Large EMI/EMC Simulations with the Hybrid PSTD/FDTD Method

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EMI/EMC problems usually contain several electrical scales of structures, including the fine scale (geometrical feature size much smaller than a wavelength), coarse scale (geometrical feature size greater than a wavelength), and the intermediate scale between the two extremes. Thus, computational electromagnetics for EMI/EMC problems can be very challenging if a single methodology, such as the FDTD method with a uniform grid, is used. For example, to model a personal computer of dimension 36 cm $\times$ 36 cm $\times$ 18 cm with smallest feature size of 0.01 cm, it will require 3600 $\times$ 3600 $\times$ 1800 cells in an FDTD method with a uniform grid, rendering the problem beyond the reach of even supercomputers.

In this work, we will utilize a hybrid PSTD/FDTD method recently developed by us to simulate such complex multiscale EMI/EMC problems. In particular, we use the PSTD (pseudospectral time-domain) method to model the regions with coarse structures (feature size larger than α wavelengths, where $\alpha \sim 1$) since the PSTD method has spectral accuracy and is efficient in this regime. On the other hand, the alternating direction implicit conformal finite-difference time-domain (ADI-CFDTD) method (M. Chai et al., IEEE Trans. EMC, submitted) is used to model fine structures (feature size smaller than β wavelengths, where $\beta \ll 1$) to speed up the time integration. Finally, the conformal FDTD (CFDTD) method improved by the enlarged cell technique (ECT) is used for the intermediate scale. We demonstrate the significant saving in computer memory and computation time for several realistic EMI/EMC problems.