Waveport Modeling for DGTD Method and Its Applications

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The finite difference time domain (FDTD), finite element method (FEM) and method of moments (MoM) have been dominant in computational electromagnetic methods in the last decades. Recently, discontinuous Galerkin time domain (DGTD) is possible to construct a novel time domain numerical method, which has most of the FDTD advantages: simplicity, spatially explicit algorithm, easy parallelization, memory and computational cost only growing linearly with the number of elements, while it retains the most benefits from the FEM method such as adaptability of the unstructured meshes and spatial high-order convergence, which enable us to deal with the problems requiring precision variation over the entire domain or the solution lack of smoothness.

A general numerical scheme is proposed for the waveport modeling and scattering-parameter (S-parameter) extraction of inhomogeneous waveports with the discontinuous Galerkin time-domain method. In this scheme, the waveports are truncated with perfectly matched layers with a hybrid mesh automatically extruded from the mesh of the physical device to be simulated. The waveports are then excited by a total-field/scattered-field technique, with which the incident and scattered waves can be obtained for an accurate calculation of the S-parameters. A novel eigenmode solver is also developed to calculate the required modal profiles for the eigenmodes in both homogeneous and inhomogeneous waveports. Special attention is paid to the S-parameter extraction for evanescent modes, which has been a difficult task for time-domain simulations. Numerical examples are given to validate the proposed numerical scheme.