Editorial

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Dependable embedded systems

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The following is an introduction to the special issue on dependable embedded systems. The motivation for this issue came from two large-scale research initiatives, namely the German DFG SPP 1500 "Dependable Embedded Systems" (coordinated by Jörg Henkel from KIT; see also: http://spp1500.itec.kit.edu) and the NSF "Variability Expedition" from the USA (coordinated by Rajesh Gupta from UC San Diego; see also: http://www.variability.org). Both research initiatives started around the same time and both address similar dependability problems. Since both initiatives have had various exchanges through joint colloquia etc., a special issue representing the newest research outcome of both appeared to be an interesting contribution to the international research community working on this topic.

Background

The International Technology Roadmap for Semiconductors (ITRS) has stated, among others reliability to be a major design issue. Since Moore's Law and Dennard Scaling have come to their limits, we face the problem to deal with inherently undependable systems. The ENIAC Strategic Research Agenda stated already in its edition from November 2007: "Emerging devices are expected to be more defective, less reliable and less controlled in both their position and physical properties. It is therefore important to go beyond simply developing fault-tolerant systems that monitor the device at run-time and react to error detection. It will be necessary to consider error as a specific design constraint and to develop methodologies for error resiliency, accepting that error is inevitable and trading off error rate against performance (e. g. speed, power consumption) in an application-dependent manner". A possible way to approach this major problem is: accepting the undependability at the device level but ensuring that errors do not propagate to the user of an embedded system.

In the past, the implicit assumption has primarily been that these systems and their devices work in a dependable manner. The circuit design techniques, the computer architectures, the operating systems, the application software etc. are all implicitly based upon this assumption. But again, this is not true any longer. This problem has been advocated and is addressed by leading researchers around the world. In fact, almost everything from the physics of the circuits up to the application software needs to be re-thought from ground up: computer architectures might need to be changed, so as application software design, operating systems, and design methodologies. Dependability has in fact become a major design constraint.

This Special Issue reports the newest trends and results from the DFG SPP 1500 "Dependable Embedded Systems" and the NSF "Variability Expedition": The paper "Adaptive multi-layer techniques for increased system dependability" focuses on reliability increasing techniques that span several hardware and/or software abstraction levels whereas "Application-aware Cross-Layer Reliability Analysis and Optimization" aims to analyze and minimize undependability issues at the application level. The third paper from the DFG SPP 1500, "Multi-Layer Software Reliability for Unreliable Hardware", presents software techniques for enhancing reliability. The newest results from the NSF Variability Expedition are reported in the paper "NSF Expedition on Variability-Aware Software: Recent Results and Contributions".

For further literature regarding the focus, motivation and initial results of the both research initiatives, the reader is referred to [1] and [2].

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Bionotes

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Jörg Henkel is currently with Karlsruhe Institute of Technology (KIT), Germany, where he is directing the Chair for Embedded Systems CES. Before, he was with NEC Laboratories in Princeton, NJ. His current research is focused on design and architectures for embedded systems with focus on low power and reliability. Prof. Henkel has organized various embedded systems and low power ACM/IEEE conferences/symposia as General Chair and Program Chair and was a Guest Editor on these topics in various journals like the IEEE Computer Magazine. He was/is Program Chair of CODES'01, RSP'02, ISLPED'06, SIPS'08, CASES'09, Estimedia'11, VLSI Design'12, ICCAD'12, PATMOS/VARI'13 and NOCS'14 and served as General Chair for CODES'02, ISLPED'09, Estimedia'12, ICCAD'13 and ESWeek 2016. He is/has been a steering committee member of major conferences in the embedded systems field like at ICCAD, ISLPED, Codes+ISSS, CASES and is/has been an editorial board member of various journals like the IEEE TVLSI, IEEE TCAD, JOLPE etc. He has given full/half-day tutorials at leading conferences incl. DAC, ICCAD, DATE etc. and has delivered six keynotes at CAD Conferences.
Prof. Henkel received the 2008 DATE Best Paper Award, the 2009 IEEE/ACM William J. Mc Calla ICCAD Best Paper Award, the Codes+ISSS 2011 Best Paper Award, the Codes+ISSS 2014 Best Paper Award and the MaXentric Technologies AHS 2011 Best Paper Award. He is the Chairman of the IEEE Computer Society, Germany Section. He was the Editor-in-Chief of the ACM Transactions on Embedded Computing Systems (ACM TECS) for six years. He is an elected board member of the DFG board on Technical Computer Science. He is an initiator and the coordinator of the German Research Foundation's (DFG) program SPP1500 on "Dependable Embedded Systems" and the site coordinator (Karlsruhe site) of the Three-University collaborative research center DFG TR89 "Invasive Computing". He holds ten US patents and he is a Fellow of the IEEE.