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The Cadence System Design Solutions Guide

I-Connect007
GOOD FOR THE INDUSTRY

The Cadence System Design Solutions Guide

Each new technology node takes the design and integration complexity to the next level and calls for new automated solutions to handle the new requirements and techniques. Cadence solutions provide semiconductor and system companies the most integrated end-to-end solution to help today's electronic designers do their best work to create products for:

- Silicon design creation, simulation, implementation, and signoff of analog and digital circuits; off-the-shelf design IP; and IC packaging, including ML-enhanced EDA tools and ML-enabled EDA flows
- System design of advanced packaging, safe and secure embedded software, and PCBs; analysis of electromagnetic and electrothermal effects of semiconductors, packages, boards, and systems; and co-optimization with semiconductor devices
- Intelligence IP for the design of inference processing in edge devices

Cadence works on delivering algorithms that operate on unimaginably huge amounts of data, scaling algorithms to be massively parallel in the cloud, and delivering and supporting software in an enterprise environment. This approach to technology is in several products enabling them to scale to large numbers of processors. Cadence multi-physics system analysis solution includes the Celsius™ Thermal Solver, Clarity™ 3D Solver, Voltus™ IC Power Integrity Solution, Sigrity™ SystemSI™ technology, and Sigrity Broadband SPICE® technology, which can be used with the Allegro® Package Designer Plus for ball-grid array (BGA) substrate layout and analysis and with the Innovus™ Implementation System for layout and analysis of 3D-IC chip stacks. Both implementation solutions integrate seamlessly with Cadence's OrbitIO™ Interconnect Designer for

system-level planning and optimization, as well as the Pegasus™ Verification System for signoff design rule checks (DRCs) and layout versus schematic (LVS).

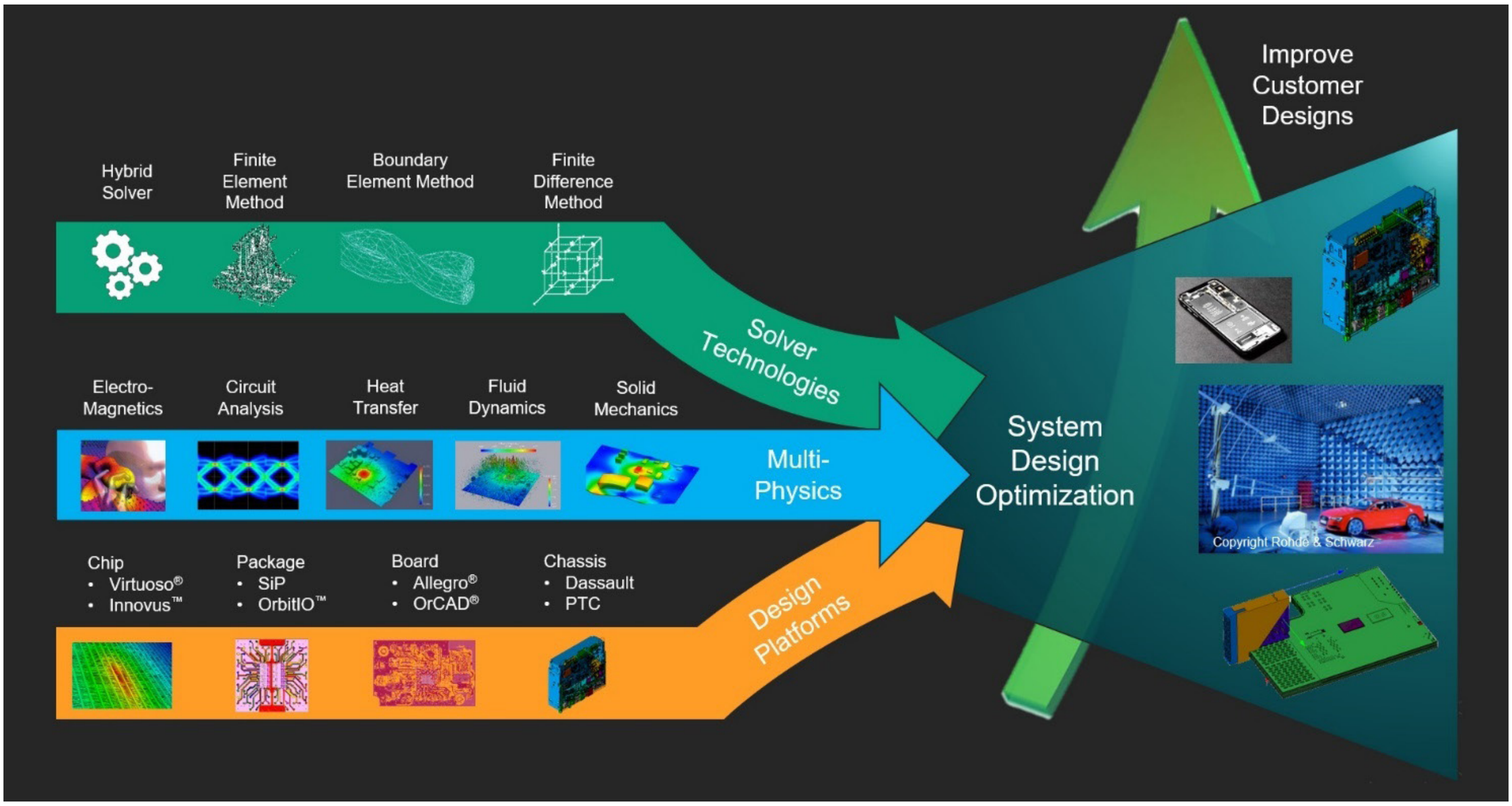

Figure 1: From chips to system analysis.

Clarity 3D Solver

Highly complex structures found in silicon interposers, rigid-flex PCBs, stacked-die IC packages, connectors and cables must be modeled accurately in 3D for structure optimization and high-speed signaling compliance. High-speed signaling, such as in 112G SerDes interfaces, relies on high-fidelity interconnect design. Any slight change in impedance can negatively impact the bit error rate, so optimization entails extensive research including dozens of complex extractions and simulations. To accommodate this workload, legacy field solvers must run on massive, expensive high-performance servers. Also, the speed and capacity limitations of legacy field solver technology require users to carefully simplify and/or partition the structure into smaller segments to fit within local computing constraints. This pseudo-3D approach creates the risk that the re-

sulting final model may contain inaccuracies due to artificial effects from the superficial model boundaries.

Clarity 3D Solver technology addresses the most complex EM challenges faced when designing systems for 5G communications, automotive/ADAS, HPC, and IoT applications. Industry-leading Cadence distributed multiprocessing technology enables the Clarity 3D Solver to deliver virtually unlimited capacity and a 10X speedup required to efficiently and effectively address these larger and more complex structures. The Clarity 3D Solver creates highly accurate S-parameter models for use in SI, PI, and electromagnetic compatibility (EMC) analysis, enabling simulation results that match lab measurement.

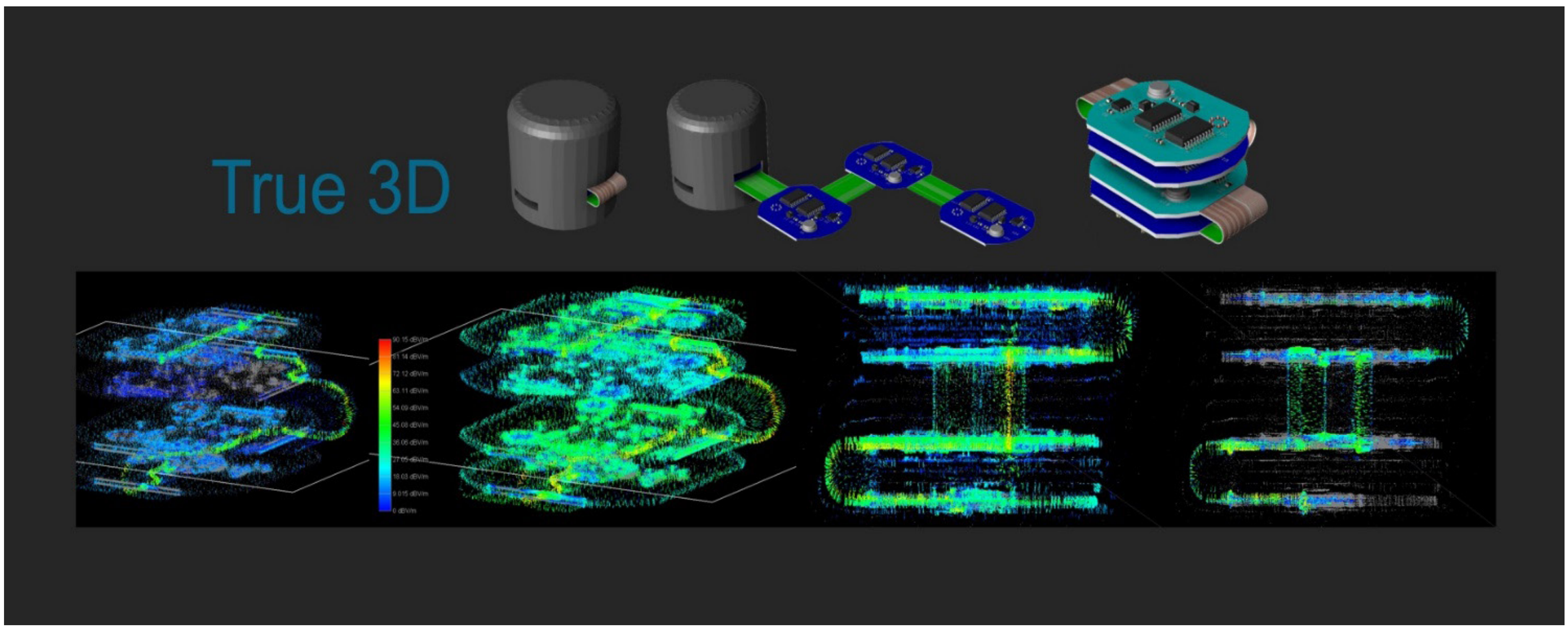

Figure 2: EM modelling results using pam4 four-voltage-level signaling.

It incorporates a 3D mechanical CAD GUI for creating, editing, and importing 3D solid models for electrical analysis. You can bring in design data from popular MCAD formats such as ACIS, IGES, and STEP as well as Cadence Allegro and Sigrity formats. 3D components are easily created with parameterization and equation expressions to allow for modeling flexibility and simulation optimization. 3D CAD geometry problems and misalignment errors can be quickly repaired with 3D Workbench's model clean-up functions. The advanced adaptive meshing algorithms allow you to automatically generate accurate meshes for small intricate 3D components to large complex electronic systems with enclosures.

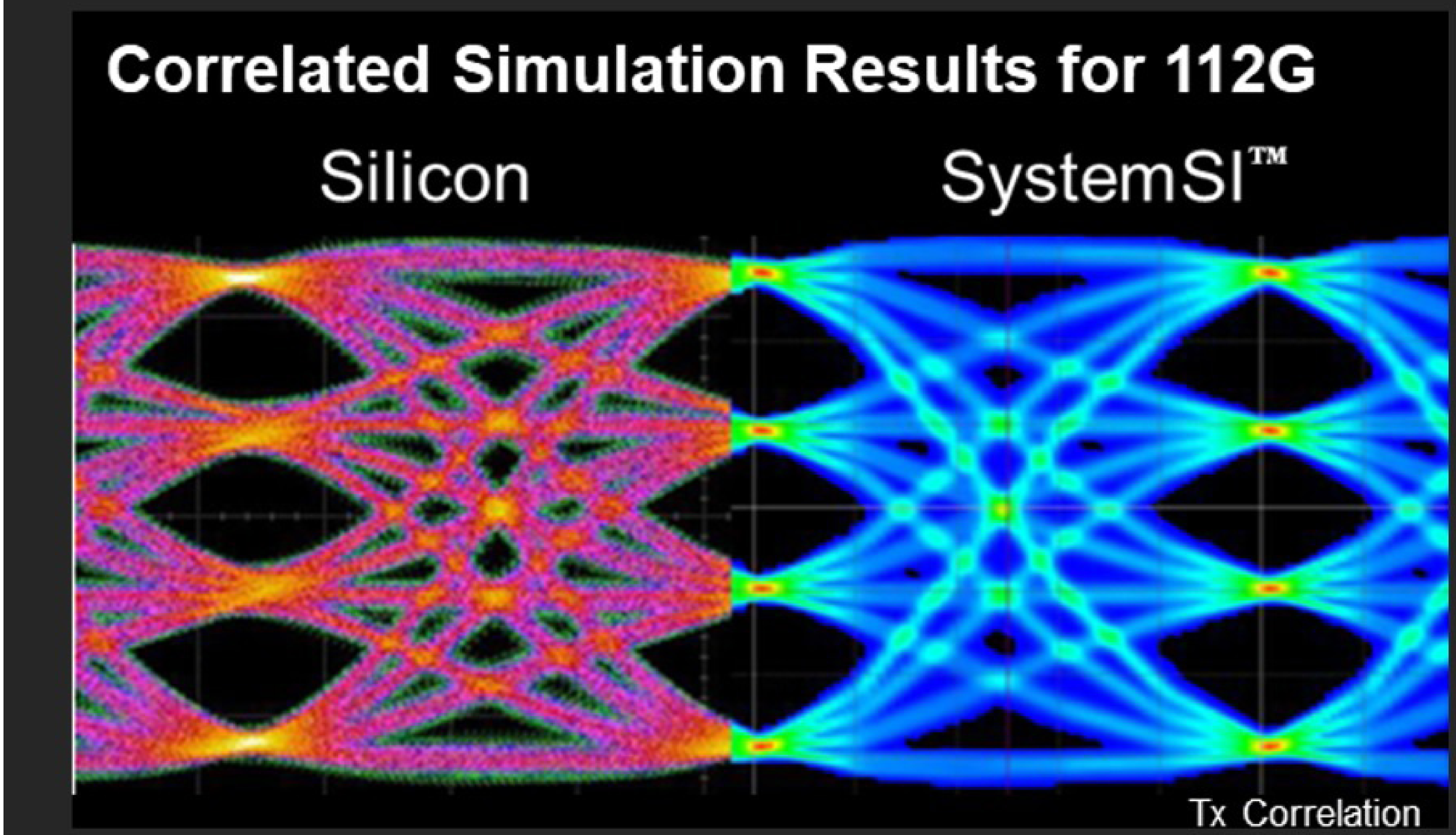

Figure 3: Real measurement from PAM4 silicon (left) compared with modelled output (right).

The three key attributes of Clarity 3D Solver are meshing, solver accuracy, and computation parallelism. It is optimized to distribute a job across multiple low-cost computers while remaining equally efficient when running on a more powerful and expensive server with terabytes of memory. The parallelization technology ensures that both meshing and frequency sweeping can be partitioned and parallelized across as many computers, configurations, and cores available, reducing the time to solve complex structures by up to 10X. A unique distributed adaptive meshing approach and significantly smaller memory requirements than legacy 3D field solvers enable the Clarity 3D Solver to extensively utilize cost-effective cloud and on-premises distributed computing. A significantly smaller memory footprint makes it cost-effective to run on a multitude of CPUs. These advantages make the cloud-ready Clarity 3D Solver an ideal choice to optimize a company's cloud computing budget.

Using the Clarity 3D Solver in conjunction with the Cadence 3D Workbench, users can merge mechanical structures such as cables and connectors with their system design and model the electrical-mechanical interconnect as a single model. The Clarity 3D Solver is also tightly integrated with the Virtuoso, Cadence SiP Layout, and Allegro implementation platforms, enabling 3D structures to be designed in the Allegro and Virtuoso environments, optimized in the analysis tool, and implemented in the design tool without being redrawn.

Clarity Transient 3D Solver

For accurate system-level modelling, performance optimization while minimizing electromagnetic interference and radiation is of key importance, both susceptibility and emission need to be analyzed. Emissions mean that the device does not emit electromagnetic radiation above the appropriate threshold. Susceptibility means that the device performs correctly even in the presence of a given level of electromagnetic noise. For example, an ECU in a car must not radiate above the threshold value. But also, it must not fail if someone turns a laptop on in the car, or people around use their cellphones.

Today's electromagnetic signoff and compliance analysis tools are crippled when it comes to accurate system-level modeling and can only simulate at the module or sub-module level. Traditionally, large systems have been analyzed at the sub-system level, and results from full-system analysis come from the measurement of prototypes in the lab. The only reliable way to achieve certification is to create a prototype and perform pre-compliance testing in an anechoic chamber with an antenna (three meters away for pre-compliance testing), which can take multiple iterations and weeks of effort. This impacts the cost as well as time-to-market. Legacy tools with old architectures scale poorly and require multiple machines with terabytes of memory, in effect requiring expensive, dedicated hardware.

Even though the anechoic test will be needed for final compliance, Cadence Clarity 3D Transient Solver can reduce dependence on anechoic chambers, especially in the early phase of product design, analysis, optimization, and fabrication. Clarity 3D Transient Solver can utilize cloud servers to analyze the entire system for EMC/EMI, reducing re-spins and accelerating time-to-market and Cadence CloudBurst™ is ideal for this since it requires no customer IT setup and is 100% web-based. Typical use is to simulate the 3m test. Clarity 3D Transient Solver can simulate the 3m anechoic chamber test. It uses finite-difference time-domain (FDTD) methods to work out all the required values needed for compliance. Since it is a time-domain method, FDTD solutions can cover a wide frequency range in a single simulation run.

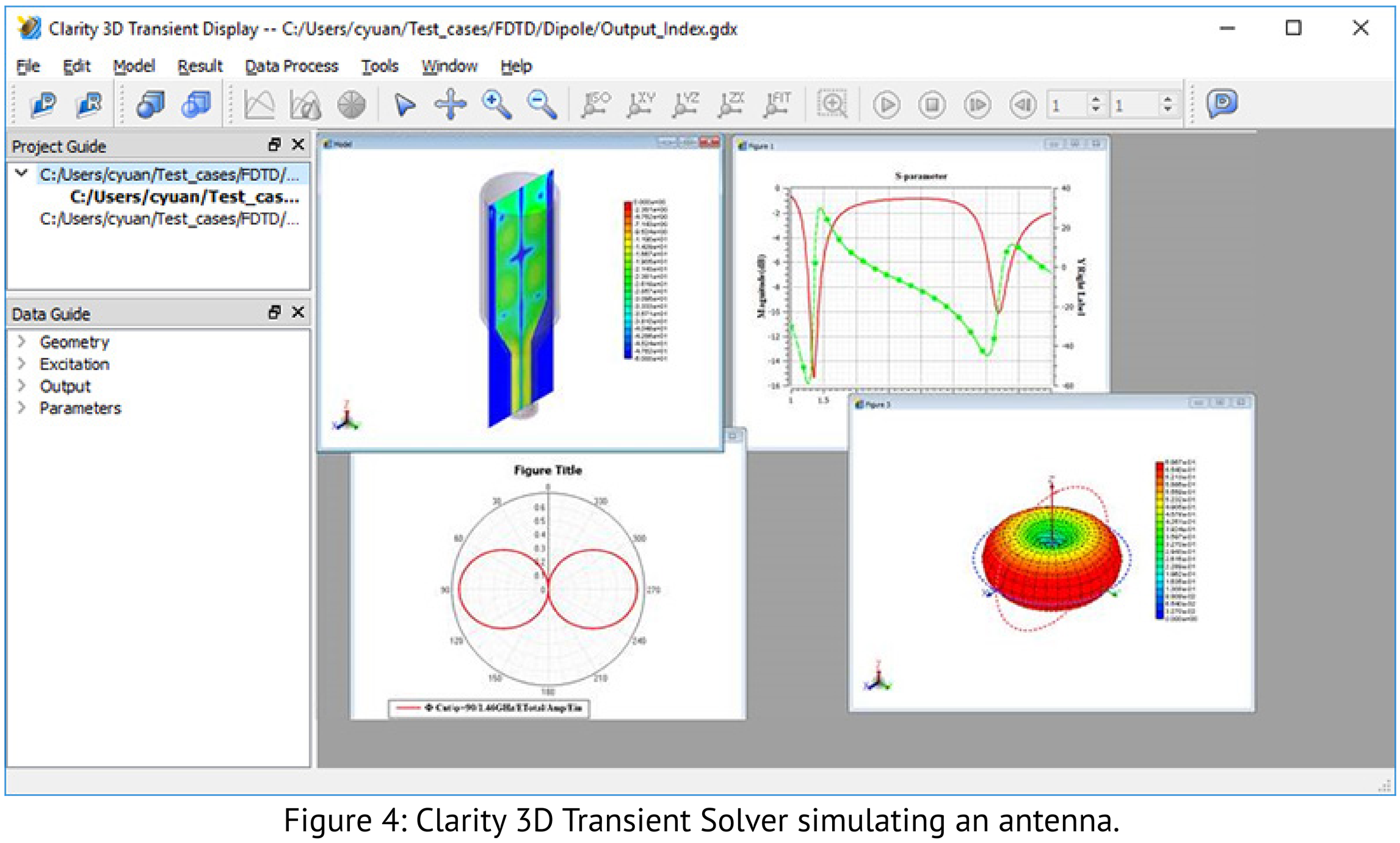

Figure 4: Clarity 3D Transient Solver simulating an antenna.

Clarity 3D Transient Solver performs accurate pre-fabrication EM interference signoff and EM radiation compliance analysis. It provides large-scale simulations using massively distributed computing to scale capacity and performance by up to 10X to handle the full system analysis. The architecture allows the solver to be run on hundreds of CPUs or dozens of

GPUs optimized for both cloud and on-premises distributed computing. It has virtually unlimited capacity with near-linear scaling as compute resources are added. There is no loss of accuracy compared to physical test measurement. The tool reads design data from all standard chip, IC package, and PCB platforms and offers unique integration with Cadence implementation platforms. These make it ideal for many complex applications in the hyperscale computing, automotive, mobile, and aerospace, and defense markets.

Celsius Thermal Solver

Thermal effects on electrical performance have always existed. Processor speed limits are set by thermal limits, and power has been a key concern for the mobile and datacenter markets for a decade. Increased electrical content logically generates more heat leaving the problem of thermal effects yet to be solved. With higher data rates more heat is generated. 400G and 800G Ethernet are supported by 100G ports, which create heat. IC heat generation is mainly a function of switching frequencies and operating conditions, and how the heat generated is dissipated/transferred out of the system depends on the environmental conditions. These two problems must be solved together, and Celsius is the only commercial thermal solver that supports both static and transient thermal analysis. System heat dissipation almost always involves both conduction and convection. The IC/package/board/enclosure interface is primarily a conduction problem best handled by finite element analysis (FEA). The enclosure/environment (air or liquid) interface is a computational fluid dynamics (CFD) problem. So not only must electrical and thermal physics domains be analyzed together, but the thermal component requires both FEA and CFD approaches.

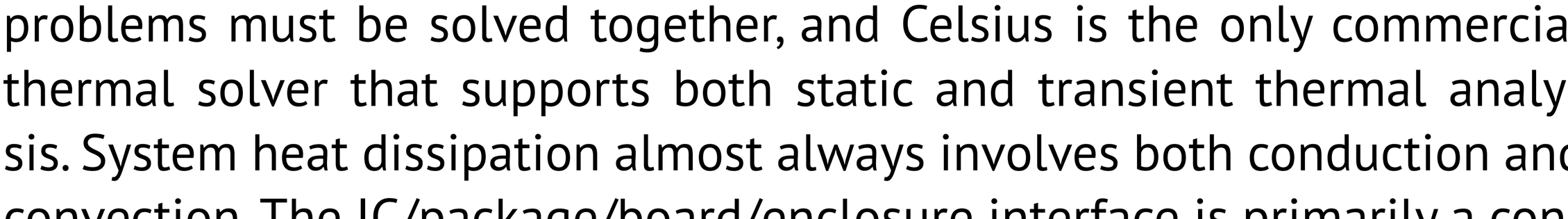

Figure 5: Simultaneous thermal and electrical analysis for ICs, packages, boards, and systems.

The Celsius Thermal Solver utilizes innovative multi-physics technology to address these challenges. By combining FEA for solid structures with CFD for fluids, the Celsius Thermal Solver enables a comprehensive system analysis in a single tool.

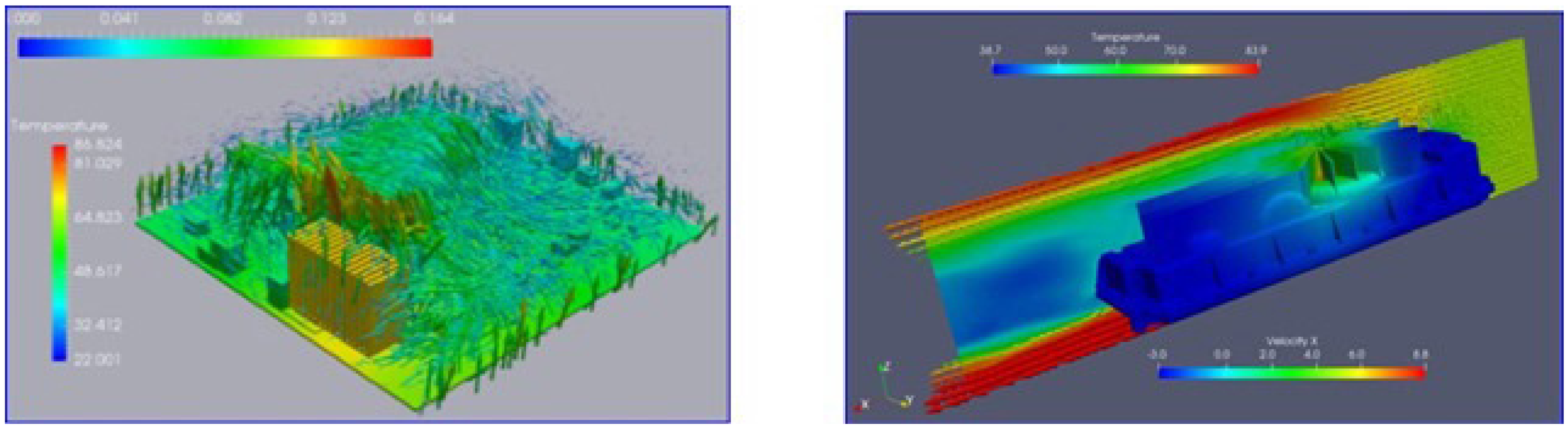

Figure 6: Combination of FEA for solid structures with CFD for airflow.

When using the Celsius Thermal Solver in conjunction with Voltus™ technology for PCB and IC packaging, engineering teams can combine electrical and thermal analysis and simulate the flow of both electricity and heat for a more accurate system-level thermal simulation than legacy tools. The Celsius Thermal Solver also integrates seamlessly with Cadence's IC, package, and PCB implementation platforms, making it easier and faster to perform design iterations. Besides, the Celsius Thermal Solver performs both static (steady-state) and dynamic (transient) electrical-thermal co-simulation based on the actual flow of electrical power in advanced 3D structures, providing visibility into real-world system behavior. The time steps can be adjusted depending on the needs of the analysis.

To truly enable system-level analysis without breaking the analysis into pieces, the Celsius Thermal Solver taps Cadence's computational software expertise in scaling enormous solvers into the cloud or on-premises datacenters to get essentially unlimited capacity and a speedup of up to 10X. This is the same advanced technology that has been production-proven in the Voltus and Clarity products.

The Cadence Celsius Thermal Solver breaks the speed limits with 5X to 10X cycle time improvements, overcomes capacity limits with up to 10X memory reduction, and eliminates the compute limits imposed by depen-

dency on super high-end servers with a solution optimized for execution on public cloud environments. The electronic industry's first complete electrical-thermal co-simulation solution combines FEA with CFD for total system analysis to:

- Perform transient as well as steady-state analysis for accurate electrical-thermal co-simulation
- Deliver massively parallel execution to achieve up to 10X faster performance than existing solutions
- Integrate with Cadence IC and PCB implementation platforms for quick iterations

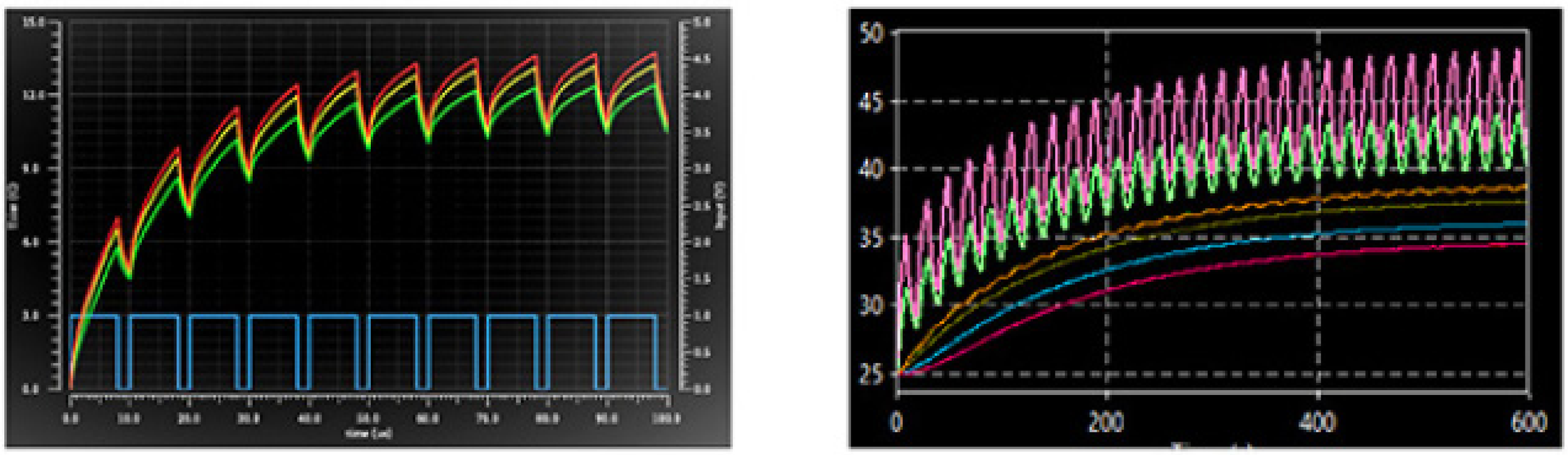

Figure 7: The Celsius Thermal Solver Transient electrical-thermal co-simulation example.

Sigrity

Sigrity solutions for SI and PI provides advanced analysis both pre-and post-layout using powerful new simulation engines. Operating early in the design cycle allows for "what if" scenario exploration, sets more accurate design constraints, and reduces design iterations. The latest addition is Sigrity X, now upgraded to offer up to 10X performance gain without sacrificing accuracy. Sigrity is the end-to-end, in-design analysis solution, and combined with Clarity, is the signoff analysis solution.

Sigrity tools read and write directly to the Allegro PCB and IC package design database for fast and accurate integration of results. It provides a SPICE-based simulator and embedded field solvers for the extraction of

2D and 3D structures. It supports transistor-level and behavioral I/O modeling, including power-aware simulation using IBIS models. Parallel bus and serial channel architecture can be explored pre-layout to compare alternatives or post-layout for a comprehensive analysis of all associated signals.

Sigrity Solution is equipped with next-generation simulation engines to solve bigger system analysis problems faster, with trusted accuracy. It scales simulations across multiple machines for applications in the hyperscale computing, mobile, automotive and aerospace, and defense markets and can address large-scale simulations with massively distributed simulations for today's cloud infrastructure. Sigrity provides a seamless transition from different analysis workflows streamlining the setup time for detailed analysis and delivers up to a 10X boost in both performance and capacity while maintaining accuracy equivalent to legacy solutions.

Sigrity SystemSI's solutions provide a comprehensive and flexible SI analysis environment for accurately assessing high-speed, chip-to-chip system designs. A block-based editor makes it easy to get started. The solutions support industry-standard model formats and automatically connect the models. With a unique combination of the frequency domain, time domain, and statistical analysis techniques, you can be confident of achieving robust parallel bus and serial link interface implementations. Integrated with Cadence PCB and IC package design tools, the next generation Sigrity technology allows for IC Packages, and PCBs designed in Allegro to be incorporated into a multi-fabric / multi-board system from end to end (transmitter to receiver/power source to power sink).

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