Driving improved automotive chip design

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A recently completed EU project developed better tools for integrated microcircuit design; achieved some world firsts in performance analysis and now may even spin off a new company to commercialise some of its new technologies.

The DEMAND project wanted to develop a reliable and cost-effective design process for 'smart power' integrated circuits. This type of microchip can integrate a wide variety of functions into one piece of silicon. The advantage is lower-cost and increased reliability.

It developed a design process specifically intended to improve the robustness and reliability of integrated circuits for the automotive industry.

Modern cars are typically riddled with microelectronics, used to control everything from the mirrors to combustion. Currently the industry's drive is towards the increase of additional electrical functions and the integration of these in a smaller number of chips.

The trade-off, however, is an increasingly expensive chip design process. The sector demands robust chips that can withstand suddenly occurring not wanted high energetic electric pulses. These pulses can mean a massive increase in electrical current and a brief, but massive, rise in temperature within the chip's circuits. Temperatures sometimes reach up to 1000 degrees centigrade for a few hundreds of nanoseconds. This can either disturb the chip function or physically destroy the chips.

"These stresses can occur either when the car is in operation, or even during manufacturing," says Dr Dionyz Pogany of the Institute for Solid State Electronics at the Vienna University of Technology, one of the DEMAND partners.

Typically this problem is encountered in cars during the switching of the different electrical machines or relays within the car, or an electrostatic discharge. This can destroy the delicate circuitry in the car's control systems.

It's hard to imagine that a simple effect like a static shock, experienced regularly by car users, could cause so much damage. But microchips, and particularly complex, integrated chips, are very small, and thus delicate. The effects of a discharge rise exponentially as a result.

The DEMAND team scored an exceptional coup by developing a new type of chip analysis system. The system verified the predictions of the improved simulations.

This analysis, called Transient Interferometric Mapping (TIM), uses infrared interferometry to reveal exactly what is happening on a chip when it receives a high current pulse. The simulation predicted the effects of stress while TIM revealed whether it actually occurred. The strength of this measurement technique is that for the first time the occurrence of moving current filaments could be experimentally proven.

The upshot is a detailed, non-invasive and non-destructive record of what exactly is happening on a chip when a high energetic pulse hits. DEMAND researchers were able to tell what problems occurred on the chip and that revealed what remedies were required to make them more robust. As a result, they helped refine the simulation models.

"In the past it was not possible to observe exactly what is happening in the chip when it receives this type of stress," says Pogany. "TIM also has the ability to take a single snap-shot of the internal dynamics of the chip, another improvement achieved by the DEMAND team."

This is invaluable information for designers, because they can see exactly what happens to the chip, what systems fail, what systems survive, and why. It provides them with a blueprint to refine the device.

The combination of understanding the destructive mechanisms of energetic pulses, improving device simulation, particularly at temperature levels that have never been reached before, and then observing the impact of electrical or thermal stress on the device, means new chips can be developed at enormously reduced cost. Reliability will be improved. And opportunities to create new devices now exist.

"Right now we will certainly work with anyone who wants to use our TIM system to help develop their microchips, but we have not yet decided if it is feasible to launch a spin-off company," says Prof Erich Gornik, who was responsible for the DEMAND project at TU Vienna. "That is a definite possibility. A lot of people in the industry are excited by what our system can do to improve chip design."

"In the meantime we want to develop more advanced models of our TIM technology. We want to make it more robust, to be able to sell it to failure analysis departments in semiconductor companies. Right now the TIM tool needs a lot a maintenance, and we hope to lower the maintenance required to make it more attractive for industry."

Source: IST Results

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