Conference in Numerical Analysis 2014 (NumAn 2014)
September 2-5, 2014
Chania,Greece

Significance-Based Computing for Reliability and Power Optimization[1]

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Abstract

Manufacturing process variability at low geometries and energy dissipation are the most challenging problems in the design of future computing systems. Currently, manufacturers go to great lengths to guarantee fault-free operation of their products by introducing redundancy in voltage margins, conservative layout rules, and extra protection circuitry. However, such design redundancy leading to significant energy overheads may not be really required, given that many modern workloads, such as multimedia, machine learning, visualization, etc. can tolerate a degree of imprecision in computations and data.

In this talk, I will introduce an approach which seeks to exploit this observation and to relax reliability requirements for the hardware layer by allowing a controlled degree of imprecision to be introduced to computations and data. It proposes to research methods that allow the system- and application-software layers to synergistically characterize the significance of various parts of the program for the quality of the end result, and their tolerance to faults. Based on this information, extracted automatically or manually, the system software will steer computations and data to either low-power, yet unreliable or higher-power and reliable functional and storage components. In addition, the system will be able to aggressively reduce its power footprint by opportunistically powering hardware modules below nominal values. Significance-based computing lays the foundations for not only approaching the theoretical limits of energy reduction of CMOS technology, but also moving beyond those limits by accepting hardware faults in a controlled manner.

Key words: Computational significance, Low-power design, Reliable Design.

[1]The present research work has been co-financed by the European Union (European Social Fund ESF) and Greek national funds through the Operational Program "Education and Lifelong Learning" of the National Strategic Reference Framework (NSRF) - Research Funding Program: THALIS. Investing in knowledge society through the European Social Fund.