

## Preface

Field-coupled nanocomputing (FCN) paradigms offer fundamentally new approaches to digital information processing that do not utilize transistors or require charge transport. Information transfer and computation are achieved in FCN via local field interactions between nanoscale building blocks that are organized in patterned arrays. Several FCN paradigms are currently under active investigation, including quantum-dot cellular automata (QDCA), molecular quantum cellular automata (MQCA), nanomagnetic logic (NML), and atomic quantum cellular automata (AQCA). Each of these paradigms has unique features that make it attractive as a candidate for post-CMOS nanocomputing, and each faces critical challenges to realization.

With the hope of bringing the community together to gauge the current status of FCN research and to consider its future directions, we requested support from the National Science Foundation for a dedicated workshop. The result was The 2013 Workshop on Field-Coupled Nanocomputing, which was held at the University of South Florida in February 2013. The international group of participants, which included experienced FCN researchers, postdoctoral scholars, and graduate students, embraced the objectives of this workshop and contributed generously to their achievement. The first objective was to take stock of major milestones that have been achieved in emerging FCN nanocomputing paradigms—at the device, circuit, architecture levels—to provide a snapshot of the current state of research in the field. The second objective was to identify and highlight promising opportunities for FCN and critical challenges facing realization of FCN-based nanocomputers. A panel discussion was dedicated specifically to these concerns, providing all participants—most importantly the graduate student participants—with a variety of perspectives on emerging research priorities and critical next steps.

Our third and final objective was to make the workshop proceedings available to a wide readership, and to do so in a way that allowed inclusion of more background, tutorial, and review material than is typically found in conference papers. To this end we invited participants to submit comprehensive, chapter-length expositions of research related to their workshop contributions, and we solicited a few such contributions from researchers who are working on intriguing aspects of FCN-related topics but were not in attendance at the workshop. This invitation was answered with a collection of quality contributions reflecting a remarkably diverse portfolio of current FCN research. These chapters were peer reviewed by referees from pool that included workshop participants and additional FCN experts. We approached Springer about publishing this collection of contributions—together with an edited transcript of the panel discussion—in their well-known *Lecture Notes in Computer Science* (LNCS) series. Alfred Hofmann of Springer was immediately receptive, and suggested publication in the LNCS *State-of-the-Art Survey* series.

The result—this volume—is divided into five topical sections. In the first section (Field-Coupled Nanocomputing Paradigms), pioneering FCN researchers provide

valuable background and perspective on the QDCA, MQCA, NML, and AQCA paradigms and their evolution. The second section (Circuits and Architectures) addresses a wide variety of current research on FCN clocking strategies, logic synthesis, circuit design and test, logic-in-memory, hardware security, and architecture. The third section (Modeling and Simulation) considers the theoretical modeling and computer simulation of large FCN circuits, as well as the use of simulations for gleanings physical insight into elementary FCN building blocks. The fourth section (Irreversibility and Dissipation) considers the dissipative consequences of irreversible information loss in FCN circuits, their quantification, and their connection to circuit structure. The fifth and final section (The Road Ahead: Opportunities and Challenges) includes an edited transcript of the panel discussion that concluded the FCN workshop.

We thank all of the contributors that made this volume possible, the reviewers who enhanced its quality, and the team at Springer—especially Alfred Hofmann, Anna Kramer, and Christine Reiss—who enabled and facilitated its publication. We gratefully acknowledge Dr. Sankar Basu of National Science Foundation for engaging us in the discussions that led to the sponsorship of the FCN workshop—and thus to this volume—and Dr. Robert Trew for attending the workshop as NSF EECS Division Director. Our sincere gratitude to Dinuka Karunaratne, Srinath Rajaram, İlke Ercan, Ravi Panchumorthy, Jayita Das, Drew Burgett, and Kevin Scott and all of the other student volunteers for workshop logistics, technical assistance, and recording of the panel discussion, and to the University of South Florida—especially the USF Student Chapter of IEEE—for local support and arrangements. Finally, we thank Katherine Anderson for assistance in transcribing the panel discussion. We hope that the collective efforts of all involved has yielded an accessible and useful resource for students and researchers who are intrigued by the possibility of future FCN-based nanocomputers and are working toward their realization.

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