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Siemens and Cadence

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Thomas Kraus, Verification Manager, Siemens

The Customer

Siemens AG (Berlin and Munich, Germany) is a global powerhouse in electronics and electrical engineering, operating in the industry, energy, and healthcare sectors with around 405,000 employees in more than 190 countries.

The Siemens Drive Technologies Division in Germany is the world's leading supplier of products, systems, applications, and services for the entire drive train with electrical and mechanical components and motion control systems for production machinery as well as machine tools. Drive Technologies serves all segments in manufacturing, process, and energy/infrastructure industries, providing answers to customers' key requirements: productivity, energy efficiency, and reliability.

The Challenge

In the application-specific integrated circuit (ASIC) design process, various verification methodologies are needed for different tasks—and it can be difficult to coordinate all these methodologies and supporting tools into a coherent plan to successfully track, measure, and manage the various forms of coverage.

Siemens Drive Technologies' ASIC design team recently finished its "DQ100" ASIC project, which represents an ARM®-based system-on-chip (SoC) solution for encoder applications. The new ASIC contains both hardware and software functionality and allows communication via the real-time protocol DRIVE-CLiQ.

Business Challenge

- Reduce overall project schedule

Design Challenges

- Build a chip-level verification plan over the entire functionality of the ASIC, including hardware and software
- Develop a flexible, trustworthy verification plan to stay on track, manage progress, and automate coverage collection
- Integrate formal analysis technology into the verification flow

Cadence Solutions

- Incisive Enterprise Manager
- Incisive Enterprise Specman Elite Testbench
- Incisive Formal Verifier
- Incisive Enterprise Simulator

Results

- Quickly developed and implemented a comprehensive verification plan
- Kept the project on track and met the needs of both engineers and management
- Developed the proof of concept for a metric-driven verification methodology
- Completed the project ahead of schedule

Using Cadence® Incisive® Enterprise Specman® Elite Testbench in conjunction with Incisive Enterprise Manager and other Cadence verification technologies (Incisive Enterprise Simulator, Formal Verifier, and Verification IP), the Siemens design team was able to achieve total coverage on its DQ100 ASIC project.

"We needed an all-encompassing chip-level verification plan over the entire functionality of the ASIC, developed together with the software customer, that would address real-life use cases and user scenarios," says Thomas Kraus, Verification Manager at Siemens. "We also needed to reduce our overall project development time—and this meant to benefit from reuse in both design and verification."

The team wanted a flexible, trustworthy verification planning solution to provide a solid base for managing and re-planning due to unforeseen specification and project changes. They also wanted to integrate an advanced formal analysis technology to aid in establishing a metric-driven verification methodology into the software/hardware verification flow.

"Metric-driven verification greatly improved overall verification progress. We highly appreciate that with Specman we did not just buy a tool, but that Cadence developed with us a complete solution providing solid concepts on how to exploit the language best and a methodology/flow (eRM, UVM, etc.) on how to actually do verification. That's what really made the difference for us and continues to bring us a great benefit."

The Solution

"The principle of metric-driven verification is to apply the best coverage metrics for each verification task," Kraus explains. "Incisive Enterprise Manager manages various forms of coverage in one unified environment, based on a top-level verification plan. With the top-level verification plan guiding our coverage and overall progress, we have more control over how all the different technologies can be applied."

Using Incisive Enterprise Manager, Kraus and his team achieved an automated flow that enabled them to view verification progress, incrementally for each item/task and also as a whole for the complete project.

"Management is more interested in the overall verification progress, while verification engineers are more interested in the coverage of their specific features and want to dive into the details," Kraus explains. "Incisive Enterprise Manager enabled us to filter the results and measure metrics to provide progress feedback to the various teams."

Kraus' team primarily used functional coverage in their simulation environment. "Due to technical limitations we couldn't employ code coverage yet, but we want to use it as an addition in the future," he says. For formal verification, the team members used property checking and coverage. In a few cases, they were able to verify modules exclusively with Incisive Formal Verifier and achieve coverage high enough to eliminate the need for simulation.

Kraus explains that if it becomes impossible to verify 100% of the ASIC's functionality, the total coverage approach provides a solid base to calculate the remaining risk. "Even if the coverage is difficult to reach and we run out of time, the solution allows us to always have visibility into what's still missing and how hard it will be to get this coverage."

As tapeout approaches, the project team holds a critical meeting and looks at where 100% coverage has been achieved and what is still missing. "We can exactly quantify the risk of going to tapeout or, instead, identify the features that need more verification effort," he says. "The important point is that with a metric-driven verification approach, we have absolute control."

Incisive Specman technology was an important aspect of Siemens' metric-driven verification approach. One of the advantages leveraged was constrained-random testing, where the team members were able to find corner cases they had not even considered. Incisive Specman technology also made it possible to design and use a number of high-grade verification components.

"Incisive Specman was especially useful for robustness tests with error insertion, finding corner cases, and generating random traffic in the system that adhered to certain requirement-dependent rules," Kraus says. "From a technical point of view, the powerful and technically mature Specman constraint solver also enabled us to develop our own high-grade generic and complex verification components."

"We highly appreciate that with Specman we did not just buy a tool, but that Cadence developed with us a complete solution providing solid concepts on how to exploit the language best and a methodology/flow (eRM, UVM, etc.) on how to actually do verification," Kraus adds. "That's what really made the difference for us and continues to bring us a great benefit."

Cadence Incisive Software Extensions, which bridge hardware verification methodologies into the software world, provided another advantage. "We found it very helpful to verify the hardware abstraction layer, the lowest level of software, with register reads and writes and interrupts," Kraus explains. "With Incisive Software Extensions, you can have all the verification components (UVCs) attached, do error insertion, and see how the software reacts. We used it on one very critical module and revealed some issues that couldn't be seen in prototyping."

Summary

The Siemens DQ100 project succeeded as a "proof of concept" for metric-driven verification, according to Kraus—providing an "absolutely reliable" verification environment with good upfront planning and multiple forms of coverage collection to measure.

"We had solid data to plan and measure progress, and we always knew what was still left to do and how long it would take," he explains. "It helped us a lot in planning and managing the overall verification project."

The two biggest wins for a metric-driven verification approach are increased quality and maintaining product delivery schedules.

"We always know where we are in a project," Kraus notes. "We can react with confidence for every unplanned event that occurs. In this particular project there were unplanned events, such as unexpected staffing changes and scheduling shifts. This was all the more reason to have a reliable verification plan."

"The main benefit is that we achieved verification closure not only on time, but ahead of schedule," summarizes Kraus. "We had other projects where we had some difficulties in finishing verification on time and had to reschedule verification tasks. But here, we planned for verification closure at least two weeks before the holidays, and that's what we reached without any tradeoffs in verification quality."