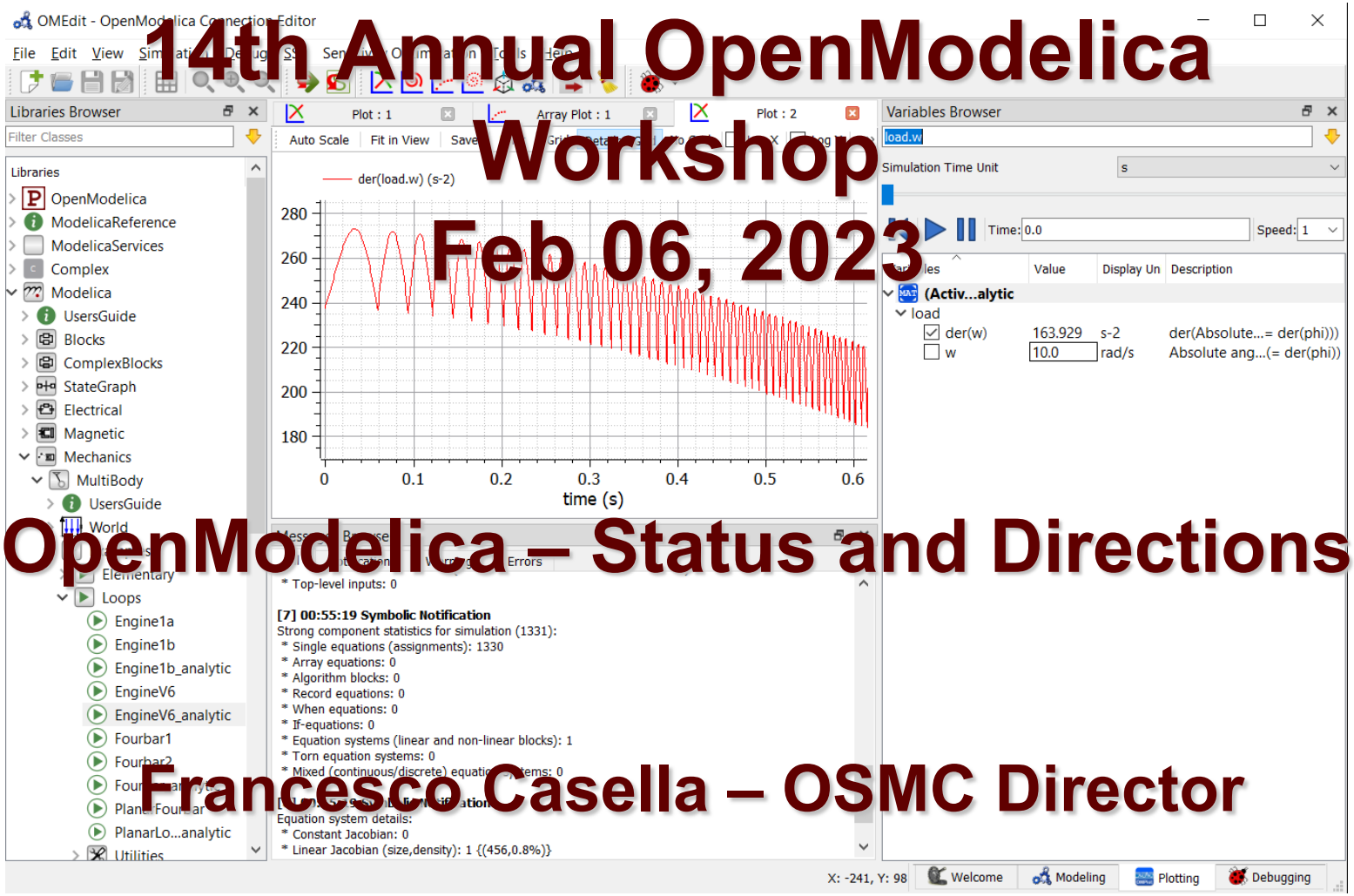
14th Annual OpenModelica Workshop
Feb 06, 2023



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

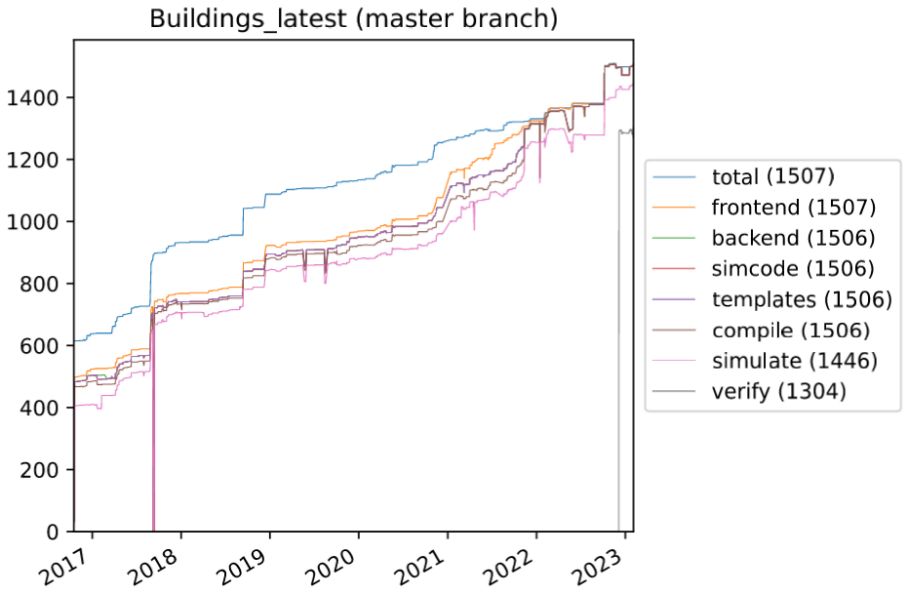
OpenModelica Releases in 2022

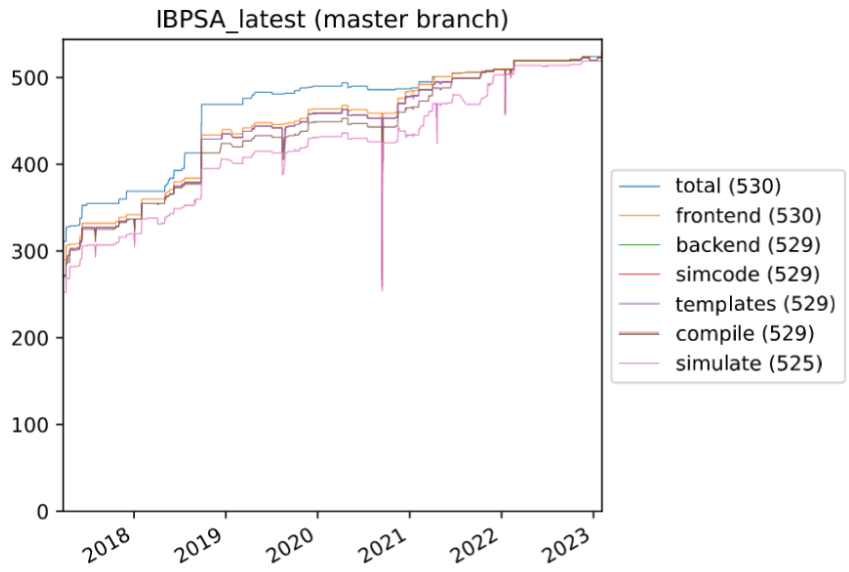
- Version **1.19.0** released 1 June 2022
- Version **1.19.2** released 4 September 2022
- Version **1.20.0** released 7 December 2022

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

Continuing 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 Energy Plus project





- **100% Build success on Buildings and IBPSA**
- **96% Simulation success on Buildings, 99% on IBPSA**

Collaboration with LBL on Buildings

Buildings_latest

Version 10.0.0-master (4d6bed94dacac6b95c388d4dac2bf18aa1ce90ea)

Branch	Total	Parsing	Frontend	Backend	SimCode	Templates	Compilation	Simulation	Verification
v1.12	1502	1502	1280	1232	1232	1232	1189	1167	1050
v1.13	1502	1502	1278	1225	1225	1225	1191	1172	1056
v1.14	1502	1502	1278	1227	1227	1227	1191	1167	1052
v1.16	1503	1503	1279	1234	1234	1234	1199	1167	1047
v1.17	1503	1503	1376	1326	1326	1326	1294	1239	1105
v1.18	1503	1503	1468	1349	1349	1349	1346	1321	1190
v1.19	1507	1507	1507	1498	1498	1498	1498	1435	1290
v1.20	1507	1507	1505	1504	1504	1504	1504	1432	1288
master	1507	1507	1507	1506	1506	1506	1506	1446	1304

- Continuous improvement!

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	2023-01-28 02:12:56	4 days, 13:57:12	10519	15056
v1.13	OMCompiler v1.13.2	2023-01-28 04:03:05	2 days, 12:15:32	10702	15056
v1.14	OMCompiler v1.14.2-v1.14.2.6+g5c52d52477	2023-01-28 05:20:09	2 days, 15:41:35	10858	15056
v1.16	OMCompiler v1.16.5-v1.16.5.1+g6adae6a043	2023-01-28 06:47:29	2 days, 13:51:33	10714	15057
v1.17	OMCompiler v1.17.0-v1.17.0.10+g03f0da6bf5	2023-01-28 08:22:28	2 days, 0:02:55	11394	15057
v1.18	OMCompiler v1.18.0-v1.18.0.38+ga767f054d8	2023-01-28 09:16:41	2 days, 1:45:20	12125	15057
v1.19	OMCompiler v1.19.2-v1.19.2.2+g9baf633d57	2023-02-03 11:12:45	2 days, 23:55:44	13104	15055
v1.20	OMCompiler v1.20.0-v1.20.0.1+g2faf7aa0ea	2023-02-03 12:28:30	2 days, 17:34:48	13088	15055
master	OMCompiler v1.21.0-dev.229+g4bf6782c8c	2023-02-03 13:50:05	2 days, 17:43:53	13151	15067

Status of New Frontend

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

  Buildings, Chemical, ClaRa, 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

- Flat Modelica output (standardization process on-going)
- Array-preserving Flat Modelica output
- Over 50 bug fixes
- On-going work: using the new front-end for faster and more complete support of GUI features via instance-based interface
  (talk later today)

Improvements to Backend and Code Generation

- On-going work on **new backend**, with more rational structure and including array-preserving analysis and code generation
- 20+ bug fixes in the old backend, although development mostly on the new backend now
- Several bug fixes and efficiency improvement in the code generation. ExternalMedia is now supported by OMC

➢ Talk on new backend later today

Improvements to Runtime

- New gbode solver by Bernhard Bachmann
  - Provides many single-step integration algorithms: Euler, Heun, Dopri, Gauss, Fehlberg, Radau, Dirk, Esdirk, Lobatto, Merson, Ssc
  - Replaces all obsolete solvers other than dassl and ida
  - All methods available fixed- and variable-time-step with error control (some with dense output), and event detection
  - Experimental adaptive multi-rate (bi-rate) integration
  - Currently available via simulation flags, will be integrated in the GUI in future versions
- Improved configuration of runtime and external libraries on Windows
- Improved CSV file input for top-level model inputs
- 25+ runtime bug fixes

➢ Talk on gbode solver later today

Improvements to OMEdit GUI

- Fully **integrated package manager** for the automatic installation of open-source Modelica libraries available online
- Automatic **off-line installation of MSL** for use behind firewalls, integrated with package manager
- Fully **integrated conversion script** support
- Improved **dynamicSelect** annotation support
- Automatic choice of **unit prefixes** for result **plots**
- **60+** bug fixes

- On-going work on new instance-based API to overcome old limitations and issues, e.g., conditional connectors, parameter-depending dialog annotations, parameter editing in replaceable classes and components
- Experimentally available by running OMEdit --NAPI = true

OSMC Plan of Operations for 2023 (1 of 2)

- Further increased library coverage, performance, and quality with special focus on the Buildings library in collaboration with LBL
  - Achieve 100% successful simulation of Buildings 8.1.x and 9.1.x
  - Improve FMI export reliability on Buildings models
  - Assess quality of simulation results and improve simulation performance
  - Resolve remaining issues with the GUI (conditional connectors, etc.)
- New Backend enabling fast compilation of large-scale power system models & other large models (significant support by RTE)
  - Use and development of New Backend
  - Fast code generation with array-preserving methods
  - Improve efficiency of event-handling
- Redesigned & enhanced OMEdit – OMC interface for model editing (significant support by LBL and Bosch-Rexroth)
  - Most of the work done in 2022
  - Finalize and make it available in a new release
  - Enable hierarchical model editing
  - Proper support of parameter-depending conditional connectors and dialogs, and replaceable classes in parameter editing

OSMC Plan of Operations for 2023 (2 of 2)

- Improved support for commercial libraries
  (Including libraries from Bosch-Rexroth, XRG, TLK-Thermo, EDF,etc.)
  - Full coverage of libraries for advanced industrial and research applications
  - Deployment of user-friendly encrypted library support
- Improved support of FMI export in OMC and FMI simulation in OMSimulator and OMC
- Enable user-friendly parallel simulation of large models (ParModAuto)
- Continue the development of web-based GUIs for lightweight deployment of OpenModelica technology
- Continue work on the Julia-based OMC implementation
- Implement model duplication functionality
- Migrate state machines and MetaModelica support to NF
- Two releases: 1.21 (middle of 2023), and 1.22 (or 2.0) end of 2023

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 56 Organizational Members, Jan 2023
(initially 7 members, 2007)

Companies and Institutes

- ABB AB, Germany
- Bosch Rexroth AG, Germany
- 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
- JSOL Corporation, Japan
- Juelich Forschungszentrum, Germany
- Maplesoft, Canada
- Metroscope, Paris, France
- Modelicon LLB, Bangalore, India
- Perpetual Labs, London, UK
- REUSE, Madrid, Spain
- RTE France, Paris, France
- Saab AB, Linköping, Sweden
- Shanghai Duanyan Information Techn., China
- SmartFluidPower, Modena, Italy
- SRON Institute, The Netherlands
- Suzhou Tongyuan, China
- 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 University, Australia
- FH Bielefeld, Bielefeld, Germany
- University of Bolivar, Colombia
- University of Buenos Aires, Discrete Sim. Lab, Argentina
- TU Braunschweig, Germany
- Univ Catalunya, Spain
- Chalmers Univ, Control,Sweden
- Chalmers Univ, Machine, Sweden
- TU Darmstadt, Germany
- TU Delft, Netherlands
- TU Dresden, Germany
- Université Laval, Canada
- TU Hamburg/Harburg Germany
- IIT Bombay, Mumbai, India
- K.U. Leuven, Belgium
- Univ Linnaeus, Sweden
- 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
- Rennslaer Polytechnic Institute, Troy, USA
- Univ SouthEast Norway
- Vanderbilt Univ, Nashville, USA

Organizational Members Update 2022

- New members:
  - Modelicon LLP, Bangalore, India
  - JSOL Company, Japan
  - KU Leuven, Leuven, Belgium
  - Shanghai Duanyan Information Technology Co., Ltd, China
  - Perpetual Labs, London, UK

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 2022

- **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 – 3 Meetings During 2022

Meeting dates

- 04/04/2022
- 16/09/2022
- 15/11/2022

Board Work

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

Santa Anna IT Research Institute

- Santa Anna IT Research Institute is 100% owned by OSMC. Created 2021, initiative by Peter Fritzson, approved by OSMC Board

- Motivation
  - Be able to apply for 100% funding in research projects as a research institute
  - Have a wider scope than OSMC which is focused on OpenModelica and FMI
  - Potential for a stronger economy because wider scope, e.g. including AI, etc.
  - Be a low-overhead organization that can employ OpenModelica developers

- Leadership: Peter Fritzson CEO from start. Niclas Fock vice CEO. From March planned: Niclas Fock CEO and Peter Fritzson vice CEO. (There was previously a similar institute, but it was taken over by RISE and decommissioned)

- *Registration document: Santa Anna is a research institute with primary goal of performing basic research, applied research, or experimental developments related to information technology and related areas. The institute shall disseminate its results through teaching, publications or technology transfer. If there is profit created from the institute operation this shall not be given as a dividend to the shareholders, instead it should be used within the institute for competence development, investments in new technology, acquisition of efficiency enhancing work aids or in some other way be used to strengthen the institutes resources. The institute should strive for collaboration with nearby universities as well as international collaboration*

Some Supporting Research Projects 2022

- 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. Started 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, 2019-2023
- EU project HUBCAP, 2020-2022

Special Thanks

- The developers who worked very hard during 2022 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.
- Online contributors to the code base that we never had a chance to meet in real life.

Conclusions and Summary 2022

- Jun 1, 2022. OpenModelica **1.19.0**
- Sep 4, 2022. OpenModelica **1.19.2**
- Dec 7, 2022. OpenModelica **1.20.0**
- Towards a standard **high performance**, **quality, compliant** open source Modelica implementation in Modelica, increased tool support for integrated systems engineering.

- **Expected OpenModelica 1.21.0 and 2.0.0 (?)** in 2023

Questions?

www.openmodelica.org