Efficient FDTD Technique for Calculating Diffraction by Infinite Three-Dimensional Material Wedges

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Wireless communication systems ideally provide contiguous coverage for mobile users in the geographical areas served. A combination of software planning tools and on-site measurements is used to determine the location and type of radio equipment that is required to achieve this goal. In urban environments, where cells are small, planning tools usually employ deterministic prediction models. Here, scattering objects such as building walls, wall corners, and rooftops are fairly well defined, and the accurate estimation of radio wave diffraction from such scattering objects becomes very important.

To this end, we have developed the generalized total-field/scattered-field (G-TF/SF) formulation of the finite-difference time-domain (FDTD) method. This technique permits modeling an infinite material wedge inside a compact three-dimensional (3-D) FDTD grid to efficiently obtain numerical diffraction coefficients. The G-TF/SF boundary is located in part within the perfectly matched layer (PML) absorbing boundary region of the FDTD grid. This allows: (1) sourcing a numerical plane wave with an arbitrary incident angle traveling into, or originating from, the PML; and (2) terminating the infinite wedge inside the PML with negligible reflection.

To validate our approach, we compare analytical diffraction coefficients for an infinite, 3-D right-angle PEC wedge obtained using the geometrical theory of diffraction (GTD) with numerical results obtained using the G-TF/SF formulation of FDTD. Then, we apply the G-TF/SF formulation to calculate numerical diffraction coefficients for a 3-D infinite right-angle dielectric wedge, covering a wide range of incident and scattering angles. Finally, we show means to compactly store the FDTD-calculated diffraction coefficients in a manner which permits: (1) easy interpolation of the results for arbitrary incidence and observation angles; and (2) straightforward interfacing with cellular planning software.