Exploiting Repeated Structures and Vectorization in Modelica

Joseph Schuchart[1] Volker Waurich[2] Martin Flehmig[1]
Marcus Walther[1] Wolfgang E. Nagel[1] Ines Gubsch[2]

[1]Center for Information Services and High Performance Computing, TU Dresden, Germany
[2]Chair of Construction Machines and Conveying Technology, TU Dresden, Germany ,
{forename.surname}@tu-dresden.de

Large and highly-detailed Modelica models are frequently modeled by utilizing repeated structures, which is a repetition of various elements that are linked together in an iterative manner. While the Modelica language standard supports the representation of repeated structures, it is still not clear how repeated structures can be handled efficiently during model compilation. Instead of preserving the compact notation from the model, all repeated equations are flattened and all array variables are expanded. This leads to unnecessary long compilation times and higher memory consumption. Another aspect that has been yet inadequately considered and is closely connected to repeated structures is vectorization. The vector units of modern CPUs can be engaged to perform SIMD (Single Instruction, Multiple Data) operations, executing the same instruction on multiple data points in parallel. This reveals a high potential for faster simulations. This paper discusses the advantages of utilizing repeated structures for modeling in order to achieve both faster compilation and simulation times. The potentials of preserving for loops throughout compilation are demonstrated using a basic implementation in the OpenModelica Compiler. The effect on the simulation time by enabling vectorization is demonstrated for an appropriate model.

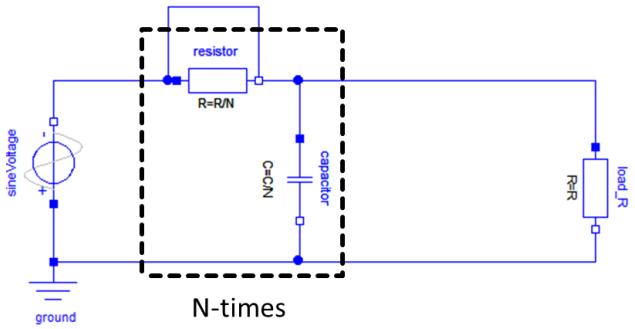

Figure 1. Discretized model of an electric transmission line utilizing a repetition of RC-elements.