

Lecture Notes in Computer Science

Edited by G. Goos, J. Hartmanis, and J. van Leeuwen

2165

Springer

Berlin

Heidelberg

New York

Barcelona

Hong Kong

London

Milan

Paris

Tokyo

Luca de Alfaro Stephen Gilmore (Eds.)

Process Algebra and Probabilistic Methods

Performance Modelling and Verification

Joint International Workshop, PAPM-PROBMIV 2001
Aachen, Germany, September 12-14, 2001
Proceedings



Springer

Series Editors

Gerhard Goos, Karlsruhe University, Germany
Juris Hartmanis, Cornell University, NY, USA
Jan van Leeuwen, Utrecht University, The Netherlands

Volume Editors

Luca de Alfaro
University of California at Berkeley, Dept. of Electr. Eng. and Computer Science
479 Cory Hall, Berkeley, CA 94720-1770, USA
E-mail: dealfaro@eecs.berkeley.edu

Stephen Gilmore
The University of Edinburgh, Laboratory for Foundations of Computer Science
Edinburgh EH9 3JZ, UK
E-mail: stg@dcs.ed.ac.uk

Cataloging-in-Publication Data applied for

Die Deutsche Bibliothek - CIP-Einheitsaufnahme

Process algebra and probabilistic methods : performance modeling and verification ; joint international workshop ; proceedings / PAPM PROBMIV 2001, Aachen, Germany, September 12 - 14, 2001. Luca de Alfaro ; Stephen Gilmore (ed.). - Berlin ; Heidelberg ; New York ; Barcelona ; Hong Kong ; London ; Milan ; Paris ; Tokyo : Springer, 2001
(Lecture notes in computer science ; Vol. 2165)
ISBN 3-540-42556-X

CR Subject Classification (1998): F.3.1, F.3, D.2.4, D.3.1, C.4

ISSN 0302-9743

ISBN 3-540-42556-X Springer-Verlag Berlin Heidelberg New York

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, re-use of illustrations, recitation, broadcasting, reproduction on microfilms or in any other way, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the German Copyright Law of September 9, 1965, in its current version, and permission for use must always be obtained from Springer-Verlag. Violations are liable for prosecution under the German Copyright Law.

Springer-Verlag Berlin Heidelberg New York
a member of BertelsmannSpringer Science+Business Media GmbH

<http://www.springer.de>

© Springer-Verlag Berlin Heidelberg 2001
Printed in Germany

Typesetting: Camera-ready by author, data conversion by PTP-Berlin, Stefan Sossna
Printed on acid-free paper SPIN: 10840347 06/3142 5 4 3 2 1 0

Preface

This volume contains the proceedings of the first joint PAPM-PROBMIV Workshop, held at the Rheinisch-Westfälische Technische Hochschule (RWTH) Aachen, Germany, 12–14 September 2001.

The PAPM-PROBMIV workshop results from the combination of two workshops: PAPM (Process Algebras and Performance Modeling) and PROBMIV (Probabilistic Methods in Verification). The aim of the joint workshop is to bring together the researchers working across the whole spectrum of techniques for the modeling, specification, analysis, and verification of probabilistic systems. Probability is widely used in the design and analysis of software and hardware systems, as a means to derive efficient algorithms (e.g. randomization), as a model for unreliable or unpredictable behavior (as in the study of fault-tolerant systems and computer networks), and as a tool to study performance and dependability properties. The topics of the workshop include specification, models and semantics of probabilistic systems, analysis and verification techniques, probabilistic methods for the verification of non-probabilistic systems, and tools and case studies.

The first PAPM workshop was held in Edinburgh in 1993; the following ones were held in Regensburg (1994), Edinburgh (1995), Torino (1996), Enschede (1997), Nice (1998), Zaragoza (1999), and Geneva (2000). The first PROBMIV workshop was held in Indianapolis, Indiana (1998); the next one took place in Eindhoven (1999). In 2000, PROBMIV was replaced by a Dagstuhl seminar on Probabilistic Methods in Verification.

The PAPM-PROBMIV workshop is held in conjunction with two other workshops: 11th GI/ITG Conference on Measuring, Modeling, and Evaluation of Computer and Communications Systems (MMB), and the 9th International Workshop on Petri Nets and Performance Models (PNPM). Together, these three workshops form the *2001 Aachen Multiconference on Measurement, Modeling, and Evaluation of Computer-Communication Systems*. We hope that this setting fosters the exchange of ideas with neighboring research fields and allows for a comparison of different viewpoints towards similar problems.

Of the 23 regular papers, 12 were accepted for presentation at the workshop and are included in the present volume. The workshop is preceded by three tutorials, given by Joost-Pieter Katoen (University of Twente) on *Probabilistic verification of Markov chains*, by Marina Ribaudó (University of Torino) on *An introduction to stochastic process algebras*, and by Roberto Segala (University of Bologna) on *Nondeterminism in probabilistic verification*. The workshop includes three invited presentations, by Shankar Sastry (University of California, Berkeley), Markus Siegle (Friedrich-Alexander Universität Erlangen-Nürnberg), and Frits Vaandrager (University of Nijmegen).

We thank all the members of the program committee, and their sub-referees, for selecting the papers to be presented. Special thanks are due to Boudewijn

Haverkort (University of Aachen), the general chair of the multi-conference and local organization, and Peter Kemper (University of Dortmund), the tool session chair. Our thanks go to the following organizations for their generous sponsorship of the Aachen multiconference: German Research Association (DFG), IBM Deutschland, Siemens AG München (Information and Communication Networks), T-Nova Deutsche Telekom Innovationsgesellschaft mbH, and TENOVIS. Our thanks also go to all the authors for meeting the tight deadlines which we set without compromising on the rigor or clarity of their papers.

July 2001

Luca de Alfaro
Stephen Gilmore

Scientific Organization

PAPM-PROBMIV 2001 Program Committee

Luca de Alfaro (Co-chair, University of California, Berkeley)
Stephen Gilmore (Co-chair, University of Edinburgh)
Gianfranco Ciardo (College of William and Mary)
Rance Cleaveland (SUNY Stony Brook)
Roberto Gorrieri (University of Bologna)
Boudewijn Haverkort (RWTH Aachen)
Ulrich Herzog (University of Erlangen)
Michael Huth (Kansas State University)
Radha Jagadeesan (Loyola University)
Joost-Pieter Katoen (University of Twente)
Leïla Kloul (University of Versailles)
Kim Larsen (University of Aalborg)
Corrado Priami (University of Verona)
Marina Ribaud (University of Turin)
Roberto Segala (University of Bologna)
Moshe Vardi (Rice University)

General Chair

Boudewijn Haverkort (University of Aachen)

Tool Session Chair

Peter Kemper (University of Dortmund)

PROBMIV Steering Committee

Marta Kwiatkowska (Chair, University of Birmingham)
Luca de Alfaro (University of California, Berkeley)
Rajeev Alur (University of Pennsylvania)
Christel Baier (University of Mannheim)
Michael Huth (Kansas State University)
Joost-Pieter Katoen (University of Twente)
Prakash Panangaden (McGill University)
Roberto Segala (University of Bologna)

PAPM Steering Committee

Ed Brinksma (University of Twente)
Roberto Gorrieri (University of Bologna)
Ulrich Herzog (University of Erlangen)
Jane Hillston (University of Edinburgh)

Referees

Alessandro Aldini	Purush Iyer
Luca de Alfaro	Paul Jackson
Suzana Andova	Radha Jagadeesan
Marco Bernardo	Joost-Pieter Katoen
Henrik Bohnenkamp	Peter Kemper
Jeremy Bradley	Uli Klehmet
Mario Bravetti	Leïla Kloul
Peter Buchholz	Rom Langerak
Gianfranco Ciardo	Kim Larsen
Graham Clark	Joachim Meyer-Kayser
Rance Cleaveland	Gethin Norman
Lucia Cloth	Prakash Panangaden
Pedro d'Argenio	Dave Parker
Jean-Michel Fourneau	Corrado Priami
Stephen Gilmore	Marina Ribaud
Roberto Gorrieri	Roberto Segala
Marco Gribaudo	Riccardo Sisto
Vineet Gupta	Gene Stark
Boudewijn Haverkort	Nigel Thomas
Holger Hermanns	Joanna Tomasik
Ulrich Herzog	Moshe Vardi
Andras Hovarth	Katinka Wolter
Michael Huth	Wlodek Zuberek

Organization

Sponsors

German Research Association (DFG)
IBM Deutschland
Siemens AG München, Information and Communication Networks
T-Nova Deutsche Telekom Innovationsgesellschaft mbH
TENOVIS

Local Arrangements Committee

Alexander Bell
Henrik Bohnenkamp
Rachid El Abdouni Kayari
Lucia Cloth
Boudewijn Haverkort
Ramin Sadre

Finance Chair

Volker Schanz (ITG, Frankfurt/Main)

Table of Contents

Invited Paper

Advances in Model Representations	1
<i>M. Siegle</i>	

Contributed Papers

Faster and Symbolic CTMC Model Checking	23
<i>J.-P. Katoen, M. Kwiatkowska, G. Norman, and D. Parker</i>	
Reachability Analysis of Probabilistic Systems by Successive Refinements	39
<i>P.R. D'Argenio, B. Jeannot, H.E. Jensen, and K.G. Larsen</i>	
Beyond Memoryless Distributions: Model Checking Semi-Markov Chains.....	57
<i>G.G. Infante López, H. Hermanns, and J.-P. Katoen</i>	
Coin Lemmas with Random Variables	71
<i>K. Folegati and R. Segala</i>	
MoDeST – A Modelling and Description Language for Stochastic Timed Systems	87
<i>P.R. D'Argenio, H. Hermanns, J.-P. Katoen, and R. Klaren</i>	
Randomization Helps in LTL Model Checking	105
<i>L. Brim, I. Černá, and M. Nečesal</i>	
An Efficient Kronecker Representation for PEPA Models.....	120
<i>J. Hillston and L. Kloul</i>	
Reward Based Congruences: Can We Aggregate More?	136
<i>M. Bernardo and M. Bravetti</i>	
Using Max-Plus Algebra for the Evaluation of Stochastic Process Algebra Prefixes	152
<i>L. Cloth, H. Bohnenkamp, and B. Haverkort</i>	
Expressing Processes with Different Action Durations through Probabilities	168
<i>M. Bravetti and A. Aldini</i>	
Quantifying the Dynamic Behavior of Process Algebras	184
<i>P. Buchholz and P. Kemper</i>	

Implementing a Stochastic Process Algebra within the Möbius Modeling Framework.....	200
<i>G. Clark and W.H. Sanders</i>	
Author Index	217

Author Index

- Aldini, A. 168
- Bernardo, M. 136
- Bohnenkamp, H. 152
- Bravetti, M. 136, 168
- Brim, L. 105
- Buchholz, P. 184
- Černá, I. 105
- Clark, G. 200
- Cloth, L. 152
- D'Argenio, P.R. 39, 87
- Folegati, K. 71
- Haverkort, B. 152
- Hermanns, H. 57, 87
- Hillston, J. 120
- Infante López, G.G. 57
- Jeannet, B. 39
- Jensen, H.E. 39
- Katoen, J.-P. 23, 57, 87
- Kemper, P. 184
- Klaren, R. 87
- Kloul, L. 120
- Kwiatkowska, M. 23
- Larsen, K.G. 39
- Nečesal, M. 105
- Norman, G. 23
- Parker, D. 23
- Sanders, W.H. 200
- Segala, R. 71
- Siegle, M. 1