On the convergence rate of dynamic iteration for coupled problems with multiple subsystems

Andreas Bartel (Angewandte Mathematik, BU Wuppertal), Markus Brunk, Sebastian Schöps

Simulator coupling is a standard technique for the transient simulation of coupled multiphysics problems. At synchronization times data between simulators is exchanged. Each simulator computes the solution for its domain only. Iteration ensures the consistency of the overall solution. In applications, this is referred to as cosimulation. In mathematics it is usually branded as dynamic iteration, since a fixed-point iteration is required to obtain convergence.
Time integration of spatially discretized partial differential equations results typcically in coupled differential algebraic equations (DAEs). Whereas the convergence of cosimulation of ordinary differential equations (ODEs) is guaranteed, this does not hold for DAEs unless a contraction condition is met. In either case the convergence is linear with a rate strongly dependening on the coupling structure.
In this paper, we discuss the rate of convergence, i.e., the error reduction per iteration, for coupled problems that consist of multiple subsystems. Furthermore, we discuss several influencing factors for the rate of convergence.