COMPLETE 3D ELECTROMAGNETIC FIELD SIMULATION

For design engineers the utilization of high frequency 3D electromagnetic field simulation not only has the potential to save prototyping time and costs but also provides invaluable insight into whether the device is likely to be viable and if further investment is warranted. To enable engineers to make these decisions the new version 5.1 of CST MICROWAVE STUDIO® (CST MWS) provides major enhancements. In particular, the implementation of 64-bit technology and the availability of the choice between transient and frequency domain simulation, and between Cartesian and tetrahedral meshing in the latter, enable considerable access to cutting-edge technology.

It is a numerical simulator for general high frequency 3D EM simulation that is based on the Finite Integration Technique (FIT). This is a versatile approach that can be and is consistently applied to all kinds of EM simulation tasks, from statics to the optical regime, to other physical problems such as thermodynamics or elastodynamics. In addition, FIT can be formulated on any kind of grid, Cartesian or general non-orthogonal, in both the time domain and in the frequency domain. The application range of the simulation software is large, encompassing antennas, filters, cavities, couplers, connectors, vias, transitions, PBGs, FSSs, radar cross section, electromagnetic compatibility, signal integrity, specific absorption rate and medical applications, to name but a few.

CST GmbH
Darmstadt, Germany

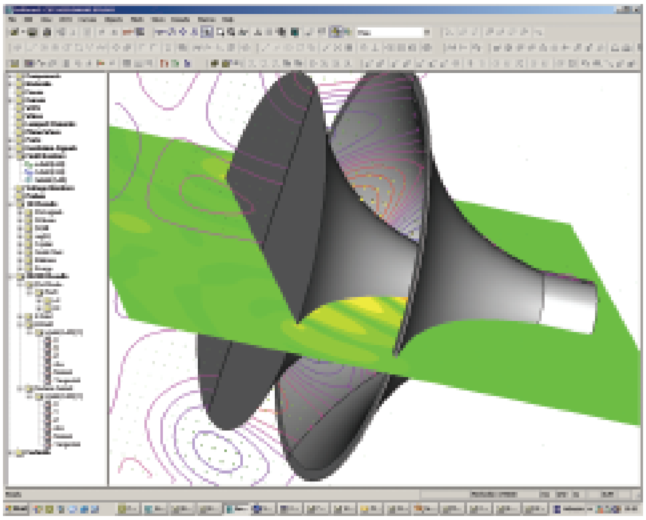

Fig. 1 A coaxial horn antenna quickly constructed using the CST MWS graphical user interface.

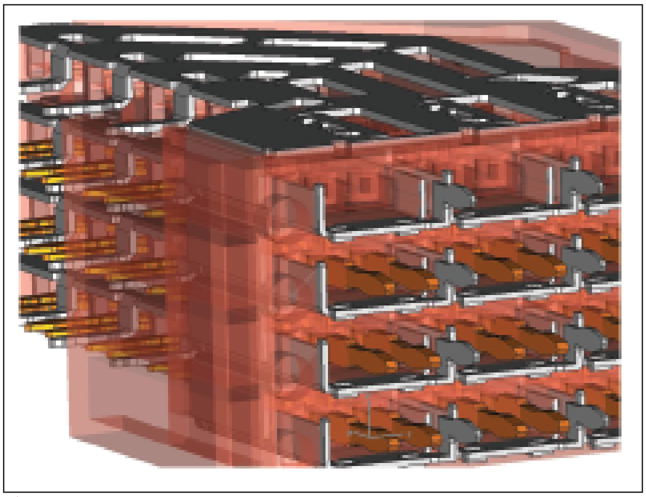

Fig. 2 An ERNI Ermet zeroXT connector simulated by AdMOS. SPICE models were extracted from the full 3D broadband simulation and used in circuit simulation.

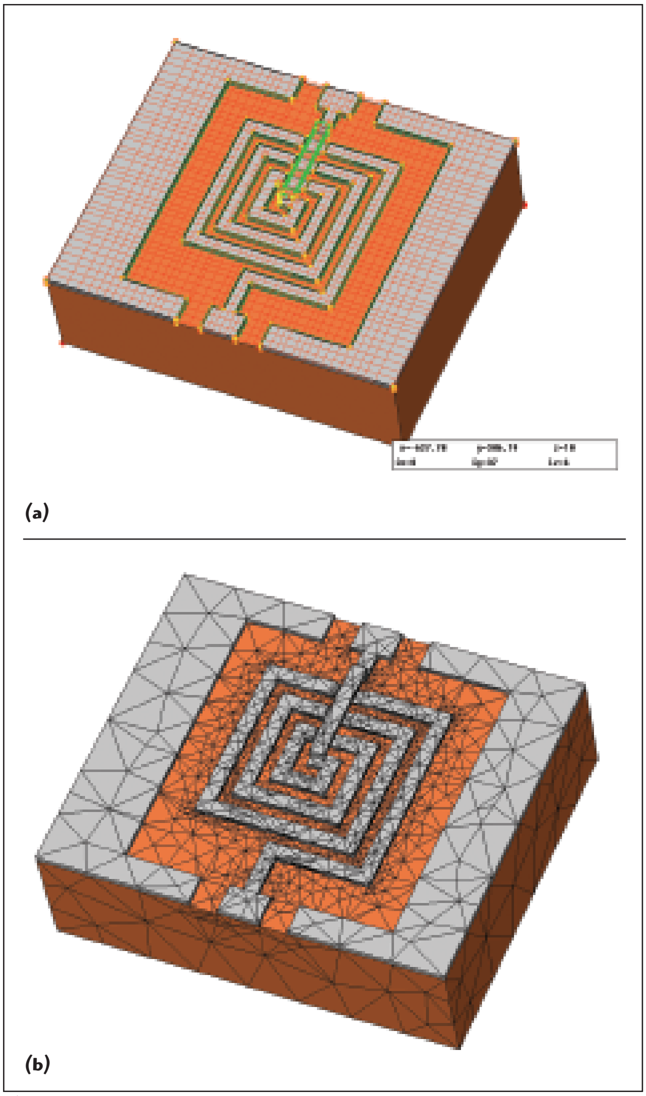

Fig. 3 Meshing performed in the frequency domain on Cartesian meshes (a) with PBA or on tetrahedral meshes (b) as illustrated with this planar coil.

INTEROPERABILITY

The CST MWS interface allows fast modeling of complex structures (see ***Figure 1***), promoting design intent capture and implicit parameterization of geometrical models. A wide range of interfaces to standardized (e.g., STEP) and proprietary (e.g., CATIA) formats of mechanical CAD tools is available. An example of how this wide range of interfaces to mechanical CAD tools allows the import of complex models is shown in ***Figure 2***. The version 5.1 modeler enables the subsequent parameterization of imported CAD-data, and thus its optimization. Interfaces to other EDA software tools include Cadence,® Allegro,® and a tight alliance with Agilent introduces 3D EM simulation to the mainstream. By integrating CST MWS in the ADS workflow, design engineers chiefly involved with simulations on a higher level of abstraction will benefit from the easy access to the richness of detail and generality of 3D EM simulation.

Traditionally, a key feature of the software has been the transient solver. Thanks to the proprietary Perfect Boundary Approximation (PBA)® CST MWS combines good geometrical accuracy with the memory efficiency and performance of broadband time domain solvers, delivering reliable results at high speed. SmartGrid™ is the latest step and is the combination of PBA with the Thin Sheet Technique (TST)™ that allows the efficient simulation of skewed metallic sheets on Cartesian meshes. The newly available Multi Level Subgridding Scheme (MSS)™ refines arbitrarily shaped structures with conformally running, staggered layers of mesh refinement.

64-BIT CAPABILITY

Despite CST MWS' ability to deal with electrically large structures, it has, up until now, been limited by 32-bit operating systems to approximately 20 wavelengths in each spatial direction. However, the implementation of 64-bit technology in version 5.1 enables much larger electrical problems to be tackled, with currently available standard 64-bit PC technology (8 GB of RAM) beyond 30 wavelengths in each direction, and theoretically much farther.

In addition to the transient solver, an eigenmode solver is offered for loss free and lossy resonant structures. A modal analysis approach extends the capabilities of the eigenmode solver to the calculation of S-parameters of filters, for example. Also, the eigenmode solver is equipped with periodic boundaries to calculate the dispersion of traveling wave tubes, frequency selective surfaces or other crystal type structures. In addition, for the first time, version 5.1 features a Model Order Reduction (MOR) solver. This is a particularly fast approach to derive the S-parameters of resonant structures directly and will be useful for filter design.

FREQUENCY DOMAIN

Last but not least there is a frequency domain solver that complements the time domain capabilities. This chiefly facilitates the study of periodic structures, for example phased arrays. Besides the increase in performance, the Floquet-mode boundary makes it possible to distinguish between the main and grating lobe. It also enables the investigation of plane wave incidents from arbitrary angles on FSS, for example, while an adaptive frequency sweep speeds up broadband investigations by reducing the number of simulations necessary to achieve the desired accuracy.

Also significant is that, in the frequency domain, users may freely switch between the standard Cartesian PBA meshing and tetrahedral meshing (see ***Figure 3***). Although adaptive meshing is available for both mesh types, the Cartesian mesh can be easily manipulated by hand or trained through the adaption process. The non-structured tetrahedral grid is advantageous for studying components with small, localized features. Besides the known approach of meshing curved surfaces by segmenting them first, the company's tetrahedral mesher also allows true surface meshing for increased accuracy.

Sophisticated post processing mechanisms enable highly automated access to simulation results that can be used individually or combined within mathematical expressions to derive arbitrary goal functions for automatic optimization. Two optimization schemes are implemented; however, results can be easily accessed through the COM/DCOM interface by other software in order to build individual evaluation schemes. Results of 3D EM simulations can be made available to other simulators via the implemented broadband SPICE-extraction schemes or simply through the TOUCHSTONE export.

Distributed computing is one further means of increasing performance. Parameter studies and optimization runs can be distributed over the network; results are collected and evaluated in one central front-end. New parameter sets for the next turn of simulations are set up and distributed again on participating computers, thus cutting down simulation time significantly.

CST MWS is tightly integrated in CST DESIGN STUDIO™ (CST DS), the company's open design environment. Here, blocks representing 3D models (and models originating from other simulation methods) by their generalized S-matrices can be combined to construct more complex structures. Sophisticated caching and interpolation schemes can again speed up the simulation process.

CONCLUSION

CST has been a pioneer in enabling access to the time domain and the frequency domain, on Cartesian or tetrahedral meshes through one, easy-to-use interface. This 'Technology on Demand' allows users to choose the most appropriate method for each task, and also to crosscheck simulations by using alternative methods and meshes. Version 5.1 continues this tradition by providing complete 3D EM simulation technology to design engineers.

CST GmbH,
Darmstadt, Germany
+ 49 (0) 6151 7303-30;

CST of America,
Wellesley Hills, MA
(781) 416-2782, www.cst.com.