6th Annual OpenModelica Workshop
Feb 3, 2014

Workshop Opening

OpenModelica – Status and Directions

Peter Fritzson
To All Participants!

Very Welcome to this Sixth Annual OpenModelica Workshop!
During 2013: Both MSL 3.2.1 & ModelicaTest 3.2.1 Coverage 92.6% and 89.6%, including most of Fluid

Another increase in coverage is expected within next 2 weeks when a bunch of new improvements are checked in.
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
The OpenModelica Open Source Enviroment

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
- OMOptim optimization tool
- ModelicaML UML Profile
- MetaModelica extension
- ParModelica extension
Main Events 2013 and January 2014

- **Modelica Compliance Test Suite** delivered to Modelica Association, more than 1000 test cases (Sept 2013)
  - Large number of incompatibilities detected and can now be tested
  - Very important for tool and library compliance in Modelica community
  - Contributed to making the MSL 3.2.1 release more Modelica compliant

- **OpenModelica 1.9.0 release** (October 2013)
  - OpenModelica compiler support for most of the Fluid library; thermo-fluid applications.
  - Good support for the **significantly updated Modelica Standard Library (MSL) 3.2.1**.
  - Much better support for the Modelica Test library
  - Significantly enhanced graphical user interface in OMEdit.

- **OpenModelica 1.9.1 beta1 release** (January 31, 2014)
  - Further improved support for a number of libraries including MSL 3.2.1, ModelicaTest 3.2.1, PetriNet, Buildings, PowerSystems, OpenHydraulics, ThermoPower, and ThermoSysPro.
  - **Breakthrough**: The first run-time Modelica debugger for equation-based models
  - Further enhanced compiler front-end scalability, speed and memory, will be part of 1.9.1 final release.
  - Better coverage of Modelica libraries using Fluid and Media, will be part of 1.9.1 final release
OpenModelica – Outlook for 2014

• Whole 2014. 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 2014. Development of more Industrial Use Cases
• February 2014. OpenModelica 1.9.1 final release; better perf. & coverage
• March 2014. Switching to Bootstrapped compiler including the Debugger within the OMEdit GUI. Better performance & coverage
• Spring 2014. GUI support for replaceable in libraries
• Spring 2014. All of Fluid library simulating
• Spring 2014. Improved FMI 2.0 support
• Fall 2014. Partial support for Modelica 3.3 clock-based synchronous and state machine features
• Whole 2014. Further improved simulation performance and coverage
During 2013 Improved Testing and Nightly Builds for increased quality

- OSMC bought two new powerful test and build multi-core servers during 2013
- Performs builds for three platforms (Windows, Linux, Mac) every night
- Significantly increased test suite size for better coverage
- Run a test suite after each check-in, using parallel builds, for quick feedback to developers to remove introduced errors
Current Main Industrial OpenModelica Usage (not including research)

- 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
- STEAG, usage in power plant applications
During 2013 – Significantly Improved OpenModelica Connection Editor OMEdit

- Supports final MSL 3.2.1
- Implemented in C++ Qt library
- Autosave and recovery features
- Improved libraries browser
- Variables browser search
- Preserving user customizations
- Convenient parameter editing in variables browser
- Fast re-simulation without re-compilation after parameter change
Run-Time Debugger for Equation-Based Models Integrated with OMEdit – first in a Modelica tool

- Mapping error
- Positions back to source model
- Tracing symbolic transformations
- Talk this afternoon
- Hands-on tutorial tomorrow
Multiple-Shooting and Collocation Dynamic Trajectory Optimization in OpenModelica

- Minimize a goal function subject to model equation constraints, useful e.g. for NMPC
- Multiple Shooting/Collocation
  - Solve sub-problem in each sub-interval

In OpenModelica 1.9.1 release
Talk later today.
Hands-on tutorial tomorrow

\[
x_i(t_{i+1}) = h_i + \int_{t_i}^{t_{i+1}} f(x_i(t), u(t), t) \, dt \approx F(t_i, t_{i+1}, h_i, u_i), \quad x_i(t_0) = h_i
\]
Prototypes of Parallel Execution with OpenModelica

- ParModelica – Parallel Algoritmic Modelica Code Execution on GPU
  - Speedup factor 300 of matrix multiplication on NVIDIA Fermi GPU

- Parallelization of partitioned models
  - Speedup factor 4 of small model on 4-core machine

- Finegrained parallelization of equation models
  - Talk later today
OpenModelica Compiler Bootstrapping

• Bootstrapping = OMC Compiler Compiles itself

• Advantages
  • Faster compilation for the developers
  • Complete Modelica language for easier programming
  • Better error messages and maintainability
  • Makes a faster Modelica debugger possible
  • Makes performance analysis possible
  • some Modelica 4 like features

• Status
  • Dec 2010, OMC first compiled itself
  • During 2011-now, used for development with the new debugger
  • Dec 2012. Automatic memory reclamation operational
  • Jan 2014. Tuned. 4 months hard testing. Ready for deployment
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.
Peter Fritzson’s Personal Release, Nov 26, 2013
New Big Modelica Book, in Print probably May 2014

Principles of Object Oriented Modeling and Simulation with Modelica 3.3

Peter Fritzson
Principles of Object Oriented Modeling and Simulation with Modelica 3.3

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
45 organizational members December 2013

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
<table>
<thead>
<tr>
<th>Companies and Institutes (22 members)</th>
<th>Universities (23 members)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bosch Rexroth AG, Germany</td>
<td>TU Berlin, Inst. UEBB, Germany</td>
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<tr>
<td>Siemens PLM, California, USA</td>
<td>FH Bielefeld, Bielefeld, Germany</td>
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<td>Siemens Turbo Machinery AB, Sweden</td>
<td>TU Braunschweig, Germany</td>
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<tr>
<td>CDAC Centre for Advanced Compu, Kerala, India</td>
<td>University of Calabria, Italy</td>
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<td>Creative Connections, Prague, Czech Republic</td>
<td>Danish Technical Univ, Denmark</td>
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<td>DHI, Aarhus, Denmark</td>
<td>TU Dortmund, Germany</td>
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<tr>
<td>EDF, Paris, France</td>
<td>TU Dresden, Germany</td>
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<tr>
<td>Equa Simulation AB, Sweden</td>
<td>Georgia Institute of Technology, USA</td>
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<tr>
<td>Fraunhofer FIRST, Berlin, Germany</td>
<td>Ghent University, Belgium</td>
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<td>Fraunhofer IWES, Bremerhaven, Germany</td>
<td>Halmstad University, Sweden</td>
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<td>Frontway AB, Sweden</td>
<td>Heidelberg University, Germany</td>
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<tr>
<td>Gamma Technology Inc, USA</td>
<td>TU Hamburg/Harburg, Germany</td>
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<td>IFP, Paris, France</td>
<td>KTH, Stockholm, Sweden</td>
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<td>ISID Dentsu, Tokyo, Japan</td>
<td>Université Laval, Canada</td>
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<td>ITI, Dresden, Germany</td>
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<td>Maplesoft, Canada</td>
<td>Univ of Maryland, Syst Eng USA</td>
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<td>TLK Thermo, Germany</td>
<td>Univ of Maryland, CEEE, USA</td>
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<tr>
<td>Sozhou Tongyuan Software and Control, China</td>
<td>Politecnico di Milano, Italy</td>
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<td>STEAG, Dehli, India</td>
<td>Ecoles des Mines, CEP, France</td>
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<td>Mälardalen University, Sweden</td>
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<td>Univ Pisa, Italy</td>
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<td>Wolfram MathCore, Sweden</td>
<td>Telemark Univ College, Norway</td>
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<td>University of Ålesund, Norway</td>
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Open Source Modelica Consortium
Individual Members

(64 individual members, 3 February 2014)

Open Source Modelica Consortium – OSMC
Board of Directors 2013

• 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
• Juha Kortelainen, Manager, VTT, Finland
• Gerhard Schmitz, Prof, Univ. Hamburg, Germany
• Francesco Casella, Prof, Politecnico di Milano, Italy
• 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 – 6 Meetings Jan 1 2013 – Dec 31 2013

<table>
<thead>
<tr>
<th>Meeting dates</th>
<th>Board Work</th>
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<tr>
<td>130110</td>
<td>• Planning and prioritizing the OSMC work</td>
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<tr>
<td>130514</td>
<td>• Admitting new members</td>
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<tr>
<td>130619</td>
<td>• Planning the workshop</td>
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<td>131002</td>
<td>• Budget</td>
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<tr>
<td>131105</td>
<td>• etc.</td>
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<td>131217</td>
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Some Supporting Research Projects

- ITEA2 MODRIO Project
- SKF- SICS East extension to MODRIO project for TLM co-simulation and Windpower application
- Simovate, national Swedish project
- STREAM, national Swedish project
- EU project PyModSimA – collaboration with DLR
- AVM project, collaboration with Vanderbilt, Xerox Parc
MODRIO-Model Driven Physical Systems Operation
Special Thanks

• The developers who worked very hard during 2013. Adrian Pop, Martin Sjölund, Per Östlund, Adeel Asghar, Willi Braun, Lennart Ochel, Vitalij Ruge, Mahder Gebremedhin, Jens Frenkel, Modelers Francesco Casella, Bruno Scaglioni, and several other people.

• The 45 OpenModelica consortium organizational members for support including Bosch-Rexroth, Wolfram-MathCore, Siemens Turbo Machinery, Siemens PLM, EDF, etc...

• Master students and PhD students who made important contributions.
Conclusions and Summary 2013/Jan 2014

- January 2013. Breakthrough - simulating more than half of Fluid Library Models
- Sept 1, 2013. Compliance Test Suite to support Modelica Language compliance for MSL and between tools
- October 2013. OpenModelica 1.9.0 final release with improved library support and enhanced GUI (OMEdit)
- January 2014. Breakthrough – Run-time debugger for equation-based models; OM 1.9.1 Beta1 release
- 2014. 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