ACM SIGDA Publications on CDROM

ISLPED 2000
July 25 - 27, 2000
Rapallo/Portofino Coast, Italy

Copyright © 2000 by the Association for Computing Machinery, Inc (ACM). Permission to make digital or hard copies of portions of this work for personal or classroom use is granted without fee provided that the copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than ACM must be honored. Abstracting with credit is permitted. To copy otherwise, to republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permission to republish from: Publications Dept. ACM, Inc., FAX +1-212-869-0481 or E-mail <permissions@acm.org>. For other copying of articles that carry a code at the bottom of the first or last page, copying is permitted provided that the per-copy fee indicated in the code is paid through the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923.

Cover Page **Table of Contents** **Author Index** **Session Index**

ISLPED '00:

Proceedings of the

2000 International Symposium on Low Power Electronics and Design

Hotel Excelsior Palace
Rapallo/Portacino Coast, Italy
July 26-27, 2000

Sponsored by

ACM/SIGDA

IEEE Circuits and Systems Society

with technical support from
IEEE Electron Devices Society

www.acm.org

The Association for Computing Machinery
1515 Broadway
New York, New York 10036

Copyright 2000 by the Association for Computing Machinery, Inc. (ACM). Permission to make digital or hard copies of portions of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyright for components of this work owned by others than ACM must be honored. Abstracting with credit is permitted. To copy otherwise, to republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permission to republish from: Publications Dept. ACM, Inc. Fax +1 (212) 869-0481 or <permissions@acm.org>.

For other copying of articles that carry a code at the bottom of the first or last page, copying is permitted provided that the per-copy fee indicated in the code is paid through the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923.

Notice to Past Authors of ACM-Published Articles

ACM intends to create a complete electronic archive of all articles and/or other material previously published by ACM. If you have written a work that has been previously published by ACM in any journal or conference proceedings prior to 1978, or any SIG Newsletter at any time, and you do NOT want this work to appear in the ACM Digital Library, please inform permissions@acm.org, stating the title of the work, the author(s), and where and when published.

ACM ISBN: 1-58113-190-9 **IEEE Catalog No:** 008TH514

Additional copies may be ordered prepaid from:

ACM Order Department
PO Box 11405
New York, NY 10286-1405

Phone: 1-800-342-6626
(US and Canada)
+1-212-626-0500
(all other countries)
Fax: +1-212-944-1318
E-mail: acmhelp@acm.org

ACM Order Number 477004
Printed in the USA

FOREWORD

Welcome to the 2000 International Symposium on Low Power Electronics and Design (ISLPED). The symposium provides a forum for the presentation of advances in low-power systems and components. All aspects of designing low-power products, from fabrication technology and circuits to systems and software, are within the scope of ISLPED. As in the past, this year's ISLPED contains a mix of invited talks and contributed papers. All invited talks will be in plenary sessions, and thus can be heard by all attendees. Most other sessions will consist of two parallel tracks, one focusing on systems and CAD and the other focusing on circuits and technology.

A total of 162 contributed papers were received. Many thanks to all the authors who submitted their manuscripts. Even with the parallel sessions, we were able to accept only 39 regular papers and 18 poster papers. Poster papers are different from regular papers in several ways. For one thing, even though they are published in the proceedings, poster papers are shorter. In addition, we will have two parallel sessions in which posters will be presented to an audience, but with only 5 minutes available for each. Finally, we will have a poster display session in which authors will stand by cardboard displays of their work, and answer questions. The intention is that the author(s) can use the 5 minute presentation time to encourage attendees to stop by later on and view the posters during the display session.

One keynote speech and two invited talks will be presented during the plenary sessions. An evening panel on the first day will feature a lively discussion on the following topic: “Do Our Low-Power Tools Have Enough Horse Power?” It should be a stimulating event of interest to all attendees. Two embedded tutorials are scheduled towards the end of the program, one on “Reliable Low-Power Design in the Presence of Deep Submicron Noise” and another on “Low-Power DSP Processors for Wireless Communications.” These tutorials will present state-of-the-art techniques employed currently in the industry as well as future trends. The symposium will conclude with a banquet that will start with a boat ride in the beautiful “Golfo del Tigullio” and a visit to local historical sites followed by dinner in the small village of Recco, featuring typical food from the Italian Riviera accompanied by famous Italian wines.

Many thanks to the technical program committee for all the hard work in paper review, paper selection, and session organization. Additional experts have also contributed to the review process, and we acknowledge their contribution. Lists of technical program committee members and of any additional reviewer can be found in the following pages. Many thanks to Lucent Technologies for generously hosting the technical program committee meeting. Thanks also to the invited speakers for graciously donating their time and to the panel organizers and panelists for what should prove to be an enlightening and entertaining evening session. Finally, we want to thank the ACM SIGDA and the IEEE Circuits and Systems Society for their sponsorship, and the IEEE Electron Devices Society for their technical support.

We hope you will find the symposium both stimulating and helpful. Please give us your comments and suggestions on any aspects of the conference.

David Blaauw & Christian Enz
General Co-Chairs

Thad Gabara & Enrico Macii
Technical Program Co-Chairs

Table of Contents

Committee List xiii

Opening and Welcome
Wednesday, July 26th, 2000 • 9:00–9:15
Welcome: David Blaauw (Motorola, General Co-Chair of ISLPED '00)
Symposium Highlights: Enrico Macii (Politecnico di Torino, Tech. Prog. Co-Chair of ISLPED '00)

Keynote Speech
Wednesday, July 26th, 2000 • 9:15–10:00
Transmeta's Crusoe: Low-Power x86-Compatible Microprocessors Built with Software xiv
Speaker: David R. Ditzel (Transmeta Corp.)
Session Chair: E. Macii (Politecnico di Torino)

Invited Talk 1
Wednesday, July 26th, 2000 • 10:00–10:45
Low-Power Micromachined Microsystems 1
Speaker: Khalil Najafi (University of Michigan)
Session Chair: D. Blaauw (Motorola)

Session 1: Power Efficient Digital Circuits and Technologies I
Wednesday, July 26th, 2000 • 11:15–12:45
Session Chair: B. Athas (House Ear Institute)
Session Organizer: J. Burr (Sun Microsystems)

- **1.1: Design Issues for Dynamic Voltage Scaling** 9
  Thomas D. Burd, Robert W. Brodersen (University of California at Berkeley)
- **1.2: Dual-V_T SRAM Cells with Full-Swing Single-Ended Bit Line Sensing for High-Performance On-Chip Cache in 0.13 µm Technology Generation** 15
  Fatih Hamzaoglu, Yibin Ye, Ali Keshavarzi, Kevin Zhang, Siva Narendra, Shekhar Borkar, Vivek De (Intel), Mircea Stan (Univ. of Virginia)
- **1.3s: An Adaptive On-Chip Voltage Regulation Technique for Low-Power Applications** 20
  Nicola Dragone (ST Microelectronics), Akshay Aggarwal, L. Richard Carley (Carnegie Mellon)
- **1.4s: Robust Ultra-Low Power Sub-threshold DTMOS Logic** 25
  Hendrawan Soeleman, Kaushik Roy, Bipul Paul (Purdue University)

Session 2: Algorithmic and Systems Issues
Wednesday, July 26th, 2000 • 11:15–12:45
Session Chair: M. Martonosi (Princeton University)
Session Organizer: K. Usami (Toshiba)

- **2.1: Algorithmic Transforms for Efficient Energy Scalable Computation** 31
  Amit Sinha, Alice Wang, Anantha P. Chandrakasan (Massachusetts Institute of Technology)
- **2.2: Operating-System Directed Power Reduction** 37
  Yung-Hsiang Lu, Giovanni De Micheli (Stanford University), Luca Benini (Università di Bologna)
- **2.3s: Energy Minimization with Guaranteed Quality of Service** 43
  Gang Qu, Miodrag Potkonjak (University of California at Los Angeles)

- **2.4s: Energy Efficient Design of Portable Wireless Systems** 49
  Tajana Simunic, Haris Vikalo, Peter Glynn, Giovanni De Micheli (Stanford University)

Session 3: Mixed Signal Design
Wednesday, July 26th, 2000 • 14:30–16:00

Session Chair: M. Pelgrom (Philips)
Session Organizer: S. Mukherjee (Philips)

- **3.1: Power Consumption Reduction in High-Speed ΣΔ Bandpass Modulators** 55
  P. Cusinato, F. Stefani (STMicroelectronics), A. Baschirotto (University of Lecce)
- **3.2: Low Power Mixed Analog-Digital Signal Processing** 61
  Mattias Duppils, Christer Svensson (Linköpings Universitet)
- **3.3s: A Low-Power Clock and Data Recovery Circuit for 2.5 Gb/s SDH Receivers** 67
  Andrea Pallotta (Siemens ICN), Francesco Centurelli, Alessandro Trifiletti (Univ. di Roma "La Sapienza")
- **3.4s: A Micro-Power Mixed Signal IC for Battery-Operated Burglar Alarm Systems** 73
  Silvio Bolliri, Luigi Raffo (University of Cagliari), Paolo Porcu (ELSA SPA)

Session 4: Architecture and Memory Design
Wednesday, July 26th, 2000 • 14:30–16:00

Session Chair: B. Moyer (Motorola)
Session Organizer: C. Piguet (CSEM)

- **4.1: A Recursive Algorithm for Low-Power Memory Partitioning** 78
  Luca Benini (Universita di Bologna), Alberto Macii, Massimo Poncino (Politecnico di Torino)
- **4.2: Optimization of High-Performance Superscalar Architectures for Energy Efficiency** 84
  V. Zyuban, P. Kogge (University of Notre-Dame)
- **4.3s: Gated-V_{dd}: A Circuit Technique to Reduce Leakage in Deep-Submicron Cache Memories** 90
  Michael Powell, Se-Hyun Yang, Babak Falsafi, Kaushik Roy, T. N. Vijaykumar (Purdue University)
- **4.4s: Voltage Scheduling in the lpARM Microprocessor System** 96
  Trevor Pering, Thomas Burd, Robert Brodersen (University of California at Berkeley)

Session 5: Digital Logic
Wednesday, July 26th, 2000 • 11:15–12:45

Session Chair: V. Germini (Compaq)
Session Organizer: D. Garrett (Lucent)

- **5.1: MOS Current Mode Logic for Low Power, Low Noise CORDIC Computation in Mixed-Signal Environments** 102
  Jason M. Musicer, Jan Rabaey (University of California at Berkeley)
- **5.2: Noise-Aware Power Optimization for On-Chip Interconnect** 108
  Ki-Wook Kim, Seong-Ook Jung, Sung-Mo Kang (University of Illinois at Urbana-Champaign), Unni Narayanan (Intel Corp.), C. L. Liu (National Tsing Hua University)
- **5.3s: New Clock-Gating Techniques for Low-Power Flip-flops** 114
  A. G. M. Strollo, E. Napoli, D. De Caro (University of Naples "Federico II")
- **5.4s: An Improved Pass Transistor Synthesis Method for Low Power, High Speed CMOS Circuits** 120
  Tudor Vinereanu, Sverre Lidholm (Cork University College)

Session 6: Synthesis and Optimization
Wednesday, July 26th, 2000 • 11:15–12:45
Session Chair: D. Marculescu (Carnegie Mellon)
Session Organizer: M. Poncino (Politecnico di Torino)

- **6.1: Achieving Utility Arbitrarily Close to the Optimal with Limited Energy** 125
  Gang Qu, Miodrag Potkonjak (University of California at Los Angeles)
- **6.2: Power Minimization of Functional Units by Partially Guarded Computation** 131
  Junghwan Choi, Jinhwan Jeon, Kiyoung Choi (Seoul National University)
- **6.3s: Systematic Cycle Budget versus System Power Trade-off: a New Perspective on System Exploration of Real-Time Data-Dominated Applications** 137
  Erik Brockmeyer, Arnout Vandecappelle, Francky Catthoor (IMEC)
- **6.4s: Low Power Sequential Circuit Design by Using Priority Encoding and Clock Gating** 143
  Xunwei Wu (Ningbo University), Massoud Pedram (University of Southern California)

Evening Panel
Wednesday, July 26th, 2000 • 18:30–20:00

Do Our Low-Power Tools Have Enough Horse Power? 149

Moderator: Giovanni De Micheli (Stanford University)
Panelists: Tony Correale (IBM), Hugo De Man (IMEC), Pietro Erratico (ST), Jerry Frankil (Sente), Srini Raghvendra (Synopsys), Vivek Tiwari (Intel)

Invited Talk 2
Thursday, July 27th, 2000 • 9:00–9:45

Low-Power Considerations in the Design of Bluetooth 151

Speaker: Sven Mattisson (Ericsson)
Session Chair: T. Gabara (Lucent)

Session 7: Power Efficient Digital Circuits and Technologies II
Thursday, July 27th, 2000 • 10:15–11:45
Session Chair: K. Roy (Purdue University)
Session Organizer: B. Barton (TI)

- **7.1: High-Speed Dynamic Logic Styles for Scaled-Down CMOS and MTCMOS Technologies** 155
  Mohamed W. Allam, Mohab H. Anis, Mohamed I. Elmasry (University of Waterloo)
- **7.2: A Three-Port nRERL Register File for Ultra-Low-Energy Applications** 161
  Jun-Ho Kwon, Soo-Ik Chae (Seoul National University), Joonho Lim (Global Communication Technology)
- **7.3s: Minimum Power And Area N-Tier Multilevel Interconnect Architectures Using Optimal Repeater Insertion** 167
  Raguraman Venkatesan, Jeffrey A. Davis, Keith A. Bowman, James D. Meindl (Georgia Institute of Technology)
- **7.4s: Practical Considerations of Clock-Powered Logic** 173
  William Athas (House Ear Institute)

Session 8: Modeling and Simulation
Thursday, July 27th, 2000 • 10:15–11:45

Session Chair: V. Tiwari (Intel)
Session Organizer: M. Nemani (Intel)

- **8.1: Model and Analysis for Combined Package and On-Chip Power Grid Simulation** 179
  Rajendran Panda, David Blaauw, Rajat Chaudhry, Vladimir Zolotov, Brian Young, Ravi Ramaraju (Motorola)
- **8.2: Cycle-Accurate Energy Consumption Measurement and Analysis: Case Study of ARM7TDMI** 185
  Naehyuck Chang, Kwanho Kim, Hyung Gyu Lee (Seoul National University)
- **8.3s: Speeding up Power Estimation of Embedded Software** 191
  Akshaye Sama, J. F. M. Theeuwen (Philips Research), M. Balakrishnan (Indian Institute of Technology)
- **8.4s: High-Level Power Estimation with Interconnect Effects** 197
  Kavel M. Büyükşahin (University of Illinois at Urbana-Champaign), Farid N. Najm (University of Toronto)

Poster Session 1
Thursday, July 27th, 2000 • 11:45–12:30

Session Chair: B. Troutman (Lucent)
Session Organizer: A. Chandrakasan (MIT)

- **P1.1: "Cool Low Power" 1 GHz Multi-Port Register File and Dynamic Latch in 1.8 V, 0.25 µm SOI and Bulk Technology** 203
  R. V. Joshi, W. Hwang, S. C. Wilson, C. T. Chuang (T. J. Watson Research Center)
- **P1.2: Low-Power Digital Filtering Using Multiple Voltage Distribution and Adaptive Voltage Scaling** 207
  Sandeep Dhar, Dragan Maksimović (University of Colorado at Boulder)
- **P1.3: Low Power Self-Timed Radix-2 Division** 210
  Jae-Hee Won, Kiyoung Choi (Seoul National University)
- **P1.4: A Rate Selection Algorithm for Quantized Undithered Dynamic Supply Voltage Scaling** 213
  Lama H. Chandrasena, Michael J. Liebelt (The University of Adelaide)
- **P1.5: Low-Power Sensing and Digitization of Cardiac Signals based on Sigma-Delta Conversion** 216
  Andrea Gerosa, Arianna Novo, Andrea Neviani (University of Padova)
- **P1.6: A 1.5V Low-Power Third Order Continuous-Time Lowpass ΣΔ A/D Converter** 219
  Friedel Gerfers, Yiannos Manoli (University of Saarland)
- **P1.7: Design of A Low-Power CMOS Baseband Circuit for Wideband CDMA Testbed** 222
  Chunlei Shi, Yue Wu, Mohammed Ismail (The Ohio State University)
- **P1.8: WITHDRAWN**
- **P1.9: A Low-Voltage CMOS Multiplier for RF Applications** 225
  Carl James Debono, Franco Maloberti (University of Pavia), Joseph Micallef (University of Malta)

Poster Session 2
Thursday, July 27th, 2000 • 11:45–12:30

Session Chair: G. Stamoulis (Intel)
Session Organizer: R. Panda (Motorola)

- **P2.1: Voltage Dependent Gate Capacitance and its Impact in Estimating Power and Delay of CMOS Digital Circuits with Low Supply Voltage** 228
  Koichi Nose, Takayasu Sakurai (University of Tokyo), Soo-Ik Chae (Seoul National University)
- **P2.2: Reducing Energy Requirements for Instruction Issue and Dispatch in Superscalar Microprocessors** 231
  Kanad Ghose (State University of New York)
- **P2.3: Low Power Synthesis of Sum-of-Products Computation** 234
  K. Masselos, S. Theoharis, P. K. Merakos, T. Stouraitis, C. E. Goutis (University of Patras)
- **P2.4: A Spatially-Adaptive Bus Interface for Low-Switching Communication** 238
  Andrea Acquaviva (Universita di Bologna), Riccardo Scarsi (Politecnico di Torino)
- **P2.5: A Low Power Unified Cache Architecture Providing Power and Performance Flexibility** 241
  Afzal Malik, Bill Moyer, Dan Cermak (Motorola, Inc.)
- **P2.6: Memory System Energy: Influence of Hardware-Software Optimizations** 244
  G. Esakkimuthu, N. Vijaykrishnan, M. Kandemir, M. J. Irwin (Pennsylvania State University)
- **P2.7: Energy-efficient Code Generation for DSP56000 family** 247
  Sathishkumar Udayanarayanan, Chaitali Chakrabarti (Arizona State University)
- **P2.8: Power-Optimal Encoding for DRAM Address Bus** 250
  Wei-Chung Cheng, Massoud Pedram (University of Southern California at Los Angeles)
- **P2.9: Profile-Driven Code Execution for Low Power Dissipation** 253
  Diana Marculescu (Carnegie Mellon University)

Session 9: Synthesis and Optimization
Thursday, July 26th, 2000 • 14:30–16:00

Session Chair: V. De (Intel)
Session Organizer: D. Xanthopoulus (ATI)

- **9.1: An Asynchronous Matrix-Vector Multiplier for Discrete Cosine Transform** 256
  Kyeounsoo Kim (Ilryung Telesys, Inc.), Peter A. Beerel (University of Southern California at Los Angeles), Youpyo Hong (Dongguk University)
- **9.2: Low Power Techniques and Design Tradeoffs in Adaptive FIR Filtering for PRML Read Channels** 262
  Khurram Muhammad, Robert B. Staszewski (Texas Instruments, Inc.), Poras T. Balsara (University of Texas at Dallas)
- **9.3: Energy-Efficient 32 x 32-bit Multiplier in Tunable Near-Zero Threshold CMOS** 268
  Vjekoslav Svilan (Stanford University), Masataka Matsui (Toshiba Corp.), James B. Burr (Sun Microsystems Labs)

Session 10: RF Design
Thursday, July 27th, 2000 • 14:30–16:00

Session Chair: S. Heine (Infineon)
Session Organizer: Q. Huang (ETHZ)

- **10.1: Tradeoffs and Design of an Ultra Low Power UHF Transceiver Integrated in a Standard Digital CMOS Process** 273
  Alain-Serge Porret, Thierry Melly (Swiss Federal Institute of Technology), E. A. Vittoz, C. C. Enz (Swiss Center for Electronics & Microtechnology)
- **10.2: An 8mA, 3.8dB NF, 40dB gain CMOS Front-End for GPS Applications** 279
  F. Svelto (Università di Bergamo), S. Deantoni, G. Montagna (STMicroelectronics), R. Castello (Università di Pavia)
- **10.3s: Bias Boosting Technique for a 1.9GHz Class AB RF Amplifier** 284
  Tirdad Sowlati, Sifen Luo (Philips Research)
- **10.4s: Analysis and Design of Low-Phase-Noise Ring Oscillators** 289
  Liang Dai, Ramesh Harjani (University of Minnesota)

Embedded Tutorial 1
Thursday, July 27th, 2000 • 16:30–17:30

Reliable Low-Power Design in the Presence of Deep Submicron Noise 295

Speakers: Naresh Shanbhag (University of Illinois at Urbana-Champaign), Krishnamurthy Soumyanath (Intel Corporation), Samuel Martin (Lucent Technologies)
Session Chair: N. Sivan (Motorola)

Embedded Tutorial 2
Thursday, July 27th, 2000 • 16:00–17:30

Low-Power DSP for Wireless Communications 303

Speakers: Ingrid Verbauwhede (University of California at Los Angeles), Chris Nicol (Lucent Technologies)
Session Chair: L. Benini (Università di Bologna)

Author Index 313

Executive Committee and Symposium Officers

General Co-Chairs: David Blaauw *(Motorola)*, Christian Enz *(CSEM)*

Technical Program Co-Chairs: Thad Gabara (Lucent Technologies), Enrico Macii (Politecnico di Torino)

Treasurer: Mary Jane Irwin (Penn. State Univ.)

Publicity Chair: Ingrid Verbauwhede (UCLA)

Local Publicity Chair: Luca Benini (Universita' di Bologna)

Local Arrangements Chair: Pierluigi Civera *(Politecnico di Torino)*

Other Members of the EC:

Brock Barton *(Texas Instruments)*
Robert Brodersen *(UC Berkeley)*
Anantha Chandrakasan *(MIT)*
Ed Cheng *(Synopsys)*
Jason Cong *(UCLA)*
Dan Dobberpuhl *(SiByte)*
Farid Najm *(Univ. of Toronto)*
Massoud Pedram *(USC)*
Jan Rabaey *(UC Berkeley)*
Takayasu Sakurai *(Univ. of Tokyo)*
Christer Svensson *(Linkoping Univ.)*
Bruce Wooley *(Stanford Univ.)*

Technical Program Committee:

Yehuda Adelman *(Motorola)*
John Arends *(Motorola)*
Bill Athas *(House Ear Institute)*
Daniel Auvergne *(LIRMM Montpellier)*
Brock Barton *(Texas Instruments)*
Luca Benini *(Univ. di Bologna)*
Kees van Berkel *(Philips)*
Alessandro Bogliolo *(Univ. di Bologna)*
Bill Bowhill *(Compaq)*
Bob Brodersen *(UC Berkeley)*
Jim Burr *(Sun)*
Rick Carley *(CMU)*
Rinaldo Castello *(Univ. di Pavia)*
Francky Catthoor *(IMEC)*
Anantha Chandrakasan *(MIT)*
Ed Cheng *(Synopsys)*
Jason Cong *(UCLA)*
Giovanni De Micheli *(Stanford Univ.)*
Chih-Shun Ding *(Connexant)*
Josef Fenk *(Infineon)*
Steve Furber *(Univ. of Manchester)*
David Garrett *(Lucent)*
Jorg Henkel *(NEC)*
Qiuting Huang *(ETHZ)*
Ed Huijbregts *(Philips)*
Mary Jane Irwin *(Penn State Univ.)*
William Kaiser *(UCLA)*
Sharad Malik *(Princeton Univ.)*
Radu Marculescu *(Univ. of Minnesota)*
Renu Mehra *(Synopsys)*
Jose Monteiro *(INESC)*
Satyen Mukherjee *(Philips)*
Farid Najm *(Univ. of Toronto)*
Kazuyuki Nakamura *(NEC)*
Unni Narayanan *(Intel)*
Wolfgang Nebel *(Univ. of Oldenburg)*
Mahadev Nemani *(Intel)*
Rajendran Panda *(Motorola)*
Massoud Pedram *(USC)*
Ernesto Perea *(EURECOM)*
Christian Piguet *(CSEM)*
Massimo Poncino *(Politecnico di Torino)*
Kaushik Roy *(Purdue Univ.)*
Takayasu Sakurai *(Univ. of Tokyo)*
Fabio Somenzi *(Univ. of Colorado)*
Mircea Stan *(Univ. of Virginia)*
Michiel Steyart *(KU Leuven)*
Ravi Subrahmanyan *(Cimaron Comm.)*
Frans Theeuwen *(Philips)*
Chi-Ying Tsui *(Univ. of Hong Kong)*
Kimiyoshi Usami *(Toshiba)*
Harry Veendrick *(Philips)*
Ingrid Verbauwhede *(UCLA)*
Eric Vittoz *(CSEM)*
Duke Xanthopoulos *(ATI)*
Roberto Zafalon *(ST)*

List of Additional Reviewers:

Manuela Anton
Hideho Arakida
Mark Bickerstaff
Pat Bosshart
Erik Brockmeyer
David Brooks
Jui-Ming Chang
Wei Chen
Mauro Chinosi
Kisup Chong
Amit Chowdhary
Phillip Christie
Ki-Seok Chung
Eui-Young Chung
Pasquale Cocchini
Cassondra Crotty
Koen Danckaert
Dirk Desmet
Robert Dick
Charutosh Dixit
Nicola Dragone
Benoit Dufort
Uma Ekambaram
Milos Ercegovac
Ulvi Erdogan
Jim Gallia
Alan Gatherer
Demetri Giannopoulos
Mototsugu Hamada
Keerthi Heragu
Cheng-Ta Hsieh
Jos Huisken
Gerd Jochens
Masahiro Kanazawa
Mahmut Kandemir
Naoyuki Kawabe
Sunil Khatri
Kamaal Khouri
Takeshi Kitahara
Tianming Kong
Lars Kruse
Chidamber Kulkarni
Marcello Lajolo
Paul Landman
Patrik Larsson
Wai Lee
Haris Lekatsas
Sung Lim
Wangning Long
Yung Hsiang Lu
Jiong Luo
Alberto Macii
Diana Marculescu
Jean-Marc Masgonty
Joong-Seok Moon
William C. Moyer
Lode Nachtergaele
Vijay Narayanan
Chris Nicol
Cees Niessen
Tsuyoshi Nishikawa
David Z. Pan
Davide Pandini
Danilo Pau
Bipul Paul
Jose Pineda de Gyvez
Qinru Qiu
Sethuraman Ramanathan
Yoram Salant
Roelof Salters
Sridhar Samudrala
Sachin Sapatnekar
Riccardo Scarsi
Eike Schmidt
Tajana Simunic
Noam Sivan
Anand Sivasubramaniam
Hendrawan Soeleman
Alexandre Solomatnikov
Leilei Song
Ansgar Stammermann
George Stamoulis
Lars Svensson
Hiroshi Takahashi
Tat Kee Tan
Nestoras Tzartzanis
Taku Uchino
Arnout Vandecappelle
Patrick Vandenameele
Carlin Vieri
Ihor Wacyk
Alan Willson
Qing Wu

Keynote Speech

Transmeta's Crusoe: Low-Power x86-Compatible Microprocessors Built with Software

Speaker
David R. Ditzel
(Transmeta Corp)

Author Index

Acquaviva, A. 238
Aggarwal, A. 20
Allam, M. W. 155
Anis, M. H. 155
Athas, W. 173
Balakrishnan, M. 191
Balsara, P. T. 262
Baschirotto, A. 55
Beerel, P. A. 256
Benini, L. 37, 78
Blaauw, D. 179
Bolliri, S. 73
Borkar, S. 15
Bowman, K. A. 167
Brockmeyer, E. 137
Brodersen, R. W. 9, 96
Burd, T. 96
Burd, T. D. 9
Burr, J. B. 268
Büyükşahin, K. M. 197
Carley, L. R. 20
Castello, R. 279
Catthoor, F. 137
Centurelli, F. 67
Cermak, D. 241
Chae, S.-I. 161, 228
Chakrabarti, C. 247
Chandrakasan, A. P. 31
Chandrasena, L. H. 213
Chang, N. 185
Chaudhry, R. 179
Cheng, W.-C. 250
Choi, J. 131
Choi, K. 131, 210
Chuang, C. T. 203
Cusinato, P. 55
Dai, L. 289
Davis, J. A. 167
De Caro, D. 114
De Micheli, G. 37, 49
De, V. 15
Deantoni, S. 279
Debono, C. J. 225
Dhar, S. 207
Dragone, N. 20
Duppils, M. 61
Elmasry, M. I. 155
Enz, C. C. 273
Esakkimuthu, G. 244
Falsafi, B. 90
Gerfers, F. 219
Gerosa, A. 216
Ghose, K. 231
Glynn, P. 49
Goutis, C. E. 234
Hamzaoglu, F. 15
Harjani, R. 289
Hong, Y. 256
Hwang, W. 203
Irwin, M. J. 244
Ismail, M. 222
Jeon, J. 131
Joshi, R. V. 203
Jung, S.-O. 108
Kandemir, M. 244
Kang, S.-M. 108
Keshavarzi, A. 15
Kim, Kw. 185
Kim, Ky. 256
Kim, K.-W. 108
Kogge, P. 84
Kwon, J.-H. 161
Lee, H. G. 185
Lidholm, S. 120
Liebelt, M. J. 213
Lim, J. 161
Liu, C. L. 108
Lu, Y.-H. 37
Luo, S. 284
Macii, A. 78
Maksimoviç, D. 207
Malik, A. 241
Maloberti, F. 225
Manoli, Y. 219
Marculescu, D. 253
Martin, S. 295

Masselos, K. 234
Matsui, M. 268
Mattisson, S. 151
Meindl, J. D. 167
Melly, T. 273
Merakos, P. K. 234
Micallef, J. 225
Montagna, G. 279
Moyer, W. 241
Muhammad, K. 262
Musicer, J. M. 102
Najafi, K. 1
Najm, F. N. 197
Napoli, E. 114
Narayanan, U. 108
Narendra, S. 15
Neviani, A. 216
Nicol, C. 303
Nose, K. 228
Novo, A. 216
Pallotta, A. 67
Panda, R. 179
Paul, B. 25
Pedram, M. 143, 250
Pering, T. 96
Poncino, M. 78
Porcu, P. 73
Porret, A.-S. 273
Potkonjak, M. 43, 125
Powell, M. 90
Qu, G. 43, 125
Rabaey, J. 102
Raffo, L. 73
Ramaraju, R. 179
Roy, K. 25, 90
Sakurai, T. 228, 271
Sama, A. 191
Scarsi, R. 238
Shanbhag, N. 295
Shi, C. 222
Simunic, T. 49
Sinha, A. 31
Soeleman, H. 25
Soumyanath, K. 295
Sowlati, T. 284
Stan, M. 15
Staszewski, R. B. 262
Stefani, F. 55
Stouraitis, T. 234
Strollo, A. G. M. 114
Svelto, F. 279
Svensson, C. 61
Svilan, V. 268
Theeuwen, J. F. M. 191
Theoharis, S. 234
Trifiletti, A. 67
Udayanarayanan, S. 247
Vandecappelle, A. 137
Venkatesan, R. 167
Verbauwhede, I. 303
Vijaykrishnan, N. 244
Vijaykumar, T. N. 90
Vikalo, H. 49
Vinereanu, T. 120
Vittoz, E. A. 273
Wang, A. 31
Wilson, S. C. 203
Won, J.-H. 210
Wu, X. 143
Wu, Y. 222
Yang, S.-H. 90
Ye, Y. 15
Young, B. 179
Zhang, K. 15
Zolotov, V. 179
Zyuban, V. 84

Session Index

Session 1: Power Efficient Digital Circuits and Technologies I
Session 2: Algorithmic and Systems Issues
Session 3: Mixed Signal Design
Session 4: Architecture and Memory Design
Session 5: Digital Logic
Session 6: Synthesis and Optimization
Session 7: Power Efficient Digital Circuits and Technologies II
Session 8: Modeling and Simulation
Poster Session 1
Poster Session 2
Session 9: Synthesis and Optimization
Session 10: RF Design