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# Programming Languages and Systems

21st European Symposium on Programming, ESOP 2012  
Held as Part of the European Joint Conferences  
on Theory and Practice of Software, ETAPS 2012  
Tallinn, Estonia, March 24 – April 1, 2012  
Proceedings

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# Foreword

ETAPS 2012 is the fifteenth 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 six sister conferences (CC, ESOP, FASE, FOSSACS, POST, TACAS), 21 satellite workshops (ACCAT, AIPA, BX, BYTECODE, CMCS, DICE, FESCA, FICS, FIT, GRAPHITE, GT-VMT, HAS, IWIGP, LDTA, LINEARITY, MBT, MSFP, PLACES, QAPL, VSSE and WRLA), and eight invited lectures (excluding those specific to the satellite events).

The six main conferences received this year 606 submissions (including 21 tool demonstration papers), 159 of which were accepted (6 tool demos), giving an overall acceptance rate just above 26%. Congratulations therefore to all the authors who made it to the final programme! I hope that most of the other authors will still have found a way to participate in this exciting event, and that you will all continue to submit to ETAPS and contribute to making it the best conference on software science and engineering.

The events that comprise ETAPS address various aspects of the system development process, including specification, design, implementation, analysis, security and improvement. The languages, methodologies and tools that 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 confederation in which each event retains its own identity, with a separate Programme Committee and proceedings. Its format is open-ended, allowing it to grow and evolve as time goes by. Contributed talks and system demonstrations are in synchronised 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.

This year, ETAPS welcomes a new main conference, *Principles of Security and Trust*, as a candidate to become a permanent member conference of ETAPS. POST is the first addition to our main programme since 1998, when the original five conferences met in Lisbon for the first ETAPS event. It combines the practically important subject matter of security and trust with strong technical connections to traditional ETAPS areas.

A step towards the consolidation of ETAPS and its institutional activities has been undertaken by the Steering Committee with the establishment of *ETAPS e.V.*, a non-profit association under German law. ETAPS e.V. was founded on April 1st, 2011 in Saarbrücken, and we are currently in the process of defining its structure, scope and strategy.

ETAPS 2012 was organised by the *Institute of Cybernetics at Tallinn University of Technology*, in cooperation with

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

and with support from the following sponsors, which we gratefully thank:

INSTITUTE OF CYBERNETICS AT TUT; TALLINN UNIVERSITY OF TECHNOLOGY (TUT); ESTONIAN CENTRE OF EXCELLENCE IN COMPUTER SCIENCE (EXCS) FUNDED BY THE EUROPEAN REGIONAL DEVELOPMENT FUND (ERDF); ESTONIAN CONVENTION BUREAU; and MICROSOFT RESEARCH.

The organising team comprised:

General Chair: *Tarmo Uustalu*

Satellite Events: *Keiko Nakata*

Organising Committee: *James Chapman, Juhan Ernits, Tiina Laasma, Monika Perkmann* and their colleagues in the *Logic and Semantics* group and *administration* of the *Institute of Cybernetics*

The ETAPS portal at <http://www.etaps.org> is maintained by *RWTH Aachen University*.

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

Vladimiro Sassone (Southampton, Chair), Roberto Amadio (Paris 7), Gilles Barthe (IMDEA-Software), David Basin (Zürich), Lars Birkedal (Copenhagen), Michael O’Boyle (Edinburgh), Giuseppe Castagna (CNRS Paris), Vittorio Cortellessa (L’Aquila), Koen De Bosschere (Gent), Pierpaolo Degano (Pisa), Matthias Felleisen (Boston), Bernd Finkbeiner (Saarbrücken), Cormac Flanagan (Santa Cruz), Philippa Gardner (Imperial College London), Andrew D. Gordon (MSR Cambridge and Edinburgh), Daniele Gorla (Rome), Joshua Guttman (Worcester USA), Holger Hermanns (Saarbrücken), Mike Hinchey (Lero, the Irish Software Engineering Research Centre), Ranjit Jhala (San Diego), Joost-Pieter Katoen (Aachen), Paul Klint (Amsterdam), Jens Knoop (Vienna), Barbara König (Duisburg), Juan de Lara (Madrid), Gerald Lüttgen (Bamberg), Tiziana Margaria (Potsdam), Fabio Martinelli (Pisa), John Mitchell (Stanford), Catuscia Palamidessi (INRIA Paris), Frank Pfenning (Pittsburgh), Nir Piterman (Leicester), Don Sannella (Edinburgh), Helmut Seidl (TU Munich),

Scott Smolka (Stony Brook), Gabriele Taentzer (Marburg), Tarmo Uustalu (Tallinn), Dániel Varró (Budapest), Andrea Zisman (London), and Lenore Zuck (Chicago).

I would like to express my sincere gratitude to all of these people and organisations, the Programme Committee Chairs and PC members of the ETAPS conferences, the organisers of the satellite events, the speakers themselves, the many reviewers, all the participants, and Springer-Verlag for agreeing to publish the ETAPS proceedings in the ARCoSS subline.

Finally, I would like to thank the Organising Chair of ETAPS 2012, Tarmo Uustalu, and his Organising Committee, for arranging to have ETAPS in the most beautiful surroundings of Tallinn.

January 2012

Vladimiro Sassone  
ETAPS SC Chair

# Preface

This volume contains the papers presented at ESOP 2012, the 21st European Symposium on Programming, held March 26–28, 2012, in Tallinn, Estonia.

ESOP is an annual conference devoted to fundamental issues in the specification, design, analysis, and implementation of programming languages and systems. ESOP 2012 was the 21st edition in the series. The Programme Committee (PC) invited papers on all aspects of programming language research including: programming paradigms and styles, methods and tools to write and specify programs and languages, methods and tools for reasoning about programs, methods and tools for implementation, and concurrency and distribution.

Following previous editions, we maintained the page limit of 20 pages, and a rebuttal process of 72 hours during which the authors could respond to the reviews of their submissions. Like last year, PC submissions were not allowed. We received 106 abstracts and in the end got 92 full submissions; four submissions were withdrawn. The remaining 88 submissions were assigned to 3 to 4 PC members; eventually the PC selected 28 papers for publication. These proceedings consist of an invited paper by Bjarne Stroustrup and of the 28 selected papers.

I would like to thank the PC and the subreviewers for their dedicated work in the paper selection process, and all authors who submitted their work to the conference. I would also like to thank the 2012 Organizing Committee, chaired by Tarmo Uustalu, and the Steering Committee, chaired by Vladimiro Sassone, for coordinating the organization of ETAPS 2012. Finally, I would like to thank Andrei Voronkov, whose EasyChair system proved (once more) invaluable throughout the whole process.

January 2012

Helmut Seidl

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Laviron, Vincent	Reps, Thomas	

# Table of Contents

Foundations of C++ .....	1
<i>Bjarne Stroustrup</i>	
What's Decidable about Weak Memory Models? .....	26
<i>Mohamed Faouzi Atig, Ahmed Bouajjani, Sebastian Burckhardt, and Madanlal Musuvathi</i>	
A Formally Verified SSA-Based Middle-End: Static Single Assignment Meets CompCert.....	47
<i>Gilles Barthe, Delphine Demange, and David Pichardie</i>	
Eventually Consistent Transactions.....	67
<i>Sebastian Burckhardt, Daan Leijen, Manuel Fähndrich, and Mooly Sagiv</i>	
Concurrent Library Correctness on the TSO Memory Model.....	87
<i>Sebastian Burckhardt, Alexey Gotsman, Madanlal Musuvathi, and Hongseok Yang</i>	
Automated Verification of Equivalence Properties of Cryptographic Protocols .....	108
<i>Rohit Chadha, Ștefan Ciobâcă, and Steve Kremer</i>	
The Call-by-Need Lambda Calculus, Revisited .....	128
<i>Stephen Chang and Matthias Felleisen</i>	
A Compositional Specification Theory for Component Behaviours .....	148
<i>Taolue Chen, Chris Chilton, Bengt Jonsson, and Marta Kwiatkowska</i>	
Probabilistic Abstract Interpretation .....	169
<i>Patrick Cousot and Michael Monerau</i>	
Multiparty Session Types Meet Communicating Automata .....	194
<i>Pierre-Malo Deniélou and Nobuko Yoshida</i>	
Complete Monitors for Behavioral Contracts .....	214
<i>Christos Dimoulas, Sam Tobin-Hochstadt, and Matthias Felleisen</i>	
A Systematic Approach to Delimited Control with Multiple Prompts ...	234
<i>Paul Downen and Zena M. Ariola</i>	
Generate, Test, and Aggregate: A Calculation-Based Framework for Systematic Parallel Programming with MapReduce.....	254
<i>Kento Emoto, Sebastian Fischer, and Zhenjiang Hu</i>	

Trace Spaces: An Efficient New Technique for State-Space Reduction . . .	274
<i>Lisbeth Fajstrup, Éric Goubault, Emmanuel Haucourt, Samuel Mimram, and Martin Raussen</i>	
A Process Algebra for Wireless Mesh Networks . . . . .	295
<i>Ansgar Fehnker, Rob van Glabbeek, Peter Höfner, Annabelle McIver, Marius Portmann, and Wee Lum Tan</i>	
On the Correctness of the SIMT Execution Model of GPUs . . . . .	316
<i>Axel Habermaier and Alexander Knapp</i>	
Reasoning about Lock Placements . . . . .	336
<i>Peter Hawkins, Alex Aiken, Kathleen Fisher, Martin Rinard, and Mooly Sagiv</i>	
Reasoning about Multi-stage Programs . . . . .	357
<i>Jun Inoue and Walid Taha</i>	
Fictional Separation Logic . . . . .	377
<i>Jonas Braband Jensen and Lars Birkedal</i>	
Validating $LR(1)$ Parsers . . . . .	397
<i>Jacques-Henri Jourdan, François Pottier, and Xavier Leroy</i>	
Adding Equations to System F Types . . . . .	417
<i>Neelakantan R. Krishnaswami and Nick Benton</i>	
GMETA: A Generic Formal Metatheory Framework for First-Order Representations . . . . .	436
<i>Gyesik Lee, Bruno C.d.S. Oliveira, Sungkeun Cho, and Kwangkeun Yi</i>	
Expansion for Universal Quantifiers . . . . .	456
<i>Sergueï Lenglet and Joe B. Wells</i>	
Non-monotonic Self-Adjusting Computation . . . . .	476
<i>Ruy Ley-Wild, Umut A. Acar, and Guy Blelloch</i>	
Java and the Java Memory Model – A Unified, Machine-Checked Formalisation . . . . .	497
<i>Andreas Lochbihler</i>	
A Type and Effect System for Determinism in Multithreaded Programs . . . . .	518
<i>Yi Lu, John Potter, Chenyi Zhang, and Jingling Xue</i>	

Linear Logical Relations for Session-Based Concurrency . . . . .	539
<i>Jorge A. Pérez, Luís Caires, Frank Pfenning, and Bernardo Toninho</i>	
Staged Computation with Staged Lexical Scope . . . . .	559
<i>Morten Rhiger</i>	
Gradual Ownership Types . . . . .	579
<i>Ilya Sergey and Dave Clarke</i>	
<b>Author Index</b> . . . . .	601