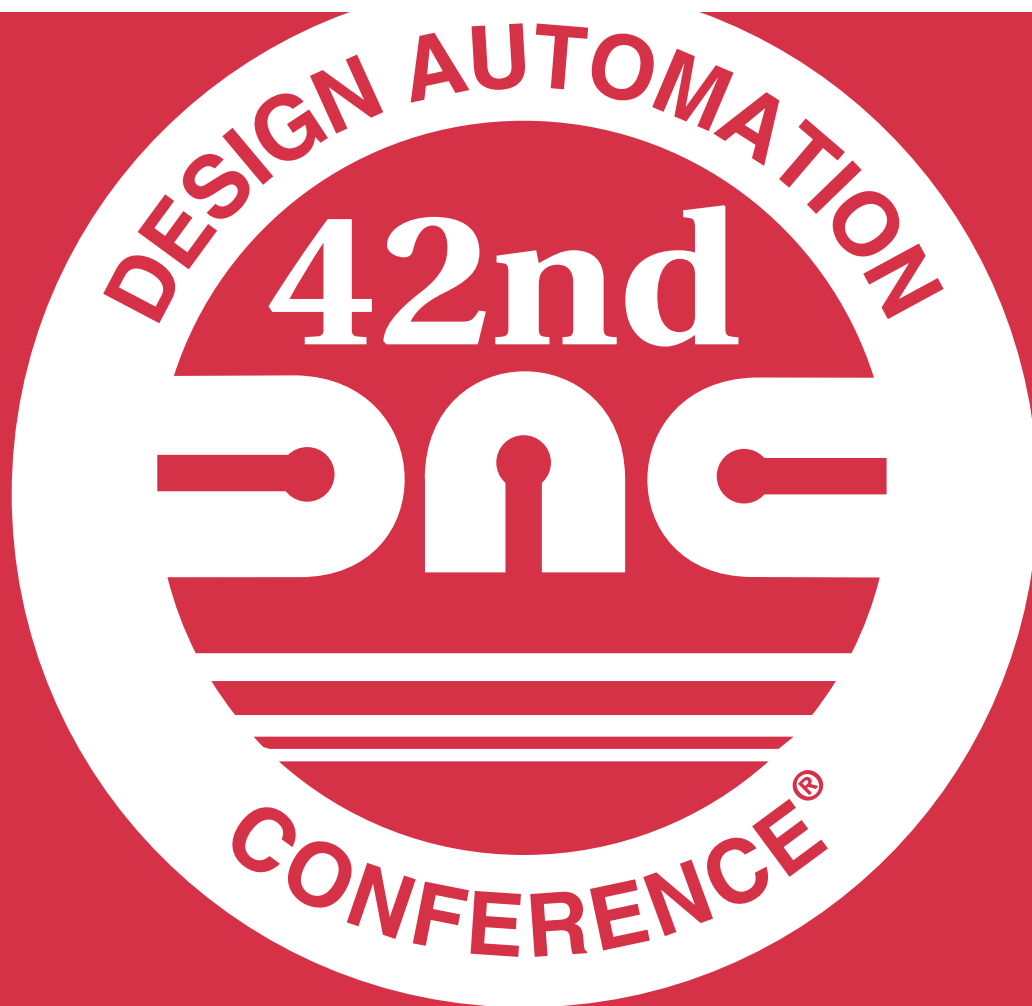


# PROCEEDINGS 2005

## DESIGN AUTOMATION CONFERENCE



Anaheim Convention Center  
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# GENERAL CHAIR'S WELCOME

Welcome to the 42nd Design Automation Conference and the city of Anaheim! More than ever, DAC is the place where researchers and developers, industry and academia, exhibitors and their customers come to learn about the latest breakthroughs, the latest products, and the latest business deals in electronic design automation.

In addition to the industry luminaries and the best and the brightest innovators, DAC has the highest density of customers who make buying decisions of any similar conference. The thousands of attendees – system and chip designers, tool developers, analysts, executives, faculty, and students – are a diverse group who make DAC the place to be, the one place to meet your customers and suppliers, your colleagues and competitors, your former students, employees, and managers! You will find others with common interests and concerns, learn about new ideas in the technical sessions and new products on the exhibit floor, and get a view of trends, challenges, and solutions in electronic design automation. Your participation is limited only by your time and stamina.

This year's Tuesday keynote speaker is Bernard S. Meyerson, IBM Fellow, Vice President, and Chief Technologist of IBM's Systems and Technology Group, who will discuss the direction of design as scaling ends. Dr. Meyerson was named by EE Times as one of thirteen people "who are influencing the course of semiconductor development technology and taking it into realms that exceed the bounds set by the inventors of the transistor more than fifty years ago." On Thursday, Ronald A. Rohrer, Wilkoff Chair University Professor Emeritus of Electrical and Computer Engineering at Carnegie Mellon University and a design automation entrepreneur, will discuss innovation in the EDA industry. Dr. Rohrer is a winner of the EDA Consortium Phil Kaufman Award and Corporate Vice President, Advanced Research and Development, Cadence Design Systems, Inc.

The technical program this year was selected from 735 submissions, and the 74 members of the Technical Program Committee had to make difficult choices. The committee has produced a diverse technical program consisting of 154 papers in 40 sessions, plus nine special sessions and eight panels. The Panel Committee has put together these exciting panels as well as 18 events in the DAC Pavilion on the exhibit floor. The week is complemented by six tutorials on timely topics on Monday and Friday. System-level design, design for manufacturability, power reduction, and verification – problems old and new – form the core of the technical program.

This year, in addition to Management Day on Tuesday, is DAC's first theme day, Wireless Wednesday, with a range of technical talks and panels, discussion on the exhibit floor in the DAC Pavilion, and the showcasing of wireless products and applications. The exhibit floor, using the integrated booth/suite layout introduced successfully last year, features over 230 companies, with 50 new exhibitors. The excitement of the DAC Pavilion, Monday's Happy Hour, and a "Wireless Walk" highlighting tools and applications, and, of course, the latest products, make the exhibits a key part of the conference.

The efforts of many people go into making DAC the success it has been for over forty years as the premier design automation event for the entire community. The authors, speakers, and session chairs; the reviewers, session organizers, moderators, and panelists; the members of the DAC Executive Committee, Technical Program Committee, and Exhibitor Liaison Committee, all volunteers, deserve special thanks. MP Associates, Inc., conference and exhibit managers, continue to be unwaveringly focused on DAC's success. We are grateful for the support of our sponsors, ACM/SIGDA, IEEE/CASS/CANDE, and the EDA Consortium, and for the technical cooperation of the IEEE Solid State Circuits Society.

And special thanks to you, the DAC attendees. We wish you a productive and exciting week at DAC!



**William H. Joyner, Jr**

*General Chair*

42nd Design Automation Conference

# PROCEEDING OF THE 42ND DESIGN AUTOMATION CONFERENCE®

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# Table of Contents

General Chair’s Welcome .....	i
Executive Committee .....	xix
Technical Program Committee .....	xxi
Panel Committee .....	xxiii
Tutorial Committee .....	xxiii
Hands-On Tutorial Committee .....	xxiii
Student Design Contest Judges .....	xxiv
Exhibitor Liaison Committee .....	xxiv
Opening Keynote Address – Bernard S. Meyerson .....	xxv
Thursday Keynote Address – Ronald A. Rohrer .....	xxvi
Marie R. Pistilli Women in EDA Achievement Award .....	xxvii
P.O. Pistilli Undergraduate Scholarships .....	xxvii
Design Automation Conference Graduate Scholarships .....	xxviii
DAC/ISSCC 2005 Student Design Content Winners .....	xxviii
<b>ACM Transactions on Design Automation of Electronic Systems (TODAES)</b>	
2005 Best Paper Award .....	xxviii
ACM/SIGDA Distinguished Service Award .....	xxviii
2004 Phil Kaufman Award for Distinguished Contributions to EDA .....	xxix
IEEE CASS Awards .....	xxix
IEEE Fellows .....	xxix
Reviewers .....	xxx
2006 Call for Papers .....	xxxiv
<b>SESSION 1: PANEL — Differentiate and Deliver: Leveraging</b>	
<b>Your Partners (CEO Panel)</b> .....	1
Chair: Jay Vleeschouwer ( <i>Merrill Lynch</i> )	
Organizers: Rich Goldman, David Park	
Panelists: W. East ( <i>ARM Holdings, plc</i> ), A. De Geus ( <i>Synopsys, Inc.</i> ), J. Hu ( <i>UMC Corp.</i> ), M. J. Fister ( <i>Cadence Design Systems, Inc.</i> ), W. C. Rhines ( <i>Mentor Graphics Corp.</i> ), R. Cassidy ( <i>TSMC</i> )	
<b>SESSION 2: Special Session: Error-Tolerant Design</b>	
Chair: Sarma Vrudhula ( <i>University of Arizona</i> )	
Organizers: Krishnendu Chakrabarty, Sarma Vrudhula	
2.1 <b>Logic Soft Errors in Sub-65nm Technologies Design and CAD Challenges</b> .....	2
S. Mitra, T. Karnik, N. Seifert, M. Zhang ( <i>Intel Corporation</i> )	
2.2 <b>SEU Tolerant Device, Circuit and Processor Design</b> .....	5
W. Heidergott ( <i>General Dynamics C4 Systems</i> )	
<b>SESSION 3: Microarchitecture-Level Power Analysis and Optimization Techniques</b>	
Chair: Mary Jane Irwin ( <i>Penn State University</i> )	
Organizers: Sujit Dey, Trevor Mudge	
3.1 <b>Variability and Energy Awareness: A Microarchitecture-Level Perspective</b> .....	11
D. Marculescu, E. Talpes ( <i>Carnegie Mellon University</i> )	

<b>3.2</b>	<b>Energy-Efficient Physically Tagged Caches for Embedded Processors with Virtual Memory</b> .....	17
	P. Petrov ( <i>University of Maryland at College Park</i> ), D. Tracy, A. Orailoglu ( <i>University of California at San Diego</i> )	
<b>3.3</b>	<b>Hybrid Simulation for Embedded Software Energy Estimation</b> .....	23
	A. Muttreja ( <i>Princeton University</i> ), A. Raghunathan, S. Ravi ( <i>NEC Laboratories</i> ), N. K. Jha ( <i>Princeton University</i> )	
<b>3.4</b>	<b>Cooperative Multithreading on Embedded Multiprocessor Architectures Enables Energy-scalable Design</b> .....	27
	P. Schaumont, B.-C. C. Lai ( <i>University of California at Los Angeles</i> ), W. Qin ( <i>Boston University</i> ), I. Verbauwhede ( <i>University of California at Los Angeles &amp; ESAT</i> )	

## SESSION 4: Leakage Analysis and Optimization

Chair: Yu Cao (*Arizona State University*)

Organizers: Tanay Karnik, Chandu Visweswariah

<b>4.1</b>	<b>Total Power Reduction in CMOS Circuits via Gate Sizing and Multiple Threshold Voltages</b> .....	31
	F. Gao, J. P. Hayes ( <i>University of Michigan</i> )	
<b>4.2</b>	<b>An Effective Power Mode Transition Technique in MTCMOS Circuits</b> .....	37
	A. Abdollahi ( <i>University of Southern California</i> ), F. Fallah ( <i>Fujitsu Labs. of America</i> ), M. Pedram ( <i>University of Southern California</i> )	
<b>4.3</b>	<b>A Self-adjusting Scheme to Determine the Optimum RBB by Monitoring Leakage Currents</b> .....	43
	N. Jayakumar ( <i>Texas A&amp;M University</i> ), S. Dhar ( <i>National Semiconductor</i> ), S. P. Khatri ( <i>Texas A&amp;M University</i> )	
<b>4.4</b>	<b>Enhanced Leakage Reduction Technique by Gate Replacement</b> .....	47
	L. Yuan, G. Qu ( <i>University of Maryland</i> )	

## SESSION 5: Analog Macromodeling

Chair: Georges Gielen (*Katholieke Universiteit*)

Organizers: Geert Van Der Plas, Helmut Graeb

<b>5.1</b>	<b>Automated Nonlinear Macromodelling of Output Buffers for High-Speed Digital Applications</b> .....	51
	N. Dong, J. Roychowdhury ( <i>University of Minnesota</i> )	
<b>5.2</b>	<b>Systematic Development of Analog Circuit Structural Macromodels through Behavioral Model Decoupling</b> .....	57
	Y. Wei, A. Daboli ( <i>Stony Brook University</i> )	
<b>5.3</b>	<b>A Combined Feasibility and Performance Macromodel for Analog Circuits</b> .....	63
	M. Ding, R. Vemuri ( <i>University of Cincinnati</i> )	

## SESSION 6: PANEL — ESL: Tales from the Trenches .....

Chair: David Maliniak (*Electronic Design*)

Organizer: Francine Bacchini

Panelists: T. Doherty (*Emulex*), S. A. Pai (*Qualcomm*), S.-K. Eo (*ST Microelectronics*),

P. McShane (*Northrop Grumman*), S. Sundararajan (*Texas Instruments, Inc.*),

P. Urard (*ST Microelectronics*)

## SESSION 7: Statistical Timing Analysis

Chair: Vinod Kariat (*Cadence Design Systems, Inc.*)

Organizers: Joel Phillips, Kenneth Shepard

<b>7.1</b>	<b>Parameterized Block-Based Statistical Timing Analysis with Non-Gaussian Parameters, Nonlinear Delay Functions</b> .....	71
	H. Chang ( <i>University of Minnesota</i> ), V. Zolotov ( <i>IBM T.J. Watson Research Center</i> ), S. Narayan ( <i>IBM Systems &amp; Technology</i> ), C. Visweswariah ( <i>IBM T.J. Watson Research Center</i> )	

<b>7.2</b>	<b>Correlation-Aware Statistical Timing Analysis with Non-Gaussian Delay Distributions</b> .....	77
	Y. Zhan, A. J. Strojwas, X. Li, L. T. Pileggi ( <i>Carnegie Mellon University</i> ), D. Newmark, M. Sharma ( <i>Advanced Micro Devices, Inc.</i> )	
<b>7.3</b>	<b>Correlation-Preserved Non-Gaussian Statistical Timing Analysis with Quadratic Timing Model</b> .....	83
	L. Zhang, W. Chen, Y. Hu, J. A. Gubner, C. C.-P. Chen ( <i>University of Wisconsin</i> )	
<b>7.4</b>	<b>A General Framework for Accurate Statistical Timing Analysis Considering Correlations</b> .....	89
	V. Khandelwal, A. Srivastava ( <i>University of Maryland, College Park</i> )	

## SESSION 8: Embedded Software

Chair: Rainer Leupers (*RWTH Aachen University*)

Organizer: Lothar Thiele

<b>8.1</b>	<b>Locality-Conscious Workload Assignment for Array-Based Computations in MPSOC Architectures</b> .....	95
	F. Li, M. Kandemir ( <i>The Pennsylvania State University</i> )	
<b>8.2</b>	<b>Automatic Scenario Detection for Improved WCET Estimation</b> .....	101
	S. V. Gheorghita, S. Stuijk, T. Basten, H. Corporaal ( <i>Eindhoven University of Technology</i> )	
<b>8.3</b>	<b>Memory Access Optimization Through Combined Code Scheduling, Memory Allocation, and Array Binding in Embedded System Design</b> .....	105
	J. Kim ( <i>Samsung Electronics Co., Ltd.</i> ), T. Kim ( <i>Seoul National University</i> )	
<b>8.4</b>	<b>Dynamic Slack Reclamation with Procrastination Scheduling in Real-Time Embedded Systems</b> .....	111
	R. Jejurikar ( <i>University of California at Irvine</i> ), R. Gupta ( <i>University of California at San Diego</i> )	

## SESSION 9: Advances in Design-for-Testability Methods

Chair: Tom Williams (*Synopsys, Inc.*)

Organizers: Erik Jan Marinissen, Patrick Girard

<b>9.1</b>	<b>Response Compaction with any Number of Unknowns Using a New LFSR Architecture</b> .....	117
	E. H. Volkerink ( <i>Agilent Laboratories, Intel Corporation</i> ), S. Mitra ( <i>Intel Corporation, Stanford University</i> )	
<b>9.2</b>	<b>Multi-Frequency Wrapper Design and Optimization for Embedded Cores Under Average Power Constraints</b> .....	123
	Q. Xu, N. Nicolici ( <i>McMaster University</i> ), K. Chakrabarty ( <i>Duke University</i> )	
<b>9.3</b>	<b>N-Detection Under Transparent-Scan</b> .....	129
	I. Pomeranz ( <i>Purdue University</i> )	
<b>9.4</b>	<b>Secure Scan: A Design-for-Test Architecture for Crypto Chips</b> .....	135
	B. Yang ( <i>Polytechnic University</i> ), K. Wu ( <i>University of Illinois</i> ), R. Karri ( <i>Polytechnic University</i> )	

## SESSION 10: Advances in Boundary Element Methods for Parasitic Extraction

Chair: J. Eric Bracken (*Ansoft Corp.*)

Organizers: Yehea Ismail, Sachin S. Sapatnekar

<b>10.1</b>	<b>A Green Function-Based Parasitic Extraction Method for Inhomogeneous Substrate Layers</b> .....	141
	C. Xu ( <i>Oregon State University</i> ), R. Gharpurey ( <i>University of Michigan</i> ), T. S. Fiez, K. Mayaram ( <i>Oregon State University</i> )	
<b>10.2</b>	<b>Analysis of Full-Wave Conductor System Impedance over Substrate Using Novel Integration Techniques</b> .....	147
	X. Hu, J. H. Lee, J. White, L. Daniel ( <i>Massachusetts Institute of Technology</i> )	
<b>10.3</b>	<b>Spatially Distributed 3D Circuit Models</b> .....	153
	M. Beattie, H. Zheng, A. Devgan, B. Krauter ( <i>IBM Corporation</i> )	

<b>10.4</b>	<b>DiMES: Multilevel Fast Direct Solver Based on Multipole Expansions for Parasitic Extraction of Massively Coupled 3D Microelectronic Structures</b> .....	159
	D. Gope, I. Chowdhury, V. Jandhyala ( <i>University of Washington</i> )	
<b>10.5</b>	<b>ICCAP: A Linear Time Sparse Transformation and Reordering Algorithm for 3D BEM Capacitance Extraction</b> .....	163
	R. Jiang ( <i>University of Wisconsin</i> ), Y.-H. Chang ( <i>National Taiwan University</i> ), C. C.-P. Chen ( <i>University of Wisconsin</i> )	
<b>100</b>	<b>Management Day Session 100</b>	
	<b>Choosing Flows and Methodologies for SoC Design</b> .....	167
	Chair: Dennis C. Wassung, Jr. ( <i>Adams Harkness, Inc.</i> ) Organizer: Yervant Zorian Speakers: M. Abadir ( <i>Freescale Semiconductor, Inc.</i> ), M. Bapst ( <i>PrairieComm</i> ), C. Harris ( <i>PMC-Sierra</i> )	
	<b>SESSION 11: PANEL: DFM Rules!</b> .....	168
	Chair: Naveed Sherwani ( <i>Open-Silicon</i> ) Organizer: Susan Lippincott Mack Panelists: A. Alexanian ( <i>Ponté Solutions</i> ), P. Buch ( <i>Magma Design Automation</i> ), C. Guardiani ( <i>PDF Solutions</i> ), H. Lehon ( <i>KLA-Tencor</i> ), P. Rabkin ( <i>Xilinx</i> ), A. Sharan ( <i>Clearshape Technologies</i> )	
	<b>SESSION 12: Recent Advances in Signal Integrity</b>	
	Chair: Eli Chiprout ( <i>Intel Corporation</i> ) Organizers: Dusan Petranovic, Lei He	
<b>12.1</b>	<b>Partitioning-Based Approach to Fast On-Chip Decap Budgeting and Minimization</b> .....	170
	H. Li, Z. Qi, S. X.-D. Tan ( <i>University of California at Riverside</i> ), L. Wu ( <i>Cadence Design Systems Inc.</i> ), Y. Cai, X. Hong ( <i>Tsinghua University</i> )	
<b>12.2</b>	<b>Navigating Registers in Placement for Clock Network Minimization</b> .....	176
	Y. Lu ( <i>Tsinghua University</i> ), C. N. Sze ( <i>Texas A&amp;M University</i> ), X. Hong, Q. Zhou, Y. Cai, L. Huang ( <i>Tsinghua University</i> ), J. Hu ( <i>Texas A&amp;M University</i> )	
<b>12.3</b>	<b>Minimizing Peak Current via Opposite-Phase Clock Tree</b> .....	182
	Y.-T. Nieh, S.-H. Huang ( <i>Chung Yuan Christian University</i> ), S.-Y. Hsu ( <i>Industrial Technology Research Institute</i> )	
<b>12.4</b>	<b>A Noise-Driven Effective Capacitance Method With Fast Embedded Noise Rule Calculation for Functional Noise Analysis</b> .....	186
	H. Su, D. Widiger, C. Kashyap, F. Liu, B. Krauter ( <i>IBM Corporation</i> )	
<b>12.5</b>	<b>Constraint-Aware Robustness Insertion for Optimal Noise-Tolerance Enhancement in VLSI Circuits</b> .....	190
	C. Zhao, Y. Zhao, S. Dey ( <i>University of California at San Diego</i> )	
	<b>SESSION 13: Physical Considerations in High-Level Synthesis</b>	
	Chair: Steven M. Burns ( <i>Intel Corporation</i> ) Organizers: Gila Kamhi, Reinaldo Bergamaschi	
<b>13.1</b>	<b>Temperature-Aware Resource Allocation and Binding in High-Level Synthesis</b> .....	196
	R. Mukherjee, S. O. Memik, G. Memik ( <i>Northwestern University</i> )	
<b>13.2</b>	<b>Leakage Power Optimization With Dual-V<sub>th</sub> Library In High-Level Synthesis</b> .....	202
	X. Tang ( <i>Magma Design Automation, Inc.</i> ), H. Zhou ( <i>Northwestern University</i> ), P. Banerjee ( <i>University of Illinois at Chicago</i> )	
<b>13.3</b>	<b>Incremental Exploration of the Combined Physical and Behavioral Design Space</b> .....	208
	Z. Gu, J. Wang, R. P. Dick, H. Zhou ( <i>Northwestern University</i> )	

<b>13.4</b>	<b>Sign Bit Reduction Encoding for Low Power Applications</b> .....	214
	M. Saneci, A. Afzali-Kusha, Z. Navabi ( <i>University of Tehran</i> )	
<b>13.5</b>	<b>A Watermarking System for IP Protection by a Post Layout Incremental Router</b> .....	218
	T. Nie, T. Kisaka, M. Toyonaga ( <i>Kochi University</i> )	
<b>SESSION 14: Architectures for Cryptography and Security Applications</b>		
Chair: Anand Raghunathan ( <i>NEC-Labs America</i> )		
Organizers: Adam Donlin, Peter Marwedel		
<b>14.1</b>	<b>A Side-Channel Leakage Free Coprocessor IC in 0.18 <math>\mu</math>m CMOS for Embedded AES-based Cryptographic and Biometric Processing</b> .....	222
	K. Tiri, D. Hwang, A. Hodjat, B. Lai, S. Yang, P. Schaumont ( <i>University of California at Los Angeles</i> ), I. Verbauwhede ( <i>University of California at Los Angeles, K.U. Leuven</i> )	
<b>14.2</b>	<b>Simulation Models for Side-Channel Information Leaks</b> .....	228
	K. Tiri ( <i>University of California at Los Angeles</i> ), I. Verbauwhede ( <i>University of California at Los Angeles, K.U. Leuven</i> )	
<b>14.3</b>	<b>A Pattern Matching Co-processor for Network Security</b> .....	234
	Y. H. Cho, W. H. Mangione-Smith ( <i>University of California at Los Angeles</i> )	
<b>14.4</b>	<b>High Performance Encryption Cores for 3G Networks</b> .....	240
	T. Balderas-Contreras, R. Cumplido ( <i>Instituto Nacional de Astrofísica, Óptica y Electrónica</i> )	
<b>14.5</b>	<b>Efficient Fingerprint-based User Authentication for Embedded Systems</b> .....	244
	P. Gupta ( <i>Princeton University</i> ), S. Ravi, A. Raghunathan ( <i>NEC Laboratories</i> ), N. K. Jha ( <i>Princeton University</i> )	
<b>SESSION 15: Performance, Energy, and Fault-Tolerance Considerations for MPSoC Designs</b>		
Chair: Gerd Ascheid ( <i>RWTH Aachen University</i> )		
Organizers: Radu Marculescu, Rainer Leupers		
<b>15.1</b>	<b>Approximate VCCs: A New Characterization of Multimedia Workloads for System-level MpSoC Design</b> .....	248
	Y. Liu, S. Chakraborty, W. T. Ooi ( <i>National University of Singapore</i> )	
<b>15.2</b>	<b>Modular Domain-Specific Implementation and Exploration Framework for Embedded Software Platforms</b> .....	254
	C. Sauer, M. Gries, S. Sonntag ( <i>Infineon Technologies</i> )	
<b>15.3</b>	<b>Simulation Based Deadlock Analysis for System Level Designs</b> .....	260
	X. Chen ( <i>University of California at Riverside</i> ), A. Davare ( <i>University of California at Berkeley</i> ), H. Hsieh ( <i>University of California at Riverside</i> ), A. Sangiovanni-Vincentelli ( <i>University of California at Berkeley</i> ), Y. Watanabe ( <i>Cadence Berkeley Laboratories</i> )	
<b>15.4</b>	<b>Fault and Energy-Aware Communication Mapping with Guaranteed Latency for Applications Implemented on NoC</b> .....	266
	S. Manolache, P. Eles, Z. Peng ( <i>Linköping University</i> )	
<b>15.5</b>	<b>High Performance Computing on Fault-Prone Nanotechnologies: Novel Microarchitecture Techniques Exploiting Reliability-Delay Trade-offs</b> .....	270
	A. V. Zykov, E. Mizan, M. F. Jacome, G. de Veciana, A. Subramanian ( <i>The University of Texas at Austin</i> )	
<b>150</b>	<b>Management Day Session 150</b>	
	<b>How to Determine the Necessity for Emerging Solutions</b> .....	274
	Chair: Nic Mokhoff ( <i>EE Times</i> )	
	Organizer: Yervant Zorian	
	Speakers: K. N. Ruparel ( <i>Cisco Systems, Inc.</i> ), F. Pessolano ( <i>Philips Semiconductors</i> ), H. Nham ( <i>eSilicon Corporation</i> ), K. S. Kim ( <i>Intel Corporation</i> )	

<b>SESSION 16: Special Session: Closing the Power Gap Between ASIC and Custom</b>	
Chair: Barry Pangrle ( <i>Synopsys, Inc.</i> )	
Organizer: Dennis Sylvester	
<b>16.1</b>	<b>Closing the Power Gap between ASIC and Custom: An ASIC Perspective</b> .....275 D. G. Chinnery, K. Keutzer ( <i>University of California at Berkeley</i> )
<b>16.2</b>	<b>Explaining the Gap Between ASIC and Custom Power: A Custom Perspective</b> .....281 A. Chang ( <i>Cadence Design Systems, Inc.</i> ), W. J. Dally ( <i>Stanford University</i> )
<b>16.3</b>	<b>Keeping Hot Chips Cool</b> .....285 R. Puri ( <i>IBM T.J. Watson Research Center</i> ), L. Stok ( <i>IBM</i> ), S. Bhattacharya ( <i>IBM T.J. Watson Research Center</i> )
<b>SESSION 17: PANEL: Interconnects are Moving from MHz-&gt;GHz Should you be Afraid? Or... “My Giga Hertz, Does Yours?”</b> .....289	
Chair: Rick Merritt ( <i>EE Times</i> )	
Organizers: Navraj Nandra, Phil Dworsky	
Panelists: J. F. D’Ambrosia ( <i>Tyco Electronics Corp.</i> ), A. Healey ( <i>Agere Systems, Inc.</i> ), B. Litinsky ( <i>RF Micro Devices, Inc.</i> ), J. Stonick ( <i>Synopsys, Inc.</i> ), J. Abler ( <i>IBM Corporation</i> )	
<b>SESSION 18: Wireless Session: Information Design Methodology</b>	
Chair: Ingrid Verbauwhede ( <i>University of California</i> )	
Organizer: Ingrid Verbauwhede	
<b>18.1</b>	<b>Design Methodology for Wireless Nodes with Printed Antennas</b> .....291 J.-S. Chenard, C. Y. Chu, Ž. Žilić, M. Popovic ( <i>McGill University</i> )
<b>18.2</b>	<b>MP Core: Algorithm and Design Techniques for Efficient Channel Estimation in Wireless Applications</b> .....297 Y. Meng, T. Sherwood, A. P. Brown, H. Lee, R. A. Iitis, R. Kastner ( <i>University of California at Santa Barbara</i> )
<b>18.3</b>	<b>From <i>Myth</i> to Methodology: Cross-Layer Design for Energy-Efficient Wireless Communication</b> .....303 W. Eberle, B. Bougard, S. Pollin, F. Catthoor ( <i>IMEC</i> )
<b>SESSION 19: Statistical Optimization and Manufacturability</b>	
Chair: Chandramouli Kashyap ( <i>IBM Corporation</i> )	
Organizers: Sani Nassif, Vivek De	
<b>19.1</b>	<b>An Efficient Algorithm for Statistical Minimization of Total Power under Timing Yield Constraints</b> .....309 M. Mani ( <i>University of Texas at Austin</i> ), A. Devgan ( <i>Magma Design Automation</i> ), M. Orshansky ( <i>University of Texas at Austin</i> )
<b>19.2</b>	<b>Robust Gate Sizing by Geometric Programming</b> .....315 J. Singh, V. Nookala, Z.-Q. Luo, S. Sapatnekar ( <i>University of Minnesota</i> )
<b>19.3</b>	<b>Circuit Optimization using Statistical Static Timing Analysis</b> .....321 A. Agarwal, K. Chopra, D. Blaauw ( <i>University of Michigan</i> ), V. Zolotov ( <i>IBM T.J. Watson Research Center</i> )
<b>19.4</b>	<b>An Exact Jumper Insertion Algorithm for Antenna Effect Avoidance/Fixing</b> .....325 B.-Y. Su, Y.-W. Chang ( <i>National Taiwan University</i> )
<b>SESSION 20: Application Specific Architecture Design Tools</b>	
Chair: Nikil Dutt ( <i>University of California</i> )	
Organizers: Joachim Gerlach, Margarida Jacome	
<b>20.1</b>	<b>Fine-grained Application Source Code Profiling for ASIP Design</b> .....329 K. Karuri, M. A. Al Faruque, S. Kraemer, R. Leupers, G. Ascheid, H. Meyr ( <i>RWTH Aachen</i> )
<b>20.2</b>	<b>Physically-Aware HW-SW Partitioning for Reconfigurable Architectures with Partial Dynamic Reconfiguration</b> .....335 S. Banerjee, E. Bozorgzadeh, N. Dutt ( <i>University of California at Irvine</i> )

<b>20.3</b>	<b>Performance Simulation Modeling for Fast Evaluation of Pipelined Scalar Processor by Evaluation Reuse</b> .....	341
	H. Y. Kim, T. G. Kim ( <i>KAIST</i> )	
<b>20.4</b>	<b>Trace-Driven HW/SW Cosimulation Using Virtual Synchronization Technique</b> .....	345
	D. Kim, Y. Yi, S. Ha ( <i>Seoul National University</i> )	
<b>SESSION 21: Special Session — The Titanic: What Went Wrong</b> .....		349
	Chair: Andrew B. Kahng ( <i>University of California</i> )	
	Organizer: Sani Nassif ( <i>IBM Research</i> )	
	<b>Metal Variation-Induced Hold Time Failures</b> , P. S. Zuchowski ( <i>IBM</i> )	
	<b>Design for Reliability: acknowledging aging effects</b>	
	C. Moughanni, M. Moosa, G. Anderson ( <i>Freescale</i> )	
	<b>Bridging the Power Reduction &amp; Estimation Gap in the Cell Processor Design Methodology</b> , S. D. Posluszny ( <i>IBM</i> )	
	<b>A Series of Unfortunate Events</b> , W. Vercruysse ( <i>AMD</i> )	
<b>SESSION 22: PANEL: Wireless Platforms: GOPS for Cents and MilliWatts</b> .....		351
	Chair: Jan Rabaey ( <i>University of California at Berkeley</i> )	
	Organizers: Francine Bacchini	
	Panelists: A. Cox ( <i>3Plus1 Technology, Inc.</i> ),	
	F. Lane ( <i>Flarion Technologies, Inc.</i> ), R. Lauwereins ( <i>IMEC</i> ),	
	U. Ramacher ( <i>Infineon Technologies AG</i> ), D. Witt ( <i>Texas Instruments</i> )	
<b>SESSION 23: Design Methods for Manufacturability Enhancements</b>		
	Chair: Nagib Z. Hakim ( <i>Intel Corp.</i> )	
	Organizers: David Blaauw, Michael Orshansky	
<b>23.1</b>	<b>Design Methodology for IC Manufacturability Based on Regular Logic-Bricks</b> .....	353
	V. Kheterpal, V. Rovner, T. G. Hersan, D. Motiani, Y. Takegawa, A. J. Strojwas, L. Pileggi ( <i>Carnegie Mellon University</i> ),	
<b>23.2</b>	<b>Advanced Timing Analysis Based on Post-OPC Extraction of Critical Dimensions</b> .....	359
	J. Yang ( <i>Advanced Micro Devices, University of Michigan</i> ), L. Capodiecici ( <i>Advanced Micro Devices</i> ), D. Sylvester ( <i>University of Michigan</i> )	
<b>23.3</b>	<b>Self-Compensating Design for Focus Variation</b> .....	365
	P. Gupta, A. B. Kahng ( <i>Blaze DFM Inc.</i> ), Y. Kim, D. Sylvester ( <i>University of Michigan at Ann Arbor</i> )	
<b>23.4</b>	<b>RADAR: RET-Aware Detailed Routing Using Fast Lithography Simulations</b> .....	369
	J. Mitra, P. Yu, D. Z. Pan ( <i>University of Texas at Austin</i> )	
<b>SESSION 24: Methods and Representations for Logic Synthesis</b>		
	Chair: Iris Bahar ( <i>Brown University</i> )	
	Organizers: James Hoe, Marek Perkowski	
<b>24.1</b>	<b>BDD Representation for Incompletely Specified Multiple-Output Logic Functions and Its Applications to Functional Decomposition</b> .....	373
	T. Sasao, M. Matsuura ( <i>Kyushu Institute of Technology</i> )	
<b>24.2</b>	<b>A New Canonical Form for Fast Boolean Matching in Logic Synthesis and Verification</b> .....	379
	A. Abdollahi, M. Pedram ( <i>University of Southern California</i> )	
<b>24.3</b>	<b>Effective Bounding Techniques for Solving Unate and Binate Covering Problems</b> .....	385
	X. Y. Li ( <i>Amazon</i> ), M. F. Stallmann, F. Brglez ( <i>North Carolina State University</i> )	

## SESSION 25: Generating Efficient Models for Analog Circuits

Chair: Richard Shi (*University of Washington*)

Organizers: Koen Lampaert, Sandeep Shukla

- 25.1 Operator-based Model-Order Reduction of Linear Periodically Time-Varying Systems** ..... 391  
Y. Wan, J. Roychowdhury (*University of Minnesota*)
- 25.2 Simulation of the Effects of Timing Jitter in Track-and-Hold and Sample-and-Hold Circuits** ..... 397  
V. Vasudevan (*Indian Institute of Technology-Madras*)
- 25.3 Scalable Trajectory Methods for On-Demand Analog Macromodel Extraction** ..... 403  
S. K. Tiwary, R. A. Rutenbar (*Carnegie Mellon University*)

## SESSION 26: Special Session: Emerging Directions in Wireless

Chair: Anantha Chandrakasan (*Massachusetts Institute of Technology*)

Organizers: Anantha Chandrakasan, Jan Rabaey

- 26.1 Cognitive Radio Techniques for Wide Area Networks** ..... 409  
W. Krenik, A. Batra (*Texas Instruments Incorporated*)
- 26.2 MIMO Technology for Advanced Wireless Local Area Networks** ..... 413  
J. M. Gilbert, W.-J. Choi, Q. Sun (*Atheros Communications, Inc.*)
- 26.4 RF MEMS in Wireless Architectures** ..... 416  
C. T.-C. Nguyen (*DARPA/MTO*)

## SESSION 27: CAD for FPGAs

Chair: Steve Trimberger (*Xilinx, Inc.*)

Organizers: Patrick Lysaght, Steven Teig

- 27.1 Multiplexer Restructuring for FPGA Implementation Cost Reduction** ..... 421  
P. Metzgen, D. Nancekievill (*Altera European Technology Center*)
- 27.2 FPGA Technology Mapping: A Study of Optimality** ..... 427  
A. Ling (*University of Toronto*), D. P. Singh, S. D. Brown (*Altera Corporation Toronto*)
- 27.3 Incremental Retiming for FPGA Physical Synthesis** ..... 433  
D. P. Singh, V. Manohararajah, S. D. Brown (*Altera Corporation Toronto*)
- 27.4 Architecture-Adaptive Range Limit Windowing for Simulated Annealing FPGA Placement** ..... 439  
K. Eguro, S. Hauck, A. Sharma (*University of Washington*)

## SESSION 28: Effective Formal Verification Using Word-level Reasoning, Bit-level Generality, and Parallelism

Chair: Howard Wong-Toi (*Jasper Design Automation, Inc.*)

Organizers: Adnan Aziz, Pei-Hsin Ho

- 28.1 Word Level Predicate Abstraction and Refinement for Verifying RTL Verilog** ..... 445  
H. Jain (*Carnegie Mellon University*), D. Kroening (*ETH Zürich*),  
N. Sharygina, E. Clarke (*Carnegie Mellon University*)
- 28.2 Structural Search for RTL with Predicate Learning** ..... 451  
G. Parthasarathy, M. K. Iyer, K.-T. Cheng, F. Brewer (*University of California at Santa Barbara*)
- 28.3 Normalization at the Arithmetic Bit Level** ..... 457  
M. Wedler, D. Stoffel, W. Kunz (*University of Kaiserslautern*)
- 28.4 Exploiting Suspected Redundancy without Proving It** ..... 463  
H. Mony, J. Baumgartner, V. Paruthi (*IBM Systems Group*),  
R. Kanzelman (*IBM Engineering & Technology Services*)
- 28.5 Multi-threaded Reachability** ..... 467  
D. Sahoo (*Stanford University*), J. Jain (*Fujitsu Labs. of America*), S. K. Iyer (*University of Texas at Austin*),  
D. L. Dill (*Stanford University*), E. A. Emerson (*University of Texas at Austin*)

## SESSION 29: Advances in Synthesis

Chair: David S. Kung (*IBM Corporation*)

Organizers: Leon Stok, Soha Hassoun

- 29.1 Automatic Generation of Customized Discrete Fourier Transform IPs** ..... 471  
G. Nordin, P. A. Milder, J. C. Hoe, M. Püschel (*Carnegie Mellon University*)
- 29.2 Race-Condition-Aware Clock Skew Scheduling** ..... 475  
S.-H. Huang, Y.-T. Nieh, F.-P. Lu (*Chung Yuan Christian University*)
- 29.3 A Novel Synthesis Approach for Active Leakage Power Reduction Using Dynamic Supply Gating** ..... 479  
S. Bhunia, N. Banerjee, Q. Chen, H. Mahmoodi, K. Roy (*Purdue University*)
- 29.4 Designing Logic Circuits for Probabilistic Computation in the Presence of Noise** ..... 485  
K. Nepal, R. I. Bahar, J. Mundy, W. R. Patterson, A. Zaslavsky (*Brown University*)
- 29.5 A Lattice-Based Framework for the Classification and Design of Asynchronous Pipelines** ..... 491  
P. B. McGee, S. M. Nowick (*Columbia University*)

## SESSION 30: Coping with Buffering

Chair: Dinesh Gaitonde (*Synopsys, Inc.*)

Organizers: Dirk Stroobandt, Igor Markov

- 30.1 Power Optimal Dual-V<sub>dd</sub> Buffered Tree Considering Buffer Stations and Blockages** ..... 497  
K. H. Tam, L. He (*University of California at Los Angeles*)
- 30.2 Net Weighting to Reduce Repeater Counts during Placement** ..... 503  
B. Goplen (*University of Minnesota*), P. Saxena (*Synopsys, Inc.*),  
S. Sapatnekar (*University of Minnesota*)
- 30.3 Path Based Buffer Insertion** ..... 509  
C. N. Sze (*Texas A&M University*), C. J. Alpert (*IBM Corporation*),  
J. Hu, W. Shi (*Texas A&M University*)
- 30.4 Diffusion-Based Placement Migration** ..... 515  
H. Ren (*IBM Corporation & University of Texas at Austin*),  
D. Z. Pan (*University of Texas at Austin*), C. J. Alpert, P. Villarrubia (*IBM Corporation*)

## SESSION 31: PANEL: Is Methodology the Highway Out of Verification Hell? ..... 521

Chair: Gabe Moretti (*EDA Consultant & Editor*)

Organizer: Francine Bacchini

Panelists: H. Foster (*Jasper Design Automation*),

J. Bergeron (*Synopsys, Inc.*), M. Nakamura (*Sony Corporation*),

S. Mehta (*Sun Microsystems*), L. Ducouso (*ST Microelectronics*)

## SESSION 32: Impact of Process Variations on Power

Chair: Sunil Khatri (*Texas A&M University*)

Organizers: Naehyuck Chang, Chaitali Chakrabarti

- 32.1 Full-Chip Analysis of Leakage Power Under Process Variations, Including Spatial Correlations** ..... 523  
H. Chang, S. S. Sapatnekar (*University of Minnesota*)
- 32.2 Variations-Aware Low-Power Design with Voltage Scaling** ..... 529  
N. Azizi (*University of Toronto*), M. M. Khellah, V. De (*Intel Laboratories*),  
F. N. Najm (*University of Toronto*)
- 32.3 Accurate and Efficient Gate-Level Parametric Yield Estimation Considering Correlated Variations in Leakage Power and Performance** ..... 535  
A. Srivastava, S. Shah, K. Agarwal, D. Sylvester, D. Blaauw, S. Director (*University of Michigan*)
- 32.4 Leakage Minimization of Nano-Scale Circuits in the Presence of Systematic and Random Variations** ..... 541  
S. Bhardwaj, S. B. K. Vrudhula (*Arizona State University*)

## SESSION 33: Special Session: The Best of Wireless at ISSCC

Chair: Wanda Gass (*Texas Instruments, Inc.*)

Organizer: Wanda Gass

- 33.1 A 135Mbps DVB-S2 Compliant Codec Based on 64800-bit LDPC and BCH Codes (ISSCC Paper 24.3)** ..... 547  
P. Urard, L. Paumier, P. Georgelin, T. Michel, V. Lebars, E. Yeo (*STMicroelectronics*),  
B. Gupta (*W5Networks*)
- 33.3 A Design Platform for 90-nm Leakage Reduction Techniques** ..... 549  
P. Royannez, H. Mair, F. Dahan, M. Wagner, M. Streeter, L. Bouetel, J. Blasquez,  
H. Clasen, G. Semino, J. Dong, D. Scott, B. Pitts, C. Raibaut, U. Ko (*Texas Instruments, Inc.*)
- 33.4 A 24 GHz Phased-Array Transmitter in 0.18  $\mu$ m CMOS** ..... 551  
A. Natarajan, A. Komijani, A. Hajimiri (*California Institute of Technology*)

## SESSION 34: Architectural Support for Communication

Chair: Petru Eles (*Linkoping University*)

Organizers: Marcello Coppola, Peter Marwedel

- 34.1 Cache Coherence Support for Non-Shared Bus Architecture on Heterogeneous MPSoCs** ..... 553  
T. Suh (*Georgia Institute of Technology*), D. Kim (*Intel Corporation*),  
H.-H. S. Lee (*Georgia Institute of Technology*)
- 34.2 A Low Latency Router Supporting Adaptivity for On-Chip Interconnects** ..... 559  
J. Kim, D. Park, T. Theocharides, N. Vijaykrishnan, C. R. Das (*The Pennsylvania State University*)
- 34.3 Floorplan-Aware Automated Synthesis of Bus-based Communication Architectures** ..... 565  
S. Pasricha, N. Dutt, E. Bozorgzadeh (*University of California at Irvine*),  
M. Ben-Romdhane (*Conexant Systems Inc.*)
- 34.4 FLEXBUS: A High-Performance System-on-Chip Communication Architecture with a Dynamically Configurable Topology** ..... 571  
K. Sekar (*University of California at San Diego*), K. Lahiri, A. Raghunathan (*NEC Laboratories*),  
S. Dey (*University of California at San Diego*)
- 34.5 Traffic Shaping for an FPGA Based SDRAM Controller with Complex QoS Requirements** ..... 575  
S. Heithecker, R. Ernst (*Technical University of Braunschweig*)

## SESSION 35: New Approaches to Physical Design Problems

Chair: Chung-Kuan Cheng (*University of California*)

Organizers: Louis Scheffer, Malgorzata Marek-Sadowska

- 35.1 Microarchitecture-Aware Floorplanning Using a Statistical Design of Experiments Approach** ..... 579  
V. Nookala, Y. Chen, D. J. Lilja, S. S. Sapatnekar (*University of Minnesota*)
- 35.2 Timing-Driven Placement by Grid-Warping** ..... 585  
Z. Xiu, R. A. Rutenbar (*Carnegie Mellon University*)
- 35.3 Faster and Better Global Placement by a New Transportation Algorithm** ..... 591  
U. Brenner, M. Struzyna (*University of Bonn*)
- 35.4 Multilevel Full-Chip Routing for the X-Based Architecture** ..... 597  
T.-Y. Ho, C.-F. Chang, Y.-W. Chang, S.-J. Chen (*National Taiwan University*)

<b>SESSION 36: Special Session: MATLAB™ — The Other Emerging System-Design Language</b>	
Chair: Randy Allen ( <i>Catalytic, Inc.</i> )	
Organizer: Steven Tjiang	
<b>36.2</b>	<b>Matlab Extensions for the Development, Testing and Verification of Real-Time DSP Software</b> ..... 603
	D. P. Magee ( <i>Texas Instruments, Inc.</i> )
<b>36.3</b>	<b>Matlab as a Development Environment for FPGA Design</b> ..... 607
	T. M. Bhatt, D. McCain ( <i>Nokia Research Center</i> )
<b>SESSION 37: PANEL: Should Our Power Approach Be Current?</b> ..... 611	
Chair: Tim Fox ( <i>Deutsche Bank Equity Research</i> )	
Organizers: Lou Covey, Susan Lippincott Mack	
Panelists: D. Heacock ( <i>Texas Instruments, Inc.</i> ), A. Kornfeld ( <i>Intel Corporation</i> ),	
E. Huijbregts ( <i>Magma Design Automation, Inc.</i> ), A. Yang ( <i>Apache Design Solutions, Inc.</i> ),	
V. Johnson ( <i>Nascentric, Inc.</i> ), P. Zuchowski ( <i>IBM Corporation</i> )	
<b>SESSION 38: Emerging Ideas in Energy Management Techniques</b>	
Chair: Rajesh Gupta ( <i>University of California</i> )	
Organizers: Diana Marculescu, Taewhan Kim	
<b>38.1</b>	<b>DTM: Dynamic Tone Mapping for Backlight Scaling</b> ..... 612
	A. Iranli, M. Pedram ( <i>University of Southern California</i> )
<b>38.2</b>	<b>Application/Architecture Power Co-Optimization for Embedded Systems Powered by Renewable Sources</b> ..... 618
	D. Li, P. H. Chou ( <i>University of California at Irvine</i> )
<b>38.3</b>	<b>User-perceived Latency Driven Voltage Scaling for Interactive Applications</b> ..... 624
	L. Yan, L. Zhong, N. K. Jha ( <i>Princeton University</i> )
<b>38.4</b>	<b>System-Level Energy-Efficient Dynamic Task Scheduling</b> ..... 628
	J. Zhuo, C. Chakrabarti ( <i>Arizona State University</i> )
<b>SESSION 39: Advances in Optimization of Mixed-signal Circuits</b>	
Chair: Koen Lampaert ( <i>Mindspeed Technologies, Inc.</i> )	
Organizers: Geert Van Der Plas, Sandeep Shukla	
<b>39.1</b>	<b>OPERA: Optimization with Ellipsoidal Uncertainty for Robust Analog IC Design</b> ..... 632
	Y. Xu ( <i>Carnegie Mellon University</i> ), K.-L. Hsiung ( <i>Stanford University</i> ),
	X. Li ( <i>Carnegie Mellon University</i> ), I. Nausieda ( <i>Harvard University</i> ),
	S. Boyd ( <i>Stanford University</i> ), L. Pileggi ( <i>Carnegie Mellon University</i> )
<b>39.2</b>	<b>A Unified Optimization Framework for Equalization Filter Synthesis</b> ..... 638
	J. Ren, M. Greenstreet ( <i>University of British Columbia</i> )
<b>39.3</b>	<b>Template-Driven Parasitic-Aware Optimization of Analog Integrated Circuit Layouts</b> ..... 644
	S. Bhattacharya, N. Jangkrajarn, C.-J. R. Shi ( <i>University of Washington</i> )
<b>39.4</b>	<b>Multi-level Approach for Integrated Spiral Inductor Optimization</b> ..... 648
	A. Nieuwoudt, Y. Massoud ( <i>Rice University</i> )
<b>SESSION 40: Circuit Performance Under Parameter Variation</b>	
Chair: L. Miguel Silveira ( <i>INESC-ID/IST/Cadence Labs.</i> )	
Organizers: Charlie Chung-Ping Chen, Joel Phillips	
<b>40.1</b>	<b>Statistical Static Timing Analysis: How simple can we get?</b> ..... 652
	C. S. Amin ( <i>Northwestern University</i> ),
	N. Menezes, K. Killpack, F. Dartu, U. Choudhury, N. Hakim ( <i>Intel Corporation</i> ),
	Y. I. Ismail ( <i>Northwestern University</i> )

<b>40.2</b>	<b>Mapping Statistical Process Variations Toward Circuit Performance Variability: An Analytical Modeling Approach</b> .....	658
	<i>Y. Cao, L. T. Clark (Arizona State University)</i>	
<b>40.3</b>	<b>Power Grid Simulation Via Efficient Sampling-Based Sensitivity Analysis and Hierarchical Symbolic Relaxation</b> .....	664
	<i>P. Li (Texas A&amp;M University)</i>	
 <b>SESSION 41: Special Session: Formally Verifying Your 10-Million Gate Design</b>		
	<i>Chair: Robert Damiano (Synopsys, Inc.)</i>	
	<i>Organizer: Pei-Hsin Ho</i>	
<b>41.1</b>	<b>Formal Verification – Is It Real Enough?</b> .....	670
	<i>Y. Wolfsthal (IBM Haifa Research Laboratory), R. M. Gott (IBM Systems and Technology Group)</i>	
<b>41.2</b>	<b>Can We Really Do Without the Support of Formal Methods in the Verification of Large Designs?</b> .....	672
	<i>U. Rossi (STMicroelectronics)</i>	
<b>41.3</b>	<b>Streamline Verification Process with Formal Property Verification to Meet Highly Compressed Design Cycle</b> .....	674
	<i>P. Chatterjee (NVIDIA Corporation)</i>	
 <b>SESSION 42: Embedded Hardware and System Software</b>		
	<i>Chair: Eugenio Villar (Universidad de Cantabria)</i>	
	<i>Organizers: Chi-Ying Tsui, Pai Chou</i>	
<b>42.1</b>	<b>TCAM Enabled On-Chip Logic Minimization</b> .....	678
	<i>S. Ahmad, R. Mahapatra (Texas A&amp;M University)</i>	
<b>42.2</b>	<b>Hardware Speech Recognition for User Interfaces in Low Cost, Low Power Devices</b> .....	684
	<i>S. Nedeveschi, R. K. Patra, E. A. Brewer (University of California at Berkeley)</i>	
<b>42.3</b>	<b>Improving Java Virtual Machine Reliability for Memory-Constrained Embedded Systems</b> .....	690
	<i>G. Chen, M. Kandemir (The Pennsylvania State University)</i>	
<b>42.4</b>	<b>Frequency-Based Code Placement for Embedded Multiprocessors</b> .....	696
	<i>C. Goldfeder (Columbia University)</i>	
 <b>SESSION 43: Power Estimation and Design Tradeoffs</b>		
	<i>Chair: Kimiyoshi Usami (Shibura Institute of Technology)</i>	
	<i>Organizers: Jerry Frenkil, Amitava Majumdar</i>	
<b>43.1</b>	<b>Power Emulation: A New Paradigm for Power Estimation</b> .....	700
	<i>J. Coburn, S. Ravi, A. Raghunathan (NEC Laboratories)</i>	
<b>43.2</b>	<b>Implementing Low-Power Configurable Processors — Practical Options and Tradeoffs</b> .....	706
	<i>J. Wei, C. Rowen (Tensilica, Inc.)</i>	
<b>43.3</b>	<b>Low Power Network Processor Design Using Clock Gating</b> .....	712
	<i>Y. Luo, J. Yu, J. Yang, L. Bhuyan (University of California at Riverside)</i>	
<b>43.4</b>	<b>A Variation-tolerant Sub-threshold Design Approach</b> .....	716
	<i>N. Jayakumar, S. P. Khatri (Texas A&amp;M University)</i>	
 <b>SESSION 44: Programmable Architectures</b>		
	<i>Chair: Pedro Diniz (USC Information Sciences Institute)</i>	
	<i>Organizers: Ryan Kastner, Steven Teig</i>	
<b>44.1</b>	<b>Leakage Efficient Chip-Level Dual-Vdd Assignment with Time Slack Allocation for FPGA Power Reduction</b> .....	720
	<i>Y. Lin, L. He (University of California at Los Angeles)</i>	

<b>44.2</b>	<b>Logic Block Clustering of Large Designs for Channel-Width Constrained FPGAs</b> .....	726
	M. Tom, G. Lemieux ( <i>University of British Columbia</i> )	
<b>44.3</b>	<b>Dynamic Reconfiguration with Binary Translation: Breaking the ILP Barrier with Software Compatibility</b> .....	732
	A. C. S. Beck, L. Carro ( <i>Universidade Federal do Rio Grande do Sul</i> )	
<b>SESSION 45: SAT: Cool Algorithms and Hot Applications</b>		
	Chair: Carl Pixley ( <i>Synopsys, Inc.</i> )	
	Organizers: Harry Foster, Rajeev Ranjan	
<b>45.1</b>	<b>Beyond Safety: Customized SAT-based Model Checking</b> .....	738
	M. K. Ganai, A. Gupta, P. Ashar ( <i>NEC Laboratories</i> )	
<b>45.2</b>	<b>Efficient SAT Solving: Beyond Supercubes</b> .....	744
	D. Babić, J. Bingham, A. J. Hu ( <i>University of British Columbia</i> )	
<b>45.3</b>	<b>Prime Clauses for Fast Enumeration of Satisfying Assignments to Boolean Circuits</b> .....	750
	HS. Jin, F. Somenzi ( <i>University of Colorado at Boulder</i> )	
<b>45.4</b>	<b>Dynamic Abstraction Using SAT-based BMC</b> .....	754
	L. Zhang ( <i>Cadence Design Systems</i> ), M. R. Prasad ( <i>Fujitsu Laboratories of America</i> ), M. S. Hsiao ( <i>Virginia Polytechnic Institute &amp; State University</i> ), T. Sidle ( <i>Fujitsu Laboratories of America</i> )	
<b>SESSION 46: Special Session: DFM and Variability: Theory and Practice</b>		
	Chair: Chandu Visweswariah ( <i>IBM Corporation</i> )	
	Organizers: Michael Orshansky, Tanay Karnik	
<b>46.1</b>	<b>BEOL Variability and Impact on RC Extraction</b> .....	758
	N. NS, T. Bonifield, A. Singh, C. Bittlestone, U. Narasimha, V. Le, A. Hill ( <i>Texas Instruments Inc.</i> )	
<b>46.2</b>	<b>An Effective DFM Strategy Requires Accurate Process and IP Pre-Characterization</b> .....	760
	C. Guardiani, M. Bertoletti, N. Dragone, M. Malcotti, P. McNamara ( <i>PDF Solutions</i> )	
<b>46.3</b>	<b>Variation-Tolerant Circuits: Circuit Solutions and Techniques</b> .....	762
	J. Tschanz, K. Bowman, V. De ( <i>Intel Corporation</i> )	
<b>46.4</b>	<b>On the Need for Statistical Timing Analysis</b> .....	764
	F. N. Najm ( <i>University of Toronto</i> )	
<b>46.5</b>	<b>CAD Tools for Variation Tolerance</b> .....	766
	D. Blaauw, K. Chopra ( <i>University of Michigan</i> )	
<b>46.6</b>	<b>Are There Economics Benefits in DFM?</b> .....	767
	M. Nowak ( <i>Qualcomm Inc.</i> ), R. Radojcic ( <i>Consultant</i> )	
<b>SESSION 47: Tools and Methods for the Verification of Processors and Processor-Based Systems</b>		
	Chair: Raghuram Tupuri ( <i>AMD</i> )	
	Organizers: Avi Ziv, Erich Marschner	
<b>47.1</b>	<b>A Generic Micro-Architectural Test Plan Approach for Microprocessor Verification</b> .....	769
	A. Adir, H. Azatchi, E. Bin, O. Peled, K. Shoikhet ( <i>IBM Haifa Labs</i> )	
<b>47.2</b>	<b>IODINE: A Tool to Automatically Infer Dynamic Invariants for Hardware Designs</b> ....	775
	S. Hangal, N. Chandra ( <i>Sun Microsystems</i> ), S. Narayanan ( <i>P.A. Semi Inc.</i> ), S. Chakravorty ( <i>Sun Microsystems</i> )	
<b>47.3</b>	<b>VLIW – A Case Study of Parallelism Verification</b> .....	779
	A. Adir, Y. Arbetman, B. Dubrov, Y. Lichtenstein, M. Rimon, M. Vinov ( <i>IBM Research Laboratory</i> ), M. A. Calligaro, A. Cofler, G. Duffy ( <i>ST Microelectronics Design Center</i> )	

<b>47.4</b>	<b>StressTest: An Automatic Approach to Test Generation Via Activity Monitors</b> .....	783
	I. Wagner, V. Bertacco, T. Austin ( <i>The University of Michigan</i> )	
<b>47.5</b>	<b>Smart Diagnostics for Configurable Processor Verification</b> .....	789
	S. Ezer, S. Johnson ( <i>Tensilica Inc.</i> )	
<b>SESSION 48: Electrical Optimization for Physical Synthesis</b>		
Chair: Gi-Joon Nam ( <i>IBM Corporation</i> )		
Organizers: Patrick Groeneveld, Phiroze Parakh		
<b>48.1</b>	<b>Power-Aware Placement</b> .....	795
	Y. Cheon, P.-H. Ho ( <i>Synopsys, Inc.</i> ), A. B. Kahng, S. Reda, Q. Wang ( <i>University of California at San Diego</i> )	
<b>48.2</b>	<b>How Accurately Can We Model Timing in a Placement Engine?</b> .....	801
	A. Chowdhary, K. Rajagopal, S. Venkatesan, T. Cao, V. Tiourin ( <i>Intel Corporation</i> ), Y. Parasuram ( <i>Sierra Design Automation</i> ), B. Halpin ( <i>Synplicity, Inc.</i> )	
<b>48.3</b>	<b>Efficient and Accurate Gate Sizing with Piecewise Convex Delay Models</b> .....	807
	H. Tennakoon, C. Sechen ( <i>University of Washington</i> )	
<b>48.4</b>	<b>Freeze: Engineering a Fast Repeater Insertion Solver for Power Minimization Using the Ellipsoid Method</b> .....	813
	Y. Peng, X. Liu ( <i>North Carolina State University</i> )	
<b>SESSION 49: Optimization Techniques in High-Level Synthesis</b>		
Chair: Matt Moe ( <i>Forte Design Systems</i> )		
Organizers: John Sanguinetti, Stephen Edwards		
<b>49.1</b>	<b>Minimising Buffer Requirements of Synchronous Dataflow Graphs with Model Checking</b> .....	819
	M. Geilen, T. Basten, S. Stuijk ( <i>Eindhoven University of Technology</i> )	
<b>49.2</b>	<b>Unified High-Level Synthesis and Module Placement for Defect-Tolerant Microfluidic Biochips</b> .....	825
	F. Su, K. Chakrabarty ( <i>Duke University</i> )	
<b>49.3</b>	<b>Towards Scalable Flow and Context Sensitive Pointer Analysis</b> .....	831
	J. Zhu ( <i>University of Toronto</i> )	
<b>49.4</b>	<b>MiniBit: Bit-Width Optimization via Affine Arithmetic</b> .....	837
	D.-U. Lee, A. A. Gaffar, O. Mencer, W. Luk ( <i>Imperial College</i> )	
<b>49.5</b>	<b>A Non-Parametric Approach for Dynamic Range Estimation of Nonlinear Systems</b> .....	841
	B. Wu, J. Zhu, F. N. Najm ( <i>University of Toronto</i> )	
<b>SESSION 50: Testing for Process- and Timing-Related Faults</b>		
Chair: Nicola Nicolici ( <i>McMaster University</i> )		
Organizers: Gordon Roberts, Kazumi Hatayama		
<b>50.1</b>	<b>Path Delay Test Compaction with Process Variation Tolerance</b> .....	845
	S. Kajihara, M. Fukunaga, X. Wen ( <i>Kyushu Institute of Technology</i> ), T. Maeda, S. Hamada, Y. Sato ( <i>Semiconductor Technology Academic Research Center</i> )	
<b>50.2</b>	<b>A DFT Approach for Diagnosis and Process Variation-Aware Structural Test of Thermometer Coded Current Steering DACs</b> .....	851
	R. O. Topaloglu, A. Orailoglu ( <i>University of California at San Diego</i> )	
<b>50.3</b>	<b>Resistive-Open Defect Injection in SRAM Core-Cell: Analysis and Comparison between 0.13 <math>\mu\text{m}</math> and 90 nm Technologies</b> .....	857
	L. Dilillo, P. Girard, S. Pravossoudovitch, A. Virazel ( <i>Université de Montpellier II / CNRS</i> ) M. Bastian ( <i>Infineon Technologies France</i> )	
<b>50.4</b>	<b>Asynchronous Circuits Transient Faults Sensitivity Evaluation</b> .....	863
	Y. Monnet, M. Renaudin, R. Leveugle ( <i>TIMA Laboratory</i> )	

## **SESSION 51: Special Session: Hierarchical Design and Design Space**

### **Exploration of Analog Integrated Circuits**

Chair: Erich Barke (*University of Hannover*)

Organizers: Helmut Graeb

- 51.1 Deterministic Approaches to Analog Performance Space Exploration (PSE)** ..... 869  
D. Mueller, G. Stehr, H. Graeb, U. Schlichtmann (*University of Muenchen*)
- 51.2 Mixed Signal Design Space Exploration through Analog Platforms** ..... 875  
F. De Bernardinis (*University of California at Berkeley & Università di Pisa*),  
P. Nuzzo (*Università di Pisa*), A. Sangiovanni-Vincentelli (*University of California at Berkeley*)
- 51.3 Performance Space Modeling for Hierarchical Synthesis of Analog Integrated Circuits** ..... 881  
G. Gielen, T. McConaghy, T. Eeckelaert (*Katholieke Universiteit Leuven*)

## **SESSION 52: PANEL: Structured/Platform ASIC Apprentices:**

### **Which Platform Will Survive Your Board Room?**

..... 887

Chair: Ron Wilson (*Electronic Engineering Times*)

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Panelists: C. Hamlin (*LSI Logic Corporation*), S. Leibson (*Tensilica, Inc.*),

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## **SESSION 53: Dynamic Voltage Scaling**

Chair: Kris Flautner (*ARM, Ltd.*)

Organizers: Diana Marculescu, Trevor Mudge

- 53.1 Quasi-Static Assignment of Voltages and Optional Cycles for Maximizing Rewards in Real-Time Systems with Energy Constraints** ..... 889  
L. A. Cortés (*Volvo Truck Corporation, Linköping University*),  
P. Eles, Z. Peng (*Linköping University*)
- 53.2 DC-DC Converter-Aware Power Management for Battery-Operated Embedded Systems** ..... 895  
Y. Choi, N. Chang, T. Kim (*Seoul National University*)
- 53.3 Energy Optimal Speed Control of Devices with Discrete Speed Sets** ..... 901  
R. Rao, S. Vrudhula (*Arizona State University*)
- 53.4 Optimal Procrastinating Voltage Scheduling for Hard Real-Time Systems** ..... 905  
Y. Zhang, Z. Lu, J. Lach, K. Skadron, M. R. Stan (*University of Virginia*)

## **SESSION 54: New Directions in FPGA Technologies**

Chair: Andre DeHon (*California Institute of Technology*)

Organizers: Jens Palsberg, Ryan Kastner

- 54.1 Flexible ASIC: Shared Masking for Multiple Media Processors** ..... 909  
J. L. Wong (*University of California at Los Angeles*),  
F. Kourshanfar (*University of California at Berkeley*),  
M. Potkonjak (*University of California at Los Angeles*)
- 54.2 Device and Architecture Co-Optimization for FPGA Power Reduction** ..... 915  
L. Cheng, P. Wong, F. Li, Y. Lin, L. He (*University of California at Los Angeles*)
- 54.3 Exploring Technology Alternatives for Nano-Scale FPGA Interconnects** ..... 921  
A. Gayasen, N. Vijaykrishnan, M. J. Irwin (*Pennsylvania State University*)

**SESSION 55: Reduced-Order Modeling**

Chair: Janet Wang Roveda (*University of Arizona*)

Organizers: Byron Krauter, Vikram Jandhyala

**55.1 Piece-wise Approximations of RLCK Circuit Responses using Moment Matching.....** 927  
C. S. Amin, Y. I. Ismail (*Northwestern University*), F. Dartu (*Intel Corporation*)

**55.2 A Quasi-Convex Optimization Approach to Parameterized Model Order Reduction ...** 933  
K. C. Sou, A. Megretski, L. Daniel (*Massachusetts Institute of Technology*)

**55.3 Structure Preserving Reduction of Frequency-dependent Interconnect .....** 939  
Q. Zhou, K. Mohanram, A. C. Antoulas (*Rice University*)

**55.4 Segregation by Primary Phase Factors: A Full-wave Algorithm  
for Model Order Reduction .....** 943  
T. J. Klemas, L. Daniel, J. K. White (*Massachusetts Institute of Technology*)

**Author/Panelist Index.....** 947

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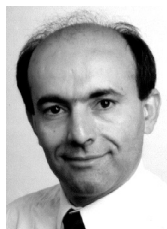
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## **How Does One Define “Technology” Now That Classical Scaling Is Dead (and Has Been for Years)?**

**Abstract:** Over the past four decades, the IT industry has relied upon the classical scaling of semiconductor technology to drive both performance and product economics. Often confused with Moore’s Law, classical scaling speaks to the science driving performance gains over the past decades, not the subset economic issue addressing the areal density of transistors on a chip. In effect, classical scaling had been the "glue" binding microprocessor economics, as stated by Moore’s Law, to expectations for ongoing progress in microprocessor performance. The impact of the loss of that linkage with the demise of classical scaling has yet to be fully comprehended.

The discontinuity engendered by the failure of classical scaling has shaken the microprocessor and IT industry to its foundation, forcing radical shifts in product roadmaps and business focus for those unprepared. This talk will briefly review the origins of this discontinuity, but more critically emphasize new strategies, such as Holistic Design, as employed to drive continued progress in IT performance. First results of the movement to Holistic Design at chip and system level will be reviewed, as will strategies meant to accelerate efforts in this vein.

**Biography:** Bernard S. Meyerson is Chief Technologist and Vice President, Technology, for IBM’s Systems and Technology Group. He joined IBM Research in 1980, and led the development of silicon germanium and other high-performance mixed-signal technologies over a period of ten years, and subsequently led several large organizations within IBM focused on the development of communications technology, spanning the range from pervasive wireless enablement to high-end data transport. Dr. Meyerson currently leads IBM’s Semiconductor Research and Development Center, the multi-company technology alliance located at IBM’s East Fishkill semiconductor facility.

Dr. Meyerson was named IBM Fellow, the company’s highest technical honor, in 1992. He is a Fellow of the American Physical Society and the IEEE and a recipient of the Materials Research Society Medal, the Electrochemical Society Electronics Division Award, the 1999 IEEE Ernst Weber Award for the body of work culminating in the commercialization of Si-Ge-based communications technology, and the IEEE Electron Devices Society J. J. Ebers Award. He was cited as “Inventor of the Year” in 1997 by the New York State Legislature, and was honored as the 1999 “United States Distinguished Inventor of the Year” by the U.S. Patent and Trademark Office. In 2002, he was elected to the National Academy of Engineering, and in 2003, he was named by EE Times as one of thirteen people “who are influencing the course of semiconductor development technology and taking it into realms that exceed the bounds set by the inventors of the transistor more than fifty years ago.” He holds a Ph.D. in physics from City College of the City University of New York.

# THURSDAY KEYNOTE ADDRESS



**Ronald A. Rohrer**

Corporate Vice President,  
*Advanced Research and Development*  
*Cadence Design Systems*

## **Innovation in the EDA Business Need Not Be an Oxymoron**

Abstract: Innovation in EDA is often thought to happen in an isolated *eureka* moment experienced by a *superstar*. As many of us have found out the hard way, such events are all too rare, and in any case do not create business success. People with a common goal and passion often together share the breakthrough ideas and their results. To sustain the level of innovation for EDA to survive, we should first recognize that it is a team effort, and then that potential breakthroughs and even just necessary progress can be part of a managed process. A renewable model for EDA innovation that is proving successful involves five steps in progression: problem to prototype, to partnership, to product and, finally, to proliferation.

Biography: Ron A. Rohrer has been affiliated with EDA in various capacities - in semiconductor and software companies, in start-ups and established companies, in universities and in venture capital - for more than forty years. As would anyone having spent so much time in and around EDA, he has seen, learned, accomplished ... and endured a lot. His passion for teamwork to achieve research, development, and business success has been evident throughout his career. Presently he is with Cadence, working as part of an RF IC EDA advanced research and development team.

Dr. Rohrer is a Fellow of the IEEE and a recipient of the IEEE Education Medal, the SRC Technical Excellence Award, the 1996 NEC Computer and Communication Prize, and the Electronic Design Automation Consortium 2002 Phil Kaufman Award. He was elected to the National Academy of Engineering in 1989 for his contributions to circuit simulation that have enabled deep submicron IC design. He started his industrial career at Fairchild Semiconductor and has served as technical consultant and advisor to many leading EDA and electronics companies. Dr. Rohrer has taught at the University of Illinois at Urbana-Champaign, Southern Methodist University, the University of California at Berkeley, and Carnegie Mellon University, where he is professor emeritus of electrical and computer engineering. An entrepreneur, he was founder of Performance Signal Integrity (later acquired by Integrated Silicon Systems and merged with ArcSys to form Avant! Corporation) and was chairman of Neolinear before its acquisition by Cadence. He holds an S.B. from MIT and a Ph.D. in electrical engineering from the University of California at Berkeley.

## **Marie R. Pistilli Women in EDA Achievement Award**

**Kathryn Kranen** - President & CEO, *Jasper Design Automation*, Mountain View, CA  
For her significant contributions in helping women advance in the field of EDA technology.

## **The P. O. Pistilli Undergraduate Scholarships for Advancement in Computer Science and Electrical Engineering**

The objective of the P. O. Pistilli Scholarship program is to increase the pool of professionals in Electrical Engineering, Computer Engineering, and Computer Science from under represented groups (women, African American, Hispanic, Native American, and physically challenged). In 1989, ACM Special Interest Group on Design Automation (SIGDA) began providing the program. Beginning in 1993, the Design Automation Conference provided the funds for the scholarship, and SIGDA continues to administer the program for DAC. DAC normally funds two or more \$4000 scholarships, renewable up to 5 years, to graduating high school seniors.

The 2005 winners are:

**Elizabeth Hong-An Boi Ha** - attending Georgia Institute of Technology

**Hans Edgar Anderson** - attending Massachusetts Institute of Technology

For more information about the P. O. Pistilli scholarship, contact Dr. Cherrice Traver, ECE Dept., Union College, Schenectady, NY 12308. email: [traverc@union.edu](mailto:traverc@union.edu)

## **Design Automation Conference Graduate Scholarships**

Each year the Design Automation Conference sponsors several \$24,000 scholarships to support graduate research and study in Design Automation (DA), with emphasis in “design and test automation of electronic and computer systems.” Each scholarship is awarded directly to a university for the Faculty Investigator to expend in direct support of one or more DA graduate students.

The criteria for granting such a scholarship expanded in 1996 to include financial need. The criteria are the academic credentials of the student(s); the quality and applicability of the proposed research; the impact of the award on the DA program at the institution; and financial need. Preference is given to institutions that are trying to establish new DA research programs.

Prof. **Elias Kougianos**, Dept. of Engineering Technology, *University of North Texas*, Denton, TX

Student: **Rahul Allawadhi**

*The SPICE Modernization Project*

Prof. **Yehia Massoud**, Dept. of Electrical and Computer Engineering, *Rice University*, Houston, TX

Student: **Arthur Nieuwoudt**

*Spiral Inductor Synthesis for Mixed-Signal Systems*

Information on next year’s DAC scholarship award program will be available on the DAC web site: <http://www.dac.com>.

## DAC/ISSCC 2005 Student Design Contest Winners

### Operational Category:

- 1st Place**     *A 50MS/s (35mW) to 1kS/s (15uW) Power Scaleable 10b Pipelined ADC with Minimal Bias Current Variation*
- (Best Overall)**     Imran Ahmed, David Johns – *University of Toronto*, Toronto, ON, Canada
- 2nd Place**     *A 1.3 TOPS H.264/AVC Single-Chip Encoder for HDTV Applications*  
Tung-Chien Chen, Yu-Wen Huang, Chen-Han Tsai, To-Wei Chen, Ching-Yeh Chen,  
Liang-Gee Chen – *National Taiwan University*, Taipei, Taiwan
- 3rd Place**     *A Side-Channel Leakage Free Coprocessor IC in 0.18  $\mu$ m CMOS for Embedded AES-based Cryptographic and Biometric Processing*  
Kris Tiri, David Hwang, Alireza Hodjat, Bo-Cheng Lai, Shenglin Yang, Patrick Schaumont,  
Ingrid Verbauwhede – *University of California*, Los Angeles, CA

### Conceptual Category:

- 1st Place**     *Design and Implementation of a Fractional-N Frequency Synthesizer for Cellular Systems*  
Petrus J. Venter, Saurabh Sinha – *University of Pretoria*, Pretoria, South Africa
- 2nd Place**     *A 1-V IEEE 802.11a/b/g-Compliant Receiver IF-to-Baseband Chip in 0.35  $\mu$ m CMOS for Low-Cost Wireless SiP*  
Pui-In Mak, Rui P. Martins – *University of Macau*, Macao SAR, China; Seng-Pan U – *Chipidea Microelectronics (Macau) Ltd.*, Macao SAR, China
- 3rd Place**     *Collision Detection System using an FPGA Implemented on the FPX Platform*  
Hasan N. Atay, Burchan Bayazit, John W. Lockwood – *Washington University*, St. Louis, MO

## ACM Transaction on Design Automation of Electronic Systems (TODAES) 2005 Best Paper Award

*Technology Mapping and Architecture Evaluation for k/m-macrocell-based FPGAs*

Volume 10, No. 1, January 2005, Pages: 3 - 23.

**Jason Cong** - *University of California*, Los Angeles, CA

**Hui Huang** - *Sun Microsystems*, Santa Clara, CA

**Xin Yuan** - *IBM Corp.*, Essex Junction, VT

## The Association for Computing Machinery/Special Interest Group on Design Automation (ACM/SIGDA) presents its Distinguished Service Award

**Mary Jane Irwin** - *Penn State University*, University Park, PA

For dedicated service as Editor in Chief of ACM TODAES (1998 - 2004), and many years of service to SIGDA, DAC, and the EDA profession.

## 2004 Phil Kaufman Award for Distinguished Contributions to EDA

**Joe Costello** - *Chairman & CEO of think3, Inc. and former Chairman & CEO of Cadence Design Systems, Inc.*  
Mr. Costello was selected to receive the 2004 Phil Kaufman Award because of his business contributions that helped grow the EDA industry. Under his leadership (1987-1997), Cadence became the world's leading supplier of EDA software and services, and one of the top ten largest software suppliers in the world.

## **IEEE Circuits and Systems Society 2005 VLSI Transactions Best Paper Award**

**Radu Marculescu** - *Carnegie Mellon University*, Pittsburgh, PA

**Girish Varatkar** - *Carnegie Mellon University*, Pittsburgh, PA

For the paper entitled, *On-Chip Traffic Modeling and Synthesis for MPEG-2 Video Applications*, IEEE Transactions on Very Large Scale Integration (VLSI) Systems, vol. 12, no. 1, pp. 108-119, January 2004

## **IEEE Circuits and Systems Society 2005 Darlington Award**

**Payam Heydari** - *University of California*, Irvine, CA

For the paper entitled, *Analysis of the PLL Jitter Due to Power/Ground and Substrate Noise*, IEEE Transactions on Circuits and Systems I: Regular Papers, vol. 51, no. 12, pp. 2404-2416, December 2004

## **IEEE Circuits and Systems Society 2005 Industrial Pioneer Award**

**Yervant Zorian** - *Virage Logic Corp.*, Fremont, CA

For his contributions to design for test technology through Built-In Self-Test solutions and design tools that dramatically boosted the quality and reliability of digital systems and the efficiency of design and test engineers.

## **IEEE Circuits and Systems Society 2005 Outstanding Young Author Award**

**Chris Hyung-II Kim** - *Purdue University*, West Lafayette, IN

For the paper entitled, *Ultra Low-Power DLMS Adaptive Filter for Hearing Aid Applications*, IEEE Transactions on Very Large Scale Integration (VLSI) Systems, vol. 11, no. 6, pp. 1058-1067, December 2003 (with H. Soeleman and K. Roy)

## **IEEE Circuits and Systems Society 2005 Donald O. Pederson Award**

**Subhasish Mitra** - *Intel Corp.*, Folsom, CA

**Kee Sup Kim** - *Intel Corp.*, Sacramento, CA

For the paper entitled, *X-compact: An Efficient Response Compaction Technique*, IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems, vol. 23, no. 3, pp. 421-432, March 2004

## **2005 IEEE Fellows**

**Fadi Joseph Kurdahi** - *University of California*, Irvine, CA

For contributions to design automation of digital systems and to reconfigurable computing.

**David J. Comer** - *Brigham Young University*, Provo, UT

For leadership in engineering education and publication of electronic circuit design textbooks.

**Kartikeya Mayaram** - *Oregon State University*, Corvallis, OR

For contributions to coupled device and circuit simulation.

**Chandu Visweswariah** - *IBM Corp.*, Yorktown Heights, NY

For contributions to large scale integrated circuits.

**Reinaldo Alvarenga Bergamaschi** - *IBM Corp.*, Yorktown Heights, NY

For contributions to the development system design tools and methodologies.

**Domine Leenaerts** - *Phillips Research*, Eindhoven, Netherlands

For contributions to nonlinear circuit theory and design.

## REVIEWERS

A total of 735 manuscripts were submitted to the 42nd DAC. The Conference Executive and Technical Program Committees wish to acknowledge the time and effort spent by the following people who reviewed these manuscripts and returned the review forms completed. Our thanks to all of those who participated and contributed to the success of the Conference.

Mark Aagaard	Peter Beerel	Wander Cesario	Marcello Dalpasso
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## TOPICS OF INTEREST

DAC 2006 is seeking papers that deal with design tools, design methods and case studies, and embedded design in a number of categories described below.

**Design Tools** papers describe contributions to the research and development of design tools and their supporting algorithms.

**Design Methods** and case studies papers describe innovative methodologies for the design of electronic circuits and systems, as well as creative experiences with design automation in state-of-the-art design projects.

**Embedded Systems** are characterized by mixed hardware and software components with limited resources. Increases in software content introduce new system design issues. Embedded design papers describe tools, methods, and case studies for applications with specific embedded system content.

Submitters no longer need to specify a tools, methods, or embedded systems track, but only specify a category from the 18 listed below.

### Categories:

#### 1. Circuit Simulation and Timing Analysis

- Electrical-level circuit and timing simulation
- Static timing analysis and timing verification
- Electrothermal simulation methods

#### 2. Design-for-Manufacturability

- Design for yield, cost issues, and impacts of DFM
- Process technology development, extraction, measurement, and modeling
- Statistical performance analysis and optimization
- Reticle enhancement, lithography-related design optimizations

#### 3. Power Analysis and Low-Power Design

- Analysis and estimation of power
- Embedded low-power approaches: partitioning, scheduling, and resource management
- Device, circuit, and system techniques for low-power design
- Impacts on thermal management of low-power design techniques

#### 4. Testing

- Digital, system, memory, analog/mixed-signal, and RF test
- ATPG, fault modeling, DFT and BIST, test debugging
- Scan-based testing, delay testing, on-line testing
- Cost issues and impacts of testability

#### 5. Verification

- Functional, transaction-level, RTL and gate-level modeling and verification of hardware design
- Dynamic simulation, equivalence checking, formal (and semi-formal) verification model and property checking
- Emulation and hardware simulators or accelerator engines
- Modeling languages and related formalisms, verification plan development and implementation
- Assertion-based verification, coverage-analysis, constrained-random testbench generation

#### 6. IC Physical Design

- Physical floorplanning, partitioning, placement
- Buffer insertion, routing, interconnect planning
- Module generation, cell sizing, and library optimization
- Physical verification

#### 7. Logic Synthesis

- Combinational, sequential, and asynchronous logic synthesis, both technology-independent and dependent
- Library mapping, cell-based design and optimization
- Transistor sizing
- Interactions between logic design and layout or physical synthesis

#### 8. High-Level Synthesis

- High-level, behavioral, algorithmic, and architectural synthesis, "C" to gates tools and methods
- HW-SW interface synthesis, communication and network synthesis
- Synthesis of digital circuits above the RTL level
- Resource scheduling, allocation, and synthesis

#### 9. Interconnect

- Interconnect modeling and extraction for current and advanced mainstream IC processes
- Model-order reduction methods for linear systems
- Substrate modeling with interconnect parasitic extraction
- High-frequency and electromagnetic simulation of circuits

#### 10. Signal Integrity and Design Reliability

- Signal integrity, thermal analysis, and reliability modeling and analysis
- Timing, clocking, and power distribution, especially novel techniques
- Power grid robustness analysis and optimization
- Capacitive and inductive crosstalk noise
- Soft-errors and single-event upsets (SEUs)

#### 11. Analog/Mixed-Signal and RF

- Analog, mixed-signal, and RF design
- Automated synthesis and macromodeling
- Simulation and optimization

#### 12. FPGA Design Tools and Applications

- Rapid prototyping
- Logical synthesis and physical design techniques for FPGAs
- Configurable and reconfigurable computing

#### 13. Embedded HW Design and Applications

- Case studies of embedded system design
- Flows and methods for specific applications and design domains

#### 14. Embedded SW Tools and Design

- Retargetable compilation
- Memory/cache optimization
- Real-time single- and multi-processor scheduling, linking, loading
- Real-time operating systems

#### 15. System-Level Design and Co-Design

- System specification, modeling, simulation, and performance analysis
- Scheduling, HW-SW partitioning
- IP and platform-based design, IP protection
- Communications-based design
- System-on-Chip (SoC), Network-on-Chip (NoC), Multi-processor SoC (MPSOC)
- Application-specific processor design tools

#### 16. New, Emerging, or Specialized Design Technologies Including, but Not Restricted to

- MEMS, sensors, actuators, imaging devices
- Nano-technologies, nano-wires, nano-tubes
- Quantum computing
- Biologically based systems
- New transistor structures and devices, new or radical process technologies

#### 17. Beyond Die-Integration and Packaging

- Chip-package-board codesign
- System-in-Package
- 3D design, stacked devices
- Analysis and optimization (signal integrity, physical layout, simulation) beyond the die

#### 18. Special Theme Day—ENTERTAINMENT, GAMES, and MULTIMEDIA

- Design issues pertaining to mobile devices, music, video, broadcast, video on demand, and other multimedia/consumer entertainment devices
- Intensive multimedia processing as part of entertainment computing and specialized entertainment engine design
- Design and implementation of game playing, video, and audio engines
- Cross-platform entertainment and game software design and design implications
- System-level design approaches for games and multimedia entertainment devices

**ALL SUBMISSIONS MUST BE MADE ELECTRONICALLY AT THE  
DAC WEB SITE: WWW.DAC.COM**

### REGULAR PAPERS DUE BEFORE 5 pm MST, Dec. 19, 2005

Regular paper submissions must (1) be in PDF format only, (2) contain an abstract of approximately 60 words clearly stating the significant contribution, impact, and results of the submission, (3) be no more than 6 pages (including the abstract, figures, tables, and references), double columned, 9pt or 10pt font, and (4) **MUST NOT** include name(s) or affiliation(s) of the author(s) anywhere on the manuscript, abstract, or bibliographic citations. Format templates are available on the DAC web site for your convenience, but are not required. Submissions not adhering to these rules, or those previously published or simultaneously submitted to another conference, will be rejected. Additional submission guidelines are available on the DAC website (after Sept. 1, 2005). All regular papers will be reviewed as finished papers. Preliminary submissions will be at a disadvantage. Authors of accepted papers must sign a copyright release form for their paper. Notice of acceptance will be sent via email by April 17, 2006.

### SPECIAL SESSIONS DUE BEFORE 5 pm MST, Nov. 2, 2005

Special session submissions must include descriptions of suggested papers and speakers, and the importance of the special session to the DAC audience. DAC reserves the right to restructure all special sessions.

### PANELS and TUTORIALS DUE BEFORE 5 pm MST, Nov. 2, 2005

Panel and tutorial suggestions should not exceed two pages, should describe the topic and intended audience, and should include a list of suggested participants. Tutorial suggestions must include a bulleted outline of covered topics. DAC reserves the right to restructure all panels and tutorials.

### STUDENT DESIGN CONTEST DUE BEFORE 5 pm MST, Dec. 6, 2005

Students are invited to submit descriptions of original electronic designs, either circuit level or system level. Student Design Contest paper submissions must (1) be in PDF format only, (2) contain the title of the project, (3) contain an abstract of approximately 60 words, (4) contain a complete description of the project, and (5) be no more than 6 pages (including the abstract, maximum of 10 figures/tables and references), double-columned, 9pt or 10pt font. The submission should clarify the originality, distinguishing features, and measured performance of the design. Two categories of designs - operational and conceptual - are eligible for awards. For operational designs, proof-of-implementation is required, while for conceptual designs, complete simulation is necessary. Designs must have taken place as part of the students' work at the university and must have been completed after June 2004. Submitted designs should not have received awards in other contests. Selected designs will be presented at the conference (and at ISSCC in February 2006). Additional submission guidelines are available on the DAC web site.

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# Author/Panelist Index

<b>A</b>		Bougard, B. ....	303	Chu, C. Y. ....	291
Abadir, M. ....	167	Bowman, K. ....	762	Clark, L. T. ....	658
Abdollahi, A. ....	37, 379	Boyd, S. ....	632	Clasen, H. ....	549
Abler, J. ....	289	Bozorgzadeh, E. ....	335, 565	Coburn, J. ....	700
Adir, A. ....	769, 779	Brenner, U. ....	591	Cofler, A. ....	779
Afzali-Kusha, A. ....	214	Brewer, E. A. ....	684	Corporaal, H. ....	101
Agarwal, A. ....	321	Brewer, F. ....	451	Cortés, L. A. ....	889
Agarwal, K. ....	535	Brglez, F. ....	385	Covey, L. ....	611
Ahmad, S. ....	678	Brown, A. P. ....	297	Cox, A. ....	351
Al Faruque, M. A. ....	329	Brown, S. D. ....	427, 433	Cumplido, R. ....	240
Alexanian, A. ....	168	Buch, P. ....	168		
Alpert, C. J. ....	509, 515			<b>D</b>	
Amin, C. S. ....	652, 927			Dahan, F. ....	549
Antoulas, A. C. ....	939	<b>C</b>		Dally, W. J. ....	281
Arbetman, Y. ....	779	Cai, Y. ....	170	D'Ambrosia, J. F. ....	289
Ascheid, G. ....	329	Cai, Y. ....	176	Daniel, L. ....	147, 933, 943
Ashar, P. ....	738	Calligaro, M. A. ....	779	Dartu, F. ....	652, 927
Austin, T. ....	783	Camposano, R. ....	887	Das, C. R. ....	559
Azatchi, H. ....	769	Cao, T. ....	801	Davare, A. ....	260
Azizi, N. ....	529	Cao, Y. ....	658	De Bernardinis, F. ....	875
		Capodiecici, L. ....	359	De Geus, A. ....	1
		Carro, L. ....	732	de Veciana, G. ....	270
<b>B</b>		Cassidy, R. ....	1	De, V. ....	529, 762
Babić, D. ....	744	Catthoor, F. ....	303	Devgan, A. ....	153, 309
Bacchini, F. ....	69, 351, 521	Chakrabarti, C. ....	628	Dey, S. ....	190, 571
Bahar, R. I. ....	485	Chakrabarty, K. ....	123, 825	Dhar, S. ....	43
Balderas-Contreras, T. ....	240	Chakraborty, S. ....	248, 757	Dick, R. P. ....	208
Banerjee, N. ....	479	Chandra, N. ....	775	Dilillo, L. ....	857
Banerjee, P. ....	202	Chang, A. ....	281	Dill, D. L. ....	467
Banerjee, S. ....	335	Chang, C.-F. ....	597	Ding, M. ....	63
Bapst, M. ....	167	Chang, H. ....	71, 523	Director, S. ....	535
Basten, T. ....	101, 819	Chang, N. ....	895	Doboli, A. ....	57
Bastian, M. ....	857	Chang, Y.-H. ....	163	Doherty, T. ....	69
Batra, A. ....	409	Chang, Y.-W. ....	325, 597	Dong, J. ....	549
Baumgartner, J. ....	463	Chatterjee, P. ....	674	Dong, N. ....	51
Beattie, M. ....	153	Chen, C. C.-P. ....	83, 163	Dragone, N. ....	760
Beck, A. C. S. ....	732	Chen, G. ....	690	Dubrov, B. ....	779
Ben-Romdhane, M. ....	565	Chen, Q. ....	479	Ducousso, L. ....	521
Bergeron, J. ....	521	Chen, S.-J. ....	597	Duffy, G. ....	779
Bertacco, V. ....	783	Chen, W. ....	83	Dutt, N. ....	335, 565
Bertoletti, M. ....	760	Chen, X. ....	260	Dworsky, P. ....	289
Bhardwaj, S. ....	541	Chen, Y. ....	579		
Bhatt, T. M. ....	607	Chenard, J.-S. ....	291	<b>E</b>	
Bhattacharya, S. ....	285	Cheng, K.-T. ....	451	East, W. ....	1
Bhattacharya, S. ....	644	Cheng, L. ....	915	Eberle, W. ....	303
Bhunias, S. ....	479	Cheon, Y. ....	795	Eeckelaert, T. ....	881
Bhuyan, L. ....	712	Chinnery, D. G. ....	275	Eguro, K. ....	439
Bin, E. ....	769	Cho, Y. H. ....	234	Eles, P. ....	266, 889
Bingham, J. ....	744	Choi, W.-J. ....	413	Emerson, E. A. ....	467
Bittlestone, C. ....	758	Choi, Y. ....	895	Eo, S.-K. ....	69
Blaauw, D. ....	321, 535, 766	Chopra, K. ....	321, 766	Ernst, R. ....	575
Blasquez, J. ....	549	Chou, P. H. ....	618	Ezer, S. ....	789
Bolsens, I. ....	887	Choudhury, U. ....	652		
Bonifield, T. ....	758	Chowdhary, A. ....	801		
Bouetel, L. ....	549	Chowdhury, I. ....	159		

<b>F</b>	
Fallah, F. ....	37
Fiez, T. S. ....	141
Fister, M. J. ....	1
Foster, H. ....	521
Fox, T. ....	611
Fukunaga, M. ....	845

<b>G</b>	
Gaffar, A. A. ....	837
Ganai, M. K. ....	738
Gao, F. ....	31
Gayasen, A. ....	921
Geilen, M. ....	819
Georgelin, P. ....	547
Gharpurey, R. ....	141
Gheorghita, S. V. ....	101
Gianelli, J. ....	887
Gielen, G. ....	881
Gilbert, J. M. ....	413
Girard, P. ....	857
Goldfeder, C. ....	696
Goldman, R. ....	1
Gope, D. ....	159
Goplen, B. ....	503
Gott, R. M. ....	670
Graeb, H. ....	869
Greenstreet, M. ....	638
Gries, M. ....	254
Gu, Z. ....	208
Guardiani, C. ....	168, 760
Gubner, J. A. ....	83
Gupta, A. ....	738
Gupta, B. ....	547
Gupta, P. ....	244, 365
Gupta, R. ....	111

<b>H</b>	
Ha, S. ....	345
Hajimiri, A. ....	551
Hakim, N. ....	652
Halpin, B. ....	801
Hamada, S. ....	845
Hamlin, C. ....	887
Hangal, S. ....	775
Harris, C. ....	167
Hauck, S. ....	439
Hayes, J. P. ....	31
He, L. ....	497, 720, 915
Heacock, D. ....	611
Healey, A. ....	289
Heidergott, W. ....	5
Heithecker, S. ....	575
Hersan, T. G. ....	353
Hill, A. ....	758
Ho, P.-H. ....	795

Ho, T.-Y. ....	597
Hodjat, A. ....	222
Hoe, J. C. ....	471
Hong, X. ....	170, 176
Hsiao, M. S. ....	754
Hsieh, H. ....	260
Hsiung, K.-L. ....	632
Hsu, S.-Y. ....	182
Hu, A. J. ....	744
Hu, Jackson ....	1
Hu, Jiang ....	176, 509
Hu, X. ....	147
Hu, Y. ....	83
Huang, L. ....	176
Huang, S.-H. ....	182, 475
Huijbregts, E. ....	611
Hwang, D. ....	222

<b>I</b>	
Iitis, R. A. ....	297
Iranli, A. ....	612
Irwin, M. J. ....	921
Ismail, Y. I. ....	652, 927
Iyer, M. K. ....	451
Iyer, S. K. ....	467

<b>J</b>	
Jacome, M. F. ....	270
Jain, H. ....	445
Jain, J. ....	467
Jandhyala, V. ....	159
Jangkrajarn, N. ....	644
Jayakumar, N. ....	43, 716
Jejurikar, R. ....	111
Jha, N. K. ....	23, 244, 624
Jiang, R. ....	163
Jin, HS. ....	750
Johnson, S. ....	789
Johnson, V. ....	611

<b>K</b>	
Kahng, A. B. ....	365, 795
Kajihara, S. ....	845
Kandemir, M. ....	95, 690
Kanzelman, R. ....	463
Karnik, T. ....	2
Karri, R. ....	135
Karuri, K. ....	329
Kashyap, C. ....	186
Kastner, R. ....	297
Keutzer, K. ....	275
Khandelwal, W. ....	89
Khatri, S. P. ....	43, 716
Khellah, M. M. ....	529
Kheterpal, V. ....	353
Killpack, K. ....	652
Kim, D. ....	345, 553

Kim, H. Y. ....	341
Kim, J. ....	105, 559
Kim, K. S. ....	274
Kim, T. ....	105, 895
Kim, T. G. ....	341
Kim, Y. ....	365
Kisaka, T. ....	218
Klemas, T. J. ....	943
Ko, U. ....	549
Komijani, A. ....	551
Kornfeld, A. ....	611
Kourshanfar, F. ....	909
Kraemer, S. ....	329
Krauter, B. ....	153, 186
Krenik, W. ....	409
Kroening, D. ....	445
Kunz, W. ....	457

<b>L</b>	
Lach, J. ....	905
Lahiri, K. ....	571
Lai, B. ....	222
Lai, B.-C. C. ....	27
Lane, F. ....	351
Lauwereins, R. ....	351
Le, V. ....	758
Lebars, V. ....	547
Lee, D.-U. ....	837
Lee, H. ....	297
Lee, H.-H. S. ....	553
Lee, J. H. ....	147
Lehon, H. ....	168
Leibson, S. ....	887
Lemieux, G. ....	726
Leupers, R. ....	329
Leveugle, R. ....	863
Li, D. ....	618
Li, F. ....	95, 915
Li, H. ....	170
Li, P. ....	664
Li, X. ....	77, 632
Li, X. Y. ....	385
Lichtenstein, Y. ....	779
Lilja, D. J. ....	579
Lin, Y. ....	720, 915
Ling, A. ....	427
Litinsky, B. ....	289
Liu, F. ....	186
Liu, X. ....	813
Liu, Y. ....	248
Lu, F.-P. ....	475
Lu, Y. ....	176
Lu, Z. ....	905
Luk, W. ....	837
Luo, Y. ....	712
Luo, Z.-Q. ....	315

**M**

Mack, S.	168, 611
Maeda, T.	845
Magee, D. P.	603
Mahapatra, R.	678
Mahmoodi, H.	479
Mair, H.	549
Malcotti, M.	760
Maliniak, D.	69
Mangione-Smith, W. H.	234
Mani, M.	309
Manohararajah, V.	433
Manolache, S.	266
Marculescu, D.	11
Massoud, Y.	648
Matsuura, M.	373
Mayaram, K.	141
McCain, D.	607
McConaghy, T.	881
McElvain, K.	887
McGee, P. B.	491
McNamara, P.	760
McShane, P.	69
Megretski, A.	933
Mehta, S.	521
Memik, G.	196
Memik, S. O.	196
Mencer, O.	837
Menezes, N.	652
Meng, Y.	297
Merritt, R.	289
Metzgen, P.	421
Meyr, H.	329
Michel, T.	547
Milder, P. A.	471
Mitra, J.	369
Mitra, S.	2, 117
Mizan, E.	270
Mohanram, K.	939
Mokhoff, N.	274
Monnet, Y.	863
Mony, H.	463
Moretti, G.	521
Motiani, D.	353
Mueller, D.	869
Mukherjee, R.	196
Mundy, J.	485
Muttreja, A.	23

**N**

Najm, F. N.	529, 764, 841
Nakamura, M.	521
Nancekievill, D.	421
Nandra, N.	289
Narasimha, U.	758
Narayan, S.	71
Narayanan, S.	775

Nassif, S. R.	349
Natarajan, A.	551
Nausieda, I.	632
Navabi, Z.	214
Nedeveschi, S.	684
Nepal, K.	485
Newmark, D.	77
Nguyen, C. T.-C.	416
Nham, H.	274
Nicolici, N.	123
Nie, T.	218
Nieh, Y.-T.	182, 475
Nieuwoudt, A.	648
Nookala, V.	315, 579
Nordin, G.	471
Nowak, M.	767
Nowick, S. M.	491
NS, N.	758
Nuzzo, P.	875

**O**

Ooi, W. T.	248
Orailoglu, A.	17, 841
Orshansky, M.	309

**P**

Pai, S. A.	69
Pan, D. Z.	369, 515
Parasuram, Y.	801
Park, D.	1, 559
Parthasarathy, G.	451
Paruthi, V.	463
Pasricha, S.	565
Patra, R. K.	684
Patterson, W. R.	485
Paumier, L.	547
Pedram, M.	37, 379, 612
Peled, O.	769
Peng, Y.	813
Peng, Z.	266, 889
Pessolano, F.	274
Petrov, P.	17
Pileggi, L. T.	77, 353, 632
Pitts, B.	549
Pollin, S.	303
Pomeranz, I.	129
Popovic, M.	291
Potkonjak, M.	909
Prasad, M. R.	754
Pravossoudovitch, S.	857
Puri, R.	285
Püschel, M.	471

**Q**

Qi, Z.	170
Qin, W.	27
Qu, G.	47

**R**

Rabaey, J.	351
Rabkin, P.	168
Radojic, R.	767
Raghunathan, A.	23, 244, 571, 700
Raibaut, C.	549
Rajagopal, K.	801
Ramacher, U.	351
Rao, R.	901
Ravi, S.	23, 244, 700
Reda, S.	795
Ren, H.	515
Ren, J.	638
Renaudin, M.	863
Rhines, W. C.	1
Rimon, M.	779
Rossi, U.	672
Rovner, V.	353
Rowen, C.	706
Roy, K.	479
Royannez, P.	549
Roychowdhury, J.	51, 391
Ruparel, K. N.	274
Rutenbar, R. A.	403, 585

**S**

Sahoo, D.	467
Saneei, M.	214
Sangiovanni-Vincentelli, A.	260, 875
Sapatnekar, S.	315, 503, 523, 579
Sasao, T.	373
Sato, Y.	845
Sauer, C.	254
Saxena, P.	503
Schaumont, P.	27, 222
Schlichtmann, U.	869
Scott, D.	549
Sechen, C.	807
Seifert, N.	2
Sekar, K.	571
Semino, G.	549
Shah, S.	535
Sharan, A.	168, 439
Sharma, M.	77
Sherwani, N.	168
Sherwood, T.	297
Shi, C.-J. R.	644
Shi, W.	509
Shoikhet, K.	769
Sidle, T.	754
Singh, A.	758
Singh, D. P.	427, 433
Singh, J.	315
Skadron, K.	905
Somenzi, F.	750
Sonntag, S.	254
Sou, K. C.	933

Srivastava, A. ....	89, 525
Stallmann, M. F. ....	385
Stan, M. R. ....	905
Stehr, G. ....	869
Stoffel, D. ....	457
Stok, L. ....	285
Stonick, J. ....	289
Streeter, M. ....	549
Strojwas, A. J. ....	77, 353
Struzyna, M. ....	591
Stuijk, S. ....	101, 819
Su, B.-Y. ....	325
Su, F. ....	825
Su, H. ....	186
Subramanian, A. ....	270
Suh, T. ....	553
Sun, Q. ....	413
Sundararajan, S. ....	69
Sylvester, D. ....	359, 365, 535
Sze, C. N. ....	176, 509

**T**

Takegawa, Y. ....	353
Talpes, E. ....	11
Tam, K. H. ....	497
Tan, S. X.-D. ....	170
Tang, X. ....	202
Tennakoon, H. ....	807
Theocharides, T. ....	559
Tiourin, V. ....	801
Tiri, K. ....	222, 228
Tiwary, S. K. ....	403
Tobias, R. ....	887
Tom, M. ....	726
Topaloglu, R. O. ....	841
Toyonaga, M. ....	218
Tracy, D. ....	17
Tschanz, J. ....	762

**U**

Urard, P. ....	69, 547
----------------	---------

**V**

Vasudevan, V. ....	397
Vemuri, R. ....	63
Venkatesan, S. ....	801
Verbauwhede, I. ....	27, 222, 228
Vijaykrishnan, N. ....	559, 921
Villarrubia, P. ....	515
Vinov, M. ....	779
Virazel, A. ....	857
Visweswariah, C. ....	71
Vleeschhouwer, J. ....	1
Volkerink, E. H. ....	117
Vrudhula, S. B. K. ....	541, 901

**W**

Wagner, I. ....	783
Wagner, M. ....	549
Wan, Y. ....	391
Wang, J. ....	208
Wang, Q. ....	795
Wassung, Jr., D. C. ....	167
Watanabe, Y. ....	260
Wedler, M. ....	457
Wei, J. ....	706
Wei, Y. ....	57
Wen, X. ....	845
White, J. ....	147, 943
Widiger, D. ....	186
Wilson, R. ....	887
Witt, D. ....	351
Wolfsthal, Y. ....	670
Wong, J. L. ....	909
Wong, P. ....	915
Wu, B. ....	841
Wu, K. ....	135
Wu, L. ....	170

**X**

Xiu, Z. ....	585
Xu, C. ....	141
Xu, Q. ....	123
Xu, Y. ....	632

**Y**

Yan, L. ....	624
Yang, A. ....	611
Yang, B. ....	135
Yang, J. ....	359, 712
Yang, S. ....	222
Yeo, E. ....	547
Yi, Y. ....	345
Yu, J. ....	712
Yu, P. ....	369
Yuan, L. ....	47

**Z**

Zaslavsky, A. ....	485
Zhan, Y. ....	77
Zhang, L. ....	83, 754
Zhang, M. ....	2
Zhang, Y. ....	905
Zhao, C. ....	190
Zhao, Y. ....	190
Zheng, H. ....	153
Zhong, L. ....	624
Zhou, H. ....	202, 208
Zhou, Q. ....	176, 939
Zhu, J. ....	831, 841
Zhuo, J. ....	628
Žilić, Ž. ....	291
Zolotov, V. ....	71, 321
Zorian, Y. ....	167, 274
Zuchowski, P. ....	611
Zykov, A. V. ....	270