Convergence Criteria for Co-Simulation of Coupled Network DAEs

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First, we present a general convergence result for a co-simulation of Gauß-Seidel and of Jacobi type for coupled DAEs of the form

$$f_1(\frac{\mathrm{d}}{\mathrm{d}t}m_1(x_1,t), x_1, g_2(x_2), t) = 0,$$
$$f_2(\frac{\mathrm{d}}{\mathrm{d}t}m_2(x_2,t), x_2, g_1(x_1), t) = 0.$$

Both DAEs may have a higher index but the perturbation index of the systems

$$f_i(\frac{\mathrm{d}}{\mathrm{d}t}m_i(x_i,t), x_i, \delta_i, t) = 0$$

is assumed to be not larger than 1 for perturbations δ_i and $i \in \{1,2\}$. Note that the perturbations δ_i reflect only perturbations at the interface between both DAE systems. We demonstrate how the convergence rate can be influenced by the interplay of the interface functions g_1 and g_2 with the DAE model functions f_1 and f_2.
In the second part, we discuss particular DAE models for flow networks (circuits, energy systems, networks of neurons) and provide network topological convergence criteria for the co-simulation.