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SigmaTel Relies on Verdi Debug System As Critical Element in Verification Strategy

Background

SigmaTel, Inc., a fabless semiconductor company based in Austin, Texas, designs and develops a diverse portfolio of proprietary mixed-signal multimedia ICs for use in portable and consumer electronics products such as MP3 players, notebook and desktop PCs, portable digital cameras, digital televisions, multi-function peripherals and set-top boxes. Its complete, system-level solutions include highly-integrated ICs, customizable firmware and software, software development tools, reference designs, and applications support.

An Evolving Market Poses Key Development Challenges

One of SigmaTel's key product lines is a portable audio System-on-Chip (SoC) platform for MP3 players, the STMP3500 is a 0.18-micron solution, based on a DSP core operating at 75 MIPs and providing greater than 50 hours of battery life. Despite these compelling characteristics, the constantly evolving industry standards and consumer preferences in the digital audio market have prompted manufacturers to demand higher performance solutions that demonstrate increased cost savings. This market demand requires a new and improved version of the STMP3500 family of products.

The job of designing the fourth generation portable audio SoC product, the STMP3600, fell to SigmaTel's Austin based design team. This team was responsible for the RTL development and verification of the next generation audio SoC platform based on a 0.18-micron ARM 9 core with DSP extensions. The STMP3600 boasts over 200 MIPs and the industry's longest battery life, achieving over 70 hours of MP3 playback.

In developing the STMP3600 platform, the Austin design team was keenly aware of the requirements of consumer electronics manufacturers including: increased functionality, performance and battery life; compatibility with emerging standards and decreased cost. The team also considered the dynamics of the MP3 market as they played a key role in driving both the price and performance of its SoC solution.

In order to meet the needs of the market, the SigmaTel design team needed to ensure the highest quality for its fourth generation audio solution while still meeting the market's performance and price needs. Accomplishing these goals mandated the use of third-party intellectual property (IP), leaving the design team free to concentrate on its areas of core competency: a high level of mixed-signal/DSP integration and power sensitive technology innovations that include both DC-DC converter technology and clock-tree technology. Such innovation is extremely critical to the highly-competitive MP3 player market as it directly translates to longer batter life for the consumer.

The use of third-party IP by SigmaTel not only substantially facilitated a faster time to market for the STMP3600 family of products, but it also increased design complexity. The use of "unfamiliar" elements in the SoC placed additional time and cost constraints on the SigmaTel design team. They were forced to find a more efficient way to debug, explore and better understand their design.

A Better Debug Strategy

To manage this challenge, the SigmaTel design team adopted an industry standard top-down design flow, customizing where necessary. This design and verification methodology utilized a mix of electronic design automation (EDA) tools including the Novas Verdi™ Automated Behavior-Based Debug System, as well as the Verilog hardware description language (HDL) with some 2001 Verilog constructs and the VERA hardware verification language. For verification, SigmaTel started at the block level and built up to a system level model that included the ARM core. Novas' Verdi debug system provided the primary means by which the design team gained visibility into the design.

Including the Verdi tool as part of the company's verification methodology was an easy decision. According to Bob Dunnigan, SigmaTel's design services manager, the company has a long established history of using the tool. "The company made the decision early on to purchase Novas' Verdi tool—despite the fact that in its start-up days, we were strapped for cash. Management felt it was a critical and sound business investment. The tool was selected specifically for its ease of use and because there was such a large buy-in from the design community. There was great value to the company in being able to cut design time with an efficient debug strategy."

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Bob Koelling, director of engineering services and technical strategy at SigmaTel, points out that "as the company's design team has grown with the addition of new engineers, the one thing that remains consistent from one engineer to another is a familiarity with the Novas tool set. As a result, it acts as a common platform by which our different engineering efforts can converge." Koelling adds that "debug has become a critical part of the overall design process, not just an afterthought to simulation. Because of this fact, today all of the designs done at SigmaTel rely on the Verdi tool."

Some members of the design team had experience with Novas' first-generation debug system, Debussy®. The Verdi Automated Behavior-Based Debug System is Novas' second-generation debugging solution and is based on the same architecture as the popular Debussy tool, including many of its same features which allow the design to be viewed through waveforms, source code, schematics and state machines. Where Verdi differs is in the approach it takes to debug. Its behavior-based methodology combines rigorous mathematical techniques for behavior analysis with new temporal visualization capabilities designed to help the user better understand complex or unfamiliar design elements. Proven synthesis technology and advanced formal methods help quickly isolate cause and effect in complex designs. As a result, the time it takes for a user to understand how a design works and why it does not is significantly reduced.

As Bryan Cope, a systems and digital IC design engineer at SigmaTel points out, "Our use of third-party cores means that my team and I have to deal with code that we did not write ourselves. We needed an efficient way to navigate through unfamiliar design elements and gain a better understanding of design behavior. While I had become familiar with the Novas Verdi tool prior to coming to SigmaTel, the use of externally-sourced IP as well as code from different team members caused me to reach a significant pain threshold in the debug process. I was forced to revisit my use of the Verdi tool. In the process I discovered that it could be used for much more than what I had traditionally used it for."

Verdi provides the SigmaTel designers and engineers with an easy and intuitive way of analyzing cause and effect. The tool automatically infers the logic functions of a design from its RTL (or gate-level) description and interprets simulation results to generate an internal model of design behavior over time. The SigmaTel engineers use this information to visualize behavior over time, explore alternate behaviors and browse through unfamiliar code. Rather than manually tracing back through a design statement by statement or gate by gate, they can use the tool's statement flow graphs to automatically trace data and unknowns back through time. Verdi's active annotation capability then allows variables to be viewed at the same point in both waveform and source code files.

The SigmaTel design team found this capability especially helpful during the design of the STMP3600 SoC platform. In fact, as Bryan explains, the ability to work with RTL schematic tools and trace unknowns was so powerful that once he started using these features the team was "hooked on the tools."

Tracing an unknown through a complex core and design element, such as a custom hard-coated DSP, is a process that normally takes a couple of hours. With Verdi, the team was able to find problems in a matter of minutes. It resulted in an order of magnitude improvement. For the team, that feature alone meant the difference between success and failure.

The SigmaTel design team continues to rely on the Verdi tool for much of its debug process, but Bryan Cope sees a growing need to delve deeper into its unique capabilities and feature set. "Originally I used the tool for nothing more than putting waveforms on the screen. Once I was exposed to some of the tool's other capabilities I realized it had a huge array of features that I had not even begun to tap into. Presently, for example, we simulate, save the results and then view them. We do not open Verdi and run the simulations directly from its graphical user interface – a feature that can save time if you are working on startup issues and need to crawl through the simulation, debugging several bugs as you go. I expect this will change over time though as I, and the rest of my design team, reach a new pain threshold. Novas is very good at anticipating our needs and the tool is ahead of us in terms of its capabilities. It's reassuring to know that the Verdi tool is capable of supporting the growing needs of my design team."

Corporate Headquarters
2025 Gateway Place
Suite 400
San Jose, CA 95110
tel: 1.888.NOVAS-38
or: 408.467.7888
fax: 408.467.7889
info@novas.com

Europe & Israel—Novas Ltd.
Enterprise House
36 Hart Street
Henley-on-Thames
Oxfordshire RG9 2AU
United Kingdom
tel: +44.1491.579863
fax: +44.1491.572497
europe@novas.com

Asia Headquarters
5F, No. 25, Industry East Road IV
Science-Based Industrial Park
Hsinchu 300, Taiwan, ROC
tel: +886.3.567.9656
fax: +886.3.567.0066
sales@novas.com.tw

www.novas.com