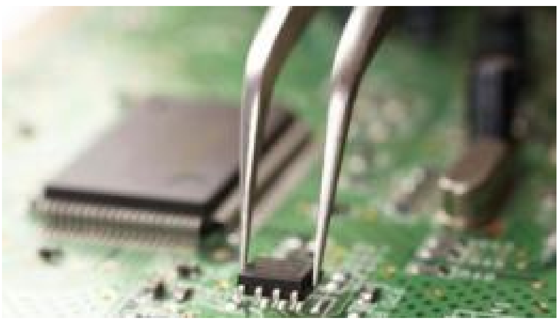
Using bad chips to build energy efficient smartphones

June 27 2012



(Phys.org) -- Is the hardware powering the current generation of smartphones and computers "too good" for what it has been designed to do? This is the question addressed by Andreas Burg, director of the Telecommunications Circuits Lab (TCL) at EPFL.

After all, smartphones and laptops are resilient to a certain level of distortions of the signal they process, so why shouldn't they be similarly resilient to a certain proportion of not-fully-reliable silicon chips in their circuits?

The researcher’s reasoning has recently proven to be correct: he and his team have shown at the Design Automation Conference (DAC) in San Francisco that it is possible to use defective chips in smartphones and computers, while still attaining performance levels in line with current commercial products. A discovery which could potentially impact industry: "manufacturers don’t produce chips that can run at very low voltage and be energy efficient, because the production yield would be low-most of the chips, after production, are unusable. Thanks to our technique, we can use the partially functional chips that would otherwise be thrown away, and maintain a high yield”, says Andreas Burg.

To test the theory, Burg's team and his colleagues at ETHZ designed a simulation system that evaluates the impact of hardware “failures” in the memory of a smartphone. The results showed that the system was able to tolerate a large number of such defects in the circuit: neither the throughput nor the performances of the smartphone were significantly affected. Even better, the system could run longer on a single battery charge. “Using bad chips allows to reduce energy consumption by performing very aggressive voltage scaling, well beyond the limits of today's conventional design paradigm,” underlines the scientist.

Application-level fault- and defect-tolerance

The team developed its concept by bringing together signal processing and circuit design, which are generally two very separate fields. “Wireless communication systems for smartphones and computers are, in general, resilient to distortions of the signals they process. They have to be: networks are full of noise and can be hampered by interference. When a user goes to a webpage from a smartphone, for example, the device will not successfully process 100% of the data it receives on the first try. In fact, only about 90% of the data is processed and stored in the device’s memory on the first attempt. To get the rest, the device employs sophisticated error correction mechanisms at the application level, or quickly sends off an automatic repeat request, and then compares what it receives to what it originally got in order to ‘fill in the gaps’ in the data,” explains Andreas Burg.

This is precisely where Burg's approach comes in. He started from the idea that the system continues to function even if some data is lost or distorted. Therefore, why not simply try to exploit this resilience to tolerate defects in a circuit that appear when operating at very low voltages? “When a mobile phone runs out of battery,” the researcher explains, “it simply switches off to avoid errors. Thanks to our technique, the phone can run at a reduced power-supply. It will then take more time to send an email, for example, but the overall capabilities of the phone will be maintained.”

Hybrid mobile phones

Going beyond the 100% reliability paradigm in wireless communications circuits paves the way to the development of hybrid, cheaper mobile phones that can switch from one mode to another. “To go even further, cheaper devices could be constituted only by chips that are routinely discarded by manufacturers today, under the condition that the client agrees for his phone to be slightly slower," says Andreas Burg.

Faulty chips: a hot topic around the world

The idea of taking advantage of the inherent resilience of many applications is also followed by other labs at EPFL and around the world. Along the same lines, the group of EPFL Professor Christian Enz from the Swiss Center for Electronics and Microtechnology (CSEM) is participating in an international collaboration between Rice University (Houston, TX) and Nanyang Technology University (Singapore). The Embedded Systems Lab of David Atienza at EPFL also works on similar issues. The groups ot the three scientists are currently discussing how to join forces to further develop and establish a new design paradigm.

More information: On the exploitation of the inherent error resilience

[of wireless systems under unreliable silicon]

Provided by Ecole Polytechnique Federale de Lausanne