Co-Simulation of Coupled Systems

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In technical simulation of time-dependent processes, the distributed modelling of large problems yields systems of differential-algebraic equations (DAEs) that are coupled via right-hand sides and/or algebraic relations. A refined network approach, which incorporates distributed elements to model second-order effects, leads to coupled systems of DAEs and partial differential equations (PDEs), for short PDAEs.

One approach to simulate such coupled problems is based on co-simulation: different simulation packages are used for different parts, and coupling is done via an appropriate iteration process. From a mathematical point of view, this ansatz is equivalent to using dynamic iteration schemes for coupled systems of DAEs. Although this approach is often used in practice, a concise convergence theory is missing.

Regarding coupled systems of DAEs, which arise from partitioning applied to VLSI circuits on the one hand, and MOL applied to PDAE system in refined network modelling on the other hand, we investigate different dynamic iteration schemes and derive the corresponding convergence theory. Examples are given where co-simulation must fail, and alternatives are discussed how to guarantee convergence.