System-Level Observation Framework for Non-Intrusive Runtime Monitoring of Embedded Systems

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The Hong Kong Polytechnic University

Abstract
As system complexity continues to increase, the integration of software and hardware subsystems within system-on-a-chip (SOC) presents significant challenges in post-silicon validation, testing, and in-situ debugging across hardware and software layers. The deep integration of software and hardware components within SOCs often prevents the use of traditional analysis methods to observe and monitor the internal state of these components. This situation is further exacerbated for in-situ debugging and testing in which physical access to traditional debug and trace interfaces is unavailable, infeasible, or cost prohibitive. In the first part of my talk, I will present previous efforts for debugging and testing embedded systems with the limitation.

In the second part of my talk, I will talk about a system-level observation framework (SOF) that provides minimally intrusive methods for dynamically monitoring and analyzing deeply integrated hardware and software components within embedded systems. The SOF monitors hardware and software events by inserting additional logic within hardware cores and by listening to processor trace ports. In addition, the SOF utilizes a dedicated event-streaming interface that allows efficient observation and analysis of rapidly occurring events at runtime. The event-streaming interface supports three alternatives: (1) an in-order priority-based event stream controller, (2) a round-robin priority-based event stream controller, and (3) a priority-level based event stream controller. The SOF provides visibility for monitoring complex execution behavior of software applications without affecting the system execution and is useful for verification and validation of SOC designs and debugging and testing of embedded systems. My talk will focus on the architecture of the SOF and structural characteristics that can overcome the limitation of traditional analysis methods.

In the final part of my talk, I will introduce my future research interests including accelerating applications with FPGAs and making FPGA implementations for mobile wireless devices.

About the Speaker
Jong Chul Lee received the B.S. degree in Electrical Engineering from the University of Ulsan in 2001, M.S. degree in Electronics Engineering from the Pusan National University in 2004, and Ph.D. degree in Electrical and Computer Engineering from the University of Arizona in 2014. He was a recipient of the Science Foundation Arizona Research Fellowship in 2008 and 2009 (US$46,350 per year). He has worked for Samsung Electronics as a software engineer for five years after obtaining his M.S. degree. He has participated in one smartphone and four feature phone projects and released three feature phones (SGH-P990, SGH-F500, and SGH-U900) in Europe. His research interests focus on embedded systems, with emphasis on non-intrusive system observation methods for in-situ analysis of complex hardware and software behavior, high-performance reconfigurable computing using FPGAs, and embedded/real-time devices for mobile and pervasive computing. He is a senior verification engineer at eWBM that is an application processor design company and works to implement more efficient verification process with his research.

All are welcome!

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