coefficient, B_r, that precedes. In fact, both forms of expression could be used to obtain the secular equation as shown in [2, (7)].

Nevertheless, the authors agree that there are typing mistakes in [2]. The amendments are made as follows:

1. Section II-B-2: "$y \geq |a|$ should be written as "$|y| \geq a$";
2. Expression (6a): K_V should be written as

$$K_v = \frac{1}{2ac(1/2 + 1/\pi)} \int_{-a}^{a} \int_{-c}^{c} h^2(x, y) \cos^2(\pi x/2c) \cdot \cos^2(\pi y/4a)\, dx\, dy$$

since the limits on x must be $\pm c$ and the limits on y must be $\pm a$.

3. Section II-B-2: The boundary condition (iii) should be written as

$$\partial H_{ZA}/\partial x = \partial H_{ZB}/\partial x = 0 \qquad \text{at } x = \pm c$$

which corresponds to the requirement that the vertical component of the electric field (but not the magnetic field as described by [1]) should vanish on the metallic wall.

In fact, if the boundary conditions (i) and (ii) are applied to the field equations (5a) and (5b), the secular equation (7) can be obtained. Boundary condition (iii) is applicable only for higher-order solutions.

4. Table III: "100 MHz" should be written as "100 GHz"

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Comments on "A Class of Symmetrical Condensed Node TLM Methods Derived Directly from Maxwell's Equations"

M. Krumpholz and P. Russer

The derivation presented in [1] is erroneous for the following reasons:

1) No mathematical justification is given for the approximation of Maxwell's equations by a system of first order two-dimensional partial differential equations, (10). Adding the three (10) yields

$$A_E\, \partial_x u + A_F\, \partial_y u + A_G\, \partial_z u = 3\, \partial_t u \qquad (1)$$

which is in contradiction to the correct (1). For the derivation of numerical methods simulating the evolution of the electromagnetic field, an approximation of Maxwell's equations should only be made by the discretization of the partial differential equations and not by replacing the partial differential equations by different partial equations. This results in unphysical, spurious solutions: The discretization of the system of first order two-dimensional partial differential equations, (10), does not in general yield an algorithm conserving the energy (only in the special case of $\alpha = 1/4$). This is in contradiction to the energy conservation embodied in Maxwell's equations.

2) For the discretization of the system of first order two-dimensional partial differential equations, (10), the authors are using $c_{\text{wave}} = c_{\text{mesh}}$, where c_{wave} represents the wave propagation velocity and c_{mesh} the velocity of the voltage pulses on the mesh. This is in contradiction to the correct relation $c_{\text{wave}} = c_{mesh}/2$ for the TLM scheme based on the condensed symmetric TLM node [2], [3].

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Reply to Comments to "A Class of Symmetrical Condensed Node TLM Methods Derived Directly from Maxwell's Equations"

Joe LoVetri and Neil R. S. Simons

In our paper, [1], we derive the three-dimensional symmetrical condensed node TLM algorithm using a characteristic based field decomposition of Maxwell's equations. We obtain identical scattering and transfer events as those originally presented in [2]. The goal and eventual result of our investigation was to present a mathematically sound method for deriving the TLM scattering and transfer events directly from Maxwell's equations (without recourse to the approximation of space by a mesh of transmission lines). The statement made by Krumpholz and Russer, that the derivation presented in [1] is erroneous, is not valid and the two specific points they raise will now be considered.

First, Krumpholz and Russer suggest that, in [1], the use of the three two-dimensional partial differential equations, (10′),

$$\partial_t u + A_E\, \partial_x u = 0, \qquad \partial_t u + A_F\, \partial_y u = 0, \qquad \partial_t u + A_G\, \partial_z u = 0 \qquad (1)$$

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to approximate (1′)

$$\partial_t u + A_E\,\partial_x u + A_F\,\partial_y u + A_G\,\partial_z u = 0 \tag{2}$$

is incorrect since (2) does not follow from (1) by summation (we use primed numbers to refer to equations appearing in [1]). This is obvious and it was never suggested that (2) could be *derived* from (1). Instead, as was described in [1], the three equations of (1) are found by the approximation of assuming there to be no field variation in the spatial directions missing in each equation. This was explicitly described in the first paragraph of Section III of [1] entitled *Numerical Approximations.* Of course if one requires (1) to be exactly derivable from (2) then one could change (1) to

$$\partial_t u + 3A_E\,\partial_x u = 0, \qquad \partial_t u + 3A_F\,\partial_y u = 0,$$

$$\partial_t u + 3A_G\,\partial_z u = 0 \tag{3}$$

which is typical of dimensional splitting methods [3]. A finite difference method for a 1/3 time step could then be used for each of the three equations. This was not done so as to not obscure the physical interpretation of the approximation being made (i.e., of plane wave propagation along the rectangular arms of each cell). It should also be noted that (3) would produce the same Riemann invariants as in (1) but propagating at three times the speed.

Starting from this approximation a class of TLM algorithms, based on a parameter α, were derived. The principle of energy conservation was then used to set $\alpha = 1/4$. It was found that other values of α caused the numerical scheme to be dissipative and the only reason these other values of α were investigated was for the possibility of strategically using a small amount of artificial dissipation at different points in the mesh. This possibility has yet to be investigated.

The second point raised by Krumpholz and Russer is the disparity between c_{wave} and c_{RI}. (We refer to c_{wave} as the group velocity for wave propagation in the mesh as $\Delta 1/\lambda \rightarrow 0$, and c_{RI} as the propagation velocity of the Riemann invariant or voltage pulse variables). This disparity has been associated with the TLM method since its introduction in 1971 [4]. Originally (in the two-dimensional formulation) Johns formulated the method with c_{RI} equal to the velocity of light in free space c_o. The resultant c_{wave} is $c_o/\sqrt{2}$, and therefore Johns referred to the "free space" medium modelled by the mesh as having a relative permittivity of 2 and a relative permeability of 1.0. To obtain results in a true free-space medium, frequency renormalization is required. For the three-dimensional symmetric-condensed TLM model, $c_{\text{wave}} = c_{RI}/2$. In the development of this model Johns no longer referred to c_{RI} as c_o, and therefore the frequency renormalization is avoided, since it can be assumed that $c_{\text{wave}} = c_o$. In general, when developing a TLM model, the relationship between c_{wave} and c_{RI} should be determined by dispersion analysis as has been the case for the development of alternative two-dimensional TLM models [5]–[7]. The specification of a physical significance to c_{RI} is not required. In fact, c_{RI} can be considered to represent a propagation velocity of information within the mesh. This information-propagation aspect of c_{RI} was beneficial in the development of the two dimensional TLM models presented in [6] and [7].

In our derivation, we do not assume that the velocity of the physical wave being modelled will be equal to c_{RI}. In fact, as was explained above, in the derivation one has the freedom to change the velocity of the voltage pulses relying on dispersion analysis to determine the correct speed. Unfortunately, we did not expand on this aspect of the derivation in our paper. The result is a sound and correct derivation (with the parameter $\alpha = 1/4$) of the three-dimensional symmetric condensed node TLM algorithm. Any criticisms regarding spurious modes or other nonphysical behavior should be directed to the CEM community at large, and not to our specific derivation of the TLM method.

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Comments on "Improvement in Calculation of Some Surface Integrals: Application to Junction Characterization in Cavity Filter Design"

G. G. Gentili

In [1], the authors claim to have "*...developed a rigorous method..., allowing the reduction of a surface integral to a contour integral*" with application to mode-matching analysis of waveguide junctions. The method have the advantage of a 50% time reduction in the evaluation of the coupling integrals in mode-matching techniques.

The authors have applied the method to analyze the transition from circular waveguide to rectangular waveguide.

This same method has been derived in [2] in its general form. In [3] some preliminary results on the discontinuity between ridged and rectangular waveguide have been presented.

The only original contribution recognized in [1] is therefore the application of method [2] to the analysis of coupling between circular cavities through rectangular irises.

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