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Dorothea Wagner Roger Wattenhofer (Eds.)

# Algorithms for Sensor and Ad Hoc Networks

Advanced Lectures

## Volume Editors

Dorothea Wagner  
University of Karlsruhe  
Faculty of Informatics, ITI Wagner  
Box 6980, 76128 Karlsruhe, Germany  
E-mail: wagner@iti.uni-karlsruhe.de

Roger Wattenhofer  
ETH Zurich  
Distributed Computing Group  
Gloriastrasse 35, 8092 Zurich, Switzerland  
E-mail: wattenhofer@tik.ee.ethz.ch

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## Preface

Thousands of mini computers (comparable to a stick of chewing gum in size), equipped with sensors, are deployed in some terrain or other. After activation the sensors form a self-organized network and provide data, for example about a forthcoming earthquake.

The trend towards wireless communication increasingly affects electronic devices in almost every sphere of life. Conventional wireless networks rely on infrastructure such as base stations; mobile devices interact with these base stations in a client/server fashion. In contrast, current research is focusing on networks that are completely unstructured, but are nevertheless able to communicate (via several hops) with each other, despite the low coverage of their antennas. Such systems are called *sensor* or *ad hoc networks*, depending on the point of view and the application.

Wireless ad hoc and sensor networks have gained an incredible research momentum. Computer scientists and engineers of all flavors are embracing the area. Sensor networks have been adopted by researchers in many fields: from hardware technology to operating systems, from antenna design to databases, from information theory to networking, from graph theory to computational geometry.

Both the tremendous growth of the subject and the broad interdisciplinary community make research progress in wireless ad hoc and sensor networking incredibly difficult to follow and apprehend. What are the key concepts of wireless multi-hop networks? Which of the fundamentals that will still be valid in 10 or 20 year's time? What are the main techniques, and why do they work?

This book is a naïve snapshot of the current research on wireless ad hoc and sensor networks. Whenever possible, we focus on algorithmic results, that is, algorithms and protocols that allow for an analysis of their efficiency and efficacy. Often these algorithmic results are complemented by lower bounds, showing that some problems cannot be solved in a better way. Many of our chapters deal with distributed algorithms, in particular local and localized

algorithms. Many problems are of an inherently distributed nature, as nodes locally sense data, or locally need to decide on a media access scheme.

Our survey is by no means complete; some topics presented in the book may be identified as wrong paths in a few year's time, and other important aspects might be missing. Most likely, some topics have made it into the book because of their *algorithmic* beauty rather than their *practical* importance. Not surprisingly, one might add. After all, these topics were either proposed or selected (from a much larger list of topics) by the participants of a *GI-Dagstuhl Seminar* held in Dagstuhl on November 23-25, 2005.

The idea of the GI-Dagstuhl Seminars is to provide young researchers with the opportunity to become actively involved in new relevant and interesting areas of computer science. Based on a list of topics and references offered by the organizers, the participants prepared overview lectures that were presented and discussed at the research seminar in Dagstuhl. Each chapter was then elaborated and carefully cross-reviewed by the participants. Although we are aware that further progress has been made since this book was written, we hope to provide at least a first overview of algorithmic results in the field, making the book a suitable basis for an advanced course.

It is our pleasure to thank the young researchers who put a huge amount of work into this book, not only as authors of the chapters but also as reviewers of other chapters. Special thanks go to Steffen Mecke and Frank Schulz who invested a lot of administrative work in the preparation of the seminar. Moreover, Steffen Mecke handled most of the technical parts of the editing process. Finally, we would like to thank the *Gesellschaft für Informatik e.V.* (GI) and *IBFI Schloss Dagstuhl* for supporting this book and the GI-Dagstuhl Seminar.

April 2007

Dorothea Wagner  
Roger Wattenhofer

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## List of Contributors

**Zinaida Benenson**

Department of Computer Science  
University of Mannheim  
A 5,6  
68159 Mannheim, Germany  
zina@uni-mannheim.de

**Erik-Oliver Blaß**

Institute of Telematics  
University of Karlsruhe  
Zirkel 2  
76128 Karlsruhe, Germany  
blass@tm.uka.de

**Kevin Buchin**

Institut für Informatik  
Freie Universität Berlin  
Takustraße 9  
14195 Berlin, Germany  
buchin@inf.fu-berlin.de

**Maike Buchin**

Institut für Informatik  
Freie Universität Berlin  
Takustraße 9  
14195 Berlin, Germany  
mbuchin@inf.fu-berlin.de

**Erik Buchmann**

IPD Böhm  
Universität Karlsruhe  
Am Fasanengarten 5  
76128 Karlsruhe, Germany  
buchmann@ipd.uni-karlsruhe.de

**Marcel Busse**

Universität Mannheim  
A5, 6  
68159 Mannheim, Germany  
busse@informatik.uni-mannheim.de

**Michael Dom**

Institut für Informatik  
Friedrich-Schiller-Universität Jena  
Ernst-Abbe-Platz 2  
07743 Jena, Germany  
dom@minet.uni-jena.de

**Benjamin Fabian**

Institute of Information Systems  
Humboldt-Universität Berlin  
Spandauer Straße 1  
10178 Berlin, Germany  
bfabian@wiwi.hu-berlin.de

**Matthias Fischmann**

Institute of Information Systems  
Humboldt-Universität Berlin  
Spandauer Straße 1  
10178 Berlin, Germany  
fis@wiwi.hu-berlin.de

**Seda F. Gürses**

Institute of Information Systems  
Humboldt-Universität Berlin  
Spandauer Straße 1  
10178 Berlin, Germany  
seda@wiwi.hu-berlin.de

**Daniel Fleischer**

Fachbereich Informatik/Inf.-Wiss.  
Universität Konstanz  
Fach D 67  
78457 Konstanz, Germany  
Daniel.Fleischer@uni-konstanz.de

**Christian Frank**

ETH Zurich  
Clausiusstr. 59, IFW  
8092 Zurich, Switzerland  
chfrank@inf.ethz.ch

**Christian Gunia**

Institute of Computer Science  
University of Freiburg  
Georges-Köhler-Allee 79  
79110 Freiburg, Germany  
gunia@informatik.uni-freiburg.de

**Hans-Joachim Hof**

Institute of Telematics  
University of Karlsruhe  
Zirkel 2  
76128 Karlsruhe, Germany  
hof@tm.uka.de

**Alexander Kröller**

Institute for  
Mathematical Optimization  
TU Braunschweig  
Pockelsstraße 14  
38106 Braunschweig, Germany  
a.kroeller@tu-bs.de

**Olaf Landsiedel**

Distributed Systems Group  
RWTH Aachen  
Ahornstraße 55  
52074 Aachen, Germany

**Steffen Mecke**

ITI Wagner  
Universität Karlsruhe  
Am Fasanengarten 5  
76128 Karlsruhe, Germany  
mecke@ira.uka.de

**Thomas Moscibroda**

Microsoft Research  
One Microsoft Way  
Redmond, WA 98052, USA  
moscitho@microsoft.com

**Christian Pich**

Universität Konstanz  
Fachbereich Informatik/Inf.-Wiss.  
Fach D 67  
78457 Konstanz, Germany  
Christian.Pich@uni-konstanz.de

**Leonid Scharf**

Institut für Informatik  
Freie Universität Berlin  
Takustraße 9  
14195 Berlin, Germany  
leo@llscharf.de

**Ludmila Scharf**

Institut für Informatik  
Freie Universität Berlin  
Takustraße 9  
14195 Berlin, Germany  
scharf@inf.fu-berlin.de

**Thilo Streichert**

Dept. of Computer Science 12  
Friedrich-Alexander-University  
Erlangen-Nuremberg  
Am Weichselgarten 3  
91058 Erlangen, Germany  
streichert@cs.fau.de

**Frank Schulz**

ITI Wagner  
Universität Karlsruhe  
Am Fasanengarten 5  
76128 Karlsruhe, Germany  
frankschulz@gmx.de

**Dorothea Wagner**

Universität Karlsruhe  
ITI Wagner  
Am Fasanengarten 5  
76128 Karlsruhe, Germany  
wagner@iti.uni-karlsruhe.de

**Roger Wattenhofer**

ETH Zürich  
Distributed Computing Group  
Gloriastrasse 35  
8092 Zurich, Switzerland  
wattenhofer@tik.ee.ethz.ch

**Aaron Zollinger**

ETH Zürich / UC Berkeley  
zollinger@tik.ee.ethz.ch

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# Contents

<b>Preface</b> .....	V
<b>1 Applications of Sensor Networks</b>	
<i>H.-J. Hof</i> .....	1
1.1 Introduction .....	1
1.2 Applications of Sensor Networks .....	2
1.3 Current Hardware Platforms .....	14
1.4 Upcoming Applications .....	19
1.5 Chapter Notes .....	20
<b>2 Modeling Sensor and Ad Hoc Networks</b>	
<i>F. Schulz</i> .....	21
2.1 Introduction .....	21
2.2 Distributed Algorithms .....	22
2.3 Communication .....	27
2.4 Energy .....	33
2.5 Mobility .....	34
2.6 Chapter Notes .....	35
<b>3 Clustering</b>	
<i>T. Moscibroda</i> .....	37
3.1 Introduction .....	37
3.2 Models .....	40
3.3 Clustering Algorithms for Unit Disk Graphs .....	41
3.4 Clustering Algorithms for General Graphs .....	54
3.5 Conclusions and Open Problems .....	59
3.6 Chapter Notes .....	60
<b>4 MAC Layer and Coloring</b>	
<i>S. Mecke</i> .....	63
4.1 Introduction .....	63



4.2	Algorithms for Vertex Coloring . . . . .	69
4.3	Conclusion . . . . .	78
4.4	Chapter Notes . . . . .	79
<b>5</b>	<b>Topology Control</b>	
	<i>K. Buchin and M. Buchin</i> . . . . .	81
5.1	Introduction . . . . .	81
5.2	Quality Criteria . . . . .	83
5.3	Locally Defined Geometric Graphs and Further Proximity Graphs . . . . .	85
5.4	Localized Algorithms . . . . .	92
5.5	Chapter Notes . . . . .	98
<b>6</b>	<b>Interference and Signal-to-Noise-Ratio</b>	
	<i>A. Kröller</i> . . . . .	99
6.1	Introduction . . . . .	99
6.2	Interference Models . . . . .	100
6.3	Low-Interference Topologies . . . . .	103
6.4	Topology Scheduling . . . . .	108
6.5	Flow and Path Scheduling . . . . .	112
6.6	Chapter Notes . . . . .	116
<b>7</b>	<b>Lower Bounds</b>	
	<i>Z. Benenson</i> . . . . .	117
7.1	Introduction . . . . .	117
7.2	A Lower Bound on 3-Coloring a Ring . . . . .	119
7.3	Locally Checkable Labelings . . . . .	126
7.4	Minimum-Weight Spanning Trees . . . . .	128
7.5	Chapter Notes . . . . .	130
<b>8</b>	<b>Facility Location</b>	
	<i>C. Frank</i> . . . . .	131
8.1	Introduction . . . . .	131
8.2	Problem Definition . . . . .	132
8.3	Centralized Approximations . . . . .	136
8.4	Simple Distributed Approximation . . . . .	144
8.5	Fast Distributed Approximation . . . . .	147
8.6	Discussion and Outlook . . . . .	157
8.7	Chapter Notes . . . . .	158
<b>9</b>	<b>Geographic Routing</b>	
	<i>A. Zollinger</i> . . . . .	161
9.1	Introduction . . . . .	161
9.2	Related Work . . . . .	164
9.3	Models and Preliminaries . . . . .	166
9.4	Greedy Routing . . . . .	170

9.5	Routing with Faces .....	171
9.6	A Lower Bound .....	179
9.7	Combining Greedy and Face Routing .....	181
9.8	Conclusion .....	184
9.9	Chapter Notes .....	184
<b>10 Compact Routing</b>		
	<i>M. Dom</i> .....	187
10.1	Introduction .....	187
10.2	Definitions.....	189
10.3	Overview .....	190
10.4	Algorithms .....	195
10.5	Chapter Notes .....	202
<b>11 Pseudo Geometric Routing for Sensor Networks</b>		
	<i>O. Landsiedel</i> .....	203
11.1	Introduction .....	203
11.2	Routing Algorithms for Sensor Networks .....	204
11.3	Virtual Coordinate Based Routing .....	206
11.4	Beacon Vector Routing.....	206
11.5	Algorithmic View .....	210
11.6	Related Work .....	212
11.7	Chapter Notes .....	213
<b>12 Minimal Range Assignments for Broadcasts</b>		
	<i>C. Gunia</i> .....	215
12.1	Introduction .....	215
12.2	The Algorithm RAPMST and Its Analysis .....	217
12.3	Distributed Computation of an MST .....	222
12.4	Further Advances.....	229
12.5	Conclusion and Open Questions .....	234
12.6	Chapter Notes .....	235
<b>13 Data Gathering in Sensor Networks</b>		
	<i>L. Scharf</i> .....	237
13.1	Introduction .....	237
13.2	Network Model .....	239
13.3	Minimum Energy Data Gathering .....	240
13.4	Maximum Lifetime Data Gathering .....	256
13.5	Chapter Notes .....	262
<b>14 Location Services</b>		
	<i>B. Fabian, M. Fischmann, and S.F. Gürses</i> .....	265
14.1	Introduction .....	265
14.2	Grid Location Service (GLS).....	266
14.3	Locality-Aware Location Service (LLS) .....	272

14.4	Mobility-Aware Location Service (MLS)	279
14.5	Outlook	280
14.6	Chapter Notes	281
<b>15</b>	<b>Positioning</b>	
	<i>D. Fleischer and C. Pich</i>	283
15.1	Introduction	283
15.2	Hardness Results	284
15.3	Algorithms	290
15.4	Chapter Notes	304
<b>16</b>	<b>Security</b>	
	<i>E.-O. Bläß, B. Fabian, M. Fischmann, and S.F. Gürses</i>	305
16.1	Introduction	305
16.2	Symmetric Key Distribution	310
16.3	Public-Key Distribution	318
16.4	Open Questions	322
16.5	Chapter Notes	322
<b>17</b>	<b>Trust Mechanisms and Reputation Systems</b>	
	<i>E. Buchmann</i>	325
17.1	Introduction	325
17.2	General Trust Models	328
17.3	Reputation-Based Trust Protocols in Ad Hoc Networks	333
17.4	Open Problems	334
17.5	Chapter Notes	335
<b>18</b>	<b>Selfish Agents and Economic Aspects</b>	
	<i>L. Scharf</i>	337
18.1	Introduction	337
18.2	Mechanism Design	337
18.3	Network Model	339
18.4	Unicast in Selfish Networks	339
18.5	Multicast in Selfish Networks	351
18.6	Chapter Notes	357
<b>19</b>	<b>Time Synchronization</b>	
	<i>M. Busse and T. Streichert</i>	359
19.1	Introduction	359
19.2	Time Synchronization Approaches	361
19.3	Synchronizing Clocks in the Presence of Faults	367
19.4	Theoretical Bounds for Clock Synchronization and Ordering of Events	373
19.5	Gradient Clock Synchronization	377
19.6	Chapter Notes	379

**Bibliography** ..... 381

**Author Index** ..... 407

**Subject Index** ..... 409