SUCCESS **STORY**

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Cadence SVG and Cadence CPG

Cadence Palladium Emulation Design Team Develops Revolutionary Hybrid Cooling System Using Celsius EC Solver to Analyze Thermal Cooling Behavior

Application
- Thermal integrity

Software
- Cadence Celsius™ EC Solver

Benefits
- Improvement in analysis performance and accuracy
- Design efficiency

Key Challenges

Cadence® Palladium® emulation platforms designed by the Cadence SVG group provide early software development and in-circuit emulation for high-performance hardware and software verification and debug of complex systems on chip (SoCs) and systems. As the industry's first data center-class emulation system, the Palladium Z2 platform bridges the verification productivity gap to accelerate the verification of SoCs, subsystems, and IP blocks, as well as system-level validation.

The Palladium Z2 platform consists of 18 logic drawers (LDs) per rack, eight application-specific ICs (ASICs) per LD, and 144 ASICs in the full system. Figure 1 is a photo of the front and back of the latest Z2 Palladium product.

Figure 1: Front and back of the Palladium Z2 platform

The Palladium high-performance rack, with its massively parallel processor-based compute engine, provides enterprise-level reliability and scalability with 5X greater emulation throughput. However, this high-power technology requires a robust cooling system. The first Palladium Z1 platform was developed with an all-liquid system that proved very expensive to manufacture, significantly increasing the overall cost of the product. When Cadence released a new, more sophisticated Celsius EC thermal integrity and optimization software, it was decided to use the technology to redesign the entire system in the next-generation Z2 model. For the first time, the Celsius EC Solver enables the team to explore a hybrid solution and determine whether a combination of less expensive air cooling with liquid cooling could lower costs without risking product failure.

The Solution

The Cadence CPG group's Celsius EC Solver technology is designed to enable electronic system designers to address the most challenging thermal/electronics cooling management problems quickly and accurately. The Celsius EC Solver's powerful computational engine and meshing technology helps designers model and analyze complex designs to reduce the risks of product failures and optimize thermal solutions to maximize performance.

With the Celsius EC Solver technology now available commercially, the Palladium team began developing a second-generation hybrid solution combining liquid and air cooling that would be very easy and cost-effective to manufacture while still meeting performance requirements.

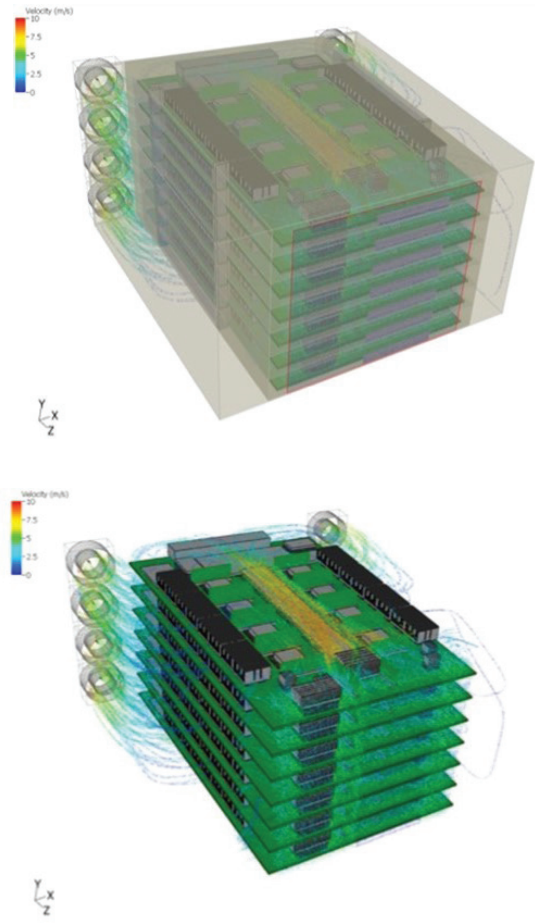

Figure 2: Chassis airflow distribution

> *When the Celsius EC Solver technology became available internally, we were able to leverage the fast and accurate analysis and optimization to develop and optimize a hybrid cooling solution that lowered manufacturing costs for the Palladium Z2 without compromising performance.*
>
> Eric Chu, Principal Thermal Mechanical Engineer, Cadence

In the initial design, the team wanted to liquid cool the optical transceivers and high-power components inside the chassis. As the optical components have a lower operating temperature, it was decided to air-cool the optical transceivers. From the ≈2000W of power consumption, about 10%, or 200W, comes from the optical transceiver.

Using the Celsius EC Solver, the team imported the entire Palladium system design and analyzed the thermal behavior of the components. The software's fast and efficient meshing and quick turnaround time enabled the engineers to optimize the hybrid cooling solution by running multiple parametric analyses. This determined where liquid cooling could be eliminated and air cooling used instead of where liquid cooling was the only option.

Figure 2 highlights the Z2 chassis airflow distribution among the modules, and Figure 3 shows the LD module airflow distribution. Figure 4 provides the component case thermal behavior analyzed by the Celsius EC Solver.

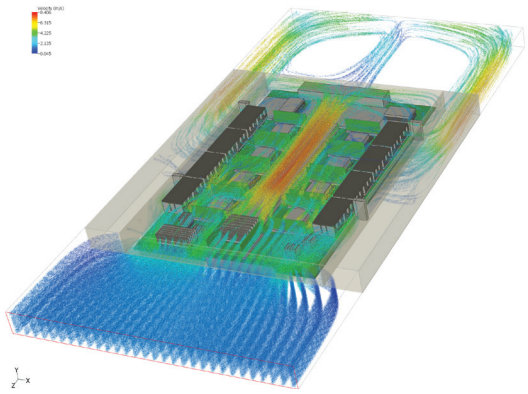

Figure 3: LD airflow distribution

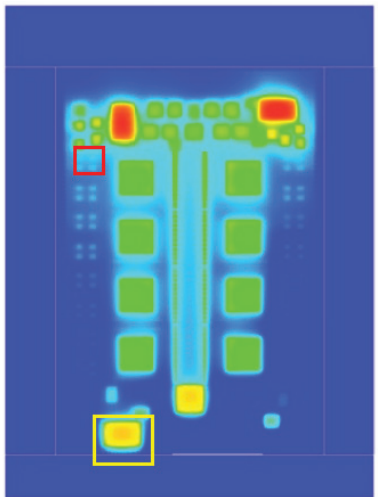

Figure 4: Component case thermal behavior

> *The hybrid Palladium Z2 emulator allows Cadence customers to run more validation cycles on bigger chips in less time, without concerns about sub-par performance or failure.*
>
> Eric Chu, Principal Thermal Mechanical Engineer, Cadence

Summary

Although the first Z1 version of the Palladium emulation rack was already out, once the designers had access to the Celsius EC Solver, despite being in the middle of the design cycle for the second generation, they decided it would be more cost-effective to return to the drawing board, use the software to develop an air-cooling solution for the optical transceiver, and release a hybrid solution, instead of a second generation of the original water-cooled product.

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