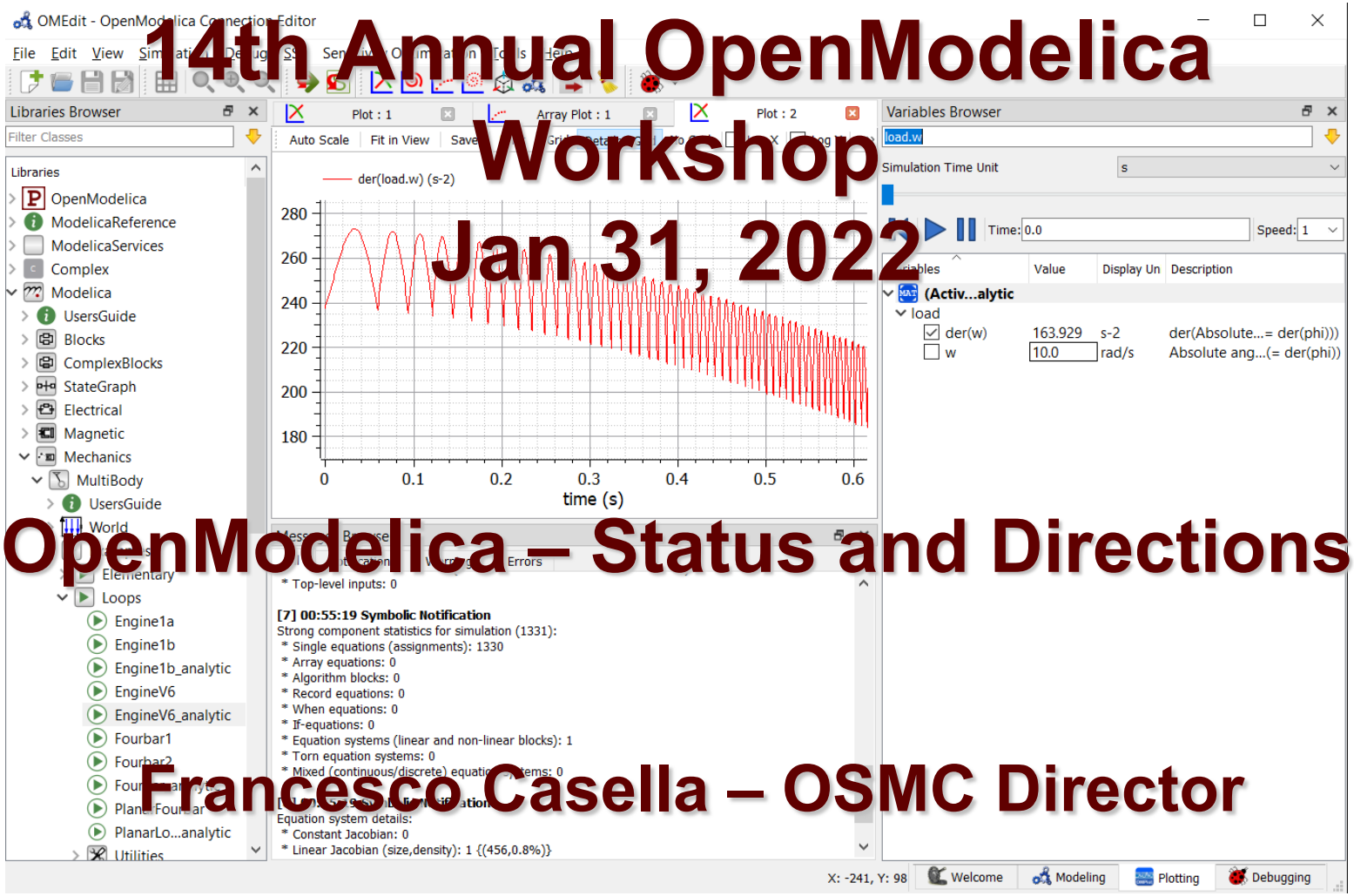
14th Annual OpenModelica Workshop

Jan 31, 2022

OpenModelica – Status and Directions



Francesco Casella – OSMC Director

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
- **Increasing** emphasis on **industrial** usage

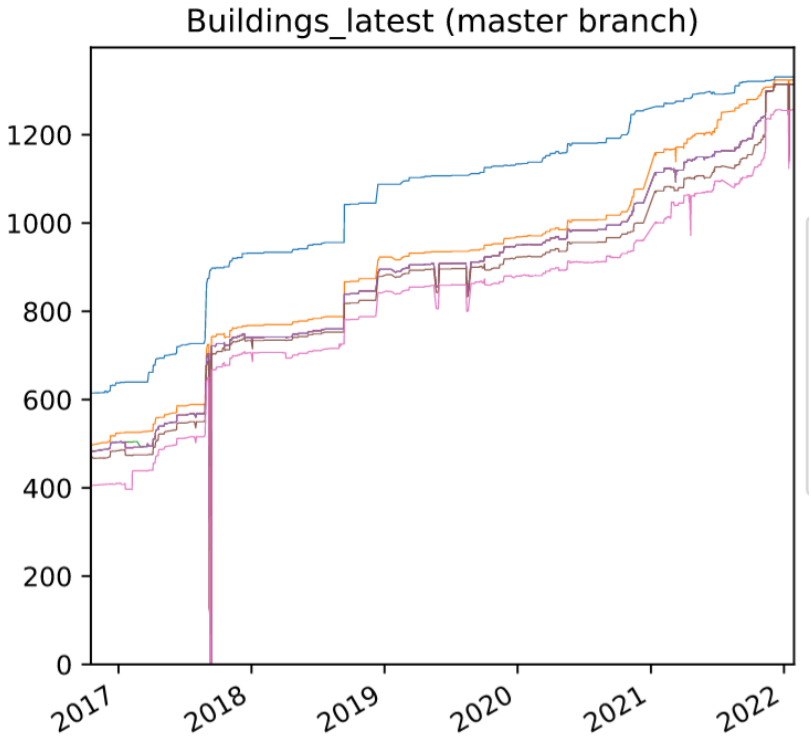
OpenModelica Releases in 2021

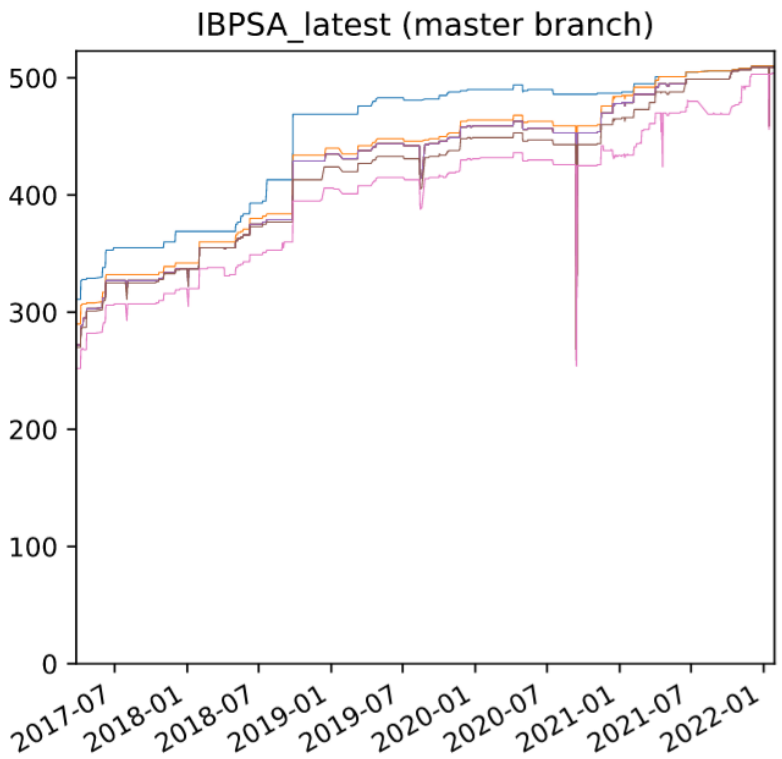
- Version **1.17.0** released 23 March 2021
- Version **1.18.0** released 4 September 2021
- Version **1.18.1** released 23 December 2021

  - ➢ Improvements of tool quality
  - ➢ Improvements of library support and coverage
  - ➢ Improvements of numerical robustness

Collaboration with LBL on Buildings

- Strategic partnership started in 2021 with LBL (US gov't laboratory in Berkeley)
- Goal: provide open-source support for Modelica libraries (Buildings, IBPSA) involved in the Spawn of EnergyPlus project





➢ **Objective for 2021: near 100% simulation success on Buildings 7.0.x**

Collaboration with LBL on Buildings

Buildings_maint.7.0.x

Library version: 7.0.3-maint.7.0.x (36967ce1b5136c4d09aa8d8dd2cd656659697e92)

Branch	Total	Parsing	Frontend	Backend	SimCode	Templates	Compilation	Simulation
v1.12	1180	1180	1008	982	982	982	942	914
v1.13	1180	1180	1008	976	976	976	948	926
v1.14	1180	1180	1008	976	976	976	947	923
v1.16	1180	1180	1008	984	984	984	956	925
v1.17	1180	1180	1096	1059	1059	1059	1039	980
v1.18	1180	1180	1161	1080	1080	1080	1080	1061
master	1180	1180	1180	1172	1172	1172	1172	1128

- Mission accomplished!

Collaboration with LBL on Buildings

- Benefits in general on the performance of OpenModelica on open-source libraries

Branch	Version	Build time	Execution time	# Simulate	# Total
v1.12	OMCompiler v1.12.0-v1.12.0.7+ga21325026	2022-01-29 03:46:20	5 days, 9:07:23	9027	12156
v1.13	OMCompiler v1.13.2	2022-01-29 07:45:05	2 days, 7:58:59	9324	12156
v1.14	OMCompiler v1.14.2-v1.14.2.6+g5c52d52477	2022-01-29 08:25:11	2 days, 11:54:48	9467	12156
v1.16	OMCompiler v1.16.5-v1.16.5.1+g6adae6a043	2022-01-29 09:11:54	2 days, 14:09:34	9282	12156
v1.17	OMCompiler v1.17.0-v1.17.0.10+g03f0da6bf5	2022-01-29 09:56:51	1 day, 21:09:11	9786	12156
v1.18	OMCompiler v1.18.0-v1.18.0.38+ga767f054d8	2022-01-29 10:31:29	1 day, 14:52:21	10475	12156
master	OMCompiler v1.19.0-dev.551+g1772c4b421	2022-01-29 10:34:50	2 days, 4:25:45	10944	12156

Status of New Frontend

- The development of the new OpenModelica frontend, started in 2016, is now nearly complete.
- OMC can now flatten **100%** of the models in the following libraries:

  Buildings (7.0.3), Chemical, ConPNLib, HanserModelica, HelmholtzMedia, IBPSA, MEV, ModelicaByExample, Modelica (3.2.3 & 4.0.0), ModelicaTest, Modelica_DeviceDrivers, OpenHydraulics, OpenIPSL, PNLib, PhotoVoltaics, PhotoVoltaics_TGM, PlanarMechanics, PowerGrids, PowerSysPro, PowerSystems, ScalableTestGrids, ScalableTestSuite, SystemDynamics, ThermoPower, TILMedia, ThermoFluidStream, VehicleInterfaces

- On-going work to fix remaining corner cases on many other libraries
- Conversion script support is now implemented

Improvements to Backend and Code Generation

- **ASSC algorithm** handles non-trivial cases of **index reduction** (e.g. 3-phase AC circuits)
- Improved algorithm to handle **mixed-determined initialization** problems due to index reduction
- Improved and more numerically robust **tearing**
- More efficient handling of **functions returning arrays**
- **spatialDistribution()** operator implemented
- Improved **delay()** implementation
- Improved **homotopy()** implementation
- Improved handling of **synchronous systems** (clocked variables)
- Many bug fixes regarding **code generation with records**
- On-going work on **new backend**, with more rational structure and including array-preserving analysis and code generation

➢ Talk by Karim Abdelhak and Bernhard Bachmann later today

Improvements to Code Compilation and Runtime

- Much improved **C++ runtime** (talk by Rudiger Franke later today)
- **Automatic selection** of linear/nonlinear **sparse solvers** for efficient simulation large algebraic loops
- Fixed memory leak in sparse solver implementation
- Much **faster C compilation** on Windows using **clang** instead of gcc
- Much faster **dynamic library linking** on Windows

Improvements to OMEdit GUI

- **Updated QT libraries** for better and faster rendering
- **More responsive** support when editing and debugging large models
- Support of **Modelica Standard Library 3.2.3** and **4.0.0**
- **Improved plotting** of results (unit prefixed, sign toggling, etc.)
- GUI integration of **data reconciliation** feature from EDF
- Many bugfixes and performance improvements

(upcoming in v. 1.19.0)

- Improved **support of choices** annotations
- Integrated **package manager** for the automatic installation of open-source Modelica libraries
- Integrated support for **conversion scripts** ($\rightarrow$ updating older libraries to MSL 4.0.0)

Experimental OpenModelica Compiler in Julia

- John Tinnerholm's PhD work continues
- Goals
  - Automatically translate MetaModelica frontend into Julia
  - Leverage on large and growing Julia ecosystem for symbolic and numerical handling of equations
  - Fast prototyping of new concepts, e.g. simulation of variable-structure systems

➢ Talk by John Tinnerholm and Adrian Pop later today

Highlights for 2022 OpenModelica Development

- Continue the cooperation with LBL on Buildings
  - Achieve 100% successful simulation of Buildings 7.0.3, 8.0.1 and 9.0.0
  - Assess quality of simulation results and improve simulation performance
- Improve performance of daeMode simulation (sponsored by RTE)
  - Analytic jacobians in daeMode
  - Correct and efficient event-handling in large systems
  - Further optimizations for efficient large system simulations
- Redesigned OMEdit – OMC interface for model editing (sponsored by LBL and Bosch-Rexroth)
  - Based on partial instantiation of models using the new frontend
  - Correct rendering of conditional connectors
  - Menu-based editing of parameters in replaceable models and classes
  - Editing of parameters and replaceable classes in hierarichically stuctured models

Highlights for 2022 OpenModelica Development

- Deploy integrated library management in OMEdit (v. 1.19.0)
  - Package manager linked to database of OSMC-supported libraries
  - Version management and automatic conversion scripts
- Improved support for commercial libraries (Bosch-Rexroth, XRG, TLK-Thermo)
  - Full coverage of libraries for advanced industrial and research applications
  - Deployment of user-friendly encrypted library support
- Enable experimental use of new backend, including support for efficient array-preserving code generation
- Improved support of FMI export and FMI simulation in OMSimulator
- Enable user-friendly parallel simulation of large models (ParModAuto)
- Continue the development of web-based GUIs for lightweight deployment of OpenModelica technology

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.

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, Institute of Thermodynamics, Germany

OSMC 57 Organizational Members, Gen 2022
(initially 7 members, 2007)

Companies and Institutes

- ABB AB, Germany
- Bosch Rexroth AG, Germany
- 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, Germany
- Fraunhofer FCC, Gothenburg, Sweden
- INRIA, Rennes, France
- ISID Dentsu, Tokyo, Japan
- Juelich, FZI, Germany
- LBL Laboratories, Berkeley CA, USA
- Maplesoft, Canada
- Metroscope, Paris, France
- REUSE, Madrid, Spain
- RISE; Sweden
- RTE France, Paris, France
- Saab AB, Linköping, Sweden
- SmartFluidPower, Modena, Italy
- Sozhou Tongyuan, China
- SRON Space Research Institute, Netherlands
- Talent Swarm, Spain
- TLK Thermo, Braunschweig, Germany
- Volvo Cars AB, Sweden
- VTI, Linköping, Sweden
- XRG Simulation GmbH, Hamburg, Germany

Universities

- Augsburg University, Germany
- Australian National Univesity, Australia
- FH Bielefeld, Bielefeld, Germany
- University of Bolivar, Colombia
- TU Braunschweig, Germany
- Chalmers Univ, Control,Sweden
- Chalmers Univ, Machine, Sweden
- TU Darmstadt, Germany
- TU Delft, Netherlands
- TU Dresden, Germany
- Université Laval, Canada
- Georgia Inst. Of Technology, Atlanta, Georgia, USA
- Ghent University, Belgium
- Halmstad University, Sweden
- TU Hamburg/Harburg Germany
- Heidelberg University, Germany
- IIT Bombay, Mumbai, India
- K.L. University, KLEF, Waddeswaram, India
- Linköping University, Sweden
- Univ of Maryland, Syst Eng USA
- Univ of Maryland, CEEE, USA
- Politecnico di Milano, Italy
- Politecnica Catalunya Spain
- Mälardalen University, Sweden
- Univ Pisa, Italy
- RPI, Troy, USA
- Univ SouthEast Norway
- Tsinghua Univ, Beijing, China
- Vanderbilt Univ, Nashville, USA

Organizational Members Update 2021

- New members:
  - Metroscope, Paris, France
  - REUSE, Madrid, Spain
  - XRG Simulation, Hamburg, Germany
  - Volvo Cars, Sweden
  - Australian National University, Australia
  - Lawrence Berkeley National Laboratories, Berkeley CA, USA
- Leaving members:
  - VTT Simulation, Finland

Open Source Modelica Consortium Individual Members (73 individual members)

- 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, Rahul Jain, 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, Sunil Shah, 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 2020

- **Rüdiger Franke**, OSMC Chairman; Manager, ABB AG, Germany
- **Oliver Lenord**, OSMC Vice Chairman; Project manager, Germany
- **Francesco Casella**, OSMC Director; Prof, Politec. di Milano, Italy
- **Peter Fritzson**, OSMC Vice Director; Prof, Linköping Univ, Sweden
- **Juha Kortelainen**, Manager, VTT, Finland
- **Gerhard Schmitz**, Prof, Univ. Hamburg, Germany
- **Adrien Guironnet**, Manager, RTE, France
- **Niklas Worschech**, Techn Specialist, Bosch-Rexroth, Germany.
- **Daniel Bouskela**, Manager, EDF, France
- **Bernhard Bachmann**, Prof, FH Bielefeld, Germany
- Adrian Pop, adjoined to the Board, Tech coordinator, OSMC

OSMC Board – 2 Meetings During 2021

Meeting dates

- 12/05/2021
- 17/12/2021

Board Work

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

Some Supporting Research Projects 2020 (2021)

- PHyMoS - Proper Hybrid Models for Smarter Vehicles. German national project including Bosch, LTX, XRG, TLK, ESI ITI GmbH, Modelon, TU Braunschweig, Universität Augsburg, FH Bielefeld. Starts 2021
- Swedish project LargeDyn, 2019 – 2022
- Swedish project ELLIIT Cloud Tooling for Large-Scale Cyber-Physical System Model-Based Development (one 5-yrs PhD)
- ITEA3 project EMBRACE, 2019-2022
- EU project HUBCAP, 2020-2022

Special Thanks

- The developers who worked very hard during 2021 and modelers who tested and gave important feedback
- The OpenModelica consortium organizational members for support including, in particular ABB, Bosch-Rexroth, EDF, LBL, RTE, XRG Simulation, TLK-Thermo, etc...
- Master students and PhD students who made important contributions.

Conclusions and Summary 2021-2022

- Mar 23, 2021. OpenModelica **1.17.0**
- Sep 4, 2021. OpenModelica **1.18.0**
- Dec 23, 2021. OpenModelica **1.18.1**
- Feb 2022 (planned) OpenModelica **1.19.0**
- Towards a standard **high performance**, **quality, compliant** open source Modelica implementation in Modelica, increased tool support for integrated systems engineering.

- **Expected OpenModelica 1.20.0 and 2.0.0 (?)** in 2022

Questions?

www.openmodelica.org