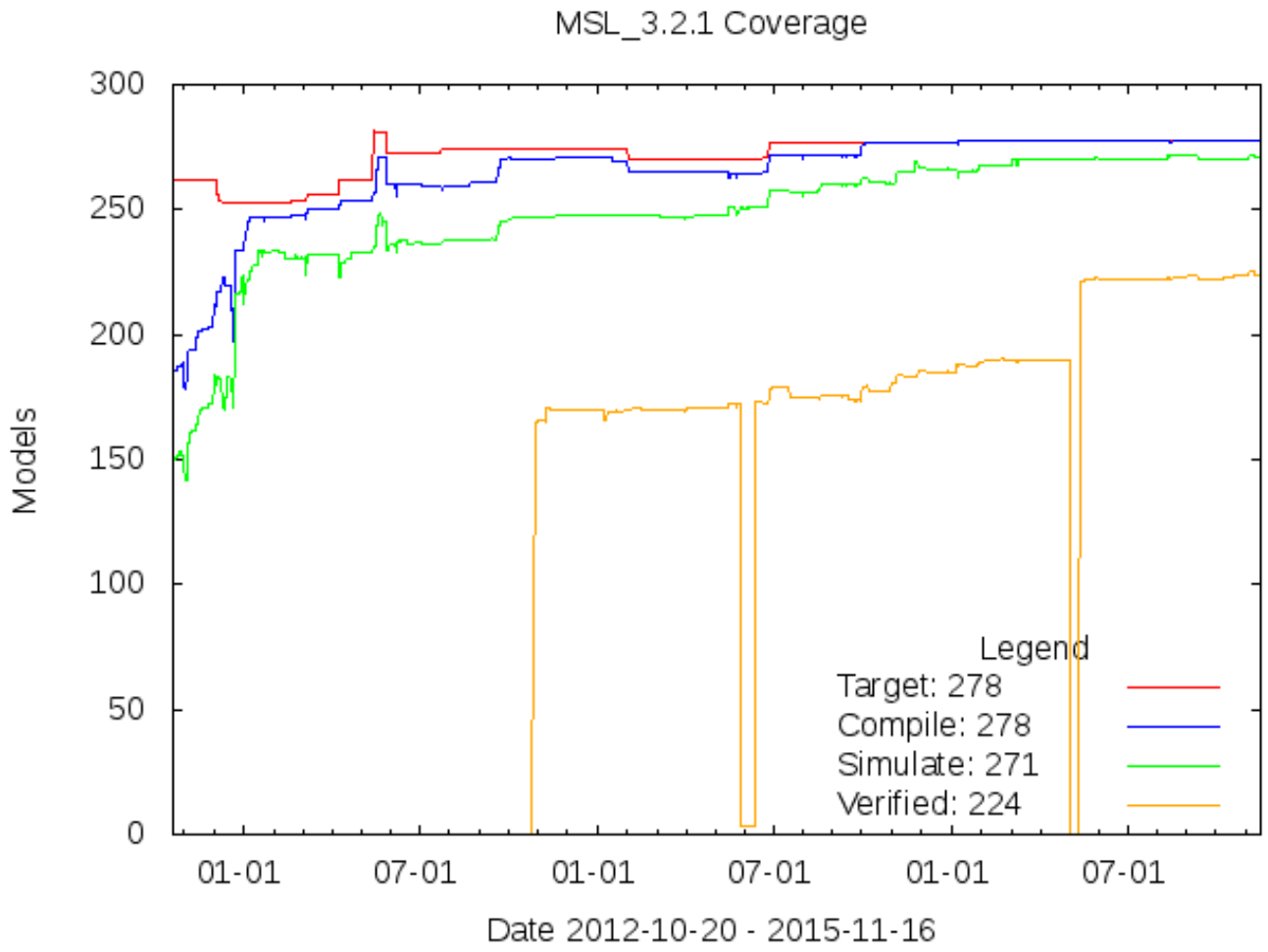
- Comprehensive **modeling, simulation and systems engineering** environment for research, teaching, and industrial usage
- **Open-source** for both **industrial** and **academic** usage
- Invitation for **open-source cooperation** around OpenModelica, tools, and applications
- **Increased** emphasis on **industrial** usage

Main Releases 2015 and January 2016

- OpenModelica **1.9.2 final release** (March 17, 2015)
  - The first release based on the **bootstrapped** OpenModelica compiler, with
  - Further improved **support** for a number of **libraries** including MSL 3.2.1, ModelicaTest 3.2.1, ThermoSysPro, ThermoPower, Buildings, and more
  - Further enhanced compiler scalability, speed, and memory
  - Significantly **improved interactive speed, factor 3-5**, of **OMEdit** graphical connection editor.
- OpenModelica **1.9.3 release** (Sept 8, 2015)
  - Further improved library coverage, Move from SVN to GIT-hub for better collaborative and parallel development; Enhanced performance analyzer.
  - Automatically generated web-based users guide. ARMf deployment
- OpenModelica **1.9.4 Beta1 release** (January 31, 2016)
  - 30% improved simulation speed. FMI 2.0 co-simulation. Improved coverage
  - Many OMEdit enhancements, including undo/redo, indentation-preserving
  - Clocked/Synchronous: Supports about 43% of library Modelica_synchronous
- OpenModelica **1.9.4 Beta2 release** (Approx Feb 8, 2016)
  - 64-bit installer for Windows; source code FMUs; large-scale model improvem.

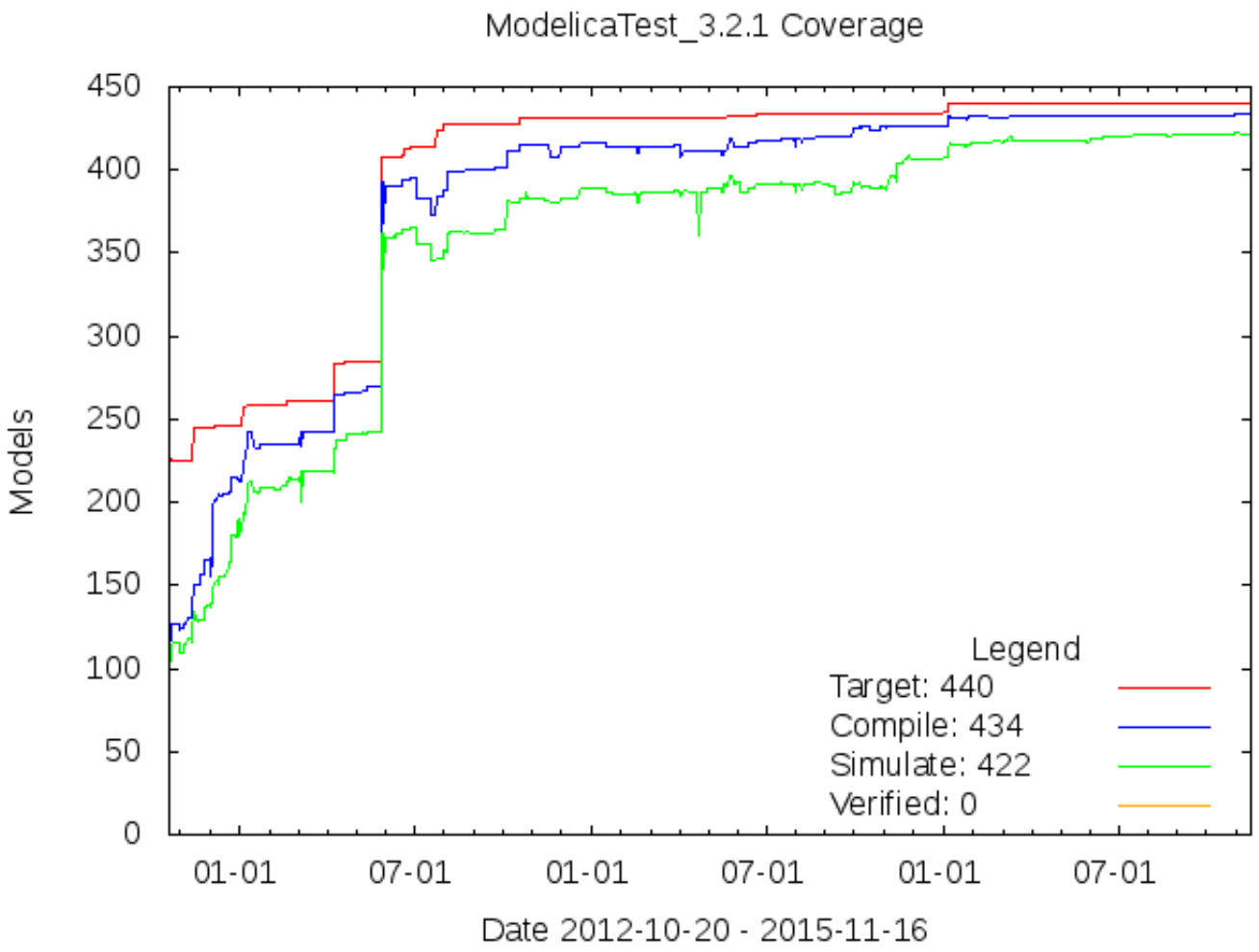
Improved MSL 3.2.1 Library Coverage

100% compilation, 97% simulation



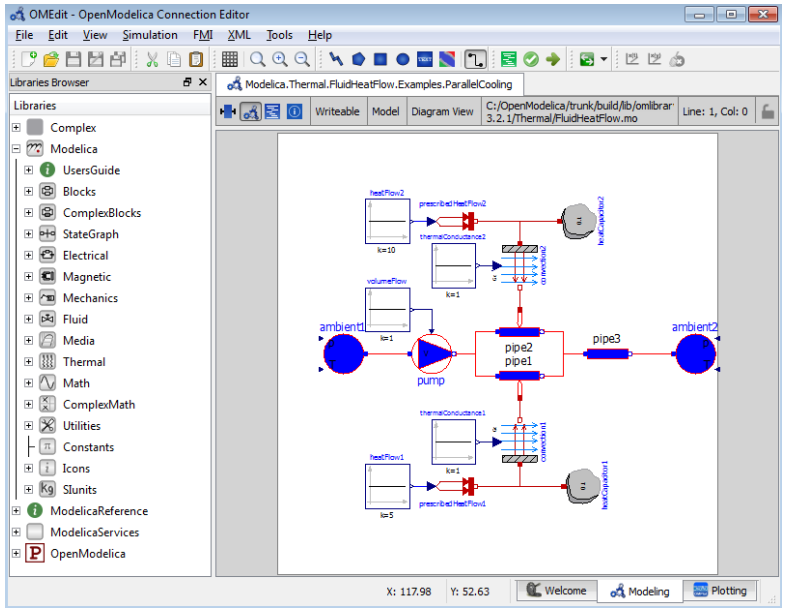
Improved ModelicaTest 3.2.1 Library Coverage

99% compilation, 96% simulation



In OpenModelica 1.9.4 – Further Enhanced OMEdit Including Undo and Improved Ease of Use

- Undo/Redo support
- Preserve text formatting, including indentation and whitespace. This is especially important for version handling
- Better support for inherited classes.
- Allow simulating models using visual studio compiler
- Support for saving Modelica package in a folder structure
- Allow reordering of classed inside a package
- Highlight matching parentheses in text view
- When copying the text retain the text highlighting and formatting
-



FMI in OpenModelica

- Model Exchange implemented (FMI 1.0 and FMI 2.0)
- FMI 2.0 Co-simulation completed
- Ongoing work on more FMI 2.0 test cases

- (Demos and exercises in tutorial tomorrow tuesday)

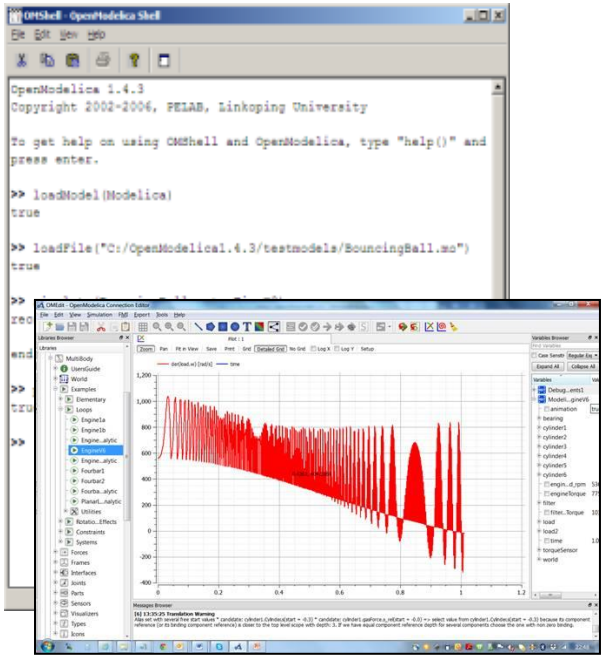
OpenModelica –Outlook for 2016

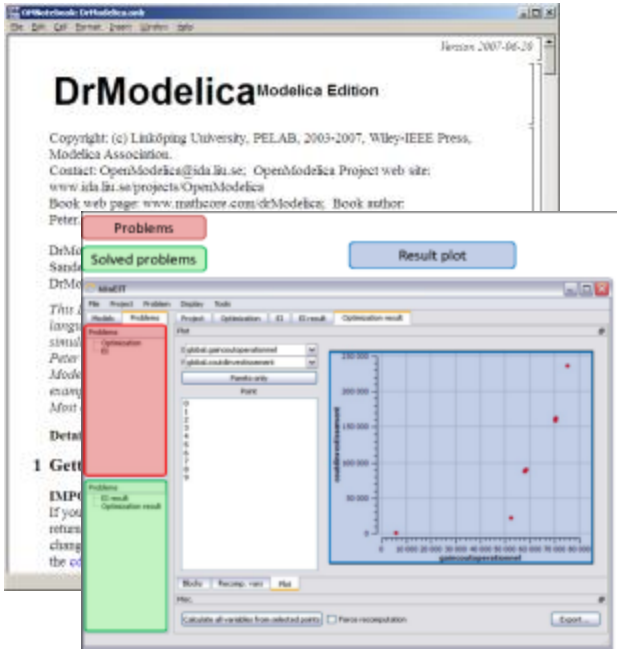
- **Main goal:** OpenModelica 2.0 release with significantly improved coverage for certain libraries
- Whole 2016. Continued **high priority** on better coverage for Modelica **libraries** including MSL 3.2.1, ModelicaTest 3.2.1, PetriNet, Buildings, PowerSystems, OpenHydraulics, ThermoPower, ThermoSysPro, etc.
- Whole 2016. Further improved compiler and simulation **performance**, including further improved support for large-scale models
- Whole 2016. Development of more **Industrial Use Cases**
- Spring 2016. Finalizing and releasing improved flattening approach**,** together with **GUI** support for **replaceable** in libraries
- Fall 2016. Full support for Modelica 3.3 **clock-based synchronous** and **state machine** features
- Further Enhanced Equation model debugging support

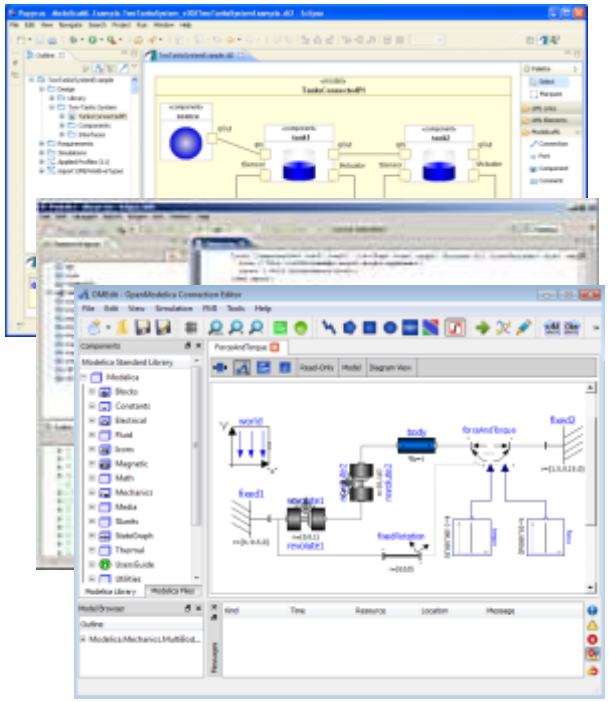
The OpenModelica Open Source Environment
www.openmodelica.org

- Advanced Interactive Modelica compiler (OMC)
  - Supports most of the Modelica Language
  - **Modelica** and **Python scripting**
- Basic environment for creating models
  - **OMShell** – an interactive command handler
  - **OMNotebook** – a literate programming notebook
  - **MDT** – an advanced textual environment in Eclipse

- **OMEdit** graphic Editor
- **OMDebugger** for equations
- **OMOptim** optimization tool
- **OM Dynamic optimizer** collocation
- **ModelicaML** UML Profile
- **MetaModelica** extension
- **ParModelica** extension





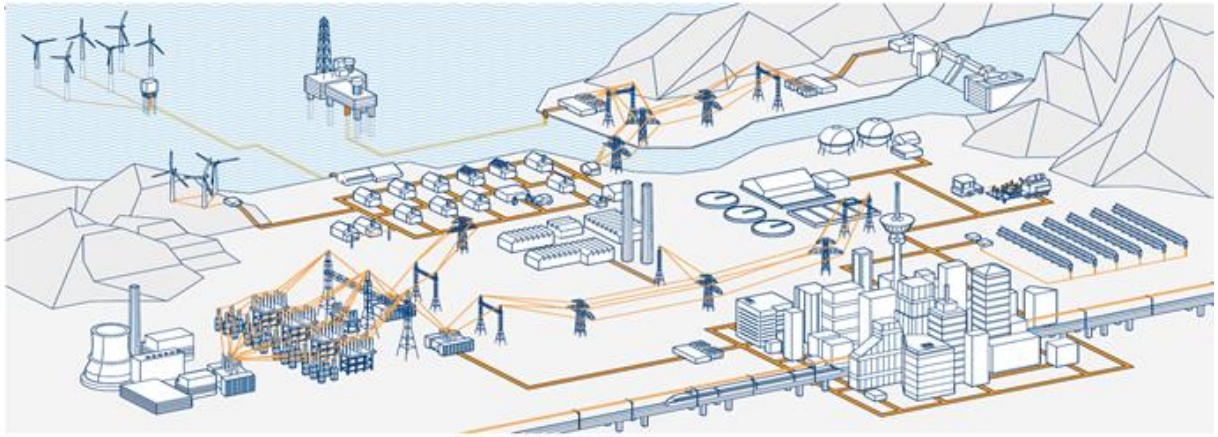


Current Main Industrial OpenModelica Usage (not including research usage)

- ABB OPTIMAX – Process control, generating code controlling almost 10% of German power production
- Wolfram-MathCore, OEM usage of OM compiler frontend in Wolfram SystemModeler product
- DHI, OEM usage of OM compiler frontend in DHI product
- Bosch-Rexroth, inhouse product usage for Modelica model import and simulation
- EDF – ThermoSysPro Library and Applications

Large OpenModelica Industrial Use Case:
ABB Industry Use of OpenModelica FMI 2.0 and Debugger

- ABB OPTIMAX® provides advanced model based control products for power generation and water utilities



- ABB: "*ABB uses several compatible Modelica tools, including OpenModelica, depending on specific application needs.*"
- ABB: "*OpenModelica provides outstanding debugging features that help to save a lot of time during model development.*"

ABB OM Application – Large-scale Virtual Power Plant
Manage vast numbers of renewable power units

ABB OPTIMAX PowerFit

- Real-time optimizing control of large-scale virtual power plant for system integration
- **Software including OpenModelica** now used in managing more than 2500 renewable plants, total up to 1.5 GW

High scalability supporting growth

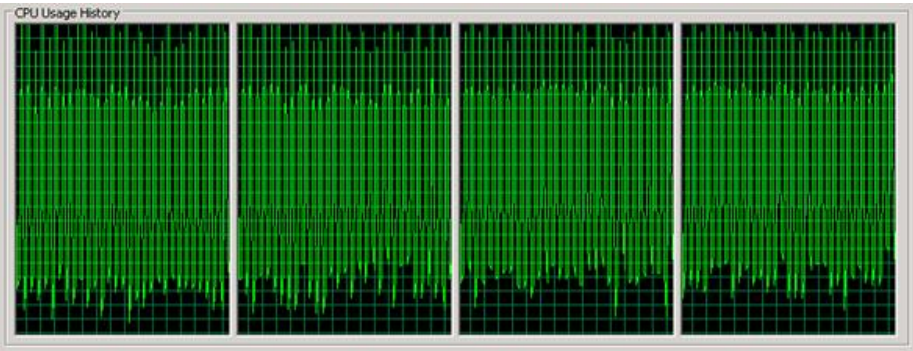
- 2012: initial delivery (for 50 plants)
- 2013: SW extension (500 plants)
- 2014: HW+SW extension (> 2000)
- 2015: HW+SW extension,
  incl. OpenModelica generating optimizing controller code in FMI 2.0 form

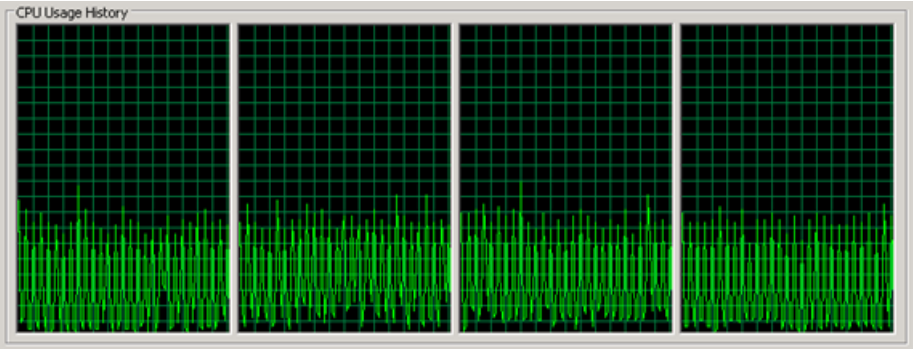
Manage 7.5% - 10% of German Power

- 2015, Aug: OpenModelica Exports FMUs for real-time optimizing control (seconds) of about **5.000 MW (7.5%) of power in Germany**

Before / After replacing S-function with FMI 2.0
Killer feature: sparse Model Structure in XML files
(Rüdiger Franke, ABB AG, Mannheim)

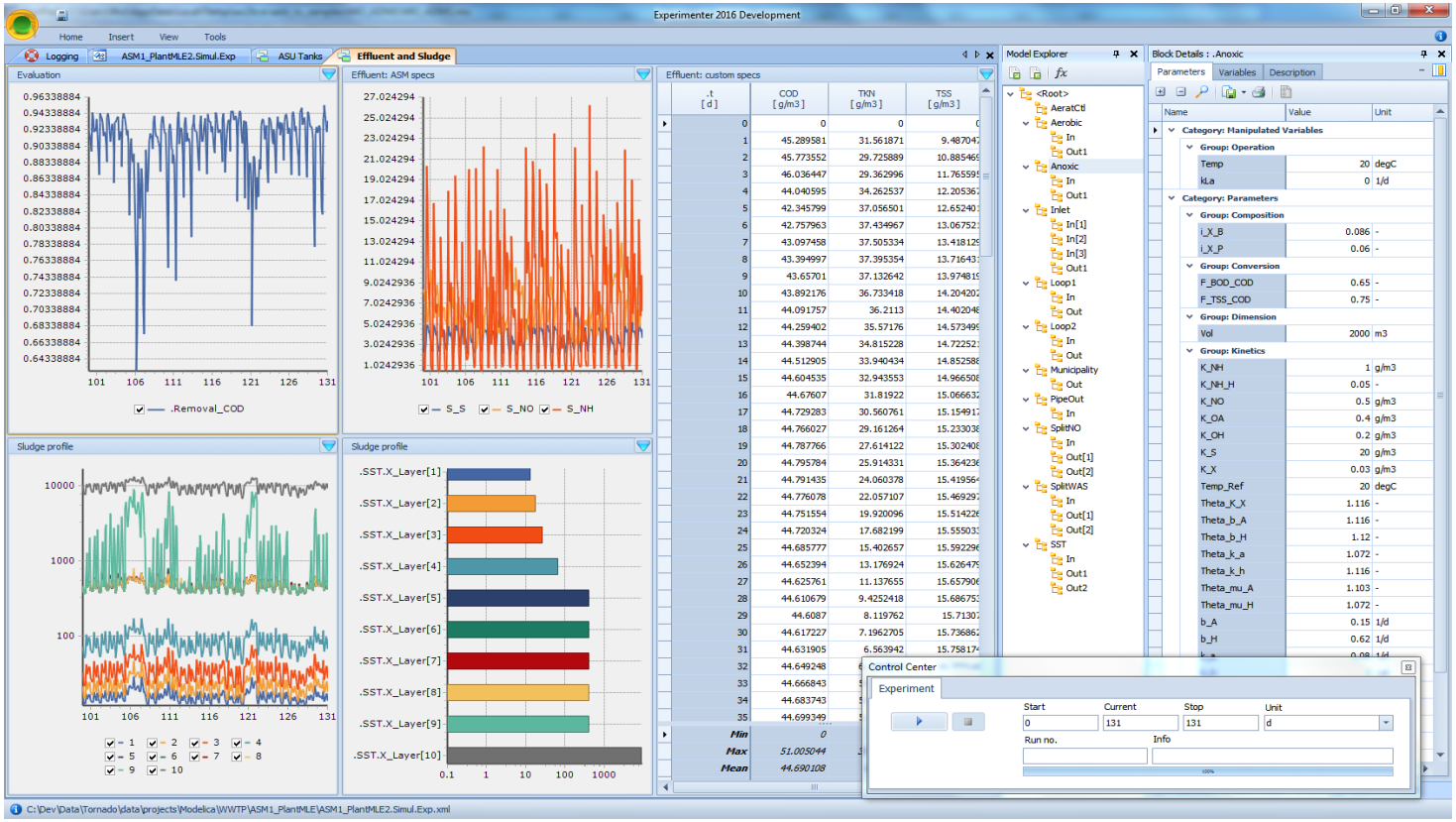
- Example VPP pool running on a 4 core virtual server
- FMI 2.0 (OM 1.9.3) reduced CPU-load by factor 2-3





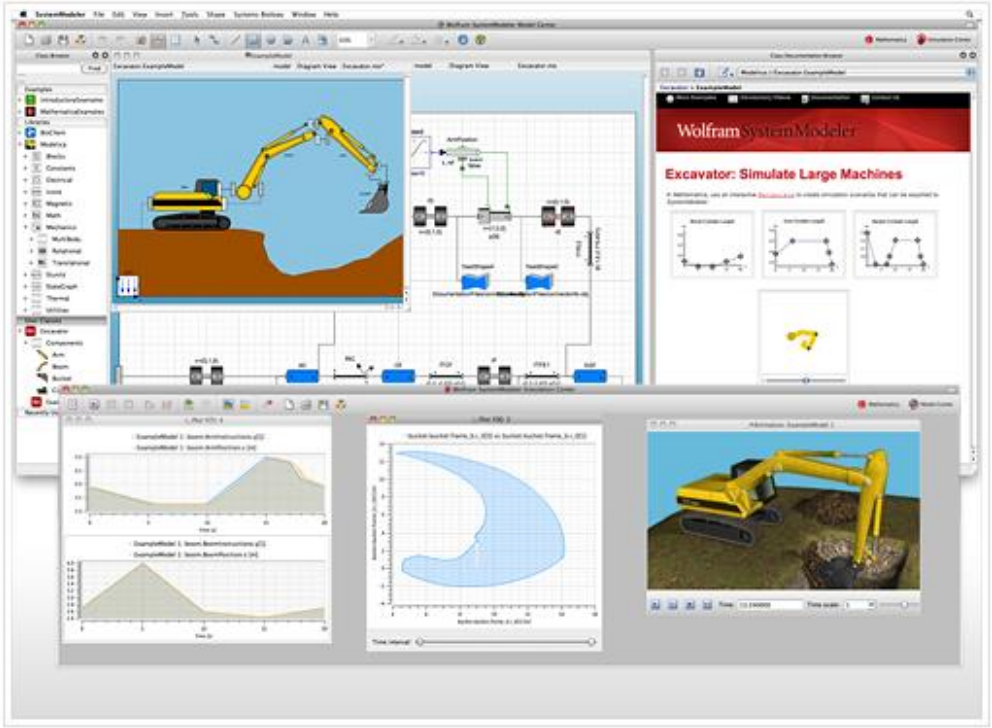
MIKE by DHI, www.mikebydhi.com, WEST Water Quality Product

- The MIKE by DHI, www.mikebydhi.com, WEST Water Quality modeling and simulation environment includes a large part of the OpenModelica compiler using the OEM license.



Wolfram SystemModeler Industrial Product – from Wolfram MathCore

- Wolfram SystemModeler product includes the OpenModelica compiler frontend
- Wolfram /SystemModeler/ is modeling and simulation environment using versatile symbolic components and computation to drive design efficiency and innovation. It integrates with the Wolfram technology platform to enable modeling, simulation, and analysis (of many types).

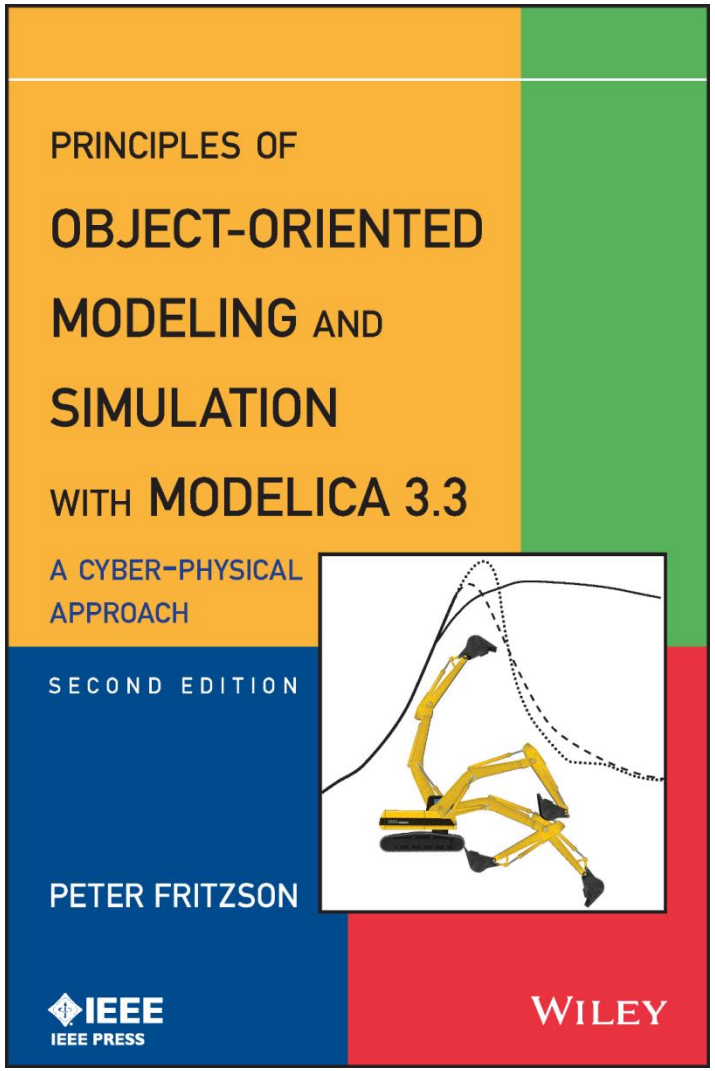


The Open Source Modelica Consortium

Purpose of the Consortium

- The Open Source Modelica Consortium, created the 4th of December 2007 in Linköping, Sweden, in the following called OSMC, is a non-profit, non-governmental organization with the aim of developing and promoting the development and usage of the **OpenModelica open source implementation of the Modelica computer language** (also named Modelica modeling language) and OpenModelica **associated open-source tools and libraries**, collectively named the OpenModelica Environment, in the following referred to as OpenModelica.
- OpenModelica is **available for commercial and non-commercial usage under the conditions of the OSMC Public License**. It is the aim of OSMC, within the limitations of its available resources, to provide **support and maintenance of OpenModelica**, to support its publication on the web, and to **coordinate** contributions to OpenModelica.

Recent New Big Modelica Book, December 2014
(Peter Fritzson's own release), New printing January 2015



Peter Fritzson

Principles of Object Oriented Modeling and Simulation with Modelica 3.3

A Cyber-Physical Approach

Can be ordered from Wiley or Amazon

Wiley-IEEE Press, 2014, 1250 pages

- OpenModelica
  - www.openmodelica.org

Open Source Modelica Consortium Originally Created Dec 4, 2007

7 Founding Organizational Members

- Bosch-Rexroth AG, Germany
- Equa Simulation AB, Sweden
- TLK Thermo, Germany
- VTT, Finland
- Linköping University, Sweden
- Hamburg University of Technology/TuTech, Institute of Thermo-Fluid Dynamics, Germany
- Technical University of Braunschweig, the Institut of Thermodynamik, Germany

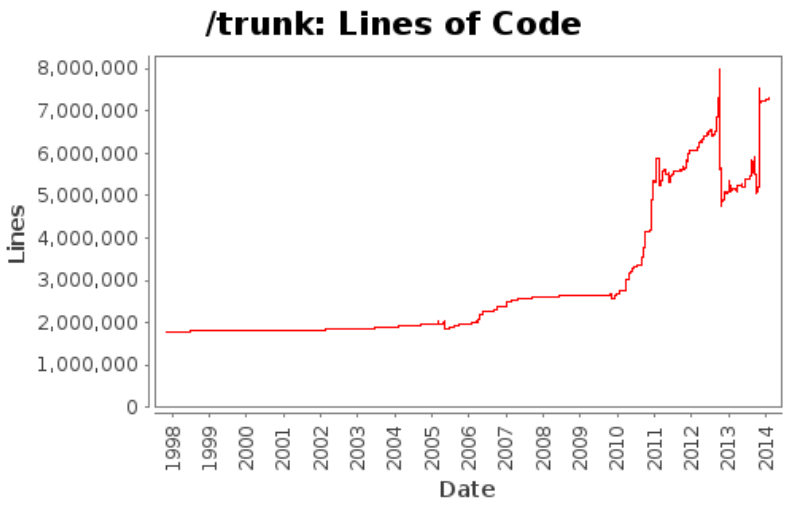
OSMC – Open Source Modelica Consortium

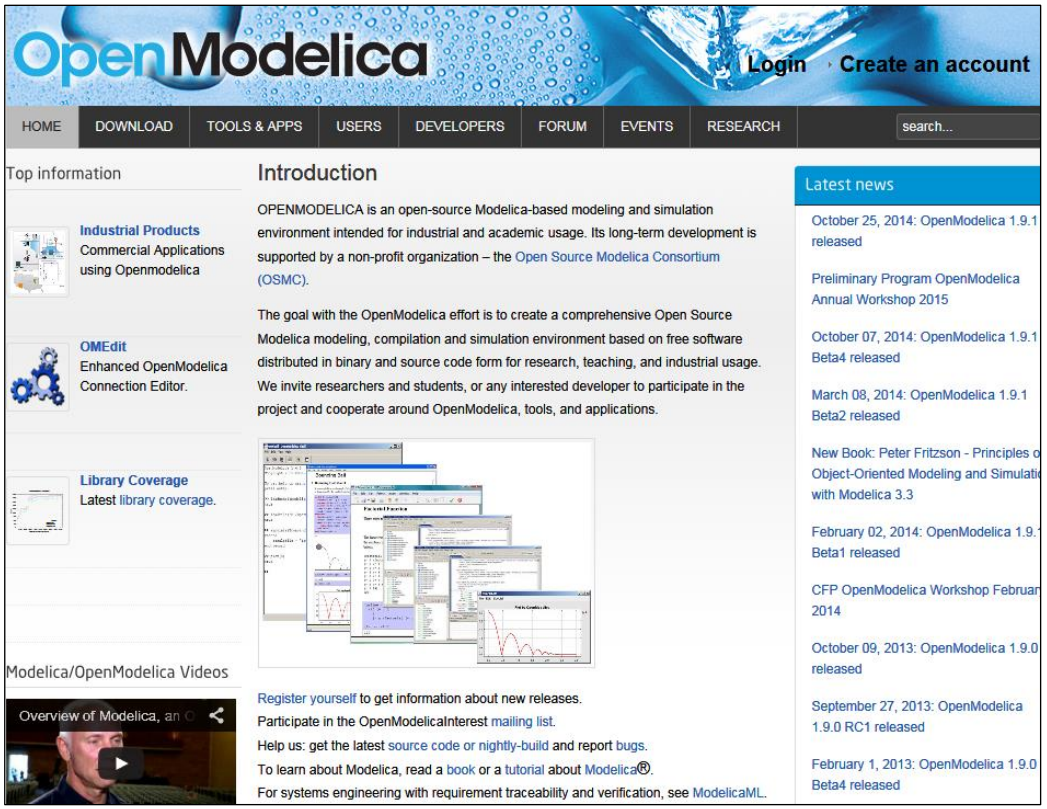
Founded Dec 4, 2007

Open-source community services

- **Website and Support Forum**
- **Version-controlled source base**
- **Bug database**
- **Development courses**
- **www.openmodelica.org**

Code Statistics





OSMC 48 Organizational Members, Feb 2016
(initially 7 members, 2007)

Companies and Institutes (23 members)

- ABB AB, Sweden, Germany, India
- Bosch Rexroth AG, Germany
- Siemens Turbo, Sweden
- CDAC Centre, Kerala, India
- Creative Connections, Prague
- DHI, Aarhus, Denmark
- Dynamica s.r.l., Cremona, Italy
- EDF, Paris, France
- Equa Simulation AB, Sweden
- Fraunhofer IWES, Bremerhaven
- IFPEN, Paris, France
- ISID Dentsu, Tokyo, Japan
- Maplesoft, Canada
- Ricardo Inc., USA
- RTE France, Paris, France
- Saab AB, Linköping, Sweden
- Scilab Enterprises, France
- SKF, Göteborg, Sweden
- TLK Thermo, Germany
- Sozhou Tongyuan, China
- VTI, Linköping, Sweden
- VTT, Finland
- Wolfram MathCore, Sweden

Universities (25 members)

- Austrian Inst Tech, Energy Dept, Vienna, Austria
- TU Berlin, Inst. UEBB, Germany
- FH Bielefeld, Bielefeld, Germany
- TU Braunschweig, Germany
- University of Calabria, Italy
- Univ California, Berkeley, USA
- Chalmers Univ Techn, Sweden
- TU Dortmund, Germany
- TU Dresden, Germany
- Université Laval, Canada
- Ghent University, Belgium
- Halmstad University, Sweden
- Heidelberg University, Germany
- Linköping University, Sweden
- TU Hamburg/Harburg Germany
- IIT Bombay, Mumbai, India
- KTH, Stockholm, Sweden
- Univ of Maryland, Syst Eng USA
- Univ of Maryland, CEEE, USA
- Politecnico di Milano, Italy
- Ecoles des Mines, CEP, France
- Mälardalen University, Sweden
- Univ Pisa, Italy
- StellenBosch Univ, South Africa
- Telemark Univ College, Norway

Open Source Modelica Consortium Individual Members

(69 individual members, 1 February 2016)

- Peter Fritzson, Adrian Pop, Martin Sjölund, Per Östlund, Peter Aronsson, Adeel Asghar, Mikael Axin, Bernhard Bachmann, Vasile Baluta, Adam Bergmark, Robert Braun, Willi Braun, David Broman, Stefan Brus, Francesco Casella, Filippo Donida, Atiyah Elsheikh, Jens Frenkel, Mahder Gebremedhin, Pavel Grozman, Daniel Hedberg, Michael Hanke, Zoheb Hossain, Alf Isaksson, Kim Jansson, Daniel Kanth, Tommi Karhela, Juha Kortelainen, Abhinn Kothari, Petter Krus, Alexey Lebedev, Oliver Lenord, Ariel Liebman, Rickard Lindberg, Håkan Lundvall, Abhi Raj Metkar, Eric Meyers, Tuomas Miettinen, Afshin Moghadam, Kenneth Nealy, Maroun Nemer, Hannu Niemistö, Peter Nordin, Kristoffer Norling, Lennart Ochel, Arunkumar Palanisamy, Karl Pettersson, Pavol Privitzer, Reino Ruusu, Per Sahlin,Wladimir Schamai, Gerhard Schmitz, Alachew Shitahun, Magnus Sjöstrand, Anton Sodja, Ingo Staack, Kristian Stavåker, Sonia Tariq, Mohsen Torabzadeh-Tari, Parham Vasaiely, Niklas Worschech, Robert Wotzlaw, Björn Zackrisson, Azam Zia

Open Source Modelica Consortium – OSMC Board of Directors 2015

- **Oliver Lenord**, OSMC Chairman; Manager, Siemens PLM, USA
- **Per Sahlin**, OSMC Vice Chairman; CEO, Equa Simulation AB
- **Peter Fritzson**, OSMC Director; Prof, Linköping Univ, Sweden
- **Francesco Casella**, OSMC Vice Director; Prof, Politec. di Milano, Italy
- **Juha Kortelainen**, Manager, VTT, Finland
- **Gerhard Schmitz**, Prof, Univ. Hamburg, Germany
- **Jan Brugård**, CEO, Wolfram MathCore AB, Sweden
- **Kilian Link**, Manager, Siemens, Germany (and Sweden)
- **Lars Mikelsons**, Manager, Bosch-Rexroth, Germany.
- **Daniel Bouskela**, Manager, EDF, France
- **Bernhard Bachmann**, Prof, FH Bielefeld, Germany

OSMC Board – 3 Meetings Jan 1 2015 – Dec 31 2015

Meeting dates

- 150518
- 150901
- 151119

Board Work

- Planning and prioritizing the OSMC work
- Admitting new members
- Planning the workshop
- Budget
- etc.

Some Supporting Research Projects 2015

- ITEA2 MODRIO Project
- STREAM, small national Swedish project
- EU project PyModSimA – collaboration with DLR
- German national project including Bosch-Rexroth and TU Dresden
- New ITEA3 project OPENCPS, starting Dec 2015
  (Open Cyber-Physical System Model-Driven Certified Development)
  Sweden, France, Finland, (Hungary?)
- New Swedish project RTISIM, starting Dec 2015

Special Thanks

- The developers who worked very hard during 2015 and modelers who tested and gave important feedback
- The OpenModelica consortium organizational members for support including ABB, Bosch-Rexroth, Wolfram-MathCore, Siemens Turbo Machinery, EDF, Ricardo, etc...
- Master students and PhD students who made important contributions.

Conclusions and Summary 2015/Jan 2016

- March 17, 2015. OpenModelica **1.9.2 release**. First release based on bootstrapped compiler platform, faster, more programmable
- Sept 8, 2015. OpenModelica **1.9.3 release**. Improved coverage, Move from SVN to GIT-hub, Web-based users guide
- January-February, 2016. OpenModelica **1.9.4 release** 64 bit on Windows, GUI enhancements including Undo, Comment and indentation preserving – important for versioning and merge/diff
- 2016. Good prospects for the future – towards a standard high quality compliant open source Modelica implementation in Modelica, increased tool support for integrated systems engineering.

Questions?

www.openmodelica.org