Introduction to Special Issue: Novel Paradigms in System-Level Design

This special issue of the ACM *Transactions on Design Automation of Electronic Systems* contains a comprehensive review of emerging directions and disciplines in system-level design in the context of newly emerging design platforms for embedded applications. In particular, the focus of the four papers included here is centered on the ideas of "communication", "platform-based design", "schedulability analysis", and "architecture exploration" as foundations of efficient design for complex (possibly reconfigurable or distributed real-time) systems of the future. In particular, these articles cover issues specific to both design methodologies and CAD tools for system-on-chip (SOC) communication infrastructure design, wireless (and ad-hoc) network design, and automotive electronics. The articles are based on invited talks given by Professors Alberto Sangiovanni-Vincentelli, Radu Marculescu, Petru Eles, and Nikil Dutt during the 41st Design Automation Conference in June 2004 as part of the ACM Multimedia Monograph Series production. A DVD containing the presentation slides and talks by each speaker is included as an insert to this special issue.

The first article by Alessandro Pinto, Alvise Bonivento, Roberto Passerone, Alberto Sangiovanni-Vincentelli, and Marco Sgroi entitled "System Level Design Paradigms: Platform-Based Design and Communication Synthesis" presents a comprehensive formalism for platform-based design with emphasis on communication synthesis and wireless network design. The authors argue that the communication specification must be entered at high levels of design abstraction, the design process ought to optimize the implementation from this specification, and platform-based design may be used to develop a successive refinement process for the synthesis of such specifications. Consequently, they describe a rigorous platform-based design framework where each step of the system-level design can be carried out automatically and optimized accordingly. They present two cases: on-chip network synthesis and wireless sensor network design, where the resulting methodology has produced encouraging results.

The second article by Radu Marculescu, Umit Ogras, and Nick Zamora entitled "Computation and Communication Refinement for Nanoscale Design: A System-Level Perspective" presents a communication-centric approach where abstract application and platform models are used to optimize an on-chip multiprocessor system via performance analysis. They advocate the view that, while selecting a platform for a target application involves extensive analysis, system designers must focus more on the communication capabilities of alternative hardware platforms. Specifically, the authors address the application and platform modeling, application to architecture mapping and performance analysis, issues related to the communication refinement and performance evaluation steps and their impact to the overall system performance.

The third article by Paul Pop, Petru Eles, and Zebo Peng entitled "Analysis and Optimization of Distributed Real-Time Embedded Systems" discusses the system-level synthesis of distributed heterogeneous real-time systems with

application to automotive electronics. The authors argue that the success of design methods for such systems depends on the availability of efficient analysis and optimization techniques. Consequently, they present schedulability analysis of hard real-time systems, highlighting important aspects related to the heterogeneous and distributed nature of the applications. They also describe a number of design optimizations that are targeted toward this class of systems, including mapping of functionality, optimization of the access to the communication channel, and assignment of scheduling policies to processes.

Finally, the fourth article by Prabhat Mishra, Aviral Srivastava, and Nikil Dutt entitled "ADL-driven Software Toolkit Generation for Architectural Exploration of Programmable SOCs" presents an Architecture Description Language (ADL)-driven exploration methodology that is capable of accurately capturing a wide variety of programmable architectures and generating efficient software toolkits including compilers and simulators. The authors observe that the application-specific nature of the embedded processors and the tight area, power dissipation, and latency/throughput constraints in embedded systems often demand a highly efficient and fully automated architecture exploration methodology. In particular, they show that ADL-driven design space exploration and software toolkit generation strategies present a viable solution to this problem, providing a systematic mechanism for a top-down design and validation of complex systems.

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—Massoud Pedram
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