Solution Profile

CST STUDIO SUITE

Discrete Manufacturing

CAE Simulation Software

(Electromagnetic Solver)

Full Power

Intel® Technologies Expedite Electromagnetic Simulation

Case Summary

Challenge	Electromagnetic (EM) simulations play a crucial role when designing and optimizing products in the electronics, telecommunications, aerospace and automotive sectors. They are mainly used for improving and optimizing the functionality of electric components, such as antennas or the signal integrity of packages. These simulations require extremely high processor and memory capabilities.
Solutions	CST, a market and technology leader in the 3D EM sector, continued to enhance the processing power of its cutting-edge software CST STUDIO SUITE™ by fine-tuning it for state-of-the-art Intel® technologies, including the Multi-Core Intel® Xeon® Processor 5000 Sequence. By adopting the newest Intel® C++ and Fortran Compilers, the company achieved software performance improvements of up to 280 percent. Finally, the use of Intel® quad-core processors partly sped up CST's solvers to run four times faster.

Expanding EM Prototyping Capabilities

Today, R&D departments struggle with the challenge of creating and designing new products in excellent quality, at minimum cost and within an extremely tight timeline. Dedicated professional software tools have not only tremendously eased product development and engineering, but at the same time, they have also fed the ever-growing industry demands and raised expectations even higher. Hence, innovations in computer-aided engineering (CAE) software particularly focus on expanding the functional range and boosting the performance of design tools.

"CST MICROWAVE STUDIO is our first choice for the 3D EM design and virtual SAR testing of our mobile phones. The performance optimization on Intel platforms will make it even more indispensable."

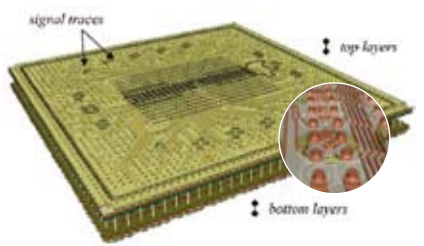
Thomas Bolin, Technical Manager Terminal Antennas, Sony Ericsson

Dealing With A Billion Unknown Factors

With any new technology, it all comes down to improving and extending capabilities and making the product smaller, lighter, and cheaper. However, miniaturization, improved versatility, and new designs and materials increase engineering complexity and impose several strains on the engineering front. The question is how can the product functionality be optimized further? Do these functional improvements cause any unintentional side effects under certain circumstances? And if so, how can these side effects be most effectively compensated? Take mobile phone antennas for example: Demands for broader bandwidth and improved connectivity have to be met while designers must reduce the electromagnetic waves beamed toward the caller's head. The same applies to cars where superior reception of GPS and mobile phone signals is becoming more and more crucial. At the same time, engineers also have to ensure electromagnetic compatibility (EMC) by preventing that integrated antennas and the frequencies they use do not influence the other components used in the car. And with circuits in chips, for instance, engineers need to ensure signal integrity and predict potential hot spots that could deform or damage the chip.

Premium simulation software able to analyze large and ever more complex designs is key for anticipating such varied interactions. More precisely: Designers need a CAE solution capable of solving huge equation systems containing millions or even billions of unknown variables. CST GmbH, a market leader in 3D electromagnetic (EM) field simulation, has been setting industry standards in terms of arithmetical capabilities, precision of visualization, performance, and throughput for the past 15 years. Consequently, thousands of customers world wide – including corporations like Panasonic, Lockheed Martin and Samsung – have been benefiting from tremendous design cycle improvements and an excellent return on investment. Since 2004, the Germany-based software vendor has been working closely with Intel® experts at the earliest possible stages to exploit fully the performance improvements of the latest and upcoming generation of Intel® Xeon® processors and technologies.

Analyzing the specific absorption rate (SAR): Using a high-resolution human head model (HUGO), the SAR analysis indicates if a mobile phone conforms to international standards and regulations by simulating how the EM fields of a mobile phone propagate.



The IBM benchmark package for signal integrity analysis. A complete IC package was provided as a Cadence® Allegro® layout with eight metallization layers and 40,000 geometrical entities. The full package, shown here in total and detailed view, was imported into CST MWS. The benchmark fraction was solved by using the transient approach and the FD solver (27 million mesh nodes and 5.3 million tetrahedrons, respectively).

Working Together to Improve Design

The first joint optimization project focused on effective code transition and tuning for 64-bit Intel® Xeon® processors. Enthused about the comprehensive technical support as an Intel® Software Partner, CST continued to accelerate further the application performance by optimizing its brand new software bundle CST STUDIO SUITE™ for the Multi-Core Intel® Xeon® Processor 5000 Sequence.

CST STUDIO SUITE™ includes all renowned CST products in one box, including the flagship software CST MICROWAVE STUDIO® (CST MWS) for high-frequency simulations. Additional CST STUDIO SUITE™ modules facilitate static and low frequency simulation, simulation of free-moving charged particles in electromagnetic fields, the break down of large simulations into small parts, and 3D circuit co-simulations. One cornerstone of CST's success has been the Perfect Boundary Approximation (PBA)® technology which combines the advantages of the two most common meshing approaches into one technology. They are the speedy cartesian grid and the geometrically more accurate tetrahedral meshing technique. The combination offers a superior modelling solution for the time domain.

Whereas the time-domain simulation with PBA® approach has its particular strengths in terms of speed and accuracy for broadband time signals, simulations using the frequency domain often prove to be the better choice for narrow-band and electrically smaller devices. Since no single method is perfect for every application, CST pioneered uniting both approaches into one interface on cartesian and tetrahedral meshes. As the first commercial vendor offering this complete technology for high frequencies, CST enables users to switch easily from one to the other solver without the need to change the model and parametric settings.

Solve the Unsolvable

Obviously, these simulations require software capable of efficiently exploiting available hardware resources to the maximum extent. One foundation for this was laid with the introduction of a highly optimized 64-bit version in 2004. This joint effort with Intel provided users with a true leap in simulation capacity enabling them to solve tasks in a complexity range which hadn't been possible before. CST's leading-edge position was most impressively demonstrated at the 15th Conference on Electrical Performance of Electronic Packaging (EPEP 2006): It was the only commercial software capable of solving the benchmark created by IBM containing 40,000 geometrical entities. CST MWS exceeded expectations by providing S-parameters for all 20 fan-out lines (only four were required) and by using both approaches - the transient as well as the FD solver. The optimization of the most performance-critical software parts for the Intel® Multi-Core architecture largely contributed to this success.

Quadruple Speed Increase

The optimization of CST MWS for the latest Multi-Core Intel® Xeon® Processor 5000 Sequence began with benchmark tests of a time-domain (TD) based algorithm and a frequency-domain (FD) based solver on different Intel and competitor platforms. Based on these initial results, the most performance-critical parts of the software were further optimized for multi-threading by using Intel® C++ Compilers, Intel® Threading Tools, Intel® Math Kernel Library (Intel® MKL), and VTune™. One main objective of these enhancements was to improve throughput. By fine-tuning the source code with compiler flags and vectorization, a performance boost of a factor 1.3 to 2.8 was achieved. When running on the latest generation of the Quad-Core Intel® Xeon® processor, CST MWS now computes two to four times faster. Further optimization will focus on code tuning on the assembler level, which additionally speeds up the application.

Performance Benchmarks CST MICROWAVE STUDIO ®

System	TD Solver		FD Solver	
	Average Memory Bandwith (GB/s)	Speed-up	Floating Point Performance (GFLOPS)	Speed-up
Intel® Xeon® processor 3.2 GHz, FSB800 Dual Processor / Single Core	4.9	**Ref.**	4.3	**Ref.**
Intel® Xeon® processor 5160 3.0 GHz, FSB1333 Dual Processor / Dual Core	10.0	**2.0**	12.7	**3.0**
Intel® Xeon® processor 5345 2.33 GHz, FSB1333 Dual Processor / Quad Core	11.0	**2.2**	17.7	**4.1**

Performance boosts on the latest Intel® Xeon® processors. Benchmarked against current Dell Precision systems with 64-bit Intel® Xeon® processors, the FD solver gains speed of up to 4.1 times.

Benefits from Superior EM Simulation

CST's success is based on offering a high-performance software solution with distinguished simulation techniques. Consequently, the EM simulation experts continue to optimize the software for next-generation Intel® technologies. The next steps may include applying the source code optimizing techniques to other modules of the CST STUDIO SUITE™. CST also envisions a concerted collaboration with Intel Software and Solutions Group in the high-performance computing area. But even today, CST STUDIO SUITE™ customers can exploit a broad range of tremendous business benefits, including:

- *Reduced Time to Market:* Virtual prototyping and product development has never been this quick and accurate.

- *Enhanced Competitive Edge:* CST STUDIO SUITE™ has repeatedly proved to be a leading software when it comes to expanding the boundaries of solving the most complex EM simulation tasks, thus facilitating new dimensions of product innovation.

- *Improved IT Resource Allocation:* With its distributed computing scheme, CST empowers product engineers to fully capitalize on the performance of all available systems in the company network without needing stand-alone licenses on individual machines.

- *Increased Employee Productivity:* Product engineers can effortlessly switch between multiple solver and meshing methods in the time and frequency domain, achieving fast and cross-verifiable results.

Above all, the joint optimization efforts have been beneficial to both CST and Intel since Intel also gained valuable knowledge into further fine-tuning its software optimization tools for specific industry demands. And by optimizing CST STUDIO SUITE™ for the new generation of Dual-Core and Quad-Core Intel® Xeon® processors, CST enables manufacturers to fully capitalize on the outstanding hardware platform in the scientific-technical computation sector with excellent performance, scalability and reliability.

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* Performance tests and ratings are measured using specific computer systems and/or components and reflect the approximate performance of Intel products as measured by those tests. Any difference in system hardware or software design or configuration may affect actual performance. Buyers should consult other sources of information to evaluate the performance of systems or components they are considering purchasing. For more information on performance tests and on the performance of Intel products, reference www.intel.com/performance/resources/benchmark_limitations.htm and any Intel source materials such as performance briefs or white papers.

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