

# **International Workshop on Cross-layer Resiliency**

## **July 11-12 2013, Austin TX, USA**

### **Workshop Report**

#### **Organizing Committee:**

- Nikil Dutt, University of California at Irvine, USA
- Joerg Henkel, Karlsruhe Institute of Technology, Germany
- Sani Nassif, IBM Research Austin, USA
- David Pan, University of Texas at Austin, USA
- Mehdi Tahoori, Karlsruhe Institute of Technology, Germany

#### **Overview:**

Improvements in chip manufacturing technology have propelled an astonishing growth of computing systems which are integrated into our daily lives. However, this trend is facing serious challenges, both at device and system levels. At the device level, as the minimum feature size continues to shrink, a host of vulnerabilities influence the robustness, reliability, and availability of embedded and critical systems. Some of these factors are caused by the stochastic nature of the nanoscale manufacturing process (e.g., process variability, sub-wavelength lithographic inaccuracies), while other factors appear because of high frequencies and nanoscale features (e.g., RLC noise, on-chip temperature variation, increased sensitivity to radiation and transistor aging). At the other end of the spectrum, these systems are seeing a tremendous increase in software content. Whereas traditional software design paradigms have assumed that the underlying hardware is fully predictable and error-free, there is now a critical need to build a software stack that is responsive to variations, and resilient against emerging vulnerabilities in the underlying hardware.

The interdisciplinary topics of cross-layer resiliency require collaboration and cooperation of various communities such as design automation, testing and design for testability, computer architecture, embedded systems and software, validation and verification, fabrication, device, circuits, and systems. Due to the importance of this topic, there are various funded programs worldwide, such as German DFG SPP1500 on “Dependable Embedded Systems”, US NSF “Variability Expedition”, Japan JST “Dependable VLSI System” and the recent NSF/SRC “Failure Resilient Systems”.

Due to the interdisciplinary nature of this work, we feel a strong need for collaboration among disciplines and various coordinated national programs and bring together the experts from various involved communities to address the challenges of cross-layer resiliency in a worldwide collaborative manner by learning from the experiences in different programs and complementary expertise. The objective of this workshop was to bring the attention of various involved communities to the multi-level resiliency challenges and solutions as well as promoting collaboration and contact among various coordinated programs on this topic.

#### **Summary Report:**

The workshop was held in two days (July 11<sup>th</sup> and 12<sup>th</sup>) at The University of Texas Austin JJ Pickle Research Campus, Commons Center. There were around 35 attendees (by invitation only). The attendance was very diverse and included experts from US, Germany, and Japan as well as representations from academia, industry and funding agencies. The format of the workshop included a) presentations and overviews from the coordinators (directors) of these four national programs, b) presentations from industry experts on the major challenges (current and future) for resilience and the industry’s perspective on this topic, c) presentations by selected principal investigators from these

programs on their specific projects, and d) various brainstorming and discussion sessions to discuss common challenges in this topic, collaboration opportunities and knowledge exchange.

### **Reports from national coordinated program:**

Dr. William Joyner, Director of the Computer Aided Design and Test (CADT) program at Semiconductor Research Consortium (SRC), provided an overview of the recent joint NSF/SRC program on Failure Resilient Systems (FRS). This program has just started and will last for three years. It covers various aspects in testing, design automation, architecture, and analog/mixed-signal. There are total of 19 projects are funded in this program for which the funding is provided by NSF and SRC.

Prof. Joerg Henkel from Karlsruhe Institute of Technology, the coordinator of DFG SPP1500, gave an overview and status report for the German SPP1500 program on “Dependable Embedded Systems”. This is a six-year program which is divided into three two-year phases. This is currently the third year of this program and there are 12 projects funded.

Prof. Rajesh Gupta from University of California at San Diego, the director of NSF Variability expedition program, provided an overview of this program. The main focus of this program is to expose the variability in the hardware layer to the software stack and design an opportunistic software stack around it. This is a five-year program including 12 PIs and it is currently in the third year.

Prof. Hidetoshi Onodera from Kyoto University presented an overview of Japan JST (Japan Science and Technology Agency) program on Dependable VLSI Systems. This program was initiated in 2007 for establishing basic VLSI technologies to enhance the dependability of VLSI systems, which could range from automobile, plant, transportation, telecom, data processing to aerospace systems. The program currently has 11 projects running that address various issues, some arising from miniaturization on the one hand and complexity on the other. This program will be concluded this year.

Prof. Andre DeHon from University of Pennsylvania presented the visioning study performed by Computing Community Consortium (CCC) on Cross-layer Reliability (RelXLayer) in 2009-2011. In this study a detailed analysis of reliability needs for various sectors (critical systems, automotive, consumer electronics, mobile systems, etc.) were performed and various recommendations were made for addressing these issues at cross-layer for the entire system stack.

### **Industry’s Perspective:**

In the afternoon of the first day (July 11<sup>th</sup>) there were three presentations from the industry (Dr. Charles Lefurgy of IBM, Dr. Vikas Chandra of ARM, and Dr. Mahesh Sharma of AMD) to discuss some of the directions that the industry is taking to address the resilience challenges and also their outlook and perspectives on the major challenges for future technologies.

### **PI Presentations:**

In the first and second days of the workshop, there were several short presentations, grouped into three sessions, from the PIs participating in the aforementioned coordinated programs to present the main visions of their projects and their perspectives on cross-layer resilience. The list of presenters is as follows:

- Sudeep Pasricha (Colorado State University)
- Yiyu Shi (Missouri State University)

- Bao Liu (University of Texas at San Antonio)
- Li-C. Wang (University of California at Santa Barbara)
- John Sartori (University of Minnesota)
- Mircea Stan (University of Virginia)
- Zhengya Zhang (University of Michigan)
- Ganesh Gopalakrishna (University of Utah)
- Jennifer Dworak (Southern Methodist University)
- David Pan (University of Texas at Austin)
- Qi Zhu (University of California at Riverside)
- Mehdi Tahoori (Karlsruhe Institute of Technology)
- Nik Dutt (University of California Irvine)
- Ulf Schlichtmann (Technical University of Munich)

### **Discussion Sessions:**

In this workshop we had three brainstorming and discussion sessions during both days, in addition to several informal discussions during lunch and coffee breaks as well as dinner, to discuss various challenges in this topic, collaboration opportunities across various programs, and how to exchange knowledge, findings, platforms and tools among researchers working across various disciplines, programs, and continents. The main objective was to form a Cross-layer Failure Resiliency community worldwide and provide the required means for collaboration. The discussions were centered on the following subjects:

- Platforms: How can we pool resources among community members?
- Infrastructure: How to develop benchmarks for this community and share them in a common website?
- Academic Needs: How can industry provide relevant data to the research community? How to circumvent the issues related to IPs?
- Industry Needs: How do we complement what is being done in industry?
- Cross-layer information exchange: How can different layers pass resilience information and what would be the appropriate interface across different layers to communicate information regarding resiliency? What would be the challenges and overheads of the cross-layer approach?
- Cross Nation Collaboration: How to devise effective collaboration mechanisms among these national programs? How can we learn from the outcomes of the other programs (particularly since different programs are at different stages of their lifetimes)?

### **Conclusions**

All the participants were in the agreement that it was a very successful workshop. We had several informative presentations and fruitful discussions. We tried to learn from what has been done in the past (including CCC review and Japan JST program) and leverage them in the on-going and future programs. The PIs and researchers from different programs and communities feel the need to collaborate and tackle this research problem in a collaborative and cross-nation manner. We also collectively felt the need to continue on this effort and hold next editions of this workshop on an annual basis. There were different proposals for the theme and also the location of the next edition of this workshop. This workshop could be expanded in the future to serve as the main event for this research community.