Efficient Indoor Wireless Channel Modeling
with a High-Order MRTD Technique

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The application of the conventional Finite Difference Time Domain (FDTD) technique to
electrically large problems is severely limited by the phase errors accumulated by numerical
waves propagating in an FDTD grid. In order to limit these phase errors, a dense discretiza-
tion is typically employed. However, this obviously results in a significant increase in the
computational resources needed to simulate practically important cases, such as the wave
propagation in indoor wireless channels. For the efficient solution of such problems, several
high-order methods have been proposed, such as the modified FDTD (2,4) scheme of [Hadi

A family of methods that has yet to be applied to wireless propagation problems is the
Multiresolution Time Domain Scheme of [Krumpholz and Katehi, IEEE Trans. Microwave
Theory Tech., 1995]. A dispersion analysis of the latter shows that it does not exhibit the
convergence properties of a high-order scheme, due to the fact that it employs pulse functions
for the temporal expansion of field components. As a result, its temporal integrator is the
well-known FDTD leap-frog scheme, that is second-order only.

This paper proposes MRTD schemes with high-order spatial and temporal finite difference
operators, stemming from the expansion of electromagnetic field components in Daubechies
and Coifman functions [I. Daubechies, Ten Lectures on Wavelets, SIAM, 1992] in both
space and time. These schemes present excellent convergence properties and constitute an
efficient class of methods for the simulation of electrically large structures. In addition,
the use of wavelet bases provides for the straightforward implementation of adaptive mesh
refinement, via the thresholding of wavelet coefficients, in the sense of the wavelet based
image compression, applied in signal processing.

The proposed techniques are applied to two-dimensional indoor wireless channel modeling.
Source modeling is rigorously studied and a total-field-scattered field approach, appropriately
formulated for the basis functions employed in this work, is suggested. The application
of boundary conditions is extensively studied. In addition to the simple perfect electric
conducting conditions that have been discussed in the literature before [Krumpholz and
Katehi], impedance boundary condition and knife edge modeling (both metal and dielectric)
is presented.