

## Foreword

ETAPS 2003 was the sixth instance of the European Joint Conferences on Theory and Practice of Software. ETAPS is an annual federated conference that was established in 1998 by combining a number of existing and new conferences. This year it comprised five conferences (FOSSACS, FASE, ESOP, CC, TACAS), 14 satellite workshops (AVIS, CMCS, COCV, FAMAS, Feyerabend, FICS, LDTA, RSKD, SC, TACoS, UniGra, USE, WITS and WOOD), eight invited lectures (not including those that are specific to the satellite events), and several tutorials. We received a record number of submissions to the five conferences this year: over 500, making acceptance rates fall below 30% for every one of them. Congratulations to all the authors who made it to the final program! I hope that all the other authors still found a way of participating in this exciting event and I hope you will continue submitting.

A special event was held to honour the 65th birthday of Prof. Wlad Turski, one of the pioneers of our young science. The deaths of some of our “fathers” in the summer of 2002 — Dahl, Dijkstra and Nygaard — reminded us that Software Science and Technology is, perhaps, no longer that young. Against this sobering background, it is a treat to celebrate one of our most prominent scientists and his lifetime of achievements. It gives me particular personal pleasure that we are able to do this for Wlad during my term as chairman of ETAPS.

The events that comprise ETAPS address various aspects of the system development process, including specification, design, implementation, analysis and improvement. The languages, methodologies and tools which support these activities are all well within its scope. Different blends of theory and practice are represented, with an inclination towards theory with a practical motivation on the one hand and soundly based practice on the other. Many of the issues involved in software design apply to systems in general, including hardware systems, and the emphasis on software is not intended to be exclusive.

ETAPS is a loose confederation in which each event retains its own identity, with a separate program committee and independent proceedings. Its format is open-ended, allowing it to grow and evolve as time goes by. Contributed talks and system demonstrations are in synchronized parallel sessions, with invited lectures in plenary sessions. Two of the invited lectures are reserved for “unifying” talks on topics of interest to the whole range of ETAPS attendees. The aim of cramming all this activity into a single one-week meeting is to create a strong magnet for academic and industrial researchers working on topics within its scope, giving them the opportunity to learn about research in related areas, and thereby to foster new and existing links between work in areas that were formerly addressed in separate meetings.

ETAPS 2003 was organized by Warsaw University, Institute of Informatics, in cooperation with the Foundation for Information Technology Development, as well as:

- European Association for Theoretical Computer Science (EATCS);
- European Association for Programming Languages and Systems (EAPLS);
- European Association of Software Science and Technology (EASST); and

– ACM SIGACT, SIGSOFT and SIGPLAN.

The organizing team comprised:

Mikołaj Bojańczyk, Jacek Chrzaszcz, Piotr Chrząstowski-Wachtel, Grzegorz Grudziński, Kazimierz Grygiel, Piotr Hoffman, Janusz Jabłonowski, Mirosław Kowaluk, Marcin Kubica (publicity), Sławomir Leszczyński (www), Wojciech Moczydłowski, Damian Niwiński (satellite events), Aleksy Schubert, Hanna Sokołowska, Piotr Stańczyk, Krzysztof Szafran, Marcin Szczuka, Łukasz Sznuć, Andrzej Tarlecki (co-chair), Jerzy Tiuryn, Jerzy Tyszkiewicz (book exhibition), Paweł Urzyczyn (co-chair), Daria Walukiewicz-Chrzaszcz, Artur Zawłocki.

ETAPS 2003 received support from:<sup>1</sup>

- Warsaw University
- European Commission, High-Level Scientific Conferences and Information Society Technologies
- US Navy Office of Naval Research International Field Office,
- European Office of Aerospace Research and Development, US Air Force
- Microsoft Research

Overall planning for ETAPS conferences is the responsibility of its Steering Committee, whose current membership is:

Egidio Astesiano (Genoa), Pierpaolo Degano (Pisa), Hartmut Ehrig (Berlin), José Fiadeiro (Leicester), Marie-Claude Gaudel (Paris), Evelyn Duesterwald (IBM), Hubert Garavel (Grenoble), Andy Gordon (Microsoft Research, Cambridge), Roberto Gorrieri (Bologna), Susanne Graf (Grenoble), Görel Hedin (Lund), Nigel Horspool (Victoria), Kurt Jensen (Aarhus), Paul Klint (Amsterdam), Tiziana Margaria (Dortmund), Ugo Montanari (Pisa), Mogens Nielsen (Aarhus), Hanne Riis Nielson (Copenhagen), Fernando Orejas (Barcelona), Mauro Pezzè (Milano), Andreas Podelski (Saarbrücken), Don Sannella (Edinburgh), David Schmidt (Kansas), Bernhard Steffen (Dortmund), Andrzej Tarlecki (Warsaw), Igor Walukiewicz (Bordeaux), Herbert Weber (Berlin).

I would like to express my sincere gratitude to all of these people and organizations, the program committee chairs and PC members of the ETAPS conferences, the organizers of the satellite events, the speakers themselves, and Springer-Verlag for agreeing to publish the ETAPS proceedings. The final votes of thanks must go, however, to Andrzej Tarlecki and Paweł Urzyczyn. They accepted the risk of organizing what is the first edition of ETAPS in Eastern Europe, at a time of economic uncertainty, but with great courage and determination. They deserve our greatest applause.

Leicester, January 2003

José Luiz Fiadeiro  
ETAPS Steering Committee Chair

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<sup>1</sup> The contents of this volume do not necessarily reflect the positions or the policies of these organizations and no official endorsement should be inferred.

## Preface

This volume contains the proceedings of the Ninth International Conference on Tools and Algorithms for the Construction and Analysis of Systems (TACAS 2003). TACAS 2003 took place in Warsaw, Poland, from April 7th to April 11th, as part of the Sixth European Joint Conferences on Theory and Practice of Software (ETAPS 2003), whose aims, organization, and history are detailed in a foreword by the ETAPS Steering Committee Chair, Jose Luiz Fiadeiro.

TACAS is a forum for researchers, developers, and users interested in rigorously based tools for the construction and analysis of systems. The conference serves to bridge the gaps between different communities – including, but not limited to, those devoted to formal methods, software and hardware verification, static analysis, programming languages, software engineering, real-time systems, and communications protocols – that have traditionally had little interaction but share common interests in, and techniques for, tool development. In particular, by providing a venue for the discussion of common problems, heuristics, algorithms, data structures, and methodologies, TACAS aims to support researchers in their quest to improve the utility, reliability, flexibility, and efficiency of tools for building systems.

TACAS seeks theoretical papers with a clear link to tool construction, papers describing relevant algorithms and practical aspects of their implementation, papers giving descriptions of tools and associated methodologies, and case studies with a conceptual message.

The specific topics covered by the conference include, but are not limited to, the following:

- specification and verification techniques,
- theorem-proving and model-checking,
- system construction and transformation techniques,
- static and run-time analysis,
- compositional and refinement-based methodologies,
- testing and test-case generation,
- analytical techniques for real-time, hybrid, and safety-critical systems,
- tool environments and tool architectures, and
- applications and case studies.

TACAS accepts two types of contributions: research papers and tool demonstration papers. Research papers are full-length papers covering one or more of the topics above, including tool development and case studies from the perspective of scientific research. Research papers are evaluated by the TACAS Program Committee. Tool demonstration papers are shorter papers that give an overview of a particular tool and its application. To stress the importance of tool demonstrations for TACAS, these papers are evaluated and selected by a specific member of the TACAS Program Committee who holds the title of Tool Chair.

In the years since it joined the ETAPS conference federation, TACAS has been the largest of the ETAPS member conferences in terms of number of submissions and papers accepted. This year, the scale of TACAS increased in several important ways. To handle the trend of a growing number of TACAS submissions, the ETAPS Steering Committee agreed to enlarge the TACAS Program Committee from 16 to 25 members. This proved to be a wise decision — TACAS 2003 received a record number of submissions: 140 research papers and 20 tool demonstration papers were submitted. From the submitted papers, 35 research papers were accepted (acceptance ratio of 25%), 6 tool demo papers were accepted (acceptance ratio of 30%), and two of the research paper submissions were invited as tool demonstration papers. Combining the paper categories, this yields an overall acceptance rate of 27%. This represents the most competitive acceptance rate to date for TACAS (the acceptance rate has never exceeded 36% since TACAS joined ETAPS in 1999).

To carry out the difficult task of selecting a program from an unusually large number of submissions in a fair and competent manner, we were fortunate to have highly qualified program committee members from diverse geographic and research areas. Each submission was evaluated by at least three reviewers. Moreover, papers submitted by program committee members were assigned an additional reviewer and were “anonymized” by removing author names and affiliations. After a five-week reviewing process, the program selection was carried out in a two-week online program committee meeting.

We believe the result of the committee deliberations is a very strong scientific program. Also, for the first time in TACAS, tool demonstrations are not grouped together in stand-alone sessions, but instead are integrated into sessions containing research papers on related topics.

Although the scope of TACAS is quite broad in that its stated aim is to provide a forum for work about rigorously justified tools based on formal methods, theorem-proving and model-checking related methods are the ones most often found in work published at TACAS. In an effort to emphasize a broader view of formal methods at TACAS, Peter Lee was invited to give a talk presenting his perspective on tools using lighter-weight formal methods such as type-theoretic methods used in proof-carrying code.

In conclusion, successfully organizing and implementing TACAS 2003 as represented by the proceedings recorded in this volume required significant effort by many different people during the past two years (indeed, the organization of TACAS 2003 started in 2001!). Although, it is impossible to mention everyone who contributed to TACAS 2003 by name, we would like to extend our sincere thanks to the following people:

- Kurt Jensen, who served as the Tool Chair,
- the program committee members and additional referees, who performed admirably in spite of the unexpectedly high workload assigned to them,

- Martin Karusseit and Tiziana Margaria (MetaFRAME, Germany), for their constant and prompt support in dealing with the online conference management system,
- Damien Bergamini (INRIA Rhône-Alpes, France), who carried out the hard work of preparing the LNCS proceedings,
- Frédéric Lang and Bruno Oudet, for their help in preparing the TACAS 2003 website (<http://www.inrialpes.fr/vasy/tacas03>),
- William Deng, Shufeng Li, and Robby (Kansas State University, USA), for their help in administering the online conference system, reviewing assignments, and program committee meeting,
- the TACAS Steering Committee, for inviting us to chair TACAS 2003 and for advising us in numerous matters along the way,
- the ETAPS 2003 Organizing Committee including the committee co-chairs Andrzej Tarlecki and Pawel Urzyczyn, and the ETAPS Steering Committee Chair José Fiadeiro for his patient guidance and prompting over the course of many months.

January 2003

Hubert Garavel & John Hatcliff

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