A matter of timing: New strategies for debugging electronics

February 1 2011, by Sandra Knisely

(PhysOrg.com) -- The components that make up the integrated circuits in electronic devices are nano-sized and number in the billions. Sometimes "bugs" lurking in these complex systems can emerge and cause significant performance errors.

One category of electronic bugs that can occur after a chip is fabricated is known as timing errors. These errors can cause components to slow down and take longer to execute operations. As components continue to become smaller, the process of preventing and solving timing errors is becoming ever more complex, increasing the time it takes to send new products to market.

University of Wisconsin-Madison Electrical and Computer Engineering assistant professor Azadeh Davoodi is one of the first people to look at solutions for timing errors, and she has received a 2011 Faculty Early Career Development Award (CAREER) and grant to support her work.

Sponsored by the National Science Foundation, CAREER awards recognize faculty members who are at the beginning of their academic careers and have developed creative projects that effectively integrate advanced research and education.

Integrated circuits go through a rigorous testing process to find and correct bugs that can cause performance errors. However, the small size and sheer volume of components mean chips realistically cannot be entirely validated before fabrication.

"These errors occur, not because the circuit isn't functioning correctly, but because it fails to operate correctly at the desired speed," Davoodi says. "The nanoscale components in the chip are so small they can have weird physical behaviors that can only be detected after they are fabricated."

The validation process involves manually opening up a chip and examining billions of transistors, which is extremely time-consuming. Timing errors often are interdependent, meaning they emerge only when certain operations are performed together. This means testing for timing errors requires predicting the chip's behavior during a vast number of possible operations and combinations of operations.

It can several months to find errors and alter chips during the validation process. Most of this time is spent dealing with timing errors, so while timing errors are not the most common problems, they are a significant factor in delaying the time to market of new chips.

Davoodi's team will develop special sensor components that can be added to a chip's design, as well as methods to analyze measurements from the components. The new components will provide custom timing information for a particular chip design, allowing developers to predict, detect and even solve errors more quickly.

Instead of manually opening up and examining chips, developers could simply use data from the sensor components as a compact representation of important areas of the design that may be causing timing errors.

"We want to increase the timing observability inside the chip," Davoodi says.

In addition to supporting cutting-edge research, CAREER awards also fund innovative outreach programs. Along with developing technical

coursework to introduce undergraduate students to sophisticated software programming, Davoodi is creating a unique course module that looks at some of the non-technical aspects of computer engineering that could inspire students to pursue the field.

The course module will be part of an introductory engineering course called Introduction to Society's Engineering Grand Challenges and explore the One Laptop Per Child project. The module will look at the societal, ethical and political implications of disseminating and using technology in developing countries.

"These aspects of the case study can be used as a different angle to interest students, particularly women, to get excited about engineering," Davoodi says.

Provided by University of Wisconsin-Madison