Parallelised Waveform Relaxation for Field/Circuit Coupled Systems

Idoia Cortes Garcia (Technische Universität Darmstadt), Iryna Kulchytska-Ruchka, Sebastian Schöps

When coupling systems, for example describing different multiphysical problems, often each subsystem can already be solved with dedicated software. This, as well as a multirate behaviour can be exploited by using waveform relaxation. Waveform relaxation with windowing divides the simulation time interval $\mathcal{I} = [T_0, T_{\text{end}}]$ into several smaller sub-intervals $\mathcal{I}_j = [T_j, T_{j+1}]$, solves there the different systems separately and exchanges information iteratively between them in order to converge to the solution of the coupled system.
On the other hand, Parareal is an algorithm that allows to parallelise time-domain simulations. The goal of this talk is to combine both methods in a multiphysics framework in order to parallelise the waveform relaxation iterations on the different sub-intervals $\mathcal{I}_j$ and eventually speed-up the time to solution. In particular, this method is used in order to simulate the coupling of the electromagnetic field inside a device with an electric circuit surrounding it. This leads to the coupling of Maxwell's equations with the system of differential algebraic equations obtained from modified nodal analysis.