First IEEE/ACM/IFIP International Conference on Hardware/Software Codesign & System Synthesis

Newport Beach, California, USA • October 1-3, 2003
Message from the Chairs

Welcome to CODES+ISSS 2003!

After over a year of preparation and hard work on the part of the organizing committee and the program committee, it is our great pleasure to introduce you the technical program of the First International IEEE/ACM/IFIP Conference on Hardware/Software Co-design and System Synthesis. This conference represents the unification of the erstwhile CODES and ISSS communities. Both the International Symposium on Hardware/Software Codesign (CODES) and the International Symposium on System Synthesis (ISSS) have been active forums with over a decade of continuous community participation and technical community building in all aspects of embedded systems hardware and software. During this period, the community also saw the emergence of a number of new forums examining specific related areas: from compilers/architectures (CASES), software (EMSOFT) to validation and testing (HLDVT). These forums are a living testament to a growing thriving community in embedded systems.

Being the oldest forums, CODES and ISSS represented the greatest momentum as reflected by the number of submissions and attendee participation. There was also a great sense of camaraderie between the two communities: over one-third of technical program committee members in one forum could also be found in the other one. As an acknowledgment of this relationship between the two forums, we started an email discussion in May 2002 on the possibility of co-locating the two events. What followed the initial email was a torrential discussion on various possibilities including the merger of two events into creating the primary event in embedded systems design. This discussion led to a thorough examination of the effectiveness of each of the two forums and the possibility of leveraging these into creating a single forum that would reflect the best and brightest of the technical advances in the broad areas of embedded systems and system-level design. This forum – it was envisioned – would provide the greatest meeting point for industry and academia looking to make a direct impact on the industry practice in system design. Following open meetings at DAC and ISSS in 2002, we converged on the guidelines and organizing committee for the new forum. A “transition committee” of the CODES and ISSS volunteers was set up to guide the merger process and the formation of the new community. Two separate polls were conducted to gather detailed community feedback on substantive issues, such as the scope of the meeting, the structure of the meeting and, of course, the naming for the new event. We reached consensus on almost all items, though we decided to postpone the invention of a new name for the meeting in favor of the more straightforward CODES+ISSS.

As you attend the conference program and read through these proceedings, we are confident that one thing would be abundantly clear: the new combined event is much greater than the sum of the parts. This is reflected in many ways from the breadth of the program, and the depth of presentations to the diversity of the conference attendees and its sponsors. The CODES+ISSS call for papers received 143 full submissions. The TPC led by TPC Co-Chairs, Alex Orailoglu and Pai Chou, organized the massive review process where on an average each paper received 5 substantial reviews (on an average 3-4 pages of reviews for each paper). Each of the submitted papers went through a close scrutiny of the reviews received and the overall reviewer opinion. A subset of the papers – composed of the papers that were evaluated to be marginal and/or exhibiting excessive divergence in reviewer opinions – was selected for a newly introduced rebuttal process. The authors were invited to read the reviews and respond to specific questions prior to the program committee meeting. An ad hoc subcommittee with program committee members outside the original reviewers subsequently examined
the reviews and the rebuttal to make a recommendation to the whole Program Committee for each such paper. Following a marathon 11-hour TPC meeting in early June 2003, held under the strictest code of conduct on conflict of interest rules, the committee identified, based on the perceived strength of the technical contribution, 30 regular papers. Four more papers that were perceived to be highly innovative were additionally selected for presentation in an “innovative work-in-progress” session. We are convinced that the collection of papers selected represents substantial advances in theory or in practice in the area of embedded systems, and hope that you would agree with our assessment.

The CODES+ISSS conference this year also features a workshop, named ESTIMedia or the First Workshop on Embedded Systems for Real-Time Multimedia. This workshop is a result of our efforts to enhance the academia-industry participation by providing opportunities for discussions on specific application areas. The ESTIMedia workshop will provide a venue for bringing together experts in multimedia systems design, theory and practice. Under the leadership of ESTIMedia general chair, Hiroto Yasuura and technical program chairs Gerhard Fohler and Radu Marculescu, the response to ESTIMedia call for papers has been tremendous. This first workshop received 38 submissions, many of very high quality. This is clearly a testament to the importance of this emerging topic area. We thank Petru Eles for driving the process of workshop selection and its organization. We hope to welcome additional workshops and synergistic events like ESTIMedia, in the future.

An ambitious conference such as CODES+ISSS’03 could not have come about without the help and support from a large number of volunteers and supporters. Foremost among them are the transition committee members (listed on a separate page) who generously gave their time and worked with the conference organizers in providing timely and measured guidance that allowed us to keep the conference charter broad and in step with the exciting developments in the area. We thank our corporate supporters for their participation and financial support that makes various elements of the conference social program, awards and student participation possible. We sincerely thank our conference managers MP Associates for their help with conference logistics, Adrienne Griscti at ACM, Lisa Tolles at Sheridan Printing, and Kathy Preas at ACM/SIGDA for their support in putting together the conference proceedings and CD-ROMs. Our special thanks to Melanie Sanders for organizing the weekly committee meetings of the conference organizers and providing timely meeting minutes to a large number of volunteers. Finally, but most importantly, our sincere thanks to you, the conference attendee, for your participation and in making all this effort worthwhile.

As we close, we would like to express our wishes that you will all find CODES+ISSS not only highly informative and valuable but also enjoyable. We hope that you will have a chance to enjoy the beautiful Newport Beach area and its weather this October. We look forward to welcoming you to Newport Beach this year and also hope to see you in Sweden in 2004!

Rajesh Gupta  
Yukihiro Nakamura  
General Co-Chairs

Pai Chou  
Alex Orailoglu  
Technical Program Co-Chairs
# Table of Contents

**Conference Organization** ........................................................................................................................................ ix

**Additional Reviewers** ............................................................................................................................................ xiii

**Session 1A: Architectural Exploration and System Simulations**  
Chairs: W. Najjar (University of California, Riverside), Y. Nakamura (Kyoto University)

- **Virtual Synchronization Technique with OS Modeling for Fast and Time-accurate Cosimulation** ............................................. 1  
  Y. Yi, D. Kim, S. Ha (Seoul National University)

- **A Modular Simulation Framework for Architectural Exploration of On-Chip Interconnection Networks** ......................................................... 7  
  T. Kogel, M. Doerper, A. Wieferink, R. Leupers, G. Ascheid, H. Meyr (Aachen University of Technology), S. Goossens (CoWare)

- **An Efficient Retargetable Framework for Instruction-Set Simulation** ......................................................................................... 13  
  M. Reshadi, N. Bansal, P. Mishra, N. Dutt (University of California, Irvine)

**Session 1B: Advances in System Modeling**  
Chairs: H. Yasuura (Kyushu University), F. Brewer (University of California, Santa Barbara)

- **Invited Talk: Transaction Level Modeling: An Overview** ....................................................................................................................... 19  
  L. Cai, D. Gajski (University of California, Irvine)

- **Extending the SystemC Synthesis Subset by Object-Oriented Features** .......................................................................................... 25  
  E. Grimpe, F. Oppenheimer (OFFIS Research Institute)

- **RTOS Scheduling in Transaction Level Models** .......................................................................................................................... 31  
  H. Yu, A. Gerstlauer, D. Gajski (University of California, Irvine)

**Session 2A: Support for Real Time & OS Services in Embedded Systems**  
Chairs: K.-J. Lin (University of California, Irvine), P. Eles (Linköping University)

- **Synthesizing Operating System Based Device Drivers in Embedded Systems** ................................................................. 37  
  S. Wang, S. Malik (Princeton University)

- **Hardware Support for Real-time Operating Systems** ........................................................................................................ 45  
  P. Kohout (EIT Technology), B. Ganesh, B. Jacob (University of Maryland, College Park)

- **Invited Talk: Programming Embedded Networked Sensor Systems** .................................................................................. 52  
  F. Zhao, J. Liu, J. Reich, M. Chu, J. Liu (Palo Alto Research Center)

**Session 2B: Case Studies in Embedded System**  
Chairs: W. Wolf (Princeton University), K. Wakabayashi (NEC Multimedia Research Laboratory)

- **Design Space Exploration of a Hardware-Software Co-designed GF(2m) Galois Field Processor for Forward Error Correction and Cryptography** ........................................................................ 53  
  W.-M. Lim, M. Benaisa (University of Sheffield)

- **A Fast Parallel Reed-Solomon Decoder on a Reconfigurable Architecture** ............................................................................... 59  
  A. Koohi, N. Bagherzadeh, C. Pan (University of California, Irvine)

- **The Analysis and Design of Architecture Systems for Speech Recognition on Modern Handheld-Computing Devices** .............. 65  
  A. Hagen, D. A. Connors, B. L. Pellom (University of Colorado at Boulder)
Keynote Talk
Chair: R. Gupta (University of California, San Diego)

- The Evolution of CDMA Wireless Devices Based on Advanced Chip Sets and BREW .......... 71
  I. M. Jacobs ( Qualcomm)

Invited Session A: Industry Best Practices in Embedded Software ........................................ 73
Chair: R. Camposano ( Synopsys)

- Embedded Software Development for Wireless Handsets: Field Lessons in Extreme Programming .............................................................. 73
  M. Underseth ( S2 Technologies)

- Parametric Superscalar Microprocessors ........................................................................... 73
  F. Karim ( STMicroelectronics)

Invited Session B: Challenges and New Directions in On-Chip Communication
Chairs: S. Hu (University of Notre Dame), J. Henkel ( NEC)

- Architectural versus Physical Solutions for On-Chip Communication Challenges .......... 74
  D. Burger ( University of Texas at Austin)

- On-Chip Communication Design: Roadblocks and Avenues .................................................. 75
  L. P. Carloni, A. L. Sangiovanni-Vincentelli ( University of California, Berkeley)

- Architecture and Synthesis for Multi-Cycle On-Chip Communication .............................. 77
  J. Cong, Y. Fan, G. Han, X. Yang, Z. Zhang (University of California, Los Angeles)

Panel 1
Organizers: R. Bergamaschi ( IBM T. J. Watson Research Center), G. Martin ( Cadence Berkeley Labs)

  Moderator: G. Martin ( Cadence Berkeley Labs)
  Panelists: G. Smith ( Gartner-Dataquest), P. Paulin ( STMicroelectronics),
             R. Fordham ( Motorola, Global Software Group), P. Hardee ( CoWare), B. Bailey ( Mentor Graphics)

Invited Talk
Chair: D. Gajski ( University of California, Irvine)

- Driving Forces Behind SOC Development ............................................................................ 81
  M. C. Chian ( Mindspeed Technologies)

Panel 2
Organizer: N. Dutt (University of California, Irvine)

- Driving Agenda for Systems Research .................................................................................. 82
  Moderator: N. Dutt ( University of California, Irvine)
  Panelists: J. Sztipanovits ( ACM SIGBED & Vanderbilt University), M. Hirata ( STARC),
            S. Basa ( NSF), D. J. Radack ( DARPA)

Session 3A: System Modeling
Chairs: L. Lavagno ( Politecnico di Torino), R. Marculescu ( Carnegie Mellon University)

  T. Pop, P. Eles, Z. Peng ( Linköping University)

- Deriving Process Networks from Weakly Dynamic Applications in System-Level Design ........ 90
  T. Stefanov, E. Deprettere ( Leiden University)
Session 3B: Case Studies
Chairs: P. Paulin (STMicroelectronics), M. Sarrafzadeh (University of California, Los Angeles)

- A Low-Cost and Low-Power Multi-Standard Video Encoder .......................................................... 97
  R. P. Llopis, R. Sethuraman, C. A. Pinto, H. Peters, S. Maul, M. Oosterhuis (Philips Research Laboratories)

- A Case Study of Mapping a Software-Defined Radio (SDR) Application on a Reconfigurable DSP Core ......................................................................................................................... 103
  B. Mohebbi, E. C. Filho, R. Maestre, M. Davies (Morpho Technologies Inc.),
  F. J. Kurdahi (University of California, Irvine)

- A Codesigned On-Chip Logic Minimizer ........................................................................................................ 109
  R. Lysecky, F. Vahid (University of California, Riverside)

Session 4A: Advances in Embedded Software Scheduling Techniques
Chairs: R. Ernst (Technical University of Braunschweig), B. Walker (Kent State University)

- Synthesis of Real-Time Embedded Software with Local and Global Deadlines ............................................ 114
  P.-A. Hsiung, C.-Y. Lin (National Chung Cheng University)

- Pareto-Optimization-Based Run-Time Task Scheduling for Embedded Systems ............................................. 120
  P. Yang, F. Catthoor (K. U. Leuven-ESAT)

- A Low Power Scheduler Using Game Theory .................................................................................................. 126
  N. Ranganathan, A. K. Murugavel (University of South Florida)

Session 4B: Architectural Design for Embedded Systems
Chairs: A. Parker (University of Southern California), F. Karim (STMicroelectronics)

- VL-CDRAM: Variable Line Sized Cached DRAMs .......................................................................................... 132
  A. Hegde, N. Vijaykrishnan, M. Kandemir, M. J. Irwin (The Pennsylvania State University)

- A Low-cost Memory Architecture with NAND XIP for Mobile Embedded Systems ......................................... 138
  C. Park, J. Seo, S. Bae, H. Kim, S. Kim, B. Kim (Samsung Electronics)

- Design Space Minimization with Timing and Code Size Optimization for Embedded DSP .......................... 144
  Q. Zhuge, Z. Shao, B. Xiao, E. H.-M. Sha (University of Texas at Dallas)

Session 5A: Work-in-Progress Session on Innovative Topics
Chairs: F. Kurdahi (University of California, Irvine), A. Wu (National Tsinghua University, Taiwan)

- SEAS: A System for Early Analysis of SoCs ........................................................................................................ 150
  R. A. Bergamaschi, Y. Shin (IBM T. J. Watson Research Center), N. Dhanwada (IBM EDA Laboratory),
  S. Bhattacharya (IBM T. J. Watson Research Center), W. E. Dougherty (IBM EDA Laboratory),
  I. Nair, J. Darringer (IBM T. J. Watson Research Center), S. Paliwal (IBM EDA Laboratory)

- Programmers’ Views of SoCs ............................................................................................................................ 156
  J. M. Paul (Carnegie Mellon University)

- Security Wrappers and Power Analysis for SoC Technologies ............................................................................. 162
  C. H. Gebotys, Y. Zhang (University of Waterloo)

- First Results with eBlocks: Embedded Systems Building Blocks ....................................................................... 168
  S. Cotterell, F. Vahid, W. Najjar, H. Hsieh (University of California, Riverside)

Session 5B: Verification, Analysis of Embedded Systems
Chairs: W. Rosenstiel (Technical University of Tuebingen), H. Hsieh (University of California, Riverside)

- Verification of Design Decisions in ForSyDe ...................................................................................................... 176
  T. Raudvere, I. Sander, A. K. Singh, A. Jantsch (Royal Institute of Technology, Sweden)
• A Multiobjective Optimization Model for Exploring Multiprocessor Mappings
  of Process Networks ................................................................. 182
  C. Erbas (University of Amsterdam), S. C. Erbas (Aachen University of Technology),
  A. D. Pimentel (University of Amsterdam)

• A Fault Model Notation and Error-Control Scheme for Switch-to-Switch Buses
  in a Network-on-Chip ............................................................... 188
  H. Zimmer (Darmstadt University of Technology), A. Jantsch (Royal Institute of Technology, Sweden)

Invited Talk
Chair: D. Thomas (Carnegie Mellon University)

• Design Technology Challenges for System and Chip Level
  Designs in Very Deep Submicron Technologies ......................................... 194
  J. Lin (National Semiconductor)

Session 6A: Performance Estimation in System Design
Chairs: M. Aboulhamid (University of Montreal), R. Rajkumar (Carnegie Mellon University)

• Schedule-Aware Performance Estimation of Communication Architecture
  for Efficient Design Space Exploration .............................................. 195
  S. Kim, C. Im, S. Ha (Seoul National University)

• Accurate Estimation of Cache-Related Preemption Delay ........................................... 201
  H. S. Negi, T. Mitra, A. Roychoudhury (National University of Singapore)

• Early Estimation of the Size of VHDL Projects ................................................. 207
  W. Fornaciari, F. Salice, D. P. Scarpazza (Politecnico di Milano)

Session 6B: Compiler Optimizations for Power, Performance
Chairs: M. Miranda (IMEC), M. Jacome (University of Texas at Austin)

• Tracking Object Life Cycle for Leakage Energy Optimization ..................................... 213
  G. Chen, N. Vijaykrishnan, M. Kandemir, M. J. Irwin (The Pennsylvania State University),
  M. Wolfzcko (Sun Microsystems)

• Compiler Parallelization of C Programs for Multi-Core DSPs with Multiple Address Spaces ... 219
  B. Franke, M. F. P. O’Boyle (University of Edinburgh)

• Architectural Analysis and Instruction-Set Optimization for Design
  of Network Protocol Processors ........................................................ 225
  H. Xie, L. Zhao, L. Bhuyan (University of California, Riverside)

Panel 3
Organizers: R. Bergamaschi (IBM T. J. Watson Research Center), G. Martin (Cadence Berkeley Labs)

• The Future of System-Level Design: Can We Find the Right Solutions
  to the Right Problems at the Right Time? ...................................................... 231
  Moderator: G. Martin (Cadence Laboratories)
  Panelists: W. Wolf (Princeton University), R. Ernst (Technical University of Braunschweig),
  K. Vissers (University of California, Berkeley), J. Kouloheris (IBM Research), J. Fisher (Hewlett-Packard)

2004 Call for Papers ................................................................. 232

Author Index ............................................................................. 233
CODES+ISSS’03 Organization

General Co-chair
Rajesh Gupta,
University of California,
San Diego, USA

General Co-chair
Yukihiro Nakamura,
Kyoto University, Japan

Program Co-chair
Alex Orailoglu,
University of California,
San Diego, USA

Program Co-chair
Pai H. Chou,
University of California, Irvine, USA

Past Chair
(ISSS) Mostapha Aboulhamid,
University of Montreal, Canada

Past Chair
(CODES) Sharon Hu,
University of Notre Dame, USA

Past Chair
(CODES) Joerg Henkel,
NEC, USA

Finance & Local Arrangements Chair
Tony Givargis,
University of California, Irvine, USA

New Topics Chair
JoAnn Paul,
Carnegie Mellon University, USA

Program Co-chair
Pai H. Chou,
University of California, Irvine, USA

Panels Chair
Reinaldo Bergamaschi,
IBM TJ Watson Research Center, USA

Publications Chair
Ali Dasdan,
Synopsys, USA

Publicity Chair
Frank Vahid,
University of California, Riverside, USA

Registration Chair
Harry Hsieh,
University of California, Riverside, USA

Special Sessions Chair
Luciano Lavagno,
Politecnico Torino, Italy

Workshops Chair
Petru Eles,
Linkoping University, Sweden
Electronic Media Chair
Ismet Bayraktaroglu,
Sun Microsystems, USA

Awards Chair
Raul Camposano,
Synopsys, USA

Administrative Support
Melanie Sanders,
University of California, Irvine, USA

Liaisons:

Industry Liaison
Grant Martin,
Cadence Design Systems, USA

CASS Liaison
Giovanni De Micheli,
Stanford University, USA

ACM SIGDA Liaison
Robert Walker,
Kent State University, USA

ACM SIGBED
Janos Sztipanovits,
Vanderbilt University, USA

ACM SIGSOFT
Mary Jean Harrold,
Georgia Tech, USA

IFIP Liaison
Nikil Dutt,
University of California, Irvine, USA

Computer Society Liaison
Wayne Wolf,
Princeton University, USA

Latin Connection
Ricardo Reis,
Universidade Federal do Rio Grande do Sul, Brazil

European Connection
Axel Jantsch,
Royal Institute of Technology, Sweden

Asian Liaison
Hiroto Yasuura,
Kyushu University, Japan
Technical Program Committee:

Guido Araujo, State Univ Campinas, Brazil
M. Balakrishnan, Indian Institute of Technology, Delhi, India
Luca Benini, University of Bologna, Italy
Joe Buck, Synopsys, USA
Sujit Dey, University of California, San Diego, USA
Rolf Ernst, Technical University of Braunschweig, Germany
Daniel Gajski, University of California, Irvine, USA
Cathy Gebotys, University of Waterloo, Canada
Soonhoi Ha, Seoul National University, Korea
Roman Hermida, Universidad Complutense de Madrid, Spain
Margarida F. Jacome, University of Texas, Austin, USA
Fadi J. Kurdahi, University of California, Irvine, USA
Juan Carlos Lopez, University of Castilla-La Mancha, Spain
Jan Madsen, Technical University of Denmark, Denmark
Lev Markov, Sun Microsystems, USA
Peter Marwedel, University of Dortmund & ICD, Germany
Anne Mignotte, INSA Lyon, France
Miguel Miranda, IMEC, Belgium
Vincent Mooney, Georgia Tech, USA
Kazuaki Murakami, Kyushu University, Japan
Walid Najjar, University of California, Riverside, USA
Sanjiv Narayan, Cadence Design Systems, USA
Sri Parameswaran, University of South Wales, Australia
Wolfgang Rosenstiel, University of Tuebingen, Germany
Alberto Sangiovanni-Vincentelli, University of California, Berkeley, USA
Majid Sarrafzadeh, University of California, Los Angeles, USA
Donatella Sciuto, Politecnico di Milano, Italy
Edwin Sha, University of Texas at Dallas, USA
Juergen Teich, Universitat Erlangen-Nuernberg, Germany
Don Thomas, Carnegie Mellon University, USA
Stamatis Vassiliadis, Technical University of Delft, Germany
Kees A. Vissers, University of California, Berkeley, USA
Kazutoshi Wakabayashi, NEC, Japan
Albert van der Werf, Philips, the Netherlands
Allen C.-H. Wu, National Tsinghua University, Taiwan
Transition Committee:

Rolf Ernst, *Technical University of Braunschweig, Germany*

Donald Thomas, *Carnegie Mellon University, USA*

Giovanni De Micheli, *Stanford University, USA*

Robert Walker, *Kent State University, USA*

Nikil Dutt, *University of California, Irvine, USA*

Sri Parameswaran, *The University of New South Wales, Australia*

Mostapha Aboulhamid, *University of Montreal, Canada*

Pai Chou, *University of California, Irvine, USA*

Juergen Teich, *University of Paderborn, Germany*

Yukihiro Nakamura, *Kyoto University, Japan*

Wayne Wolf, *Princeton University, USA*

Rajesh Gupta, *University of California, San Diego, USA*
Additional Reviewers

Javed Absar, IMEC, Belgium
Bilge Akgul, Georgia Tech, USA
Tankut Akgul, Georgia Tech, USA
Iosif Antochi, University of California, Irvine, USA
Tetsuya Aoyama, NEC, Japan
Baris Arslan, University of California, San Diego, USA
Isabelle Augé-Blum, INSA Lyon, France
Rodolfo Azevedo, University of Campinas, Brazil
Jean-Philippe Babau, INSA Lyon, France
Xiaoliang Bai, University of California, San Diego, USA
Marco Bekooij, Philips Research Eindhoven, The Netherlands
Etienne Bergeron, University of Montreal, Canada
Erik Brockmeyer, IMEC, Belgium
Humberto Calderón, University of California, Irvine, USA
Jeremy Chan, University of South Wales, Australia
Na.hyuck Chang, Seoul National University, Korea
Luc Charest, University of Montreal, Canada
Li Chen, University of California, San Diego, USA
Dmitry Cheresiz, University of California, Irvine, USA
Newton Cheung, University of South Wales, Australia
Kyoung Choi, Seoul National University, Korea
Susan Cotterell, University of California, Riverside, USA
Dan Crisu, University of California, Irvine, USA
Kristof Denolf, IMEC, Belgium
Dirk Desmet, IMEC, Belgium
Marc Duranton, Philips Research Eindhoven, The Netherlands
Nur Engin, Philips Research Eindhoven, The Netherlands
Heiko Falk, University of Dortmund, Germany
Sune Fallegaard, Nielsen Technical University of Denmark, Denmark
Milagros Fernandez, Universidad Complutense, Spain
Antoine Fraboulet, INSA Lyon, France
Paolo Gai, The Sant’Anna School of University Studies and Doctoral Research, Italy
Om Prakash Gangwal, Philips Research Eindhoven, The Netherlands
Oscar Garnica, Universidad Complutense, Spain
Georgi Gaydadjiev, Delft University of Technology, The Netherlands
Arijit Ghosh, University of California, Irvine, USA
John Glossner, University of California, Irvine, USA
Kees Goossens, Philips Research Eindhoven, The Netherlands
Ann Gordon-Ross, University of California, Riverside, USA
Hui Guo, University of South Wales, Australia
Masachika Hamabe, NEC, Japan
Gerald Heim, University of Tuebingen, Germany
Ignacio Hidalgo, Universidad Complutense, Spain
Hans Holten-Lund, Technical University of Denmark, Denmark
Pao-Ann Hsiung, National Chung Cheng University, Taiwan, ROC
Chih-Tsun Huang, National Tsing Hua University, Taiwan, ROC
I.-J. Huang, National Sun Yet Sen University, Taiwan, ROC
Raynald Huaultme, INSA Lyon, France
Andhi Janapsatya, University of South Wales, Australia
Murali Jayapala, Katholieke Universiteit Leuven
Jer-Min Jou, National Cheng Kung University, Taiwan, ROC
Igor Katchan, University of Tuebingen, Germany
Arun Kejariwal, University of California, Irvine, USA
Jihong Kim, Seoul National University, Korea
Pramote Kuacharoen, Georgia Tech, USA
Casper Lageweg, University of California, Irvine, USA
Kanishka Lahiri, University of California, San Diego, USA
Walter Lange, University of Tuebingen, Germany
Dong-Gi Lee, University of California, San Diego, USA
Jaehwan Lee, Georgia Tech, USA
Kasia Leijten-Nowak, Philips Research Eindhoven, The Netherlands
Rainer Leupers, RWTH Aachen, Germany
Donglin Liu, University of Notre Dame, USA
Marisa López-Velajo, University of Madrid, Spain
Markus Lorenz, University of Dortmund, Germany
Ivan Lu, University of South Wales, Australia
Tiehan Lv, Princeton University, USA
Roman Lyseecky, University of California, Riverside, USA
Zhe Ma, IMEC, Belgium
Shankar Mahadevan, Technical University of Denmark, Denmark
Theodore Marescaux, IMEC, Belgium
Bingfeng Mei, IMEC, Belgium
Jose M. Mendias, Universidad Complutense, Spain
Carsten Menn, FZI, Germany
Bart Mesman, Philips Research Eindhoven, The Netherlands
Maria Michael, University of Notre Dame, USA
Maria C. Molina, Universidad Complutense, Spain
Additional Reviewers (continued)

Nahri Moreano, UFMS, Brazil
Francisco Moya, University of Castilla-La Mancha, Spain
José Manuel Moya, University of Madrid, Spain
Akira Mukaiyama, NEC, Japan
Shoubhik Mukhopadhyay, University of California, San Diego, USA
Richard Murphy, University of Notre Dame, USA
Andre Costi Nacul, University of California, Irvine, USA
Masayuki Nakajima, NEC, Japan
Noritsugu Nakamura, NEC, Japan
Rick Nas, Philips Research Eindhoven, The Netherlands
Edna Natividade, UFPE, Brazil
Gabriela Nicolescu, University of Montreal, Canada
Shinichi Noda, NEC, Japan
Tobias Oppold, University of Tuebingen, Germany
Elena Moscu Panainte, University of California, Irvine, USA
Debhashis Panigrahi, University of California, San Diego, USA
Antonis Papanikolaou, IMEC, Belgium
Jun Cheol Park, Georgia Tech, USA
Sean Patrick, McCarthy University of California, Irvine, USA
Jorgen Peddersen, University of South Wales, Australia
Prakash Peranandam, University of Tuebingen, Germany
Peter Petrov, University of California, San Diego, USA
Luis Pinuel, Universidad Complutense, Spain
Manuel Prieto, Universidad Complutense, Spain
Gang Quan, University of South Carolina, USA
Andrei Radulescu, Philips Research Eindhoven, The Netherlands
Naomi Ramos, University of California, San Diego, USA
Wenjing Rao, University of California, San Diego, USA
Edwin Rijpkema, Philips Research Eindhoven, The Netherlands
Fernando Rincón, University of Castilla-La Mancha, Spain
Tanguy Risset, INSA Lyon, France
Jürgen Ruf, University of Tuebingen, Germany
Kyeong Keol Ryu, Georgia Tech, USA
Marcos Sanchez-Elez, Universidad Complutense, Spain
Stephen Schmitt, University of Tuebingen, Germany
Jürgen Schnerr, FZI, Germany
Carsten Schulz-Key, University of Tuebingen, Germany
Thomas Schweizer, University of Tuebingen, Germany
Krishna Sekar, University of California, San Diego, USA
Mohamed Shalan, Georgia Tech, USA
Zili Shao, University of Texas at Dallas, USA
Eung Shin, Georgia Tech, USA
Axel Siebenborn, University of Tuebingen, Germany
Mihai Sima, University of California, Irvine, USA
Ozgur Sinanoglu, University of California, San Diego, USA
Martin Stark, Robert Bosch, Germany
Joergen Steensgaard-Madsen, Technical University of Denmark, Denmark
Stefan Steinke, University of Dortmund, Germany
Greg Stitt, University of California, Riverside, USA
Katsuharu Suzuki, NEC, Japan
Klass Tack, IMEC, Belgium
Wataru Takahashi, NEC, Japan
Takashi Takenaka, NEC, Japan
Yudong Tan, Georgia Tech, USA
Clark Taylor, University of California, San Diego, USA
Bo Tian, University of California, Irvine, USA
Takao Toi, NEC, Japan
Minoru Tomobe, NEC, Japan
Rasit Topaloglu, University of California, San Diego, USA
Daniel Tracy, University of California, San Diego, USA
Albert van der Werf, Philips Research Eindhoven, The Netherlands
Karel Van Oudheusden, IMEC, Belgium
Tom Vander Aa, Katholieke Universiteit Leuven, Belgium
Andreas Vörg, FZI, Germany
Flavio Rech Wagner, Universidade Federal do Rio Grande do Sul, Brazil
Jens Wagner, University of Dortmund, Germany
Eduardo Wanderley, CEFET-RN, Brazil
Zhong Wang, University of Notre Dame, USA
Lars Wehmeyer, University of Dortmund, Germany
Markus Winterholer, University of Tuebingen, Germany
Stephan Wong, University of California, Irvine, USA
Jiang Xu, Princeton University, USA
Tsukasa Yamauchi, NEC, Japan
Peng Yang, IMEC, Belgium
Shengqi Yang, Princeton University, USA
Chuanjun Zhang, University of California, Riverside, USA
Yumin Zhang, Synopsys, USA
Yi Zhao, University of California, San Diego, USA
Qingfeng Zhuge, University of Texas at Dallas, USA
Author Index

Aschied, G. ......................................................... 7
Bae, S. .............................................................. 138
Bagherzadeh, N. .............................................. 59
Bailey, B. ............................................................ 79
Bansal, N. ............................................................ 13
Benaissa, M. ...................................................... 53
Bergamaschi, R. .............................................. 79, 150, 231
Bhattacharya, S. .............................................. 150
Bhuyan, L. ............................................................ 225
Burger, D. ............................................................ 74
Cai, L. ................................................................. 19
Camposano, R. .................................................. 73
Carloni, L. P. ....................................................... 75
Catthoor, F. .......................................................... 120
Chen, G. .............................................................. 213
Chian, M. C. .......................................................... 81
Chu, M. ............................................................... 52
Cong, J. ............................................................... 77
Connors, D. A. .................................................... 65
Cotterell, S. .......................................................... 168
Darringer, J. .......................................................... 150
Davies, M. ............................................................ 103
Deprettere, E. ..................................................... 90
Dhanwada, N. .................................................... 150
Doerper, M. .......................................................... 7
Dougherty, W. E. .................................................. 150
Dutt, N. ............................................................... 13, 82
Eles, P. ................................................................. 83
Erbas, C. ............................................................... 182
Erbas, S. C. ............................................................ 182
Ernst, R. ............................................................... 231
Fan, Y. ................................................................. 77
Filho, E. C. ............................................................ 103
Fordham, R. ....................................................... 79
Fornaciari, W. ..................................................... 207
Franke, B. ............................................................. 219
Gajski, D. ............................................................. 19, 31
Ganesh, B. ............................................................. 45
Geboytys, C. H. .................................................... 162
Gerstlauer, A. ..................................................... 31
Goossens, S. .......................................................... 7
Grimpe, E. ............................................................. 25
Ha, S. ................................................................. 1, 195
Hagen, A. ............................................................. 65
Han, G. ............................................................... 77
Hardee, P. ............................................................. 79
Hegde, A. ............................................................. 132
Hirata, M. ............................................................. 82
Hsieh, H. .............................................................. 168
Hsiung, P.-A. ...................................................... 114
Im, C. ................................................................. 195
Irwin, M. J. ......................................................... 132, 213
Jacobs, I. ............................................................... 71
Jacob, B. ............................................................... 45
Jantsch, A. ......................................................... 176, 188
Kandemir, M. ................................................... 132, 213
Karim, F. ............................................................... 73
Kim, B. ............................................................... 138
Kim, D. ................................................................. 1
Kim, H. ............................................................... 138
Kim, S. ............................................................... 138, 195
Kogel, T. ............................................................... 7
Kohout, P. ............................................................. 45
Koohi, A. ............................................................. 59
Kouloheris, J. ..................................................... 231
Kurdahi, F. J. ..................................................... 103
Leupers, R. .......................................................... 7
Lim, W.-M. ........................................................... 53
Lin, C.-Y. ............................................................. 114
Lin, J. ................................................................. 194
Liu, Jie ............................................................... 52
Liu, Juan ............................................................. 52
Llopis, R. P. ......................................................... 97
Lysecky, R. .......................................................... 109
Maestre, R. ......................................................... 103
Malik, S. ............................................................. 37
Martin, G. ......................................................... 79, 231
Maul, S. ............................................................ 97
Meyr, H. .............................................................. 7
Mishra, P. ............................................................ 13
Mitra, T. ............................................................ 201
Mohebbi, B. ....................................................... 103
Murugavel, A. K. ............................................... 126
Nair, I. ............................................................... 150
Najjar, W. ........................................................... 168
Negi, H. S. ......................................................... 201
O’Boyle, M. F. P. ............................................... 219
Oosterhuis, M. ................................................... 97
<table>
<thead>
<tr>
<th>Name</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oppenheimer, F.</td>
<td>25</td>
</tr>
<tr>
<td>Paliwal, S.</td>
<td>150</td>
</tr>
<tr>
<td>Pan, C.</td>
<td>59</td>
</tr>
<tr>
<td>Park, C.</td>
<td>138</td>
</tr>
<tr>
<td>Paul, J. M.</td>
<td>156</td>
</tr>
<tr>
<td>Paulin, P.</td>
<td>79</td>
</tr>
<tr>
<td>Pellom, B. L.</td>
<td>65</td>
</tr>
<tr>
<td>Peng, Z.</td>
<td>83</td>
</tr>
<tr>
<td>Peters, H.</td>
<td>97</td>
</tr>
<tr>
<td>Pimentel, A. D.</td>
<td>182</td>
</tr>
<tr>
<td>Pinto, C. A.</td>
<td>97</td>
</tr>
<tr>
<td>Pop, T.</td>
<td>83</td>
</tr>
<tr>
<td>Ranganathan, N.</td>
<td>126</td>
</tr>
<tr>
<td>Raudvere, T.</td>
<td>176</td>
</tr>
<tr>
<td>Reich, J.</td>
<td>52</td>
</tr>
<tr>
<td>Reshadi, M.</td>
<td>13</td>
</tr>
<tr>
<td>Roychoudhury, A.</td>
<td>201</td>
</tr>
<tr>
<td>Salice, F.</td>
<td>207</td>
</tr>
<tr>
<td>Sander, I.</td>
<td>176</td>
</tr>
<tr>
<td>Sangiovanni-Vincentelli, A. L.</td>
<td>75</td>
</tr>
<tr>
<td>Scarpazza, D. P.</td>
<td>207</td>
</tr>
<tr>
<td>Seo, J.</td>
<td>138</td>
</tr>
<tr>
<td>Sethuraman, R.</td>
<td>97</td>
</tr>
<tr>
<td>Sha, E. H.-M.</td>
<td>144</td>
</tr>
<tr>
<td>Shao, Z.</td>
<td>144</td>
</tr>
<tr>
<td>Shin, Y.</td>
<td>150</td>
</tr>
<tr>
<td>Singh, A. K.</td>
<td>176</td>
</tr>
<tr>
<td>Smith, G.</td>
<td>79</td>
</tr>
<tr>
<td>Stefanov, T.</td>
<td>90</td>
</tr>
<tr>
<td>Sztpanovits, J.</td>
<td>82</td>
</tr>
<tr>
<td>Underseth, M.</td>
<td>73</td>
</tr>
<tr>
<td>Vahid, F.</td>
<td>109, 168</td>
</tr>
<tr>
<td>Vijaykrishnan, N.</td>
<td>132, 213</td>
</tr>
<tr>
<td>Vincentelli, A. L. S.</td>
<td>75</td>
</tr>
<tr>
<td>Vissers, K.</td>
<td>231</td>
</tr>
<tr>
<td>Wang, S.</td>
<td>37</td>
</tr>
<tr>
<td>Wieferink, A.</td>
<td>7</td>
</tr>
<tr>
<td>Wolezko, M.</td>
<td>213</td>
</tr>
<tr>
<td>Wolf, W.</td>
<td>231</td>
</tr>
<tr>
<td>Xiao, B.</td>
<td>144</td>
</tr>
<tr>
<td>Xie, H.</td>
<td>225</td>
</tr>
<tr>
<td>Yang, P.</td>
<td>120</td>
</tr>
<tr>
<td>Yang, X.</td>
<td>77</td>
</tr>
<tr>
<td>Yi, Y.</td>
<td>1</td>
</tr>
<tr>
<td>Yu, H.</td>
<td>31</td>
</tr>
<tr>
<td>Zhang, Y.</td>
<td>162</td>
</tr>
<tr>
<td>Zhang, Z.</td>
<td>77</td>
</tr>
<tr>
<td>Zhao, F.</td>
<td>52</td>
</tr>
<tr>
<td>Zhao, L.</td>
<td>225</td>
</tr>
<tr>
<td>Zhuge, Q.</td>
<td>144</td>
</tr>
<tr>
<td>Zimmer, H.</td>
<td>188</td>
</tr>
</tbody>
</table>
CODES+ISSS 2004
PRELIMINARY CALL FOR PAPERS
http://www.ida.liu.se/codes/
Submission deadline: Monday, April 12, 2004

PREMIER EVENT IN SYSTEM LEVEL DESIGN
CODES+ISSS 2004 is the Second IEEE/ACM International Conference on Hardware/Software Codesign and System Synthesis. It is the premier event in design of embedded systems hardware, software, and tools. We are proud to continue the tradition of upholding high quality in an open forum for promoting active discussion on innovative topics. The program actively seeks industry participation. High-quality original papers will be accepted for oral presentation followed by interactive poster sessions. Proceedings are published by ACM SIGDA, and select papers from the conference proceedings will be targeted for journal publication in a special issue.

AREAS OF INTEREST
The CODES-ISSS Conference invites papers on all aspects of the design and architecture of semi-custom heterogeneous embedded computing systems – such as medical devices, cell phones, network processors, handheld computers, automotive and multimedia systems, systems-on-a-chip (SoCs). Topics of interest include, but are not limited to:

1) High-level, architectural and system-level synthesis
Specification and modeling, design representation, synthesis, partitioning, estimation, design space exploration, codesign for reliable systems.

2) Hardware/software codesign
Codesign methodologies, test and debug strategies, interaction between architecture and software design, design space exploration beyond traditional hw/sw boundary, theory and algorithms.

3) Specification languages
System level models and semantics, timing, power, formal properties, heterogeneous systems and components.

4) Embedded systems software
Compilers, memory management, virtual machines, scheduling, concurrent software for SoCs, distributed/resource aware OS, OS and middleware support for application specific processors.

5) Embedded systems architecture
Heterogeneous multiprocessors, reconfigurable platforms, memory management support, communication, protocols, network-on-chip.

6) Application-specific processor architectures and synthesis
Network processors, media processors, app-specific HW accelerators, reconfigurable processors, low power embedded processors, bio/fluidic processors.

7) Synthesis, modeling, and analysis
Low power, power-aware, testable, reliable, verifiable systems, performance modeling, validation and cosimulation, security issues.

8) Industrial practices and benchmark suites
System design, processor design, software, tools, case studies, trends, emerging technologies, experience maintaining benchmark suites, representation, interchange format, tools, copyrights, maintenance, reference implementations, and metrics.

9) New topics
New challenges for next generation semi-custom heterogeneous computing systems, arising from new technologies (e.g., nanotechnology) or new applications (e.g., ubiquitous computing). Studies of how technology and applications interact to motivate new solutions and design approaches, e.g., on-chip heterogeneous multiprocessors and user-friendly HCI leading to new programmer’s views in system-level design and resulting in new benchmarks, models, architectures, design tools and methodologies.

New for 2004!
10) Design track: new solutions for the design of embedded systems
This track will be devoted to contributions that highlight design experiences of great interest to the community, by demonstrating the application of new theoretical approaches as well as state-of-the-art methodologies and tools to real-life problems.

PAPER SUBMISSION
Papers should represent original work not published or submitted for publication in other forums. Formal proceedings will be published by ACM SIGDA in hardcopy, web page, and a CD-ROM forms. Papers should be submitted electronically over the web. By Mar.15 the CODES-ISSS website will open its paper submission page that will guide the authors through the submission process. The paper must be in PDF and should not exceed 6 pages. It should follow the ACM two-column proceedings format at a minimum of 9pt on 8.5”x11”, letter-sized page (no A4 please). For the purpose of anonymous review, DO NOT REVEAL AUTHORSHIP DIRECTLY OR INDIRECTLY THROUGH REFERENCES. LaTeX users: please make sure your PDF uses vector fonts, not bitmap fonts.

By submitting a paper, the authors agree to prepare the final camera-ready version and to present the paper in person at the symposium, if the paper is accepted.

Attention must be paid to audience participation in such discussions. Proposals for group discussions and special sessions are also invited. These should be single page proposals succinctly outlining the topic, problem(s) addressed, positioning and likely participants.

Papers submitted after the deadline, exceeding the page limit, or unveiling the authorship will automatically be rejected.

IMPORTANT DATES
Deadline for submission: Monday, April 12, 2004
Notification of acceptance: Friday, June 11, 2004
Deadline for final version: Monday, July 5, 2004

Papers should represent original work not published or submitted for publication in other forums. Formal proceedings will be published by ACM SIGDA in hardcopy, web page, and a CD-ROM forms. Papers should be submitted electronically over the web. By Mar.15 the CODES-ISSS website will open its paper submission page that will guide the authors through the submission process. The paper must be in PDF and should not exceed 6 pages. It should follow the ACM two-column proceedings format at a minimum of 9pt on 8.5”x11”, letter-sized page (no A4 please). For the purpose of anonymous review, DO NOT REVEAL AUTHORSHIP DIRECTLY OR INDIRECTLY THROUGH REFERENCES. LaTeX users: please make sure your PDF uses vector fonts, not bitmap fonts.

By submitting a paper, the authors agree to prepare the final camera-ready version and to present the paper in person at the symposium, if the paper is accepted.

Attention must be paid to audience participation in such discussions. Proposals for group discussions and special sessions are also invited. These should be single page proposals succinctly outlining the topic, problem(s) addressed, positioning and likely participants.

Papers submitted after the deadline, exceeding the page limit, or unveiling the authorship will automatically be rejected.

IMPORTANT DATES
Deadline for submission: Monday, April 12, 2004
Notification of acceptance: Friday, June 11, 2004
Deadline for final version: Monday, July 5, 2004

Papers submitted after the deadline, exceeding the page limit, or unveiling the authorship will automatically be rejected.

General Co-Chairs:
Alex Orailogu
CSE, Univ. of California, San Diego
alex@cs.ucsd.edu
Pat H. Chou
EECS, Univ. of California, Irvine
chou@eece.uci.edu

Program Co-Chairs:
Petru Eles
Linköping University, Sweden
petru@ida.liu.se
Axel Jantsch
Royal Institute of Technology, Sweden
axelj@mit.kth.se

Past General Co-Chairs:
Rajesh Gupta
CSE, Univ. of California, San Diego
gupta@cs.ucsd.edu
Yukihiro Nakamura
Kyoto University, Japan
nakamura@i.kyoto-u.ac.jp

Co-sponsored by (pending)