Technical Overview of OpenModelica and its Development Environment

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2015-02-02

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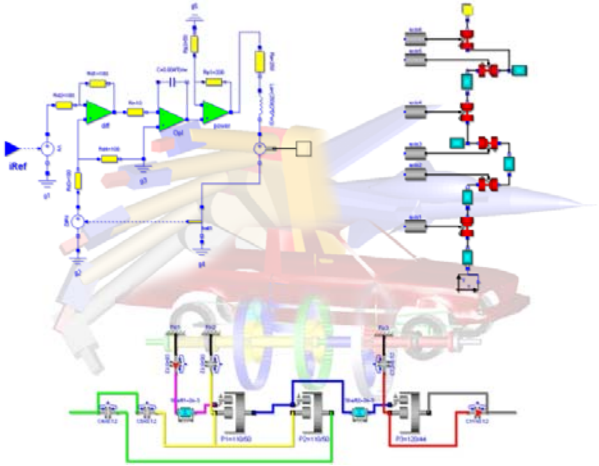
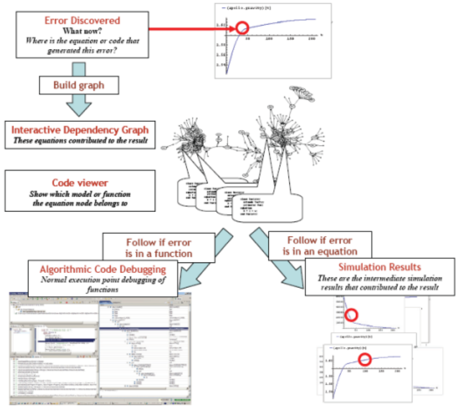
www.OpenModelica.org





Error Discovered
What now?
Where is the equation or code that generated this error?

Build graph

Interactive Dependency Graph
These equations contributed to the result

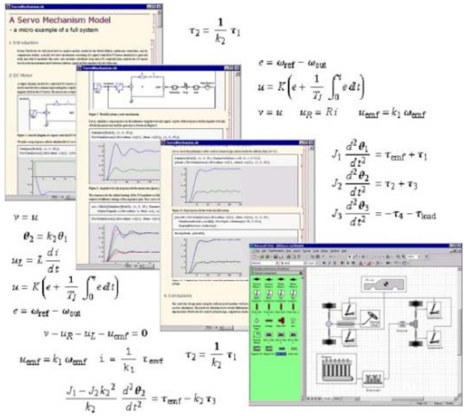
Code viewer
Show which model or function the equation node belongs to

Follow if error is in a function

Algorithmic Code Debugging
Normal execution point debugging of functions

Follow if error is in an equation

Simulation Results
These are the intermediate simulation results that contributed to the result



Outline

- OpenModelica
  - What is OpenModelica?
  - The past
- OpenModelica Technical Overview
  - OMC, OMShell, OMNotebook,
  - OMEdit, ModelicaML, SimForge
- OpenModelica Development Environment
  - MetaModelica (RML/OMC)
  - The Eclipse Environment (MDT)
- OpenModelica Latest Developments (2014-2015)

What is OpenModelica? (0)

OpenModelica is ... ***<u>its developers, testers, bug reporters, contributors</u>***

Thank you!

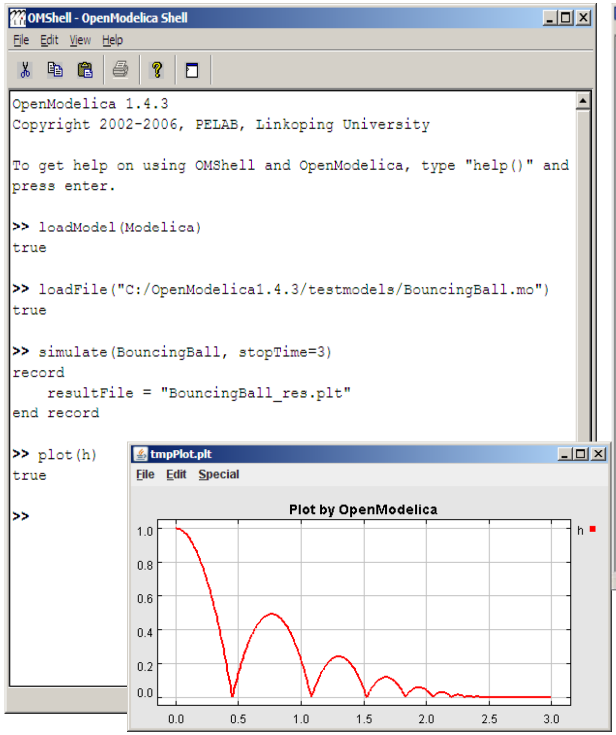
asodja, sjoelund.se, sebco011, lochel, wbraun, niklwors, hubert.thieriot, petar, perost, Frenkel TUD, Unknown, syeas460, adeas31, ppriv, ricli576, haklu, dietmarw, levsa, mahge930, x05andfe, mohsen, nutaro, x02lucpo, florosx, x06hener, x07simbj, stebr461, x08joekl, x08kimja, Dongliang Li, jhare950, x97davka, krsta, edgarlopez, hanke, henjo, wuzhu.chen, fbergero, harka011, tmtuomas, bjozac, AlexeyLebedev, x06klasj, ankar, kajny, vasaie_p, niemisto, donida, hkiel, davbr, otto@mathcore.com, Kaie Kubjas, x06krino, afshe, x06mikbl, leonardo.laguna, petfr, dhedberg, g-karbe, x06henma, abhinnk, azazi, x02danhe, rruusu, x98petro, mater, g-bjoza, x02kajny, g-pavgr, x05andre, vaden, jansilar, ericmeyers, x05simel, andsa, leist, choeger, Ariel.Liebman, frisk, vaurich, mwalther, mtiller, ptauber, casella, vitalij, hkiel, janK, adrpo

<u>Developers (96)</u>

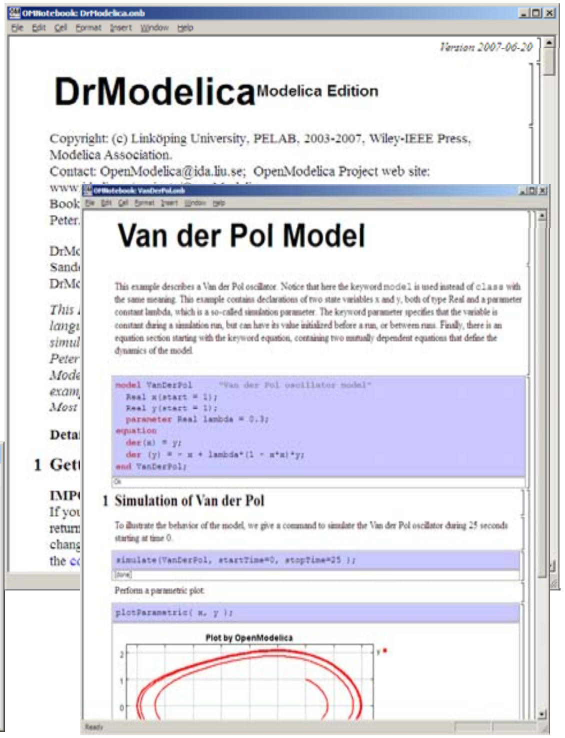
Martin
Per
Adeel
Jens
Willi
Lennart
Alexey
Mahder
Olena
Mohsen
Kristian
Hubert
Niklas
Kaie
Kiel
Peter *
Leonardo
Filippo
Xenofon
Frederico
Edgar
Kaj
Levon
Stefan
Rickard
Bjorn
David
Otto
Eric
...
Adrian

What is OpenModelica? (I)

- Advanced Interactive Modelica compiler (OMC)
  - Supports MLS v. 3.1/MSL v. 3.2.1/MSL trunk
- Basic and advanced environments for creating models
  - OMShell – an interactive command handler
  - OMNotebook – a literate programming notebook
  - OMEdit – OpenModelica Connection Editor
  - OMPlot – OpenModelica Plotting
  - OMOptim – OpenModelica Optimization Editor
  - OMPython – OpenModelica Python Environment
  - MDT – an advanced textual environment in Eclipse



```
OpenModelica 1.4.3
Copyright 2002-2006, PELAB, Linkoping University

To get help on using OMShell and OpenModelica, type "help()" and
press enter.

>> loadModel(Modelica)
true

>> loadFile("C:/OpenModelica1.4.3/testmodels/BouncingBall.mo")
true

>> simulate(BouncingBall, stopTime=3)
record
    resultFile = "BouncingBall_res.plt"
end record

>> plot(h)
true

>>
```


OMNotebook: DrModelica.onb
File Edit Cell Format Insert Window Help
OMNotebook: VanDerPol.onb
File Edit Cell Format Insert Window Help
Ready
Plot by OpenModelica
y
2
1
0

Version 2007-06-20

DrModelica Modelica Edition

Copyright: (c) Linköping University, PELAB, 2003-2007, Wiley-IEEE Press, Modelica Association.
Contact: OpenModelica@ida.liu.se; OpenModelica Project web site:
www
Book
Peter.

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Van der Pol Model

This example describes a Van der Pol oscillator. Notice that here the keyword `model` is used instead of `class` with the same meaning. This example contains declarations of two state variables x and y, both of type Real and a parameter constant lambda, which is a so-called simulation parameter. The keyword parameter specifies that the variable is constant during a simulation run, but can have its value initialized before a run, or between runs. Finally, there is an equation section starting with the keyword equation, containing two mutually dependent equations that define the dynamics of the model.

```
model VanDerPol     "Van der Pol oscillator model"
  Real x(start = 1);
  Real y(start = 1);
  parameter Real lambda = 0.3;
equation
  der(x) = y;
  der (y) = - x + lambda*(1 - x*x)*y;
end VanDerPol;
```

Ok

1 Simulation of Van der Pol

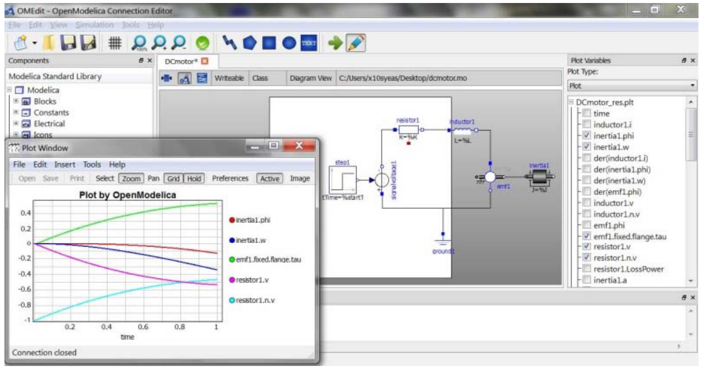
To illustrate the behavior of the model, we give a command to simulate the Van der Pol oscillator during 25 seconds starting at time 0.

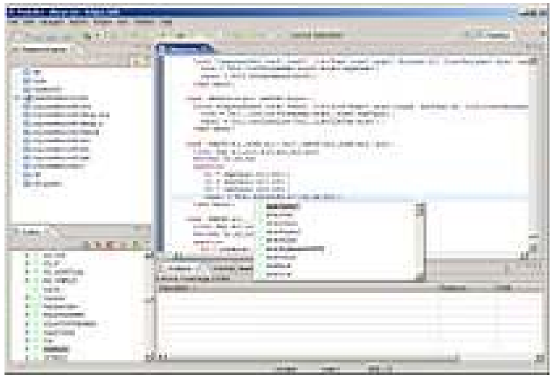
```
simulate(VanDerPol, startTime=0, stopTime=25 );
```

[done]

Perform a parametric plot.

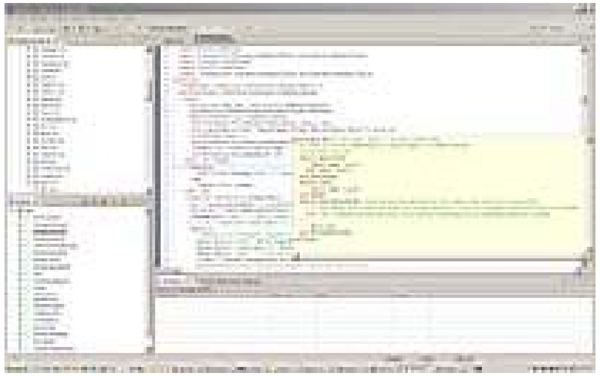
```
plotParametric( x, y );
```

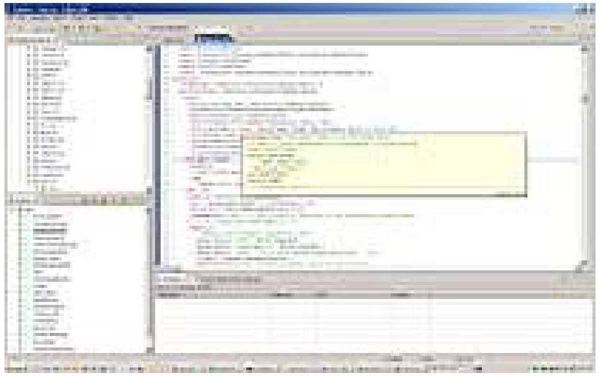


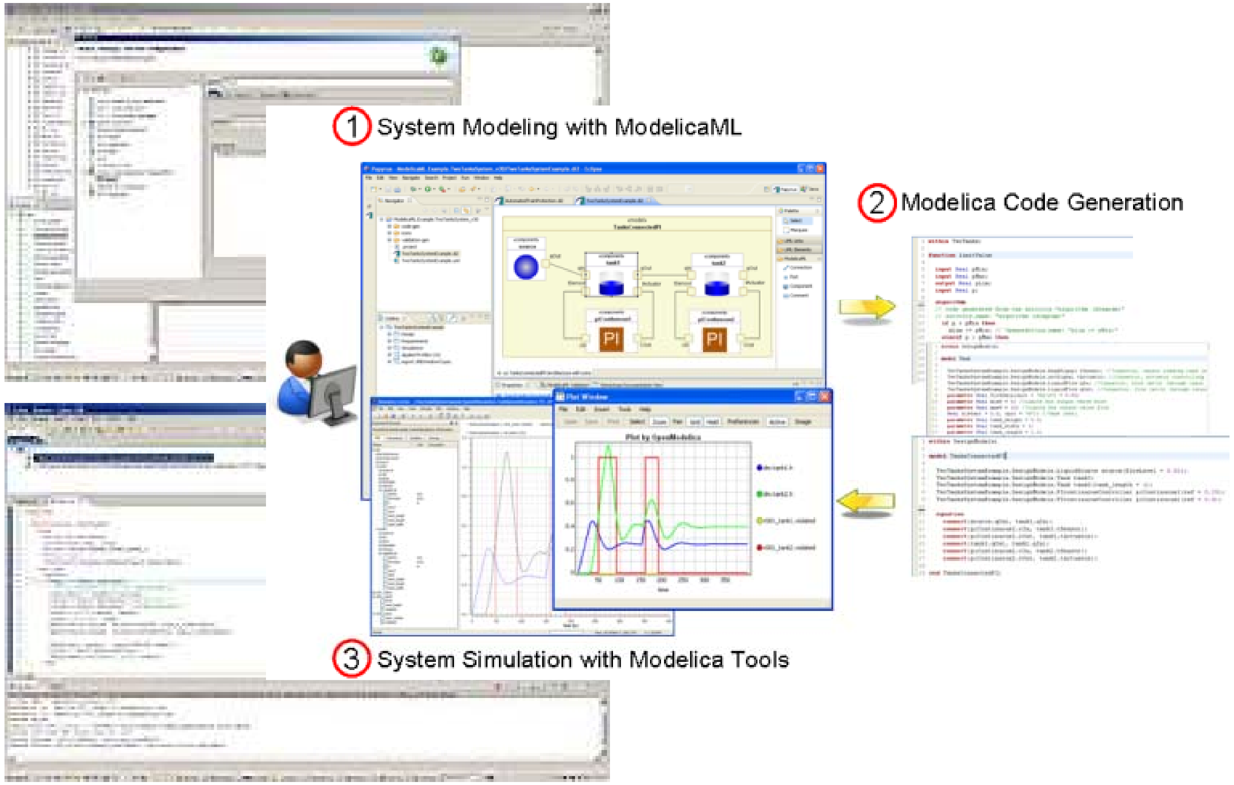


What Is OpenModelica? (II)

- **Advanced Eclipse-based Development Environment**
- **Modelica Development Tooling (MDT) - started in 2005**
    - Code Assistance, Debugging, Outline & a lot more
    - *Used heavily for OpenModelica development*
    - Used in many OpenModelica Development Courses
- **ModelicaML UML/SysML integration**







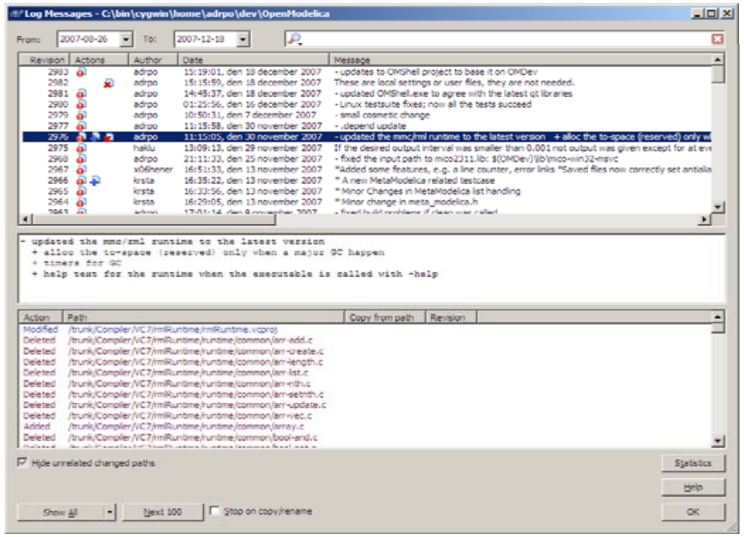
1 System Modeling with ModelicaML

2 Modelica Code Generation

3 System Simulation with Modelica Tools

What is OpenModelica? (III)

- Open-source community services
  - Website and Support Forum
  - Version-controlled source base
  - Trac with bug database
  - Development courses
  - Mailing lists



Log Messages - C:\bin\cygwin\home\adrpo\dev\OpenModelica

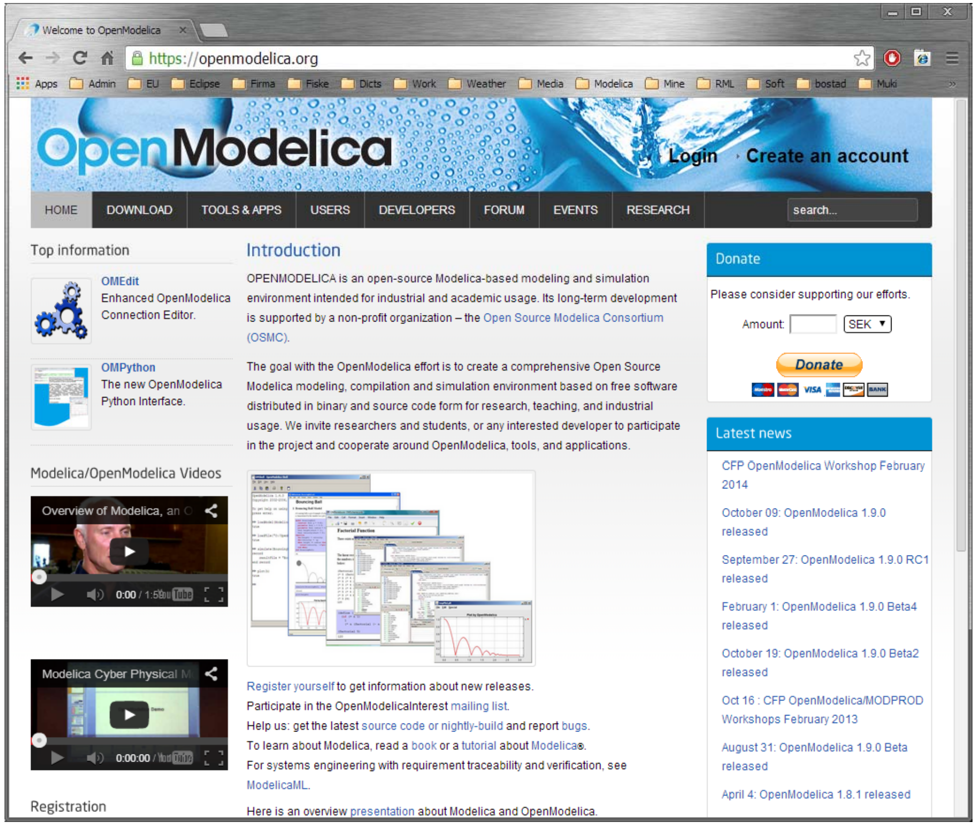
From: 2007-08-26 To: 2007-12-18

Revision	Actions	Author	Date	Message
2983		adrpo	15:19:01, den 18 december 2007	- updates to OMShell project to base it on OMDev
2982		adrpo	15:15:59, den 18 december 2007	These are local settings or user files, they are not needed.
2981		adrpo	14:45:37, den 18 december 2007	- updated OMShell.exe to agree with the latest qt libraries
2980		adrpo	01:25:56, den 16 december 2007	- Linux testsuite fixes; now all the tests succeed
2979		adrpo	10:50:31, den 7 december 2007	- small cosmetic change
2977		adrpo	11:15:58, den 30 november 2007	- .depend update
2976		adrpo	11:15:05, den 30 november 2007	- updated the mmc/rml runtime to the latest version + alloc the to-space (reserved) only wi
2975		haklu	13:09:13, den 29 november 2007	If the desired output interval was smaller than 0.001 not output was given except for at ev
2968		adrpo	21:11:33, den 25 november 2007	- fixed the input path to mico2311.lib: $(OMDev)\lib\mico-win32-msvc
2967		x06hener	16:51:33, den 13 november 2007	*Added some features, e.g. a line counter, error links *Saved files now correctly set antiala
2966		krsta	16:35:22, den 13 november 2007	* A new MetaModelica related testcase
2965		krsta	16:33:56, den 13 november 2007	* Minor Changes in MetaModelica list handling
2964		krsta	16:29:05, den 13 november 2007	* Minor change in meta_modelica.h
2963		adrpo	17:01:14, den 9 november 2007	- fixed build problems if clean was called

```
- updated the mmc/rml runtime to the latest version
  + alloc the to-space (reserved) only when a major GC happen
  + timers for GC
  + help text for the runtime when the executable is called with -help
```

Action	Path	Copy from path	Revision
Modified	/trunk/Compiler/VC7/rmlRuntime/rmlRuntime.vcproj		
Deleted	/trunk/Compiler/VC7/rmlRuntime/runtime/common/arr-add.c		
Deleted	/trunk/Compiler/VC7/rmlRuntime/runtime/common/arr-create.c		
Deleted	/trunk/Compiler/VC7/rmlRuntime/runtime/common/arr-length.c		
Deleted	/trunk/Compiler/VC7/rmlRuntime/runtime/common/arr-list.c		
Deleted	/trunk/Compiler/VC7/rmlRuntime/runtime/common/arr-nth.c		
Deleted	/trunk/Compiler/VC7/rmlRuntime/runtime/common/arr-setnth.c		
Deleted	/trunk/Compiler/VC7/rmlRuntime/runtime/common/arr-update.c		
Deleted	/trunk/Compiler/VC7/rmlRuntime/runtime/common/arr-vec.c		
Added	/trunk/Compiler/VC7/rmlRuntime/runtime/common/array.c		
Deleted	/trunk/Compiler/VC7/rmlRuntime/runtime/common/bool-and.c		

☑ Hide unrelated changed paths



Top information

OMEdit
Enhanced OpenModelica Connection Editor.

OMPython
The new OpenModelica Python Interface.

Modelica/OpenModelica Videos

Registration

Introduction

OPENMODELICA is an open-source Modelica-based modeling and simulation environment intended for industrial and academic usage. Its long-term development is supported by a non-profit organization – the Open Source Modelica Consortium (OSMC).

The goal with the OpenModelica effort is to create a comprehensive Open Source Modelica modeling, compilation and simulation environment based on free software distributed in binary and source code form for research, teaching, and industrial usage. We invite researchers and students, or any interested developer to participate in the project and cooperate around OpenModelica, tools, and applications.

Register yourself to get information about new releases.
Participate in the OpenModelicaInterest mailing list.
Help us: get the latest source code or nightly-build and report bugs.
To learn about Modelica, read a book or a tutorial about Modelica®.
For systems engineering with requirement traceability and verification, see ModelicaML.

Here is an overview presentation about Modelica and OpenModelica.

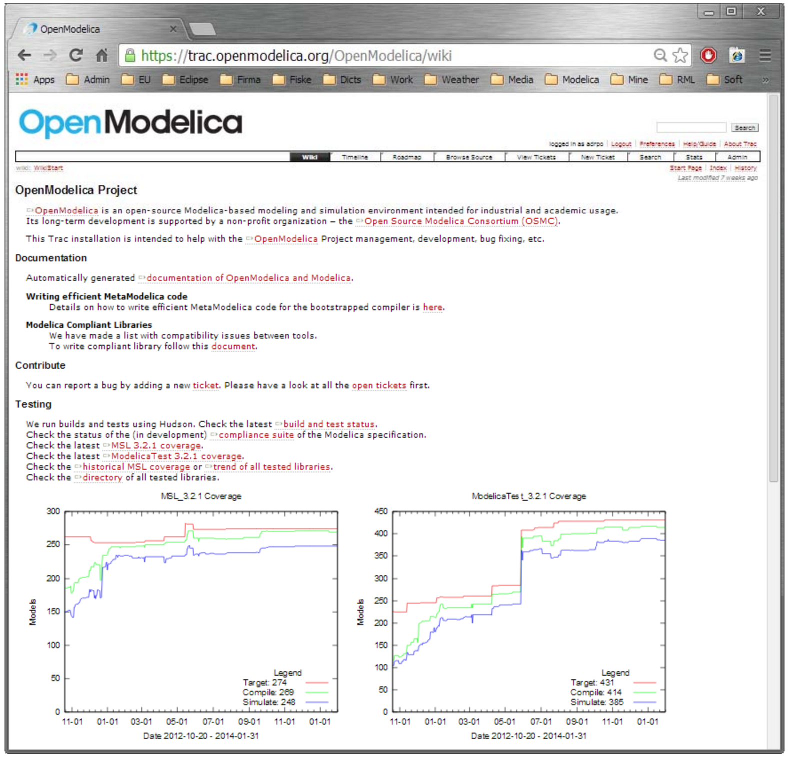
Donate

Please consider supporting our efforts.

Amount: SEK

Latest news

- CFP OpenModelica Workshop February 2014
- October 09: OpenModelica 1.9.0 released
- September 27: OpenModelica 1.9.0 RC1 released
- February 1: OpenModelica 1.9.0 Beta4 released
- October 19: OpenModelica 1.9.0 Beta2 released
- Oct 16 : CFP OpenModelica/MODPROD Workshops February 2013
- August 31: OpenModelica 1.9.0 Beta released
- April 4: OpenModelica 1.8.1 released



OpenModelica Project

OpenModelica is an open-source Modelica-based modeling and simulation environment intended for industrial and academic usage. Its long-term development is supported by a non-profit organization – the Open Source Modelica Consortium (OSMC).

This Trac installation is intended to help with the OpenModelica Project management, development, bug fixing, etc.

Documentation

Automatically generated documentation of OpenModelica and Modelica.

Writing efficient MetaModelica code
Details on how to write efficient MetaModelica code for the bootstrapped compiler is here.

Modelica Compliant Libraries
We have made a list with compatibility issues between tools.
To write compliant library follow this document.

Contribute

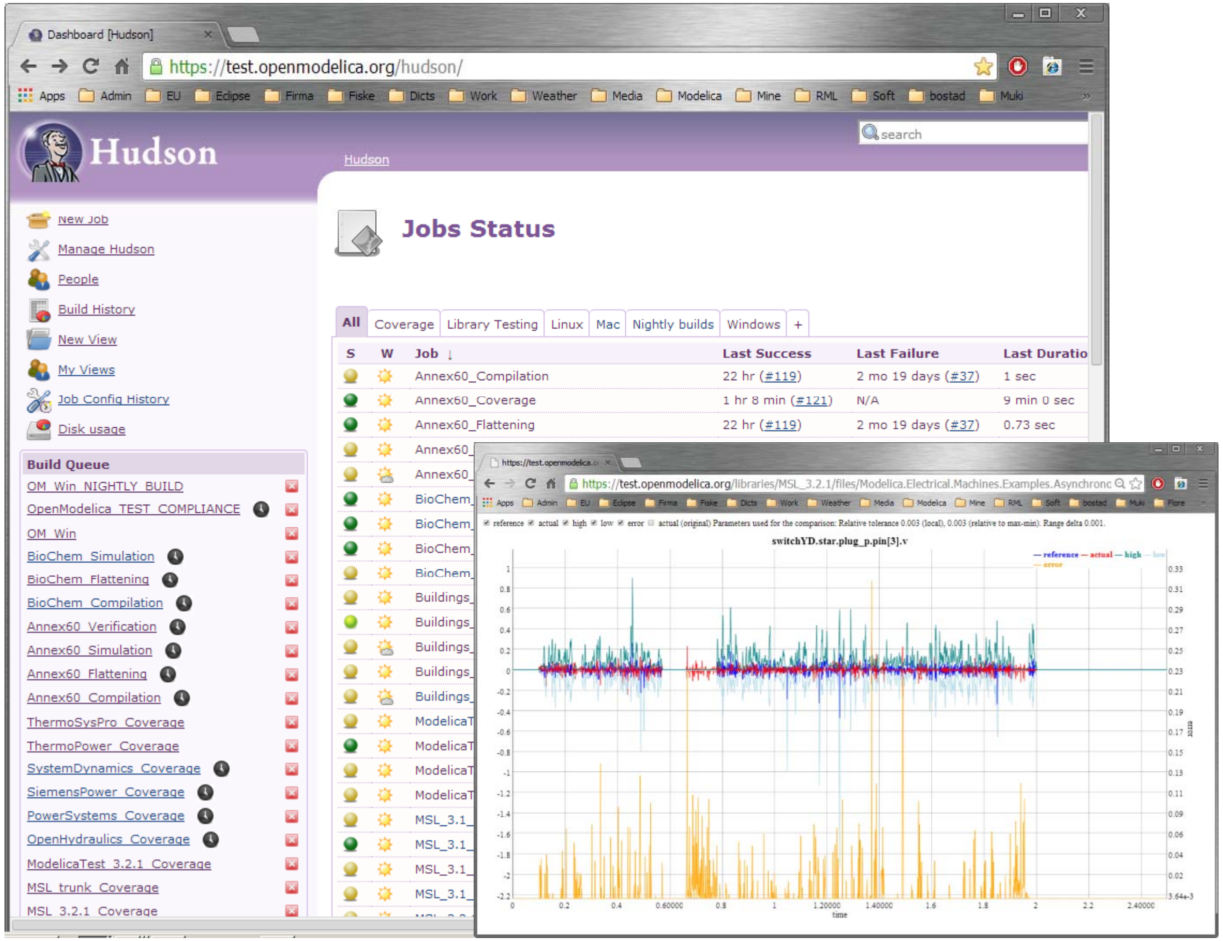
You can report a bug by adding a new ticket. Please have a look at all the open tickets first.

Testing

We run builds and tests using Hudson. Check the latest build and test status.
Check the status of the (in development) compliance suite of the Modelica specification.
Check the latest MSL 3.2.1 coverage.
Check the latest ModelicaTest 3.2.1 coverage.
Check the historical MSL coverage or trend of all tested libraries.
Check the directory of all tested libraries.

What is OpenModelica? (IV)

- Open-source community services
  - Extensive testing (unit & library coverage: MSL 3.2.1, ModelicaTest 3.2.1, PetriNet, Buildings, PowerSystems, OpenHydraulics, ThermoPower, and ThermoSysPro) with interactive result comparison
  - ~2800 tests ran on each commit via Hudson (4 test servers currently)
    - Linux (GCC & CLANG), Windows (MinGW GCC), Mac OS (GCC)
  - Automatic nightly builds for Window & Linux & Mac OS



Jobs Status

All | Coverage | Library Testing | Linux | Mac | Nightly builds | Windows | +

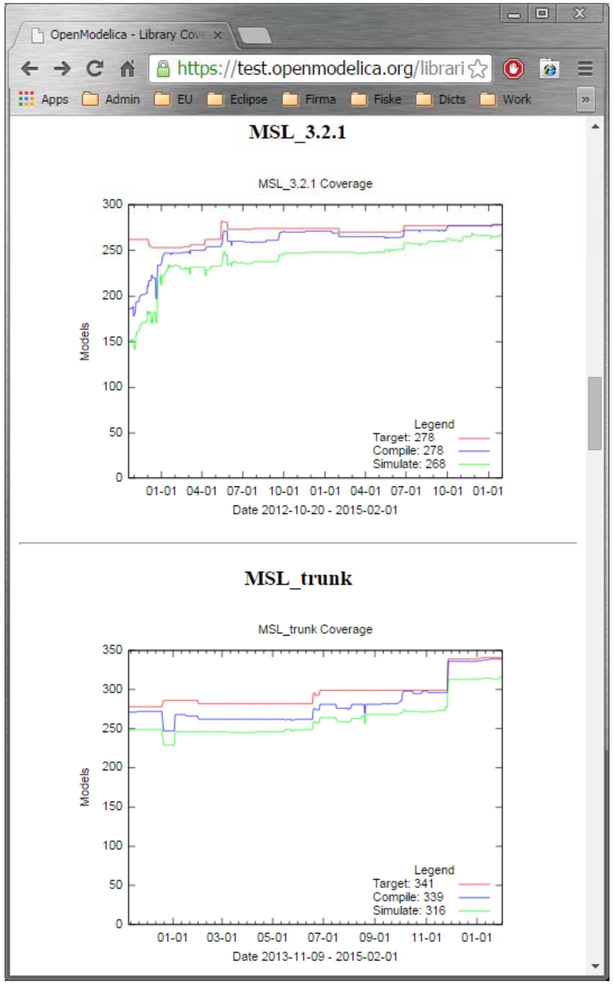
S	W	Job ↓	Last Success	Last Failure	Last Duratio
●	☼	Annex60_Compilation	22 hr (#119)	2 mo 19 days (#37)	1 sec
●	☼	Annex60_Coverage	1 hr 8 min (#121)	N/A	9 min 0 sec
●	☼	Annex60_Flattening	22 hr (#119)	2 mo 19 days (#37)	0.73 sec
●	☼	Annex60_			
●	☼	Annex60_			
●	☼	BioChem_			
●	☼	BioChem_			
●	☼	BioChem_			
●	☼	BioChem_			
●	☼	Buildings_			
●	☼	Buildings_			
●	☼	Buildings_			
●	☼	Buildings_			
●	☼	Buildings_			
●	☼	ModelicaT			
●	☼	ModelicaT			
●	☼	ModelicaT			
●	☼	ModelicaT			
●	☼	MSL_3.1_			
●	☼	MSL_3.1_			
●	☼	MSL_3.1_			
●	☼	MSL_3.1_			

Build Queue

- OM_Win_NIGHTLY_BUILD
- OpenModelica_TEST_COMPLIANCE
- OM_Win
- BioChem_Simulation
- BioChem_Flattening
- BioChem_Compilation
- Annex60_Verification
- Annex60_Simulation
- Annex60_Flattening
- Annex60_Compilation
- ThermoSysPro_Coverage
- ThermoPower_Coverage
- SystemDynamics_Coverage
- SiemensPower_Coverage
- PowerSystems_Coverage
- OpenHydraulics_Coverage
- ModelicaTest_3.2.1_Coverage
- MSL_trunk_Coverage
- MSL_3.2.1_Coverage

https://test.openmodelica.o
https://test.openmodelica.org/libraries/MSL_3.2.1/files/Modelica.Electrical.Machines.Examples.Asynchronc
Apps
Admin
EU
Eclipse
Firma
Fiske
Dicts
Work
Weather
Media
Modelica
Mine
RML
Soft
bostad
Muki
Flore

☑ reference ☑ actual ☑ high ☑ low ☑ error □ actual (original) Parameters used for the comparison: Relative tolerance 0.003 (local), 0.003 (relative to max-min). Range delta 0.001.



What is OpenModelica? (V)

- An incubator platform for research
  - 7 PhDs since 2004 (Debugging, Parallelization, PDEs Extensions)
  - 32 Master's theses since 2004
  - Both the students and the project benefit
- Master theses at PELAB 2006-2014
  - Refactoring/Parsing and Language extensions
  - UML/SysML view of Modelica code
  - 2D and 3D visualization tools
  - Static and runtime debugging tools
  - Advanced code generation and parallelization of simulation code
  - Bootstrapping and Java Interface
  - Function pointers
  - NVIDIA for Cuda and OpenCL parallel simulation
  - OMEdit – Modelica Connection Editor
  - OMWeb – server based Modelica simulation for teaching
  - OMCcc parser
- External Master theses
  - Model based diagnostics at ISY (Dep. Of Electrical Engineering)
  - Monte-Carlo simulation of Satellite Separation Systems at SAAB
  - Interactive Simulations (EADS)
  - Additional Solvers + Event handling (FH-Bielefeld)
  - EADS – ModelicaML
- A Base for commercial and open source products
  - MathCore AB, Bosch Rexroth, InterCAX (MagicDraw SysML), VTT, Equa, Evonik

OpenModelica Roadmap - Past

1997 - started as a master thesis

2003 – first usable internal version

2004 – first external version: OpenModelica 1.1

2005 – more development: OpenModelica 1.3.1

2006 – major milestone

- Translated the whole compiler to MetaModelica
- Integrated Development Environment for the compiler
- OpenModelica website started
- Moved the code repository to Subversion management
- Extended the OpenModelica environment with new tools
- 4 versions released during the year
- External people start using OpenModelica
  - ~ 200 downloads/month
  - first development course at INRIA

OpenModelica Roadmap - Past

2007 – continued development and community involvement

- Improvement in website, support and documentation
- Answered ~1000 questions on the forum
- Portability is highly improved, ported to 4 platforms
  - Linux, Mac, Solaris, Windows (version 1.4.3)
- Improvement of the compiler development tools in Eclipse
- OpenModelica Community starts to react
  - contribute code & report bugs & request enhancements & participate in answering questions in the OpenModelica forum
  - participate at courses and workshops
- New server acquired for better community services
- Increased usage: ~600 downloads/month
- Open Modelica Consortium created in December 4
  - 4 months of work
  - 9 organizations as members already (3 Universities, 6 Companies)
  - discussions are ongoing with other 6 companies

OpenModelica Roadmap - Past

2008 – Further work on the compiler

- Release 1.4.4 and 1.4.5
  - Linux, Mac, Solaris, Windows
- New Solver Interface
- Refactoring
- Dynamic loading of functions
- Merging of MathCore front-end code
- 744 commits in Subversion
- Other things I don’t remember

OpenModelica Roadmap – Past

2009

- Work mainly happened in OSMC (partially on a non-public branch)
- Front-end
  - Refactoring (OSMC)
  - Enumerations (OSMC)
  - Java Interface and Bootstrapping (Martin Sjölund)
  - MultiBody flattening (OSMC)
  - Constraint connection graph breaking (VTT + OSMC)
  - Support for Modelica 3.x and 3.x annotations (OSMC)
- Back-end
  - Tearing in the back-end (Jens Frenkel)
  - Template Code Generation and CSharp backend (Pavol Privitzer, Charles University Prague)
  - Interactive Simulations (EADS)
  - C++ Code generation (Bosch Rexroth)
  - Java Interface and Bootstrapping (Martin Sjölund)
  - Additional Solvers + Events (Willi Braun, FH-Bielefeld)
- General
  - New ModelicaML + SysML prototype (EADS)
  - 1144 commits in subversion (Since 2009 to February 8, 2010)
  - Bug fixes (OSMC)
  - Release 1.5.0 and 1.5.0-RC_X (Linux, Mac, Solaris, Windows)
- More things I don’t remember

OpenModelica Roadmap – Past

2010 – 2011

- Support for Modelica Standard Library 3.1 (Media & Fluid in works)
- Front-end
  - MultiBody flattening (OSMC)
  - Support for Modelica 3.x and 3.x annotations (OSMC)
  - Performance Enhancements
  - Stream connectors
  - Media & Fluid work is on the way
- Back-end
  - Back-end redesign (Jens, Willi, Martin, Per, Adrian, Kristian, Filippo)
  - Tearing in the back-end (Jens Frenkel)
  - Template Code Generation and CSharp backend (Pavol Privitzer, Charles University Prague)
  - Interactive Simulations (EADS)
  - C++ Code generation (Bosch Rexroth)
  - Additional Solvers + Events + Linearization (Willi Braun, FH-Bielefeld)
- General
  - OMEdit – new connection editor
  - Bootstrapping OMC (90% finished)
  - 2550 commits in subversion from 2010 to Feb. 7, 2011 (double than 2009-2010)
  - Bug fixes ~300+ (OSMC)
  - Release 1.6.0 (Linux, Mac, Windows)
  - Downloads Windows (~16434) , Linux (~8301), Mac (~2816)
- More things I don’t remember

OpenModelica Roadmap – Past

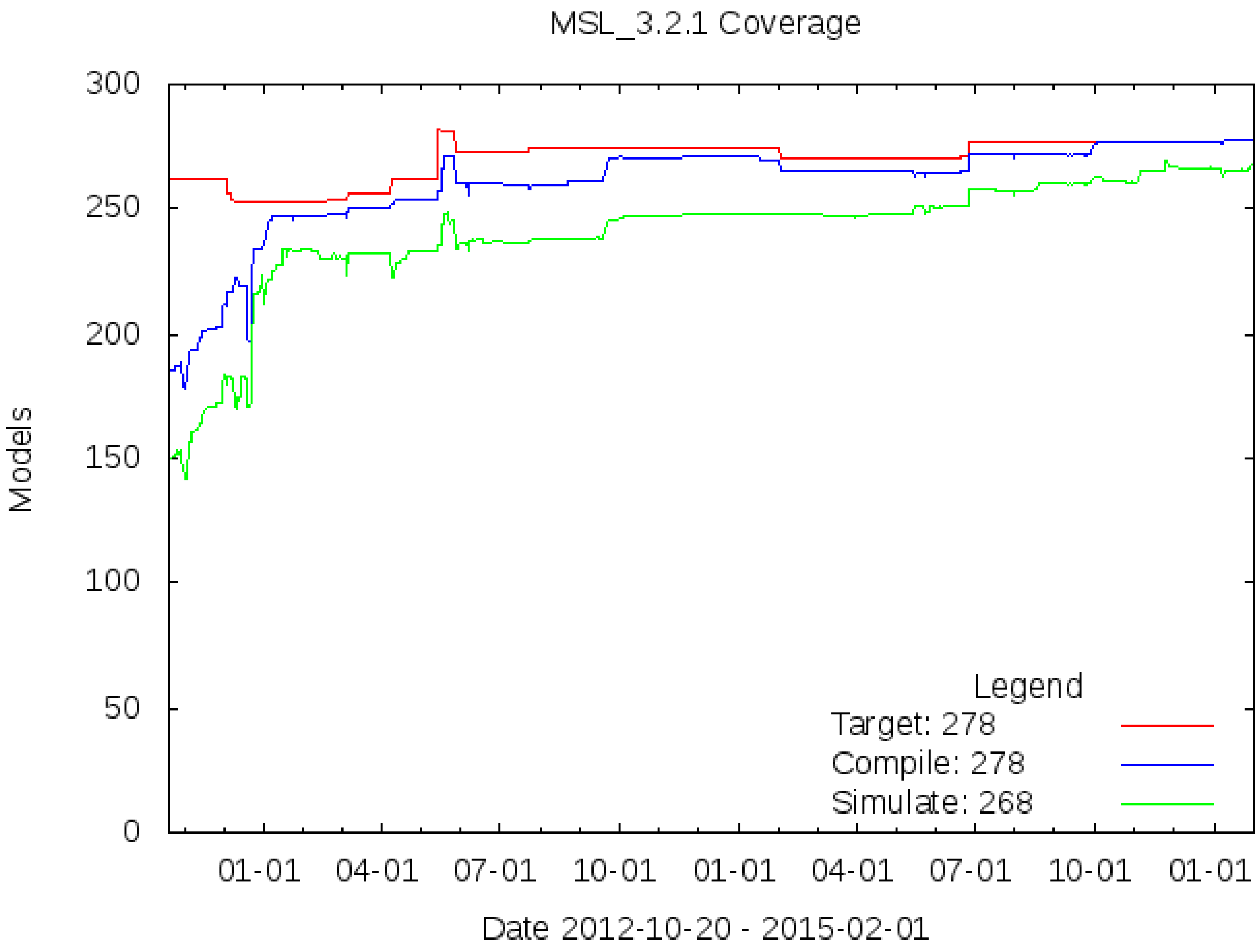
2012 – 2013

- Support for Modelica Standard Library 3.2.1 including Media & Fluid

- Front-end
  - Performance Enhancements
  - Media & Fluid work
  - Operator overloading
  - New instantiation module started
- Back-end
  - Modular back-end with more optimization modules (Jens, Willi, Martin)
  - New simulation runtime redesign (Willi, Lennart, Jens, Martin, Adrian)
  - C++ Code generation (Bosch Rexroth)
  - FMI export & import
  - Initialization, Jacobians (Lennart Lochel, Willi Braun, FH-Bielefeld)
  - Support for parallelization (Martin)
  - Parallel extensions in functions
- General
  - Uncertainties support (OpenTURNS connection & Data reconcilation)
  - MDT GDB debugging based on GDB and the bootstrapped compiler
  - OMEdit – improvements
  - Bootstrapping OMC (100% finished) using Boehm GC
  - 3909 commits in subversion from 2012 to Feb. 4, 2013
  - 2000 forum posts (questions and answers)
  - Bug fixes ~247+ (OSMC)
  - Release 1.9.0 (Linux, Mac, Windows)
  - Downloads Windows (~45307) , Linux (~15543), Mac (~5367)
- More things I don’t remember

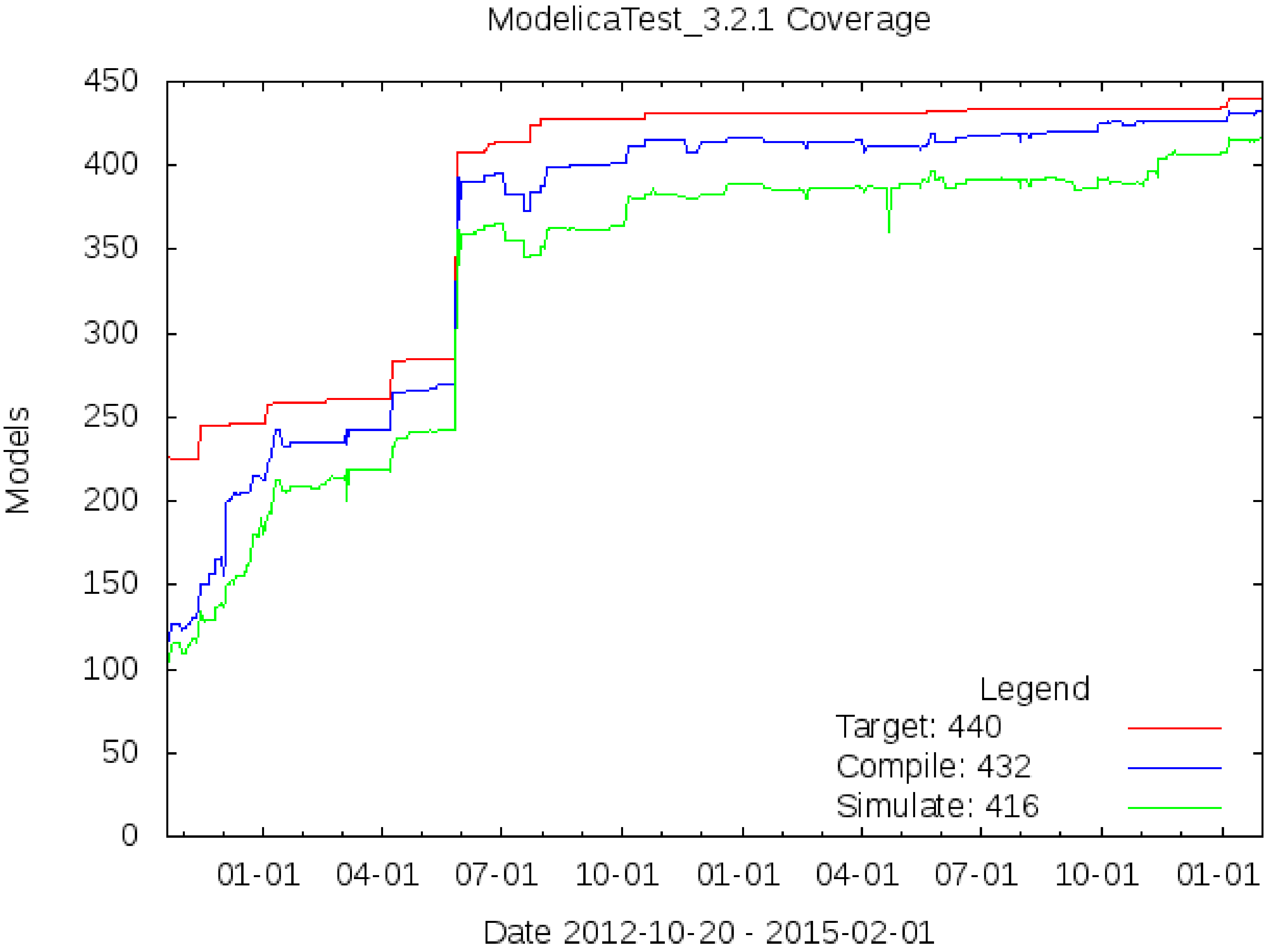
OpenModelica Testing (I)

- 2015-02-02 r24359 - total 278 - build 278 (100%) - sim 268 (97%)

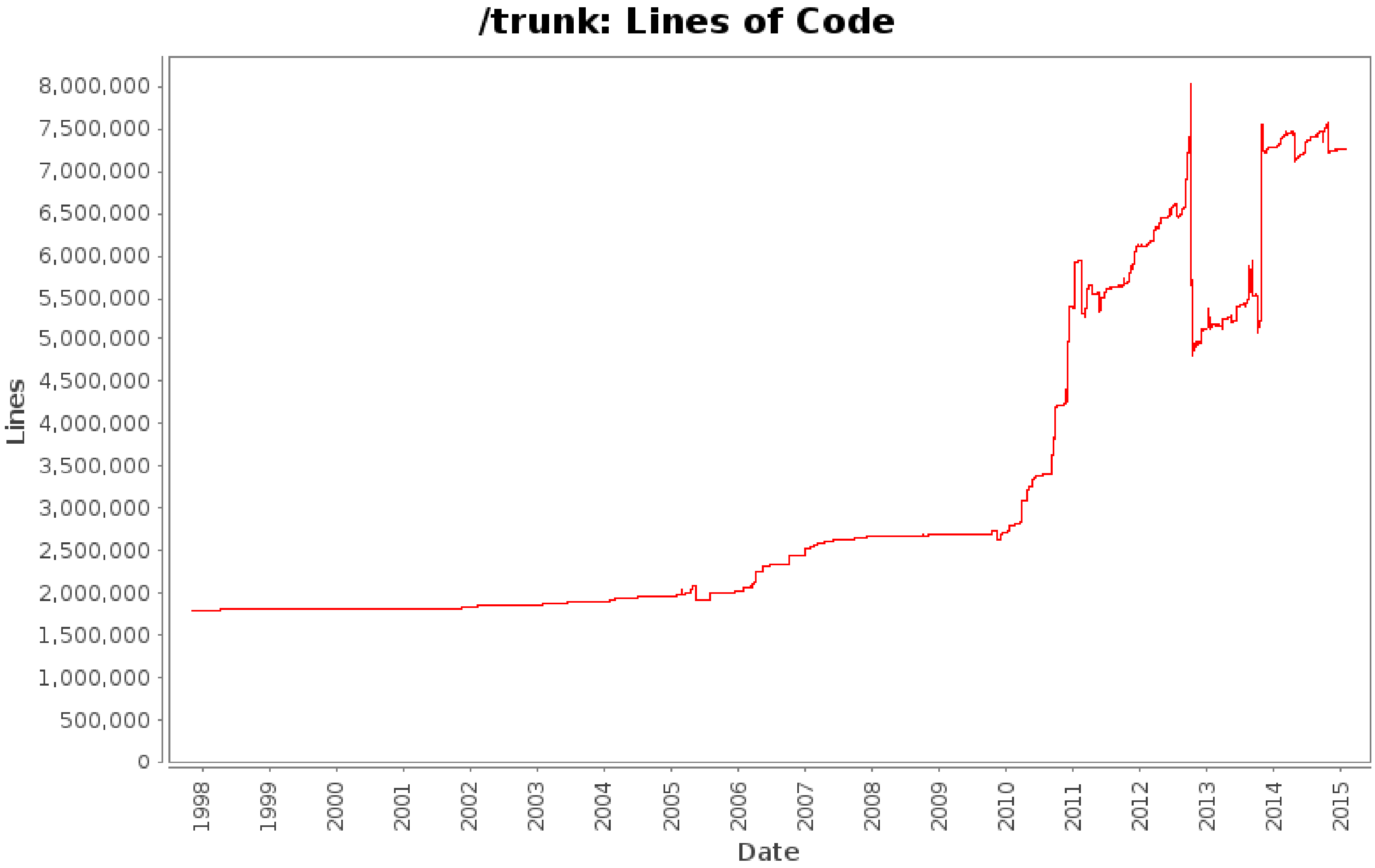


OpenModelica Testing (II)

- 2015-02-02 r24359 - total 440 - build 432(99%) - sim 416 (95%)

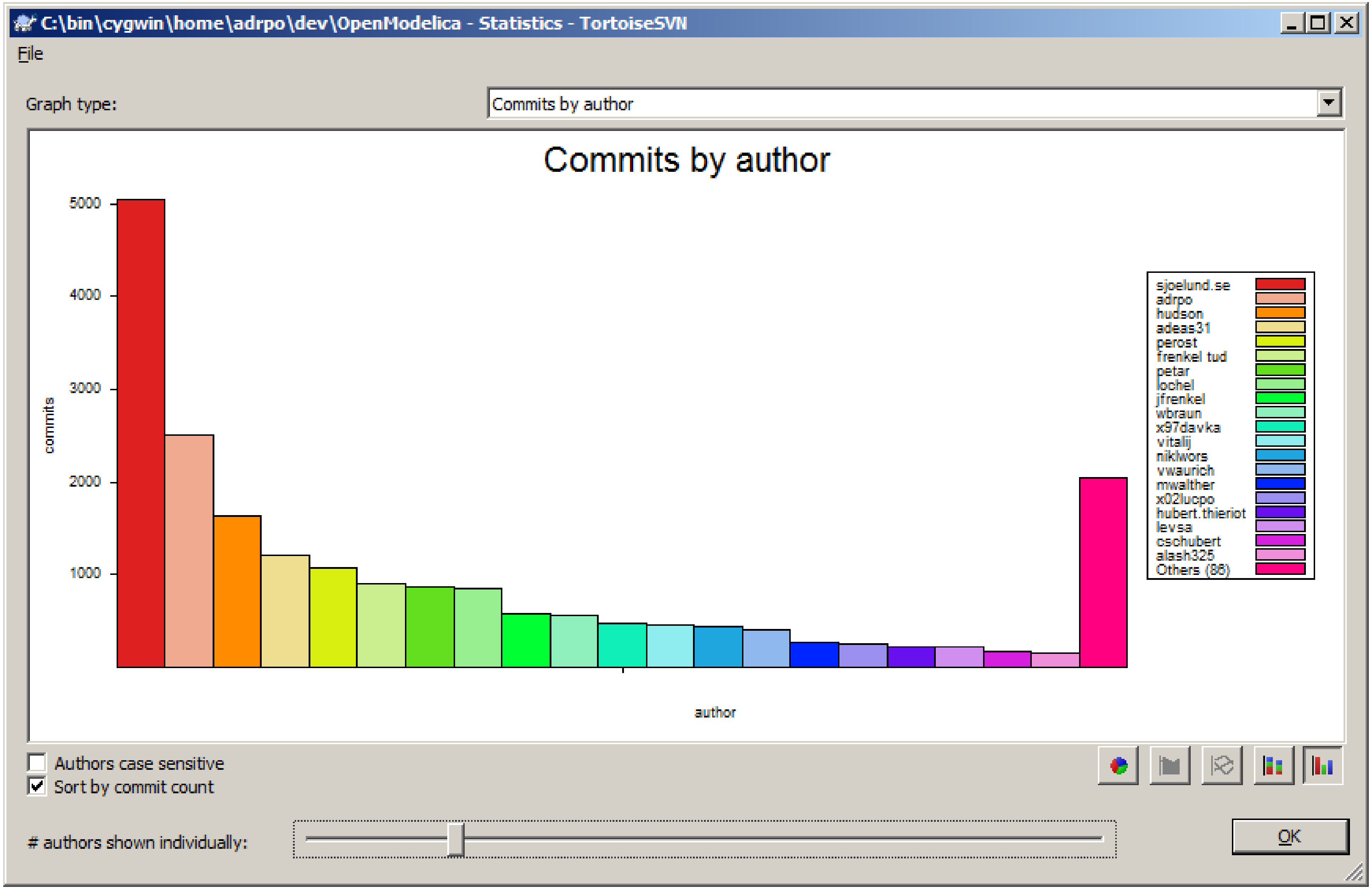


OpenModelica Statistics (I)



- Mature code base (http://build.openmodelica.org/omc/statsvn_trunk/)
- ~ 7000K lines of code and tests

OpenModelica Statistics (II)



C:\bin\cygwin\home\adrpo\dev\OpenModelica - Statistics - TortoiseSVN

File

Graph type: Commits by author

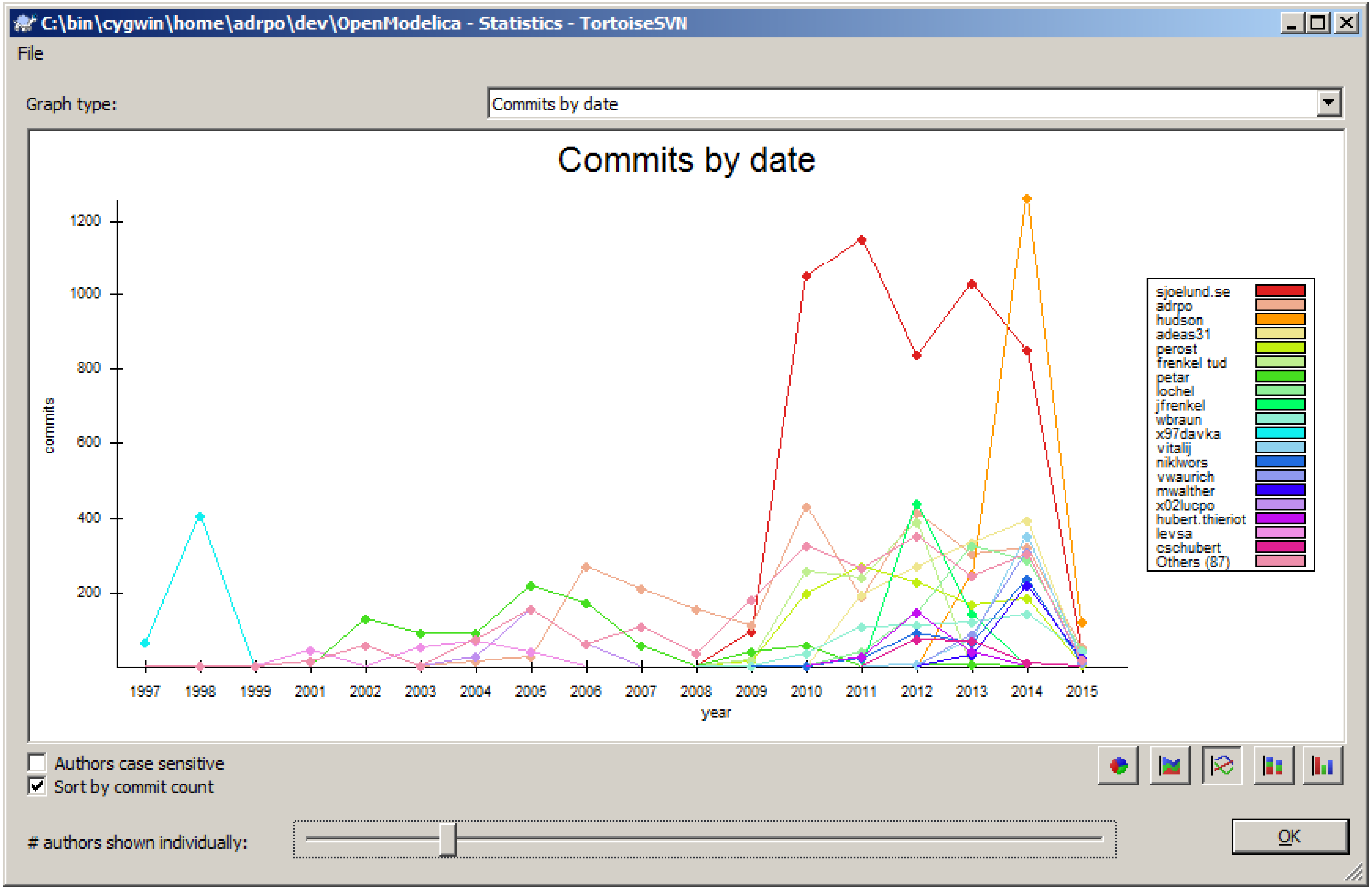
□ Authors case sensitive

☑ Sort by commit count

authors shown individually:

OK

OpenModelica Statistics (III)



C:\bin\cygwin\home\adrpo\dev\OpenModelica - Statistics - TortoiseSVN

Graph type: Commits by date

☐ Authors case sensitive

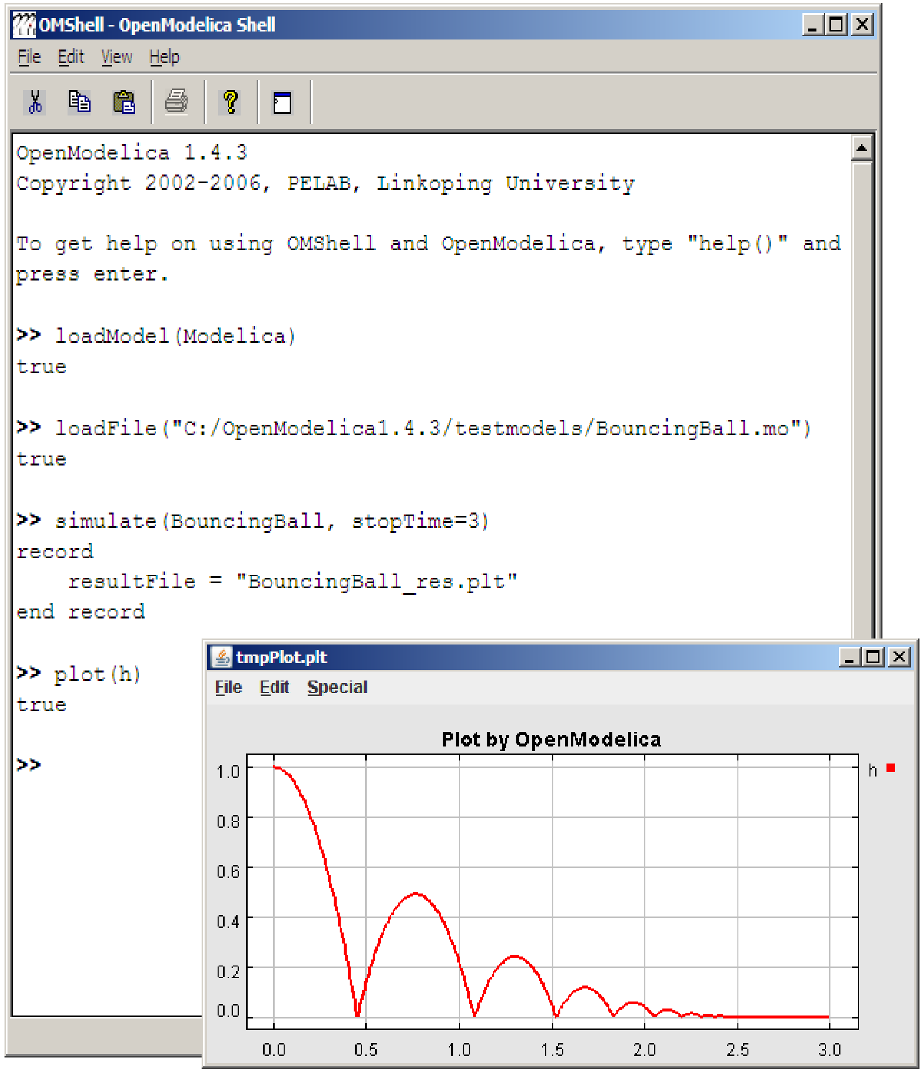
☑ Sort by commit count

Outline

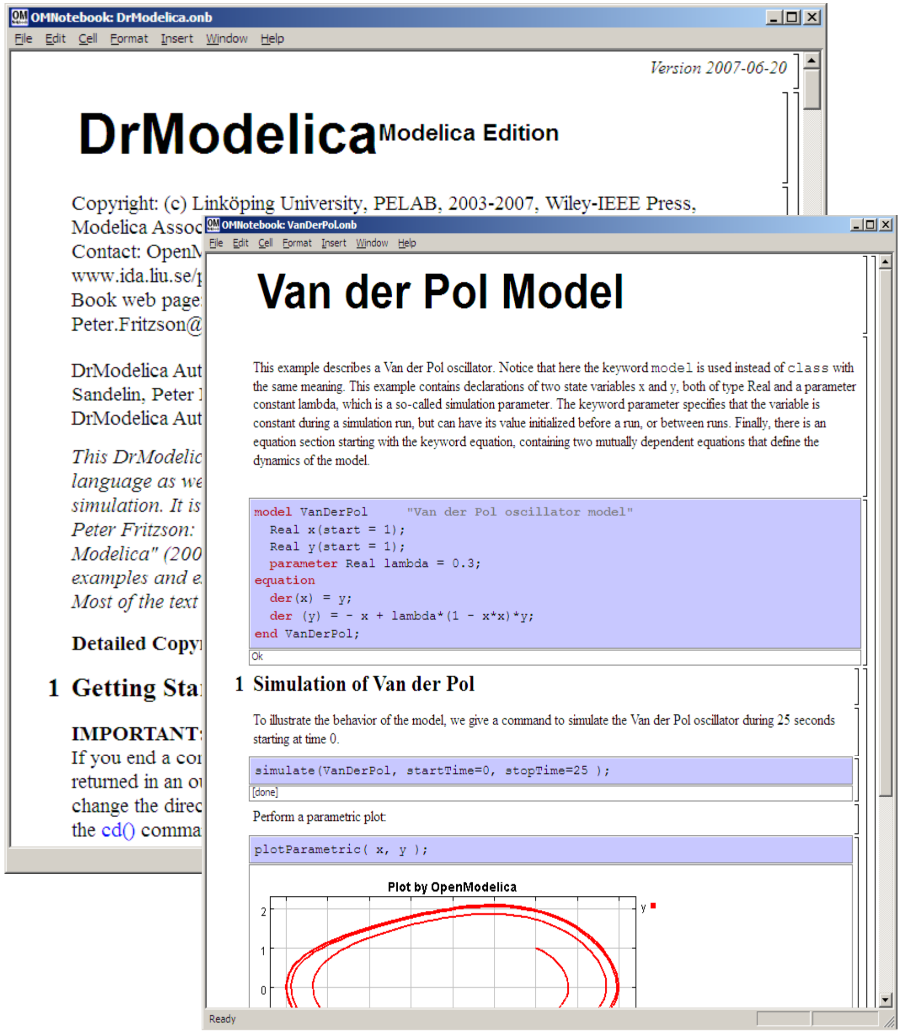
- OpenModelica
  - What is OpenModelica?
  - The past
- OpenModelica Technical Overview
  - OMC, OMShell, OMNotebook,
  - OMEdit, ModelicaML, SimForge
- OpenModelica Development Environment
  - MetaModelica (RML/OMC)
  - The Eclipse Environment
- OpenModelica Latest Developments (2014-2015)

OMShell & OMNotebook

- Demo?



```
OpenModelica 1.4.3
Copyright 2002-2006, PELAB, Linkoping University

To get help on using OMShell and OpenModelica, type "help()" and
press enter.

>> loadModel(Modelica)
true

>> loadFile("C:/OpenModelica1.4.3/testmodels/BouncingBall.mo")
true

>> simulate(BouncingBall, stopTime=3)
record
    resultFile = "BouncingBall_res.plt"
end record

>> plot(h)
true

>>
```



OMNotebook: DrModelica.onb
File Edit Cell Format Insert Window Help

Version 2007-06-20

DrModelica Modelica Edition

Copyright: (c) Linköping University, PELAB, 2003-2007, Wiley-IEEE Press,
Modelica Assoc
Contact: OpenM
www.ida.liu.se/p
Book web page
Peter.Fritzson@

DrModelica Aut
Sandelin, Peter I
DrModelica Aut

This DrModelic
language as we
simulation. It is
Peter Fritzson:
Modelica" (200
examples and e
Most of the text

Detailed Copyr

1 Getting Sta

IMPORTANT:
If you end a co
returned in an o
change the direc
the cd() comma

OMNotebook: VanDerPol.onb
File Edit Cell Format Insert Window Help

Van der Pol Model

This example describes a Van der Pol oscillator. Notice that here the keyword `model` is used instead of `class` with the same meaning. This example contains declarations of two state variables x and y, both of type Real and a parameter constant lambda, which is a so-called simulation parameter. The keyword parameter specifies that the variable is constant during a simulation run, but can have its value initialized before a run, or between runs. Finally, there is an equation section starting with the keyword equation, containing two mutually dependent equations that define the dynamics of the model.

```
model VanDerPol     "Van der Pol oscillator model"
  Real x(start = 1);
  Real y(start = 1);
  parameter Real lambda = 0.3;
equation
  der(x) = y;
  der (y) = - x + lambda*(1 - x*x)*y;
end VanDerPol;
```

Ok

1 Simulation of Van der Pol

To illustrate the behavior of the model, we give a command to simulate the Van der Pol oscillator during 25 seconds starting at time 0.

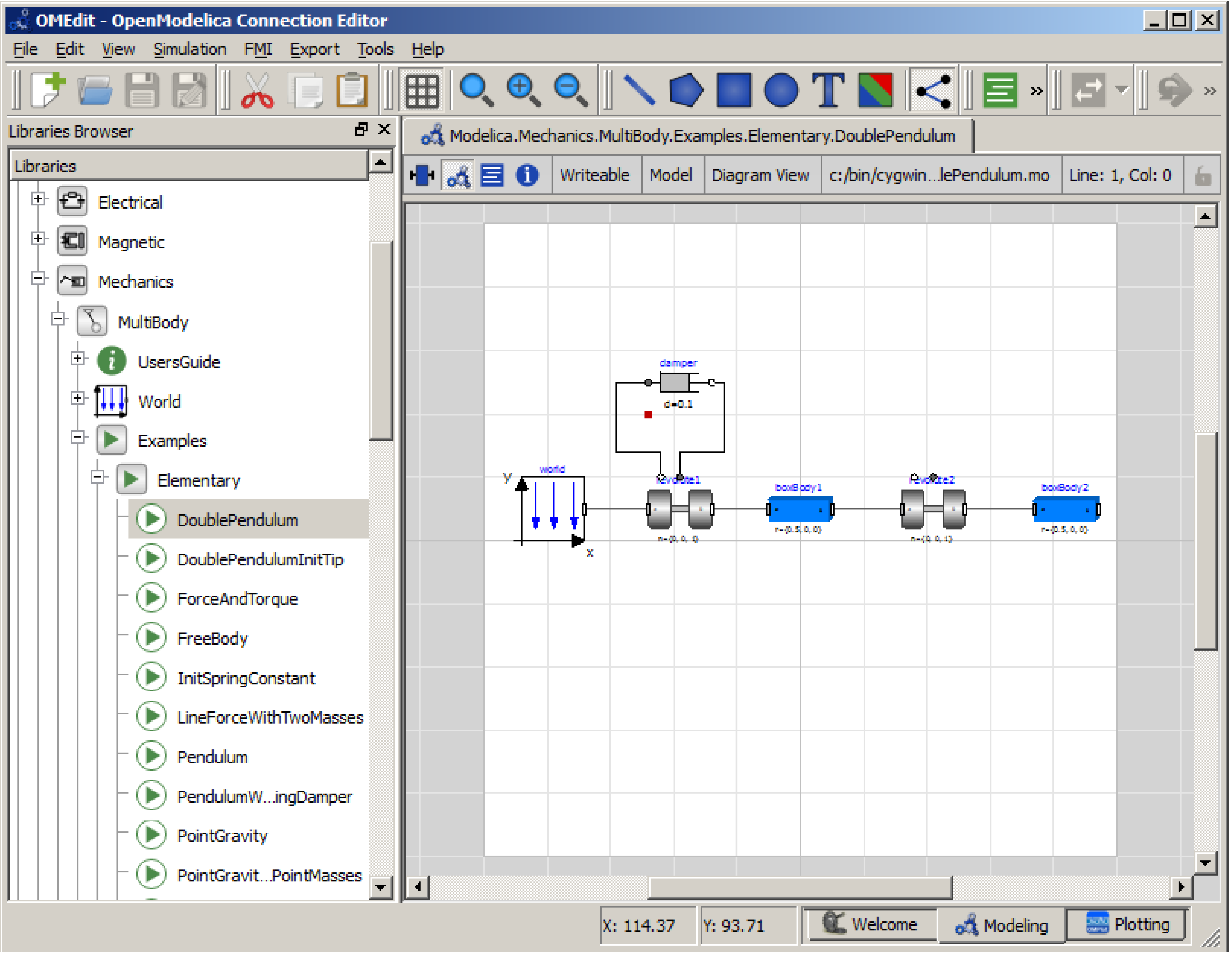
```
simulate(VanDerPol, startTime=0, stopTime=25 );
```

[done]

Perform a parametric plot:

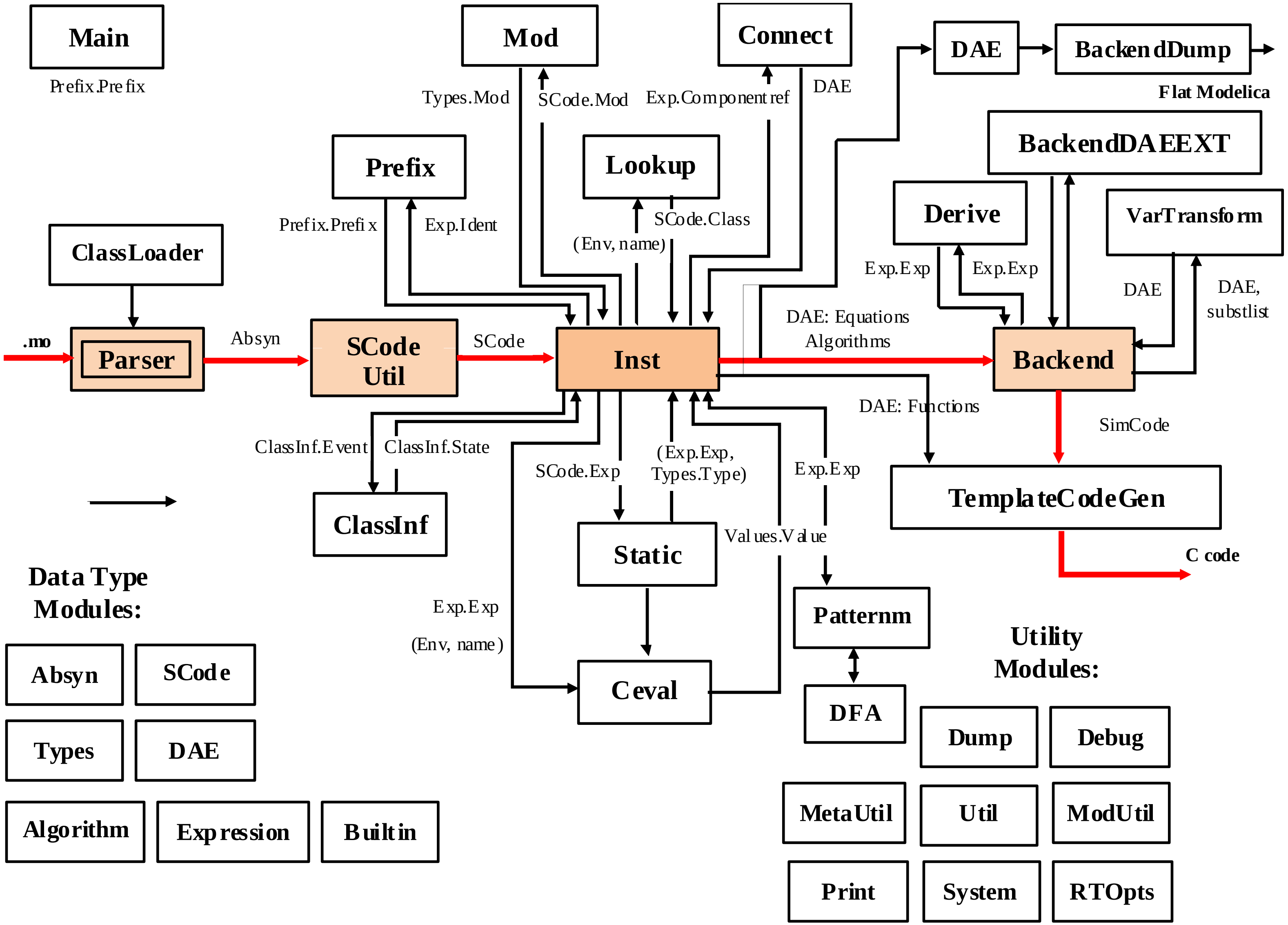
```
plotParametric( x, y );
```

OMEdit- OpenModelica Connection Editor



The OMC Compiler

- Implemented mainly in MetaModelica and C/C++
- The compiler has 258 packages



Modelica->AST->SCode->DAE->C Code

```
// Parse the file and get an AST back
ast = Parse.parse(modelicaFile);

// Translate to simplified C code
scode = SCode.absyn2SCode(ast);

// flatten the simplified code
(cache, dae1) = Inst.instantiate(Env.emptyCache, scode);

// Call the function that optimizes the DAE
optimizeDae(scode, ast, dae, dae, lastClassName);
```

Outline

- OpenModelica
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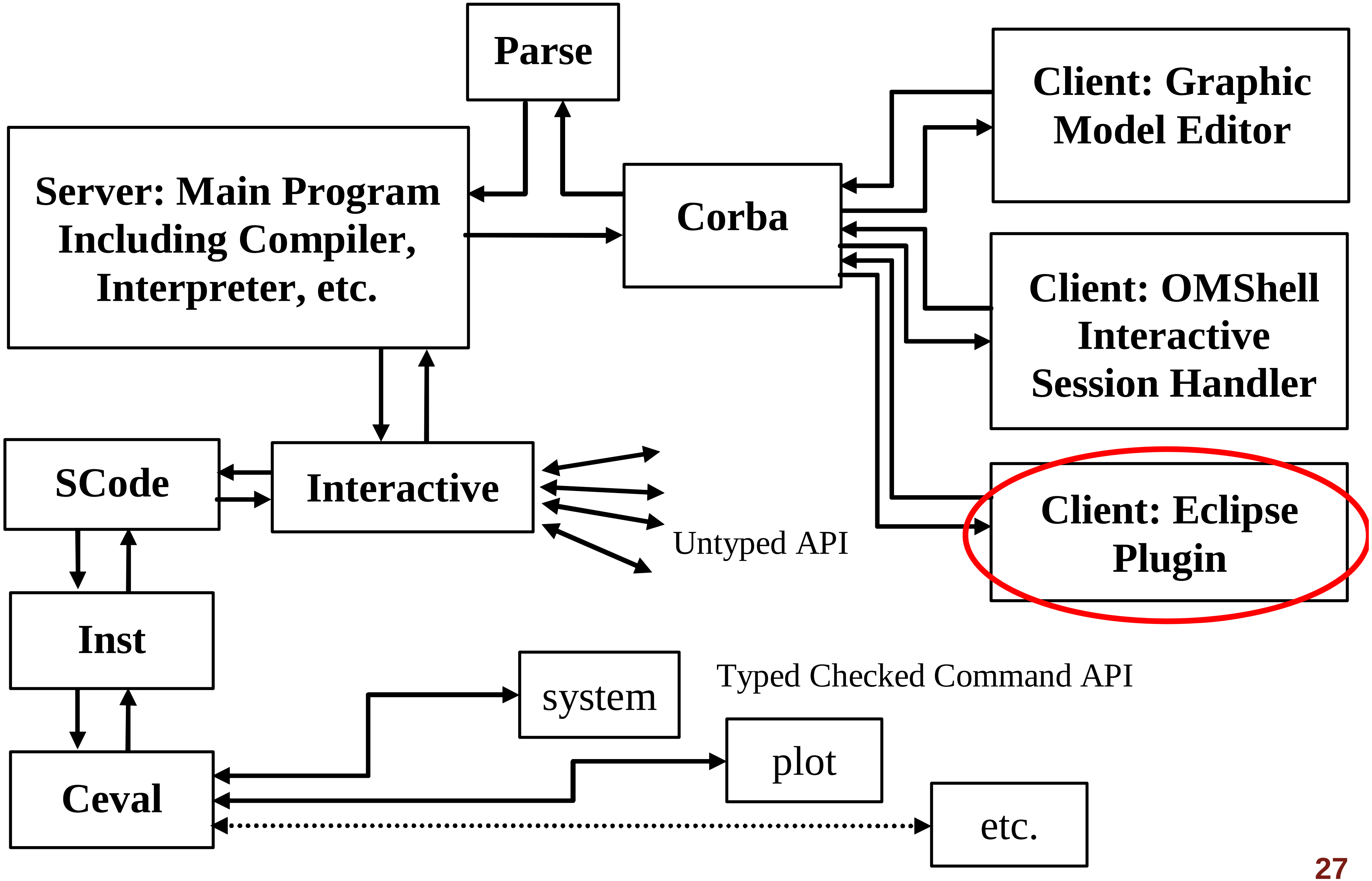
MetaModelica

- OMC
  - Implemented mainly in MetaModelica and C/C++

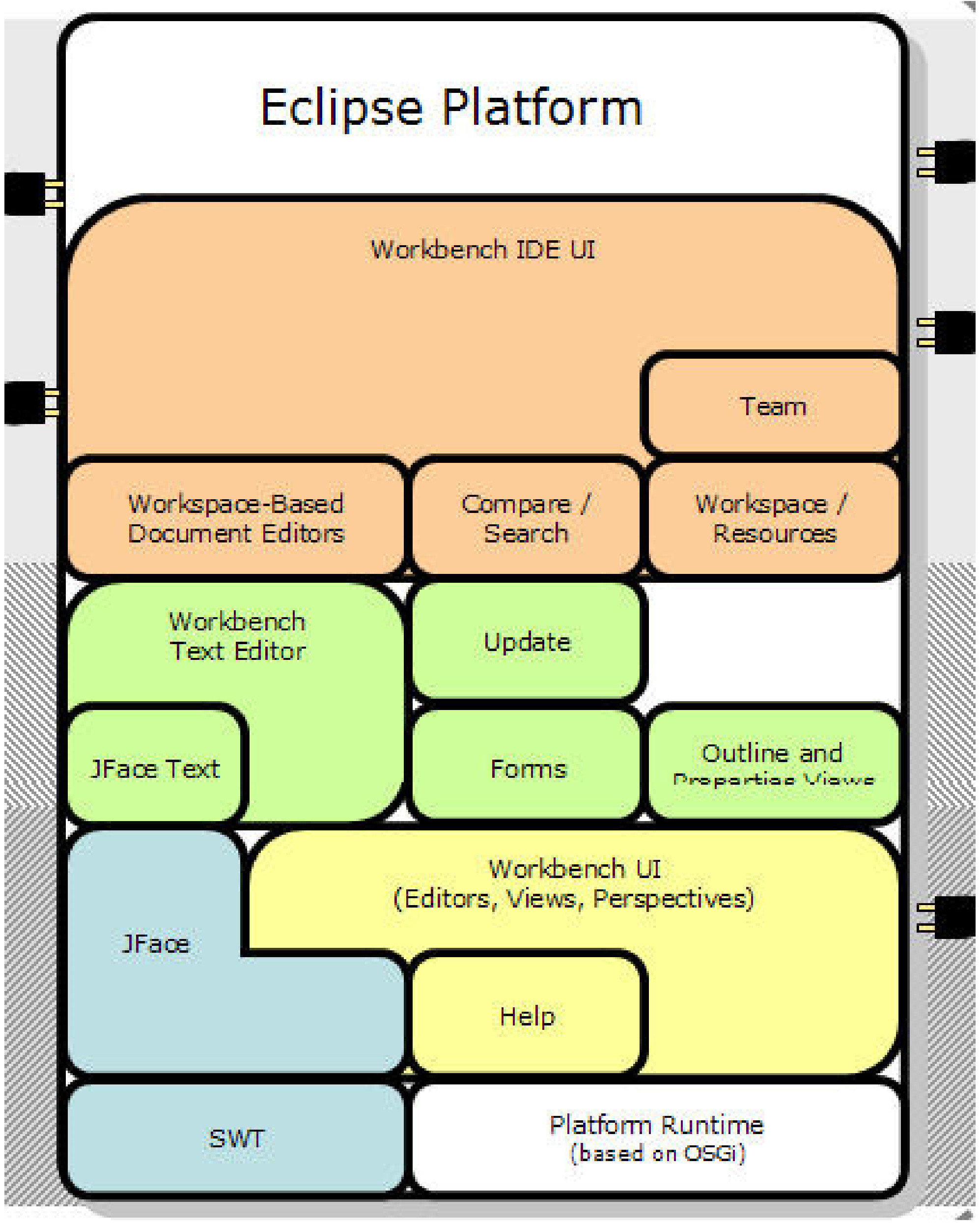
- Modelica
  - classes, models, records, functions, packages
  - behavior is defined by equations or/and functions
  - equations
    - differential algebraic equations and conditional equations

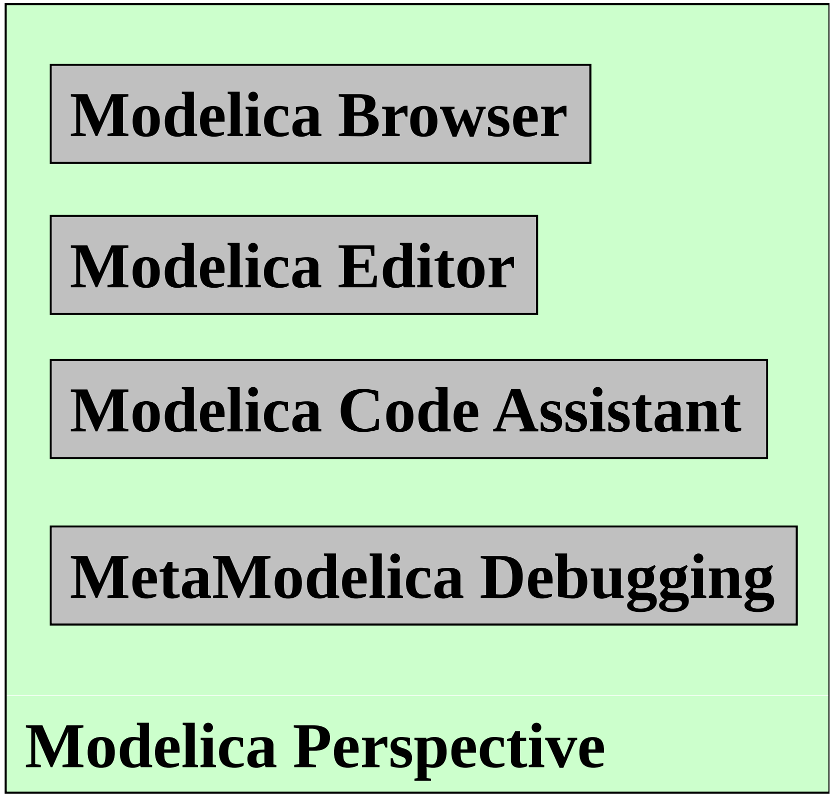
- MetaModelica extensions
  - local equations
  - pattern equations
  - match expressions
  - high-level data structures: lists, tuples, option and uniontypes

OpenModelica Context

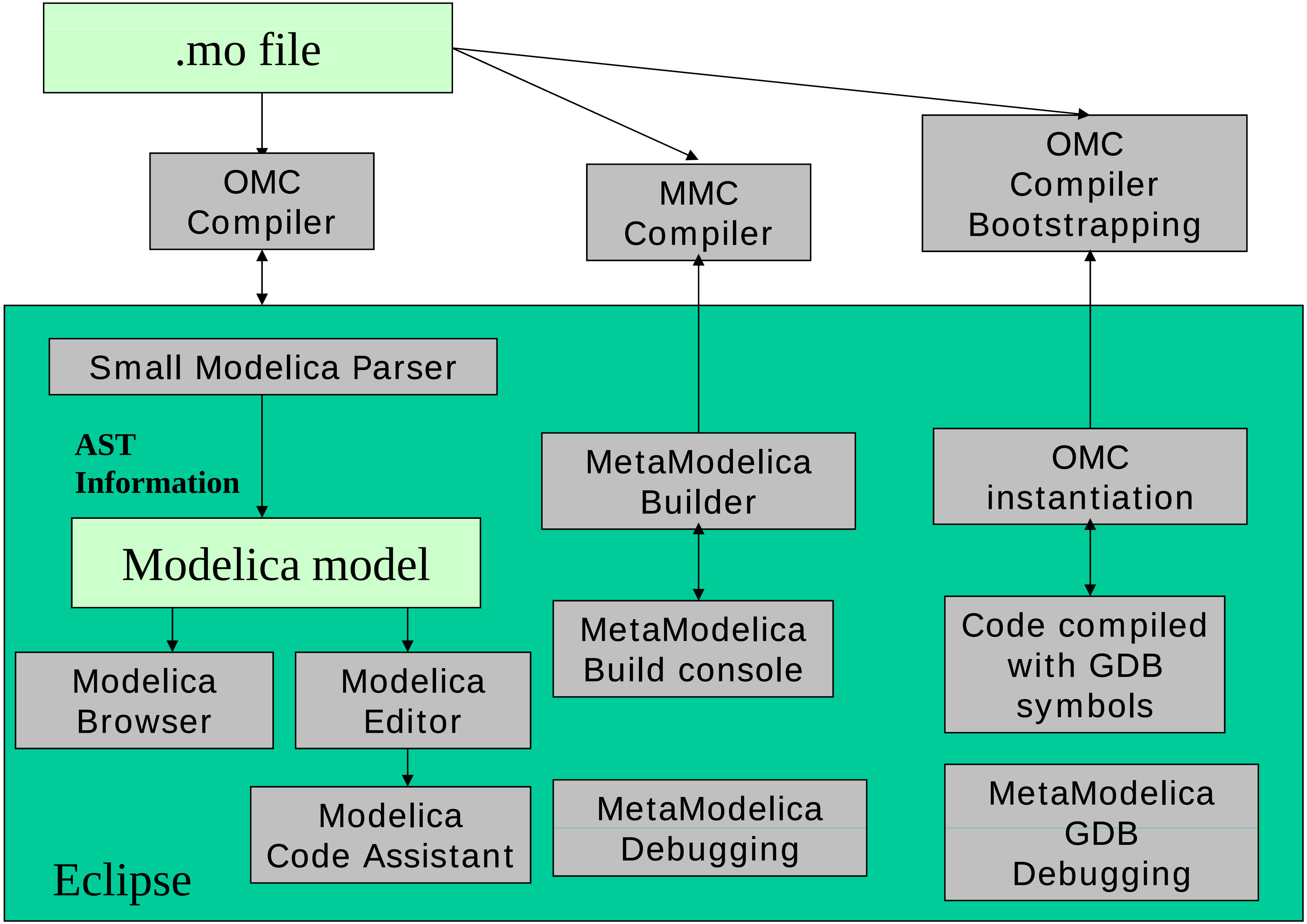

Parse
Server: Main Program Including Compiler, Interpreter, etc.
Corba
Client: Graphic Model Editor
Client: OMShell Interactive Session Handler
Client: Eclipse Plugin
SCode
Interactive
Untyped API
Inst
Ceval
system
Typed Checked Command API
plot
etc.

The MDT Eclipse Environment (I)

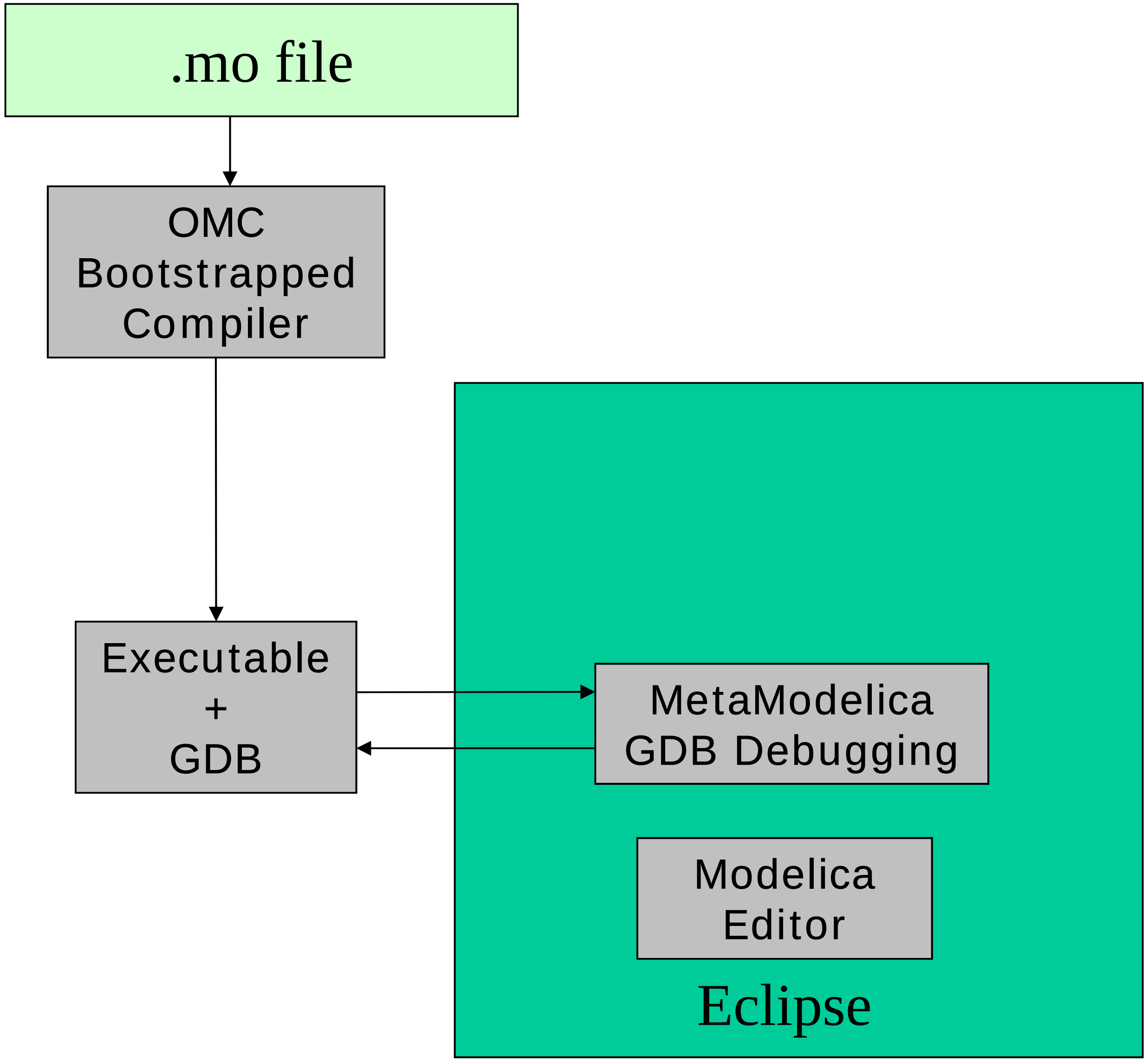

Eclipse Platform
Workbench IDE UI
Team
Workspace-Based Document Editors
Compare / Search
Workspace / Resources
Workbench Text Editor
Update
JFace Text
Forms
Outline and Properties Views
Workbench UI (Editors, Views, Perspectives)
JFace
Help
SWT
Platform Runtime (based on OSGi)



The MDT Eclipse Environment (II)



The MDT Eclipse Environment (III)



.mo file

OMC Bootstrapped Compiler

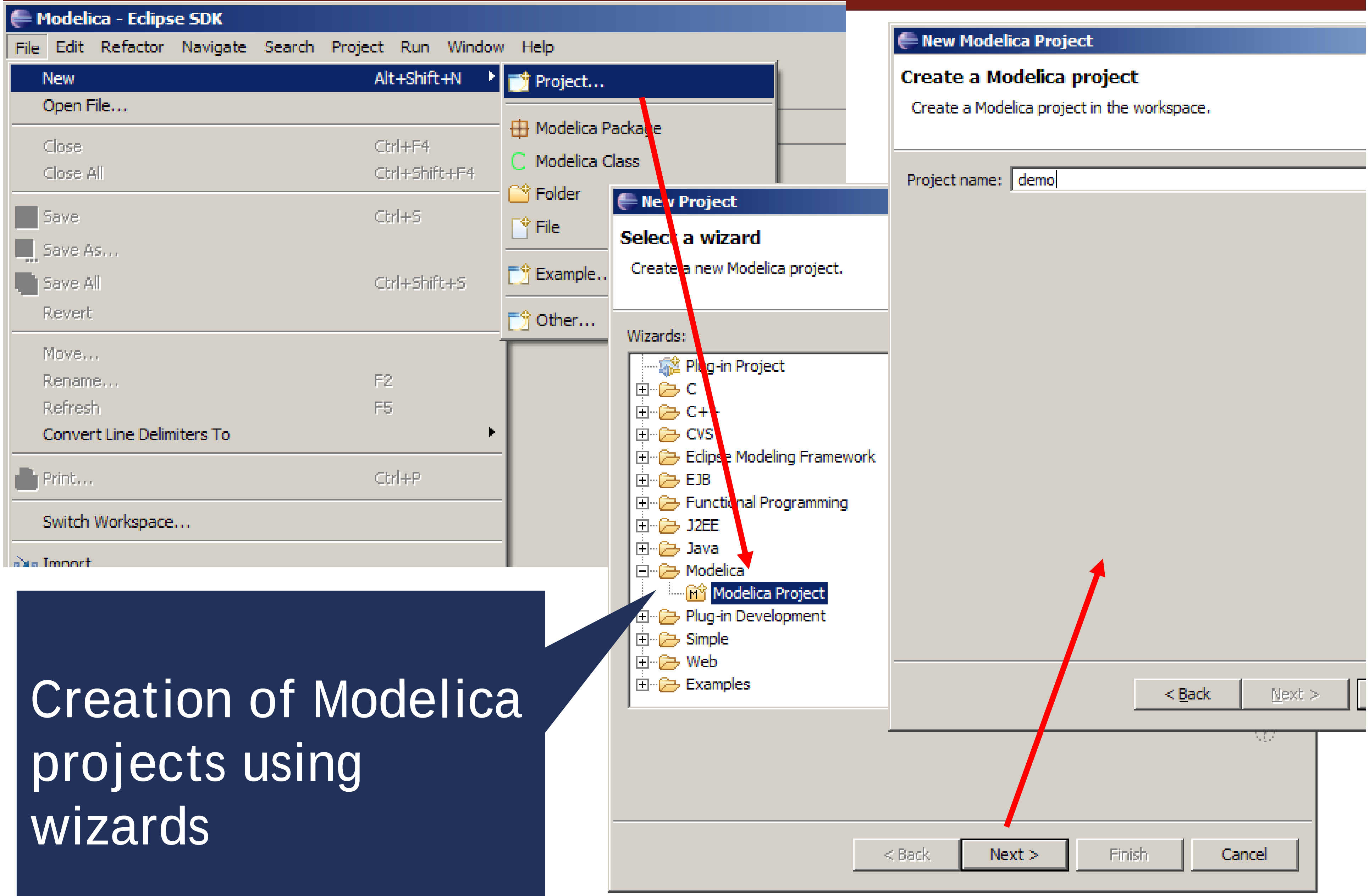
Executable + GDB

MetaModelica GDB Debugging

Modelica Editor

Eclipse

Creating Modelica projects (I)



Select a wizard

Create a new Modelica project.

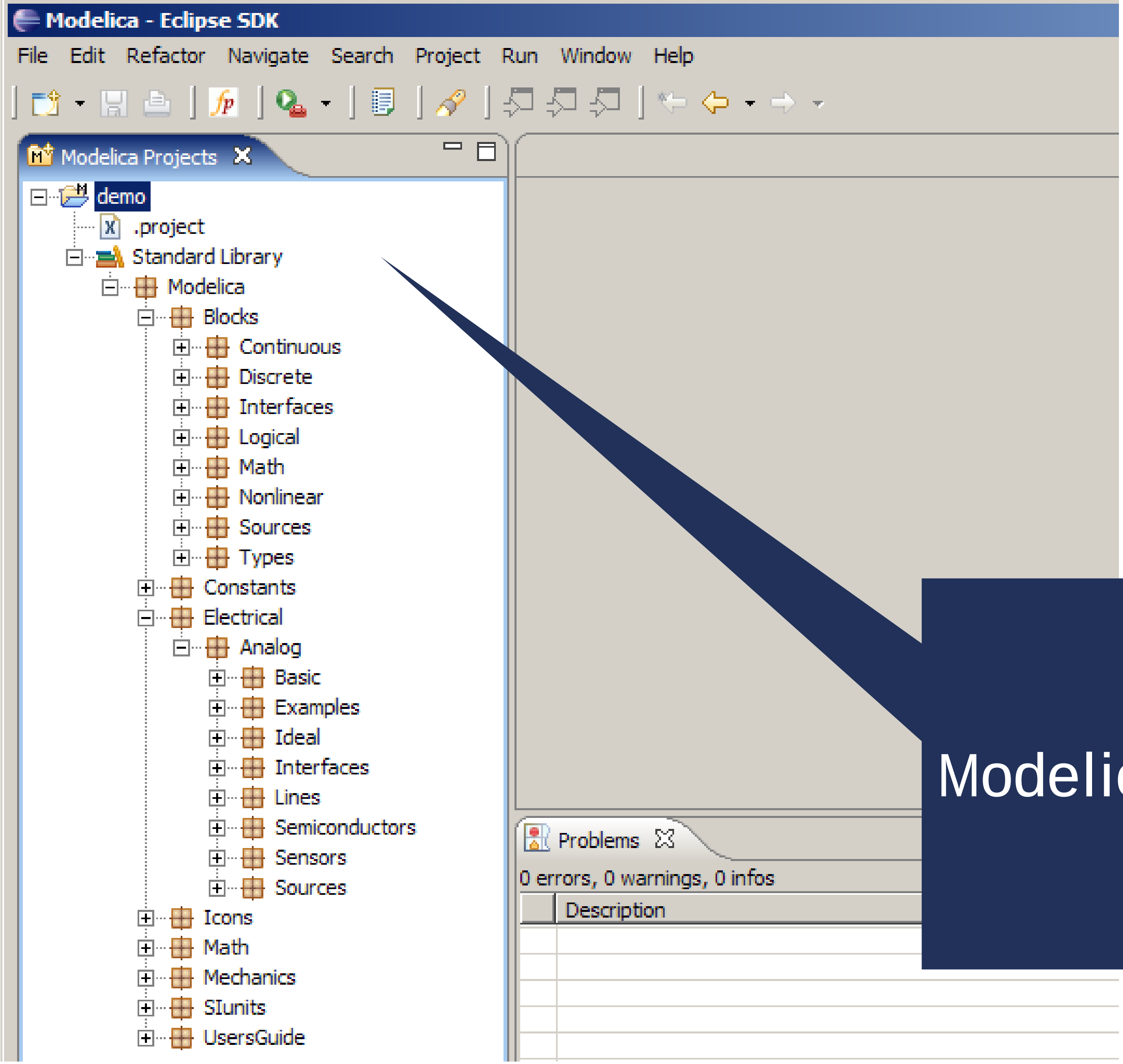
Create a Modelica project

Create a Modelica project in the workspace.

Project name: demo

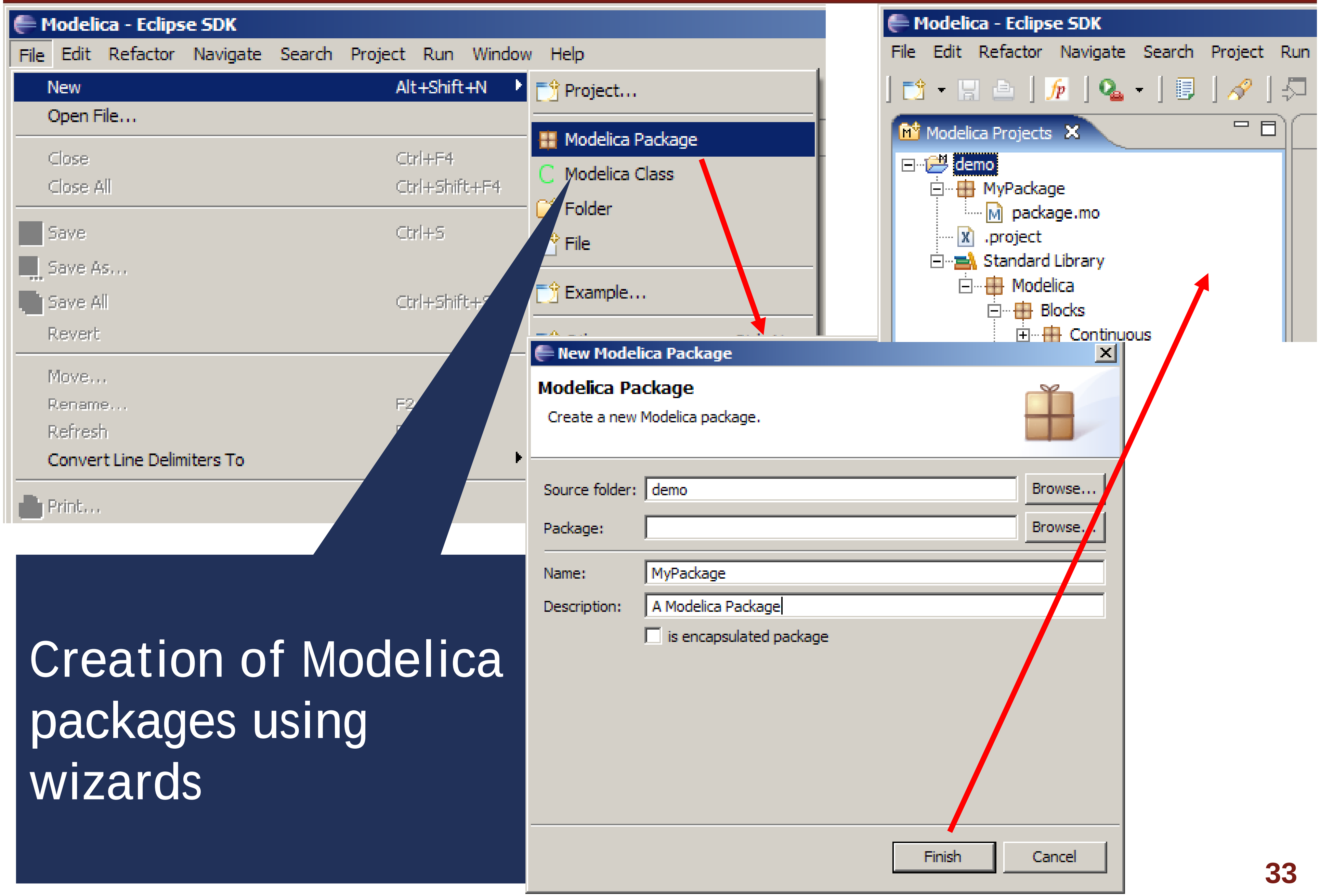
Creation of Modelica projects using wizards

Creating Modelica projects (II)



Modelica project

Creating Modelica packages



New Modelica Package

Modelica Package

Create a new Modelica package.

Source folder: demo

Package:

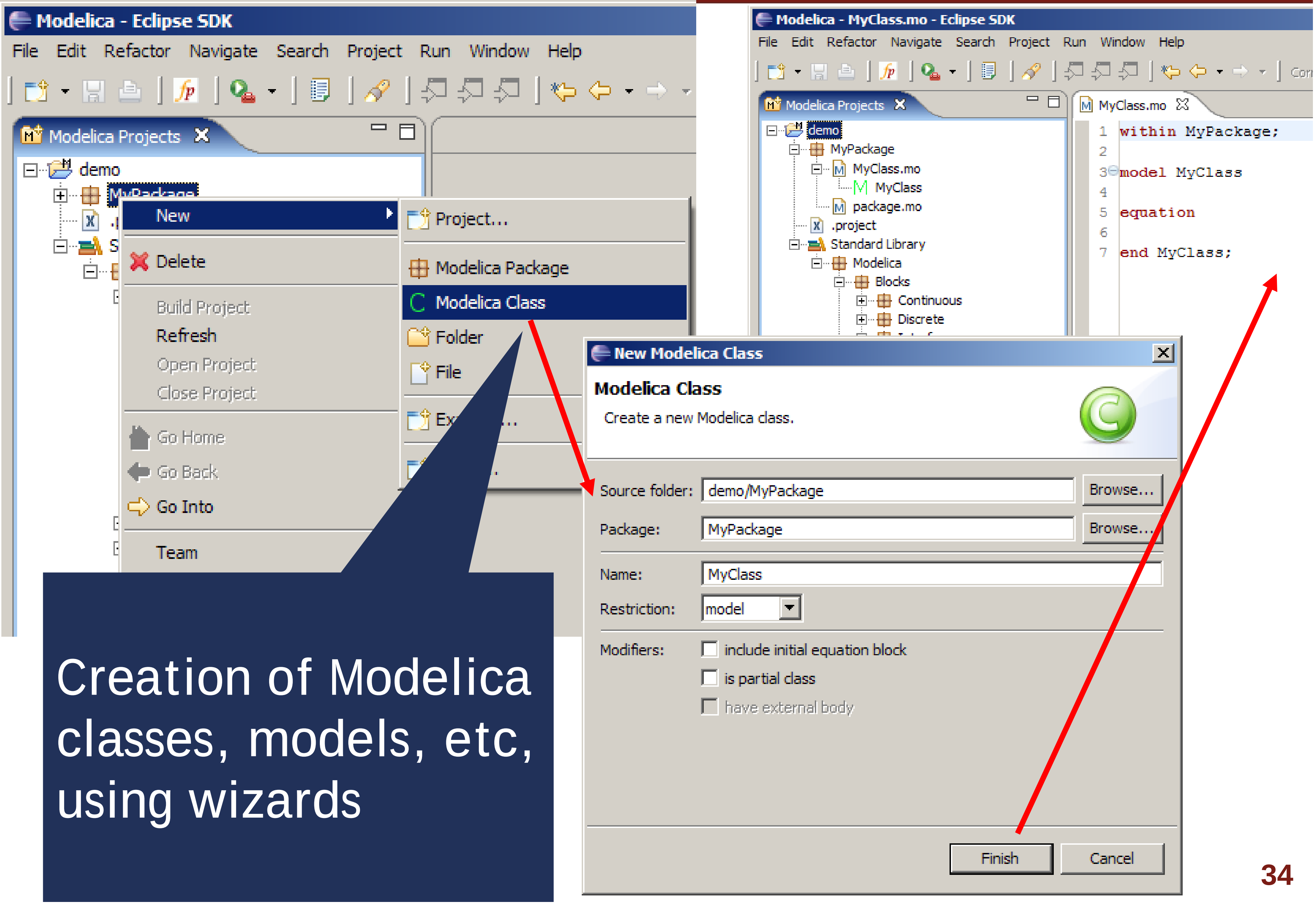
Name: MyPackage

Description: A Modelica Package

□ is encapsulated package

Creation of Modelica packages using wizards

Creating Modelica classes



```
within MyPackage;

model MyClass

equation

end MyClass;
```

New Modelica Class

Modelica Class

Create a new Modelica class.

Source folder: demo/MyPackage

Package: MyPackage

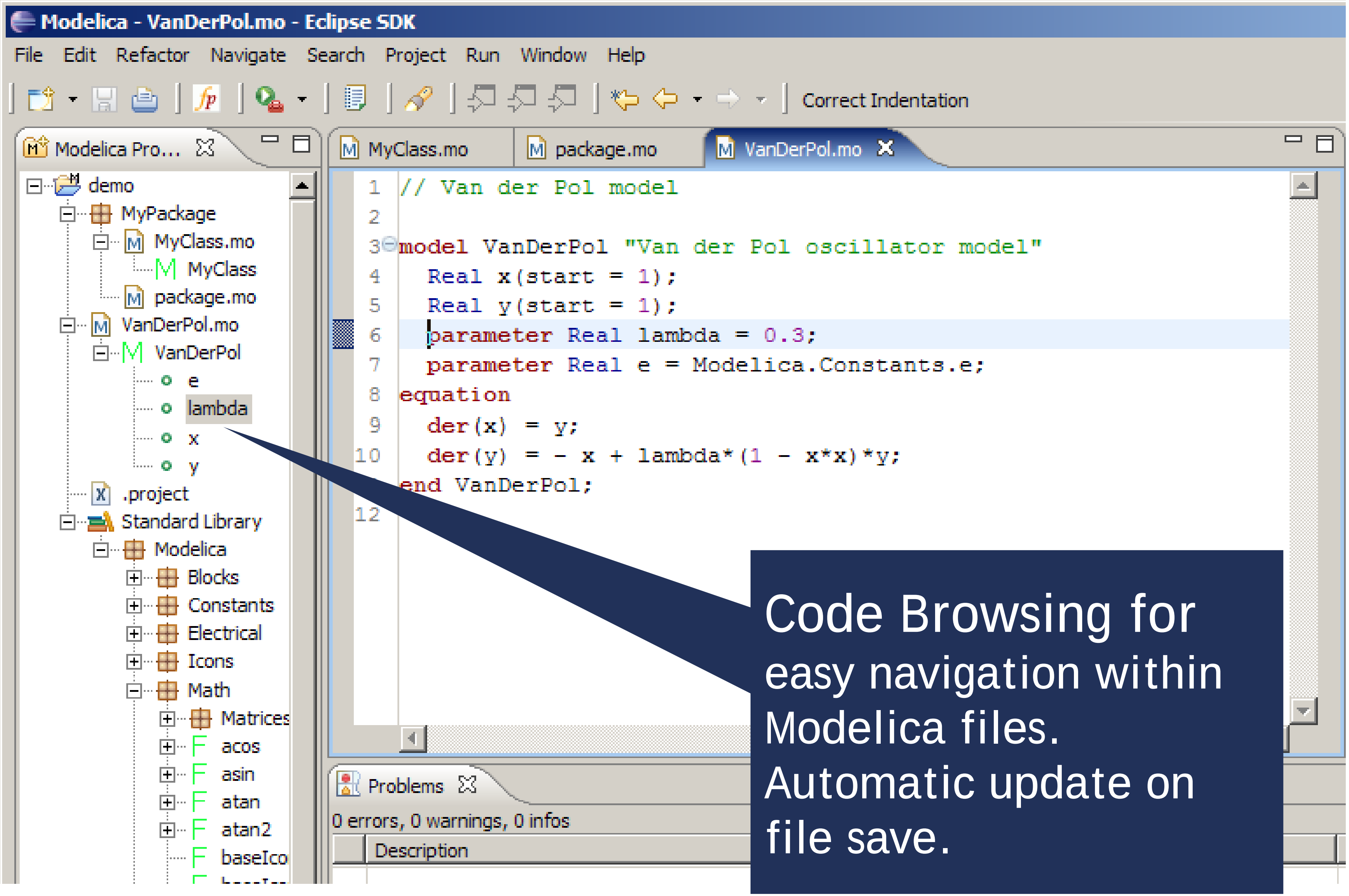
Name: MyClass

Restriction: model

Modifiers:
□ include initial equation block
□ is partial class
□ have external body

Creation of Modelica classes, models, etc, using wizards

Code browsing

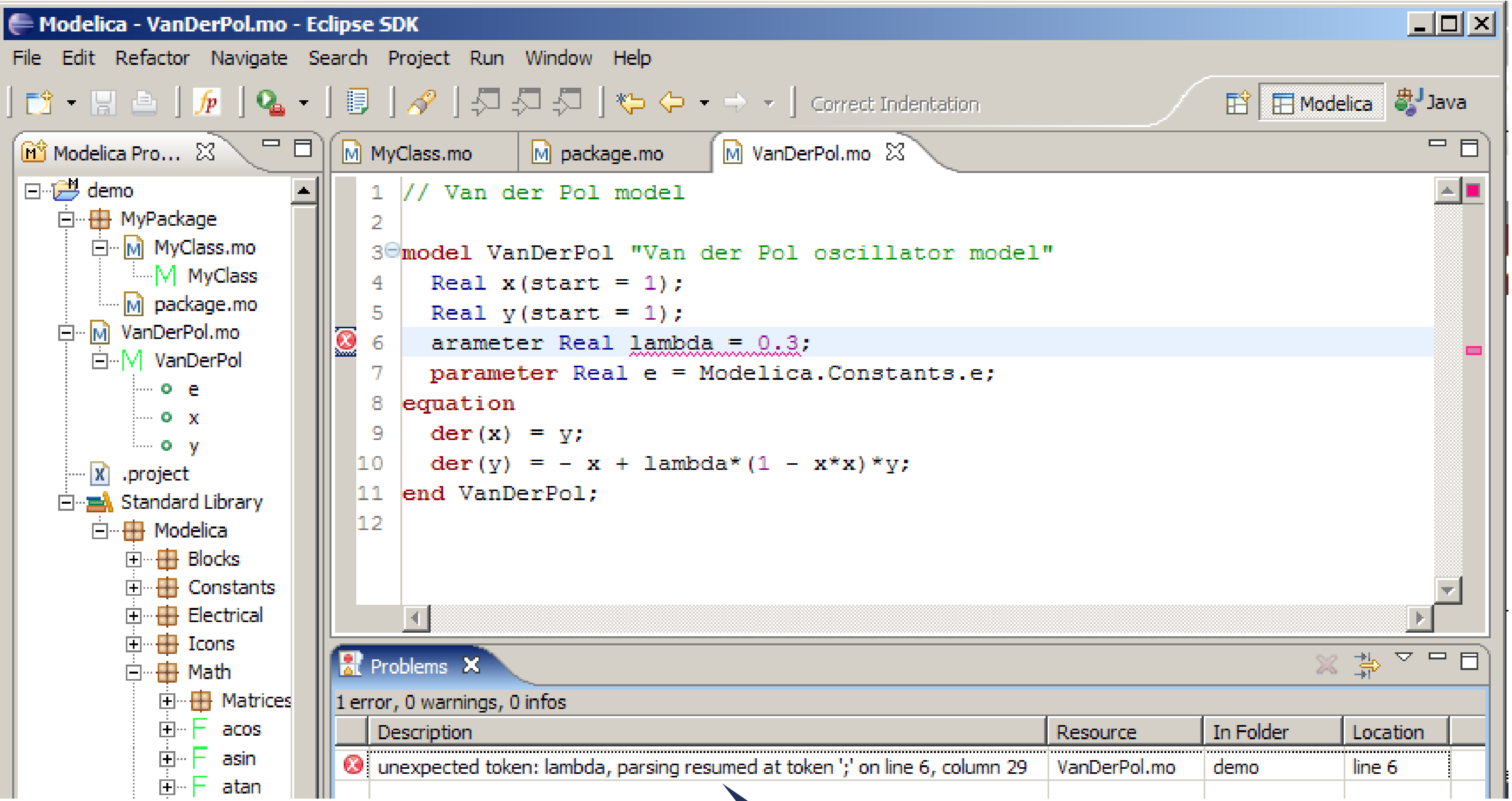


```
// Van der Pol model

model VanDerPol "Van der Pol oscillator model"
  Real x(start = 1);
  Real y(start = 1);
  parameter Real lambda = 0.3;
  parameter Real e = Modelica.Constants.e;
equation
  der(x) = y;
  der(y) = - x + lambda*(1 - x*x)*y;
end VanDerPol;
```

Code Browsing for easy navigation within Modelica files. Automatic update on file save.

Error detection (I)



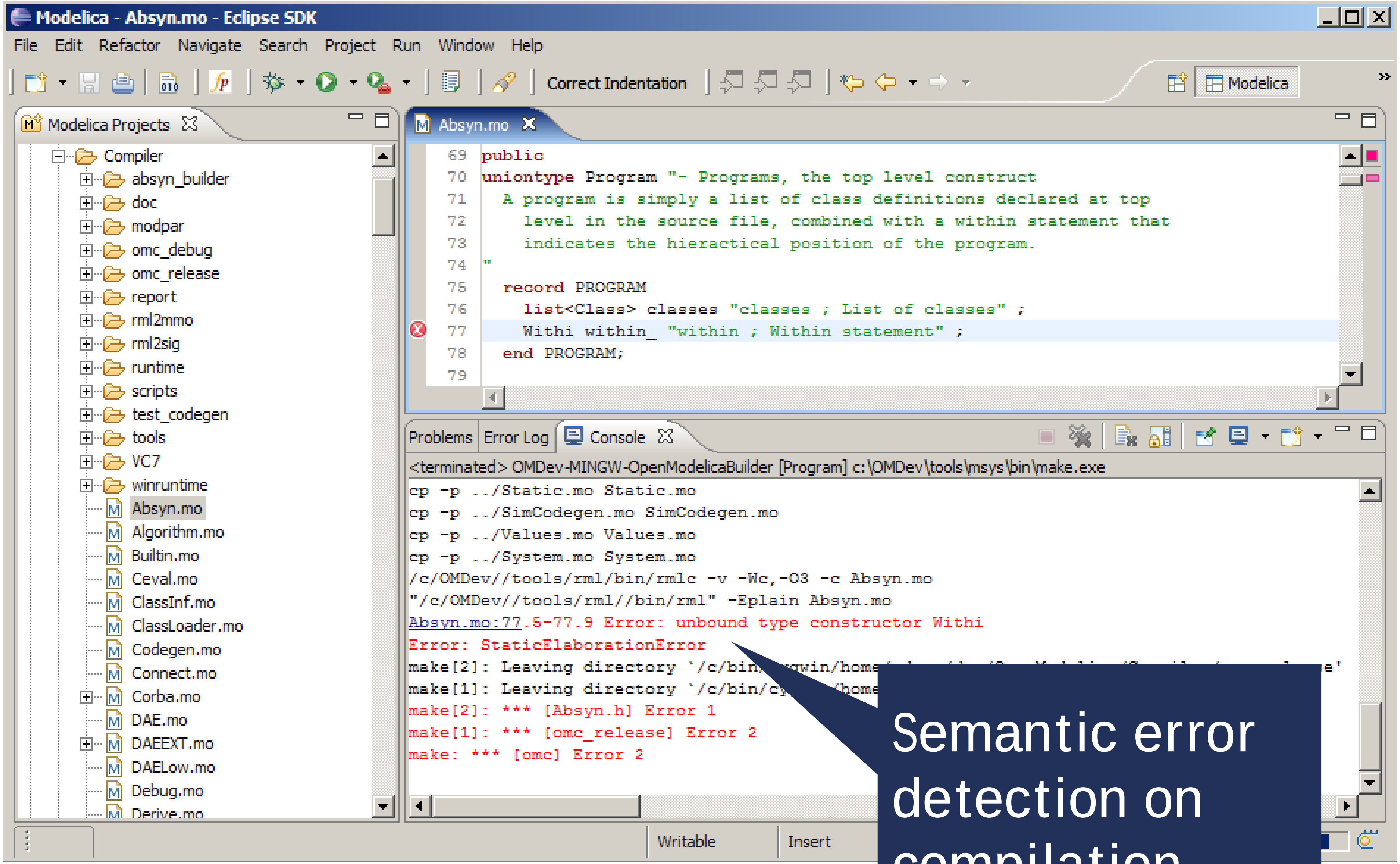
```
 1 // Van der Pol model
 2
 3 model VanDerPol "Van der Pol oscillator model"
 4   Real x(start = 1);
 5   Real y(start = 1);
 6   arameter Real lambda = 0.3;
 7   parameter Real e = Modelica.Constants.e;
 8 equation
 9   der(x) = y;
10   der(y) = - x + lambda*(1 - x*x)*y;
11 end VanDerPol;
12
```

1 error, 0 warnings, 0 infos

Description	Resource	In Folder	Location
unexpected token: lambda, parsing resumed at token ';' on line 6, column 29	VanDerPol.mo	demo	line 6

Parse error detection on file save

Error detection (II)

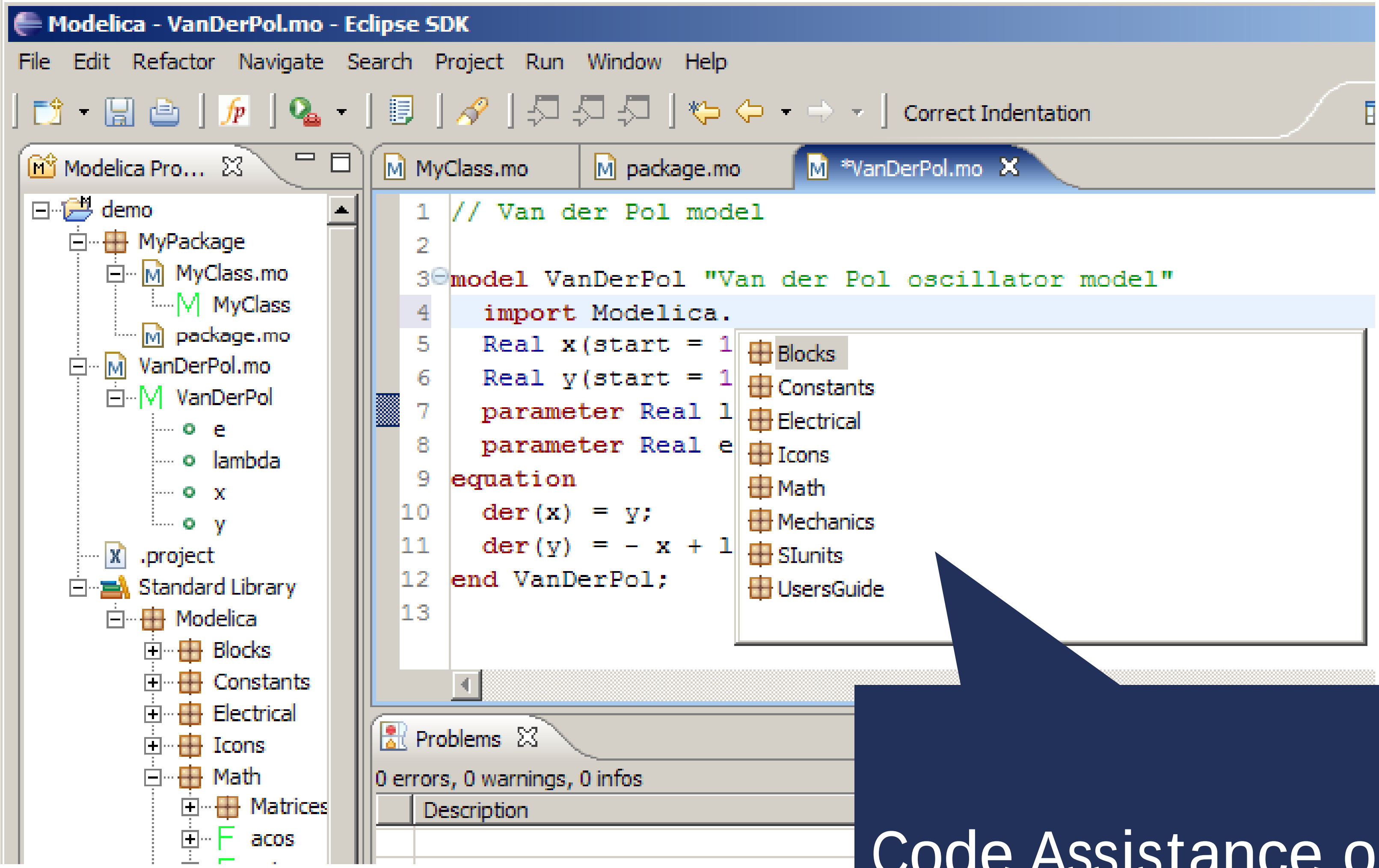


```
public
uniontype Program "- Programs, the top level construct
  A program is simply a list of class definitions declared at top
    level in the source file, combined with a within statement that
    indicates the hieractical position of the program.
"
  record PROGRAM
    list<Class> classes "classes ; List of classes" ;
    Withi within_ "within ; Within statement" ;
  end PROGRAM;
```

```
<terminated> OMDev-MINGW-OpenModelicaBuilder [Program] c:\OMDev\tools\msys\bin\make.exe
cp -p ../Static.mo Static.mo
cp -p ../SimCodegen.mo SimCodegen.mo
cp -p ../Values.mo Values.mo
cp -p ../System.mo System.mo
/c/OMDev//tools/rml/bin/rmlc -v -Wc,-O3 -c Absyn.mo
"/c/OMDev//tools/rml//bin/rml" -Eplain Absyn.mo
Absyn.mo:77.5-77.9 Error: unbound type constructor Withi
Error: StaticElaborationError
make[2]: Leaving directory `/c/bin/
make[1]: Leaving directory `/c/bin/cy
make[2]: *** [Absyn.h] Error 1
make[1]: *** [omc_release] Error 2
make: *** [omc] Error 2
```

Semantic error detection on compilation

Code assistance (I)



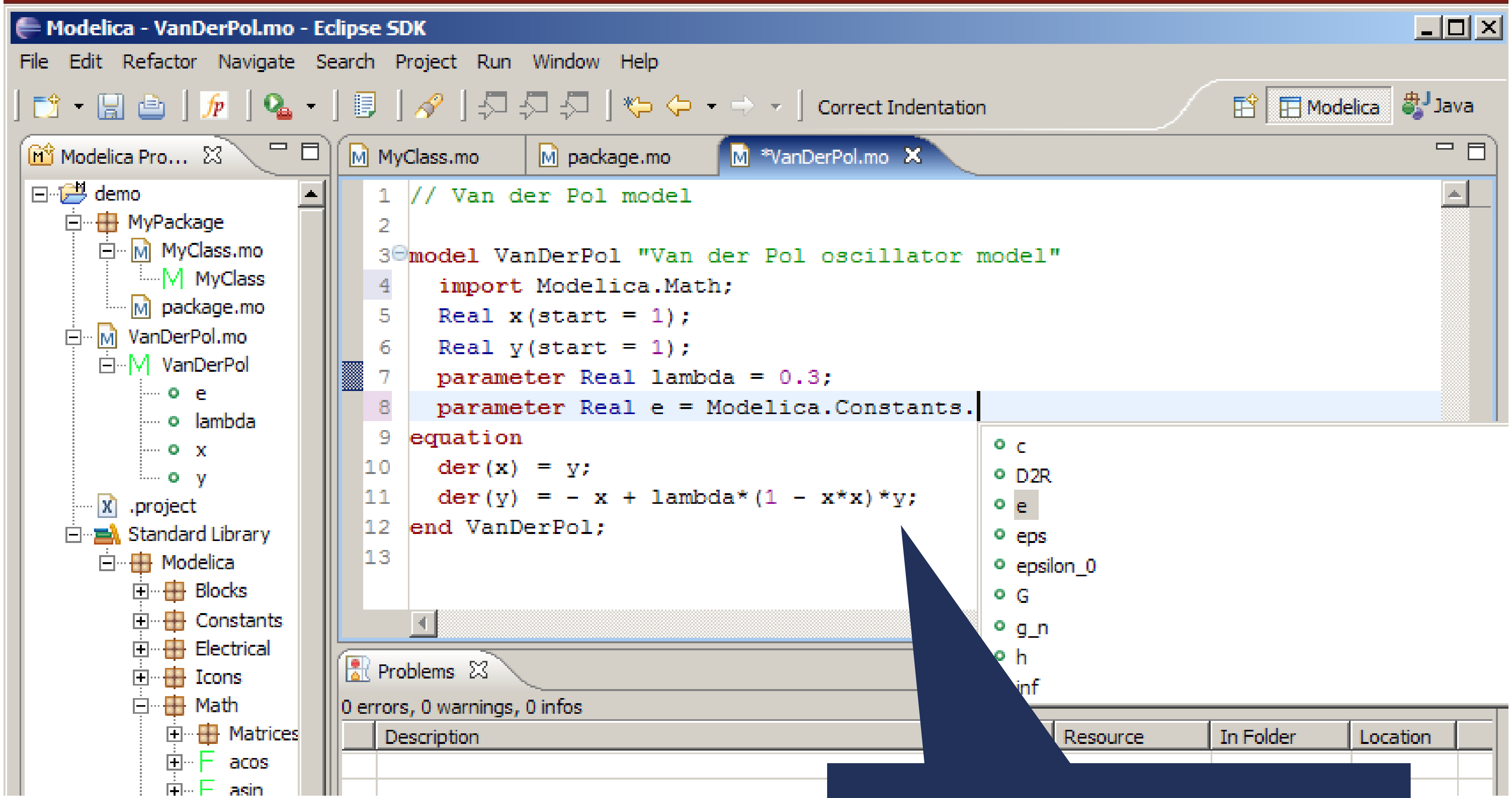
```
// Van der Pol model

model VanDerPol "Van der Pol oscillator model"
  import Modelica.
  Real x(start = 1
  Real y(start = 1
  parameter Real l
  parameter Real e
equation
  der(x) = y;
  der(y) = - x + l
end VanDerPol;
```

0 errors, 0 warnings, 0 infos

Code Assistance on imports

Code assistance (II)



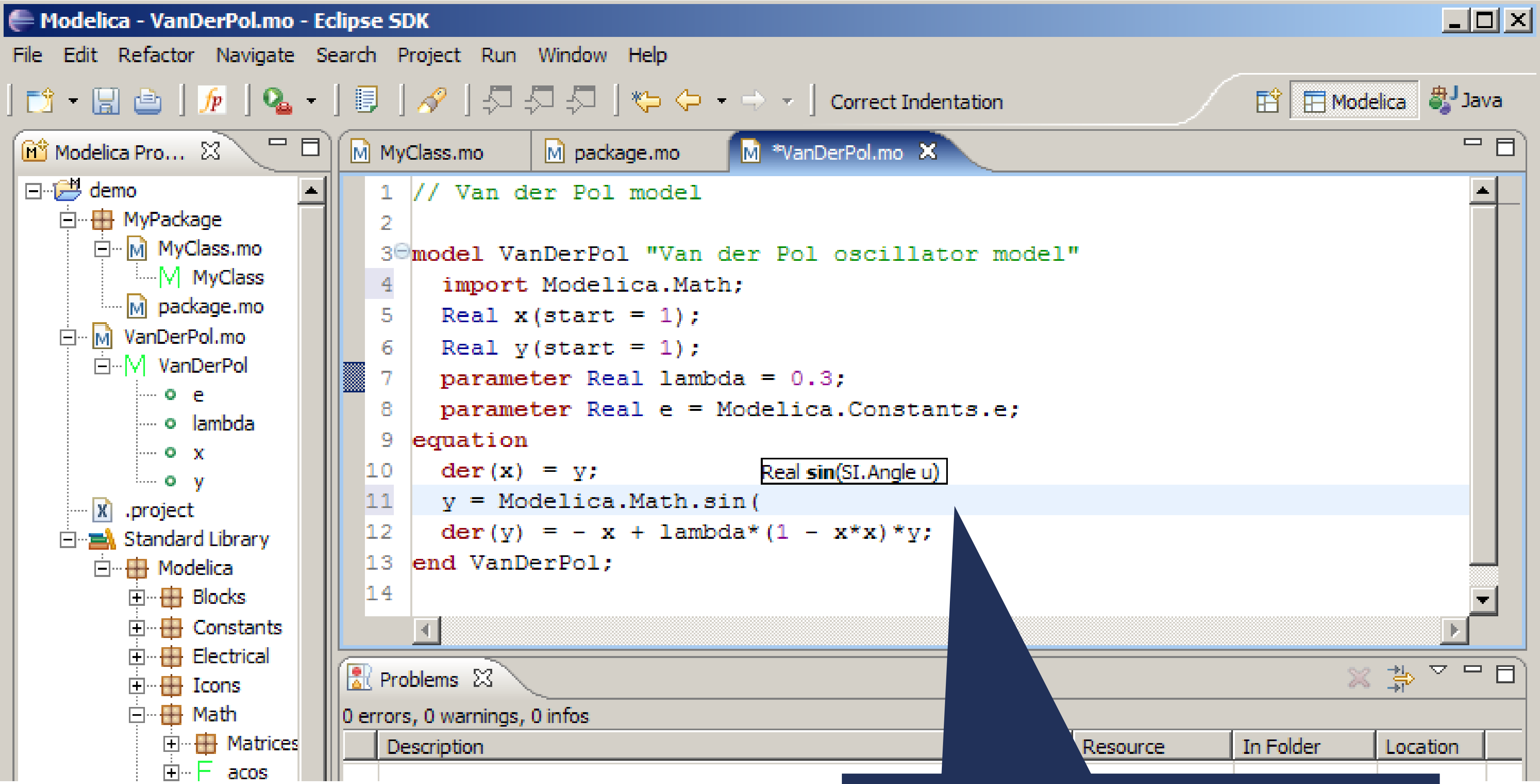
```
// Van der Pol model

model VanDerPol "Van der Pol oscillator model"
  import Modelica.Math;
  Real x(start = 1);
  Real y(start = 1);
  parameter Real lambda = 0.3;
  parameter Real e = Modelica.Constants.
equation
  der(x) = y;
  der(y) = - x + lambda*(1 - x*x)*y;
end VanDerPol;
```

0 errors, 0 warnings, 0 infos

Code Assistance on assignments

Code assistance (III)



```
// Van der Pol model

model VanDerPol "Van der Pol oscillator model"
  import Modelica.Math;
  Real x(start = 1);
  Real y(start = 1);
  parameter Real lambda = 0.3;
  parameter Real e = Modelica.Constants.e;
equation
  der(x) = y;
  y = Modelica.Math.sin(
  der(y) = - x + lambda*(1 - x*x)*y;
end VanDerPol;
```

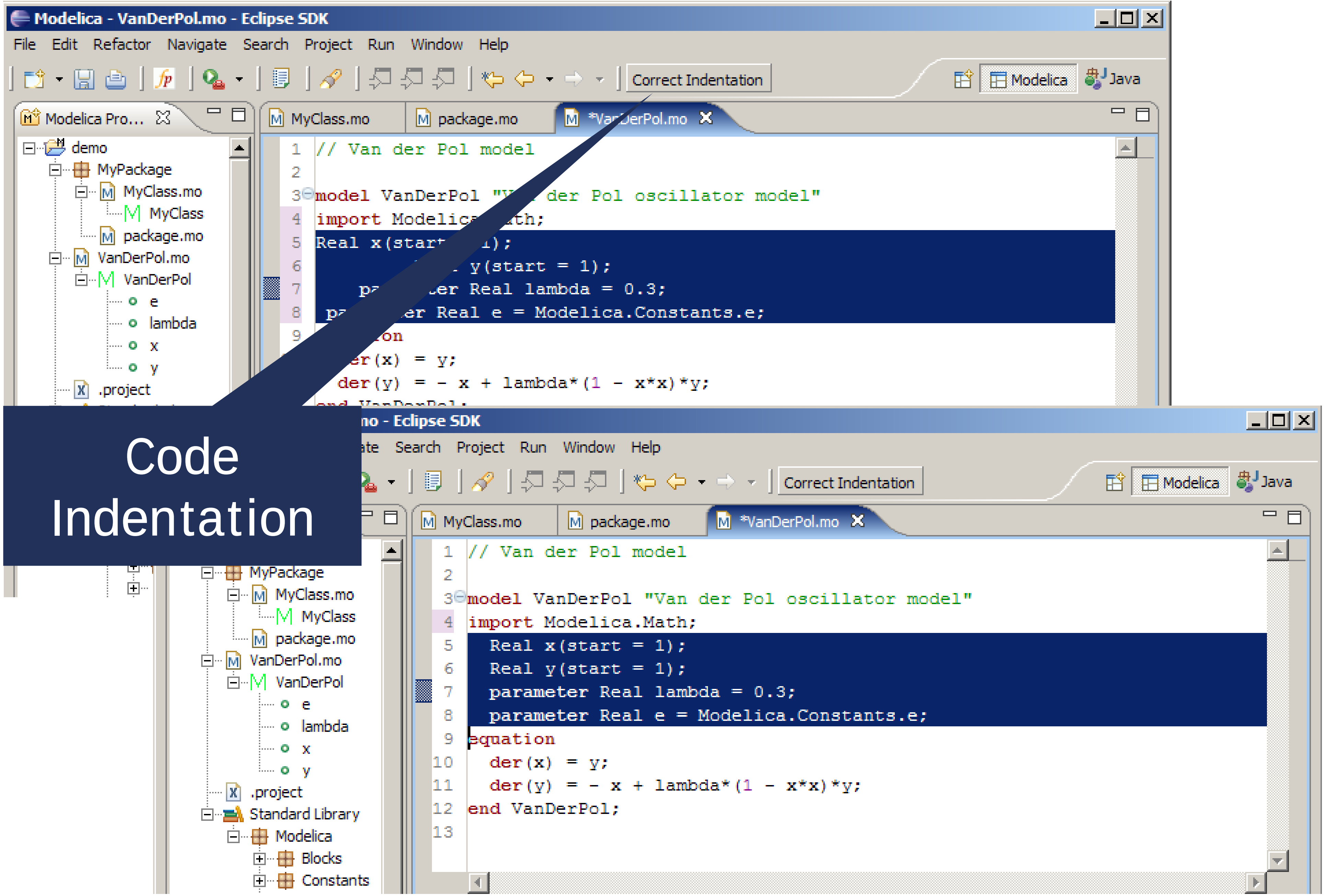
Real **sin**(SI.Angle u)

0 errors, 0 warnings, 0 infos

Description	Resource	In Folder	Location

Code Assistance on function calls

Code indentation



Code Indentation

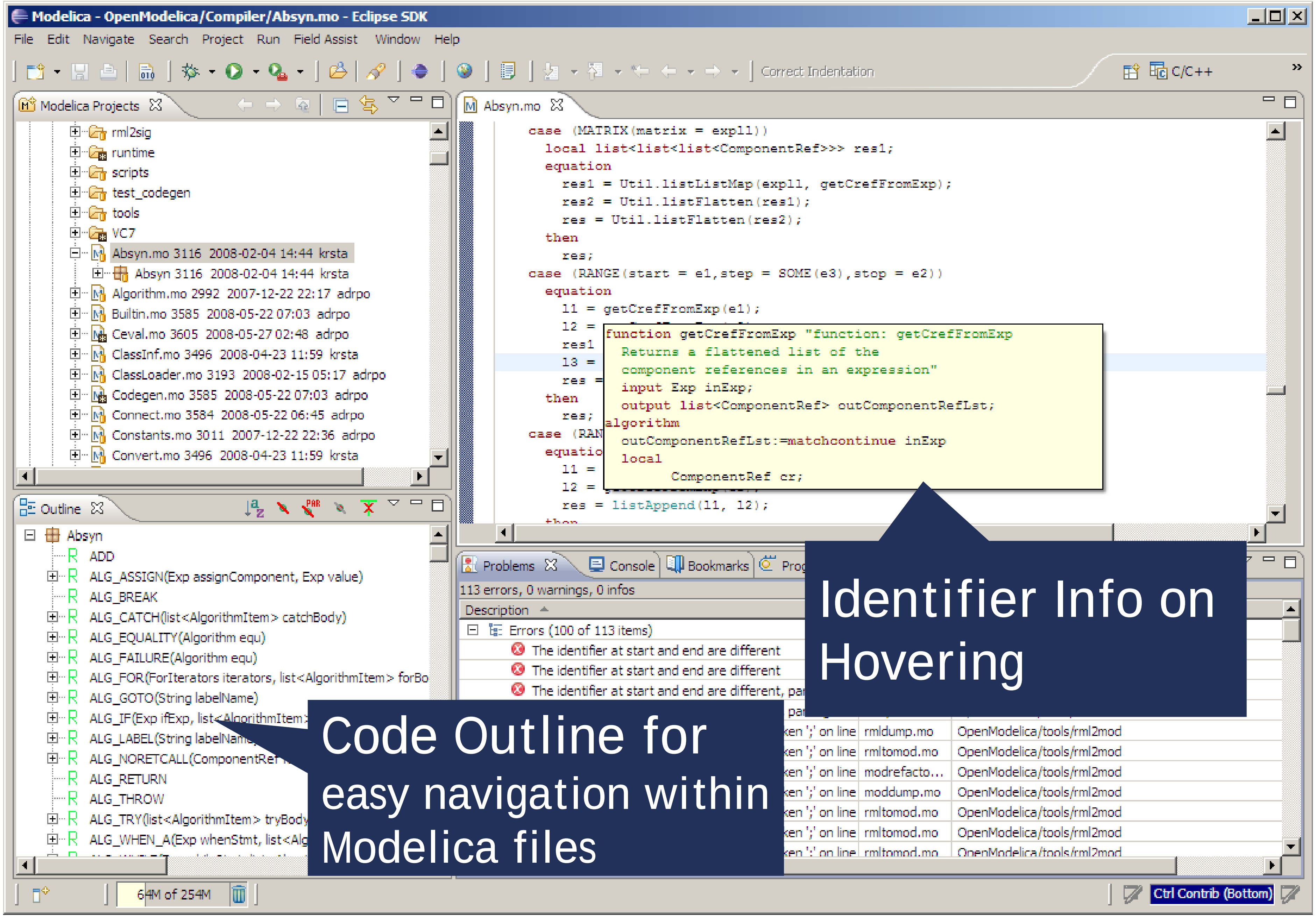
```
// Van der Pol model

model VanDerPol "V    der Pol oscillator model"
import Modelica    ath;
Real x(start    1);
           y(start = 1);
    pa    ter Real lambda = 0.3;
 pa    er Real e = Modelica.Constants.e;
         on
      er(x) = y;
  der(y) = - x + lambda*(1 - x*x)*y;
```

```
// Van der Pol model

model VanDerPol "Van der Pol oscillator model"
import Modelica.Math;
  Real x(start = 1);
  Real y(start = 1);
  parameter Real lambda = 0.3;
  parameter Real e = Modelica.Constants.e;
equation
  der(x) = y;
  der(y) = - x + lambda*(1 - x*x)*y;
end VanDerPol;
```

Code Outline and Hovering Info


Modelica - OpenModelica/Compiler/Absyn.mo - Eclipse SDK
File Edit Navigate Search Project Run Field Assist Window Help
Correct Indentation
C/C++
Modelica Projects
Absyn.mo
Outline
Problems
Console
Bookmarks
Prog
64M of 254M
Ctrl Contrib (Bottom)

rml2sig
runtime
scripts
test_codegen
tools
VC7
Absyn.mo 3116 2008-02-04 14:44 krsta
Absyn 3116 2008-02-04 14:44 krsta
Algorithm.mo 2992 2007-12-22 22:17 adrpo
Builtin.mo 3585 2008-05-22 07:03 adrpo
Ceval.mo 3605 2008-05-27 02:48 adrpo
ClassInf.mo 3496 2008-04-23 11:59 krsta
ClassLoader.mo 3193 2008-02-15 05:17 adrpo
Codegen.mo 3585 2008-05-22 07:03 adrpo
Connect.mo 3584 2008-05-22 06:45 adrpo
Constants.mo 3011 2007-12-22 22:36 adrpo
Convert.mo 3496 2008-04-23 11:59 krsta

```
    case (MATRIX(matrix = expll))
      local list<list<list<ComponentRef>>> res1;
      equation
        res1 = Util.listListMap(expll, getCrefFromExp);
        res2 = Util.listFlatten(res1);
        res = Util.listFlatten(res2);
      then
        res;
    case (RANGE(start = e1,step = SOME(e3),stop = e2))
      equation
        l1 = getCrefFromExp(e1);
        l2 =
        res1
        l3 =
        res =
      then
        res;
    case (RAN
      equatio
        l1 =
        l2 =
        res = listAppend(l1, l2);
```

```
function getCrefFromExp "function: getCrefFromExp
  Returns a flattened list of the
  component references in an expression"
  input Exp inExp;
  output list<ComponentRef> outComponentRefLst;
algorithm
  outComponentRefLst:=matchcontinue inExp
  local
        ComponentRef cr;
```

Absyn
R ADD
R ALG_ASSIGN(Exp assignComponent, Exp value)
R ALG_BREAK
R ALG_CATCH(list<AlgorithmItem> catchBody)
R ALG_EQUALITY(Algorithm equ)
R ALG_FAILURE(Algorithm equ)
R ALG_FOR(ForIterators iterators, list<AlgorithmItem> forBo
R ALG_GOTO(String labelName)
R ALG_IF(Exp ifExp, list<AlgorithmItem>
R ALG_LABEL(String labelNam
R ALG_NORETCALL(ComponentRef
R ALG_RETURN
R ALG_THROW
R ALG_TRY(list<AlgorithmItem> tryBody
R ALG_WHEN_A(Exp whenStmt, list<Alg

113 errors, 0 warnings, 0 infos

Description

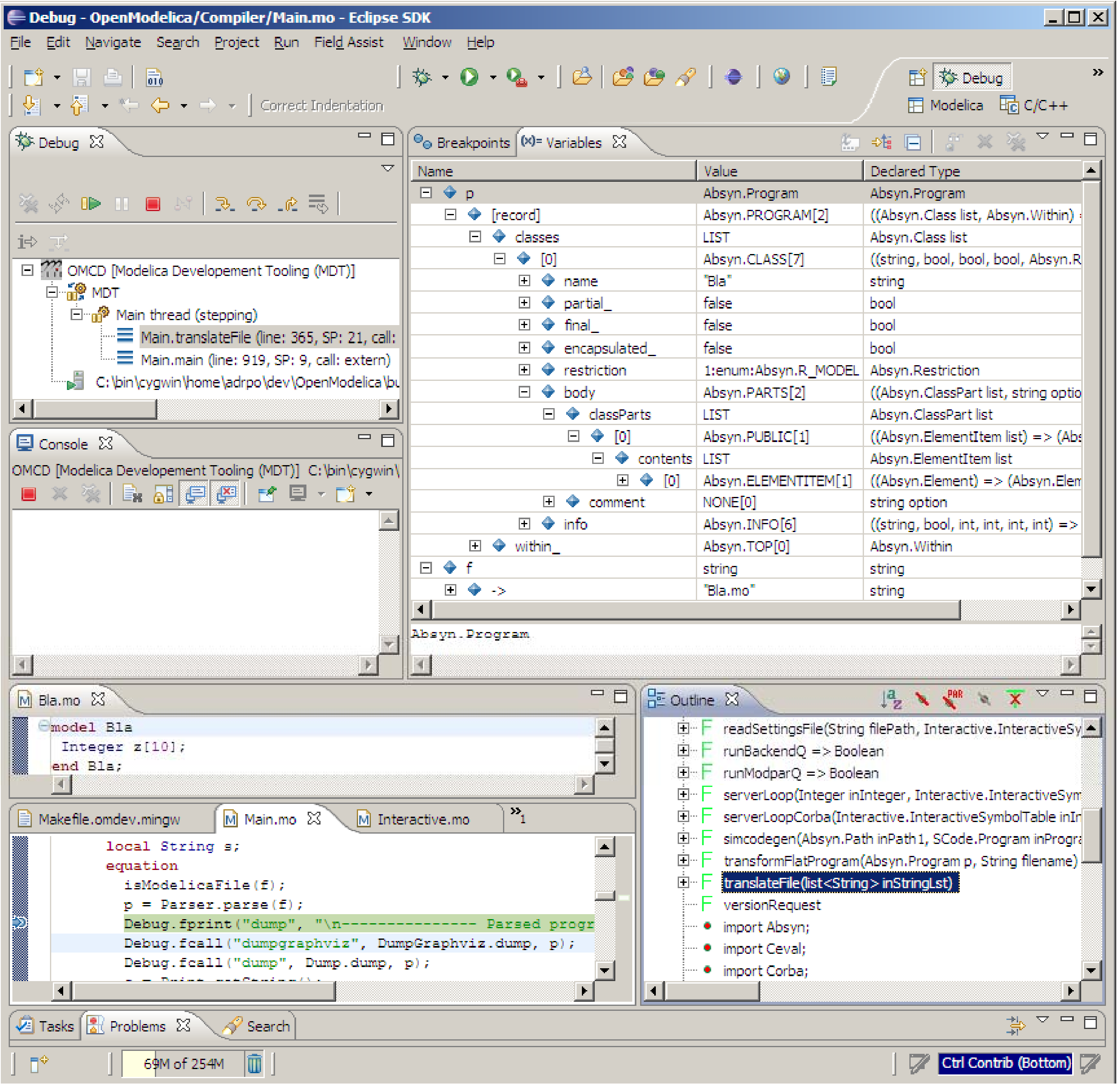
Errors (100 of 113 items)
The identifier at start and end are different
The identifier at start and end are different
The identifier at start and end are different, par
par

ken ';' on line	rmldump.mo	OpenModelica/tools/rml2mod
ken ';' on line	rmltomod.mo	OpenModelica/tools/rml2mod
ken ';' on line	modrefacto...	OpenModelica/tools/rml2mod
ken ';' on line	moddump.mo	OpenModelica/tools/rml2mod
ken ';' on line	rmltomod.mo	OpenModelica/tools/rml2mod
ken ';' on line	rmltomod.mo	OpenModelica/tools/rml2mod
ken ';' on line	rmltomod.mo	OpenModelica/tools/rml2mod

Identifier Info on Hovering

Code Outline for easy navigation within Modelica files

Eclipse Debugging Environment



OMCD [Modelica Developement Tooling (MDT)]
MDT
Main thread (stepping)
Main.translateFile (line: 365, SP: 21, call:
Main.main (line: 919, SP: 9, call: extern)
C:\bin\cygwin\home\adrpo\dev\OpenModelica\bu

Name	Value	Declared Type
p	Absyn.Program	Absyn.Program
[record]	Absyn.PROGRAM[2]	((Absyn.Class list, Absyn.Within)
classes	LIST	Absyn.Class list
[0]	Absyn.CLASS[7]	((string, bool, bool, bool, Absyn.R
name	"Bla"	string
partial_	false	bool
final_	false	bool
encapsulated_	false	bool
restriction	1:enum:Absyn.R_MODEL	Absyn.Restriction
body	Absyn.PARTS[2]	((Absyn.ClassPart list, string optio
classParts	LIST	Absyn.ClassPart list
[0]	Absyn.PUBLIC[1]	((Absyn.ElementItem list) => (Abs
contents	LIST	Absyn.ElementItem list
[0]	Absyn.ELEMENTITEM[1]	((Absyn.Element) => (Absyn.Elem
comment	NONE[0]	string option
info	Absyn.INFO[6]	((string, bool, int, int, int, int) =>
within_	Absyn.TOP[0]	Absyn.Within
f	string	string
->	"Bla.mo"	string

```
Absyn.Program
```

OMCD [Modelica Developement Tooling (MDT)] C:\bin\cygwin\

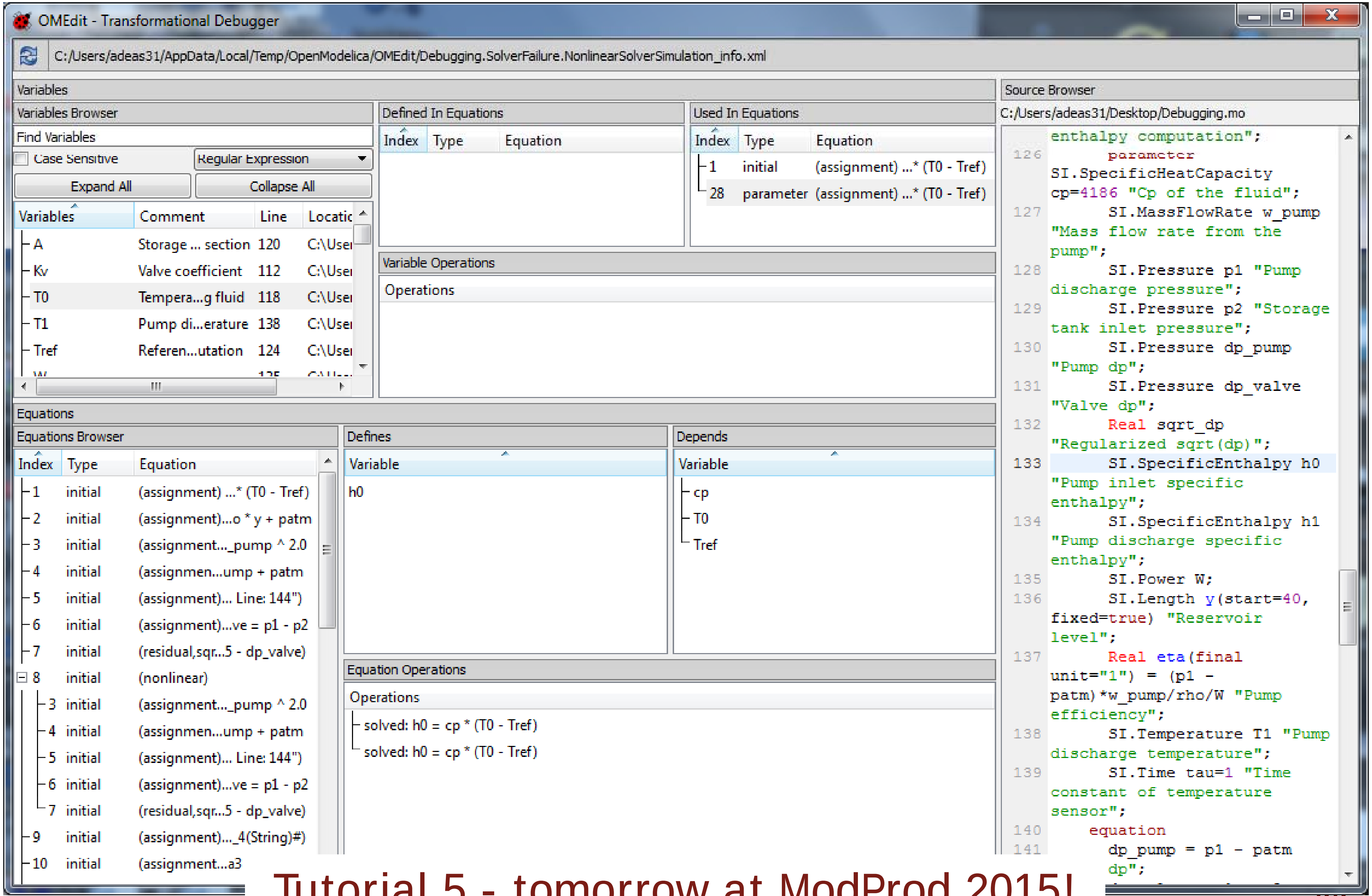
```
model Bla
 Integer z[10];
end Bla;
```

```
     local String s;
     equation
       isModelicaFile(f);
       p = Parser.parse(f);
       Debug.fprint("dump", "\n---------------- Parsed progr
       Debug.fcall("dumpgraphviz", DumpGraphviz.dump, p);
       Debug.fcall("dump", Dump.dump, p);
```

readSettingsFile(String filePath, Interactive.InteractiveSy
runBackendQ => Boolean
runModparQ => Boolean
serverLoop(Integer inInteger, Interactive.InteractiveSym
serverLoopCorba(Interactive.InteractiveSymbolTable inIr
simcodegen(Absyn.Path inPath1, SCode.Program inProgra
transformFlatProgram(Absyn.Program p, String filename)
translateFile(list<String> inStringLst)
versionRequest
import Absyn;
import Ceval;
import Corba;

- Type information for all variables
- Browsing of complex data structures
- GDB based

OMEdit Debugging Environment



OMEdit - Transformational Debugger

C:/Users/adeas31/AppData/Local/Temp/OpenModelica/OMEdit/Debugging.SolverFailure.NonlinearSolverSimulation_info.xml

Variables

Variables Browser

Find Variables

□ Case Sensitive   Regular Expression

Expand All   Collapse All

Variables	Comment	Line	Locatic
A	Storage ... section	120	C:\User
Kv	Valve coefficient	112	C:\User
T0	Tempera...g fluid	118	C:\User
T1	Pump di...erature	138	C:\User
Tref	Referen...utation	124	C:\User

Defined In Equations

Index	Type	Equation

Used In Equations

Index	Type	Equation
1	initial	(assignment) ...* (T0 - Tref)
28	parameter	(assignment) ...* (T0 - Tref)

Variable Operations

Operations

Equations

Equations Browser

Index	Type	Equation
1	initial	(assignment) ...* (T0 - Tref)
2	initial	(assignment)...o * y + patm
3	initial	(assignment..._pump ^ 2.0
4	initial	(assignmen...ump + patm
5	initial	(assignment)... Line: 144")
6	initial	(assignment)...ve = p1 - p2
7	initial	(residual,sqr...5 - dp_valve)
8	initial	(nonlinear)
3	initial	(assignment..._pump ^ 2.0
4	initial	(assignmen...ump + patm
5	initial	(assignment)... Line: 144")
6	initial	(assignment)...ve = p1 - p2
7	initial	(residual,sqr...5 - dp_valve)
9	initial	(assignment)..._4(String)#)
10	initial	(assignment...a3

Defines

Variable
h0

Depends

Variable
cp
T0
Tref

Equation Operations

Operations

solved: h0 = cp * (T0 - Tref)

solved: h0 = cp * (T0 - Tref)

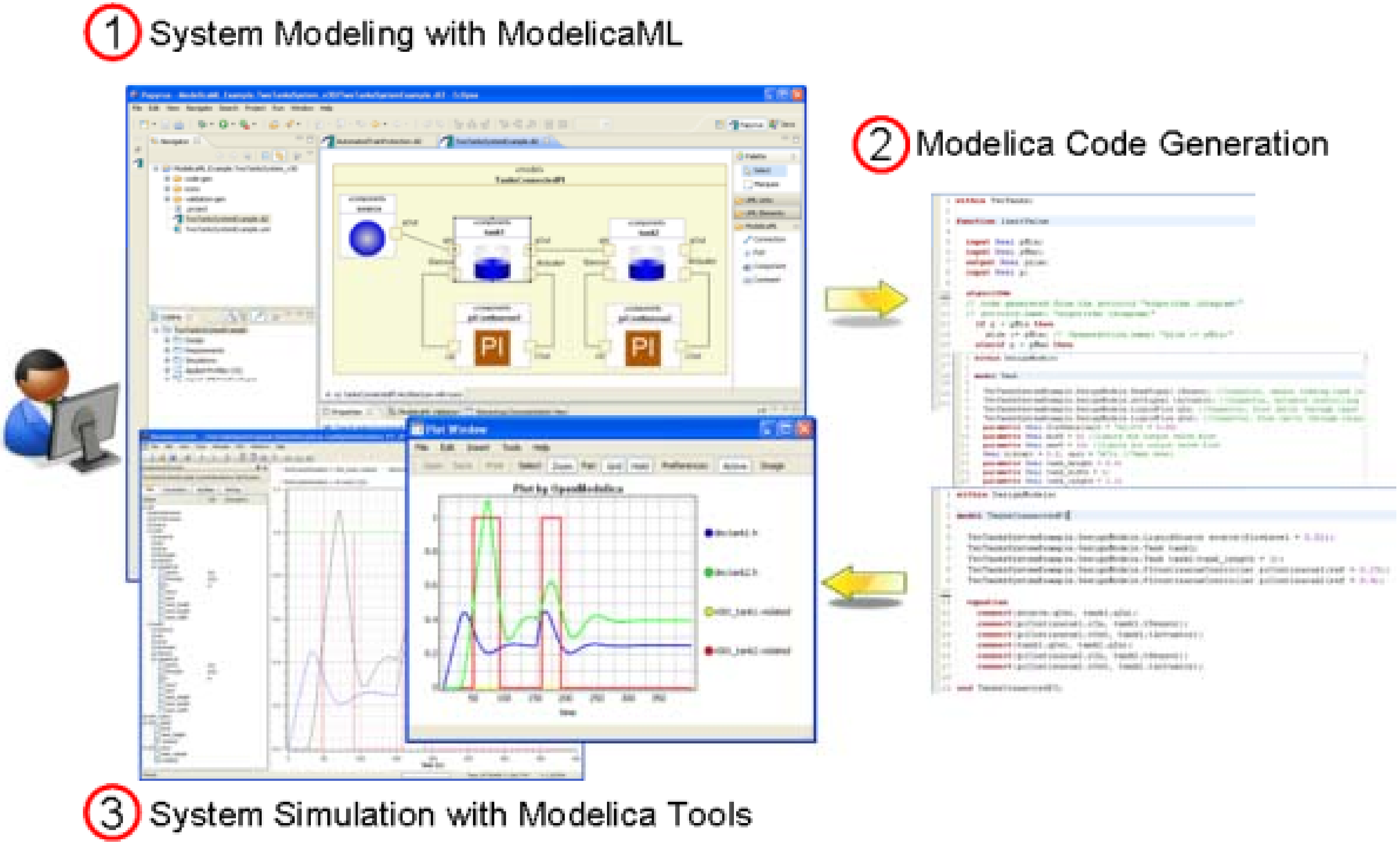
Source Browser

C:/Users/adeas31/Desktop/Debugging.mo

```
enthalpy computation";
        parameter
SI.SpecificHeatCapacity
cp=4186 "Cp of the fluid";
        SI.MassFlowRate w_pump
"Mass flow rate from the
pump";
        SI.Pressure p1 "Pump
discharge pressure";
        SI.Pressure p2 "Storage
tank inlet pressure";
        SI.Pressure dp_pump
"Pump dp";
        SI.Pressure dp_valve
"Valve dp";
        Real sqrt_dp
"Regularized sqrt(dp)";
        SI.SpecificEnthalpy h0
"Pump inlet specific
enthalpy";
        SI.SpecificEnthalpy h1
"Pump discharge specific
enthalpy";
        SI.Power W;
        SI.Length y(start=40,
fixed=true) "Reservoir
level";
        Real eta(final
unit="1") = (p1 -
patm)*w_pump/rho/W "Pump
efficiency";
        SI.Temperature T1 "Pump
discharge temperature";
        SI.Time tau=1 "Time
constant of temperature
sensor";
    equation
        dp_pump = p1 - patm
        dp";
```

Tutorial 5 - tomorrow at ModProd 2015!

Eclipse environment for ModelicaML



1 System Modeling with ModelicaML

2 Modelica Code Generation

3 System Simulation with Modelica Tools

Outline

- OpenModelica
  - What is OpenModelica?
  - The past
- OpenModelica Technical Overview
  - OMC, OMShell, OMNotebook
- OpenModelica Development Environment
  - MetaModelica
  - The Eclipse Environment
- OpenModelica Latest Developments (2014-2015)

Latest Developments (2014-2015)

- 2014 – 2015 – Most focus on libraries support & performance
  - MSL 3.2.1 (100% build/97% simulate), ModelicaTest 3.2.1, PetriNet, Buildings, PowerSystems, OpenHydraulics, ThermoPower, and ThermoSysPro
  - Switch to bootstrapped compiler

- Front-end, Back-end, Simulation Runtime, Graphical Clients
  - Development switched to bootstrapped compiler since November 2014
  - Partially new graph-based front-end with better support for libraries
  - Improved back-end: initialization, system solving, parallelization, cse optimization, dynamic optimization
  - Faster and much more user friendly OpenModelica Connection editor

- General
  - 4960 commits in subversion from Feb. 2014 to Feb., 2015
  - Bug fixes
  - Release 1.9.2 (Linux, Mac, Windows)

Latest Developments (2014-2015)

- Front-end issues fixed since Feb 2014
  - support for calling function via instance (MultiBody, VehicleDynamics, PowerTrain)
    world.gravityAcceleration(...)
  - handle same type with different redeclares (Media & Fluid)
    T x1(redeclare function f = f1)
    T x2(redeclare function f = f2)
  - better support for package constants (ExternalMedia, Media & Fluid)
  - fix remaining redeclare issues (Media.Examples.R134*)
- Front-end issues still in works
  - support for querying the instance of a flattened model
    needed for OMEdit handling of model structure
  - support for choicesAllMatching annotation (subtyping relationship of models/comps)
    needed for OMEdit handling of replaceable components/models
  - scalability & performance
    basically do things once and not several times
    separate lookup, modifier application, typing, array expansion, equation & connection handling, etc.
- General
  - 64 bit Windows versions

Thank You!

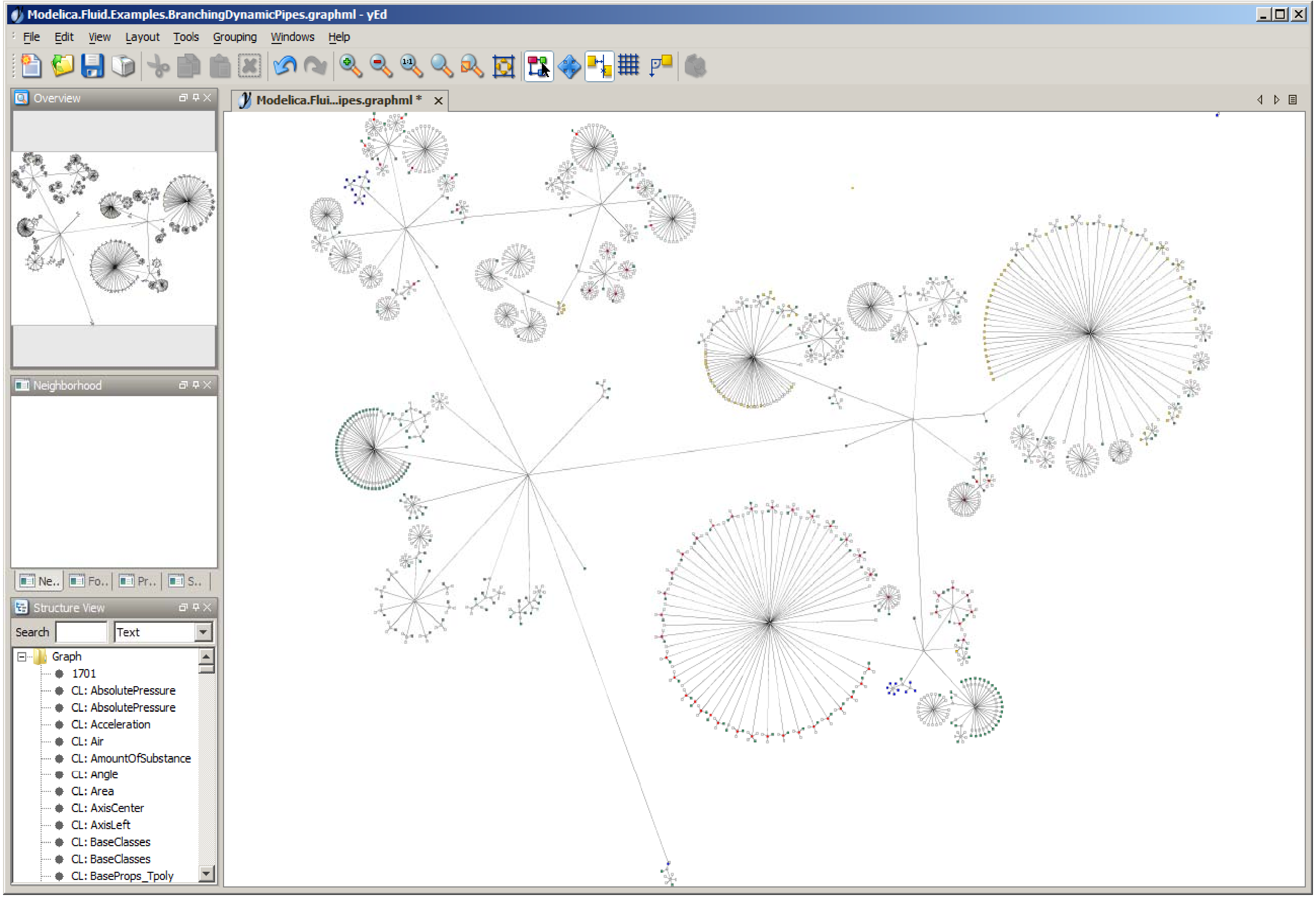
Questions?

asodja, sjoelund.se, sebco011, lochel, wbraun, niklwors, hubert.thieriot, petar, perost, Frenkel TUD, Unknown, syeas460, adeas31, ppriv, ricli576, haklu, dietmarw, levsa, mahge930, x05andfe, mohsen, nutaro, x02lucpo, florosx, x06hener, x07simbj, stebr461, x08joekl, x08kimja, Dongliang Li, jhare950, x97davka, krsta, edgarlopez, hanke, henjo, wuzhu.chen, fbergero, harka011, tmtuomas, bjozac, AlexeyLebedev, x06klasj, ankar, kajny, vasaie_p, niemisto, donida, hkiel, davbr, otto@mathcore.com, Kaie Kubjas, x06krino, afshe, x06mikbl, leonardo.laguna, petfr, dhedberg, g-karbe, x06henma, abhinnk, azazi, x02danhe, rruusu, x98petro, mater, g-bjoza, x02kajny, g-pavgr, x05andre, vaden, jansilar, ericmeyers, x05simel, andsa, leist, choeger, Ariel.Liebman, frisk, vaurich, mwalther, mtiller, ptauber, casella, vitalij, hkiel, janK, adrpo

OpenModelica Project

http://www.OpenModelica.org

Modelica.Fluid.Examples.BranchingDynamicPipes



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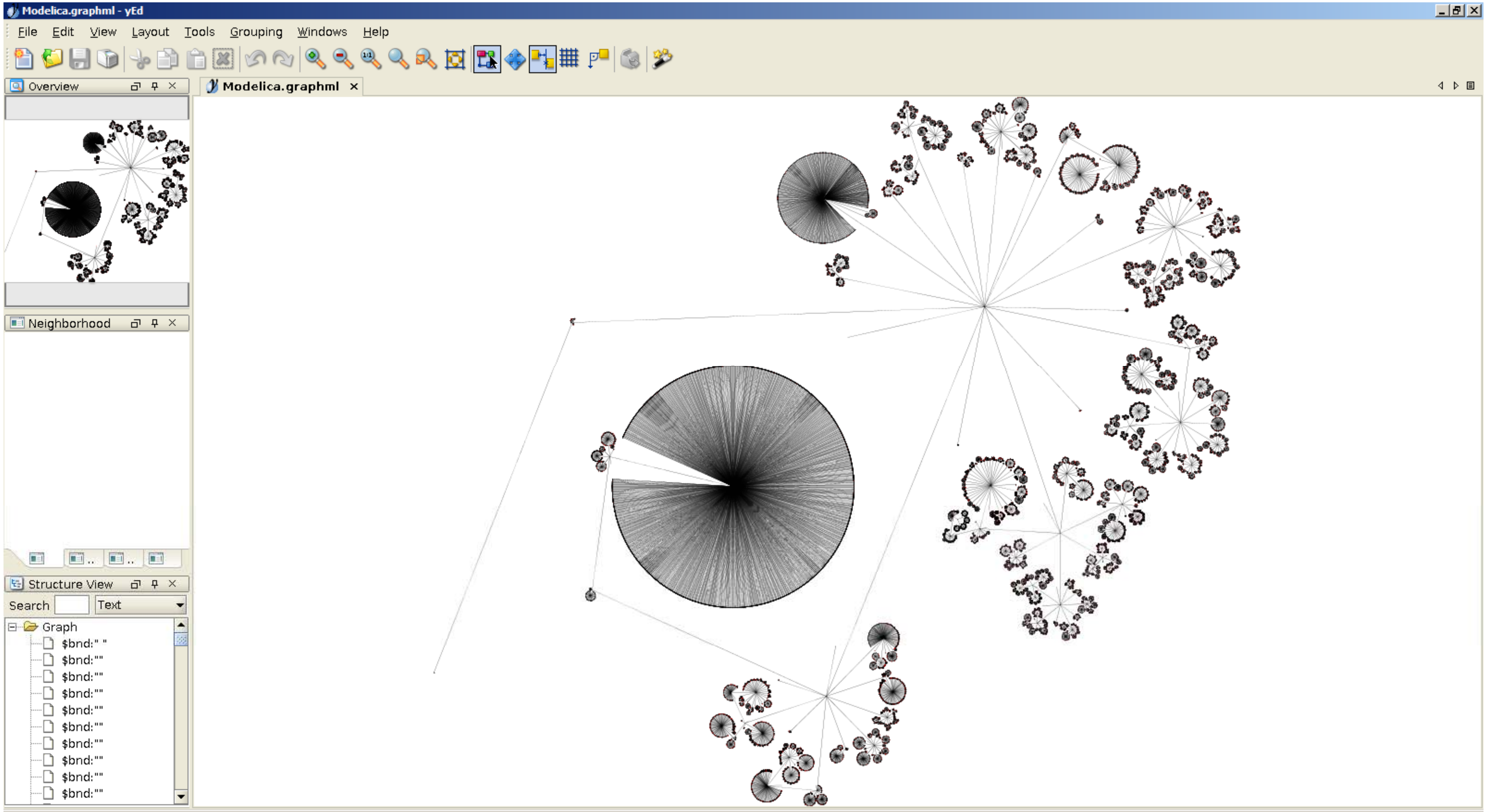
Text

- Graph
  - 1701
  - CL: AbsolutePressure
  - CL: AbsolutePressure
  - CL: Acceleration
  - CL: Air
  - CL: AmountOfSubstance
  - CL: Angle
  - CL: Area
  - CL: AxisCenter
  - CL: AxisLeft
  - CL: BaseClasses
  - CL: BaseClasses
  - CL: BaseProps_Tpoly

Modelica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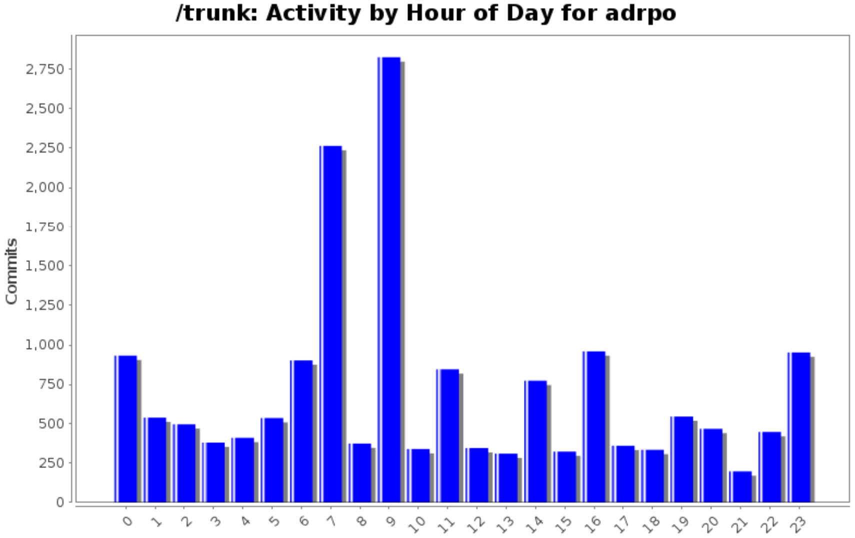
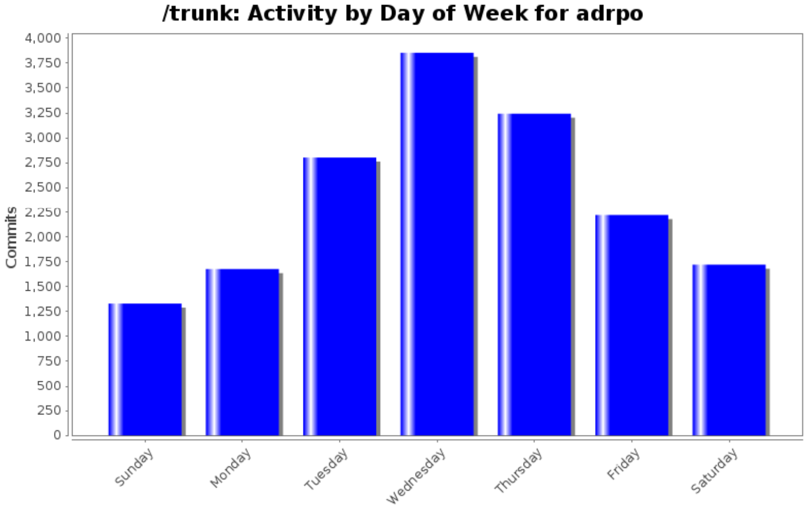
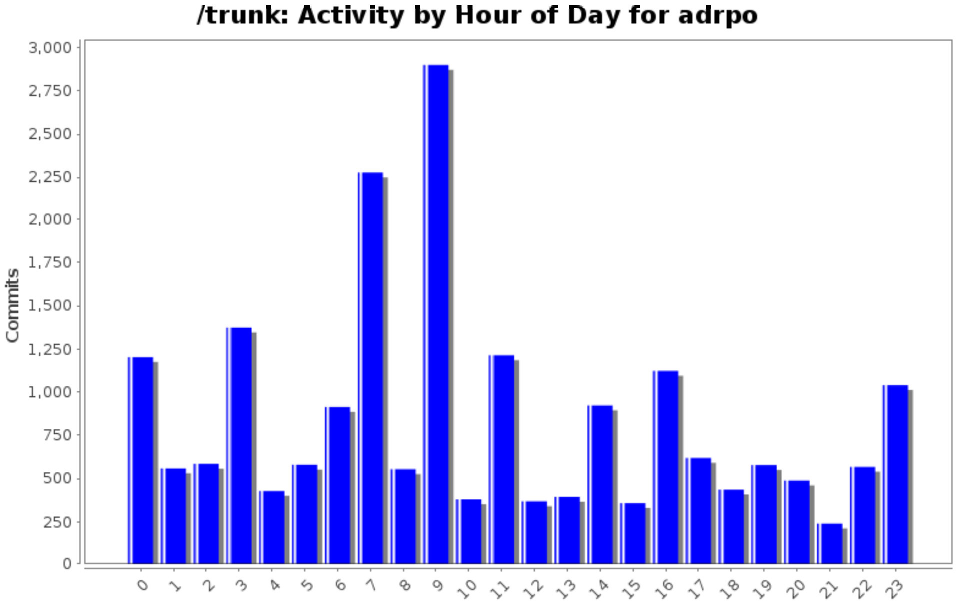
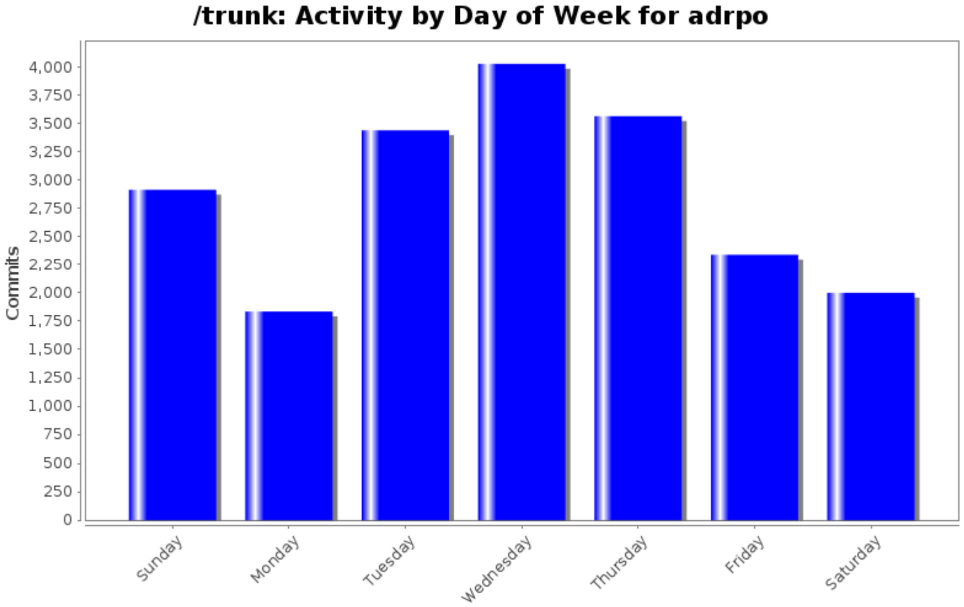
Funny Facts

- 2012 (left) vs. 2015 (right)


/trunk: Activity by Hour of Day for adrpo
Commits


/trunk: Activity by Day of Week for adrpo
Commits
Sunday
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday


/trunk: Activity by Hour of Day for adrpo
Commits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