Implementation of Arbitrarily Oriented Wires in 3D-TLM Method

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The Transmission Line Matrix method is a well known time domain numerical tool suitable to the analysis of complex structures in a wide frequency range. In 3D-TLM mesh, the six components of the electromagnetic field are located at the center of the cell. This allows accurate modelling of boundaries between different media. In addition, the use of a variable mesh allows the study of complex antenna including fine details with reasonable computation time and memory storage.

However, the simulation of VLF antennas is difficult to perform since such structures are very large (several hundred meters) and contain a multitude of arbitrarily-oriented-thin-conductors (diameters of several millimeters). Furthermore, a reliable analysis of VLF antenna needs also to consider the soil, the finite ground plane and the surrounding infrastructures. With such constraints, the use of a non uniform mesh cannot avoid prohibitive computation time and memory storage. Then, it is necessary to implement an arbitrarily-oriented-thin-wires model in the 3D-TLM method for this kind of electromagnetic analysis.

The model used in this work allows arbitrarily located and oriented wires with respect to the Cartesian grid. The Maxwell equations are discretized by a finite differential approximation on a hexahedral mesh. The wires are described by two equations which symmetrically associate the electrical field and the current along the wire. Those equations are coupled using the TLM scheme in the same way as done in the FDTD method by Edelvik [1]. The performance of the arbitrarily-oriented-thin-wire model in TLM is evaluated for a dipole when comparing theory and the FDTD method. Simulation results for a VLF T-Antenna are provided and compared with measurements and analytical models.

REFERENCES

1. Edelvik, F., "A new technique for accurate and stable modeling of arbitrarily oriented thin wires in the FDTD method," *IEEE Transactions on Electromagnetic Compatibility*, Vol. 45, No. 2, 416–423, May 2003.