

*Commenced Publication in 1973*

Founding and Former Series Editors:

Gerhard Goos, Juris Hartmanis, and Jan van Leeuwen

## Editorial Board

David Hutchison

*Lancaster University, UK*

Takeo Kanade

*Carnegie Mellon University, Pittsburgh, PA, USA*

Josef Kittler

*University of Surrey, Guildford, UK*

Jon M. Kleinberg

*Cornell University, Ithaca, NY, USA*

Alfred Kobsa

*University of California, Irvine, CA, USA*

Friedemann Mattern

*ETH Zurich, Switzerland*

John C. Mitchell

*Stanford University, CA, USA*

Moni Naor

*Weizmann Institute of Science, Rehovot, Israel*

Oscar Nierstrasz

*University of Bern, Switzerland*

C. Pandu Rangan

*Indian Institute of Technology, Madras, India*

Bernhard Steffen

*TU Dortmund University, Germany*

Madhu Sudan

*Microsoft Research, Cambridge, MA, USA*

Demetri Terzopoulos

*University of California, Los Angeles, CA, USA*

Doug Tygar

*University of California, Berkeley, CA, USA*

Gerhard Weikum

*Max Planck Institute for Informatics, Saarbruecken, Germany*

Roberto Baldoni Nicolas Nisse  
Maarten van Steen (Eds.)

# Principles of Distributed Systems

17th International Conference, OPODIS 2013  
Nice, France, December 16-18, 2013  
Proceedings

## Volume Editors

Roberto Baldoni

Sapienza Research Center of Cyber Intelligence and Information Security

*and*

Università degli Studi di Roma "La Sapienza"

Dipartimento di Ingegneria Informatica, Automatica e Gestionale "Antonio Ruberti"

Via Ariosto 25, 00185 Rome, Italy

E-mail: baldoni@dis.uniroma1.it

Nicolas Nisse

Inria, France

*and*

Université Nice Sophia Antipolis CNRS, 13S, UMR 7271

06900 Sophia Antipolis, France

E-mail: nicolas.nisse@inria.fr

Maarten van Steen

Vrije Universiteit Amsterdam

Department of Computer Science

De Boelelaan 1081a, 1081 HV Amsterdam, The Netherlands

E-mail: steen@cs.vu.nl

ISSN 0302-9743

e-ISSN 1611-3349

ISBN 978-3-319-03849-0

e-ISBN 978-3-319-03850-6

DOI 10.1007/978-3-319-03850-6

Springer Cham Heidelberg New York Dordrecht London

Library of Congress Control Number: 2013954562

CR Subject Classification (1998): C.2.4, C.2, F.2, D.2, I.2.11, G.2.2

LNCS Sublibrary: SL 1 – Theoretical Computer Science and General Issues

© Springer International Publishing Switzerland 2013

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed. Exempted from this legal reservation are brief excerpts in connection with reviews or scholarly analysis or material supplied specifically for the purpose of being entered and executed on a computer system, for exclusive use by the purchaser of the work. Duplication of this publication or parts thereof is permitted only under the provisions of the Copyright Law of the Publisher's location, in its current version, and permission for use must always be obtained from Springer. Permissions for use may be obtained through RightsLink at the Copyright Clearance Center. Violations are liable to prosecution under the respective Copyright Law.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

While the advice and information in this book are believed to be true and accurate at the date of publication, neither the authors nor the editors nor the publisher can accept any legal responsibility for any errors or omissions that may be made. The publisher makes no warranty, express or implied, with respect to the material contained herein.

*Typesetting:* Camera-ready by author, data conversion by Scientific Publishing Services, Chennai, India

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

# Preface

This volume contains the papers presented at OPODIS 2013. OPODIS, the International Conference on Principles of Distributed Systems, is an international forum for the exchange of state-of-the-art knowledge on distributed computing and systems among researchers from around the world. The 17th edition of OPODIS was held during December 16–18, 2013 in Nice, France.

Papers were sought soliciting original research contributions to the theory, specification, design and implementation of distributed systems. In response to the call for papers, 41 submissions were received, out of which 18 papers were accepted, after a rigorous reviewing process that involved 33 Program Committee members and at least three reviews per paper.

We would like to thank the Program Committee members, as well as the external reviewers, for their fundamental contribution in selecting the best papers.

In addition to the technical papers, the program included five invited presentations by: Marcos k. Aguilera (Microsoft Research, USA), Eitan Altman (Inria, France), Hein Meling (University of Stravanger, Norway), Nuno Preguica (Universidade Nova de Lisboa, Portugal) and Marc Shapiro (Inria, France).

September 2013

Roberto Baldoni  
Nicolas Nisse  
Maarten van Steen

# Organization

## Program Committee

Marco Aiello	University of Groningen, The Netherlands
Roberto Baldoni	Università di Roma “La Sapienza”, Italy
Christian Cachin	IBM Research, Zurich, Switzerland
Antonio Carzaniga	University of Lugano, Switzerland
Gregory Chockler	IBM Haifa Research Laboratory, Israel
Allen Clement	Max Planck Institute for Software Systems, Germany
Paolo Costa	Microsoft Research Cambridge, UK
Dick Epema	Delft University of Technology, The Netherlands
Patrick Eugster	Purdue University, USA
Pascal Felber	Université de Neuchâtel, Switzerland
Antonio Fernandez Anta	Institute IMDEA Networks, Spain
Paola Flocchini	University of Ottawa, Canada
Ali Ghodsi	University of California at Berkeley, USA
Rachid Guerraoui	EPFL, Switzerland
Aaron Harwood	University of Melbourne, Australia
Konrad Iwanicki	University of Warsaw, Poland
Mark Jelasity	University of Szeged, Hungary
Ricardo Jimenez Peris	Universidad Politécnica de Madrid, Spain
Anne-Marie Kermarrec	Inria, France
Hein Meling	University of Stavanger, Norway
Alessia Milani	Bordeaux Institute of Technology, France
Alberto Montresor	University of Trento, Italy
Nicolas Nisse	Inria, France
Peter Pietzuch	Imperial College London, UK
Maria Potop-Butucaru	Université Pierre et Marie Curie-LIP6, France
Luis Rodrigues	Universidade de Lisboa, Portugal
Cristina Seceleanu	Malardalen University, Sweden
Marc Shapiro	Inria, Univ. Pierre et Marie Curie-LIP6, France
Alex Shraer	Google, USA
Peter Triantafillou	University of Glasgow, Scotland
Frits Vaandrager	Radboud University Nijmegen, The Netherlands
Maarten van Steen	VU University Amsterdam, The Netherlands
Paulo Verissimo	Universidade de Lisboa, Portugal

Roman Vitenberg  
Spyros Voulgaris  
Masafumi Yamashita

University of Oslo, Norway  
Vrije Universiteit Amsterdam, The Netherlands  
Kyushu University, Fukuoka, Japan

## **Additional Reviewers**

Anagnostopoulos, Christos  
Ananthanarayanan, Ganesh  
Arad, Cosmin  
Culhane, William  
Dobre, Dan  
Georgievski, Ilche  
Godard, Emmanuel  
Jehl, Leander  
Kogan, Kirill  
Lamani, Anissa  
Lehmann, Anja  
Marinescu, Raluca  
Mostefaoui, Achour  
Pagani, Giuliano Andrea

Perelman, Dmitri  
Schmid, Ulrich  
Sens, Pierre  
Shafaat, Tallat M.  
Shavit, Nir  
Sutra, Pierre  
Taherkordi, Amir  
Travers, Corentin  
Trehan, Amitabh  
Tretmans, Jan  
Tso, Posco  
Urdaneta, Guido  
Verbeek, Freek  
Vilaca, Xavier

## **Invited Talks**

# Geo-Distributed Storage in Data Centers

Marcos K. Aguilera

Microsoft Research  
Mountain View, CA, USA

**Abstract.** Data centers increasingly have a storage system that is *geo-distributed*, that is, distributed across several geographic locations. We explain the general characteristics of this setting and the challenges that it brings, chief among them the need to operate with low latency despite significant network delays. These challenges lead to many interesting problems: migrating data online, dealing with congestion, providing efficient transactions, and more. We discuss these problems and some recent solutions, which bring together techniques from distributed computing, distributed systems, and database systems. Despite much progress, however, several algorithmic and fundamental questions remain open and serve as inspiration for further investigation.



# Dynamic Game Models in Complex Systems

Eitan Altman \*

Inria, France

`eitan.altman@inria.fr`

**Abstract.** We begin the tutorial with a theoretic part that covers two areas: non-cooperative game theory, and population propagation models. In the game theory part, a particular attention will be given to potential games. We shall focus in particular on congestion games and on the game version of the generalized Kelly mechanism problem, both of which are known to be potential games. In our presentation of models for population propagation models, we shall present several models which we shall classify according to the size of population of potential interested destination nodes (which can be finite and constant, finite but non-constant or infinite), and the virality of the content. This will include branching and epidemic models. We shall then use these tools to study various applications to large networks. This will include (1) security issues related to e-virus attacks, (2) the question of what type of content should service providers specialize in, which will be solved by transforming it into an equivalent congestion game, (3) issues related to viral marketing and competition issues in social networks. In these problems the generalized Kelly mechanism will be frequently used. The game theoretic analysis will allow us to get insight on how much to spend on advertising products and on what product should we advertise. Both journal and conference papers as well as video presentations covering this tutorial are available at <http://www-sop.inria.fr/members/Eitan.Altman/dodescaden.html>

---

\* This work was supported by CONGAS Project (FP7- ICT-2011-8-317672), see [www.congas-project.eu](http://www.congas-project.eu)

# Table of Contents

Tutorial Summary: Paxos Explained from Scratch . . . . .	1
<i>Hein Meling and Leander Jehl</i>	
On Two-Party Communication through Dynamic Networks . . . . .	11
<i>Sebastian Abshoff, Markus Benter, Manuel Malatyali, and Friedhelm Meyer auf der Heide</i>	
Eventual Leader Election in Evolving Mobile Networks . . . . .	23
<i>Luciana Arantes, Fabíola Greve, Pierre Sens, and Véronique Simon</i>	
Self-stabilizing Leader Election in Population Protocols over Arbitrary Communication Graphs . . . . .	38
<i>Joffroy Beauquier, Peva Blanchard, and Janna Burman</i>	
$\alpha$ -Register . . . . .	53
<i>David Bonnin and Corentin Travers</i>	
How (Not) to Shoot in Your Foot with SDN Local Fast Failover: A Load-Connectivity Tradeoff . . . . .	68
<i>Michael Borokhovich and Stefan Schmid</i>	
Message Passing or Shared Memory: Evaluating the Delegation Abstraction for Multicores . . . . .	83
<i>Irina Calciu, Dave Dice, Tim Harris, Maurice Herlihy, Alex Kogan, Virendra Marathe, and Mark Moir</i>	
Reputation-Based Mechanisms for Evolutionary Master-Worker Computing . . . . .	98
<i>Evgenia Christoforou, Antonio Fernández Anta, Chryssis Georgiou, Miguel A. Mosteiro, and Angel (Anxo) Sánchez</i>	
State-Driven Testing of Distributed Systems . . . . .	114
<i>Domenico Cotroneo, Roberto Natella, Stefano Russo, and Fabio Scippacercola</i>	
Self-stabilizing Resource Discovery Algorithm . . . . .	129
<i>Seda Davtyan, Kishori M. Konwar, and Alexander A. Shvartsman</i>	
Hybrid Distributed Consensus . . . . .	145
<i>Roy Friedman, Gabriel Kliot, and Alex Kogan</i>	

Speculative Concurrent Processing with Transactional Memory in the Actor Model . . . . .	160
<i>Yaroslav Hayduk, Anita Sobe, Derin Harmanaci, Patrick Marlier, and Pascal Felber</i>	
An Optimal Broadcast Algorithm for Content-Addressable Networks . . .	176
<i>Ludovic Henrio, Fabrice Huet, and Justine Rochas</i>	
On Local Fixing . . . . .	191
<i>Michael König and Roger Wattenhofer</i>	
A Skiplist-Based Concurrent Priority Queue with Minimal Memory Contention . . . . .	206
<i>Jonatan Lindén and Bengt Jonsson</i>	
VirtuCast: Multicast and Aggregation with In-Network Processing : An Exact Single-Commodity Algorithm . . . . .	221
<i>Matthias Rost and Stefan Schmid</i>	
Mobile Byzantine Agreement on Arbitrary Network . . . . .	236
<i>Toru Sasaki, Yukiko Yamauchi, Shuji Kijima, and Masafumi Yamashita</i>	
On Scheduling Algorithms for MapReduce Jobs in Heterogeneous Clouds with Budget Constraints . . . . .	251
<i>Yang Wang and Wei Shi</i>	
Fast and Scalable Queue-Based Resource Allocation Lock on Shared-Memory Multiprocessors . . . . .	266
<i>Deli Zhang, Brendan Lynch, and Damian Dechev</i>	
<b>Author Index . . . . .</b>	<b>281</b>