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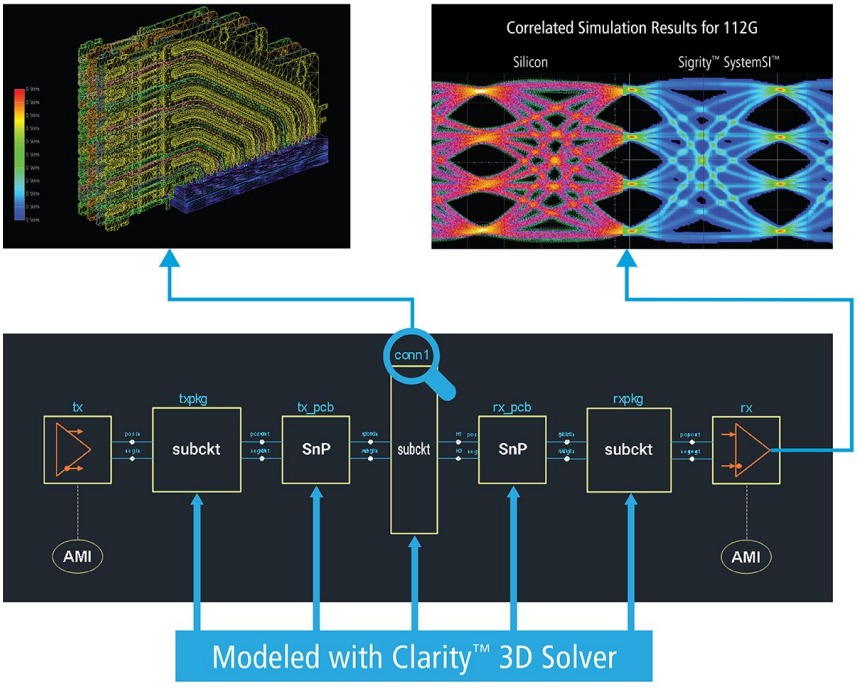
3D Solver Speeds System Analysis and Design

This EM simulator performs system-level analysis on 3D structures within many different types of complex designs, such as IC-to-package and package-to-board interconnections.

System designers now have a powerful new software tool for analysis and simulation at the circuit board and integrated-circuit (IC) package level—the Clarity 3D Solver from Cadence (www.cadence.com). From a software developer long associated with efficient and effective semiconductor design tools, this three-dimensional (3D) electromagnetic (EM) simulation software takes design and analysis at least one level higher—to the system level. Thus, one can study the effects of different circuit structures, such as package interconnections, on the overall performance of the circuit/system.

The 3D analysis software is well-suited for simulating the impact of different materials on ICs, system on IC (SoIC) devices, and system-in-package (SiP) designs, and even to predict the effects of different interconnections within each PCB and from PCB to PCB. Perhaps best of all, the Clarity 3D Solver does not require a specialized computer for its system-level simulations: It performs simulations even on a laptop computer! For users with more powerful computing resources, Clarity 3D Solver has nearly linear scalability in terms of processing power when using multiple machines to analyze complex structures.

System-level simulators have often been associated with oversized models of circuit assemblies dominated by a single complex component, such as a frequency synthesizer, and requiring extensive computing power to analyze system-level behavior like receiver sensitivity. Even when considering the EM behavior of high-frequency transmission lines, such as microstrip or stripline, in planar form in two dimensions (2D), software simulators have traditionally required breaking a design into pieces or subsystems that can be analyzed and simulated separately to effectively use available computer processing power.



The Clarity 3D Solver allows system designers to study as much of a design as desired, making efficient use of available computer processing power. (Courtesy of Cadence)

The Clarity 3D Solver not only performs EM analysis of high-frequency circuit structures in 3D, such as through transmission lines as well as through plated viaholes in a PCB, but can handle the additional simulation data from all three dimensions without special computer needs. The firm's advanced distributed multiprocessing technology

fully leverages the computing power at hand, including in "the cloud."

System designers are faced with growing demands for increasing functional density, which involves design approaches like multilayer circuit substrate materials, multifunction monolithic microwave integrated circuits (MMICs), and system-in-package (SiP) and system-on-IC (SoIC) devices mounted on high-thermal-conductivity PCBs. Software tools such as SiP Layout from Cadence have been used for complex 3D SiP designs, to analyze the interconnections between semiconductor die and package connections.

Fortunately, the Clarity 3D Solver readily integrates this package-level simulation tool with the many 3D mechanical and electrical structures of a full system design, allowing a smooth flow between design and optimization. Therefore, a design developed as a 3D SiP, for example, can be optimized in the system-level Clarity 3D Solver without being redrawn.

In addition to its integration with SiP Layout, the Clarity 3D Solver can be integrated with the Virtuoso and Allegro software tools from Cadence. Virtuoso is a popular custom IC design platform that includes design and analysis functions across ICs, packages, modules, and PCBs for ready integration at the system level. Allegro is a PCB design and analysis solution that similarly enables a circuit to be integrated and modeled as part of a larger system in the Clarity 3D Solver.

Solving Systems

The Clarity 3D Solver allows system designers to treat a design as a block diagram that interconnects several components and/or subsystems in a serial *(see figure)* or parallel orientation. By selecting the components within the block diagram for analysis, a designer can choose as much or as little of the system for design and optimization. The approach conserves computer resources and performs simulations with the most practical application of computer power possible.

In addition, the software automatically matches the complexity of a simulation to the available computer resources. Distributed multiprocessing technology is used to share the computing power of multiple central processing units (CPUs) when available, such as within a network, to perform complex analysis tasks in the shortest times possible.

The Clarity 3D Solver software can be accessed on premises or from "the cloud" and will run on almost any reasonably equipped modern PC, including a laptop. While it can also provide outstanding performance from a high-performance-computing (HPC) workstation, this is a software tool that's very memory-efficient, enabling it to capably run on a bank of low-cost computers, distributing simulation tasks among the multiple CPUs.

With its processing flexibility, the software is able to perform complex tasks, such as a study of the various coaxial-connector interfaces on a PCB, without the need to separate the system into smaller subsections. The software, which can do true 3D model extraction of circuit structures, is designed to read design data from multiple sources, e.g., electronic-computer-aided-design (ECAD) and mechanical-computer-aided-design (MCAD) software, and even merge mechanical structures like cables and connectors within a design. As a result, it's possible to integrate many different designs within a Clarity 3D Solver simulation. The software can create accurate S-parameter models of circuit structures for analysis purposes, such as for signal-integrity (SI), power-integrity (PI), and electromagnetic-compatibility (EMC) analysis, with accuracy that matches closely with measured results.

Even with the complexity and large amount of data represented by 3D circuit structures, for example, coaxial connector interfaces or semiconductor die within high-pin-count packages, the Clarity 3D Solver software can perform an analysis in a relatively short time, using a process known as parallelization to achieve enhanced processing power when using multiple CPUs. Parallelization allows the use of as many computers and CPUs as possible, reducing the simulation processing time. Solution times are directly related to the number of computers and computer cores available: If the number of cores can be doubled, then the performance of the Clarity 3D Solver may be doubled, with the processing time nearly cut in half.

One of the satisfied users of the Clarity 3D Solver software is Teradyne and its semiconductor group. As Rick Burns, the vice president of engineering for the Semiconductor Test Division at Teradyne explains, "At gigabit speeds on our highly dense PCBs with over 30 layers, we depend on accurate interconnect extraction of our complex structures to support signal integrity analysis."

Burns notes the difference that the Clarity 3D Solver has made: "With the Cadence Clarity 3D Solver, we can achieve the necessary accuracy in a fraction of the time it has previously taken. This has opened up a new era of analysis possibilities for us since we can now run dozens of simulations in the time it has previously taken to run one. This reduces design respins and helps us fulfill our promise of delivering the highest throughput and lowest cost of test for our customers."

As is clear from the Teradyne example, the Clarity 3D Solver has made a significant impact in a major test application, helping accelerate the development of many other test designs. It should also aid designers in two rapidly growing high-frequency application areas, for the millimeter-wave radar systems in advanced driver assistance systems (ADAS) for autonomous vehicles and in 5G wireless communications systems. Both applications seek the high functional density that can be optimized with a 3D electromagnetic modeling tool like the Clarity 3D Solver.

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