Behavioral Modeling Approached for Analog, Mixed Signal, and RF

Helene Thibieroz - January 25, 2013

As a chair for the AMS track at DesignCon, I wanted to talk about a special event I put together for DesignCon AMS track. I specifically created this year a tutorial to emphasize on behavioral modeling. Because DesignCon is a broad conference, going from chip design to signal integrity and board level design, I wanted to cover different modeling techniques available for Analog, Mixed Signal and/or RF.

[Click here for information on DesignCon 2013, Jan. 28-31 at the Santa Clara Convention Center.]

My end goal was not only to give some general insights to someone new to behavioral modeling or someone expert for one type(for example VerilogAMS) that would like to get exposed to other techniques (such as Matlab/Simulink or real number modeling) but also to correlate/compare those modeling techniques by presenting pros and cons of each approach.

The tutorial can be accessed here.

Because I wanted this tutorial to be comprehensive and give an overview of modeling languages available for different domains, I asked several experts to talk about their area of expertise .This session shall address the past, present, and future state-of-the-art in behavioral modeling approaches for AMS. The agenda is the following:

1. Introduction and general presentation- Helene Thibieroz, Synopsys Inc
2. Analog modeling with IBIS- Michael Mirmak, Intel
3. AMS modeling with Matlab- Mike Woodward, Mathworks
4. Analog and Mixed signal Modeling with VerilogA/AMS- Dave Cronauer, Synopsys Inc
5. Analog Behavioral Modeling for Digital Simulators, Ozan Erdoğan - Maxim Integrated

In this interview, I asked each speaker to give me his insights about this tutorial and a high level overview of what they are going to present.

Mike Woodward, Mathworks

Mike Woodward is the communications and semiconductor industry marketing manager at MathWorks. He has degrees in Semiconductor and Microwave Physics and has been active in the communications and semiconductor industry for many years. Mike worked on the transmission infrastructure for the UK’s commercial DAB transmission network, a project that was awarded the British Computer Society’s IT Award for Excellence in 2000. He has also worked on audio processing and has several audio processing patents. Over the last few years, he has been working on mixed-
signal design at MathWorks and has written a number of articles on system-level mixed-signal design.

Dave Cronauer, Synopsys Inc.

David Cronauer has 25-plus years in analog-mixed signal design and simulation. His experience has spanned research, product development, marketing and sales support. In his role as senior consulting application engineer at Synopsys, focusing on mixed signal and verilog-AMS languages. Dave started his career at Boeing, and went on to join Analogy in 1990. As a key member of the product marketing team, Dave provided worldwide engineering support for designing systems-level circuits in medical, automotive, and mobile designs. Analogy was ultimately acquired by Synopsys, where he resides today. Dave holds a BSEE from Penn State University.

Ozan Erdogan, Maxim Integrated

Dr. Erdoğan is Executive Director of IC Design, Touch Interface Products at Maxim Integrated. He received his Ph.D. degree from University of California, Davis in IC Design, and M.S. degree in Signal Processing from Northwestern University. Prior to Maxim he started a mixed-signal IP company, Yonga Semiconductor, held leadership and technical positions at Berkana Wireless (acquired by Qualcomm), and C-Cube Microsystems (acquired by LSI Logic). He has worked on data converters, RF ICs, cable modems front ends, and touch interface products. His interests are in circuit design, mixed-signal SoCs architecture, and behavioral modeling for SoC verification.

Hello everyone, can you tell us more about the section of the tutorial you are covering?
What can attendees gain from your presentation?

Mike: I will be showing how MATLAB and Simulink are used for mixed-signal design. More broadly, I want to demonstrate why people are so interested in behavioral modeling for mixed-signal design. I can sum it up in one word: speed. I intend to demonstrate extremely fast simulation of ADCs, PLLs, and SERDES and explain why these simulations are as fast as they are.

Speedy simulation has consequences for the design process. Speed makes it possible to interact with models while they are running and examine the impact of tweaking parameters etc. – something that’s impossible to do if your simulation takes hours to run. Speed also makes it possible to run parameter sweeps to examine the effects of manufacturing tolerances and the interplay of imperfections etc.

Behavioral modeling doesn’t standalone - it’s part of a bigger design process. I’ll go on to show how behavioral models can be linked into more traditional, circuit-level simulations. This isn’t a theoretical or academic presentation – everything I’ll show is inspired by real-world examples and you’ll get to see how you can practically reduce design time and see how other people in other companies are using behavioral modeling.

Dave: My section will start with an overview of the different modeling languages, such as Verilog-A, Verilog-AMS and VHDL-AMS and their usages and then drill down into how and when to effectively use these languages, either at the transistor level, cell level, block level or in a testbench. Finally, I’ll go into a few details of Verilog-AMS language and techniques on making proper behavioral models.

Ozan: I will cover various aspects of modeling analog circuits in digital simulators, from building discrete time models of analog circuits to partitioning, and netlisting issues. Although the concept of real number modeling is simple, putting it to practice has some challenges because we are using a
digital simulator outside its intended purpose. I will try to bridge this gap by providing several practical examples from personal experience. These techniques were successfully applied to ADCs, RF chips, PLL/synthesizers, and mixed-signal chips with embedded microcontrollers. The presentation will be of interest to chip leads, mixed-signal designers, and digital designers.

What do you foresee as the future of behavioral modeling (for your specific area) in the next five years?

**Mike:** My firm belief is that behavioral modeling will become the dominant ‘initial’ design methodology for mixed-signal design. Almost all complex mixed-signal designs will start with some form of behavioral modeling. The reason is simulation speed and the consequential reduction in design time. For years, people have been talking about executable specifications and the benefits they offer. Finally, this dream will become more real. With the widespread adoption of behavioral modeling, the barriers to creating executable specifications are falling, and I believe as a result, executable specifications will be adopted more widely. I would also expect to see code generation, both HDL and C, becoming more important. If you have behavioral model that describes your analog and digital logic, why not generate code from it to make the digital side (at least) a lot easier to do? Behavioral modeling will also become more relevant to verification. I’m already seeing this in the field and I would expect to see more of it over the next few years. The advantages are compelling.

**Dave:** The future is very bright for analog and mixed-signal behavioral modeling, but there is still much work ahead. The committees are starting to see how Verilog-AMS and SystemVerilog can merge into a unified language; a user community of modelers and designers who are proficient in modeling languages is growing to a point of critical mass, and other languages, such as SystemC are adding mixed-signal constructs to their language.

**Ozan:** Behavioral modeling of analog blocks in digital simulators is a powerful tool for speeding up simulation times, and allowing full chip verification of mixed-signal SoCs. We will see significant activity and new tools from EDA vendors easing behavioral modeling, partitioning, and netlisting issues. Although there are some solutions today, they do not address the needs of advanced users. We will also see better behavioral modeling support in simulation languages and simulators.

Thanks to our four speakers for their insights. As you can see, it should be a great tutorial. Hope to see you there!