The OpenModelica New Front-End: a Quantum Leap from a User's Perspective

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OpenModelica

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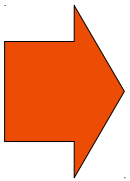
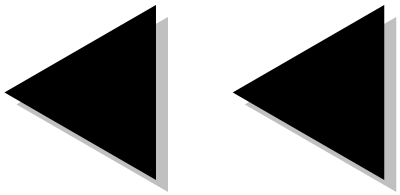


This talk:
status and impact on end-users

4 Feb 2019



5 Feb 2018

Q10: Most wanted or missing features

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The new Front-End Fast handling of models using Modelica.Media Support of replaceable classes and models

Improve source code generation for embedded targets, specially that state machines will be supported.

1) improving of efficiency of front-end and back-end processes, especially for models which involves complex libraries like Modelica.Media, or for very large models, like power transmissions grids. 2) management of replaceable models, 3) recursively exploring of instances of a model in order to change parameters, 4) to adopt a text-editor policy which allow to save a model or to switch to another model without checking of the current model, to make possible the saving of our work also if it is in an intermediate status (which can still contain errors) 5) improving of omc error messages, for example: - omc should returns the equations involved in found algebraic loops - omc should give indication about the redundant equations in case of structural singularity of the initialization system (like Dymola does) - the possibility to hide the errors which gives information to the developers but it is not relevant for the users (like scripting errors) - the warning messages should not be shown in the same colour (red) of the errors

Web-based interface for server deployment; database integration; I/O libraries.

Support for commercial (encrypted) Modelica libraries. Both full flattening and full simulation coverage of the MSL and the most important additional libraries.

Still problems to run large models with high speed

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- Full support of stream variables (ticket 4441) - Full support of libraries using inner/outer and record dependencies (ticket 4442)

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A better support of complex numbers. No need to specify what features in detail, since there exist several specific tickets on the trac about this.

Should be able to do sequential modular (SM) simulation. At present, we have only the equation oriented approach. The SM approach will help establish initial conditions for difficult problems. It will also help carry out startup and shutdown simulations.

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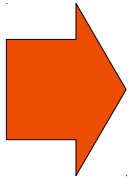
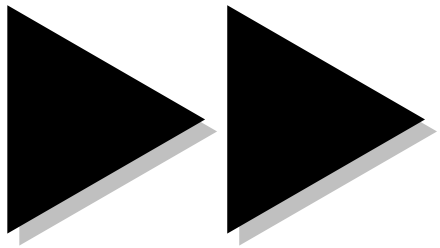


New front-end!



4 Feb 2019

Summary of New Frontend Features

- Redesigned from scratch (with several iterations in the first phases)
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- Each phase is applied to entire model, instead of fully flattening one object at a time
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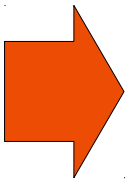
Impact

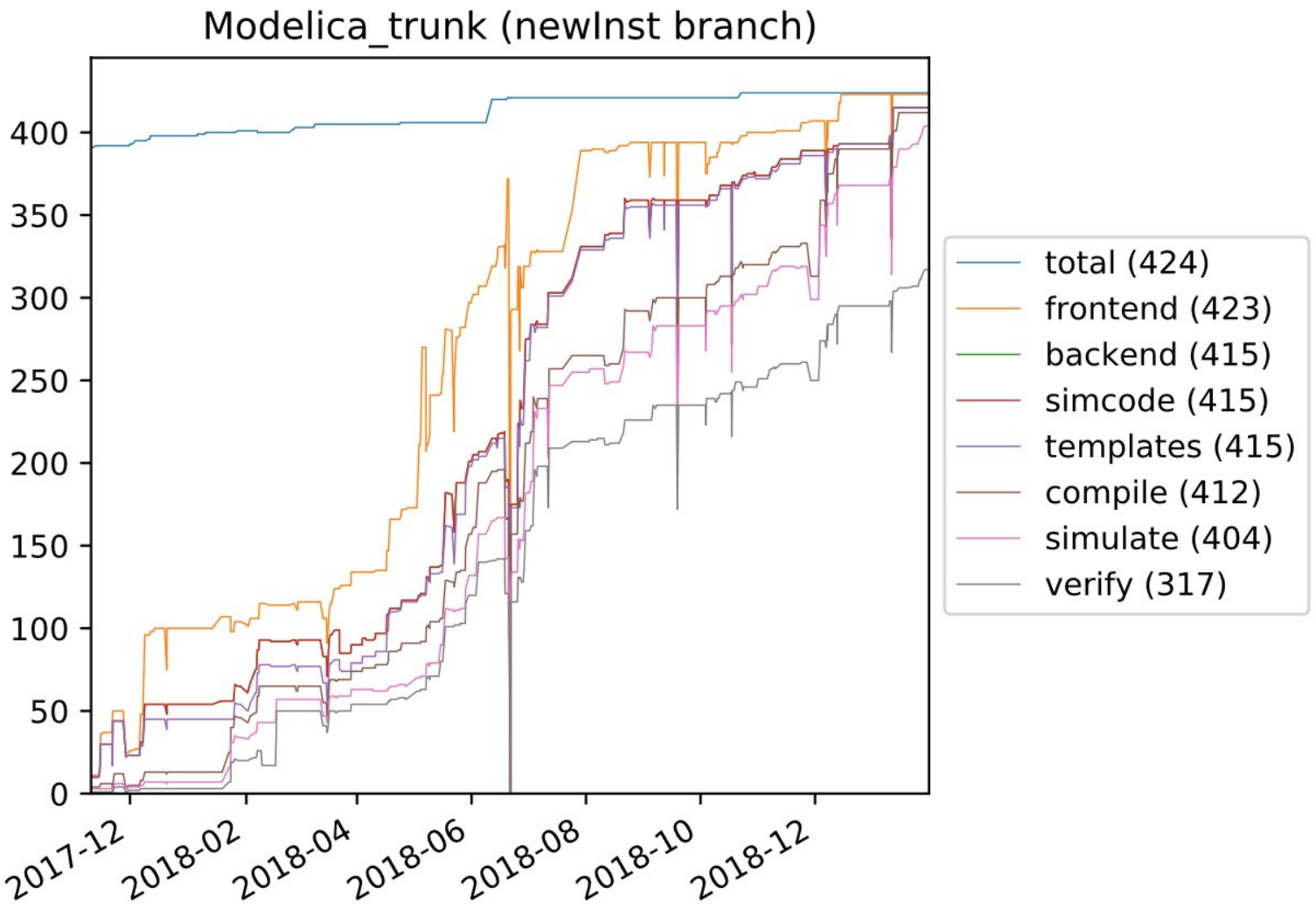
- Much easier to solve coverage issues that were hard to tackle in old FE
- Much faster compilation of models (esp. Media/Fluid)
- Much faster response of API used by OMEdit for graphical rendering



Addresses many user requests!

Current Status

Coverage of MSL 3.2.3



Current Status

Coverage of Other Selected Libraries

Library	*Simulate*	*Verify*
PlanarMechanics	100%	100%
PNLib	99%	99%
ScalableTestSuite	100%	100%
PowerGrids	100%	100%
OpenIPSL	92%	
ModelicaTest	89%	
ThermoPower	76%	
PowerSystems	69%	
Buildings	65%	

Project Management

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  - Other minor non-conformities to the Modelica specification
- Interesting side question: are Modelica tools accepting non-Modelica code good, questionable, or evil?

Old Frontend Problems Solved: Some Examples

- Incorrect handling of mass fractions in Modelica.Media mixture models
  - Historic bug: ticket #2858, 4 years old
  - Gave incorrect results with mixture gases in some cases
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- Issues with Complex Variables
  - Eight issues with the old frontend were identified when handling Complex variables, collected in ticket #4835
  - Five already solved in the new frontend so far

Remaining Open Issues

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  - Example 2: missing array expansion breaks derivative annotation (#5298)
  - Example 3: missing evaluation in MultiBody model (#5301)
- It takes some time to identify the root cause of each failure,
  but usually a short time to fix the issue once it has been pinned down
- On average, we expect a few issues per week to be fixed,
  based on estimated effort and on past performance in 2018

Live Demo: Flattening

Performance Comparison

- Examples of large-scale models from the ScalableTestSuite
- Comparison between Dymola, OMC new frontend, OMC current frontend

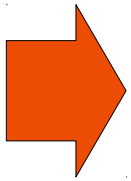
No	Model	Equations	Dym (s)	OMC NF/CF (s)
1	Electrical.DSystemAC.SE.DistributionSystemLinear_N_40_M_40	99776	15.53	06.32 / 91.33
2	Electrical.DSystemAC.SE.DistributionSystemLinear_N_80_M_80	397936	40.50	17.76 / 435.32
3	Electrical.DSystemAC.SE.DistributionSystemLinear_N_112_M_112	779312	74.21	32.31 / 1076.54
4	Electrical.DSystemDC.SE.DistributionSystemModelicaActiveLoads_N_80_M_80	129929	18.04	08.33 / 159.28
5	Electrical.TransmissionLine.SE.TransmissionLineModelica_N_1280	26915	09.84	04.45 / 47.77
6	Elementary.ParameterArrays.SE.Table_N_100_M_100	0	06.59	05.09 / 06.21
7	Elementary.ParameterArrays.SE.Table_N_400_M_400	0	10.25	12.19 / 18.03
8	Elementary.ParameterArrays.SE.Table_N_1600_M_100	0	09.77	19.04 / 28.17
9	Power.ConceptualPowerSystem.SE.PowerSystemStepLoad_N_64_M_16	11907	17.29	03.99 / 28.57
10	Vectorized.SolarSystem(n=10000) from section 4	60001	146.30	34.12 / 314.8 **(02.95)**
11	Vectorized.SolarSystem(n=100000) from section 4	600001	14458.68	2450.57 / 19760.42 **(02.95)**

- Media/Fluid examples

Model	*New Frontend*	*Current Frontend*
Modelica.Fluid.Examples.AST_BatchPlant.BatchPlant_StandardWater	2.38	27.47
Modelica.Fluid.Examples.HeatExchanger.HeatExchangerSimulation	1.51	20.28
ThermoPower.Examples.RankineCycle.Simulators.ClosedLoop	1.44	20.24
ThermoPower.Examples.HRB.Simulators.OpenLoopSimulatorSimplified	1.24	18.07
Modelica.Media.Examples.ReferenceAir.MoistAir1	0.64	19.81

New API for OMC-OMEdit interaction

- Many requests for a faster, more responsive OMEdit GUI
  - Opening models is slow
  - Dragging and dropping components is slow
  - Moving components around is slow



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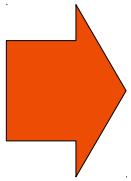

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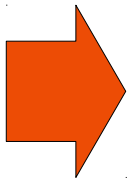
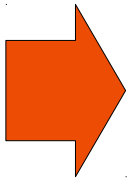
- OMEdit gets all the information (particularly graphical annotations) from the frontend, via a suitable API
- Some functions (e.g. getComponentAnnotations()) are very slow, because they rely on the slow current frontend
- A new API is currently being developed, based on the new Frontend



Faster Frontend → Faster OMEdit

Other Features of the OMEdit Benefitting from NF

- Handling of replaceable classes and components with drop-down menus showing compatible classes
- Dynamic update of parameter display attributes based on parameter values
- Dynamic update of conditional connectors in components based on parameter values
- Inspection and modification of parameters and replaceable classes/components in sub-models (a.k. “Show Component” in Dymola)



Faster Frontend → Implementation possible

Other Features of the OMEdit Benefitting from NF

- Handling of replaceable classes and components with drop-down menus showing compatible classes
- Dynamic update of parameter display attributes based on parameter values
- Dynamic update of conditional connectors in components based on parameter values
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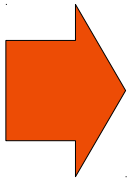

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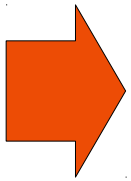

On-going development
Still some unresolved issues

Live Demo: OMEdit with new API

Future Plans

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- - Vectorized back-end
  - NF allows to keep arrays (-d=-nfScalarize).
  - Experimental work by R. Franke to exploit in the backend
  - Code generation time and size: from O(N) to O(1),
  - Much faster runtime (no cache misses due to large exec code)
  - Conceptual and theoretical problems still open
    e.g. how to causalize arrays with non-symmetric equation structure
  - Research project proposal submitted by FH Biele
  - 2 ITN Marie Curie PhD proposal submitted by Polimi

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- Vastly improved performance, on average 20x
  - Faster model compilation
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- Ready for high-efficiency vectorized handling of large-scale models
- Work almost finished, roll-out in the next few months
  - Version 1.14.0, new API, new FE optional
  - Version 2.0.0, new FE default

Thank you for your kind attention!