Proceedings

18th International Conference on VLSI Design

held jointly with

4th International Conference on Embedded Systems Design

About the Cover

A banyan tree (*Ficus benghalensis*) grows wide-spreading branches that send down aerial roots like clumps of rope, until they enter the ground and become trunks. The ***Great Banyan tree*** is a landmark of Kolkata. It stands in the Indian Botanic Gardens which is about 8 kms. from the heart of the city, across the River Hooghly. This tree is more than 250 years old and finds mention in the Guinness Book of World Records for its canopy. It existed on a Phoenix (date palm) tree before the establishment of the garden in 1787. In 1925, the main trunk of this tree measuring 16m in girth had to be removed after it was infected by wood rotting fungi. There are more than 2800 prop roots and it covers an area of 1.50 hectares. The circumference of its canopy is about 450 m and gives the appearance of a small forest which has developed purely from a single tree during the course of time. The front cover gives us a glimpse of this famous tree.

The theme of this conference *Power-Aware design of VLSI systems* encompasses a wide spectrum of challenges which have to be met by the support of several disciplines in science and engineering, intertwined like a banyan tree.

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Proceedings

18th International Conference on VLSI Design

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4th International Conference on Embedded Systems Design

3-7 January 2005
Kolkata, India

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Message from the General Chairs

Sandip Kundu

Partha Pratim Das

It is a great privilege to welcome you to Kolkata for the joint 18th International Conference on VLSI Design and 4th International Conference on Embedded Systems. As a premier event, the conference packs a three-day technical program with plenary sessions, technical presentations, panel discussions, embedded tutorials followed by two days of tutorials.

The joint conference is a multidisciplinary event with the objective of fostering interaction between system architecture, logic and circuit design and device fabric domains. Design automation has been a traditional theme at this conference. Embedded systems design, rapid prototyping and embedded software design run as a parallel theme at this event. Conference tracks have been organized around these themes.

This year's major theme of the conference is *Power-aware Design of VLSI Systems*. Demand for power-aware designs is driven by the need for lower power mobile devices as well as high power systems where performance has to be traded with the cost of cooling. Given the exploding market demand in both of these segments, *power-aware design of VLSI systems* is a highly relevant topic today.

VLSI design conference has a proud tradition of bringing together top researchers from the academic institutions, research laboratories and high-technology companies from all over the world. This year is no exception. For 2005, the conference received 352 paper submissions from 25 countries. Of the 352 papers originally submitted to the conference, the program committee selected 97 regular papers (28%), 16 short papers (4.5%) and 24 poster papers (6.8%). Tutorials are a popular feature of this conference. This year 21 tutorial proposals were received, of which 6 were chosen for full day presentations and 4 for half day presentations.

In recognition of growing reputation of this conference, IEE proceedings on Computer and Digital techniques is planning a special issue on this edition of the conference. Beginning this year, the Design Automation Conference executive committee has designated sister conference status to this conference.

This year, the conference features several luminaries from industry and academia as keynote speakers. On Monday, Prof. C. L. Liu will deliver the opening keynote, "The High Walls have Crumpled". Dr. Alan Naumann, CEO of CoWare Incorporated and Dr. Ted Vucurevich,

CTO of Cadence Design Systems are Tuesday morning keynote speakers. Dr. Walden Rhines, CEO of Mentor Graphics Corporation will deliver a banquet speech on Tuesday evening. Shekhar Borkar, an Intel Fellow, is the featured speaker on Wednesday morning.

The conference is co-sponsored by VLSI Society of India, IEEE Circuits and Systems Society, IEEE Solid State Circuits Society, IEEE Electron Devices Society, ACM SIGDA.

The conference is an excellent venue for networking. Coffee breaks throughout the day provide opportunity for informal networking. A separate track is dedicated to Industry Forum. What better way to exchange ideas and forge friendship with peers across the industry?

We would be remiss without a few words about the host city. Kolkata is well known for its rich cultural and literary traditions and continues to attract writers and artists from all over the world. For those of you, who have traveled great distances to come to this conference, we will certainly recommend you to venture out to experience the color and vitality of this city first hand!

The conference is a product of hard work by many volunteers who have freely given their time, planning for this event to come together. First and foremost, we thank Prof. Vishwani Agrawal, the steering committee chair, for providing the vision and being the inspiration behind the conference from year to year. Our sincere gratitude goes to the technical program co-chairs, Prof. Susmita Sur-Kolay and Prof. Kaushik Roy who worked diligently throughout the year starting with call for papers, assembling a world class technical program committee, managing an on-time review process and working through the details of the final program. We thank Prof. Rana Dattagupta, chair of the organizing committee for local arrangements and Prof. Sivaji Chakravorti, the vice chair, for his able assistance. The tutorial chairs Prof. Parthasarathi Dasgupta and Prof. Krishnendu Chakrabarty, special session and panels chairs Prof. Debesh K. Das and Prof. Pallab Dasgupta, industry forum chairs Dr. Sudipta Bhawmik and Dr. Pradip Dutta, publication chair Dr. Srimat Chakradhar, fellowship chair Prof. Susanta Sen, design contest chairs Dr. Raj Sekhar Mitra and Prof. Biplab Sikdar, publicity chairs Prof. Susanta Chakraborty, Prof. Kewal Saluja, Prof. Atsushi Takahashi and Prof. Paul Molitor deserve special recognition for their efforts. We also thank our ACM/SIGDA liaison Prof. Sharad Seth, IEEE liaison Prof. N. Ranganathan and VSI liaison Dr. Biswadeep Mitra for obtaining society sponsorships. We cannot thank enough our exhibit and sponsorship chairs Dr. C. P. Ravikumar and Dr. Partha Ray for their diligent handling of exhibitors and sponsors. Special recognition is also due to our finance chair Nand G. Chattopadhyay, who was instrumental in every operational aspect of the conference including legal contracts with conference hotel and other suppliers. The organization of the conference hinged critically on the professional services of the event managers, the New Wave Display Services (P) Ltd. The support provided by their representatives Rex Anthony and Soumen Bose have been pivotal for us. Ashis Auddy did not hold any office but made himself available for anything that needed attention to details – especially contributing to every aspect of esthetic designs. Gautam Das and Subhra Lahiri helped manage the Conference website. We thank them all. We also thank the student volunteers, technical program committee and local organizing committee members for making this event a success. The conference is critically dependent on services of volunteers. If you are interested in volunteering in coming years, conference organizers are eager to hear from you. The conference needs constant infusion of people and ideas to sustain its growth and stay in tune with times.

A conference of this magnitude cannot be held without generous support from our industrial partners. We gratefully acknowledge Cadence Design Systems, Intel Corporation, Mentor Graphics, Synopsys, Texas Instruments, Centillium Communications, CoWare, Infineon,

National Semiconductor, Tensilica, Virage Logic, CG-CoreEI, IBM, Interra Systems, LogicVision, Mechantronics Test Equipment, nSys, eInfoChips, Open-Silicon and Trident TechLabs for their financial support. Many others have also expressed their intention to support the Conference. We thank them in advance. We thank all our authors, reviewers, speakers and session chairs for making VLSI Design Conference and Embedded Systems Conference, premier events in their respective fields. Lastly, a special word of thanks to all of you, our conference attendees! We have worked hard to bring you a substantive technical program as well as providing a forum for informal exchanges. We wish you a productive, informative and enjoyable conference experience.

October 11, 2004

Sandip Kundu, General Co-Chair
Partha Pratim Das, General Co-Chair

Message from the Program Chairs

Susmita Sur-Kolay **Kaushik Roy**

Welcome to the 18th International Conference on VLSI Design and the 4th International Conference on Embedded Systems!

The degree of scaling in VLSI technology and ever increasing integration density have led to unprecedented levels of power dissipation in current day VLSI circuits, and possibly creating a barrier to further scaling and integration unless effective design techniques are developed to reduce power. Aptly, the theme of the conference this year is power-aware design and several papers address this problem at various levels of design abstraction – from devices to circuits and architecture.

VLSI Design '05 will provide an excellent forum for students, researchers and other professionals to present and discuss various state-of-the-art of VLSI Design and Embedded Systems issues including synthesis, testing, EDA tools, mixed signal design and architecture with emphasis low power design. With technical co-sponsorship from IEEE CASS, SSCS and EDS and ACM SIGDA, we received a record number of 352 submissions from researchers located in 25 countries. Of these, there were 52 proposals for embedded tutorials. The increasing popularity and importance of this conference around the globe has led to its recognition as a Sister Conference by the Design Automation Conference (DAC) Committee.

For the first time in the history of the VLSI Design Conference, the notion of tracks was introduced to enable better processing of the wide range of topics. The three tracks, with two track chairs per track, were on Design Methods, Design Tools and Embedded Systems. We wish to express our sincere thanks to the track chairs: Prof. Navakant Bhat, Dr. Rajiv Joshi, Prof. Sachin Sapatnekar, Dr. Alok Kumar, Prof. Nikil Dutt and Prof. S. Ramesh. Once again web-based submission and review process employed DOCMAN, a document management system which was developed for this conference in 2001 by Dr. Srimat Chakradhar. The papers and embedded tutorial proposals were reviewed by an international pool of reviewers, which primarily included a 75-member strong program committee (PC), consisting of top VLSI experts from all over the world.

In keeping with tradition, paper selection for the final program was done in two phases of program committee meetings: the first one was held in USA and the second one in India. Teleconferencing and emails were used to exchange opinion and decisions between the two committees in order to ensure uniformity of the paper selection process. Based on the views of the referees and the PC members, the decision on selection of the papers was finalized

unanimously from both ends. We were able to accept 97 regular papers, 16 short papers and 23 posters, along with 5 embedded tutorials. Unfortunately, due to conference size limitations, many good papers had to be rejected. Eight of the selected papers were nominated for the Best Paper award. Four of these eight papers were also nominated for the Best Student Paper award. A blue-ribbon international panel reviewed the candidate papers, and ranked them against each other. The panel members were chosen on the basis of their outstanding contributions to the area of VLSI Design and CAD, with the requirement that none of them had submitted papers to VLSI Design '05.

The program also includes four keynote addresses, four invited plenary talks, one banquet speech, and a panel discussion by eminent experts in the industry. An excellent industry forum program with vendor presentations and panel discussions has been put together by Dr. Pradip Dutta and Dr. Sudipto Bhawmik. Owing to the outstanding work of the tutorial chairs, Prof. Partha Sarathi Dasgupta and Prof. Krishnenedu Chakrabarti, we have an excellent program of seven full-day tutorials and two half-day tutorials to be presented in four parallel tracks over two days following the conference. The tutorials were selected from 21 submissions after careful review.

On behalf of the 2005 Program Committee, we thank all the reviewers, the volunteers of the program committee, the awards panel of judges, the conference steering committee, and the authors. In particular, we wish to thank Vishwani Agrawal, whose guidance and involvement continue to be invaluable resources behind the success of this conference. We wish to thank publication chair, Srimat Chakradhar of NEC, for this arduous task of managing all the camera-ready manuscripts, and Jeniferdawn Cantarella of IEEE Computer Society Press for her assistance in printing the proceedings. Our special thanks go to Dr. C. P. Ravikumar of Texas Instruments, Bangalore, Dr. Rob Roy of Zenasis Technologies USA for their support, and to Professor M. Bushnell of Rutgers University for hosting program committee meetings with teleconferencing between two committees. We are highly indebted to the general chairs, Partha Pratim Das and Sandip Kundu, and organizing chair, Prof. Rana Dattagupta, for providing the infrastructure and financial support necessary for running the conference. Special thanks are due to Prof. P. P. Chakrabarti, Prof. Pallab Dasgupta of IIT Kharagpur, Prof. Debesh Das of Jadavpur University, Dr. S. C. Nandy of ISI Kolkata. Grateful acknowledgement is also due to of Pritha Banerjee, Debasis Mitra, Sambhu Pradhan, Suchandra Roy Bagchi, Pramita Chakraborty of ISI, Swarup Bhunia of Purdue University and Soumen Bose of New Wave for their help with the many facets of the program committee. Finally, we would like to express our gratitude for the invaluable support provided by Interra Systems Kolkata; the Indian Statistical Institute, Calcutta; Rutgers University, NEC USA; and Purdue University.

We are certain that you will have an extremely fruitful experience while attending this joint Conference. We hope that you continue to participate in the International Conference on VLSI Design and Embedded Systems. Your comments and suggestions for further improvement in this will be greatly appreciated.

May you enjoy the cultural panorama of India during your stay in and around this historic city of Kolkata which has been a haven for world-famous scientists, philosophers and artists!

Kaushik Roy
Susmita Sur-Kolay

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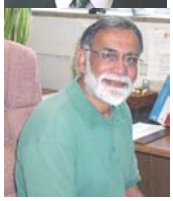

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VLSI Design 2004 Conference Awards

Technical Paper Awards

Arun Kumar Choudhury Best Paper Award (Tie)

"Gate Sizing and Buffer Insertion Using Economic Models for Power Optimization"

Ashok K. Murugavel and N. Ranganathan
University of South Florida

"Design of RF Tuner for Cable Modem Applications"

V. Veeresh Babu, Sumantra Seth, and A. N. Chandorkar
IIT Bombay

Nripendra Nath Biswas Best Student Paper

"Static Timing Analysis of Irreversible Crosstalk Noise Pulse Faults"

Marong Phadoongsidhi and Kewal K. Saluja
University of Wisconsin, Madison

Design Contest Awards

"Katha Mala: A Voice Output Communication Aid for Children with Severe Speech and Multiple Disorders"

Arijit Mukhopadhyay, Pratik Worah, Susmit Biswas, Saptarshi Biswas, Ramasish Das, and Anupam Basu

"High Speed Optoelectronic Receivers in Si-Ge"

Amit Gupta, Steven P. Levitan, Leo Selavao, and Donald M. Chirarulli

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Jim F. Plusquellic
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Nachiketa Prachanda
Vani Prasad
Anand Raghunathan
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Rajesh Raina
Sanjay Rajopadhye
Krithivasan Ramamritham
N. Ranganathan
S.S.S. P. Rao
Ramgopal Rao
Paruj Ratanaworabhan
C. P. Ravikumar
Partha Ray
Arijit Raychowdhury
Sudhakar M. Reddy
Marly Roncken
Subir Kumar Roy
Rob (Rabindra) K. Roy
Margaret Marek Sadowska
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Hiranmay Saha
Kaushik Saha
Prakash Ranjan Sahay
Kewal K. Saluja
Gagandeep Sandha
Sachin S. Sapatnekar
Dharmendra Saraswat
Subir Kumar Sarkar
Majid Sarrafzadeh
Prashant Saxena
Susanta Sen
Indranil Sengupta
Sharad C. Seth
Ramesh Sethu
Rajamani Sethuram
Alena Shamsheyeva
Li Shang
Dinesh Sharma
Seng Lin Shee
Sandeep K. Shukla
Adit D. Singh
Arani Sinha
Mani Soma
Abhishek Somani
Peilin Song
Arcot Sowmya
Ramalingam Sridhar
Rajagopalan Srinivasan
S. Srinivasan
Ashok Srivastava
Kenneth S. Stevens
Dirk Stroobandt
Charles E. Stroud
Savithri Sundareswaran
Susmita Sur-Kolay
Andrei Sergeevich Terechko
Hiroyuki Tomiyama
Raghuram S. Tupuri
Akhilesh Tyagi
Noppanunt Utamaphethai
Keith Vallerio
Dirk Van Compernolle
Fabian Vargas
Kuruvilla Varghese
Kamakoti Veezhinathan
Miroslav N. Velev
Hari Vijay Venkatanarayanan
Raguraman Venkatesan
G. S. Visweswaran
Wayne Wolf
Martin D.F. Wong
Jiang Xu
Kiat Seng Yeo
Tomohiro Yoneda
Hoi-Jun Yoo
Baozhen Yu
Sujit T. Zachariah
Yong Zhan
Junwu Zhang
Tong Zhang
Rui Zhang

VLSI Design Conference History

Meeting Sequence	Place	Dates	Number of Papers	Number of Posters	Number of Tutorials	Proceedings Pages
First	Madras, India	Dec. 26-28, 1985	29	0	1	193
Second	Bangalore, India	Dec. 15-18, 1988	26	21	4	496
Third	Bangalore, India	Jan. 6-9, 1990	30	22	4	390
Fourth	New Delhi, India	Jan. 4-8, 1991	45	16	9	315
Fifth	Bangalore, India	Jan. 4-7, 1992	57	24	4	378
Sixth	Bombay, India	Jan. 3-6, 1993	70	9	6	371
Seventh	Calcutta, India	Jan. 5-8, 1994	87	0	6	448
Eighth	New Delhi, India	Jan. 4-7, 1995	77	6	6	456
Ninth	Bangalore, India	Jan. 3-6, 1996	75	16	6	480
Tenth	Hyderabad, India	Jan. 4-7, 1997	84	18	6	608
Eleventh	Chennai, India	Jan. 4-7, 1998	98	0	6	624
Twelfth	Goa, India	Jan. 7-10, 1999	103	0	6	682
Thirteenth	Calcutta, India	Jan. 3-7, 2000	93	0	6	590
Fourteenth	Bangalore, India	Jan. 3-7, 2001	77	0	9	592
Fifteenth	Bangalore, India	Jan. 7-11, 2002	109	0	8	834
Sixteenth	New Delhi, India	Jan. 4-8, 2003	84	0	6	622
Seventeenth	Mumbai, India	Jan. 5-9, 2004	120	44	8	1132
Eighteenth	Kolkata, India	Jan. 3-7, 2005				922

Workshop on Embedded Systems Design: History

Meeting Sequence	Place	Dates	Number of Papers	Number of Speakers	Proceedings Pages
First	New Delhi, India	Jan. 2-4, 2002	8	8	70
Second	New Delhi, India	Jan. 4-8, 2003	84	84	622
Third	Mumbai, India	Jan. 5-9, 2004	120	120	1132
Fourth	Kolkata, India	Jan. 3-7, 2005			922