

how big can you dream?[™]



Automatic Behavioral Model Generation: Our Future or Our Fantasy?

Ken Kundert

4:30 PM Monday, Oct. 7

Design Challenge: Size and Complexity



- Increasing complexity as circuits become larger
 - Increasing integration
 - To reduce cost, size, weight, and power dissipation
- Increasing complexity of signal processing
 - Implementation of algorithms in silicon
 - Adaptive circuits, error correction, PLL's, etc.
- Designers must improve their productivity to keep up
- Huge productivity ratio between design groups
 - As much as 14x (Collett International, 1998)

Design Productivity



- Bottom-up design style is responsible for poor productivity
 - Problems are found late in design cycle, causing redesign
 - Simulation is expensive, and so usually inadequate
 - Inadequate verification requires silicon prototypes
 - Too many serial dependencies
- A formal top-down design process is the solution
 - Methodically proceed from architecture to transistor level
 - Thoroughly explore system design with high-level simulation
 - Partition design and use behavioral models to coordinate design
 - Carefully verify each transition using mixed-level simulation

The Issue



- Adoption predicated on the availability of behavioral models
- Needed models very specialized, resist library-based solutions
 - Generic models work well for high-level simulations
 - Must be tailored to design for transition to implementation
- Management has not added modeling experts to design teams
- Dearth of effective modeling tools
- Designers are slow to learn modeling languages
- *Top-down design is not being adopted due to a lack of models*
 - *Is there a tool that solves this problem in our future?*

The Breadth of the Problem



- Linear, possibly distributed, models
 - High Q, high order, noisy data, passivity, causality, limited frequency range, large number of ports
 - SAW filters
- Linear time varying models
 - Mixers, SC filters, samplers, chopper-stabilized amplifiers, etc.
 - High-Q SC filters, receivers
- Mildly nonlinear, possibly time-varying, models
 - Nonlinear dynamics (slew rate limiting)

The Breadth of the Problem (cont)



- Strongly nonlinear models with limited memory
 - ADC, DAC, comparators (metastability)
- Strongly nonlinear models with substantial memory
 - Frequency divider, pulse-width modulators, $\Sigma\Delta$ converters, finite-state machines

Setting the Stage



- Joel Phillips — Cadence Berkeley Labs
 - Extract models using lots of obscure mathematics
- David Root — Agilent
 - Nonlinear behavioral models from measured data
- Richard Shi — University of Washington
 - Symbolic analysis
- Jaijeet Roychowdhury — University of Minnesota
 - Open-source model libraries