

ESWeek 2014 Tutorial

Title:

Mitigation of soft errors: from adding selective redundancy to changing the abstraction stack

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Abstract:

The goal of this tutorial is to present advanced techniques to cope with soft errors in several layers of the abstraction stack with focus on how to achieve high reliability, high performance and low energy designs. We start with a characterization of the problem and its causes, developing an overview of the mechanisms involved in soft errors creation by ionizing radiation and other sources. We then present some approaches that can be used to mitigate soft error effects. The occurrence of soft errors tends to increase as circuits get smaller, and their effects are magnified as advanced technologies are embedded in commonly used systems. These advances in the technology, while reducing the overall reliability of the system, have also opened up the opportunity for re-designing the stack of abstraction and associated programming models. Topics to be covered are the following: characterizing soft errors, its causes and its effects, traditional strategies for error mitigation and detection; causes and consequences of soft error; concrete examples/reports of disruptions caused by soft errors in critical applications (avionics, space applications, automotive, medicine, nuclear plants, etc; current approaches: triple modular redundancy, invariant checkers, block signature checking, processor watchdogs; challenges for the re-design of the computational stack to achieve high reliability, high performance and low energy designs in different application domains; how soft errors can be taking into account when designing a new computational stack; the effect of soft errors in massively parallel machines, and how to cope with them using only software related techniques and programming guides; how to estimate/predict how sensitive to soft errors a circuit is? Reports on experiments with real radiation.