BuildSysPro library on OpenModelica: a compatibility case study

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Background

- EDF developed two open source Modelica libraries: ThermoSysPro and BuildSysPro
- Make BuildSysPro accessible on OpenModelica
- User point-of-view who wants to use a library developed on Dymola on another Modelica tools => library developers impacts
Our methodology

• Use the example models of the library to:
  − detect incompatibilities
  − observe graphical difference
  − verify results consistency

• On OpenModelica 16.0 with BuildSysPro 3.3.0
OpenModelica tools

Libraries referenced on openmodelica.org are tested and a verification report is accessible online

+ Page “Writing libraries compliant to the Modelica specification”
trac.openmodelica.org/OpenModelica/wiki/WritingCompliantLibraries
Some code incompatibilities

Variable declaration of a function

function CalculPs "Compute the saturation pressure"
  parameter Real Tmin=273.16;
  parameter Real Tmax=647.3;
  output Real ps;
  input Real T;
  protected
    Real tk;

  algorithm
    tk:=min(Tmax,max(Tmin,T));
    ps:=exp(a/tk + b*\log(tk) + c*tk + d);
end CalculPs;

Accepted by Dymola, understandable by a user
BUT
not Modelica standard, error in OpenModelica
Some code incompatibilities

Modelica_LinearSystems2

\[
\text{parameter } \text{Modelica.Units.SI.Time sampleTime} = 1
\]
corrected in Modelica_LinearSystems2 by
\[
\text{parameter } \text{Modelica.SIunits.Time sampleTime} = 1
\]

Modelica.Blocks.Sources.BooleanTable

<table>
<thead>
<tr>
<th>Table data definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>table {10368000, 23328000}</td>
</tr>
</tbody>
</table>

Dymola allows to change unit and save it as “displayUnit=” in the code but that gives error message in Open Modelica
Some code incompatibilities

Conditional classes

Accepted by Dymola, understandable by a user
BUT
not Modelica standard, warning on OpenModelica, error on Modelon Impact

*Ecl* is a conditional class that shall be only use in connection statements.
Some graphic interface differences?

Except concerning conditional classes, a final user on OpenModelica sees the graphic interface the model developer has created.
Results consistency


Two windows lighting a room
Assessment of electric lighting needed following french regulations
Results consistency

Observation on dynamic representation and overall key indicator: insignificant gap

<table>
<thead>
<tr>
<th>Lighting transmission [W] (North window) during 1 month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lighting electric consumption [kWh]</td>
</tr>
<tr>
<td>OpenModelica-Dassl                                323.47</td>
</tr>
<tr>
<td>OpenModelica-Cvode                                  323.44</td>
</tr>
<tr>
<td>Dymola-Dassl                                          323.46</td>
</tr>
<tr>
<td>Dymola-Cvode                                          323.45</td>
</tr>
<tr>
<td>ModelonImpact-Cvode                                  323.45</td>
</tr>
</tbody>
</table>
Results consistency


Low energy building
Air conditioner for heating only
On/off closed loop control
Simulation for 1 year
Results consistency

About dynamic, closed loop control leads some time shift. Correct for an annual observation.

Max 0,81 % gap on the annual consumption.

<table>
<thead>
<tr>
<th>Conditioner electric consumption for heating [kWh]</th>
</tr>
</thead>
<tbody>
<tr>
<td>OpenModelica-Dassl</td>
</tr>
<tr>
<td>OpenModelica-Cvode</td>
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<td>Dymola-Dassl</td>
</tr>
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<td>Dymola-Cvode</td>
</tr>
<tr>
<td>ModelonImpact-Cvode</td>
</tr>
</tbody>
</table>

Air conditioner heating power [W] during 1 day
Results consistency

A new model developed to represent a more complex case:
- seven-rooms house
- four hot water heaters with PI controller
- hydraulic distribution network
- on/off air-to-water heat pump with 50°C +/- 3 control
Results consistency

For a complex (multi-control/dynamic/physics) model, the gaps are still very limited.

Heat pump electric consumption for heating [kWh]

- OpenModelica-Dassl: 1030.3
- OpenModelica-Cvode: -
- Dymola-Dassl: 1030.2
- Dymola-Cvode: 1030.2
- ModelonImpact-Cvode: 1028.8

Max 0.15% difference

Heat pump heating power [W] during 10 days
Conclusion

Modelica is a non-proprietary equation based language used in several modeling tools.

Those modeling tools allow different flexibility levels with Modelica standard that could create some incompatibilities.

Modelica standard is and needs to remain an under-development language. The tools offered some flexibility to facilitate the modeling and simulation. It should not be restricted. It may be useful that those extra-features can be saved outside the Modelica code.

On this study, 12 BuildSysPro models have been simulated with very good results consistency (<0.5%). The highest gap (1.7%) was on two solvers from a same modeling tool. The results consistency is not related to the tools but to the solver implementation.
Thank you for your time