Simulation Speed Analysis and Improvements of Modelica Models for Building Energy Simulation

Filip Jorissen[1,3]   Michael Wetter[2]   Lieve Helsen[1,3]

[1]KU Leuven, Leuven, Belgium, {filip.jorissen, lieve.helsen}@kuleuven.be
[2]Lawrence Berkeley National Laboratory, Berkeley, CA, USA, mwetter@lbl.gov
[3]EnergyVille, Waterschei, Belgium

This paper presents an approach for speeding up Modelica models.

Firstly insight is provided into how Modelica models are solved and what determines the tool's computational speed. Aspects such as algebraic loops, Modelica code efficiency, time constants, numeric/analytic Jacobians and debugging options are discussed and illustrated using simple building simulation examples and Dymola. OpenModelica is used to verify the generality of the results. These examples demonstrate that implementing relatively simple measures can lead to significant reductions in computation time, such as in Figure 1a. The examples are based on the IEA-EBC Annex 60 Modelica library (Wetter et al., 2015) and are available on Github and are also applicable to other types of problems.
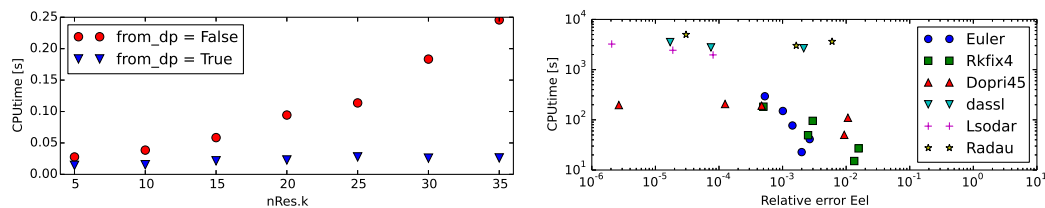
(a) Example illustrating computation time for solving mass flow rates through *nRes.k* parallel resistances with and without code optimization

(b) Relative errors for various solvers and tolerances or fixed time step sizes for a large building model

Figure 1. Result of a) an individual code optimization and b) solver choice on CPUtime

Secondly we discuss how for large models the elimination of fast dynamics, together with good integrator choice can lead to high simulation speeds. A medium sized office building including building envelope, heating ventilation and air conditioning (HVAC) and control strategy was simulated at a speed five hundred times faster than real time using a fixed step explicit integrator, which is one hundred times faster than Dassl, as illustrated in Figure 1b.

References

Michael Wetter, Marcus Fuchs, Pavel Grozman, Lieve Helsen, Filip Jorissen, Moritz Lauster, Dirk Müller, Christoph Nytsch-Geusen, Damien Picard, Per Sahlin, and Matthis Thorade. IEA EBC Annex 60 Modelica library - an international collaboration to develop a free open-source model library for buildings and community energy systems. In Building simulation 2015, submitted, Hyderabad, 2015.