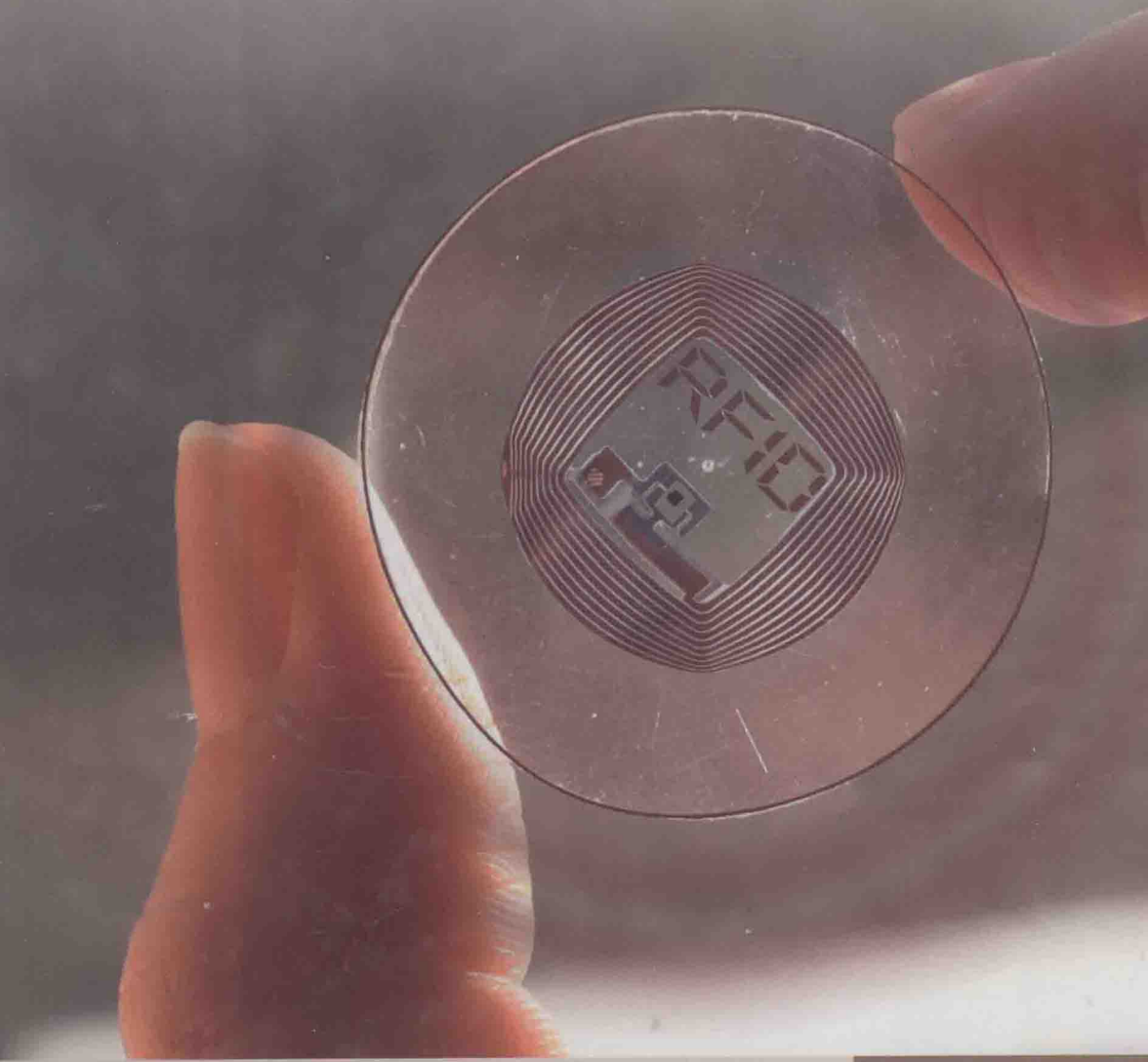
RFID SYSTEMS

RESEARCH TRENDS AND CHALLENGES

MIODRAG BOLIĆ | DAVID SIMPLOT-RYL | IVAN STOJMENOVIĆ



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WILEY
A John Wiley and Sons, Ltd., Publication

This edition first published 2010

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Except for: Chapter 5, 'Design of Passive Tag RFID Readers' © 2010 Intel Corporation

Registered office
John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, United Kingdom

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Library of Congress Cataloging-in-Publication Data

RFID systems : research trends and challenges / edited by Miodrag Bolic, David Simplot-Ryl, and Ivan Stojmenovic.
p. cm.
Includes index.
ISBN 978-0-470-74602-8 (cloth)
1. Radio frequency identification systems. I. Bolic, Miodrag. II. Simplot-Ryl, David. III. Stojmenovic, Ivan.
TK6570.I34R4868 2010
658.7′87–dc22

2010003318

A catalogue record for this book is available from the British Library.

ISBN 978-0-470-74602-8 (H/B)

Set in 10/12 Times by Laserwords Private Limited, Chennai, India
Printed and Bound in Singapore by Markono Print Media Pte Ltd

RFID SYSTEMS

To my wife Andjelka and children Marija, Natasa and Katarina.

Miodrag Bolić

To Isabelle, my wife.

David Simplot-Ryl

To my wife Natasa and children Milos and Milica.

Ivan Stojmenović

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Preface

RFID networks are currently recognized as one a research area of priority. Research activities related to RFID technology have been booming recently. A number of ongoing projects are being funded in Europe, Asia, and North America. According to leading market analysts, the development of the RFID market is projected to increase from approximately $3 billion in 2005 to $25 billion in 2015. Several countries have dedicated innovation programs to support and develop RFID systems and related technologies: the RFID initiative in Taiwan, Ubiquitous Japan and the NSF SBIR program in the USA. The EU has recently advertised its Strategic Research Roadmap concerning the Internet of Things, which first of all refers to the RFID technology before being extended to communicating devices as in M2M (Machine to Machine). In this roadmap, several application domains have been identified:

- Aerospace and aviation
- Automotive
- Telecommunications
- Intelligent buildings
- Medical technology, healthcare
- Independent living
- Pharmaceutical
- Retail, logistics, supply chain management
- Manufacturing, product lifecycle management
- Oil and gas
- Safety, security and privacy
- Environment monitoring
- People and goods transportation
- Food traceability
- Agriculture and breeding
- Media, entertainment and ticketing
- Insurance
- Recycling

The potential of RFID technology is huge. Contrary to popular belief, RFID technology is not recent and the delay in its deployment in commercial applications is not only due to its excessive cost. Ten years ago, standardization activities were insufficiently developed to allow the emergence of one standard which guarantees interoperability. In the meantime, ISO and worldwide organizations such as GS1 have proposed solutions, but new problems have arisen such as privacy issues and reading accuracy in proximity of certain materials

such as water. The integration of RFID data in information systems is also a non-trivial problem. In the vision of the Internet of Things, future applications bring scalability and programmability issues.

The book is intended to cover a wide range of recognized problems in RFID protocols and low-level research challenges, striking a balance between theoretical and practical coverage. The theoretical contributions are limited to the scenarios and solutions that are believed to have some practical relevance. This book is unique in addressing RFID protocols and communication issues in comprehensive manner.

The book is divided into four parts. Part I provides an introduction and describes architectures of both passive UHF readers and tags. In addition, it defines performance metrics and introduces different classifications of RFID systems. Part II is related to networking protocols that involve one reader and multiple tags with the goal of resolving tag-to-tag interference. Tag identification protocols are covered in a systematic way. They include Aloha-based and tree-based protocols, which are the most popular. In addition tag-talks-first and tag-talks-only protocols are discussed and compared with reader-talks-first protocols. Part III provides coverage of networking protocols that involve a host and multiple readers. First, the interface between the host and the readers is considered. Next, MAC layer solutions for reducing reader-to-tag interference are discussed. In addition, the redundant reader elimination problem and delay-tolerant networks are covered. In Part IV, several major research challenges in the RFID field are presented, such unsatisfactory read accuracy even in the most favorable RF environments, low read ranges, security problems, localization of tags, energy harvesting and simulators and emulators for RFID systems. Some of these challenges are so serious that they are preventing the widespread use of RFID technology (e.g. low read accuracy and security). Therefore, a number of these challenges and potential solutions are analyzed in this part of the book.

At the end of most chapters, problems are presented and the solutions to some of the problems are provided on the book's website http://www.wiley.com/go/bolic_rfid.

We believe that this book is an appropriate and timely forum, where industry, and academics from several different areas can learn more about the current trends in RFID networking and become aware of the protocols and current issues in RFID networks. It is well recognized that RFID technology will become a part of everyday life soon. Additionally, we believe that, given the huge interest in this topic shown by the industrial and academic worlds, this book can become a standard guide to modern RFID systems.

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Acknowledgements

We would like to express our gratitude to the authors of book chapters who not only contributed a book chapter but also reviewed one additional chapter. In addition, we would like to thank a number of people who helped us review this book as shown below (the reviewers are not listed in any specific order).

Gustaw Mazurek (Warsaw University of Technology), Daniel M. Dobkin (Enigmatics), Timo Kasper (Ruhr-Universität Bochum), Venkatesh Sarangan (Oklahoma State University), Carlisle Adams (University of Ottawa), Zhang Xiong (Beihang University), Jeffrey S. Fu (Chang Gung University), Masahiro Miyakawa (Tsukuba University of Technology), Justin Wenck (University of California, Davis), Pradeep Shah (Texas MicroPower Inc.), Christoph Angerer (Vienna University of Technology), Seok Joong Hwang (Korea University), Ilker Onat (University of Ottawa), Md. Suruz Miah (University of Ottawa), Lin Wang (University of Pittsburgh), Fusheng Wang (Emory University), Junho Yeo (Daegu University), Stevan Preradovic (Monash University), Nicolas Pauvre (GS1 France), Mustapha Yagoub (University of Ottawa), Rony Amaya (Carleton University), Francesca Lonetti (ISTI-CNR), Francesca Martelli (Università di Pisa), Gaetano Marrocco (Università di Roma), Michael E. Knox (Mode1corp), Pankaj Mishra (University of Ottawa), Nemai Chandra Karmakar (Monash University), Zhou Yuan (Nanyang Technological University), Guan Yong Liang (Nanyang Technological University), Petar M. Djuric (Stony Brook University), Ali Miri (University of Ottawa), Mohamad Forouzanfar (University of Ottawa), Daniel Shapiro (University of Ottawa), Qinghan Xiao (Defence Research and Development Canada), Qiang Guan (Chinese Academy of Sciences), Bela Stantic (Griffith University), Xianjin Zhu (Stony Brook University) and many others.

We greatly appreciate the support, guidance and encouragement given by Wiley's team including Sarah Tilley, Anna Smart and Tiina Ruonamaa.

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