

Preface

This year marks a milestone in the history of FST&TCS, which first took place in 1981. We would like to take this opportunity to express our appreciation of the foresight and commitment to excellence shown by the early organizers of the conference. The conference is now organized by IARCS (Indian Association for Research in Computing Science), and the conference has been the foundation on which the IARCS community has been built.

To commemorate the *Silver Jubilee* of FST&TCS, we had an extra day to accommodate special sessions and a larger number of invited speakers. As in previous years, we were fortunate to have a number of highly eminent researchers giving plenary talks. It gives us great pleasure to thank Manindra Agrawal, Tom Henzinger, Russell Impagliazzo, Raimund Seidel, Natarajan Shankar, Joel Spencer and Igor Walukiewicz for agreeing to give talks and for contributing to this volume.

This year's conference attracted 167 submissions with authors from 29 countries. Except for some papers which were deemed to be out of scope by the Program Committee (PC), each submission was reviewed by at least three members of the PC, with help from many external reviewers. With 466 reviews at hand, the PC deliberated for more than two weeks before finally selecting the 38 papers included in this volume. We thank all the reviewers for their invaluable help. The PC members put in a great deal of hard work to select the best papers from the submissions. We express our gratitude to all PC members for doing an excellent job. Special thanks are due to Kamal Lodaya for managing the conference software as well.

FST&TCS included two pre-conference workshops: one on *Algorithms in Networking* coordinated by Amit Kumar (IIT Delhi) and Aravind Srinivasan (University of Maryland), and another on *Software Verification* coordinated by P. Madhusudan (University of Illinois at Urbana Champaign) and Sriram Rajamani (Microsoft Research). We thank the organizers as well as the speakers at the workshops for contributing so significantly to the program.

The conference was held at the International Institute of Information Technology, Hyderabad, and the satellite workshops at the adjoining campus of the University of Hyderabad. We thank the Organizing Committee for taking on the responsibility. We gratefully acknowledge the infrastructural help provided by our institutes, the Institute of Mathematical Sciences, Chennai, and the Indian Institute of Technology, Kharagpur.

We thank Springer for their continued support of FST&TCS over the years in publishing the proceedings.

December 2005

R. Ramanujam and Sandeep Sen
Co-chairs, Program Committee,
FST&TCS 2005

CALL FOR PAPERS

Conference on FOUNDATIONS OF SOFTWARE TECHNOLOGY and THEORETICAL COMPUTER SCIENCE

Sponsored by
**National Centre for Software Development and
Computing Techniques (NCSDCT)**

December 11-12, 1981 Bangalore, India

Contributed papers are invited for the first conference scheduled to be held at
The Indian Institute of Science, Bangalore, India.

Topics : The following list of possible topics illustrate the intended scope of the conference :

Foundations of Software Technology: programming methodology, program correctness, programming languages (design, implementation, environment), operating systems, abstract software specifications.

Theoretical Computer Science : complexity of algorithms, automata theory, formal languages, theory of computation.

The conference is being organized to provide a forum for discussion at an advanced level of research topics of current interest in the areas indicated above. The conference will provide an opportunity to staff members and advanced level research students in institutions in India that have specialized post-graduate computer science programmes, for presenting their ongoing research work and plan future research/teaching activities.

The technical contents of the conference will be planned and organized by a committee comprising :

Dr. M. Joseph (NCSDCT, Bombay)
Dr. R. K. Shyamasundar (NCSDCT, Bombay)
Prof. S. V. Rangaswamy (IISc, Bangalore)
Prof. C. R. Muthukrishnan (IIT, Madras)
Prof. S. L. Mehndiratta (IIT, Bombay)
Prof. S. Maheswari (IIT, Delhi)
Prof. K. V. Nori (IIT, Kanpur)
Prof. Rani Siromoney (Madras Christian College, Madras)

Submission of Papers : Authors are requested to inform

Dr. R. K. Shyamasundar
NCSDCT
Tata Institute of Fundamental Research
Homi Bhabha Road, Bombay 400 005, India

of their intent to present a paper with a 200 words abstract before **May 15, 1981.**

Two copies of the complete version of the paper must be sent to the same address as above before **July 31, 1981.**

Authors will be notified of acceptance/rejection by **September 15, 1981.**

25 Years of FST&TCS

This Conference ... is the first of its kind being held in India and it is hoped that this would be the start of a series of such conferences to serve as a forum for discussing at an advanced level ...

Thus began the foreword to the proceedings of FST&TCS 1981. The conference aimed to provide a forum for computer science in India, a window to the rest of the world and, above all, a challenging environment in which critical analysis would ensure that high quality was scrupulously maintained. FST&TCS has fulfilled these early hopes, and may also claim to have set a standard for other computer science conferences in the region.

In 1981, there were many unknowns and neither the financial requirements nor participation from peers was assured. R. Narasimhan of Tata Institute of Fundamental Research (TIFR) provided unstinted support in all forms including funds and encouragement. Robin Milner looked past our shaky start (with flaky microphones and a projector that worked some of the time) and urged us to persevere. Maurice Nivat, the Keynote Speaker of FST&TCS 1981 and also Editor-in-Chief of the journal Theoretical Computer Science at that time, offered to bring out special issues of the journal from selected papers from the conference: this brought academic rigor as well as international visibility. From 1984 onwards, the proceedings have been published in the LNCS series by Springer. Many distinguished computer scientists have been invited speakers and have also contributed as reviewers.

Over the years, the series has redefined its goals. The focus has moved away from some of the areas that were seen as important 20 years ago. There is today altogether less focus on software technology and a great deal more on foundations. FST&TCS has also been an important step in the growth of many careers in India: many of the research students who hesitatingly submitted papers and even more hesitatingly presented them are now senior computer scientists with established reputations. In many ways, the maturing of FST&TCS has mirrored the maturing of computer science in India. The satellite workshops of the conference on state-of-the-art topics and special tutorial workshops have greatly helped to further research in India, especially for graduate students whose ability to travel abroad for conferences is limited.

Finally, we must thank all those (from India and abroad) who submitted papers, for sharing with us the belief that a conference like this was worth having and long overdue.

Thus ended the preface in 1981 and initiated the long journey that has taken us to 2005 with no fears of faltering.

December 2005

Mathai Joseph and R.K. Shyamasundar
Editors, FST&TCS 1981 Proceedings

Organization

The 25th (*Silver Jubilee*) FST&TCS conference was held at the International Institute of Information Technology, Hyderabad during December 15–18, 2005. The associated workshops were held at the University of Hyderabad, India on December 13 and December 14, 2005.

Program Committee

Luca Aceto, *Aalborg/Reykjavik University*
Mikhail Atallah, *Purdue University*
Anuj Dawar, *Cambridge University*
Paul Gastin, *École Normale Supérieure de Cachan*
Dimitra Giannakopoulou, *NASA Ames Research Center*
Sudipto Guha, *University of Pennsylvania*
Venkatesan Guruswami, *University of Washington*
Sariel Har Peled, *University of Illinois at Urbana-Champaign*
Samir Khuller, *University of Maryland*
Amit Kumar, *Indian Institute of Technology Delhi*
Kamal Lodaya, *Institute of Mathematical Sciences, Chennai*
P. Madhusudan, *University of Illinois at Urbana-Champaign*
Yossi Matias, *Tel Aviv University*
Anca Muscholl, *Université Paris 7*
Tobias Nipkow, *Technische Universität München*
Greg Plaxton, *University of Texas at Austin*
Sanjiva Prasad, *Indian Institute of Technology Delhi*
Jaikumar Radhakrishnan, *TIFR, Mumbai and TTI, Chicago*
G. Ramalingam, *IBM Research*
Rajeev Raman, *University of Leicester*
R. Ramanujam, *Institute of Mathematical Sciences, Chennai (Co-chair)*
Mark Reynolds, *University Western Australia, Perth*
Sandeep Sen, *Indian Institute of Technology Kharagpur (Co-chair)*
Santosh Vempala, *Massachusetts Institute of Technology*

Local Organizing Committee

R.K. Bagga, <i>IIIT, Hyderabad</i>	Atul Negi, <i>Univ. of Hyderabad</i>
R. Govindarajulu, <i>IIIT, Hyderabad</i>	Arun K. Pujari, <i>Univ. of Hyderabad</i>
Prosenjit Gupta, <i>IIIT, Hyd. (Chair)</i>	Kannan Srinathan, <i>IIIT, Hyderabad</i>
H. Mohanty, <i>Univ. of Hyderabad</i>	V.Ch. Venkaiah, <i>IIIT, Hyderabad</i>

Referees

Parosh Abdulla	Ewen Denney	Sanjiv Kapoor
Bharat Adsul	Alin Dobra	Deepak Kapur
Klaus Aehlig	Bruce Donald	Srinivas Kashyap
Pankaj Agarwal	Gilles Dowek	Krishnaram Kenthapadi
Rajeev Alur	Alon Efrat	Delia Kesner
Boris Aronov	Zoltán Ésik	Astrid Kiehn
Christel Baier	François Fages	David Kirkpatrick
Mohua Banerjee	Tomás Feder	Vladlen Koltun
Paul Beame	Kaspar Fischer	Stefan Kreutzer
Arnold Beckmann	Lance Fortnow	M.R.K. Krishna Rao
Eli Ben-Sasson	Cédric Fournet	Karl Krukow
Béatrice Bérard	Martin Fränzle	Michal Kunc
Mark de Berg	Tim French	Orna Kupferman
Binay Bhattacharya	Nicola Galesi	Dietrich Kuske
Bruno Blanchet	Naveen Garg	Salvatore La Torre
Mikolaj Bojanczyk	Rahul Garg	V.S. Lakshmanan
Benedikt Bollig	Blaise Genest	Ralf Lämmel
Ahmed Bouajjani	Thomas Genet	Cosimo Laneve
Patricia Bouyer	Hugo Gimbert	François Laroussinie
Guillaume Brat	Leslie Goldberg	Martin Leucker
Mario Bravetti	Dimitar Guelev	Jean-Jacques Lévy
Michele Bugliesi	Rachid Guerraoui	Nutan Limaye
Andrei Bulatov	Vladimir Gurchich	Christof Löding
Franck Cassez	Stefan Haar	Markus Lohrey
Ilaria Castellani	Boulos Harb	Alessio Lomuscio
Rohit Chadha	Ramesh Hariharan	Etienne Lozes
Amine Chaieb	Rafi Hassin	Meena Mahajan
Supratik Chakraborty	Nevin Heintze	Mohammad Mahdian
Timothy M. Chan	Tom Henzinger	Narciso Martí-Oliet
Krishnendu Chatterjee	Miki Hermann	Jean Mayo
Soma Chaudhuri	Thomas Hildebrandt	Richard Mayr
Chandra Chekuri	John Hitchcock	David McAllester
Meir Cohen	Michael Hoffmann	Ron van der Meyden
Hubert Comon	Lisha Huang	Gatis Midrijanis
Graham Cormode	Joe Hurd	Peter Bro Miltersen
Giovanna D'Agostino	Hans Hüttel	Alexandre Miquel
Deepak D'Souza	Anna Ingólfssdóttir	Bud Mishra
Victor Dalmau	Radu Iosif	Mike Mislove
Anupam Datta	François Irigoin	Joseph S.B. Mitchell
Rowan Davies	Franjo Ivančić	Mark Moir
Kalyanmoy Deb	Radha Jagadeesan	Larry Moss
Carole Delporte-Gallet	Kamal Jain	Asish Mukhopadhyay
Stéphane Demri	David Janin	Madhavan Mukund
X. Deng	Marcin Jurdziński	Andrzej Murawski

S. Muthukrishnan	Rahul Santhanam	Fabien Tarissan
K. Narayan Kumar	Sudeshna Sarkar	David Teller
Rolf Niedermeier	Jayalal Sarma	Denis Thérien
Susana Nieva Soto	Alan Schmitt	P.S. Thiagarajan
Yoshio Okamoto	Gerardo Schneider	Mitul Tiwari
S.P. Pal	Philippe Schnoebelen	Tayssir Touili
Vinayaka Pandit	Falk Schreiber	Stavros Tripakis
Paritosh Pandya	Stefan Schwoon	Kasturi Varadarajan
Amit Paradkar	Carsten Schürmann	Moshe Vardi
Frank Pfenning	Luc Segoufin	Vinodchandran Variyam
Reinhard Pichler	Géraud Sénizergues	Björn Victor
Val Pinciu	Peter Sewell	Mitchell Wand
Amir Pnueli	Natarajan Shankar	Pascal Weil
Teresa Przytycka	Priti Shankar	Jennifer Welch
Shaz Qadeer	Nikolay V. Shilov	Ryan Williams
Balaji Raghavachari	Janos Simon	James Worrell
Sriram Rajamani	Sunil Simon	Bożena Woźna
Edgar Ramos	Aravinda Sistla	Hiroaki Yamamoto
Jean-François Raskin	Milind Sohoni	Noson S. Yanofsky
Julian Rathke	Maria Sorea	Nobuko Yoshida
Anders P. Ravn	Christoph Sprenger	Francesco Zappa Nardelli
Noam Rinetzky	Jiri Srba	Marc Zeitoun
Grigore Rosu	Frank Stephan	Lisa Zhang
Tim Roughgarden	Colin Stirling	Wiesław Zielonka
Yogish Sabharwal	C.R. Subramanian	
Prahlad Sampath	S.P. Suresh	