Construction and Properties of Consistent 3D-Subgrids for FIT / FDTD

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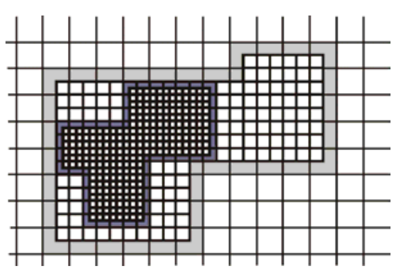
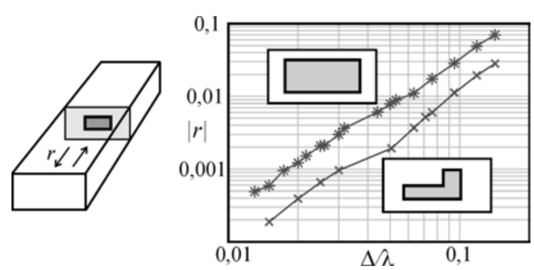
The purpose of so-called subgridding approaches for the FDTD method is to provide a local refinement in a Cartesian grid, either to resolve geometric details or to supply for a finer resolution of the electromagnetic fields e.g. near singularities. Besides this increase of accuracy in the spatial discretization, an important requirement for such subgrids is to preserve the stability and conservation properties of the FDTD method. These properties can preferably be analyzed using the notation of the Finite Integration Technique (FIT, cf. Weiland, *Int. J. Num. Mod.* **9**, 259-319, 1996) which on Cartesian grids and combined with the leapfrog time integration is computationally equivalent to FDTD. The so-called spatial stability of FIT / FDTD can here be easily proven by some elementary matrix properties which have to be preserved also in the subgrid-extension of the method. The consistency of the FIT with the geometric principles of Maxwell's equations have been summarized e.g. in (Schuhmann, Weiland: *PIER Monograph Series* **32**, 301-316, 2001).
In this presentation we explain the systematic construction of an enhanced subgrid scheme which has been first proposed for electrostatic problems by Podebrad (*PhD-Thesis, TU Darmstadt*, 2001). In contrast to former approaches, the basegrid-subgrid interface is located on faces of the dual grid. This new concept is responsible for a considerably increased flexibility of the subgrids, including L-shaped and cascaded subgrids (cf. left Fig.).



Flexible and cascaded subgrids.



Reflection at basegrid-subgrid interfaces.

We present the proof for the long-term stability and the conservation properties of the new scheme and perform a detailed analysis of the parasitic reflections at basegrid-subgrid interfaces in waveguides (cf. right Fig.). It is shown that these reflections, a measure for the accuracy of the subgrid interface, are in the range of the theoretical minimum of a corresponding one-dimensional grid refinement.