

IEEE PIMRC 2016



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Welcome



Welcome from the General Chairs

Dear colleagues,

It is our pleasure to welcome you all to the 2016 edition of PIMRC, the Annual IEEE International Symposium on Personal, Indoor and Mobile Radio Communications, to be held in Valencia, a nice and modern city on the shore of the Mediterranean Sea.

The Symposium will be an outstanding event for worldwide researchers on wireless technologies and mobile networks, with a plethora of amazing talks, panels, tutorials and exhibitions, together with an exciting social program. This is the 27th edition of this prestigious conference, started in 1991 in London and coming back to Europe after two very successful events in Washington, DC, USA, in 2014 and Hong-Kong, China, in 2015. We would like to thank PIMRC's Steering Committee for giving us the opportunity to host the 2016 edition in Valencia.

The scientific program of PIMRC 2016 reflects the current best research results on the evolution of mobile radio communications, these days focused mainly, but not only, on the specification of 5G networks. 5G is aimed to include a wide range of technologies that will enable the realization of the very many different wireless communication scenarios foreseen for the future hyper-connected society. Cars, machines, sensors, drones, computers, etc., and also phones, of course, will connect each other to access or exchange information through electromagnetic waves, over any of the available radio channels and systems. This abstraction of such future radio communications world inspired the motto of this year's edition: Sailing the Waves of Information.

We would like to thank all of those who have contributed to the technical program of PIMRC 2016, starting with the authors, and in particular those with submitted papers that were above the average quality but haven't been accepted because of the limited capacity of the conference. This year's PIMRC has received a total of 903 submissions from 60 countries, for both conference tracks and workshops, from which 49% have been accepted. Our special appreciation goes also to the Track Chairs who dedicated so much time and effort to manage all submissions and the corresponding reviews, to ensure the high quality of the technical program.

The final program is organized into 76 oral sessions, plus 23 workshop sessions. Besides the oral sessions, we have 6 outstanding keynote talks from Industry and Academia, 5 Panels on the most relevant topics of the conference, and 8 tutorials offered to students and researchers during the previous and posterior days of the conference. These wonderful events along with the technical sessions of the conference have been organized thanks to the commitment of the tutorial, keynote, workshop and panel chairs. Many thanks to all of them for their volunteer dedication to PIMRC.

As a novelty of this year's edition, PIMRC will have an exhibition area with 10 companies and institutions showing their best on hardware and software technologies. Thanks to all of them, as well as to the 6 industrial patrons for their generous contributions.

Finally, the organization of such a big event like PIMRC would not be possible without the participation of an enthusiastic group of people from the Universitat Politècnica de Valencia, personnel and volunteers, from the CFP and the iTEAM, together with the publicity and publication chairs. All they have made possible that this conference will be a memorable event.

Enjoy PIMRC 2016, discover Valencia, and sail the waves... of information. Thank you for coming.

Narcís Cardona and **Luis M. Correia**

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Corneliu Eugen D. Sterian	Polytechnic University of Bucharest	Romania
Aaron Striegel	University of Notre Dame	USA
Erik Ström	Chalmers University of Technology	Sweden
Qinliang Su	The University of Hong Kong	Hong Kong
Szu-Lin Su	National Cheng Kung University	Taiwan
Chika Sugimoto	Yokohama National University	Japan
Li Sun	Xi'an Jiaotong University	P.R. China
Liang Sun	Beihang University	P.R. China
Yan Sun	Queen Mary University of London	United Kingdom
Yichuang Sun	University of Hertfordshire	United Kingdom
Ki Won Sung	KTH Royal Institute of Technology	Sweden
Himal Suraweera	University of Peradeniya	Sri Lanka
Satoshi Suyama	NTT DOCOMO, INC.	Japan
Tommy Svensson	Chalmers University of Technology	Sweden
Jan Sykora	Czech Technical University in Prague	Czech Republic
Istvan Szini	Aalborg University	USA
Takuji Tachibana	University of Fukui	Japan
Jun-ichi Takada	Tokyo Institute of Technology	Japan
Yutaka Takahashi	Kyoto University	Japan
Kenichi Takizawa	National Institute of Information and Communications Technology	Japan
Jun Tan	Nokia	USA
Hirokazu Tanaka	Hiroshima City University	Japan
Ravi Tandon	University of Arizona	USA
Jianhua Tang	Singapore University of Technology and Design	Singapore
Suhua Tang	The University of Electro-Communications	Japan
Xiaofeng Tao	Beijing University of Posts and Telecommunications	P.R. China
Visa Tapio	University of Oulu	Finland
Daniele Tarchi	University of Bologna	Italy
Wee Peng Tay	Nanyang Technological University	Singapore
Werner Teich	Ulm University	Germany
Chintha Tellambura	University of Alberta	Canada
Stephan ten Brink	University of Stuttgart	Germany
Michel Terré	CNAM	France
George Theodorakopoulos	Cardiff University	United Kingdom
Fabrice Theoleyre	CNRS - University of Strasbourg	France
Reiner Thomä	Ilmenau University of Technology	Germany
Guiyun Tian	Newcastle University	United Kingdom
Ruiyuan Tian	Huawei Technologies	Finland
Sameer Tilak	University of California at San Diego	USA
Ilenia Tinnirello	University of Palermo	Italy
Antti Tölli	University of Oulu	Finland
Sibel Tombaz	Ericsson Research	Sweden
Matías Toril	University of Málaga	Spain
Johan Torsner	Ericsson Research	Finland
Elias Tragos	Foundation for Reseach and Technology Hellas	Greece
Velio Tralli	University of Ferrara - Italy	Italy
Ramona Trestian	Middlesex University	United Kingdom
Peter Trifonov	Saint-Petersburg State Polytechnic University	Russia
Dirk Trossen	InterDigital Europe	United Kingdom
Kostas Tsagkaris	University of Piraeus	Greece
Shiao-Li Tsao	National Chiao Tung University	Taiwan

Theodoros Tsiftsis	Nazarbayev University	Kazakhstan
George Tsoulos	University of Peloponnese	Greece
Fredrik Tufvesson	Lund University	Sweden
Antonia Tulino	Bell Laboratories	USA
Pere Tuset-Peiro	UOC	Spain
Kurt Tutschku	Blekinge Institute of Technology	Sweden
Piotr Tyczka	ITTI Sp. z o. o.	Poland
Sana Ullah	Polytechnic Insitute of Porto	Portugal
Sennur Ulukus	University of Maryland	USA
Tomas Uricar	Czech Technical University in Prague	Czech Republic
Mikko Uusitalo	Nokia Technologies	Finland
Murat Uysal	Ozyegin University	Turkey
Iman Vakili	Volvo Car Corporation	Sweden
Daniela Valente	Dalhousie University	Canada
Mikko Valkama	Tampere University of Technology	Finland
Risto Valkonen	Nokia Bell Labs	Finland
Hans van den Berg	TNO	The Netherlands
Emmanuel Van Lil	Katholieke Universiteit Leuven	Belgium
Luc Vandendorpe	Université catholique de Louvain	Belgium
Johanna Vartiainen	Centre for Wireless Communications, University of Oulu	Finland
Emmanouel Varvarigos	University of Patras & Computer Technology Institute	Greece
Athanasios Vasilakos	Lulea University of Technology	Sweden
Ivaylo Vasilev	Lund University	Sweden
Fernando Velez	University of Beira Interior	Portugal
Iakovos Venieris	National Technical University of Athens	Greece
Parv Venkitasubramaniam	Lehigh University	USA
Véronique Vèque	University of Paris-Sud 11	France
Roberto Verdone	University of Bologna	Italy
Christos Verikoukis	CTTC	Spain
Giacomo Verticale	Politecnico di Milano	Italy
Quoc-Tuan Vien	Middlesex University	United Kingdom
Ville Viikari	Aalto University	Finland
Guillaume Villemaud	Université de Lyon, INRIA, INSA-Lyon, CITI	France
Alexey Vinel	Halmstad University	Sweden
Vasileios Vitsas	TEI Thessaloniki	Greece
Jens Voigt	Actix GmbH	Germany
Baptiste Vrigneau	University of Rennes 1	France
Risto Vuoltoniemi	University of Oulu	Finland
Bernhard Walke	RWTH Aachen University	Germany
Brett Walkenhorst	NSI-MI Technologies	USA
Jon Wallace	Lafayette College	USA
Florian Wamser	University of Wuerzburg	Germany
Jiafu Wan	South China University of Technology	P.R. China
Beibei Wang	University of Maryland	USA
Chaowei Wang	Beijing University of Posts and Telecommunications	P.R. China
Dongming Wang	Southeast University	P.R. China
Gang Wang	NEC Labs	P.R. China
Hui-Ming Wang	Xi'an Jiaotong University	P.R. China
Kun Wang	Nanjing University of Posts and Telecommunications	P.R. China
Lei Wang	Dalian University of Technology	P.R. China
Li-Chun Wang	National Chiao Tung University	Taiwan
Lin Wang	Xiamen University	P.R. China
Mea Wang	University of Calgary	Canada
Mingxi Wang	Qualcomm Technologies Inc	USA
Stephen Wang	Toshiba Research Europe Limited	United Kingdom
Xianbin Wang	University of Western Ontario	Canada

Xiangyang Wang	Southeast University	P.R. China
Xiaoqin Wang	Institute of Automation, Chinese Academy of Sciences	P.R. China
Xiaoyan Wang	Ibaraki University	Japan
Xijun Wang	Xidian University	P.R. China
Xin Wang	DOCOMO Beijing Communications Laboratories Co., Ltd	P.R. China
Yi Wang	Huawei Technologies Co., Ltd	P.R. China
Yufeng Wang	Qualcomm	USA
Yuhong Wang	Institute for Infocomm Research	Singapore
Rainer Wansch	Fraunhofer IIS	Germany
Thomas Watteyne	Inria	France
Tobias Weber	Uni Rostock	Germany
Miaowen Wen	South China University of Technology	P.R. China
Bernd-Ludwig Wenning	Cork Institute of Technology	Ireland
Stefan Wesemann	Nokia Bell Labs	Germany
Krzysztof Wesołowski	Poznan University of Technology	Poland
Risto Wichman	Aalto University School of Electrical Engineering	Finland
Christian Wietfeld	TU Dortmund University	Germany
Thorsten Wild	Nokia Bell Labs	Germany
Leif Wilhelmsson	Ericsson AB	Sweden
Bernd Wolfinger	University of Hamburg	Germany
Adam Wolisz	TUB	Germany
Seok Won	ETRI	Korea
Kainam Wong	Hong Kong Polytechnic University	Hong Kong
Bruce Worthman	IEEE Communications Society	USA
Celimuge Wu	The University of Electro-Communications	Japan
Chih-Feng Wu	School of Information Science and Engineering, Fujian University of Technology, Fuzhou	P.R. China
Gang Wu	University of Electronic Science and Technology of China	P.R. China
Hongyi Wu	University of Louisiana at Lafayette	USA
Hsiao-Chun Wu	Louisiana State University	USA
Nan Wu	Beijing Institute of Technology	P.R. China
Yanyan Wu	Xi'an Jiaotong-Liverpool University	P.R. China
Zhiqiang Wu	Wright State University	USA
Dirk Wübben	University of Bremen	Germany
Gerhard Wunder	FU Berlin, Heisenberg Communications and Information Theory Group	Germany
Christos Xenakis	University of Piraeus	Greece
Bin Xia	Shanghai Jiao Tong University	P.R. China
Minghua Xia	Sun Yat-sen University	P.R. China
Pei Xiao	University of Surrey	United Kingdom
Zhu Xiao	Hunan University	P.R. China
Ge Xiaohu	Huazhong University of Science & Technology	P.R. China
Chengwen Xing	Beijing Institute of Technology	P.R. China
Jie Xu	Guangdong University of Technology	P.R. China
Wei Xu	Southeast University	P.R. China
Michel Daoud Yacoub	State University of Campinas	Brazil
Animesh Yadav	Memorial University of Newfoundland	Canada
Osman Yağan	Carnegie Mellon University	USA
Wataru Yamada	Nippon Telegraph and Telephone Cooperation	Japan
Kun Yan	Guilin University of Electrical Technology	P.R. China
Chenyang Yang	Beihang University	P.R. China
Hong-Chuan Yang	University of Victoria	Canada
Lei Yang	University of Nevada, Reno	USA
Luxi Yang	Southeast University	P.R. China
Halim Yanikomeroglu	Carleton University	Canada
Evsen Yanmaz	University of Klagenfurt	Austria
Raziq Yaqub	University of Tennessee Chattanooga	USA

Kok-Lim Alvin Yau	Sunway University	Malaysia
Kai Yen	Institute for Infocomm Research	Singapore
Yunjung Yi	LG Electronics	Korea
Sixing Yin	Beijing University of Posts and Telecommunications	P.R. China
Hiroyuki Yomo	Kansai University	Japan
Kiyohito Yoshihara	KDDI R&D Laboratories Inc.	Japan
Shohei Yoshioka	NTT DOCOMO, INC.	Japan
Neji Youssef	Ecole superieure des communications de Tunis	Tunisia
Chia-Hao Yu	MediaTek	Taiwan
Rong Yu	Guangdong University of Technology	P.R. China
Rongshan Yu	Institute for Infocomm Research	Singapore
Di Yuan	Linköping University	Sweden
Xiaojun Yuan	ShanghaiTech University	P.R. China
Chau Yuen	Singapore University of Technology and Design	Singapore
Ji-Hoon Yun	Seoul National University of Science and Technology	Korea
Alenka Zajic	Georgia Institute of Technology	USA
Yasir Zaki	New York University Abu Dhabi (NYUAD)	United Arab Emirates (UAE)
Jens Zander	KTH Royal Institute of Technology	Sweden
Alberto Zanella	Istituto di Elettronica e di Ingegneria dell'Inform. e delle Telecomunicazioni	Italy
Andrea Zanella	University of Padova	Italy
Sherali Zeadally	University of Kentucky	USA
Thomas Zemen	AIT Austrian Institute of Technology GmbH	Austria
Qing-An Zeng	North Carolina A&T State University	USA
Yonghong Zeng	Institute for Infocomm Research	Singapore
Kristina Zetterberg	Ericsson Research	Sweden
Engin Zeydan	Türk Telekom Labs	Turkey
Dan Zhang	Technische Universität Dresden	Germany
Jianhua Zhang	Beijing University of Posts and Telecommunications	P.R. China
Jiayi Zhang	National Institute of Standards and Technology	USA
Jie Zhang	University of Sheffield, Dept. of Electronic and Electrical Engineering	United Kingdom
Jingyuan Zhang	University of Alabama	USA
Jun Zhang	Telecom ParisTech	France
Lei Zhang	University of Surrey	United Kingdom
Lin Zhang	Sun Yat-sen University	P.R. China
Qi Zhang	SUTD	Singapore
Tiankui Zhang	Beijing University of Posts and Telecommunications	P.R. China
Wensheng Zhang	Shandong University	P.R. China
Wenyi Zhang	University of Science and Technology of China	P.R. China
Xin Zhang	Technical University Dresden	Germany
Xing Zhang	Beijing University of Posts and Telecommunications	P.R. China
Yan Zhang	University of Oslo & Simula Research Laboratory	Norway
Yan Zhang	Beijing Institute of Technology	P.R. China
Ying Zhang	Xi'an Jiaotong University	P.R. China
Zhongshan Zhang	University of Science and Technology Beijing (USTB)	P.R. China
Xiongwen Zhao	North China Electric Power University	P.R. China
Gan Zheng	Loughborough University	United Kingdom
Bo Zhou	Qualcomm Inc.	USA
Qingfeng Zhou	Hefei University of Technology	P.R. China
Sheng Zhou	Tsinghua University	P.R. China
Xiaotian Zhou	Shandong University	P.R. China
Dengkui Zhu	RF DSP Inc.	USA
Meifang Zhu	Lund University	Sweden
Pengcheng Zhu	National Mobile Communications Research Laboratory, Southeast University	P.R. China
Weihua Zhuang	University of Waterloo	Canada
Thomas Zinner	University of Wuerzburg	Germany

Enrica Zola	Technical University of Catalonia	Spain
Yaning Zou	Technische Universität Dresden	Germany

Technical Program

SuA1: Workshop 1: From M2M Communications to Internet of Things

Local and Body Area Communications for IoT

A Novel Technique for ZigBee Coordinator Failure Recovery and Its Impact on Timing Synchronization

Davide Scazzoli, Atul Kumar, Navuday Sharma, Maurizio Magarini and Giacomo Verticale

An Analytical Model of the Effective Delay Performance for Bluetooth Low Energy

Raúl Rondón, Krister Landernäs and Mikael Gidlund

Comparison of 802.11ah and BLE for a Home Automation Use Case

Luis Felipe Del Carpio Vega, Piergiuseppe Di Marco, Per Skillermark, Roman Chirikov, Karin Lagergren and Parth Amin

Measurement and Characterization on a Human Body Communication Channel

Yan Zhang, Zunwen He, Yang Liu, Luis Alberto Lago Enamorado and Xiang Chen

SuA2: Workshop 2: IRACON - Inclusive Radio Communication Networks for 5G and Beyond

Compact Dual-band Antenna Array for Massive MIMO

Linsheng Li, Muhammad Ali and Katsuyuki Haneda

On stochastically emulating continuous scattering structures by discrete sources for OTA testing of DuT with highly directive antennas

Wim A. Th. Kotterman, Markus Landmann and Giovanni Del Galdo

SuA3: Workshop 3: 6th International Workshop on Self-Organizing Networks (IWSON)

Small cells

On attachment optimization and muting pattern selection in eICIC

Ole Grøndalen, Kashif Mahmood and Olav Norvald Østerbø

Self-Optimization of Coverage and Sleep Modes of Multi-Vendor Enterprise Femtocells

Lester Ho, Holger Claussen and Haris Gacanin

SuA5: Workshop 8: Deployment perspectives of Physical Layer Security into wireless public RATs

About new academic and experimental results on Physsec schemes

Secure Compute-and-Forward Transmission With Artificial Noise and Full-Duplex Devices

Stefano Tomasin

Secure Multiuser MISO Communication Systems with Quantized Feedback

Berna Özbek, Özgecan Özdoğan and Gunes Karabulut Kurt

SuA6: Workshop 5: Internet of Things for Ambient Assisted Living (IoTAAL)

Enabling technologies

A Transmit Power Control Scheme for Body Area Networks used in Ambient Assisted Living

Son Dinh Van, Simon Cotton and David B Smith

A two stages fuzzy logic approach for Internet of Things (IoT) wearable devices

Amilcare-Francesco Santamaria, Pierfrancesco Raimondo, Floriano De Rango and Abdon Serianni

Indoor Localization System for AAL over IPv6 WSN

Paola Pierleoni, Luca Pernini, Alberto Belli, Lorenzo Maurizi, Lorenzo Palma and Simone Valenti

Smartphone-Centric Wi-Fi Device-to-Device Sensor Communication for User Mobility in AAL Services

Thomas Lindh and Jonas Wahslen

MQTT in AAL Systems for Home Monitoring of People With Dementia

Antonio Del Campo, Ennio Gambi, Laura Montanini, Davide Perla, Laura Raffaelli and Susanna Spinsante

SuA8: Tutorial 2

The Road to 5G: Small-Cells, Context-Awareness and Ultra Dense Networks

While small cell densification is a promising solution to tame increasing traffic demands, a systematic deployment of small cells is cost-inefficient and poses serious challenges in terms of backhaul and interference. In this tutorial, we provide a brief overview on SCNs while highlighting key challenges, associated techniques, and future landscape towards 5G. First, we delve into the details of advanced interference management techniques by introducing concepts such as cell range expansion (CRE), cell association, and intercell and interference coordination (ICIC) that lie at the heart of 5G networks. Then, we discuss in detail the concept of self-organizing networks (SONs) and its key role in self-configuring and self-optimizing small cell deployment. Here, we focus on novel game-theoretic and learning techniques that are seen as an enabler for deploying self-optimizing and self-configuring heterogeneous and small cell networks. In the second part of the tutorial, we will present an array of important topics such as cellular-WiFi integration (2015 COMSOC Fred Ellersick Prize), multi connectivity, dynamic TDD and decoupled uplink-downlink, full duplexing, co-primary operator spectrum sharing (CoPSS), backhaul-aware resource management, and context-aware edge caching (2016 COMSOC Best Tutorial Prize). The tutorial will conclude with a number of trending topics including connected vehicles (V2V/V2I), deployment of unmanned aerial vehicles (UAV), and other 5G-related topics. The objective of this tutorial is two-fold, first it will provide a good overview of the technical challenges and open problems of 5G, and second it will showcase a number of mathematical tools from which the audience will benefit.

SuB1: Workshop 1: From M2M Communications to Internet of Things

Low-Power Wide-Area Communications for IoT

NB-IoT Deployment Study for Low Power Wide Area Cellular IoT

Nitin Mangalvedhe, Rapeepat Ratasuk and Amitava Ghosh

Trusted D2D-based Data Uploading in In-band Narrowband-IoT with Social Awareness

Leonardo Militano, Antonino Orsino, Giuseppe Araniti, Michele Nitti, Luigi Atzori and Antonio Iera

Measurements, Performance and Analysis of LoRa FABIAN, a real-world implementation of LPWAN

Tara Petric, Mathieu Goessens, Loutfi Nuaymi, Laurent Toutain and Alexander Pelov

SuB2: Workshop 2: IRACON - Inclusive Radio Communication Networks for 5G and Beyond

Indoor Experiment on 5G Radio Access Using Beam Tracking at 15 GHz Band

Kiichi Tateishi, Daisuke Kurita, Atsushi Harada, Yoshihisa Kishiyama, Shoji Itoh, Hideshi Murai, Arne Simonsson and Peter Ökvist

Evaluation of massive MIMO systems using time-reversal beamforming technique

Marie Mbeutcha, Wei Fan, Johannes Hejlselbæk and Gert Pedersen

Large Scale Experimental Trial of 5G Mobile Communication Systems—TDD Massive MIMO with Linear and Non-linear Precoding Schemes

Xin Wang, Xiaolin Hou, Huiling Jiang, Anass Benjebbour, Yuya Saito, Yoshihisa Kishiyama, Jing Qiu, Haihua Shen, Chen Tang, Tingjian Tian and Tsuyoshi Kashima

SuB3: Workshop 3: 6th International Workshop on Self-Organizing Networks (IWSN)

Self-healing and traffic steering

A Robust Algorithm for Anomaly Detection in Mobile Networks

Levente Bodrog, Márton Kajó, Szilárd Kocsis and Benedek Schultz

Self-optimizing adaptive transmission mode selection for LTE-WLAN aggregation

Irina Balan, Eva Perez, Bernhard Wegmann and Daniela Laselva

Evolution from Network Planning to SON Management using the Simulator for Mobile Networks (SiMoNe)

Dennis M. Rose, Sören Hahn and Thomas Kürner

QoE driven SON for Mobile Backhaul Demo

Lajos Bajzik, Csaba Deák, Tamas Karasz, Péter Szilágyi, Zoltán Vincze and Csaba Vulkán

Demonstrator for Utility-based SON Management

Christoph Frenzel, Simon Lohmüller, Lars Christoph Schmelz and Henning Sanneck

SuB4: Workshop 4: Radio and Innovative Spectrum Sharing Paradigms for Future Networks (CRAFT 2016)

Innovations in Spectrum Sharing

Keynote title:

TV White Spaces: Technical trial results in Colombia, challenges and perspectives

Potential Sharing between DTT and IoT Services in the UHF band

Gerardo Martinez-Pinzon, Kevin Llamas and Narcis Cardona

Sharing under Licensed Shared Access in a LTE real test network at 2.3-2.4 GHz

Doriana Guiducci, Claudia Carciofi, Valeria Petrini, Eva Spina, Domenico Massimi, Giuseppe De Sipio and Pravir Chawdhry

Spectrum sharing efficiency analysis in rule regulated networks with decentralized occupation control

Alexandr Kuzminskiy, Yuri Abramovich, Pei Xiao and Rahim Tafazolli

SuB5: Workshop 8: Deployment perspectives of Physical Layer Security into wireless public RATs

About the implantation perspectives of physec scheme

RECiP: Wireless Channel Reciprocity Restoration Method for Varying Transmission Power

Gerhard Wunder, Rick Fritschek and Khan Reaz

SuB6: Workshop 5: Internet of Things for Ambient Assisted Living (IoTAAL)

Applications

Ambient Assisted Living Systems in the Context of Human Centric Sensing and IoT Concept: eWall Case Study

Nikola Zaric, Milica Pejanovic-Djurisic and Albena Mihovska

A Model for Adaptive Accessibility of Everyday Objects in Smart Cities

Ilaria Torre and Ilknur Celik

AAL solutions toward cultural heritage enjoyment

Fabio Franchi, Claudia Rinaldi, Fabio Graziosi and Francesco Tarquini

SuB8: Tutorial 2 (cont.)

The Road to 5G: Small-Cells, Context-Awareness and Ultra Dense Networks

SuC1: Workshop 1: From M2M Communications to Internet of Things

Ultrareliability and Security Aspects for IoT

Analysis of Transmission Modes for Ultra-reliable Communications

Hamidreza Shariatmadari, Ruifeng Duan, Zexian Li, Sassan Iraj, Mikko A Uusitalo and Riku Jäntti

Ultra-Reliable Communication in a Factory Environment for 5G Wireless Networks: Link Level and Deployment Study

Bikramjit Singh, Zexian Li, Olav Tirkkonen, Mikko A Uusitalo and Preben Mogensen

SuC2: Workshop 2: IRACON - Inclusive Radio Communication Networks for 5G and Beyond

A Self-Interference Cancellation Testbed for Full-Duplex Transceiver Prototyping

Chunqing Zhang, Leo Laughlin, Mark Beach, Kevin A Morris and John Haine

FQAM-FBMC Design and Its Application to Machine Type Communication

Yinan Qi and Milos Tesanovic

Waveform Performance For Asynchronous Wireless 5G Uplink Communications

Shendi Wang, Jean Armstrong and John Thompson

SuC3: Workshop 3: 6th International Workshop on Self-Organizing Networks (IWSON)

5G Neighbor relations and cell search

On Automatic Establishment of Relations in 5G Radio Networks

Pradeepa Ramachandra, Fredrik Gunnarsson, Kristina Zetterberg, Reza Moosavi, Mehdi Amirijoo, Stefan Engström, Claes Tidestav and Edgar Ramos

Self-organizing Networks for 5G: Directional Cell Search in mmW Networks

Furqan Ahmed, Junquan Deng and Olav Tirkkonen

SuC4: Workshop 4: Radio and Innovative Spectrum Sharing Paradigms for Future Networks (CRAFT 2016)

Innovations in Cognitive Technologies

Weighted sum rate maximization with filtered multi-carrier modulations for D2D underlay communications

Mylene Pischella, Rostom Zakaria and Didier Le Ruyet

cooperative ARQ in full duplex cognitive radio networks

Vahid Towhidlou and Mohammad Shikh-Bahaei

Non-cooperative superposition relaying for multicarrier cognitive networks

Donatella Darsena, Giacinto Gelli and Francesco Verde

Network Architecture Self-adaption Technology in Cognitive Radio Networks

Haijun Wang, Haitao Zhao, Jiaxun Li, Shan Wang and Ji-Bo Wei

Using Trust to Mitigate Malicious and Selfish Behavior of Autonomous Agents in CRNs

Konstantinos Ntemos, Nicholas Kolokotronis and Nicholas Kalouptsidis

SuC5: Workshop 7: 2nd International Workshop on Vehicular Networking and Intelligent Transportation systems (VENITS'16)

Vehicular Networking and Communications

Communication Protocol for Platoon of Electric Vehicles in Mixed Traffic Scenarios

Ibrahim Rashdan, Hong Quy Le and Stephan Sand

Beaconing from Connected Vehicles: IEEE 802.11p vs. LTE-V2V

Alessandro Bazzi, Barbara M Masini, Alberto Zanella and Ilaria Thibault

Context-aware Unified Routing for VANETs Based on Virtual Clustering

Celimuge Wu, Tsutomu Yoshinaga and Yusheng Ji

V2VUNet - A Filtering Out Concept For Packet Forwarding Decision in Three-Dimensional Inter-vehicular Communication Scenarios

Lisa Kristiana, Corinna Schmitt and Burkhard Stiller

SuC6: Workshop 6: The International Workshop on mmWave Networks—fundamental limits, protocols, and experimental research platforms (mmWave)

Outage Probability Analysis of the Millimeter-Wave Relaying Systems

Nima Eshraghi, Behrouz Maham and Vahid Shah-Mansouri

Optimal Opportunistic Transmissions Over Directional mmWave Channels

David Ramirez, Lei Huang, Yi Wang and Behnaam Aazhang

Experimental Evaluation of a Novel Fast Beamsteering Algorithm for Link Re-Establishment in mm-Wave Indoor WLANs

Avishek Patra, Ljiljana Simić and Marina Petrova

Field Experimental Evaluation of Beamtracking and Latency Performance for 5G mmWave Radio Access in Outdoor Mobile Environment

Shohei Yoshioka, Yuki Inoue, Satoshi Suyama, Yoshihisa Kishiyama, Yukihiro Okumura, James Kepler and Mark Cudak

SuC7: Tutorial 3

Towards Network Softwarization

This tutorial will be shedding light on network softwarisation, an important vision towards the realization of elastic and flexible 5G mobile systems. The tutorial will commence with a brief introduction of major 3GPP wireless technologies, namely GSM, GPRS, UMTS and LTE, comparing amongst the different relevant architectures and their evolution to the nowadays' Evolved Packet System (EPS). After a short discussion on the basic principles of LTE, the tutorial presents the major architectural enhancements that have been already standardized within 3GPP for supporting EPS. The tutorial will subsequently lay emphasis on the functional and technical requirements of 5G mobile systems and discuss relevant opportunities, challenges, and expectations. The tutorial will be afterwards touching upon cloud computing technologies, virtualization techniques, and software defined networking (SDN). The main focus

will be towards the use-case of these technologies in the context of network softwarisation to create programmable virtual mobile networks, highlighting the key performance indicators and aspects for ensuring carrier-grade service delivery. The tutorial will also cover the concept of network function virtualization (NFV), detailing virtual network function (VNF) management and orchestration, and showcasing NFV and SDN as key technology enablers for the creation of elastic and flexible 5G mobile systems. The tutorial will be then describing, using concrete examples, how cloud-based virtual mobile networks can be designed, instantiated, configured, managed, and orchestrated, and that using current cloud infrastructure management tools, such as OpenStack and OpenDaylight. The tutorial will finish by highlighting few open issues that are forming the focus of research efforts in the network softwarisation arena.

SuC8: Tutorial 5

Internet of Medical things: Wearable wireless sensors systems for healthcare monitoring applications

Recent technological advancements in wireless low power/low range communication systems, MicroElectroMechanical Systems (MEMS) technology and integrated circuits have enabled low-power, intelligent, miniaturised, nano-technology sensor nodes strategically placed around the human body to be used in various applications, such as wearable wireless healthcare monitoring systems. This exciting new area of research is called Wireless Body Area Networks (WBANs) and leverages the emerging IEEE 802.15.6 and IEEE 802.15.4j standards, specifically standardised for Internet of Medical Things (IoMTs). This tutorial provides a survey on the current state-of-art of WBANs based on the latest standards which enable IoMTs with a range of representative applications. From these applications, we will abstract out the major challenges to realising the wearable wireless sensors systems for healthcare monitoring applications. Part I of the tutorial will start with an overview of WBANs, with a focus on the fundamental concepts of healthcare sensor hardware and measurement circuits. Furthermore related low power /low range wireless communication technologies and standards used for WBANs, the challenges and impairments of wireless media for IoMTs will be addressed. Introduction session will conclude by addressing the data acquisition and validation techniques for processing the healthcare data collected from the wearable wireless sensor networks. In Part II of the tutorial, the key design issues for wearable Activity Recognition systems, as an example of healthcare applications, will be presented. Design issues with respect to type/number/location of sensors according to the purpose of the application will be discussed. Emerging IoMTs research opportunities and challenges will be discussed in Part III of the tutorial. Topics in this section cover both theoretical and practical aspects, including the wearable system limitations, selection of attributes and sensors, obtrusiveness, data collection protocols, recognition performance criteria, energy consumption, processing and user flexibility. Open issues and challenges within each area are also explored as a source of inspiration towards future developments in WBANs. An activity recognition prototype demonstration will conclude the tutorial to provide the practical aspects and challenges for a wearable wireless sensor network solution.

SuC9: Tutorial 4

Energy-Neural System-Level Analysis and Optimization of 5G Wireless Networks

The Internet of Things (IoT) will connect billions of devices by 2020. Such systems suppose batteries and/or energy harvesting from the environment, which also bets for very low energy devices. In order to enable IoT service capabilities, 5G wireless networks will need to bring a drastic energy efficiency improvement and will need to develop energy harvesting capabilities. This energy chase will cover low-energy devices and network elements, and will rely on the availability of renewable energy sources, dedicated power sources, as well as the possibility of harvesting energy directly from the radio waves that are primarily used for data transmission. This leads to a new design space, where the availability of energy is not deterministic anymore but may depend on environmental factors, the interference may not necessarily be harmful as it may be a natural source electromagnetic-based power to be used for replenishing the batteries of low-energy devices, and the intended signals may be exploited for both data transmission and energy harvesting. This paradigm-shift introduces a new concept in the design of 5G wireless networks: energy-neutrality. Energy-neutral networks are systems that not only make an efficient use of the available energy, but, more importantly, that operate in a complete self-powered fashion. The present tutorial provides the audience with a complete survey of the potential benefits, research challenges, implementation efforts and application of technologies and protocols for achieving energy-neutrality, as well as the mathematical tools for their modeling, analysis and optimization. This tutorial is unique of its kind, as it tackles both system-level modeling and optimization aspects, which are usually treated independently. Special focus will be put on two methodologies for enabling the system-level modeling and the system-level and distributed optimization of energy-neutral 5G wireless networks: stochastic geometry and fractional programming. In the proposed tutorial, we illustrate how several candidate transmission technologies, communication protocols, and network architectures for 5G can be modeled, studied and optimized for their energy-neutral operation.

SuD1: Workshop 1: From M2M Communications to Internet of Things

Energy, Architecture and Technoeconomical Aspects for IoT

Feasibility and Fundamental Limits of Energy-Harvesting Based M2M Communications

Jukka Rinne, Jari Keskinen, Paul Berger, Donald Lupo and Mikko Valkama

Performance analysis of ambient backscattering for green Internet of Things

Donatella Darsena, Giacinto Gelli and Francesco Verde

RELOAD/CoAP Architecture with Resource Aggregation/Disaggregation Service

Luís Rodrigues, Joel Guerreiro and Noelia Correia

Theoretical Analysis of UNB-based IoT Networks with Path Loss and Random Spectrum Access

Yuqi Mo, Claire Goursaud and Jean-Marie Gorce

Value Creation and Competition in M2M Ecosystem - The Case of Smart City

Amirhossein Ghanbari, Andres Laya and Jan Markendahl

SuD2: Workshop 2: IRACON - Inclusive Radio Communication Networks for 5G and Beyond

Numerology and Frame Structure for 5G Radio Access

Jaakko Vihriälä, Ali Zaidi, Venkatkumar Venkatasubramanian, Ning He, Esa Tirola, Jonas Medbo, Eeva Lähtekangas, Karl Werner, Kari Pajukoski, Andreas Cedergren and Robert Baldemair

Performance Analysis of K-Tier Cellular Networks with Time-Switching Energy Harvesting

Yan Liao, Jing Zhang, Yanxia Zhang, Min Chen, Qiang Li and Tao Han

Energy Efficiency for Cloud-Radio Access Networks with Imperfect Channel State Information

Bayan Al-Oquibi, Osama Amin, Hayssam Dahrouj, Tareq Y. Al-Naffouri and Mohamed-Slim Alouini

Joint Remote Radio Head Selection and User Association in Cloud Radio Access Networks

Aini Li, Yan Sun, Xiaodong Xu and Chunjing Yuan

SuD3: Workshop 3: 6th International Workshop on Self-Organizing Networks (IWSON)

5G Management Challenges

Network Management Automation in 5G: Challenges and Opportunities

Stephen S. Mwanje, Guillaume Decarreau, Christian Mannweiler, Muhammad Naseer-ul-islam and Lars Christoph Schmelz

SuD4: Workshop 4: Radio and Innovative Spectrum Sharing Paradigms for Future Networks (CRAFT 2016)

Spectrum Sharing and Coexistence Mechanisms for 5G

Panel:

Panel Discussion on Spectrum Sharing and Coexistence Mechanisms for 5G Networks

Panel Chair:

Maziar Nekovee (Samsung Electronics, UK)

Panelists:

- **Pravir Chawdhry** (Joint Research Centre of the European Commission, Italy/EU)
- **Martha Suarez** (Agencia Nacional del Espectro, Colombia)
- **Faouzi Bader** (CentraleSupélec, France)
- **Andres Navarro Cadavid** (Universidad Icesi, Colombia)

Distributed Beam Scheduling for Multi-RAT Coexistence in mm-Wave 5G Networks

Maziar Nekovee, Yinan Qi and Yue Wang

SuD5: Workshop 7: 2nd International Workshop on Vehicular Networking and Intelligent Transportation systems (VENITS'16)

Network Services over VANETs

Named Data Networking for Priority-based Content Dissemination in VANETs

Marica Amadeo, Claudia Campolo and Antonella Molinaro

Hierarchical Adaptive Trust Establishment Solution for Vehicular Networks

Chaker abdelaziz Kerrache, Carlos T. Calafate, Nasreddine Lagraa, Juan-Carlos Cano and Pietro Manzoni

Multimedia Transmissions over Vehicular Networks

Armir Bujari, Claudio E. Palazzi and Daniele Ronzani

SuD6: Workshop 6: The International Workshop on mmWave Networks—fundamental limits, protocols, and experimental research platforms (mmWave)

Effects of Vehicle Vibrations on mm-Wave Channel: Doppler Spread and Correlative Channel Sounding

Jiri Blumenstein, Josef Vychodil, Martin Pospíšil, Tomas Mikulasek and Ales Prokes

Radio Parameter Design for OFDM-based Millimeter-Wave Systems

Lei Huang, Yi Wang, Zhenyu Shi and Rong Wen

Delay Characteristics for Directional and Omni-Directional Channel in Indoor Open Office and Shopping Mall Environments at 28 GHz

Lei Tian, Jianhua Zhang, Pan Tang, Fusheng Huang and Yi Zheng

A SAGE Algorithm for Channel Estimation using Signal Eigenvectors for Direction-Scan Sounding

Luxia Ouyang and Xuefeng Yin

SuD7: Tutorial 3 (cont.)

Towards Network Softwarization

SuD8: Tutorial 5 (cont.)

Internet of Medical things: Wearable wireless sensors systems for healthcare monitoring applications

SuD9: Tutorial 4 (cont.)

Energy-Neural System-Level Analysis and Optimization of 5G Wireless Networks

MoA1: Massive MIMO Scheduling and Transceiver Design

Low-Complexity Symbol Detection for Massive MIMO Uplink Based on Jacobi Method

Byeong Yong Kong and In-Cheol Park

User Scheduling and Beam Allocation for Massive MIMO Systems with Two-Stage Precoding

Chen Lu, Wenjin Wang, Wen Zhong and Xiqi Gao

Correlation-based User Scheduling and Multi-planar Parallelogram Array for Massive Antenna Systems

Takuto Arai, Atsushi Ohta, Satoshi Kurosaki, Kazuki Maruta, Tatsuhiko Iwakuni and Masataka Iizuka

Message-Passing Detector for Uplink Massive MIMO Systems Based on Energy Spread Transform

Lixin Gu, Wenjin Wang, Wen Zhong and Xiqi Gao

A Novel User Selection Algorithm for Multiuser Hybrid Precoding in mmWave Systems

Wenfang Yuan, Simon Armour and Angela Doufexi

MoA2: Relaying

A Thompson Sampling Approach to Channel Exploration-Exploitation Problem in Multihop Cognitive Radio Networks

Viktor Toldov, Laurent Clavier, Valeria Loscrí and Nathalie Mitton

Opportunistic Relay Scheme Exploiting Channel Coherence Time in IEEE 802.15.6 Wireless Body Area Networks

Ruifeng Zhang, Nick Francis Timmons and Jim Morrison

Hierarchical Mesh Routing Implementation for Indoor Data Collection

Verotiana Rabarjaona, Fumihide Kojima and Hiroshi Harada

Broadcasting in LTE-Advanced networks using multihop D2D communications

Giovanni Nardini, Giovanni Stea, Antonio Virdis, Dario Sabella and Marco Caretti

Connectivity Study in Professional Mobile Radio Networks with Portable 4G Base Stations

Leonardo Goratti, Karina Mabell Gomez, Tinku Rasheed and Sam Reisenfeld

MoA3: Cognitive Radio and D2D

Continuous Hidden Markov Model Based Interference-Aware Cognitive Radio Spectrum Occupancy Prediction

Rana Al Halaseh and Dirk Dahlhaus

Compressive Cognitive Radio with Causal Primary Message

Wenbo Xu, Yifan Wang and Jiaru Lin

Performance Improvements of Reputation-Based Cooperative Spectrum Sensing

Francesco Benedetto, Antonio Tedeschi, Gaetano Giunta and Pietro Coronas

Social Comparison Based Relaying in Device-to-Device Networks

Young Jin Chun, Gualtiero Colombo, Simon Cotton, William G. Scanlon, Roger Whitaker and Stuart Allen

Interference Management Scheme for Network-Assisted Multi-Hop D2D Communications

Laila Melki, Sameh Najeh and Hichem Besbes

MoA4: Wireless Ad Hoc and Mesh Networks

Fair Queueing for mmWave WMN Backhaul

Kari Seppänen and Jouko Kapanen

QoI-aware Tradeoff Between Communication and Computation in Wireless Ad-hoc Networks

Sepideh Nazemi Gelyan, Kin K. Leung and Ananthram Swami

An Efficient Routing Strategy for Performance Improvement in WMNs

Francesco Valentini, Elena Cinque and Marco Pratesi

Multi-hop Multi-AP Multi-channel Cooperation for High Efficiency WLAN

Yinghong Ma, Jiandong Li, Hongyan Li, Haibin Zhang and Ronghui Hou

High-Reliability Scheduling in Deterministic Wireless Multi-hop Networks

Guillaume Gaillard, Dominique Barthel, Fabrice Theoleyre and Fabrice Valois

MoA5: Emergency and Healthcare

Mobile Network Service Demand in case of Electricity Network Disturbance Situation

Joonas Sæe and Jukka Lempiäinen

Designing an Adaptive Emergency Warning System for Heterogeneous Environments

Gareth Tyson, John Bigham, Eliane L Bodanese, Nadeem Akhtar, Pradipta Biswas, Pat Langdon, Vineet Mimrot, Pratyay Mukhopadhyay and Vinay J. Ribeiro

An Ambient Assisted Living System for Elderly Assistance Applications

Luca Mainetti, Luigi Manco, Luigi Patrono, Andrea Secco, Ilaria Sergi and Roberto Vergallo

Impact of physical channels and physical signals from LTE small cell eNB in audible frequency band

Suna Choi

Heartbeat Detection with Doppler Radar Based on Estimation of Average R-R Interval Using Viterbi Algorithm

Eriko Mogi and Tomoaki Ohtsuki

MoA6: MAC and Routing for Wireless Sensor Networks

Improving Robustness of Beacon-Enabled IEEE 802.15.4 with Round-Robin Channel Diversity

Liviu-Octavian Varga, Martin Heusse, Roberto Guizzetti and Andrzej Duda

Using RTS/CTS to Enhance the Performance of IEEE 802.15.6 CSMA/CA

Martina Barbi, Kamran Sayrafian and Mehdi Alasti

Ultra-low Power MAC Protocol Complied with RIT in IEEE 802.15.4e for Wireless Smart Utility Networks

Jun Fujiwara, Ryota Okumura, Keiichi Mizutani, Hiroshi Harada, Sota Tsuchiya and Takuya Kawata

Energy-Delay Constrained Minimal Relay Placement in Low Duty-Cycled Sensor Networks Under Anycast Forwarding

Messaoud Doudou, Jose M. Barcelo-Ordinas and Jorge Garcia-Vidal

CRRP: A Cooperative Relay Routing Protocol for IoT Networks

Jingwen Bai, Yan Sun and Chris Phillips

MoA7: LTE System Design and Evaluation

Adaptive Physical Resource Block Design for Enhancing Voice Capacity over LTE network in PMR Context

Manh-Cuong Nguyen, Hang Nguyen, Duy-Huy Nguyen, Eric Georgeaux, Philippe Mege and Laurent Martinod

Multi-antenna Feature Comparison in Urban Environment for 4 TX Base Stations

Andreas Nilsson and Martin Johansson

Enhanced Time of Arrival Estimation and Quantization for Positioning in LTE Networks

Henrik Rydén, Ali Zaidi, Sara Modarres Razavi, Fredrik Gunnarsson and Iana Siomina

Single-rate and Multi-rate Multi-service Systems for Next Generation and Beyond Communications

Lei Zhang, Ayesha Ijaz, Pei Xiao, Atta Ul Quddus and Rahim Tafazolli

Experimental evaluation of timing synchronization accuracy for QZSS short message synchronized SS-CDMA communication

Kei Ohya, Suguru Kameda, Hiroshi Oguma, Akinori Taira, Noriharu Suematsu, Tadashi Takagi and Kazuo Tsubouchi

MoA8: Energy Efficient Communications 1

Antenna Selection based on Mutual Coupling and Spatial Correlation among Integrated Antennas for Maximum Energy Efficiency

Lakju Sung, Daehee Park and Dong-Ho Cho

An Adaptive Polarization-QAM Modulation Scheme for Improving the Power Amplifier Energy Efficiency in OFDM Systems

Shulun Zhao, Zhimin Zeng, Chunyan Feng, Fangfang Liu and Yao Nie

SWIPT Techniques for Multiuser MIMO Broadcast Systems

Javier Rubio, Antonio Pascual-Iserte, Daniel P Palomar and Andrea Goldsmith

Energy efficient power allocation and relay selection in MIMO relay channels

Zijian Wang and Luc Vandendorpe

Optimization of Energy Efficiency in Computationally-Aware Adaptive OFDM Systems

Bartosz Bossy and Hanna Bogucka

MoA9: Multiple Access Techniques

Performance Evaluation of Subcarrier Hopping Multiple Access in Wireless LAN Scenarios

Yuta Hori and Hideki Ochiai

Inherent instability of user channels in the localized SC-FDMA under doubly selective fading

Takeshi Hashimoto and Chenggao Han

On the Performance Analysis of Binary Non-Coherent Modulations with Selection Combining in Double Rice Fading Channels

Rym Khedhiri, Nazih Hajri and Neji Youssef

Generalized Spatial Modulation for Downlink Multiuser MIMO Systems with Multicast

Robinson Pizzio, Bartolomeu F. Uchôa-Filho, Marco Di Renzo and Didier Le Ruyet

CSI enhancement for multi-user superposed transmission using the second best feedback

Karol Schober, Panu Lähdekorpi, Mikko Kokkonen, Mikko Mäenpää and Mihai Enescu

MoB0: Opening

MoB0: Plenary 1. Part I

Leap Forward to 5G Commercialization

Abstract:

It is envisioned that 5G will embrace machine to machine and machine to human communication in addition to human to human communication. To enable this vision, extreme high throughput, ultra low latency/high reliability and massive connectivities are the design target of 5G. This talk will present the framework and a set of enabling technologies to build such a system including some latest Huawei's field trial efforts and results. In addition, a high level view of standardization efforts will be given to provide a roadmap toward the commercialization of 5G system.

Short Bio:

Dr. Peiying Zhu is a Huawei Fellow. She is currently leading 5G wireless system research in Huawei. The focus of her research is advanced wireless access technologies with more than 150 granted patents. She has been regularly giving talks and panel discussions on 5G vision and enabling technologies. She served as the guest editor for IEEE Signal processing magazine special issue on the 5G revolution and co-chaired for various 5G workshops. She is actively involved in IEEE 802 and 3GPP standards development. She is currently a WiFi Alliance Board member. Prior to joining Huawei in 2009, Peiying was a Nortel Fellow and Director of Advanced Wireless Access Technology in the Nortel Wireless Technology Lab. She led the team and pioneered research and prototyping on MIMO-OFDM and Multi-hop relay. Many of these technologies developed by the team have been adopted into LTE standards and 4G products. Peiying Zhu received the Master of Science degree and Doctor Degree from Southeast University and Concordia University in 1985 and 1993 respectively.

MoB0: Plenary 1. Part II

Remote Tele-surgery via Haptic Communications- Potential and Challenges

Abstract:

A number of important developments have taken place in the evolving field of robotic surgery. This includes the Touch and Image guided robotic surgery (TIGERS) project. Haptics is expected to play an important role in the future. In addition we have seen the development of a number of soft robots which learn to avoid danger from a surgeons movements. In parallel to this the imminent arrival of 5G will hopefully improve the underpinning communication between these hi tech devices. Finally it is expected that the cost to providers and patients will be cheaper in coming years.

Short Bio:

Professor Prokar Dasgupta is the Editor-in-Chief of the BJUI. He leads academic urology at Guy's Hospital, King's College London. He has over 500 publications and a highly productive team of clinician-scientists developing novel robotics for the delivery of cytotoxic therapies in prostate cancer. He is credited with the "Dasgupta technique" of injecting Botulinum toxin in overactive bladders. He was awarded the Golden Telescope by BAUS for a significant and lasting contribution to urology.

MoC0: Panel 1

What is relevant research for 5G Advanced?

Panellists:

- **Dr. Magnus Frodigh** (Ericsson, Stockholm, Sweden)
- **Dr. Maziar Nekovee** (mmMAGIC/Samsung R&D, Staines, Surrey, UK)
- **Dr. Christian Mannweiler** (Nokia Bell Labs, Munich, Germany)
- **Sébastien Hémard** (Magnetis Marelli, China)

Motivation and Background:

At the time of PIMRC the standardisation of 5G has been running for some time and the first deployments are only one and a half year into the future. What is clear though is that this first wave will be followed by a number of innovations and improvements. At this time it is important to start thinking about initiating research on topics that will be important in the future but at the moment may have taken a back seat to the standardisation efforts.

The panel will provide the view of a number of industry and academic leaders on the topics that will shape the development of 5G advanced and make a guess at important emerging fields.

Questions:

1. What research areas do you see to be important in 3-5 years?
2. What services will be important that we cannot imagine today?
3. When would you expect the first 5G system to be fully deployed?
4. What would be the most important feature for the first 5G system to be considered 5G?
5. What do you expect will not be standardised in the first wave of standards?

MoC1: Massive MIMO Channel Measurement, Modeling and Calibration

Massive MIMO Real-time Channel Measurements and Theoretic TDD Downlink Throughput Predictions

Siming Zhang, Paul Harris, Angela Doufexi, Andrew Nix and Mark Beach

Geometry-Based Stochastic Channel Models for 5G: Extending Key Features for Massive MIMO

Àlex Oliveras Martínez, Patrick Eggers and Elisabeth de Carvalho

A Receive/Transmit Calibration Technique based on Mutual Coupling for Massive MIMO Base Stations

Joao Vieira, Fredrik Rusek and Fredrik Tufvesson

A Phase Calibration Method Based on L1-norm Minimization for Massive MIMO Systems

Zhensheng Jiang, Wenjin Wang, Xiaodong Xie and Xiqi Gao

A Simple Over-the-Air Hardware Calibration Procedure in TDD Systems

Samer Bazzi and Wen Xu

MoC2: Relaying/Cooperative Relaying 1

Multi-hopping Loss in MIMO Decode-and-Forward Cooperative Relaying

Ishtiaq Ahmad, Khoa D. Nguyen, André Pollok and Nick A Letzepis

Amplify-and-Forward Relay based Spectrum Sensing with Generalized Selection Combining

Vaibhav Kumar, Deep Kandpal, Ranjan Gangopadhyay and Soumitra Debnath

Outage Probability of Dual-Hop FSO Fixed Gain Relay Transmission Systems

Emna Zedini, Hamza Soury and Mohamed-Slim Alouini

Outage Probability of Non-Orthogonal Multiple Access Schemes with Partial Relay Selection

Sunyoung Lee, Daniel Benevides da Costa and Trung Q. Duong

System-Level Performance Analysis of Relay-Aided Multiple-Antenna Cellular Networks

Konstantinos Ntontin, Marco Di Renzo and Christos Verikoukis

MoC3: Device-to-device (D2D) communications 1

A Two-Step Resource Allocation Algorithm for D2D Communication in Full Duplex Cellular Network

Luming Ren, Ming Zhao, Xinyu Gu and Lin Zhang

A Distributed MAC Protocol for Multi-Packet Reception Wireless Networks

António Furtado, Rodolfo Oliveira, Rui Dinis and Luis Bernardo

Interference Coordination in HetNet: Can D2D Communication Help?

Mustapha Amara, Afef Feki and Luca Rose

Q-Learning Based Power Control Algorithm for D2D Communication

Shiwen Nie, Zhiqiang Fan, Ming Zhao, Xinyu Gu and Lin Zhang

Joint Subcarrier Assignment and Power Allocation for D2D Communication Underlying Full-Duplex Cellular Networks

Long Liu, Zhi Zhang and Yue Xu

MoC4: Wireless Sensor Networks: Applications and Localization

Dynamic Service Switching for the Medical IoT

Philipp Kindt, Daniel Yunge, Andreas Tobola, Georg Fischer and Samarjit Chakraborty

Cloud-based Self-Organizing Localization with Virtual Network Topology for Wireless Sensor Networks and Its Implementation

Takamasa Kitanouma, Naotoshi Adachi and Yasuhisa Takizawa

Antenna Cluster Selection for Localization- Communication Dual Mode Operation

Stephen Lingfeng Wang, Yuechuan Zhang and Zhong Fan

Factor Graph Approach for Joint Passive Localization and Receiver Synchronization in Wireless Sensor Networks

Weijie Yuan, Nan Wu, Hua Wang and Jingming Kuang

Joint Optimization for Social Content Dissemination in Wireless Networks

Xiangnan Weng and John Baras

MoC5: Opportunistic Communications

A Green Coalitional Store-and-Forward Scheme for Delay Tolerant Networks

Sara Arabi, Sara Handouf, Essaid Sabir and Mohamed Sadik

BALCON: BACKward Loss Concealment Mechanism for Scalable Video Dissemination in Opportunistic Networks

Merza Klaghstan, David Coquil, Harald Kosch, Nadia Bennani and Lionel Brunie

Incentivizing User Provided Connectivity for Enhanced Quality of Service

Sinan Emre Tasci and Omer Korcak

Content- and Context-Aware Opportunistic Cellular Communications in Device-Centric Wireless Networks

Baldomero Coll-Perales and Javier Gozalvez

Estimating Data Transfer Capacity for Intermittent Connectivity: A Transport Aware Model

Johan Garcia, Stefan Alfredsson and Anna Brunstrom

MoC6: Medium Access Control (MAC) 1

Fair Resource Allocation Using the MCS Map for Multi-user Superposition Transmission (MUST)

Hung-Yun Hsieh, Ming-Jie Yang and Chun-Hsiung Wang

Joint Coding of Sequential HARQ Feedback

David Cooper

Improved Message Passing Algorithms for Resource Allocation in Two-Tier Femtocell Networks

Qun Gu, Ying-lei Teng and Mei Song

A Novel Dynamical Uplink Power Control Scheme for Dual Connectivity

Shizhou Lv, Chang Yongyu, Yang Sun and Mengshi Hu

Ephemeral: Lightweight Pseudonyms for 6LoWPAN MAC addresses

Jessye Dos Santos, Christine Hennebert, Cedric Lauradoux and Jean Christophe Fonbonne

MoC7: LTE Networks

Measurement-Based Modelling of LTE Performance in Dublin City

Miguel Báguena, Douglas Leith and Pietro Manzoni

Quality of Service for LTE Public Safety Networks with Satellite Backhaul

Laurent Reynaud, Karina Mabell Gomez and Tomaso De Cola

Feasibility Study of LTE Middle-Mile Networks in TV White Spaces for Rural India

Chaitanya Prasad N, Soubhik Deb and Abhay Karandikar

Dynamic and Adaptive QoE Management for OTT Application Sessions in LTE

Balázs Héder, Péter Szilágyi and Csaba Vulkán

Indoor Planning and Optimization of LTE-U Radio Access over WiFi

Omar Sandoval, David González G, Jyri Hämäläinen and Sangjo Yoo

MoC8: Energy Efficient Communications 2

Physical and MAC Cross-Layer Analysis of Energy-Efficient MIMO Networks

Guilherme Peron, Glauber Brante and Richard Demo Souza

Energy Efficiency Optimization in Cognitive Radio Inspired Non-Orthogonal Multiple Access

Yi Zhang, Qian Yang, Tong-Xing Zheng, Hui-Ming Wang, Ying Ju and Yue Meng

Energy Efficient Optimization for Full-duplex Assisted Closed-loop MISO Downlink Transmission

Yu Zhang, Shengqian Han, Chenyang Yang and Gang Wang

Impact of Uncertainty in Predicting the User's Request on Pushing

Chuting Yao and Chenyang Yang

Energy-Efficient Optimization for MISO Gaussian Broadcast Channel with Integrated Services

Weidong Mei, Lingxiang Li, Zhi Chen and Chuan Huang

MoD0: Panel 2

mmWave - The Path to 5G Enhanced Mobile Broadband

Panellists:

- **Prof. Fredrik Tufvesson** (Lund Univ., Lund, Sweden)
- **Prof. Mark Beach** (Bristol Univ., Bristol, UK)
- **Dr. Laurent Dussopt** (Research Director, CEA-LETI, Lyon, Francia)
- **Jyri Putkonen** (Lead Researcher, Nokia, Espoo, Finland)
- Alternate: **Prof. Nuria González Prelcic** (Vigo Univ., Vigo, Spain)

Motivation and Background:

The world's standardization bodies are moving to define the next generation of wireless access including the 3GPP. Enhanced Mobile Broadband with a goal of peak data rates exceeding 10 Gbit/s has been proposed as one goal but other objectives touch on latency, supporting billions of new types of devices, enhanced communication at the cell edge, and improved spectral efficiency. Many researchers are investigating cmWave and mmWave technologies as possible options for addressing these goals. However, research as these frequencies has really just begun and many questions remain including the use, deployment strategy, viability and potential integration with existing 4G structure. This panel will discuss cmWave and mmWave technologies for addressing the goals and objectives for next generation wireless and access to support a broad range of new applications.

Questions:

1. Are mmWave and cmWave frequencies possible for next generation wireless access?

2. If so, what applications are better for communication in these frequencies?
3. What frequencies could be possible for cmWave and mmWave frequencies for next generation wireless access?
4. How can cmWave and mmWave be used in a mobile access network?
5. What are the challenges for cmWave and mmWave for wide adoption?

MoD1: Massive MIMO Channel Estimation and Precoding

Compressive Downlink CSI Estimation for FDD Massive MIMO Systems: A Weighted Block L1 - Minimization Approach

Chih-Chun Tseng, Jwo-Yuh Wu and Ta-Sung Lee

Pilot Design and AMP-Based Channel Estimation for Massive MIMO-OFDM Uplink Transmission

Xiaying Wu, Lixin Gu, Wenjin Wang and Xiqi Gao

Exploiting Antenna Correlation in Measured Massive MIMO Channels

Jose Flordelis, Sha Hu, Fredrik Rusek, Ove Edfors, Ghassan S Dahman, Xiang Gao and Fredrik Tufvesson

Nonlinear Block Multi-diagonalization Precoding for High SHF Wide-band Massive MIMO in 5G

Hiroshi Nishimoto, Akinori Taira, Hiroki Iura, Shigeru Uchida, Akihiro Okazaki and Atsushi Okamura

MMSE based Two-stage Beamforming for Large-Scale Multi-user MISO Systems

Younghyun Jeon, Changick Song, Seung Joo Maeng, Myonghee Park and Inkyu Lee

MoD2: Relaying/Cooperative Relaying 2

Performance of Two-Way AF MIMO Relay Networks with Single and Multiple Antenna Selection Schemes

Efendi Fidan and Oğuz Kucur

Statistical Properties of Two Hop Relay Systems With Polarization Diversity

Maja Delibasic and Milica Pejanovic-Djurisic

Efficient hierarchical embedded signaling scheme for nodes identification in cooperative wireless networks with relay selection

Mariam Ayedi, Noura Sellami and Mohamed Siala

Joint Optimization of Throughput and Delay Over PPP Interfered Relay Networks

Young Jin Chun, Simon Cotton, Mazen Omar Hasna and Ali Ghrayeb

On the Reception Criteria Adopted in Asynchronous Multi-Packet Networks Relying on Spatial Reuse

Fulvio Babich and Massimiliano Comisso

MoD3: Device-to-device (D2D) communications 2

Resource Allocation in D2D-based V2V Communication for Maximizing the Number of Concurrent Transmissions

Shiyu Zhang, Yanzhao Hou, Xiaodong Xu and Xiaofeng Tao

Cooperative Spectrum Sharing Between D2D Users and Edge-Users: A Matching Theory Perspective

Yiling Yuan, Tao Yang, Yuedong Xu and Bo Hu

Investigation of Decision Metrics for Reuse Link Selection in Device-to-Device Communication

Markus Klügel, Mu He and Wolfgang Kellerer

Clustered Device-to-Device Caching Based on File Preferences

Xiangyang Zhang, Ying Wang, Ruijin Sun and Dong Wang

ProVa: A Proximity Validation Approach For Enhanced Device Discovery

Dimitris Tsolkas, Nikos Passas and Lazaros Merakos

MoD4: Wireless Sensor Networks: Architecture, Security, Traffic

SOL: An End-to-end Solution for Real-World Remote Monitoring Systems

Keoma Brun-Laguna, Thomas Watteyne, Sami Malek, Ziran Zhang, Carlos Oroza, Steven D Glaser and Branko Kerkez

Priority-oriented Multicast Transmission Schemes for Heterogeneous Traffic in WSNs

Debasish Ghose and Frank Y. Li

Analysing Indirect Sybil Attacks in Randomly Deployed Wireless Sensor Networks

Panagiotis Sarigiannidis, Eirini Karapistoli and Anastasios A. Economides

Adaptive Scheme for Collaborative Mobile Sensing in Wireless Sensor Networks: Bacterial Foraging Optimization approach

Ado Adamou Abba Ari, Abdelhak (Mourad) Gueroui, Nabila Labraoui, Blaise Omer Yenke, Chafik Titouna and Damakoa Irépran

MoD5: QoS and ultra-reliability

Optimized Transmission and Resource Allocation Strategies for Ultra-Reliable Communications

Hamidreza Shariatmadari, Sassan Iraj, Zexian Li, Mikko A Uusitalo and Riku Jäntti

QoE and Throughput Aware Radio Resource Allocation Algorithm in LTE Network with Users using Different Applications

Takahiro Hori and Tomoaki Ohtsuki

Power Allocation for Statistically Delay Constrained Video Streaming in Femtocell Networks based on Nash Bargaining Game

Hamed Hosseiny, Mohammadamin Baniassadi, Vahid Shah-Mansouri and Mohammad Ghanbari

QoE-based Video Delivery over LTE Hierarchical Architecture

Nabeel Khan and Maria G. Martini

QoE-aware Power Allocation for Device-to-Device Video Transmissions

Nima Eshraghi, Vahid Shah-Mansouri and Behrouz Maham

MoD6: Medium Access Control (MAC) 2

Stochastic Resource Allocation with a Backhaul Constraint for the Uplink

Javier Rubio, Olga Muñoz-Medina, Antonio Pascual-Iserte and Josep Vidal

Improvement of HARQ Based on Redundant Data of Near User in Non-Orthogonal Multiple Access

Dongseok Roh, Minhoe Kim and Dong-Ho Cho

Compressed Sensing based ACK Feedback for Grant-Free Uplink Data Transmission in 5G mMTC

Xianjun Yang, Wang Xin, Weiwei Wang and Jian Zhang

Two-tier Distributed and Open Loop Multi-point Cooperation Using SCMA

Hadi Baligh, Alireza Bayesteh, Yicheng Lin, Usa Vilaipornsawai and Keyvan Zarifi

User Cooperation Enabled Traffic Offloading in Urban Hotspots

Tim Rüegg, Yahia Hassan and Armin Wittneben

MoD7: LTE and WiFi Coexistence and Offloading Techniques

Optimal Scheduling for Incentive WiFi Offloading under Energy Constraint

Juntao Gao, Minoru Ito and Norio Shiratori

Mobile Data Offloading addressing the Service Quality vs. Resource Utilisation Dilemma

Alicia Whittier, Parag Kulkarni, Fengming Cao and Simon Armour

Performance Analysis of Delayed Mobile Data Offloading With Multi-level Priority

Heng Xu, Xiangming Wen, Zhaoming Lu, Zhiqun Hu, Wenpeng Jing and Kun Chen

A New Data Offloading Algorithm by Considering Interactive Preferences

Amir Mohammad Hatami, Mahtab Mirmohseni and Farid Ashtiani

MoD8: Energy Awareness and Power Control

On joint energy and information transfer in relay networks with an imperfect power amplifier

Mahdi Haghighat, Behrooz Makki, Masoumeh Nasiri-Kenari and Tommy Svensson

Energy and Spectrum Efficient Wireless LAN by Tightly Integrating Low-Power Wake-up Radio

Suhua Tang, Chao Zhang, Hiroyuki Yomo and Sadao Obana

Energy-Efficient Data Transmission with Non-FIFO Packets

Qing Zhou and Nan Liu

Transmission Power Control in WBAN Using the Context-Specific Temporal Correlation Model

Sukhumarn Archasantisuk, Takahiro Aoyagi, Minseok Kim and Jun-ichi Takada

Energy-Efficient Power Control for OFDMA Cellular Networks

Lokman Sboui, Zouheir Rezki and Mohamed-Slim Alouini

TuA0: Plenary 2. Part I

The Road to Massive MIMO mmWave Mobile Communications Systems

Abstract:

Massive MIMO promises to increase the capacity of wireless systems through high-channel count multi-user MIMO techniques. mmWave offers new spectrum above 24 GHz that offer multi GHz of bandwidth. The inevitable marriage of these techniques promise to revolutionize next generation wireless communications systems enabling efficient, low power, high data rate communications solutions. In this talk we discuss the evolution of bands being considered at mmWave frequencies and the obstacles research must overcome on the road to making this a commercially viable technology. Discussion includes the need for open, reconfigurable platforms that enable both early channel sounding research and advanced prototyping of real-time 2-way communications protocols that accelerate the prototyping process. New advances in RF, ADC and DAC, FPGA, and RFIC technologies provide the building blocks necessary to fully exercise this new spectrum.

Short Bio:

Mr. Erik Luther (KF5LTV), Senior Group Manager - 5G Prototyping Solutions, leads the 5G product marketing team at National Instruments (NI) focused on accelerating next generation wireless research. Over the last 5 years he has managed product marketing for NI and Ettus Research software defined radio solutions including product roadmaps, outbound marketing, and collaborations with leading industry, academic, and government wireless research teams. Since joining NI in 2002, Luther has held positions across applications engineering and product marketing focused on advancing NI design platforms, specifically making prototyping and experimentation more accessible for both research and education. Early in his career, Luther pioneered NI's efforts to support universities with curriculum and textbooks, launching NI's independent textbook publishing arm NTS Press. His accomplishments include collaboration on more than 50 published textbooks and lab related materials on topics that include RF/communications, DSP, circuit design, and real-time control which have been utilized by more than 100,000 engineering students around the world. Luther led the IEEE Communication Society Education and Training initiative to establish <http://labs.comsoc.org> a community focused on establishing best practices for hands-on education and teaching resources for wireless communications. Luther holds a bachelors degree from the University of Missouri in Electrical Engineering.

TuA0: Plenary 2. Part II

Beyond IoT - Ubiquitous Sensing and Human Experience

Abstract:

This talk will overview the broad theme of interfacing humans to the ubiquitous electronic "nervous system" that sensor networks will soon extend across things, places, and people, going well beyond the 'Internet of Things,' and in different ways challenging the notion of physical presence. I'll illustrate this through two avenues of research - one looking at a new kind of digital "omniscience" (e.g., different kinds of browsers for sensor network data & agile frameworks for sensor representation) and the other looking at buildings & tools as "prosthetic" extensions of humans (e.g., making HVAC and lighting systems an extension of your natural activity and sense of comfort, or smart tools as human-robot cooperation in the hand), drawing from many projects that are running in my group at the MIT Media Lab.

Short Bio:

Joe Paradiso is the Alexander W. Dreyfoos (1954) Professor in Media Arts and Sciences at the MIT Media Laboratory, where he directs the Responsive Environments group, which explores how sensor networks augment and mediate human experience, interaction and perception. He received his PhD in Physics from MIT in 1981 and a BSEE from Tufts University in 1977. After two years developing precision drift chambers at the Lab for High Energy Physics at ETH in Zurich, he joined the Draper Laboratory in 1984, where his research encompassed spacecraft control systems, image processing algorithms, underwater sonar, and precision alignment sensors for large high-energy physics detectors. He joined the Media Lab in 1994, where his current research interests include embedded sensing systems and sensor networks, wearable and body sensor networks, energy harvesting and power management for embedded sensors, ubiquitous and pervasive computing, human-computer interfaces, & interactive media.

TuB0: Panel 3

Wireless Communications for the Internet of Things

Panellists:

- **Prof Angeliki Alexiou** (Digital Systems Department, Univ. of Piraeus, Piraeus, Greece)
- **Dr Jesus Alonso-Zarate** (CTTC, Barcelona, Spain)
- **Henrik Lund Staermose** (Neogrid Technologies ApS, Northern Region, Denmark)
- **Prof Mahesh Sooriyabandara** (Associate Managing Director of Toshiba TRL, Bristol, UK)

Motivation and Background:

One of the major growth application areas for future wireless communications is in the area of the Internet of Things. Enabling connectivity between different electronic devices and systems will open up many new application areas in different industries and different aspects of life. This panel is sponsored by the European Project ADVANTAGE which studies communications and power technologies for the emerging "smart grid". The smart grid will provide a more intelligent power grid in the future, which should provide a better match between supply and demand, as well as integrating increasing levels of renewable energy sources which are intermittent in terms of the power provided. Wireless communications and the internet of things is a key building block in enabling better sharing of information within the smart grid to support improved control and decision making. The first wave of this technology can be seen in smart meters which are currently being rolled out across Europe. This panel will discuss in detail the technology requirements for the internet of things in general as well as focussing on the application to smart grid technology in more detail.

Questions:

1. What are the key steps to move towards mass deployment of Internet of Things technology?
2. What the stumbling blocks and problems that still need to be overcome to enable this vision?
3. How will the Internet of Things be used in the Smart Grid in future?
4. How will our lives be changed when the Smart Grid is fully deployed?
5. What are the future research challenges in this area?

TuB1: Beamforming Techniques

Robust Beamforming Method for SDMA with Interleaved Subarray Hybrid Beamforming

Shunsuke Fujio, Chikara Kojima, Toshihiro Shimura, Kenichi Nishikawa, Kazuyuki Ozaki, Zhengyi Li, Atsushi Honda, Shohei Ishikawa, Takenori Ohshima, Hiroshi Ashida, Masahiko Shimizu and Yoji Ohashi

Linearization of nonlinear MISO channel

Ilia Iofedov and Dov Wulich

Block diagonalization for interference mitigation in Ka-band backhaul networks

Rudolf Zetik, Venkatesh Ramireddy, Marcus Grossmann, Markus Landmann and Giovanni Del Galdo

A Top-down SCMA Codebook Design Scheme Based on Lattice Theory

Haonan Yan, Hui Zhao, Zhaobiao Lv and Haojun Yang

TuB2: Coding Techniques

RAID-6 Reed-Solomon Codes with Asymptotically Optimal Arithmetic Complexities

Sian-Jheng Lin, Amira Alloum and Tareq Y. Al-Naffouri

On Physical-Layer Raptor Coded Modulation with Gray-mapped 16QAM

Shiuan-Hao Kuo, Hsuan-Kuan Wu and Mao-Chao Lin

The Design of Protograph LDPC Codes for Channel-Coded Physical-layer Network Coding

Pingping Chen, Kaixiong Su, Yi Fang and Lingjun Kong

Analysis and Design of Rate Compatible LDPC Codes

Fulvio Babich, Matteo Noschese and Francesca Vatta

Improved Turbo Product Coding dedicated for 100 Gbps Wireless Terahertz Communication

Lukasz Lopacinski, Jörg Nolte, Steffen Büchner, Marcin Brzozowski and Rolf Kraemer

TuB3: Cognitive radio

Ant Colony System Based Control Channel Selection Scheme for Guaranteed Rendezvous in Cognitive Radio Ad-hoc Network

Henry Ohize and Mqhele E. Dlodlo

Fair and Regulated Spectrum Allocation in Licensed Shared Access Networks

M. Majid Butt, Carlo Galiotto and Nicola Marchetti

Blind Channel Selection Strategies for Distributed Cognitive MAC

Nazanin Rastegardoost and Bijan Jabbari

Energy-Efficient Power Allocation for Simultaneous Wireless Information-and-Energy Multicast in Cognitive OFDM Systems

Wei Chen, Wenjun Xu, Fengyu Wang, Shengyu Li and Jiaru Lin

Design and experimental evaluation of C-MAC solutions for heterogeneous spectrum sharing

Iker Sobron, Cristina Regueiro, Iñaki Eizmendi, Unai Gil and Manuel Velez

TuB4: HetNets and Energy-Aware Communications

Energy and Spectrum Efficient User Association in 5G Heterogeneous Networks

Agapi Mesodiakaki, Ferran Adelantado, Angelos Antonopoulos, Luis Alonso and Christos Verikoukis

An Energy-Efficient Radio Resource Allocation Algorithm for Heterogeneous Wireless Networks

Mary Adedoyin and Olabisi Emmanuel Falowo

Distributed Power and Resource Allocation for Weighted Sum Energy-Efficiency Maximization in OFDMA Smallcell Network

Guodong Zhang, Jinming Hu, Wei Heng and Wang Gang

Fuzzy Q-Learning based Energy Management of Small Cells Powered by the Smart Grid

Mouhcine Mendil, Antonio De Domenico, Vincent Heiries, Raphael Caire and Noredine Hadjsaid

Energy-Delay Analysis for Partial Spectrum Sharing in Heterogeneous Cellular Networks with Wired Backhaul

Zhiyan Cui, Qimei Cui, Zheng Wei and Zhen Li

TuB5: 5G System Design and Evaluation

A 5G Hybrid Channel Model Considering Rays and Geometric Stochastic Propagation Graph

Gerhard Steinboeck, Anders Karstensen, Pekka Kyösti and Aki Hekkala

Uplink Control Channel Design for 5G Ultra-Low Latency Communication

Shuqiang Xia, Xianghui Han, Xiao Yan, Zhisong Zuo and Feng Bi

Effects of Channel Estimation Errors on Ultra-Dense Small Cell Networks

Yosub Park, Jihaeng Heo, Jintae Kim, Sooyong Choi and Daesik Hong

TuB6: Relaying and Satellite Communications

Selective Multi-Hop Relaying for Ultra-Reliable Communication in a Factory Environment

Bikramjit Singh, Olav Tirkkonen, Zexian Li, Mikko A Uusitalo and Risto Wichman

Dynamic Relay Selection and Channel Adaptive Uplink For LTE Device-to-Device (D2D) Communication

Bighnaraj Panigrahi, Rashmi Ramamohan, Hemant Kumar Rath and Anantha Simha

Toward High Throughput Contact Plan Design in Resource-Limited Small Satellite Networks

Di Zhou, Min Sheng, Jiandong Li, Chao Xu, Runzi Liu and Yu Wang

Joint Relay Selection and Power Allocation for Maximum Energy Efficiency in Hybrid Satellite-Aerial-Terrestrial Systems

Yichun Xu, Ying Wang, Ruijin Sun and Yuan Zhang

Capacity Analysis of Zero-Forcing Precoding in Multibeam Satellite Systems with Rain Fading

Ishtiaq Ahmad, Khoa D. Nguyen, André Pollok and Nick A Letzepis

TuB7: Security, Authentication and Pricing

Dynamic Multi-Factor Authentication for Smartphone

Alexander Yohan, Nai-Wei Lo and Henry Roes Lie

Delay-Reliability Tradeoff for Wireless-Connected Indoor Robot Surveillance Based on Radio Environment Map

Yunlong Wu, Bo Zhang, Chaoqun Wang, Xuefeng Chang, Xiaodong Yi and Yuhua Tang

A Game Theoretic Model for Network Virus Protection

Iyed Khammassi, Rachid El-Azouzi, Majed Haddad and Issam Mabrouki

Biometric Authentication using Hand Movement Information from Wrist-worn PPG Sensors

Hiroto Kamoi and Tomoaki Ohtsuki

Optimal Pricing Strategy for a Wireless Sensor Data Broker under a Zipf-distributed Sensing Rate Offer

Luis Guijarro, Maurizio Naldi, Vicent Pla and Jose Ramon Vidal

TuB8: Access Point and Base Station Deployment and Selection

Two-stage Access Point Selection for Hybrid VLC and RF Networks

Xiping Wu, Dushyantha Basnayaka, Majid Safari and Harald Haas

An Energy Efficient Base Station Deployment for mm-wave Based Wireless Backhaul

Miryam Gonzalez and John Thompson

Environment-based Roadside Unit Deployment for Urban Scenarios

Jose Leon Calvo, Halil Alper Tokel and Rudolf Mathar

Access Point Selection in Li-Fi Cellular Networks with Arbitrary Receiver Orientation

Mohammad Dehghani Soltani, Xiping Wu, Majid Safari and Harald Haas

Inverse Fingerprinting: Server Side Indoor Localization with Bluetooth Low Energy

Jae Hyung An and Lynn Choi

N2Women

Tips Success in Different Stages of One's Career

It's time for Networking Networking Women (N2Women) Meeting

N2Women is a discipline-specific community for researchers in the communications and networking research fields. Join us for networking and open discussion!

- Main Speaker: Prof. Ana Garcia Armada
- Contact: Mary Adedoyin, addmar004@myuct.ac.za, +27630341165

N2Women is supported by ACM SIGMOBILE, ACM SIGCOMM, IEEE Communications Society, IEEE Computer Society (CS), Technical Committee on Computer Communications (TCCC), NSF Division of Computer and Network Systems, CRA-W, Microsoft Research, HP Labs, and Google Research.

Learn more about N2 Women at <http://n2women.comsoc.org/>.

TuC0: Panel 4

From Vehicular Networks to the Internet of Vehicles

Panellists:

- **Dino Flore** (Qualcomm, Barcelona, Spain)
- **Angela Doufexi** (Univ. of Bristol, Bristol, UK)
- **Leonardo Goratti** (CREATE-NET, Varese, Italy)

Motivation and Background:

Vehicular Networks pose some still open challenges, but their potential is well recognized. As we move towards the so-called Internet of Vehicles, the problems compound with the need to up-scale to the level of a city, region, even continent, and to integrate the whole range of legacy (i.e., dumb) to semi-autonomous and eventually autonomous, as well as unmanned, vehicles. (This Panel will not focus on Autonomous Driving per se.)

The critical aspects of interaction with humans (pedestrians and drivers) and with infrastructure (built or self-organizing) also need to be taken into consideration. In this regard, large-scale deployments are essential to test and validate solutions in context. Complex Cyber-Physical Systems (CPS) approaches need also to be explored.

Questions:

1. What are the major open challenges in Vehicular Networks? How can these scale up as needed for example in the context of Smart Cities? What underlying technologies will be needed?
2. What role for Unmanned Vehicles (land, air, sea and underwater) in the future Internet of Everything? How to optimally combine them to extract real-time system information, including in emergency situations? How to secure their interaction with humans and other vehicles?
3. What role for large-scale deployments extending from Intelligent Transportation Systems to Smart Cities? How to address the challenge of multi-vendor offerings and of complex system integration?
4. As we move towards connected vehicles, how expensive will on-board technology be, versus handheld solutions, and what impact in terms of coexistence with legacy and varying levels of smart public infrastructure, versus ad hoc solutions?

TuC1: Millimetre-Wave Beamforming 1

Linear Baseband Precoding Strategies for Millimeter Wave MIMO Multi-X Channels

Venkatesh Ramireddy, Marcus Grossmann, Markus Landmann, Rudolf Zetik and Giovanni Del Galdo

Experiment of 28 GHz Band 5G Super Wideband Transmission Using Beamforming and Beam Tracking in High Mobility Environment

Tatsunori Obara, Yuki Inoue, Yuuichi Aoki, Satoshi Suyama, Jaekon Lee and Yukihiro Okumura

Millimeter-Wave Beam Multiplexing Method Using Hybrid Beamforming

Masahiko Shimizu, Atsushi Honda, Shohei Ishikawa, Kazuyuki Ozaki, Shunsuke Fujio, Kenichi Nishikawa, Zhengyi Li, Chikara Kojima, Toshihiro Shimura, Hiroshi Ashida, Takenori Ohshima, Yoji Ohashi and Makoto Yoshida

Performance of Hybrid Beamforming for mmW Multi-antenna Systems in Dense Urban Scenarios

Sonia Gimenez, Sandra Roger, David Martín-Sacristán, Jose F Monserrat, Paolo Baracca, Volker Braun and Hardy Halbauer

Reconfigurable Hybrid Beamforming for Dual-Polarized mmWave MIMO Channels

Sau-Hsuan Wu, Jing-Wen Wang and Ju-Ya Chen

TuC2: Modulation and Coding Techniques

Joint Recognition of Error Correcting Codes and Interleaver Parameters in a Robust Environment

Swaminathan Ramabadran and A S Madhukumar

Layered Source-Channel Coding for Uniformly Distributed Sources over Parallel Fading Channels

Hieu T. Nguyen, Ilangko Balasingham and Tor A. Ramstad

Adaptive Coded Modulation for Mobility Constrained Indoor Wireless Environments

Indrakshi Dey and Ronald Y. Chang

Constellation Shaping for Bit-Interleaved Polar Coded-Modulation

Dekun Zhou, Kai Niu and Chao Dong

Modulation Recognition of PSK and QAM Signals Based on Envelope Spectrum Analysis

Min Li, Lili Liang, Dong Wei, Meng Zhang and Chunwei Miao

TuC3: Cognitive Techniques and Self Organizing Networks

Tradeoff Between Energy Consumption and Detection Capabilities in Collaborative Cognitive Wireless Networks

Marco Martalò, Gianluigi Ferrari and Andrea Abrardo

Sender-Jump Receiver-Wait: a blind rendezvous algorithm for distributed cognitive radio networks

Jiaxun Li, Haitao Zhao, Ji-Bo Wei, Dongtang Ma, Chunsheng Zhu, Xiping Hu and Li Zhou

A Robust Conscious Model For Enhancing Cognitive Radio Quality of Service

Periola A Ayodele and Olabisi Emmanuel Falowo

Self Optimizing Network (SON) Framework for Automated Vertical Sectorization

Dereje Woldemedhin Kifle, Bernhard Wegmann, Ingo Viering and Anja Klein

A Double Auction Mechanism for Virtual Resource Allocation in SDN-based Cellular Network

Di Zhang, Zheng Chang, F. Richard Yu, Xianfu Chen and Timo Hämäläinen

TuC4: HetNets and Resource Management

Analysis of Interference Avoidance with Load Balancing in Heterogeneous Cellular Networks

Fazal Muhammad, Ziaul Haq Abbas and Lei Jiao

Tridimensional Frequency Reuse Based Interference Mitigation Strategy in Two-Tier Femtocell Networks

Weilong Ren, Haichao Wei and Wuyang Zhou

Dynamic Cell Selection and Resource Allocation in Cognitive Small Cell Networks

Xiaoge Huang, Sijia Liu, Yangyang Li, Fan Zhu and Qianbin Chen

Resource Allocation via Hierarchical Clustering in Dense Small Cell Networks: A Correlated Equilibrium Approach

Zhu Xiao, Yu Jianzhi, Tong Li, Zhiyang Xiang, Dong Wang and Wenjie Chen

Control Plane Load Balancing in Wireless C/U Split Architectures

Jinwei Gang and Vasilis Friderikos

TuC5: OFDM 1

Blind Frequency Synchronization for OFDM System with I/Q Imbalance

Yue Meng, Weile Zhang, Wenjie Wang, Hui-Ming Wang and Yi Zhang

Selective Clipping and Filtering: A Low-EVM PAPR Reduction Scheme for OFDM Standards

Audrey Cuenin and Nur Engin

Subcarrier Index Modulation OFDM for Multiuser MIMO Systems with Iterative Detection

Huiying Zhu, Wenjin Wang, Qing Huang and Xiqi Gao

SINR Analysis of OFDM and f-OFDM for Machine Type Communications

Kun Chen Hu and Ana Garcia Armada

Using Maximal Ratio Combining and Subcarrier Selection to Improve the OFDM Receiver Performance in IEEE802.15.4g

Gabriel da Silva, Eduardo de Lima and Cesar G Chaves

TuC6: Energy Aware Wireless Sensor Networking

Semidefinite Programming based Resource Allocation for Energy Consumption Minimization in Software Defined Wireless Sensor Networks

Yueyue Zhang, Yaping Zhu, Feng Yan, Zhengquan Li and Lianfeng Shen

Energy Efficient Adaptive Transmission Strategy Using Cooperative Diversity for Wireless Sensor Networks

Nesrine Atitallah, Hela Hakim, Kais Loukil, Abdulfattah M. Obeid and Mohamed Abid

Energy Efficiency Cooperative Scheme for Cluster-based Capillary Networks in Internet of Things Systems

Liumeng Song, Kok Keong Chai, Yue Chen and John Schormans

Decentralized Data Dissemination and Harvesting for Urban Monitoring

Milica Milojevic and Javier A. Barria

Energy-Efficient Mobile Groupcasting Protocol in Wireless Sensor Networks

Jeongcheol Lee, Min Yoon, Hyun-kyu Lee, Yongje Shin, Euisin Lee and Mario Gerla

TuC7: Physical Layer Security 1

Intercept Probability-Constrained Secure MIMO AF Relaying with Arbitrarily Distributed ECSI Errors

Jiaxin Yang, Qiang Li, Hao Li and Benoit Champagne

Experimental Channel-Based Secret Key Generation with Integrated Ultra Wideband Devices

Marharyta Bulenok, Iulia Tunaru, Lionel Biard, Benoit Denis and Bernard Uguen

Novel Joint Secure Resource Allocation Optimization for Full-duplex Relay Networks with Cooperative Jamming

Zhenyu Xu, Jie Zhong, Gaojie Chen, Minjian Zhao and Liyan Li

A Hybrid Channel Estimation Strategy Against Pilot Spoofing Attack in MISO System

Fengyi Bai, Pinyi Ren, Qinghe Du and Li Sun

Secrecy Capacity Analysis for α - μ / κ - μ and κ - μ / α - μ Fading Scenarios

Nidhi Bhargav and Simon Cotton

TuC8: Network Planning and Topology Design

Drone Formation Algorithm on 3D Space for a Drone-based Network Infrastructure

Seongjoon Park, Hyunsoon Kim, Kangho Kim and Hwangnam Kim

Coverage and Performance of Stratospheric Balloons Wireless Networks

Jean-Marc Kelif

A Machine Learning enabled network Planning tool

Jessica Moysen, Lorenza Giupponi and Josep Mangués-Bafalluy

Capacity-aware Cost-efficient Network Reconstruction for Post-Disaster Scenario

Xiaoyan Wang, Hao Zhou, Lei Zhong, Yusheng Ji, Kiyoshi Takano, Shigeki Yamada and Guoliang Xue

Radio Environment Map Techniques and Performance in the Presence of Errors

Tim D Farnham

TuD0: Panel 5

Smart Cities and the Internet Of Things

Panellists:

- **Gema Roig** (INNDEA Valencia, Spain)
- **Ramón Ferri** (VLCi Smart City Platform, Valencia, Spain)
- **Miguel Montesinos** (Prodevelop, Valencia, Spain)
- **Francisco Sanchis** (Pay [in], Valencia, Spain)
- **Javier Ferrer** (WiTraC, Valencia, Spain)

TuD1: Millimetre-Wave Beamforming 2

Speeding Up mmWave Beam Training through Low-Complexity Hybrid Transceivers

Joan Palacios, Danilo De Donno, Domenico Giustiniano and Joerg Widmer

Low-Complexity Spatial Channel Estimation and Hybrid Beamforming for Millimeter Wave Links

Hsiao-Lan Chiang, Tobias Kadur, Wolfgang Rave and Gerhard Fettweis

System Validation of Millimeter-Wave Beam Multiplexing with Interleaved Hybrid Beamforming Antennas

Atsushi Honda, Shohei Ishikawa, Kazuyuki Ozaki, Shunsuke Fujio, Kenichi Nishikawa, Zhengyi Li, Chikara Kojima, Toshihiro Shimura, Hiroshi Ashida, Takenori Ohshima, Masahiko Shimizu and Yoji Ohashi

Transmitter Design for Analog Beamforming Aided Spatial Modulation in Millimeter Wave MIMO Systems

Ming-Chun Lee and Wei-Ho Chung

On the Performance of Millimeter Wave-based RF-FSO Links with HARQ Feedback

Behrooz Makki, Tommy Svensson and Mohamed-Slim Alouini

TuD2: Coding, Transport and Routing solutions for Wireless Networks

Efficient Scheduling to Reduce Latency for Signaling Traffic using CMT-SCTP

Johan Eklund, Anna Brunstrom and Karl-Johan Grinnemo

Transmission of Scalable Video Coding over Heterogeneous Cellular Networks

Mojtaba Ghermezcheshmeh, Vahid Shah-Mansouri and Mohammad Ghanbari

Q-SWiM: QoE-based Routing algorithm for SVC Video Streaming over Wireless Mesh Networks

Tran Anh Quang Pham, Kandaraj Piamrat, Kamal Deep Singh and César Viho

Performance and Complexity of Tunable Sparse Network Coding with Gradual Growing Tuning Functions over Wireless Networks

Pablo Garrido, Chres W. Sørensen, Daniel E. Lucani and Ramón Agüero

Study of the enhanced algorithm for control information dissemination in Wi-Fi Mesh networks

Andrey Belogaev, Evgeny Khorov, Artem Krasilov and Andrey Lyakhov

TuD3: Spectrum Sensing and User Selection in Cognitive Radio Networks

Wireless Power Transfer Based Spectrum Leasing with User Selection in Cognitive Radio Networks

Chao Zhai, Ju Liu, Lina Zheng and Xinhua Wang

Secure Transmission via Jamming in Cognitive Radio Networks with Possion Spatially Distributed Eavesdroppers

Xiang Hu, Xing Zhang, Haozhou Huang and Yongjing Li

Sparse Spectrum Sensing in Infrastructure-less Cognitive Radio Networks via Binary Consensus Algorithms

Mohamed Seif Eldin Mohamed, Tamer ElBatt and Karim G Seddik

Embedded primary users identification and channel estimation for underlay cognitive radio network based on Compressive sensing

Imen Sahnoun, Inès Kammoun and Mohamed Siala

TuD4: Small cells and HetNets

Almost Blank Subframes versus Partially Shared Deployment in Heterogeneous Networks

Ararat Shaverdian, Santhana Krishnan and Catherine Rosenberg

A Source-Destination Based Dynamic Pricing Scheme to Control Congestion in Heterogeneous Wireless Networks

Jeremiah Mutungi and Olabisi Emmanuel Falowo

Load-Balanced User Association and Resource Allocation Under Limited Capacity Backhaul for Small Cell Networks

Chia-Yu Wang, Pei-Rong Li, Chia-Lin Tsai and Kai-Ten Feng

Energy Efficiency Optimization in OFDMA Heterogeneous Networks with RF Energy Harvesting

Zhiqiang Chen, Xiangming Wen, Zhaoming Lu, Wenpeng Jing, Zeguo Xi and Kun Chen

Radio Resource Allocation with Proportional-Fair Energy Efficiency Guarantee for Smallcell Networks

Wenpeng Jing, Xiangming Wen, Zhaoming Lu, Zhiqun Hu and Tao Lei

TuD5: OFDM 2

Characterizing and Optimizing the Throughput of FFR/SFR-aided OFDMA Networks

Jan Garcia-Morales, Guillem Femenias and Felip Riera-Palou

Ultra-multi-amplitude-level BPSK based SSB-DFTs-OFDM to Achieve Higher Spectrum Efficiency

Hirokazu Fusayasu, Shigeki Nihei, Masahiro Umehira, Jun-ichi Abe and Jun Mashino

Atomic-Norm for Joint Data Recovery and Narrow-Band Interference Mitigation in OFDM Systems

Hanan Al-Tous, Imad Barhumi and Naofal Al-Dhahir

Performance Evaluation of Filterbank Multicarrier Systems in an Underwater Acoustic Channel

Mohammud Junaid Bocus, Angela Doufexi and Dimitris Agrafiotis

TuD6: Energy Harvesting and Smart Grids

Energy Outage and Achievable Throughput in RF Energy Harvesting Cognitive Radio Networks

Shanai Wu, Yoan Shin, Jin Young Kim and Dong In Kim

Spatial Throughput of Energy Harvesting Cognitive Radio Networks

Xiao Yang, Min Sheng, Hongguang Sun, Xijun Wang and Jiandong Li

Reducing the impact of solar energy shortages on the wireless access network powered by a PV panel system and the power grid

Margot Deruyck, Daniela Renga, Michela Meo, Luc Martens and Wout Joseph

Battery State Based Power and Time Allocation in Wireless Powered MIMO Uplink Transmission

Liqin Shi, Liqiang Zhao and Kai Liang

Holistic Link Quality Estimation-based Routing Metric for RPL Networks in Smart Grids

Sana Rekik, Nouha Baccour, Mohamed Jmaiel and Khalil Drira

TuD7: Physical Layer Security 2

Physical Layer Security with Hostile Jammers and Eavesdroppers: Secrecy Transmission Capacity

Chenzhi Si, Hongguang Sun, Min Sheng, Xijun Wang and Jiandong Li

Transmission mode selection scheme for Physical Layer Security in Multi-user Multi-relay systems

Asma Mabrouk, Kamel Tourki and Nouredine Hamdi

Secure Communications for SWIPT over MIMO Interference Channel

Shiqi Gong, Chengwen Xing, Fei Zesong and Jingming Kuang

Secrecy Throughput Maximization for Millimeter Wave Systems with Artificial Noise

Ying Ju, Hui-Ming Wang, Tong-Xing Zheng, Yi Zhang, Qian Yang and Qinye Yin

TuD8: Performance Analysis in Wireless Communications

On the Symmetric α -Stable Distribution with Application to Symbol Error Rate Calculations

Hamza Soury and Mohamed-Slim Alouini

An Exact Power Series Formula of the Outage Probability with Noise and Interference over Generalized Fading Channels

Nadhir Ben Rached, Abba Kammoun, Mohamed-Slim Alouini and Raul Tempone

Approximate Capacity Formulas for Generalized Fading Radio Channels

Natalia Ermolova

BER Analysis of Asynchronous and non Linear FBMC Based Multi-Cellular Networks

Brahim Elmaroud, Mohamed Abbad and Driss Aboutajdine

Modeling and Throughput Analysis of Distributed WiFi Networks

Shweta Suresh Sagari, Krishna Balachandran, Joseph Kang, Mehmet Kemal Karakayali and Kiran M Rege

WeA0: Plenary 3. Part I

Enabling the Internet of Things with NB-IoT

Abstract:

Today's M2M technologies only partially address some key verticals, limiting new IoT business opportunities. Narrow Band Internet of Things (NB-IoT) is a radio access technology that has been standardised in 3GPP Rel13 that will enable telecom industry to extend the existing products and services to address the key Low Power Wide Area requirements, battery, coverage and cost. In the last two year Vodafone has champion the technology with Huawei and has become the industry thought leaders, completing the first pre-standard NB-IoT field trial and developing a 3GPP global standard. Vodafone will present their experience on the technology and plans to continue to lead in this space.

Short Bio:

Mabel has recently been appointed to Head of Strategy in Group Technology. Mabel's career with Vodafone began nearly 10 years ago when she joined Vodafone Ireland as a network optimisation engineer, later moving into customer experience management and the introduction of Vodafone first CEM system. Mabel became optimisation manager, and played a major role in helping Ireland to achieve network leadership - Vodafone Ireland's data performance moved from last to 1st within 3 months of Mabel taking on the role. Following a year spent helping VHA to improve network performance in Australia, Mabel joined Vodafone UK to manage network performance in London, including optimisation of 4G when it was first launched. In 2015 she moved to Vodafone Group to manage the New Technologies and Innovation team within the Networks organisation where she has been critical to the success of 4GFi, Crowd Cell and other key initiatives such as Narrow Band IoT. Prior to joining Vodafone, Mabel was an Accenture Consultant in Madrid and London. Mabel earned her first degree in Electronic Engineering from Universidad de Valencia, Spain, and then undertook a two year Masters by Research with the Cork Institute of Technology in Ireland.

WeA0: Plenary 3. Part II

Heterogeneous V2X Networks for Connected and Automated Vehicles

Abstract:

Connected vehicles will rely on V2X communications to improve traffic safety and management. V2X communications can also facilitate the development of cooperative driving and sensing applications for automated vehicles. The automotive industry is currently working to deploy connected vehicles that will initially rely on the IEEE802.11p/ITS-G5 standard. At the same time, the cellular industry has started the evolution of 4G LTE standards to integrate V2X communications, and has identified the automotive sector as one of the key verticals in the development of 5G. A massive deployment of connected and automated vehicles demand the capacity to provide reliable, scalable, and low-latency V2X communications. Providing such levels of quality of service is a challenge, and this keynote will discuss the need, opportunities and challenges for heterogeneous V2X networks to support connected and automated vehicles.

Short Bio:

Javier Gozávez received an electronics engineering degree from the Engineering School ENSEIRB (Bordeaux, France), and a PhD in mobile communications from the University of Strathclyde, Glasgow, U.K. Since October 2002, he is with the Universidad Miguel Hernández de Elche (UMH), Spain, where he is currently an Associate Professor and Director of the UWICORE laboratory. At UWICORE, he leads research activities in the areas of vehicular networks, multi-hop cellular networks and D2D communications, and wireless industrial networks. He has published over 125 papers in international conferences and journals. He has received several awards at international and national conferences, the best research paper award from the Journal of Network and Computer Applications (Elsevier) in 2014, and the Runner-up prize for the "Juan López de Peñalver" award of the Royal Academy of Engineering in Spain that recognizes the most notable Spanish engineers aged below 40. He is an elected member to the Board of Governors (2011-2016) and 2016 President of the IEEE Vehicular Technology Society (IEEE VTS). He was an IEEE Distinguished Lecturer for the IEEE VTS, and currently serves as Distinguished Speaker. He currently serves as Mobile Radio Senior Editor of the IEEE Vehicular Technology Magazine, and on the Editorial Board of the Computer Networks journal. He was the General Co-Chair for the IEEE VTC-Spring 2015 conference in Glasgow (UK), ACM VANET 2013, ACM VANET 2012 and ISWCS 2006, and TPC Co-Chair for 2011 IEEE VTC-Fall and 2009 IEEE VTC-Spring.

Web1: Millimetre-Wave Channel Sounding and Modeling 1

mm-Wave Channel Sounding Using a Fully Programmable SoC

Jan Erik Håkegård, Helge Rustad, Isabelle Tardy, Tor A Myrvoll and Vidar Ringset

Ultrawideband VNA Based Channel Sounding System for Centimetre and Millimetre Wave Bands

Johannes Hejselbæk, Wei Fan and Gert Pedersen

E-Band Millimeter Wave Indoor Channel Characterization

Aliou Bamba, Francesco Mani and Raffaele D'Errico

Spatio-Temporal Channel Sounding in a Street Canyon at 15, 28 and 60 GHz

Reza Naderpour, Joni Vehmas, Sinh Nguyen, Jan Järveläinen and Katsuyuki Haneda

Millimeter-Wave Channel Model Parameters for Urban Microcellular Environment Based on 28 and 38 GHz Measurements

Jae-Joon Park, Jinyi Liang, Juyul Lee, Heon Kook Kwon, Myung-Don Kim and Bonghyuk Park

Web2: Transceiver Design 1

A Low Complexity Detector with MRC Diversity Reception for MCIC-OFDM

Eleftherios Chatziantoniou, James Crawford and Youngwook Ko

Graph-Based Detectors for Filter Bank Multicarrier Systems

Fangyu Cui, Minjian Zhao and Jie Zhong

A New Digital Communications Receiver Using Partial Knowledge of the Channel State Information

Arafat Al-Dweik, Youssef Iraqi and Mohammed Al-Mualla

Coherent Detection in a Receive Diversity PLC System Under Nakagami-m Noise Environment

Soumya Prakash Dash, Ranjan K. Mallik and Saif Khan Mohammed

Optimum Receiver Filter for a Noise-based Frequency-Offset Modulation System

Ibrahim Bilal, Arjan Meijerink and Mark J. Bentum

WeB3: Vehicular Communications 1

Propagation Experiment on Millimeter Wave for High-speed Rail Trains

Tetsunori Hattori and Tsukasa Kudo

Radar Cross Section Measurement with 77 GHz Automotive FMCW Radar

Seongwook Lee, Seokhyun Kang, Jae-Eun Lee and Seong-Cheol Kim

Hardware Testbed for Sidelink Transmission of 5G Waveforms without Synchronization

David Garcia-Roger, Josue Flores de Valgas, Nicolo Incardona, Jose F Monserrat and Narcis Cardona

Methods for Downlink Performance Enhancement in HST SFN

Fankui Lin, Chang Yongyu, Xizeng Dai, Qiming Li and Li Anjian

A Cooperative Relay Selection Scheme in V2V Communications under Interference and Outdated CSI

Petros S. Bithas, George Efthymoglou and Athanasios G. Kanatas

WeB4: Ultra Dense Networks

Uplink Reference Signals Enabling User-Transparent Mobility in Ultra Dense Networks

Xavier Gelabert, Christer Qvarfordt, Mario Costa, Petteri Kela and Kari Leppanen

Joint User Scheduling and Transmit Direction Selection in 5G TDD Dense Small Cell Networks

Sandra Lagen, Adrian Agustin and Josep Vidal

Long-term Provisioning of Radio Resources Based on their Utilization in Dense OFDMA Networks

Sandra Lagen, Olga Muñoz-Medina, Antonio Pascual-Iserte, Josep Vidal and Adrian Agustin

Game-Theoretic Hierarchical Resource Allocation in Ultra-Dense Networks

Yuanfei Liu, Ying Wang, Yuan Zhang, Ruijin Sun and Lisi Jiang

WeB5: Caching, Multi-Cell and Software Defined Networks (SDN)

Optimizing The Service Capacity of SDN-based Cellular Networks with Service Chaining and NFV

Rung-Hung Gau, Hsiao-Ting Chiu and Pei-Kan Tsai

OpenE2EQoS: Meter-based Method for End-to-end QoS of multimedia services over SDN

Tsungnan Lin, Yang-Ming Hsu, Sheng-Yi Kao and Po-Wen Chi

Real-time monitoring of SDN networks using non-invasive cloud-based logging platforms

Bartlomiej Siniarski, Philip A Perry, Cristian Olariu, John Murphy and Trevor Parsons

Power Allocation and Receive Antenna Selection Algorithm in Multi-cell Cooperative Networks

Chao Meng, Wei Heng, Wang Gang, Tian Liang and Jinming Hu

A Collaborative Caching Scheme with Network Clustering and Hash-routing in CCN

Wei yuan Li, Yang Li, Wei Wang, Yonghui Xin and Yuemei Xu

WeB6: Resource and Interference Management in Wireless Networks

Mobility-aware Scheduler in CoMP Systems

Nivine Abbas, Thomas Bonald and Berna Sayrac

Joint real-time scheduling and interference coordination for wireless factory automation

Sébastien Auroux, Donald Parruca and Holger Karl

Inter-WBANs Interference Mitigation Using Orthogonal Walsh Hadamard Codes

Mohamad Ali, Hassine MOUNGLA, Mohamed Younis and Ahmed Mehaoua

Resource Allocation with Interference Information Sharing in Multi-Carrier Networks

Marco Schito, Hamid Reza Barzegar and Luca Reggiani

Sparse Multi-User Detection for Non-Orthogonal Multiple Access in 5G Systems

K. HE, Y. Li and Changchuan Yin

WeB7: Applications

A Mobile App for Real-Time Testing of Path-Loss Models and Optimization of Network Planning

David Plets, Roel Mangelschots, Kris Vanhecke, Luc Martens and Wout Joseph

A Novel Dynamic Adaptive Video Streaming Solution in Content-Centric Mobile Network

Yiran Wei, Changqiao Xu, Mu Wang and Jianfeng Guan

Cross Video HTTP Adaptive Streaming for Short Video Improvement

Xiaoli Wang and Atsushi Minokuchi

Combining Scheme of Multiple Differential Filter Outputs for Direct Conversion Receiver

Takaaki Kitano and Yukitoshi Sanada

WeB8: Localization and Tracking

Emender: Signal Filter for Trilateration based Indoor Localisation

Paul Crane, Zhiyi Huang and Haibo Zhang

Non-line-of-sight Mitigation in Wireless Localization and Tracking via Semidefinite Programming

Yueyue Zhang, Yaping Zhu, Feng Yan, Zhengquan Li and Lianfeng Shen

A GPR-PSO incremental regression framework on GPS/INS integration for vehicle localization under urban environment

Zhu Xiao, Sui Zhan, Zhiyang Xiang, Dong Wang and Wenjie Chen

Evaluation of Fast Human Localization and Tracking using MIMO Radar in Multi-path Environment

Dai Sasakawa, Naoki Honma, Kentaro Nishimori, Takeshi Nakayama and Shoichi Iizuka

A ToA/IMU Indoor Positioning System by Extended Kalman Filter, Particle Filter and MAP Algorithm

Xuechen Chen, Shupeng Song and Jihong Xing

WeB9: Full Duplex Transmission and Networks

Full-duplex based Successive Interference Cancellation in Heterogeneous Networks

Lei Huang, Shengqian Han, Chenyang Yang and Gang Wang

Tight Upper Bound Ergodic Capacity of an AF Full-Duplex Physical-Layer Network Coding System

Bilal Jebur, Charalampos C. Tsimenidis and Jonathon Chambers

Binary Power Control for Full-Duplex Networks

Rongpeng Li, Yan Chen and Yiqun Wu

A Virtual Full Duplex Distributed Spatial Modulation Technique for Relay Networks

Amir Shehni, Sandeep Narayanan and Mark F. Flanagan

Outage Analysis of Full-Duplex DF Relaying with Limited Dynamic Range of ADC

JaeHyun KO, Minwoo Jung and Hu Jin

WeC1: Millimetre-Wave Channel Sounding and Modeling 2

Dual-Polarized Indoor Propagation at 26 GHz

Jesper Ø Nielsen and Gert Pedersen

Dense Multipath Component Parameter Estimation in 11GHz-band Indoor Environment

Kentaro Saito, Jun-ichi Takada and Minseok Kim

Comparison of Characteristics of 13-17 GHz Propagation Channels in Indoor Environments with Different Measurement Configurations

Cen Ling, Xuefeng Yin, Haowen Wang and Xiaomei Zhang

Polarimetric Millimeter Wave Propagation Channel Measurement and Cluster Properties in Outdoor Urban Pico-cell Environment

Karma Wangchuk, Kento Umeki, Tatsuki Iwata, Minseok Kim, Kentaro Saito and Jun-ichi Takada

Measured and Modelled Corner Diffraction at Millimetre Wave Frequencies

Tom Barratt, Evangelos Mellios, Peter Cain, Andrew Nix and Mark Beach

WeC2: Transceiver Design 2

Fast Convergence of Joint Demodulation and Decoding Based on Joint Sparse Graph for Spatially Coupling Data Transmission

Zhengxuan Liu, Yanyan Guo, Guixia Kang, Zhongwei Si and Ningbo Zhang

Channel Shortening Algorithms for Multiple Intersymbol Interference Channels

Sha Hu and Fredrik Rusek

A Filter-Bank Based Transmission Scheme for Two-Component Carrier Aggregation

Stelios Stefanatos and Fotis Foukalas

A Novel Compressed Data Transmission Scheme In Slowly Time-Varying Channel

Yupeng Cui, Wenbo Xu and Jiaru Lin

A Cross-Polarization Discrimination Compensation Algorithm for Polarization Modulation

Jinjin Yuan, Fangfang Liu, Caili Guo, Chunyan Feng and Yao Nie

WeC3: Vehicular Communications 2

Accurate and Platform-agnostic Time-of-flight Estimation in Ultra-Wide Band

Francois Despaux, Katia Jaffrès-Runser, Adrien van den Bossche and Thierry Val

Improving CAMs Broadcasting in VANETs through Full-Duplex Radios

Claudia Campolo, Antonella Molinaro and Antoine O. Berthet

A Channel Access Scheme for Bluetooth Low Energy to Support Delay-Sensitive Applications

Made Harta Dwijaksara, Wha Sook Jeon and Dong Geun Jeong

A Reliable Token-Based MAC Protocol for V2V Communication in Urban VANET

Ali Balador, Annette Böhm, Carlos T. Calafate and Juan-Carlos Cano

WeC4: Small Cells and Network Densification

Fast Cell Select for Mobility Robustness in Intra-frequency 5G Ultra Dense Networks

Fasil Tesema, Ahmad Awada, Ingo Viering, Meryem Simsek and Gerhard Fettweis

Backhaul-aware Adaptive TP Selection for Virtual Cell in Ultra-dense Networks

Zihua Yang, Hongtao Zhang, Peng Hao and Xiao Yan

Boosted WiFi through LTE Small Cells: The Solution for an All-Wireless Enterprise

David López-Pérez, Jonathan Ling, Bong Ho Kim, Subramanian Vasudevan, Satish Kanugovi and Ming Ding

Canonical Domains for Cellular Networks: Analysis of the One-Dimensional Case

David González G and Jyri Hämäläinen

Intra-Cluster Autonomous Coverage Optimization For Dense LTE-A Networks

Ali Esswie

WeC5: Software Defined Networking and NFV

Handover Implementation in a 5G SDN-based Mobile Network Architecture

Jonathan Prados, Oscar Adamuz-Hinojosa, Pablo Ameigeiras, Juan J. Ramos-Muñoz, Pilar Andres-Maldonado and Juan M. Lopez-Soler

Understanding Processing Latency of SDN based Mobility Management in Mobile Core Networks

Clarissa Cassales Marquezan, Zoran Despotovic, Ramin Khalili, David Perez-Caparrós and Artur Hecker

RAVA - Resource Aware VNF Agnostic NFV Orchestration Method for Virtualized Networks

Faqir Zarrar Yousaf, Carlos Gonçalves, Luis Moreira-Matias and Xavier Costa Pérez

Virtualized EPC - Runtime Offload for Fast Data-Plane Scaling

Marco Liebsch and Faqir Zarrar Yousaf

WeC6: Scheduling

User Assignment and Discrete Power Control for Scalable NOMA Multicast in Cellular Networks

Rung-Hung Gau and Hsiao-Ting Chiu

Fair and Efficient Full Duplex MAC Protocol based on the IEEE 802.11 DCF

Jinho D Kim, David I Laurenson and John Thompson

Forecast scheduling for mobile users

Hind Zaaraoui, Zwi Altman, Eitan Altman and Tania Jimenez

Mobility-driven Scheduler for Mobile Networks Carrying Adaptive Streaming Traffic

Nivine Abbas, Yu-Ting Lin and Berna Sayrac

Frequency-Dependent Modulation and Coding Rates for LTE Link Adaptation in Static Conditions

Javier Lorca and Carlos F Lopez

WeC7: Information Centric Networking and Caching Strategies

An Autonomous System Collaboration Caching Strategy Based on Content Popularity in CCN

Wang Kaili, Wu Muqing, Min Zhao and Cheng Yanqing

Distributed Optimal Caching for Information Centric Networking (ICN)

Samar Shailendra, Bighnaraj Panigrahi, Senthilmurugan Sengottuvelan, Hemant Kumar Rath and Anantha Simha

A Cost-Oriented Cooperative Caching for Software-Defined Radio Access Networks

Qiang Li, Caixia Zhang, Ge Xiaohu, Tao Chen and Tao Zhang

An In-network Caching Scheme Based on Betweenness and Content Popularity Prediction in Content-centric Networking

Xiaoqiang Zhou, Min Zhao and Wu Muqing

High Quality Guarantee for Video Streaming in Massive MIMO Relay Networks with Caching

Bowen Liu, Heli Zhang, Hong Ji, Xi Li and Ke Wang

WeC8: Localization, Mobility and Link Quality Prediction

Characterizing and modeling the distance of mobile calls: a metropolitan case study

Nicolas Tastevin and Mathieu Bouet

A Hybrid Indoor Positioning Algorithm based on WiFi Fingerprinting and Pedestrian Dead Reckoning

Qian Lu, Xuewen Liao, Shulin Xu and Wei Zhu

PerfLoc (Part 1): An Extensive Data Repository for Development of Smartphone Indoor Localization Apps

Nader Moayeri, M. Onur Ergin, Filip Lemic, Vlado Handziski and Adam Wolisz

User Mobility Prediction based on Lagrange's Interpolation in Ultra-Dense Networks

BangXu Li, Hongtao Zhang and Haitao Lu

Predicting Link Quality of Wireless Channel of Vehicular Users Using Street and Coverage Maps

Nabajeet Barman, Stefan Valentin and Maria G. Martini

WeC9: Visible Light Communications (VLC)

Visible Light Communication Systems Using Blue Color Difference Modulation for Digital Signage

S. Sato, Hiraku Okada, Kentaro Kobayashi, Takaya Yamazato and Masaaki Katayama

Enhanced Bayesian MMSE Channel Estimation for Visible Light Communication

Xianyu Chen and Ming Jiang

Spatial Modulation in Layered Space-Time Coding for Image-Sensor-Based Visible Light Communication

Keisuke Masuda, Koji Kamakura and Takaya Yamazato

A Novel Mirror Diversity Receiver for Indoor MIMO Visible Light Communication Systems

Ki-Hong Park, Wael Alheadary and Mohamed-Slim Alouini

Bit Error Rate Analysis of Free-Space Optical Communication Over General Malaga Turbulence Channels with Pointing Error

Wael Alheadary, Ki-Hong Park and Mohamed-Slim Alouini

WeD1: Channel Measurement, Characterization and Modeling

Power Delay Profile Measurement for VHF-band Broadband Mobile Communication System

Hiroki Ohara, Hirokazu Sawada, Masayuki Oodo, Hideki Kobayashi, Fumihide Kojima, Hiroshi Harada and Jun-ichi Takada

Stochastic Misalignment Model for magneto-inductive SISO and MIMO Links

Gregor Dumphart and Armin Wittneben

Spectrum Database-assisted Radio Propagation Prediction for Wireless Distributed Networks: A Geostatistical Approach

Koya Sato, Kei Inage and Takeo Fujii

Analysis of the Doppler Shift due to Pendulation and Static Spinning for Projectile Antennas

Manuel Milla, Hervé Boeglen, Loïc Bernard, Dirk Schmoltzi and Rodolphe Vauzelle

WeD2: MIMO Systems

Non-reused Pilot Design for Large-scale Multi-cell Multiuser MIMO System

Dedan Meng, Li Guo, Chao Dong, Qian Deng and Tianyu Kang

Antenna Selection Based Dimming Scheme for Indoor MIMO Visible Light Communication Systems Utilizing Multiple Lamps

Zhipei Wang, Caili Guo, Yang Yang and Qiang Li

An Improved Mixed Gibbs Sampling Algorithm Based on Multiple Random Parallel Markov Chains For Massive MIMO Systems

Cheng Gao, Jin Xu, Xiaofeng Tao and Zhiheng Qin

A channel estimation error adapted uplink scheduling algorithm in coordinated MIMO systems

Siqi Liu, Jianyuan Cui, Jin Xu and Xiaofeng Tao

Channel Prediction for Massive MIMO with Channel Compression based on Principal Component Analysis

Rei Nagashima, Tomoaki Ohtsuki, Wenjie Jiang, Yasushi Takatori and Tadao Nakagawa

WeD3: Vehicular Communications 3

Performance Assessment of 5G-Candidate Waveforms in High Speed Scenarios

José Rodríguez-Piñeiro, Tomás Domínguez-Bolaño, José A. García-Naya and Luis Castedo

UE Autonomous Cell Management in a High-Speed Scenario with Dual Connectivity

Lucas Chavarria Gimenez, Per Henrik Michaelsen and Klaus Pedersen

A FLRBF Scheme for Optimization of Forwarding Broadcast Packets in Vehicular Ad Hoc Networks

Zhifang Miao, Xuelian Cai, Qu Yuan Luo and Weiwei Dong

Adaptive Mobility Aware Call Admission Control For Mobile Hotspot Networks

Enoruwa Obayiuwana and Olabisi Emmanuel Falowo

Two-Tier Cellular Communication Systems with Enhanced Vehicular-Based Primary Nodes

Samer Henry, Ahmed Alsohaily and Elvino Silveira Sousa

WeD4: WLAN networks

Enhancement of Full-Duplex Efficiency in an Asymmetric IEEE 802.11-Based WLAN

Shirin Goshtasbpour, Farid Ashtiani and Mahtab Mirmohseni

Addressing MAC Layer Inefficiency and Deafness of IEEE802.11ad Millimeter Wave Networks using a Multi-Band Approach

Gek Hong Sim, Thomas Nitsche and Joerg Widmer

A New Contention Based Adaptive MAC Protocol Based on the Renewal Access Protocol

Youngrock Oh, Yunbae Kim, Ganguk Hwang and Seung Keun Park

Evaluation of the DSC algorithm and the BSS Color scheme in dense cellular-like IEEE 802.11ax deployments

Ioannis Selinis, Marcin Filo, Seiamak Vahid, Jonathan Rodriguez and Rahim Tafazolli

Wi-Fi Channel Load Estimation Based on Control Frames Metrics

Pablo Romero-Hierro, Mari Carmen Aguayo-Torres, Carlos Cardenas and Janie Baños

WeD5: Cloud-RAN and SDN Cellular Networks

Dynamic Resource Allocation Exploiting Mobility Prediction in Mobile Edge Computing

Jan Plachy, Zdenek Becvar and Emilio Calvanese Strinati

Ultra-Low Latency Service Provision in 5G Fog-Radio Access Networks

Te-Chuan Chiu, Wei-Ho Chung, Ai-Chun Pang, Ya-Ju Yu and Pei-Hsuan Yen

A Service-tailored TDD Cell-Less Architecture

Vincenzo Sciancalepore, Konstantinos Samdanis, Rudraksh Shrivastava, Adlen Ksentini and Xavier Costa-Perez

Reallocation Strategies for User Processing Tasks in Future Cloud-RAN Architectures

Sebastian Scholz and Heidrun Grob-Lipski

A Framework for Resources Allocation In Virtualised C-RAN

Imad Samman, Matteo Artuso, Henrik Christiansen, Angela Doufexi and Mark Beach

WeD6: Cooperative Communications

Evaluation of the Effect of Base Station Antenna Polarization on the Performance of CoMP Transmission Techniques based on Synchronous Multi-Link Measurements

Sakib Bin Redhwan, Ahmad Shekhan, Ghassan S Dahman, Jose Flordelis and Fredrik Tufvesson

Performance Evaluation of CoMP Transmission Schemes using: Measurements versus the COST 2100 Channel Model

Panagiotis Papaioannou, Ghassan S Dahman, Jose Flordelis and Fredrik Tufvesson

Dynamic Clustering for Max-Min Fairness with Joint Processing CoMP

Mubarak Aminu, Jarkko Kaleva and Antti Tölli

Low Complexity Moore-Penrose Inverse for Large CoMP Areas with Sparse Massive MIMO Channel Matrices

Amir M. Ahmadian, Wolfgang Zirwas, Rakash SivaSiva Ganesan and Berthold Panzner

WeD7: Ultra-Wideband (UWB)

Pulse Shaping for High Capacity Impulse Radio Ultra-Wideband Wireless Links Under the Russian Spectral Emission Mask

Eilzaveta Grakhova, Simon Rommel, Antonio Jurado Navas, Albert Sultanov, Juan Jose Vegas Olmos and Idelfonso Tafur Monroy

Up to 35 Gbps Ultra-Wideband Wireless Data Transmission Links

Rafael Puerta, Simon Rommel, Juan Jose Vegas Olmos and Idelfonso Tafur Monroy

Improved Propagation Modeling in Ultra-Wideband Indoor Communication Systems Utilizing Vector Fitting Technique of the Dielectric Properties of Building Materials

Konstantinos Prokolidis, Dimitrios Zografopoulos, Christos Kalialakis and Apostolos Georgiadis

UWB Planar Monopole Antenna with Differential Feed

Marko Sonkki, Eva Antonino-Daviu, Nora Mohamed Mohamed-Hicho, Miguel Ferrando-Bataller and Erkki T. Salonen

WeD8: Body Area Networks

Simultaneous Channel Measurements of the On-Body and Body-to-Body Channels

Nidhi Bhargav, Simon Cotton, Gareth A Conway, Adrian D McKernan and William G. Scanlon

Joint Orientation and Position Estimation from Differential RSS Measurements at On-Body Nodes

Benoit Denis, Bernard Uguen, Francesco Mani, Raffaele D'Errico and Nicolas Amiot

Experimental Ultra Wideband Path Loss Models for Implant Communications

Concepcion Garcia-Pardo, Raúl Chávez-Santiago, Alejandro Fornes-Leal, Sverre Brovoll, Øyvind Aardal, Jacob Bergsland, Rafael Palomar, Svein-Erik Hamran, Narcis Cardona and Ilangko Balasingham

Antenna for Wireless Capsule Endoscopy at Ultra Wideband Frequency

Kamya Yekeh Yazdandoost

BLE Analysis and Experimental Evaluation in a Walking Monitoring Device for Elderly

Antonio Del Campo, Laura Montanini, Davide Perla, Ennio Gambi and Susanna Spinsante

WeD9: Faster-than-Nyquist (FTN)/Equalization

A Graphical Model based Frequency Domain Equalization for FTN Signaling in Doubly Selective Channels

Weijie Yuan, Nan Wu, Xiaotong Qi, Hua Wang and Jingming Kuang

Interference Detection in Centralized Cooperative Spectrum Sensing from Sub-Nyquist Samples

Anastasia Lavrenko, Anibal Sosa, Andres Navarro and Reiner S. Thomä

Cyclic prefix/suffix-assisted Frequency-Domain Equalization for Faster-than-Nyquist Signaling Block Transmission

Seong Beom Hong and JongSoo Seo

ThA1: Workshop ARCO5G

Session I

ThA2: Tutorial 6

Wireless Proactive Caching for 5G

In the 90s, the world-wide-web traffic exploded, leading its inventor Sir Tim Berners-Lee to declare the network congestion as one of the main issue of the future internet. In this client-server model, a website is downloaded from the same server by every Internet user, resulting in bottlenecks in heavy traffic conditions and creating scalability issues in the network. This has been resolved by usage of proxy/caching servers and later on with the rise of content delivery networks (CDNs). The key idea was to geographically replicate the contents (i.e., video, picture, audio, etc..) closer to the users, so that the end-to-end delay is decreased and unnecessary usage of the infrastructure is avoided. Nowadays, researchers are revisiting the same challenge in the context of wireless networks. Mobile data traffic sharply increases each year, due to the rich multi-media applications, video streaming, social networks, and billions of connected users and devices. This increasing mobile data traffic is expected to reach by 2018 roughly 60% of the total network traffic. In this regard, caching contents at the edge of the network, namely at the base station and user terminals, is a promising way of offloading the backhaul (especially crucial in dense network deployments) and decreasing the end-to-end content access delays, since the requested contents become very close to the users. Although the key motivation of wireless edge caching is similar to the caching in wired networks, a number of technical challenges remain unsolved and involve several scientific disciplines such as networking, information theory, machine learning, and wireless communications. The aim of this tutorial is therefore to present some of key techniques available in wireless edge caching and discuss existing challenges and future directions. Some of well-known technical misconceptions and business barriers are also elaborated.

ThA3: Tutorial 9

Radio Propagation: Measurements, Modelling and Channel Characterisation

This tutorial outlines methods, measurement equipment, and analysis and modelling procedures used by experts to make radio channel models and design parameters available to systems engineers. The target audience is one of students and practicing engineers considering research in the field or systems engineers who use the results from such work and are seeking better knowledge of how information of importance to them is compiled. The tutorial begins with an overview, using material from "Radio Propagation Measurement and Channel Modelling," by Prof. Salous, of radio propagation basics with special attention to frequencies between 6 GHz and 60 GHz. Representation of radio channels as linear filters, estimation of channel impulse response functions, and applications are covered next. Best practices for analysing measured data, including: estimation and reporting of impulse response estimates and static rms delay spreads; appropriate intervals for dynamic channel analysis and estimation and application of average power delay profile, dynamic rms delay spread, frequency correlation function, and coherence bandwidth results are discussed. An overview of advanced topics related to double directional sounding and spatial channel modelling for MIMO applications follows. Attention is finally turned to narrowband channel modelling for a discussion on the removal of the influence of long term fading from measurements, and the modelling of short term fading, including estimation of Rician K ratios, and determining the goodness of fit of experimentally-determined fading distributions to hypothesised models. A discussion of passive and active measurement techniques using both standard test equipment, and custom radio channel sounders opens the second part of the tutorial. Observations are made on the assessment of radio coverage for placement of relay stations and spectral sensing for cognitive radio. Considerations in the design and implementation of radio channel measurement equipment are discussed as well as the planning and conduct of measurements for different environments. This includes consideration of: waveforms, processing gains, time and frequency synchronisation, stability and phase noise, time delay windowing and Doppler coverage. Resolution in time delay and Doppler shift are related to the radar ambiguity function, and techniques for the calibration of sounders are described and compared. Suitable sounder architectures for probing single band as well as multiple band radio links, with both single antenna and multi-antenna sounders are discussed. The tutorial ends with examples showing and comparing measured data and experimental results from the GSM and UMTS bands as well as from higher frequencies ranging up to 60 GHz.

ThB1: Workshop ARCO5G

Session II

ThB2: Tutorial 6 (cont.)

Wireless Proactive Caching for 5G

ThB3: Tutorial 9 (cont.)

Radio Propagation: Measurements, Modelling and Channel Characterisation

ThC1: Workshop ARCO5G

Session III

ThC2: Tutorial 7

Software Defined Wireless Networks

Software defined wireless networking (SDWN) is a new communications paradigm and an essential technology in the next-generation 5G systems. SDWN separates the data plane and the control plane in the wireless communication networks. In an SDWN, software oriented network architecture design, the separation of the data and control planes, and network virtualization, can unfold numerous advantages to manage network complexity and dynamics. SDWN is a very new research topic. It is very important to discuss and promote the concept and the potentials of SDWN. In this tutorial, we will start from basic concepts and main principles on both software defined networking and software defined wireless networks. Then we will discuss about the architectures, protocol design and performance issues for the emerging SDWN scenarios. These applications include software defined radio access networks, software defined sensor networks, software defined mesh networks and software defined vehicular networks. Next we will focus on the research challenges related to resource management, control and optimization in SDWN. We will also discuss about the implementation examples and testbed for SDWN. Finally, the tutorial will point out several new research directions in this area.

ThC3: Tutorial 8

Standards for the Industrial IoT: a hands-on tutorial on with OpenWSN and OpenMote

This tutorial aims at acquainting its audience with ongoing standardization activities around the Industrial Internet of Things (IIoT), and provide hands-on experience through the OpenWSN and OpenMote ecosystems. OpenWSN was founded in 2010 and together with the OpenMote platform, which was launched in 2014, it has become the de-facto open-source implementation of IEEE802.15.4 Time Synchronized Channel Hopping (TSCH). TSCH is the standard at the heart of the IIoT, which enables ultra-high reliability and low-power operation. This tutorial is tailored to the level of practicing engineers and advanced researchers who are interested in IIoT, as well as hands-on experience.

ThD2: Tutorial 7 (cont.)

Software Defined Wireless Networks

ThD3: Tutorial 8 (cont.)

Standards for the Industrial IoT: a hands-on tutorial on with OpenWSN and OpenMote

Program

2016 IEEE 27th Annual International Symposium on Personal, Indoor, and Mobile Radio Communications (PIMRC)

IEEE PIMRC 2016 Workshop IoT: 2016 IEEE 27th Annual International Symposium on Personal, Indoor, and Mobile Radio Communications (PIMRC) - Workshop: From M2M Communications to Internet of Things

Workshop 1: From M2M Communications to Internet of Things

<i>A Novel Technique for ZigBee Coordinator Failure Recovery and Its Impact on Timing Synchronization</i>	
Davide Scazzoli (Politecnico di Milano, Italy), Atul Kumar (Politecnico di Milano, Italy), Navuday Sharma (Politecnico di Milano, Italy), Maurizio Magarini (Politecnico di Milano, Italy), Giacomo Verticale (Politecnico di Milano, Italy)	1
<i>An Analytical Model of the Effective Delay Performance for Bluetooth Low Energy</i>	
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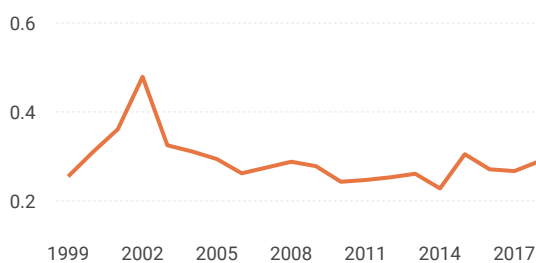
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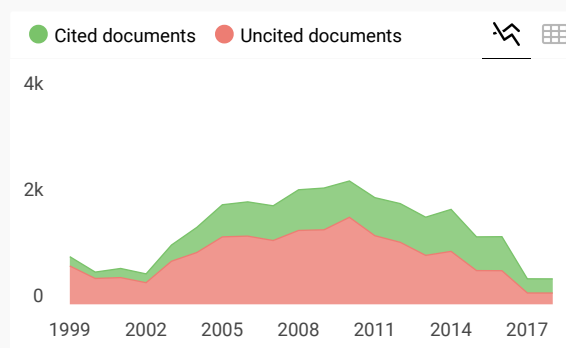
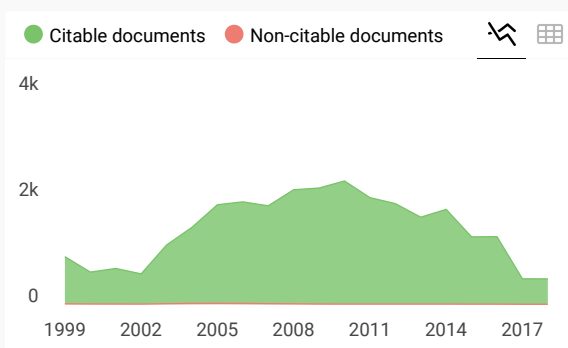
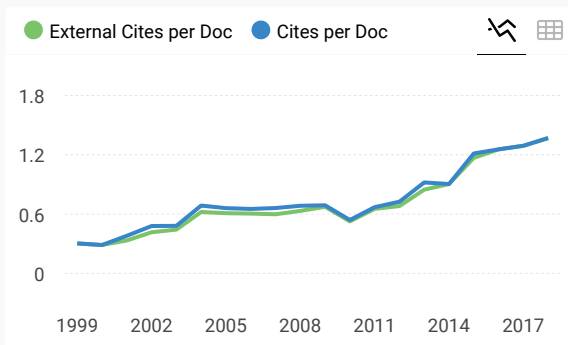
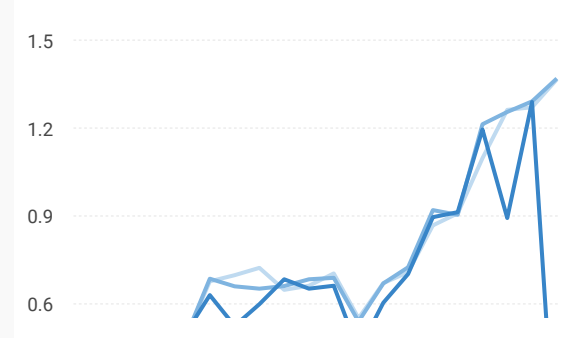
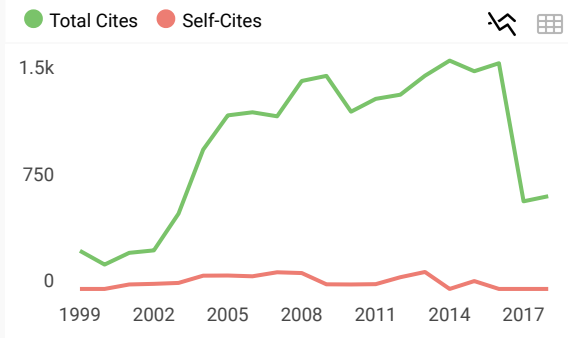
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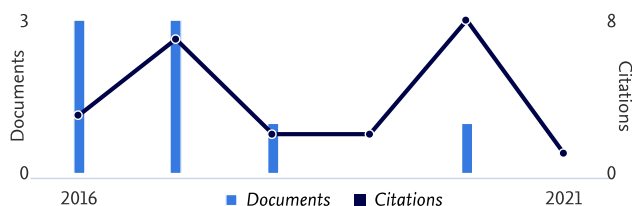
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V2VUNet - A Filtering Out Concept For Packet Forwarding Decision in Three-Dimensional Inter-vehicular Communication Scenarios

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Abstract—Reliability and stability for connectivity are the important factors to enhance inter-vehicular communication. In order to achieve such factors, challenges especially in a large city environment due to signal attenuation and a typically poor transmission coverage issues are investigated. Both issues are caused by the existence of obstacles (*i.e.*, overpass constructions and buildings) and road level topology (*i.e.*, a three-dimensional case). Thus, this paper investigates explicitly the horizontal and vertical transmission distances that apply in a three-dimensional case. These distances are covered by existing propagation models of a large city by modeling them as a log-distance path loss with obstacle fading. The scenario of the dedicated three-dimensional case is simulated through the introduction of Vertical Relative Angles (VRA) and Horizontal Relative Angles (HRA) as supporting factors for the forwarding decision. The evaluation shows that applying HRA and VRA reach higher delivery ratio and reduces relatively lower delay in a large city scenario.

Index Terms—Vertical relative angle (VRA), Horizontal relative angle (HRA), Forwarding scheme, Inter-vehicular communication

I. INTRODUCTION

Inter-vehicular communications can support both safety and non-safety applications. Safety applications, *i.e.* car crash prevention [2], typically take into account a short range wireless transmission technology like Dedicated Short Range Communication (DSRC) [29]. For non-safety applications, *i.e.*, Web surfing and social networking [3], [4], other aspects are relevant, since these applications typically benefit from the use of alternative communication options of the unlicensed spectrum, such as for Wi-Fi and WiMAX [1]. One challenge of providing non-safety application is the high mobility of vehicles, which leads to frequent topology changes of the communication network based on nodes (*i.e.*, vehicle) and respective disconnections. In case of frequent topology changes, vehicles will have to search for a new communication path in order to substitute the “broken” path. This will introduce higher transmission delay. Several studies show that DSRC can run non-safety applications [26]. However, as of today, not many vehicles are fully equipped with IEEE 802.11p [1], [30], thus, the basic study of the dedicated three-dimensional case of Inter-vehicular communications here is compared to IEEE 802.11a [31].



Fig. 1. Road Topology and Traffic in a Large City Environment [25]

Another challenge related to inter-vehicular communication is the real environment of a large city itself, such as traffic condition and road level topology (cf. Fig. 1). The traffic conditions in terms of high density and sparse traffic can create high load and poor connection situations. Road topologies include massive obstacles, such as overpass constructions and buildings, and other static and dynamic objects, such as trees and tall vehicles [15], introduce loss and delay into a connection. Moreover, the road topology reveals different levels of heights [6], such as tunnels/overpasses. These observations indicate an influence on the reliability and stability of the connectivity among vehicles. Due to these challenges, inter-vehicle communications offer several alternative forwarding schemes as an approach to increase the network performance to good throughput and low delay. Forwarding schemes determine the core of the routing mechanism and they use several metrics as weight values to forward the packet [10]. These weighted parameters, such as distance, direction, and angle, are used to determine neighboring vehicles to be used as the next relay hop, *i.e.*, intermediate node. Thus, the optimized decision on determining the next intermediate node does support efficient forwarding schemes [19]. As up to now these weight values are mainly exploited in a two-dimensional case. Thus, the distance from the source node to the next intermediate node in a three-dimensional case is very different compared to the distance in a two-dimensional case. While a few approaches investigate routing methods in three-dimensional environments [13], [14], these three-dimensional approaches do not consider the different road level, where vehicles are located. Since the location coordinate of vehicles on different road levels within a given and dynamically changing topology do affect the decision of any forwarding scheme, the for-

warding scheme in this paper here takes explicitly into account the distance between two communicating vehicles [11]. As the distance as a weight value in a three-dimensional case is less sufficient to be used to determine the intermediate node, this paper applies the real transmission coverage distance among vehicles in a scenario where the disconnection occurs under the overpass. Moreover, due to the high mobility and the existence of obstacles, the Vertical Relative Angles (VRA) and Horizontal Relative Angles (HRA) are introduced as the additional weight values that improve the forwarding scheme [5]. Finally, this improved forwarding scheme is proposed to be part of a Vehicular-to-vehicular Urban Network (V2VUNet), which is designed especially to suit large city environments.

The remainder of this paper is organized as follow, Section II describes related work. Section III introduces the key idea of the angle forwarding scheme being part of a V2VUNet. The simulation and preliminary results are discussed in Section IV, followed by the summary and future work in Section V.

II. RELATED WORK

A reliable and stable inter-vehicular communication covers the need for a successful delivery of messages and an immediate finding of a new path due to the frequently changing topology [12]. Participating vehicles operate as a sender S , a receiver R , or a relay I . The degree of a successful delivery is defined by the Packet Delivery Ratio (PDR) given in percentage.

Unlike in several three-dimensional environments such as in an Under Water Acoustic (UWA) [32] or Unmanned Aerial Vehicle (UAV) [33] Network, the inter-vehicular network coverage and connectivity are more complex due to a Non-Line-Of-Sight (NLOS) propagation [27]. The NLOS propagation in inter-vehicular network is a result of the vehicle's road path. Therefore, this paper here focuses on suitable propagation and forwarding schemes in a large city environment only and is described as follows:

A. Propagation in Large City Environment

In a large city environment, roads have many different contours and different amount of traffic depending of time of a day. Thus, static and dynamic objects may influence the signal transmission and reception. Objects with different heights do also influence an inter-vehicle communication. The transmission and reception of signals are diffracted (*i.e.*, by buildings and overpass) and scattered (*i.e.*, by trees and any small objects) [34]. A number of various propagation models have been developed to obtain a realistic large city environment [7], [8]. The signals are effected by large- and short-scale fading during transmission. In case of an ideal condition [13], in a three-dimensional area, the signal attenuation is not considered [14]. The prominent propagation models for a large city environment are the log-distance path loss and the shadowing model. The latter considers various building sizes and various obstructions [15], [16]. Therefore, it is necessary to consider propagation models that take into account the existence of obstacles to be used as an approach to determine an optimum transmission. The obstacle fading model is a type propagation model, where the existence of a concrete block, for example, being under the overpass, will attenuate or even restrict the signal transmission and reception. Fig. 2 shows a test measurement done in last August when a mobile phone is used inside a bus in Indonesia. The mobile phone is used to track the vehicle's mobility and the arrows indicate the two occurring signal loss periods while driving beneath two over-

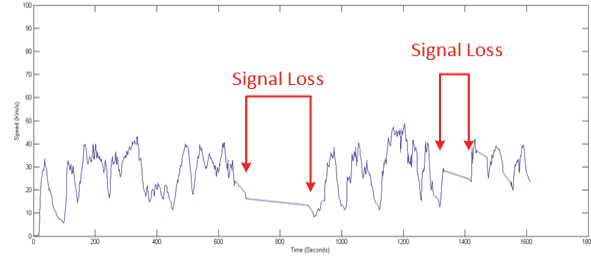


Fig. 2. GPS Connection Lost Occurs Under the Overpass [28]

B. Angle-based Forwarding Scheme

The angle-based forwarding scheme (AFS) takes into account angle measurements between source S and receiver R [18]. The distance between S and R in a planar area is determined based on the imaginary line as illustrated in Fig. 3. This imaginary line is used as the reference for the angle calculation. An angle θ is a shape formed by two straight lines that has a vertex as illustrated in Fig. 3. The AFS selects the candidate having the smallest angle θ measurement [19]. The advantage of an angle-based forwarding scheme is to limit the forwarding area, thus, the efficient routing can be obtained [20], [21], [22].

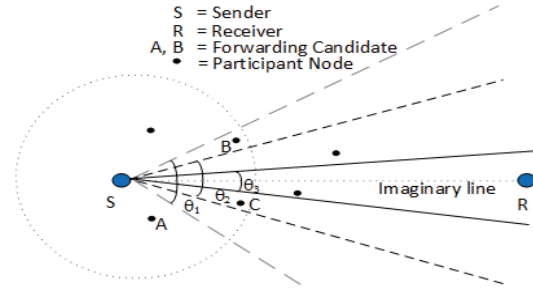


Fig. 3. Angle-based Forwarding Scheme

III. PROPOSED V2VUNET APPROACH

The concept of selecting the proper intermediate node is a first part of the proposed V2VUNet approach here. V2VUNet indicates the transmission range depending on measuring factors:

1) **Distance:** As shown in Fig. 4, there is a difference between the distance in two-dimensional and in three-dimensional case. In two-dimensional case, the distance is shown by the solid line indicated by d_x , which actually shorter compared to the distance in three-dimensional case, which is shown by the dashed line d_z .

2) **Angle:** A current node and intermediate node on a different road hierarchical topology (*i.e.*, vehicles on upper road layer and lower road layer) contribute to angular difference between them as shown in Fig. 4. The angle measurement in two-dimensional area aims to calculate the actual distance between S to R . In case of three-dimensional area, the distance between S to R is relatively different with the planar area.

The proposed V2VUNet approach forwards packets using the filtering out concept. The forwarding decision based on the distance and angle of the potential intermediate nodes. Therefore, two assumption must be made:

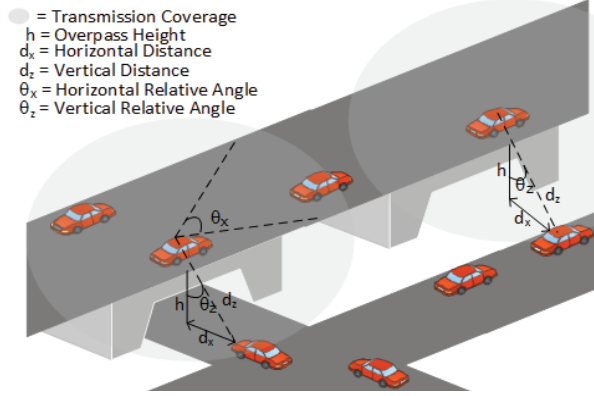


Fig. 4. Horizontal and Vertical Distances

First, the angle is measured from origin node to destination node. The origin node is assumed to be located on upper layer. The x -axis represents the width of road, y -axis represents the length of road, and z -axis represents the height of road (cf. Fig. 5). In order to simplify the angle calculation between two nodes (*i.e.*, source and intermediate nodes), the z -axis is predefined.

Second, the angle is measured when a source node detects an intermediate node located on the lower layer and in line with the current source node on the upper layer. Thus, the measured angle forms perpendicular intersection of two straight lines.

A. Horizontal and Vertical Relative Angle

HRA forwarding scheme, which is basically a distance scheme in two-dimensional environment, is compared to VRA [9]. The difference between HRA and VRA is shown in Fig. 5. HRA works actually by considering the distance in two-dimensional case, while VRA works to discover the real distance in three-dimensional case. When the angle measurement is calculated within the same road level topology, it is called HRA. In contrast, VRA is a term that refers to angle measurement in different road level topology.

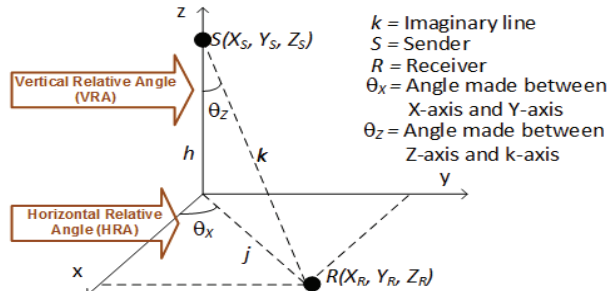


Fig. 5. HRA and VRA Schemes

As illustrated in Fig. 5, the sender is on the overpass *i.e.* located on h and the receiver is under overpass. The imaginary line (cf. Fig. 3) is also defined as k (cf. Fig. 5) can be obtained by the Equation 1 [24].

$$\Delta k = \sqrt{(x_r - x_s)^2 + (y_r - y_s)^2 + (z_r - z_s)^2} \quad (\text{Eqn. 1})$$

B. Packet Forwarding Scheme Using Filtering Out Concept

The concept of V2VUNet shows the angle forwarding scheme with a real location coordinate (*e.g.*, provided by GPS) of mobile node. This angle forwarding scheme is applicable for mobile node's location coordinates on top of other mobile node's location coordinates. This condition has been neglected at most simulations although it is significant in the real experiments. The reason is that mobile nodes (*i.e.*, usually vehicles) are moving on the ground level. Using distance between mobile nodes in planar position will influence the signal power (transmission power information), speed and direction (mobility information), and angle (non-planar position information) as parameters of forwarding decision. It is obvious that the higher the overpass, the larger the distance between two communicating vehicles becomes. Therefore, the height of overpass leads to another impact factor with respect to transmission coverage. Both HRA and VRA are implemented in forwarding decision. This forwarding decision works by applying a filtering out concept. The principal of filtering out concept is to select the relay node I , which fulfills HRA and VRA requirements. There are two steps of filtering out concept by implementing HRA and VRA as follow:

1) HRA and VRA Decision:

This filtering out concept selects neighboring nodes within the transmission range of source node S restricting the searching area for intermediate node candidates. HRA and VRA implementations as illustrated in Fig. 3 define the θ_1 as the maximum angle of transmission area. The value of θ_1 decreases to θ_2 in order to restrict candidates and select the node located closest to planned receiver R . Dashed lines indicate the search radius of source S for the intermediate candidate in direction of receiver R . A node satisfying both HRA and VRA decision will be determined as an intermediate node candidate I .

2) HRA and VRA Execution:

Once the HRA and VRA decision has been made, the next step is to execute the packet forwarding. This execution involves two cases. The first case is when vehicles are located on the same road level. Here, the log-distance path loss model is applied. The second case is when vehicles are located on the different road level and experiencing a connection lost as described in Section II.A.

IV. SIMULATION

The evaluation of the two applied metrics VRA and HRA in the proposed filtering out concept is conducted in simulations to determine the performance of a V2VUNet approach in a large city environment including the three-dimensional case. In order to obtain a realistic city environment, typical parameters for the influencing factors are chosen as shown in Table I. The Network Simulator-3 (NS-3) [23] is used to simulate wireless technologies (*i.e.*, IEEE 802.11p and IEEE 802.11a), the routing protocol (*i.e.*, Greedy Perimeter Source Routing (GPSR) [17]), the mobility, the road topology, and the network density. The IEEE 802.11a is used since it is a well-deployed wireless technology in Indonesia. However, it is also necessary to evaluate IEEE 802.11p since it is designed to cope the frequent topology changing in VANET. In order to reach a realistic mobility, the speed of vehicles on average is between 40 and 70 km/h, low and high network density with various number of nodes (*i.e.*, 10 to 40 vehicles) are simulated to determine peak time and a non-peak time

road traffic in 0.25 km² area. Pairs of connections (*i.e.*, *S* to *R*) are generated randomly, which means that any participant nodes can be *S* or *R*, and/or *I*. In addition, *S*, *R*, and *I* are placed randomly both on two different road levels. However, the direction of vehicles is set as non-random, because vehicles have to follow the predefined driving lane.

TABLE I: PARAMETER SETTINGS

Parameter	Unit
Transmission Range IEEE 802.11a/p	up to 300 m
Routing Protocols	GPSR
Number of Nodes	10 - 40
Simulation Area	500 m x 500 m
Upper Road Height	10 m
Average Vehicle Velocity	40-70 km/h
Packet Size	1024 Byte
Simulation Time	200s
Number of Driving Lanes	2

Moreover, the number of *S* and *R* are generated linearly, which means a 10 nodes network contains of 5 senders and 5 receivers. The simulation area covers an environment which involves crossing and parallel overpass scenarios (c.f. Fig. 4) in order to show filtering concept in three dimensional area. The simulation time is set to 200 s in order to reach the required transmission time of 1024 Bytes packet size. In addition, during 200 s of simulation time, each vehicle is expected to run a distance with the experience of moving under and on the overpass on two driving lanes.

First results are shown in Fig. 6 and 7 as an initial part of the V2VUNet approach in crossing overpass scenario. Fig. 6 shows the PDR using both IEEE 802.11a and IEEE 802.11p, indicates that HRA and VRA weight values have significant impacts on the connection. This means when candidates do not fulfill HRA and VRA measurements, the sender will not forward the packet. The filtering out concept shows better PDR results compared to an unfiltering out concept. This indicates that the proposed V2VUNet with filtering concept including the relative angle as an additional metric to the forwarding decision is necessary to determine the proper intermediate node out of the neighboring candidates. However, the highest obtained PDR for IEEE 802.11a and for IEEE 802.11p are 20% and 30%, respectively. These considerably low percentages are caused by the overpass and the specific feature of the selected routing protocol. Since this scenario under investigation focuses on the road topology with overpasses, obstacles (*i.e.*, overpass constructions) are added between two different levels of roads and those obstacles block the signal reception. Additionally, the chosen routing protocol, GPSR, in its search location mechanism considers vehicles which are located under the overpass as “undetected” since in 2-dimensional perspective, those vehicle are located at the same position. Overall, the PDR decreases due to the higher speed of vehicles and due to frequent disconnections.

However, handling the End-to-End (E2E) delay is considered as a trade-off. Fig. 7 shows the E2E delay of IEEE 802.11a and IEEE 802.11p. The filtering out concept reduces E2E delay, even though fluctuating results shown on higher number of participant nodes.

Second results are shown in Fig. 8 indicate the V2VUNet approach in parallel overpass scenario deploying IEEE

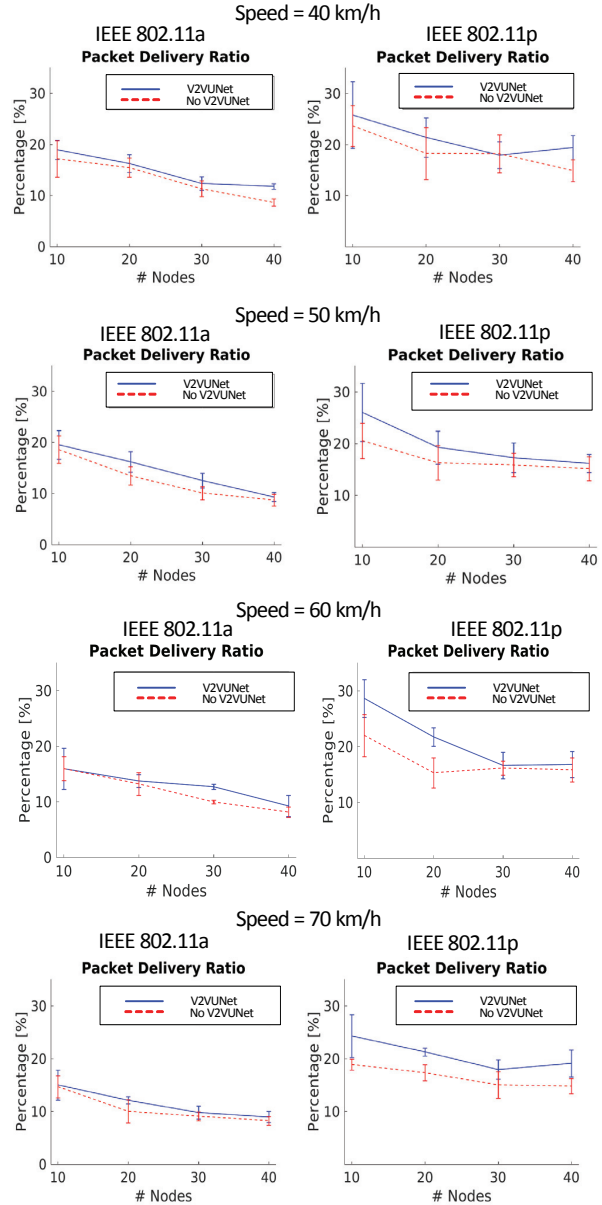


Fig. 6. Packet Delivery Ratio in Crossing Overpass

802.11p. The highest obtained PDR is 85% which indicates that inter-vehicle communication is more reliable with the speed 60 to 70 km/h. Moreover, the PDR results with the filtering out concept applied reach 20% higher compare to unfiltering out concept.

However, the E2E delay shows fluctuating results and it is confirmed in Fig. 7 and Fig. 8 (right side) that the delay observed is the result of the routing protocol mechanism applied which searches for a new connection or path once the current path is disconnected or broken.

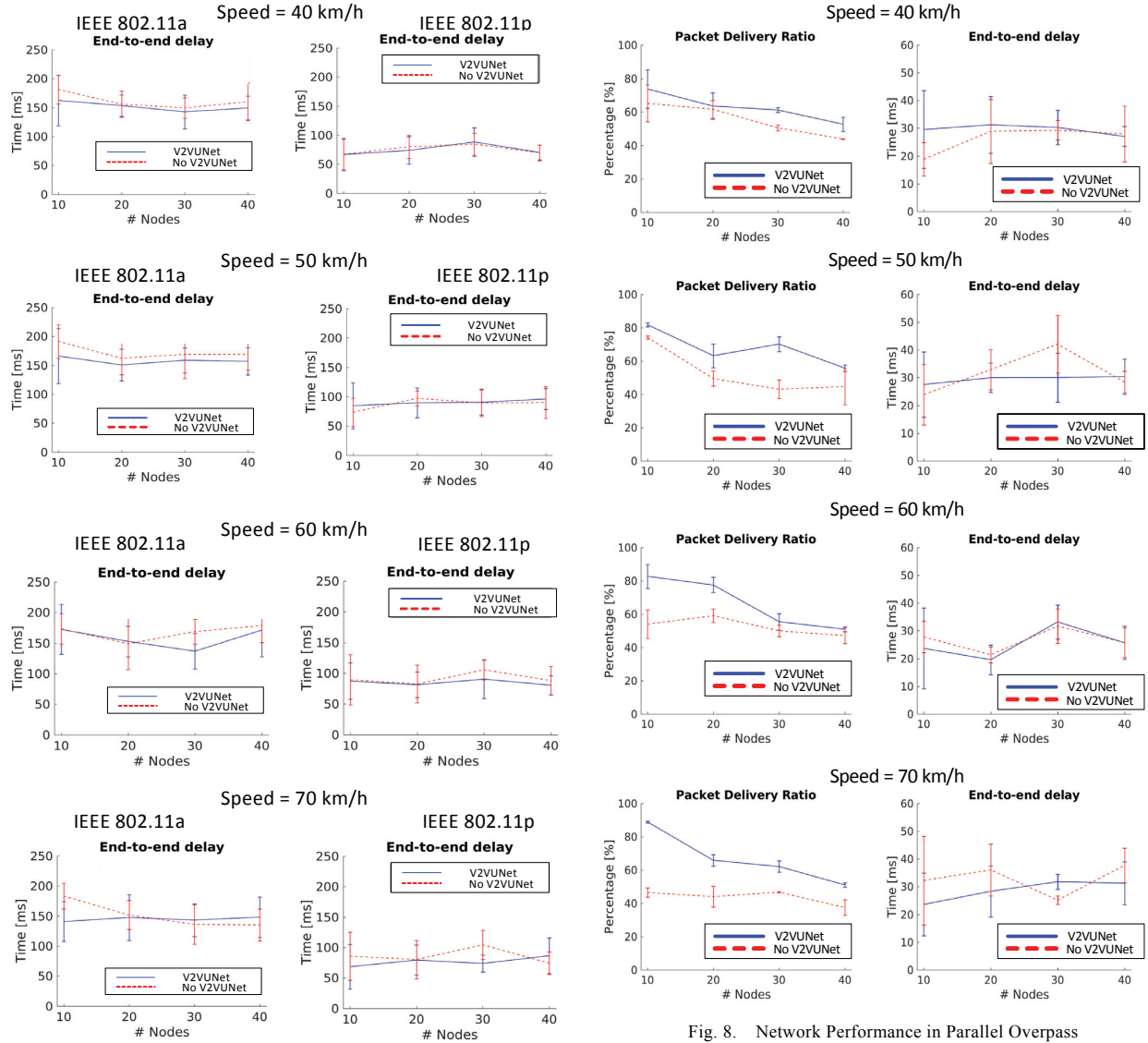


Fig. 8. Network Performance in Parallel Overpass

Fig. 7. End-to-End Delay in Crossing Overpass

V. SUMMARY AND FUTURE WORK

This work proposed a V2VUNet approach with filtering out concept to establish a better inter-vehicle communication in three-dimensional large city environments. This solution includes additional weight values to known HRA and VRA algorithms to determine the next intermediate node candidate in the communication way between two vehicles. Furthermore, it is shown that HRA and VRA metrics avoid unnecessary candidates with a high chance of disconnection in crossing overpass scenario and out of transmission range in parallel overpass scenario. Additionally, the E2E delay becomes significant better by the proposed approach.

In future work, the V2VUNet is expected to address the movement challenge by adding a direction weight value to

improve the filtering out concept, thus a more realistic mobility model will be used. The direction of vehicles will be applied in order to predict vehicles' movements. Furthermore, the movement prediction will be combined with filtering concept as a complete part of V2VUNet approach.

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