Lecture Notes in Computer Science

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
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 Nikoletseas, 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 Gusthriot 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
VI  Message from the General Co-chairs

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 Nikoletseas
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 Nikoletseas  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 Nikoletseas  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
X Organization

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)
Organization XI

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  
James Aspnes  
Costas Busch  
Bogdan Chlebus (Chair)  
Andrea Clementi  
Eric Fleury  
Rachid Guerraoui  
Evangelos Kranakis  
Shay Kutten  
Miroslaw Kutylowski  
Andrew McGregor  

Bell Labs, USA  
Yale, USA  
Louisiana State University, USA  
University of Colorado Denver, USA  
University of Rome ‘Tor Vergata’, Italy  
ENS Lyon/INRIA, France  
EPF Lausanne, Switzerland  
Carleton University, Canada  
Technion, Israel  
Wroclaw Technical University, Poland  
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

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

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**

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

Performance of a Propagation Delay Tolerant ALOHA Protocol for Underwater Wireless Networks .......................... 1
   Joon Ahn and Bhaskar Krishnamachari

Time Synchronization in Heterogeneous Sensor Networks ............. 17
   Isaac Amundson, Branislav Kusy, Peter Volgyesi, Xenofon Koutsoukos, and Akos Ledeczi

Stochastic Counting in Sensor Networks, or: Noise Is Good .......... 32
   Y.M. Baryshnikov, E.G. Coffman, K.J. Kwak, and Bill Moran

On the Deterministic Tracking of Moving Objects with a Binary Sensor Network .................................................. 46
   Yann Busnel, Leonardo Querzoni, Roberto Baldoni, Marin Bertier, and Anne-Marie Kermarrec

An Adaptive and Autonomous Sensor Sampling Frequency Control Scheme for Energy-Efficient Data Acquisition in Wireless Sensor Networks .......................................................... 60
   Supriyo Chatterjea and Paul Havinga

LiveNet: Using Passive Monitoring to Reconstruct Sensor Network Dynamics ........................................................ 79
   Bor-rong Chen, Geoffrey Peterson, Geoff Mainland, and Matt Welsh

Broadcast Authentication in Sensor Networks Using Compressed Bloom Filters ......................................................... 99
   Yu-Shian Chen, I-Lun Lin, Chin-Laung Lei, and Yen-Hua Liao

On the Urban Connectivity of Vehicular Sensor Networks ............. 112
   Hugo Conceição, Michel Ferreira, and João Barros

FIT: A Flexible, LIght-Weight, and Real-Time Scheduling System for Wireless Sensor Platforms .............................. 126
   Wei Dong, Chun Chen, Xue Liu, Kougen Zheng, Rui Chu, and Jiajun Bu

Automatic Collection of Fuel Prices from a Network of Mobile Cameras ................................................................. 140
   Y.F. Dong, S. Kanhere, C.T. Chou, and N. Bulusu

Techniques for Improving Opportunistic Sensor Networking Performance ............................................................... 157
   Shane B. Eisenman, Nicholas D. Lane, and Andrew T. Campbell
On the Average Case Communication Complexity for Detection in Sensor Networks ................................................ 176
N.E. Venkatesan, Tarun Agarwal, and P. Vijay Kumar

Fault-Tolerant Compression Algorithms for Delay-Sensitive Sensor Networks with Unreliable Links ................................................ 190
Alexandre Guitton, Niki Trigoni, and Sven Helmer

Improved Distributed Simulation of Sensor Networks Based on Sensor Node Sleep Time ................................................ 204
Zhong-Yi Jin and Rajesh Gupta

Frugal Sensor Assignment ................................................ 219
Matthew P. Johnson, Hosam Rowaihy, Diego Pizzocaro, Amotz Bar-Noy, Stuart Chalmers, Thomas La Porta, and Alun Preece

Yuh-Jzer Joung and Shih-Hsiang Huang

Towards Diagnostic Simulation in Sensor Networks .................. 252
Mohammad Maifi Hasan Khan, Tarek Abdelzaher, and Kamal Kant Gupta

Sensor Placement for 3-Coverage with Minimum Separation Requirements ................................................ 266
Jung-Eun Kim, Man-Ki Yoon, Junghee Han, and Chang-Gun Lee

Power Assignment Problems in Wireless Communication: Covering Points by Disks, Reaching few Receivers Quickly, and Energy-Efficient Travelling Salesman Tours ........................................ 282
Stefan Funke, Sören Laue, Rouven Naujoks, and Zvi Lotker

Distributed Activity Recognition with Fuzzy-Enabled Wireless Sensor Networks ................................................ 296
Mihai Marin-Perianu, Clemens Lombriser, Oliver Amft, Paul Havinga, and Gerhard Tröster

CaliBree: A Self-calibration System for Mobile Sensor Networks........ 314
Emiliano Miluzzo, Nicholas D. Lane, Andrew T. Campbell, and Reza Olfati-Saber

An Information Theoretic Framework for Field Monitoring Using Autonomously Mobile Sensors ................................................ 332
Hany Morcos, George Atia, Azer Bestavros, and Ibrahim Matta

Coverage Estimation in the Presence of Occlusions for Visual Sensor Networks ................................................ 346
Cheng Qian and Hairong Qi
Time-Bounded and Space-Bounded Sensing in Wireless Sensor Networks .................................................. 357
   Olga Saukh, Robert Sauter, and Pedro José Marrón

SAKE: Software Attestation for Key Establishment in Sensor Networks .................................................. 372
   Arvind Seshadri, Mark Luk, and Adrian Perrig

Improving the Data Delivery Latency in Sensor Networks with Controlled Mobility .................................. 386
   Ryo Sugihara and Rajesh K. Gupta

Decoding Code on a Sensor Node .................................................. 400
   Pascal von Rickenbach and Roger Wattenhofer

Local PTAS for Independent Set and Vertex Cover in Location Aware Unit Disk Graphs (Extended Abstract) ........ 415
   Andreas Wiese and Evangelos Kranakis

Multi-root, Multi-Query Processing in Sensor Networks .................................................. 432
   Zhiguo Zhang, Ajay Kshemkalyani, and Sol M. Shatz

Short Papers

Snap and Spread: A Self-deployment Algorithm for Mobile Sensor Networks .................................................. 451
   N. Bartolini, T. Calamoneri, E.G. Fusco, A. Massini, and S. Silvestri

An In-Field-Maintenance Framework for Wireless Sensor Networks .................................................. 457
   Qiuhua Cao and John A. Stankovic

Deterministic Secure Positioning in Wireless Sensor Networks .................................................. 469
   Sylvie Delaët, Partha Sarathi Mandal, Mariusz A. Rokicki, and Sébastien Tixeuil

Efficient Node Discovery in Mobile Wireless Sensor Networks .................................................. 478
   Vladimir Dyo and Cecilia Mascolo

Decentralized Deployment of Mobile Sensors for Optimal Connected Sensing Coverage .................. 486
   Adriano Fagioliini, Lisa Tani, Antonio Bicchi, and Gianluca Dini

Data Collection in Wireless Sensor Networks for Noise Pollution Monitoring .................................. 492
   Luca Filipponi, Silvia Santini, and Andrea Vitaletti

Energy Efficient Sleep Scheduling in Sensor Networks for Multiple Target Tracking .................................. 498
   Bo Jiang, Binoy Ravindran, and Hyeonjoong Cho
Optimal Rate Allocation for Rate-Constrained Applications in Wireless Sensor Networks ........................................... 510
   Chun Lung Lin, Hai Fu Wang, Sheng Kai Chang, and Jia Shung Wang

Energy-Efficient Task Mapping for Data-Driven Sensor Network Macroprogramming .............................................. 516
   Animesh Pathak and Viktor K. Prasanna

Robust Dynamic Human Activity Recognition Based on Relative Energy Allocation ................................................ 525
   Nam Pham and Tarek Abdelzaher

SenQ: An Embedded Query System for Streaming Data in Heterogeneous Interactive Wireless Sensor Networks ............... 531
   Anthony D. Wood, Leo Selavo, and John A. Stankovic

SESAME-P: Memory Pool-Based Dynamic Stack Management for Sensor Operating Systems ........................................ 544
   Sangho Yi, Seungwoo Lee, Yookun Cho, and Jiman Hong

Author Index ........................................................................................................................................ 551