

Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering

261

Editorial Board

Ozgur Akan

Middle East Technical University, Ankara, Turkey

Paolo Bellavista

University of Bologna, Bologna, Italy

Jiannong Cao

Hong Kong Polytechnic University, Hong Kong, Hong Kong

Geoffrey Coulson

Lancaster University, Lancaster, UK

Falko Dressler

University of Erlangen, Erlangen, Germany

Domenico Ferrari

Università Cattolica Piacenza, Piacenza, Italy

Mario Gerla

UCLA, Los Angeles, USA

Hisashi Kobayashi

Princeton University, Princeton, USA

Sergio Palazzo

University of Catania, Catania, Italy

Sartaj Sahni

University of Florida, Florida, USA

Xuemin Sherman Shen

University of Waterloo, Waterloo, Canada

Mircea Stan

University of Virginia, Charlottesville, USA

Jia Xiaohua

City University of Hong Kong, Kowloon, Hong Kong

Albert Y. Zomaya

University of Sydney, Sydney, Australia


More information about this series at <http://www.springer.com/series/8197>

Ingrid Moerman · Johann Marquez-Barja
Adnan Shahid · Wei Liu
Spilios Giannoulis · Xianjun Jiao (Eds.)


Cognitive Radio Oriented Wireless Networks

13th EAI International Conference, CROWNCOM 2018
Ghent, Belgium, September 18–20, 2018
Proceedings


Editors

Ingrid Moerman 
Ghent University
Ghent, Belgium

Johann Marquez-Barja
University of Antwerp
Antwerpen, Belgium

Adnan Shahid 
Ghent University
Zwijnaarde, Belgium

Wei Liu
Ghent University
Zwijnaarde, Belgium

Spilios Giannoulis 
Ghent University
Zwijnaarde, Belgium

Xianjun Jiao
Ghent University
Zwijnaarde, Belgium

ISSN 1867-8211

ISSN 1867-822X (electronic)

Lecture Notes of the Institute for Computer Sciences, Social Informatics
and Telecommunications Engineering

ISBN 978-3-030-05489-2

ISBN 978-3-030-05490-8 (eBook)

<https://doi.org/10.1007/978-3-030-05490-8>

Library of Congress Control Number: 2018963585

© ICST Institute for Computer Sciences, Social Informatics and Telecommunications Engineering 2019

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.

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.

The publisher, the authors, and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

We are delighted to introduce the proceedings of the second edition of the 2018 European Alliance for Innovation (EAI) International Conference on Cognitive Radio-Oriented Wireless Networks (CROWNCOM). This conference has brought together researchers from around the world from academia, industry, standards, and policy to present their new solutions of how cognitive radio systems will help deliver the required stringent requirements of future 5G and beyond 5G networks.

The technical program of CROWNCOM 2018 consisted of 19 full papers, divided into three tracks. The tracks were: Track 1, Experimental; Track 2, Licensed Shared Access and Dynamic Spectrum Access; and Track 3, PHY and Sensing. Aside from the high-quality technical paper presentations, the technical program also featured four keynote speeches, two discussion panels, two technical workshops, and four tutorials.

The four keynote speakers were Prof. Jens Zander from KTH, Sweden, Dr. Haris Gacanin from Nokia Bell labs, Belgium, Prof. Danijela Cabric from UCLA, USA, and Dr. Domenico Giustiniano from IMDEA, Spain. The two discussion panels were focused on issues regarding “5G and Beyond” and also on the “Struggle for Spectrum.” The two workshops organized were the Orchestration and Reconfiguration of Networked Software-Defined Radios (ORCA) and the Open Radio Platforms for 5G Research and Beyond. The ORCA workshop aimed to present advanced SDR capabilities and how these capabilities can be used by wireless innovators from academia and industry to increase spectrum efficiency and end-to-end performance in verticals that have to cope with extreme and diverging communication needs. The second workshop aimed to present the latest developments on existing platforms (both in the hardware and software domains) for 5G research and beyond, with a special focus on open source developments, as the latter facilitate innovation in the mobile networks ecosystem. The four tutorials were: Unlicensed Spectrum Technologies: From Wi-Fi to 5G and Beyond; NOMA for Next-Generation Wireless Networks: State of the Art, Research Challenges, and Future Trends; Wireless Link Virtualization and Network Function Virtualization in Cognitive Radio Networks: Theories, Use-Cases, and Hands-On Experiments; and Transceiver Design for Spectrum Sharing Full Duplex Radio.

Coordination with the steering chair Imrich Chlamtac and the rest of the Steering Committee members was essential for the success of the conference. We sincerely appreciate their constant support and guidance. It was also a great pleasure to work with such an excellent Organizing Committee team, they truly gave their best in organizing and supporting the conference. In particular, we thank the Technical Program Committee, led by our TPC co-chairs, Dominique Nogu  t, Johann Marquez-Barja, Xianjun Jiao, Miquel Payaro, Pierluigi Gallo, and Andres Garcia Saavedra, who completed the peer-review process of technical papers and compiled a high-quality technical program. We are also grateful to our conference manager,

Andrea Piekova, and the EAI team for their support and all the authors who submitted their papers to the CROWNCOM 2018 conference and workshops.

We strongly believe that CROWNCOM conference provides a good forum for all researchers interested in wireless communications to discuss all science and technology aspects that are relevant to cognitive radios and new immersing wireless technologies applicable to 5G and beyond. We also expect that CROWNCOM will continue to be a successful and stimulating conference, as indicated by the contributions presented in this volume and the challenges that still arise in front of us in the wireless research domain.

November 2018

Ingrid Moerman

Organization

Steering Committee

Chair

Imrich Chlamtac	Bruno Kessler Professor, University of Trento, Italy
-----------------	--

Members

Thomas Hou	Virginia Tech, USA
Abdur Rahim Biswas	CREATE-NET, Italy
Tao Chen	VTT – Technical Research Centre of Finland, Finland
Tinku Rasheed	CREATE-NET, Italy
Dominique Noguet	CEA-LETI, France

Organizing Committee

General Chair

Ingrid Moerman	IMEC – Ghent University, Belgium
----------------	----------------------------------

TPC Chair and Co-chairs

Dominique Noguet	CEA-LETI, France
Johann Marquez-Barja	IMEC – University of Antwerp, Belgium
Xianjun Jiao	IMEC – Ghent University, Belgium
Pierluigi Gallo	CNIT, Italy
Miquel Payaro	CTTC, Spain
Andres Garcia Saavedra	NEC Laboratories Europe, Germany

Sponsorship and Exhibit Chair

Steven Latré	IMEC – University of Antwerp, Belgium
--------------	---------------------------------------

Local Co-chairs

Karen Van Landegem	IMEC – Ghent University, Belgium
Muhammad Aslam	IMEC – Ghent University, Belgium

Workshops Chair

Wei Liu	IMEC – Ghent University, Belgium
---------	----------------------------------

Publicity and Social Media Co-chairs

Margherita Trestini	Martel Innovate, Switzerland
Adnan Shahid	IMEC – Ghent University, Belgium

Publications Chair

Spilios Giannoulis IMEC – Ghent University, Belgium

Posters and PhD Track Chair

Felipe Augusto Pereira de Figueiredo IMEC – Ghent University, Belgium

Panels Chair

Jorge Pereira European Commission, Belgium

Demos Co-chairs

Sofie Pollin KU Leuven, Belgium
Ivan Seskar Rutgers University, USA

Tutorials Chair

Hamed Ahmadi University of Essex, UK

Technical Program Committee

Youping Zhao	Beijing Jiaotong University, China
Chung Shue Chen	Nokia Bell Labs, Paris, France
Rahman	Rice University, USA
Doost-Mohammady	
Mubashir Husain Rehmani	Waterford Institute of Technology (WIT), Ireland
Keith Nolan	Intel, Ireland
Syed Ali Hassan	National University of Sciences and Technology, Pakistan
Shahriar Shahabuddin	Centre for Wireless Communications, University of Oulu, Finland
Tanguy Risset	INSA-Lyon, France
Takeo Fujii	The University of Electro-Communications, Japan
Ludovic Apvrille	Telecom ParisTech, France
Henning Sanneck	Nokia Bell Labs, Research, Munich, Germany
Yue Gao	Queen Mary University of London, UK
Vincent Le Nir	Royal Military Academy, Belgium
Adrian Kliks	Poznan University of Technology, Poland
Fernando Velez	IT-DEM, Universidade da Beira Interior, Portugal
Bernd Bochow	Fraunhofer FOKUS, Germany
Zexian Li	Nokia Bell Labs, Finland
Michael Gundlach	Nokia Networks, Munich, Germany
Seppo Yrjölä	Nokia
Angelos Antonopoulos	CTTC, Spain

Pawel Kryszkiewicz	Poznan University of Technology, Poland
Pravir Chawdhry	European Commission Joint Research Centre, Italy
Olivier Sentieys	IRISA/Inria, France
Hans-Jürgen Zepernick	Blekinge Institute of Technology, Sweden
Igor Radusinovic	University of Montenegro, Montenegro
Dionysia Triantafyllopoulou	University of Surrey, UK
Hamed Ahmadi	University College Dublin, Ireland
Luca De Nardis	Sapienza University of Rome, Italy
Adnan Aijaz	Toshiba Research Europe, UK
Marco Di Felice	University of Bologna, Italy
Anwer Al-Dulaimi	EXFO Inc., Toronto, Canada
Marc Emmelmann	Technical University of Berlin, Germany
Paulo Marques	IT, Portugal
Mika Kasslin	Nokia Bell Labs, Finland
Antonio De Domenico	CAE Leti, France
Allen MacKenzie	Virginia Tech, USA
Carlos Caicedo	Syracuse University, USA
Serhat Erkucuk	Kadir Has University, Turkey
Samson Lasaulce	CNRS, France
Paweł Kaniewski	Military Communication Institute, Poland
Matthieu Gautier	Université de Rennes 1, IRISA, Inria, France
William Lehr	MIT, USA
Kimion Kontovasilis	NCSR Demokritos, Greece
Martin Weiss	University of Pittsburgh, USA
Heikki Kokkinen	Fairspectrum, Finland
Doug Brake	ITIF, USA
Stefan Aust	NEC Communication Systems, Ltd., Japan
Seong-Lyun Kim	Yonsei University, Japan
Dominique Noguet	CEA-LETI, France
Milica Pejanovic Djuricic	University of Montenegro, Montenegro
Ozgur Ergul	Koc University, Turkey
Jean-Baptiste Doré	CEA-LETI, France
Fabio Giust	NEC Laboratories Europe, Germany
Ozgur Akan	Koc University, Turkey
Markus Mueck	Intel Mobile Communications, Germany
Rogério Dionisio	Instituto Politecnico de Castelo Branco, Portugal
Cristina Cano	Universitat Oberta de Catalunya, Spain
Klaus Moessner	University of Surrey, UK
Vincenzo Sciancalepore	NEC Laboratories Europe GmbH, Germany
Marco Gramaglia	Universidad Carlos III de Madrid, Spain
Karthick Parashar	IMEC, Belgium
Mohammad Hossein Anisi	University of Essex, UK
Victor Valls	Trinity College Dublin, Ireland
Rahman	Rice University, USA
Doost-Mohammady	

X Organization

Luis Diez	University of Cantabria, Italy
Paul Patras	The University of Edinburgh, UK
Yuanjie Li	UCLA, USA
Dan Lubar	RelayServices, USA
Carlos Donato	imec, Univeristy of Antwerp, Belgium
Gerhard Wunder	Fu Berlin, Germany

Contents

Experimental

Experimental Analysis of 5 GHz WiFi and UHF-TVWS Hybrid Wireless Mesh Network Back-Haul Links	3
<i>Richard Maliwatu, Natasha Zlobinsky, Magdeline Lamola, Augustine Takyi, David L. Johnson, and Melissa Densmore</i>	
High-Level and Compact Design of Cross-Channel LTE DownLink Channel Encoder.	15
<i>Jieming Xu and Miriam Leeser</i>	
Detection of Different Wireless Protocols on an FPGA with the Same Analog/RF Front End	25
<i>Suranga Handagala, Mohamed Mohamed, Jieming Xu, Marvin Onabajo, and Miriam Leeser</i>	
Demonstration of Shared Spectrum Access of Different User Groups.	36
<i>Topi Tuukkanen, Heikki Kokkinen, Seppo Yrjölä, Jaakko Ojaniemi, Arto Kivinen, and Tero Jokela</i>	
A Low-Latency Wireless Network for Cloud-Based Robot Control	46
<i>Seyed Ali Hassani and Sofie Pollin</i>	

Licensed Shared Access and Dynamic Spectrum Access

Comparison of Incumbent User Privacy Preserving Technologies in Database Driven Dynamic Spectrum Access Systems.	55
<i>He Li, Yaling Yang, Yanzhi Dou, Chang Lu, Doug Zabransky, and Jung-Min (Jerry) Park</i>	
Spectrum Leasing for Micro-operators Using Blockchain Networks.	66
<i>Junho Kim, Han Cha, and Seong-Lyun Kim</i>	
SZ-SAS: A Framework for Preserving Incumbent User Privacy in SAS-Based DSA Systems.	78
<i>Douglas Zabransky, He Li, Chang Lu, and Yaling Yang</i>	
Secrecy Outage Probability of Cognitive Small-Cell Network with Unreliable Backhaul Connections.	89
<i>Jinghua Zhang, Chinmoy Kundu, and Emi Garcia-Palacios</i>	

Polarization-Space Based Interference Alignment for Cognitive Heterogeneous Cellular Network	99
<i>Xiaofang Gao, Caili Guo, and Shuo Chen</i>	
The Vision of 5G and the Need for Change in Mobile Spectrum Access	109
<i>Peter Anker</i>	
Coexistence of LTE Networks Under LSA Paradigm in 2.6 GHz Band	119
<i>Jaakko Ojaniemi, Heikki Kokkinen, Arto Kivinen, Georgios Agapiou, Stamatis Perdikouris, August Hoxha, and Adrian Kliks</i>	
Pricing Private LTE and 5G Radio Licenses on 3.5 GHz	133
<i>Heikki Kokkinen, Seppo Yrjölä, Jan Engelberg, and Topias Kokkinen</i>	
LSA System Development with Sensing for Rapidly Deployable LTE Network	143
<i>Kalle Lähetkangas, Harri Posti, Harri Saarnisaari, and Ari Hulkkonen</i>	
Maxmin Strategy for a Dual Radar and Communication OFDM Waveforms System Facing Uncertainty About the Background Noise	154
<i>Andrey Garnaev, Wade Trappe, and Athina Petropulu</i>	
Using Deep Learning and Radio Virtualisation for Efficient Spectrum Sharing Among Coexisting Networks	165
<i>Wei Liu, Joao F. Santos, Xianjun Jiao, Francisco Paisana, Luiz A. DaSilva, and Ingrid Moerman</i>	
PHY and Sensing	
Evaluating Deep Neural Networks to Classify Modulated and Coded Radio Signals	177
<i>Phui San Cheong, Miguel Camelo, and Steven Latré</i>	
Improving Spectrum Efficiency in Heterogeneous Networks Using Granular Identification	189
<i>Rohit Singh and Douglas Sicker</i>	
Interference Rejection Combining for Black-Space Cognitive Radio Communications	200
<i>Sudharsan Srinivasan and Markku Renfors</i>	
An Image Processing Approach to Wideband Spectrum Sensing of Heterogeneous Signals	211
<i>Ha Q. Nguyen, Ha P. K. Nguyen, and Binh T. Nguyen</i>	
Author Index	223