

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

University of Dortmund, Germany

Madhu Sudan

Massachusetts Institute of Technology, MA, USA

Demetri Terzopoulos

University of California, Los Angeles, CA, USA

Doug Tygar

University of California, Berkeley, CA, USA

Gerhard Weikum

Max-Planck Institute of Computer Science, Saarbruecken, Germany

Sotiris E. Nikolettseas Bogdan S. Chlebus
David B. Johnson Bhaskar Krishnamachari (Eds.)

Distributed Computing in Sensor Systems

4th IEEE International Conference, DCOSS 2008
Santorini Island, Greece, June 11-14, 2008
Proceedings

Volume Editors

Sotiris E. Nikolettseas
CTI and University of Patras
Computer Engineering and Informatics Department
Patras, Greece
E-mail: nikole@cti.gr

Bogdan S. Chlebus
University of Colorado at Denver
Department of Computer Science and Engineering
Denver CO 80217, USA
E-mail: Bogdan.Chlebus@cudenver.edu

David B. Johnson
Rice University
Department of Computer Science
Houston, TX 77005-1892, USA
E-mail: dbj@cs.rice.edu

Bhaskar Krishnamachari
University of Southern California
Department of Electrical Engineering
Los Angeles, CA 90089, USA
E-mail: bkrishna@usc.edu

Library of Congress Control Number: 2008928150

CR Subject Classification (1998): C.2.4, C.2, D.4.4, E.1, F.2.2, G.2.2, H.4

LNCS Sublibrary: SL 5 – Computer Communication Networks
and Telecommunications

ISSN 0302-9743
ISBN-10 3-540-69169-3 Springer Berlin Heidelberg New York
ISBN-13 978-3-540-69169-3 Springer 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. Violations are liable to prosecution under the German Copyright Law.

Springer is a part of Springer Science+Business Media

springer.com

© Springer-Verlag Berlin Heidelberg 2008
Printed in Germany

Typesetting: Camera-ready by author, data conversion by Scientific Publishing Services, Chennai, India
Printed on acid-free paper SPIN: 12275786 06/3180 5 4 3 2 1 0

Message from the General Co-chairs

We are pleased to welcome you to Santorini Island, Greece, for DCOSS 2008, the IEEE International Conference on Distributed Computing in Sensor Systems, the fourth event in this series of annual conferences. The DCOSS meetings cover the key aspects of distributed computing in sensor systems, such as high-level abstractions, computational models, systematic design methodologies, algorithms, tools, and applications. This meeting would not be possible without the tireless efforts of many volunteers. We are indebted to the DCOSS 2008 Program Chair, Sotiris Nikolettseas, for overseeing the review process, composing the technical program, and making the local arrangements. We appreciate his leadership in putting together a strong and diverse Program Committee, whose members cover the various aspects of this multidisciplinary research area. We would like to thank the Program Committee Vice Chairs, Bogdan Chlebus, Bhaskar Krishnamachari, and David B. Johnson, as well as the members of the Program Committee, the external referees consulted by the PC, and all of the authors who submitted their work to DCOSS 2008. We also wish to thank the keynote speakers for their participation in the meeting.

Several volunteers contributed significantly to the realization of the meeting. We wish to thank the organizers of the workshops collocated with DCOSS 2008 as well as the DCOSS Workshop Chair, Koen Langendoen, for coordinating workshop activities. We would like to thank Yang Yu and Thiemo Voigt for their efforts in organizing the poster session and demo session, respectively. Special thanks goes to Kay Romer for organizing the Work-in-Progress session and to Luis Almeida for the DCOSS competition event. Special thanks also goes to Tian He and Cristina Pinotti for handling conference publicity, and to Zachary Baker for his assistance in putting together this proceedings volume. Many thanks also go to Animesh Pathak for maintaining the conference webpage and Germaine Gusthiot for handling the conference finances.

We would like to especially thank Jose Rolim, DCOSS Steering Committee Chair, for inviting us to be the General Chairs. His invaluable input in shaping this conference series and his timely intervention in resolving meeting-related issues are gratefully acknowledged.

Finally, we would like to acknowledge the sponsors of DCOSS 2008. Their contributions are always a key enabler of a successful conference. The research area of sensor networks is rapidly evolving, influenced by fascinating advances in supporting technologies. We sincerely hope that this conference series will continue to serve as a forum for researchers working in different, complementary areas of this multidisciplinary field to exchange ideas and interact, cross-fertilizing research on the algorithmic and foundational side, as well as of high-level approaches and the

more applied and technological issues related to the tools and applications of wireless sensor networks.

We hope you enjoy the meeting.

June 2008

Tarek Abdelzaher
Viktor K. Prasanna

Message from the Program Chair

This proceedings volume contains the accepted papers of the Fourth International Conference on Distributed Computing in Sensor Systems. DCOSS 2008 received a record of 116 submissions to its three tracks covering the areas of Algorithms, Systems, and Applications. During the review procedure at least two reviews for all papers and three (or more) reviews for most papers were solicited. After a fruitful exchange of opinions and comments during the final stage, 29 papers (25% acceptance ratio) were accepted as regular papers. Also, 12 papers were accepted as short papers.

The research contributions in these proceedings span diverse important aspects of sensor networking, including energy management, communication, coverage and tracking, time synchronization and scheduling, key establishment and authentication, compression, medium access control, code update, and mobility. A multitude of novel algorithmic design and analysis techniques, systematic approaches, and application development methodologies are proposed for distributed sensor networking, a research area in which complementarity and cross-fertilization are of vital importance.

I would like to thank the three Program Vice Chairs, Bogdan Chlebus (Algorithms), David B. Johnson (Systems), Bhaskar Krishnamachari (Applications) for agreeing to lead the review process in their Track and for an efficient and smooth cooperation; also, the members of the strong and broad DCOSS 2008 Program Committee, as well as the external reviewers who worked with them. I wish to thank the Steering Committee Chair, Jose Rolim, and the DCOSS 2008 General Chairs, Tarek Abdelzaher and Viktor Prasanna, for their trust and their valuable contribution to the organization of the conference, as well as the Proceedings Chair, Zachary Baker, for his tireless efforts in preparing these conference proceedings.

June 2008

Sotiris Nikolettseas

Organization

General Chair

Tarek Abdelzaher Univ. of Illinois, Urbana Champaign, USA

Vice General Chair

Viktor K. Prasanna University of Southern California, USA

Program Chair

Sotiris Nikolettseas University of Patras and CTI, Greece

Program Vice Chairs

Algorithms

Bogdan Chlebus Univ. of Colorado at Denver, USA

Applications

Bhaskar Krishnamachari Univ. of Southern California, USA

Systems

David B. Johnson Rice University, USA

Steering Committee Chair

Jose Rolim University of Geneva, Switzerland

Steering Committee

Sajal Das University of Texas at Arlington, USA
Josep Diaz UPC Barcelona, Spain
Deborah Estrin University of California, Los Angeles, USA
Phillip B. Gibbons Intel Research, Pittsburgh, USA
Sotiris Nikolettseas University of Patras and CTI, Greece
Christos Papadimitriou University of California, Berkeley, USA
Kris Pister University of California, Berkeley, and Dust,
Inc., USA
Viktor Prasanna University of Southern California, Los Angeles,
USA

Poster Chair

Yang Yu Motorola Labs, USA

Workshops Chair

Koen Langendoen Delft University of Technology,
The Netherlands

Proceedings Chair

Zachary Baker Los Alamos National Lab, USA

Publicity Co-chairs

Tian He University of Minnesota, USA
Cristina Pinotti University of Perugia, Italy

Web Publicity Chair

Animesh Pathak Univ. of Southern California, USA

Finance Chair

Germaine Gusthiot University of Geneva, Switzerland

Work-in-Progress Chair

Kay Römer ETH, Zurich, Switzerland

Demo Chair

Thiemo Voigt Swedish Institute of Computer Science, Sweden

Competition Chair

Luís Almeida Universidade de Aveiro, Portugal

Sponsoring Organizations

IEEE Computer Society Technical Committee on Parallel Processing (TCPP)
IEEE Computer Society Technical Committee on Distributed Processing
(TCDP)

INTRALOT (www.intralot.com)
 University of Patras (www.upatras.gr)
 Greek Ministry of National Education and Religious Affairs (www.ypepth.gr)
 University of Geneva (www.unige.ch)
 TCS-Sensor Lab (Theoretical Computer Science and Sensor Nets) at the
 University of Geneva (<http://tcs.unige.ch/>)

Support from

Computer Engineering and Informatics Department of U. of Patras
 (www.ceid.upatras.gr)
 Research Academic Computer Technology Institute (CTI, www.cti.gr)
 SensorsLab at CTI/Research Unit 1 (ru1sensorslab.cti.gr)
 EU R&D Project AEOLUS (Algorithmic Principles for Building Efficient
 Overlay Computers, aeolus.ceid.upatras.gr)
 EU R&D Project FRONTS (Foundations of Adaptive Networked Societies
 of Tiny Artefacts, fronts.cti.gr)
 EU R&D Project ProSense (Promote, Mobilize, Reinforce and Integrate
 Wireless Sensor Networking Research and Researchers: Towards Pervasive
 Networking of WBC and the EU)
 EU R&D Project WISEBED (Wireless Sensor Network Testbeds)

Held in Co-operation with

ACM Special Interest Group on Computer Architecture (SIGARCH)
 ACM Special Interest Group on Embedded Systems (SIGBED)
 European Association for Theoretical Computer Science (EATCS)
 IFIP WG 10.3

Program Committee

Algorithms

Matthew Andrews	Bell Labs, USA
James Aspnes	Yale, USA
Costas Busch	Louisiana State University, USA
Bogdan Chlebus (Chair)	University of Colorado Denver, USA
Andrea Clementi	University of Rome 'Tor Vergata', Italy
Eric Fleury	ENS Lyon/INRIA, France
Rachid Guerraoui	EPF Lausanne, Switzerland
Evangelos Kranakis	Carleton University, Canada
Shay Kutten	Technion, Israel
Mirosław Kutylowski	Wrocław Technical University, Poland
Andrew McGregor	University of California San Diego, USA

Muthu Muthukrishnan	Google, USA
Christian Scheideler	Technical University Munich, Germany
Maria Serna	Technical University of Catalonia, Spain
Paul Spirakis	University of Patras and CTI, Greece
Srikanta Tirthapura	Iowa State University, USA

Applications

Dinos Ferentinos	Agricultural University of Athens, Greece
Paul Havinga	University of Twente, Netherlands
Stuart Kininmonth	Australian Institute of Marine Sciences, Australia
Bhaskar Krishnamachari (Chair)	University of Southern California, USA
Koen Langendoen	TU Delft, Netherlands
Suman Nath	Microsoft Research, USA
Neal Patwari	University of Utah, USA
Joe Polastre	Sentilla, USA
Cem Saraydar	General Motors, USA
Vikram Srinivasan	National University of Singapore, Singapore
Andrea Terzis	Johns Hopkins University, USA
Sameer Tilak	San Diego Supercomputer Center, UC San Diego, USA
Kamin Whitehouse	University of Virginia, USA
Yang Yu	Motorola Research, USA
Kasun De Zoysa	University of Colombo, Sri Lanka

Systems

Stefano Basagni	Northeastern University, USA
Prithwish Basu	BBN, USA
Jan Beutel	ETH Zurich, Switzerland
Andrew Campbell	Dartmouth College, USA
Amol Deshpande	University of Maryland, USA
Yih-Chun Hu	University of Illinois at Urbana-Champaign, USA
David B. Johnson (Chair)	Rice University, USA
Bill Kaiser	University of California, Los Angeles, USA
Sharad Mehrotra	University of California, Irvine, USA
Shivakant Mishra	University of Colorado at Boulder, USA
Santashil PalChaudhuri	Aruba Networks, USA
Adrian Perrig	Carnegie Mellon University, USA
Chiara Petrioli	University of Rome “La Sapienza”, Italy
Mani Srivastava	University of California, Los Angeles, USA
Wei Ye	USC Information Sciences Institute, USA
Vladimir Zadorozhny	University of Pittsburgh, USA

Referees

Joon Ahn	Ravi Jammalamadaka	Sundeep Patterm
Novella Bartolini	Vikas Kawadia	Michał Ren
Tiziana Calamoneri	Marcin Kik	Niky Riga
Alessio Carosi	Mirosła Korzeniowski	Gianluca Rossi
Jerry Chaing	Michał Koza	Amit Saha
Jihyuk Choi	Prashant Krishnamurthy	Stefan Schmid
Anshuman Dasgupta	Rajesh Krishnan	Jens Schmitt
Miriam Di Ianni	Rajnish Kumar	Divyasheel Sharma
Shane Eisenman	Nic Lane	Simone Silvestri
Vissarion Ferentinos	Chih-Kuang Lin	Avinash Sridharan
Emanuele Fusco	Francesco Lo Presti	Mario Strasser
Sachin Ganu	Mihai Marin-Perianu	Ahren Studer
Maciej Gebala	Daniel Massaguer	Ronen Vaisenberg
Amitabha Ghosh	Michele Mastrogiovanni	Paola Vocca
Luciano Guala	Jonathan McCune	Yi Wang
Min Guo	Alberto Medina	Matthias Woehrle
Jason Haas	Ghita Mezzour	Bo Xing
Elyes Ben Hamida	Emiliano Miluzzo	Xingbo Yu
Bijit Hore	Gianpiero Monaco	Marcin Zawada
Kévin Huguenin	Mirco Musolesi	
Hojjat Jafarpour	Michele Nati	

Table of Contents

Performance of a Propagation Delay Tolerant ALOHA Protocol for Underwater Wireless Networks	1
<i>Joon Ahn and Bhaskar Krishnamachari</i>	
Time Synchronization in Heterogeneous Sensor Networks	17
<i>Isaac Amundson, Branislav Kusy, Peter Volgyesi, Xenofon Koutsoukos, and Akos Ledeczi</i>	
Stochastic Counting in Sensor Networks, or: Noise Is Good	32
<i>Y.M. Baryshnikov, E.G. Coffman, K.J. Kwak, and Bill Moran</i>	
On the Deterministic Tracking of Moving Objects with a Binary Sensor Network	46
<i>Yann Busnel, Leonardo Querzoni, Roberto Baldoni, Marin Bertier, and Anne-Marie Kermarrec</i>	
An Adaptive and Autonomous Sensor Sampling Frequency Control Scheme for Energy-Efficient Data Acquisition in Wireless Sensor Networks	60
<i>Supriyo Chatterjea and Paul Havinga</i>	
LiveNet: Using Passive Monitoring to Reconstruct Sensor Network Dynamics	79
<i>Bor-rong Chen, Geoffrey Peterson, Geoff Mainland, and Matt Welsh</i>	
Broadcast Authentication in Sensor Networks Using Compressed Bloom Filters	99
<i>Yu-Shian Chen, I-Lun Lin, Chin-Laung Lei, and Yen-Hua Liao</i>	
On the Urban Connectivity of Vehicular Sensor Networks	112
<i>Hugo Conceição, Michel Ferreira, and João Barros</i>	
FIT: A Flexible, LIght-Weight, and Real-Time Scheduling System for Wireless Sensor Platforms	126
<i>Wei Dong, Chun Chen, Xue Liu, Kougen Zheng, Rui Chu, and Jiajun Bu</i>	
Automatic Collection of Fuel Prices from a Network of Mobile Cameras	140
<i>Y.F. Dong, S. Kanhere, C.T. Chou, and N. Bulusu</i>	
Techniques for Improving Opportunistic Sensor Networking Performance	157
<i>Shane B. Eisenman, Nicholas D. Lane, and Andrew T. Campbell</i>	

On the Average Case Communication Complexity for Detection in Sensor Networks	176
<i>N.E. Venkatesan, Tarun Agarwal, and P. Vijay Kumar</i>	
Fault-Tolerant Compression Algorithms for Delay-Sensitive Sensor Networks with Unreliable Links	190
<i>Alexandre Guitton, Niki Trigoni, and Sven Helmer</i>	
Improved Distributed Simulation of Sensor Networks Based on Sensor Node Sleep Time	204
<i>Zhong-Yi Jin and Rajesh Gupta</i>	
Frugal Sensor Assignment	219
<i>Matthew P. Johnson, Hosam Rowaihy, Diego Pizzocaro, Amotz Bar-Noy, Stuart Chalmers, Thomas La Porta, and Alun Preece</i>	
Tug-of-War: An Adaptive and Cost-Optimal Data Storage and Query Mechanism in Wireless Sensor Networks	237
<i>Yuh-Jzer Joung and Shih-Hsiang Huang</i>	
Towards Diagnostic Simulation in Sensor Networks	252
<i>Mohammad Maifi Hasan Khan, Tarek Abdelzaher, and Kamal Kant Gupta</i>	
Sensor Placement for 3-Coverage with Minimum Separation Requirements	266
<i>Jung-Eun Kim, Man-Ki Yoon, Junghee Han, and Chang-Gun Lee</i>	
Power Assignment Problems in Wireless Communication: Covering Points by Disks, Reaching few Receivers Quickly, and Energy-Efficient Travelling Salesman Tours	282
<i>Stefan Funke, Sören Laue, Rowen Naujoks, and Zvi Lotker</i>	
Distributed Activity Recognition with Fuzzy-Enabled Wireless Sensor Networks	296
<i>Mihai Marin-Perianu, Clemens Lombriser, Oliver Amft, Paul Havinga, and Gerhard Tröster</i>	
CaliBree: A Self-calibration System for Mobile Sensor Networks	314
<i>Emiliano Miluzzo, Nicholas D. Lane, Andrew T. Campbell, and Reza Olfati-Saber</i>	
An Information Theoretic Framework for Field Monitoring Using Autonomously Mobile Sensors	332
<i>Hany Morcos, George Atia, Azer Bestavros, and Ibrahim Matta</i>	
Coverage Estimation in the Presence of Occlusions for Visual Sensor Networks	346
<i>Cheng Qian and Hairong Qi</i>	

Time-Bounded and Space-Bounded Sensing in Wireless Sensor Networks	357
<i>Olga Saukh, Robert Sauter, and Pedro José Marrón</i>	
SAKE: Software Attestation for Key Establishment in Sensor Networks	372
<i>Arvind Seshadri, Mark Luk, and Adrian Perrig</i>	
Improving the Data Delivery Latency in Sensor Networks with Controlled Mobility	386
<i>Ryo Sugihara and Rajesh K. Gupta</i>	
Decoding Code on a Sensor Node	400
<i>Pascal von Rickenbach and Roger Wattenhofer</i>	
Local PTAS for Independent Set and Vertex Cover in Location Aware Unit Disk Graphs (Extended Abstract)	415
<i>Andreas Wiese and Evangelos Kranakis</i>	
Multi-root, Multi-Query Processing in Sensor Networks	432
<i>Zhiguo Zhang, Ajay Kshemkalyani, and Sol M. Shatz</i>	
Short Papers	
Snap and Spread: A Self-deployment Algorithm for Mobile Sensor Networks	451
<i>N. Bartolini, T. Calamoneri, E.G. Fusco, A. Massini, and S. Silvestri</i>	
An In-Field-Maintenance Framework for Wireless Sensor Networks	457
<i>Qihua Cao and John A. Stankovic</i>	
Deterministic Secure Positioning in Wireless Sensor Networks	469
<i>Sylvie Delaët, Partha Sarathi Mandal, Mariusz A. Rokicki, and Sébastien Tixeuil</i>	
Efficient Node Discovery in Mobile Wireless Sensor Networks	478
<i>Vladimir Dyo and Cecilia Mascolo</i>	
Decentralized Deployment of Mobile Sensors for Optimal Connected Sensing Coverage	486
<i>Adriano Fagiolini, Lisa Tani, Antonio Bicchi, and Gianluca Dini</i>	
Data Collection in Wireless Sensor Networks for Noise Pollution Monitoring	492
<i>Luca Filipponi, Silvia Santini, and Andrea Vitaletti</i>	
Energy Efficient Sleep Scheduling in Sensor Networks for Multiple Target Tracking	498
<i>Bo Jiang, Binoy Ravindran, and Hyeonjoong Cho</i>	

Optimal Rate Allocation for Rate-Constrained Applications in Wireless Sensor Networks	510
<i>Chun Lung Lin, Hai Fu Wang, Sheng Kai Chang, and Jia Shung Wang</i>	
Energy-Efficient Task Mapping for Data-Driven Sensor Network Macroprogramming	516
<i>Animesh Pathak and Viktor K. Prasanna</i>	
Robust Dynamic Human Activity Recognition Based on Relative Energy Allocation	525
<i>Nam Pham and Tarek Abdelzaher</i>	
SenQ: An Embedded Query System for Streaming Data in Heterogeneous Interactive Wireless Sensor Networks	531
<i>Anthony D. Wood, Leo Selavo, and John A. Stankovic</i>	
SESAME-P: Memory Pool-Based Dynamic Stack Management for Sensor Operating Systems	544
<i>Sangho Yi, Seungwoo Lee, Yookun Cho, and Jiman Hong</i>	
Author Index	551