



# VTC2021-Fall

## *ONLINE*

*Connecting the Mobile World*

The flagship conference of IEEE Vehicular Technology Society

## Final Program

2021 IEEE 94th Vehicular Technology Conference  
27 September – 28 October 2021 • Virtual Event



**IEEE**

IEEE

**VTS**





## Final Program



***2021 IEEE 94<sup>th</sup> Vehicular Technology Conference***

***27 September – 28 October 2021***

**Online Virtual Conference**

---

## Welcome from the General Chair

On behalf of the entire IEEE VTC2021-Fall Organizing Committee I warmly welcome you to this second virtual edition of the Vehicular Technology Conference, the flagship conference of the IEEE Vehicular Technology Society. After very careful analysis of the extraordinary circumstances created by the global pandemic, the Board of Governors of the Society has decided to hold the conference again in a virtual format to ensure your physical safety in these trying times of still not very well known dangers to the well-being of us all. This is not a perfect solution, but the best possible under the current difficult circumstances. We all hope that in spite of this unconventional conference format you will still very much benefit from the intellectually stimulating technical program that the Organizing Committee has prepared for you. We also hope that when this global pandemic is finally behind us, we will be able to welcome you to a future regular-format VTC in beautiful Nanjing, China.

The cutting-edge technologies that are within the scope of our conference are of essential importance to enhancing the quality of our daily lives and to making our economy more efficient and sustainable. One example is 5G systems and networks that are being deployed at an increasing pace worldwide. Their different use cases have a potential of impacting all areas of human activity to the degree that still at this time is not easy to predict or even imagine. Their progressing evolution into the future 6G systems and networks creates challenges that need to be addressed

by new ground-breaking directions of research emerging in both industrial and academic environments. We believe the technical program of our conference contains numerous and extensive samples of such research efforts.

The virtual format of the VTC2021-Fall will provide an efficient platform for exchange of new ideas in our area of research interest and expertise. We will assemble via the marvel of our global telecommunication network to discuss the latest research results of interest to our professional community. Our discussions will focus on 461 technical papers, multiple keynote sessions, highly relevant and informative tutorials, and leading-edge workshops.

The IEEE Vehicular Technology Conference has a long and remarkable history. For the past seven decades the VTC has established itself as the prominent conference in the areas of wireless communications and networks, vehicular electronics and transportation systems. This two year the VTC2020-Spring, the VTC2020-Fall, the VTC2021-Spring and our VTC2021-Fall are making history as the first four IEEE Vehicular Technology Conferences to be held in a remote on-line format. Once again, welcome to our conference. I hope you will enjoy it and benefit from it in spite of not being able to visit our beautiful Nanjing in person.

Jianhua Lu  
*General Chair, IEEE VTC2021-Fall*

## Welcome from the TPC Co-chairs

On behalf of the Technical Program Committee, we would like to welcome you to the 94th IEEE Vehicular Technology Conference (VTC2021-Fall) that will be, for the sake of safety and health of all participants, organized in a virtual online format.

This fully virtual edition of VTC has been able to attract an exciting technical program ranging across the latest areas of research in wireless systems and networks, connected and autonomous vehicles, both manned and unmanned, emerging trends in applications of machine learning and artificial intelligence in wireless communications, and many other emerging topics. We received more than 825 paper submissions, out of which 461 outstanding papers will be presented in 12 technical tracks, workshops, and the recent results track that comprise the IEEE VTC2021-Fall technical program. In addition to the regular and recent results sessions, the conference will feature 12 topical workshops, 18 tutorials delivered by the leading experts in the field, and five extraordinary keynote speakers, one of them is from industry and the others are from the academia.

We would like to use this opportunity to thank all 13 track co-chairs for their excellent work. They all managed to obtain at least 3 reviews for each paper within a short time frame, and the decision process went extremely smoothly. We would like to thank the members of the IEEE VTC2021-Fall organizing committee for their great responsiveness and support during the entire period of technical program preparation and development. We would also like to thank the technical program committee (TPC) members for their diligent work. Finally, we would like to thank the authors, who always stood by in difficult times, waiting for last minute changes and updates for the conference organization. We hope you are proud to have your work as part of this virtual edition, and still enjoy the virtual networking. We encourage you all to maximally dive into the program, and to engage with the many experts that will gather virtually. Let's learn, interact, and enjoy!

Xiaohu You, Bamidele Adebisi, Tomoaki Ohtsuki,  
Marco Di Renzo, Ning Zhang  
*TPC Co-chairs, IEEE VTC2021-Fall*

---

## Welcome from the VTS President

On behalf of the IEEE Vehicular Technology Society, it is truly an honor and a pleasure to welcome all of you to our society's semi-annual flagship conference, the 2021 IEEE 94th Vehicular Technology Conference – VTC2021-Fall.

This year's Fall 2021 edition of the Vehicular Technology Conference series will provide attendees with a magnificent collection of technical paper presentations, tutorials, plenary talks, and workshops, all on a virtual platform. With the continuation of COVID-19 global health crisis, the VTS Board of Governors has decided to again convert IEEE VTC2021-Fall to a fully virtual conference with the original dates, 27-30 September 2021. We will however extend the virtual conference availability dates so attendees from different parts of the world could access the rich program at their own convenient time. We do realize that virtual conference will not allow to reproduce the professional networking environment that you are used to, but it will allow VTC2021-Fall to still attain a portion of its objectives. Please know that our thoughts are with those affected by the COVID-19 outbreak. The health and safety of our members, conference attendees, and volunteers is the utmost priority of our society.

It is always our intention to be flexible and helpful to everyone during this time of difficulty. VTS is fully supportive of IEEE's mission statement and we wish you and all people success in dealing with any local challenges you may be facing. We have thus relaxed standard requirements for onsite presentation of papers for authors and provided some financial adjustments to

the cost of conference attendance. VTS understands the fact that conferences are important factor in publications of peer-reviewed papers by graduate students and academics, in dissemination of new product and services by industry and government agencies, and in providing a networking platform for the profession. We therefore decided to make sure that we can still publish papers accepted in our major conferences so the students can graduate, and our researchers can register their novel ideas and outcomes.

Organizing a world-class conference event such as VTC2021-Fall in normal times involves a large and highly dedicated team of volunteers, and with the change from a physical to virtual conference that has even become more challenging. We are very thankful to everyone making this conference an outstanding success! I would like to sincerely thank the General Chair Jianhua Lu and the General Co-Chairs, Hao Yin, Fumiyuki Adachi, Ping Zhang, and Minh Jo; the Technical Program Co-chairs Xiaohu You, Bamidele Adebisi, Tomoaki Ohtsuki, Marco Di Renzo, and Ning Zhang, and the rest of the conference organizing and technical team for their time, effort, dedication, and commitment for making VTC2021-Fall one of the premier “virtual” international conference events in vehicular technology!

I am looking forward to the end of pandemic and seeing all of you in person in 2022, where we will continue *Connecting the Mobile World!* Stay safe.

Abbas Jamalipour, *President*  
IEEE Vehicular Technology Society

---

## Organizing Committee

<b>General Chair</b>	<i>Jianhua Lu</i>	Tsinghua University, China
<b>General Co-chairs</b>	<i>Hao Yin</i>	Chinese Academy of Sciences, China
	<i>Fumiyuki Adachi</i>	Tohoku University, Japan
	<i>Ping Zhang</i>	Beijing University of Posts and Telecommunications, China
	<i>Minho Jo</i>	Korea University, South Korea
<b>Vice Chairs</b>	<i>Hongbo Zhu</i>	Nanjing University of Posts and Telecommunications, China
	<i>Honggang Wang</i>	University of Massachusetts Dartmouth, USA
	<i>Yun Lin</i>	Harbin Engineering University, China
<b>Executive Chair</b>	<i>Guan Gui</i>	Nanjing University of Posts and Telecommunications, China
<b>Technical Program Chairs</b>	<i>Xiaohu You</i>	Southeast University, China
	<i>Bamidele Adebisi</i>	Manchester Metropolitan University, UK
	<i>Tomoaki Ohtsuki</i>	Keio University, Japan
	<i>Marco Di Renzo</i>	CentraleSupélec, Paris-Saclay University, France
	<i>Ning Zhang</i>	University of Windsor, Canada
<b>Publications Chair</b>	<i>James Irvine</i>	University of Strathclyde, UK
<b>Keynotes and Panels Co-chairs</b>	<i>Shi Jin</i>	Southeast University, China
	<i>Peiyang Zhu</i>	Huawei Technologies, Canada
	<i>Amnart Boonkajay</i>	Institute for Infocomm Research, Singapore
	<i>Mugen Peng</i>	Beijing University of Posts and Telecommunications, China
<b>Tutorials Chairs</b>	<i>Chengxiang Wang</i>	Southeast University, China
	<i>Jun Zhao</i>	Nanyang Technological University, Singapore
	<i>Ahmet M. Elbir</i>	University of Luxembourg, Turkey
	<i>Koichi Adachi</i>	The University of Electro-Communications, Japan
<b>Workshops Co-chairs</b>	<i>Qihui Wu</i>	Nanjing University of Aeronautics and Astronautics, China
	<i>Jian Andrew Zhang</i>	University of Technology Sydney, Australia
	<i>Min Jia</i>	Harbin Institute of Technology, China
	<i>Yongxu Zhu</i>	London South Bank University, UK
<b>Industry Program Chairs</b>	<i>Alvin Chin</i>	BMW Group Tech Office USA, USA
	<i>Sanyogita Shamsunder</i>	Verizon, USA
<b>Patronage &amp; Exhibit Co-chairs</b>	<i>Liang Guo</i>	China Academy of Information and Communications Technology, China
	<i>Lin Shan</i>	National Institute of Information and Communications Technology, Japan
	<i>Haitao Zhao</i>	Nanjing University of Posts and Telecommunications, China
<b>Publicity Chairs</b>	<i>Tomohiko Taniguchi</i>	Fujitsu Laboratories Limited, Japan
	<i>Shucheng Yu</i>	Stevens Institute of Technology, USA
	<i>Yue Gao</i>	University of Surrey, UK
	<i>Hongyang Chen</i>	Zhejiang Lab, China
<b>Finance Chair</b>	<i>J. R. Cruz</i>	The University of Oklahoma, USA
<b>Conference Administrators</b>	<i>Rodney C. Keele</i>	The University of Oklahoma, USA
	<i>Cerry Leffler</i>	IEEE VTS, USA

---

## Logistics

<b>IEEE eXpress Conference Publishing</b>	<i>Christina Zarrello</i>	IEEE, USA
<b>IEEE Conference Services</b>	<i>Brianna Hunt-Fornaro</i>	IEEE, USA

---

---

## Technical Program Committee

<b>Chairs</b>	<i>Xiaohu You</i> <i>Bamidele Adebisi</i> <i>Tomoaki Ohtsuki</i> <i>Marco Di Renzo</i> <i>Ning Zhang</i>	Southeast University, China Manchester Metropolitan University, UK Keio University, Japan CentraleSupélec, Paris-Saclay University, France University of Windsor, Canada
<b>Vice-Chairs, Airborne and Maritime Mobile systems and Services</b>	<i>Hong-Ning Dai</i> <i>Xianfu Chen</i> <i>Chia-Ho Ou</i>	Macau University of Science and Technology, Macau VTT Technical Research Centre, Finland National Pingtung University, Taiwan
<b>Vice-Chairs, Antenna Systems, Propagation and RF Design</b>	<i>Kelvin Anoh</i> <i>Shulabh Gupta</i> <i>Sunday Ekpo</i> <i>Anthony Adoghe</i>	University of Bolton, UK Carleton University, Canada Manchester Metropolitan University, UK Covenant University, Nigeria
<b>Vice-Chairs, Electric Vehicles, Vehicular Electronics and Intelligent Transportation</b>	<i>Augustine Ikpehai</i> <i>Ning Lu</i> <i>Haibo Zhou</i> <i>Max Mauro Dias Santos</i>	Sheffield Hallam University, UK Queen's University, Canada Nanjing University, China Universidade Tecnológica Federal do Paraná – Ponta Grossa
<b>Vice-Chairs, Emerging Technologies, 6G and Beyond</b>	<i>Kenichi Higuchi</i> <i>Peng Yang</i> <i>Khaled Rabie</i> <i>Zhi Liu</i>	Tokyo University of Science, Japan Huazhong University of Science and Technology, China Manchester Met University, UK Shizuoka University, Japan
<b>Vice-Chairs, Green Communications and Networks</b>	<i>Miao Pan</i> <i>Mostafa Fouda</i> <i>Peng Yu</i>	University of Houston, USA Idaho State University, USA Beijing University of Posts and Telecommunications, China
<b>Vice-Chairs, IoV, IoT, M2M, Sensor Networks and Ad-Hoc Networking</b>	<i>Susumu Ishihara</i> <i>Moayad Aloqaily</i> <i>Lin Bai</i> <i>Aderemi Atayero</i>	Shizuoka University, Japan xAnalytics Inc., USA Beihang University, China Covenant University, Nigeria
<b>Vice-Chairs, Machine Learning and AI for Communications</b>	<i>Jinlong Sun</i> <i>Mikio Hasegawa</i> <i>Tao Han</i> <i>Zubair Fadlullah</i>	Nanjing University of Posts and Telecommunications, China Tokyo University of Science, Japan University of North Carolina – Charlotte, USA Lakehead University, Canada
<b>Vice-Chairs, Multiple Antennas and Cooperative Communications</b>	<i>Dimitrie Popescu</i> <i>Miao Liu</i> <i>Siyu Lin</i>	Old Dominion University, USA Nanjing University of Posts and Telecommunications, China Beijing Jiaotong University, China
<b>Vice-Chairs, Positioning, Navigation and Sensing</b>	<i>Kai-Ten Feng</i> <i>Habila Mormi John</i> <i>Virginia Pilloni</i>	National Chiao Tung University, Taiwan University of Bath, UK University of Cagliari, Italy
<b>Vice-Chairs, Signal Processing for Wireless Communications</b>	<i>Kazunori Hayashi</i> <i>Chongwen Huang</i> <i>Byonghyo Shim</i>	Kyoto University, Japan Zhejiang University, China Seoul National University, South Korea
<b>Vice-Chairs, Spectrum Management, Radio Access Technology, Services and Security</b>	<i>Takeo Fujii</i> <i>Nan Cheng</i> <i>Yuanxiong Guo</i> <i>Feng Ye</i>	The University of Electro-Communications, Japan Xidian University, China University of Texas – San Antonio, USA University of Dayton, USA
<b>Vice-Chairs, Vehicle Cooperation and Control, Assisted and Autonomous Driving</b>	<i>Zhengguo Sheng</i> <i>Ahmed Hamdi Sakr</i> <i>Feng Lyu</i>	University of Sussex, UK University of Windsor, Canada Central South University, China
<b>Vice-Chairs, Recent Results</b>	<i>Xiaohu You</i> <i>Bamidele Adebisi</i> <i>Tomoaki Ohtsuki</i> <i>Marco Di Renzo</i> <i>Ning Zhang</i>	Southeast University, Bangladesh Manchester Metropolitan University, UK Keio University, Japan Centre National de la Recherche Scientifique, France University of Windsor, Canada

## Members

*Javad Abdoli*, Huawei Technologies Canada Co.  
*Mahmoud Abdulsalam*, City University of London  
*Philip Abidoeye*, Cape Peninsula University of Technology  
*Sylvester Boadi Aboagye*, Memorial University  
*Fumiyuki Adachi*, Tohoku University  
*Koichi Adachi*, The University of Electro-Communications  
*E. A. Adedokun*, Ahmadu Bello University  
*Anthony Adoghe*, Covenant University

*Damilola Adu*, Covenant University  
*Niaz Ahmed*, Missouri University of Science and Technology  
*Shakil Ahmed*, Utah State University  
*Mobayode Akinsolu*, Wrexham Glyndwr University  
*Ziad Qais Al Abbasi*, The Middle Technical University (MTU) - Baquba Technical Institute  
*Michele Albano*, Aalborg University  
*Mohammad Alibakhshikenari*, University of Rome

**Ala'a Al-Momani**, Ulm University  
**Moayad Aloqaily**, xAnalytics Inc.  
**Kelvin Anoh**, University of Bolton  
**Evans C. Ashigwuike**, University of Abuja  
**Bulus Azi Atang**, Plateau State Polytechnic  
**Aderemi Atayero**, Covenant University  
**Sergei Avedisov**, Toyota Motor North America  
**Ferheen Ayaz**, University of Sussex  
**Tong Bai**, Queen Mary University of London  
**Venkatraman Balasubramanian**, Arizona State University  
**Akram Bati**, University of Bolton  
**Khaled Bedda**, Cairo University  
**Daniel Benevides da Costa**, Federal University of Ceara  
**Yin Bo**, Beijing Information Science and Technology University  
**Carsten Bockelmann**, University of Bremen  
**A B M Bodrul Alam**, Lakehead University  
**Amnart Boonkajay**, Institute for Infocomm Research  
**Ouns Bouachir**, Zayed University  
**Cesar Briso**, Universidad Politecnica de Madrid  
**Berna Bulut**, University of Bristol  
**Wei Cai**, The Chinese University of Hong Kong Shenzhen  
**Glaucio Carvalho**, Sheridan College  
**Paulo Carvalho**, FCT- Universidade Nova de Lisboa  
**Nan Chen**, Tennessee Tech University  
**Chung Shue Chen**, Bell Labs  
**Tzung-Shi Chen**, National University of Tainan  
**Xianfu Chen**, VTT Technical Research Centre of Finland  
**Yan Chen**, NJUPT  
**Nan Cheng**, Xidian University  
**Luca Chiaraviglio**, University of Rome Tor Vergata  
**Vlad-Mihai Chiriac**, Technical University "Gheorghe Asachi" of Iasi  
**Sooyong Choi**, Yonsei University  
**Kishak Zakka Cinfwat**, University of Jos  
**Sinem Coleri**, Koc University  
**Ciprian Romeo Comsa**, Technical University "Gheorghe Asachi" of Iasi  
**Haibo Dai**, Nanjing University of Posts and Telecommunications  
**Hong-Ning Dai**, Macau University of Science and Technology  
**Danjuma Danshik Dajab**, University of Jos  
**Olawande Daramola**, Cape Peninsula University of Technology  
**Panagiotis Demestichas**, University of Piraeus  
**Yongheng Deng**, Tsinghua University  
**Kapal Dev**, Trinity College  
**Max Mauro Dias Santos**, Universidade Tecnológica Federal do Paraná - Ponta Grossa  
**Arash Moradinegade Dizqah**, University of Essex  
**Quang Vinh Do**, Pusan National University  
**Octavia A. Dobre**, Memorial University  
**Chen Dong**, University of Southampton  
**Mianxiong Dong**, Muroran Institute of Technology  
**Xuewen Dong**, Xidian University  
**Xinwei Du**, BNU-HKBU United International College  
**Sijing Duan**, Central South University  
**Sunday Ekpo**, Manchester Metropolitan University  
**Ahmet M. Elbir**, Duzce University  
**Mohamed Elshafei**, Lakehead university  
**Samy El-Tawab**, James Madison University  
**Emmanuel Majiyabo Eronu**, University of Abuja  
**Zubair Fadlullah**, Lakehead University  
**Fu Fang**, Shanxi University  
**Xiaojie Fang**, Harbin Institute of Technology  
**Abraham O. Fapojuwo**, University of Calgary  
**Aya Hassan Farrag**, Lakehead University  
**Nasir Faruk**  
**Kai-Ten Feng**, National Chiao Tung University  
**Lei Feng**, Beijing University of Posts and Telecommunications  
**Mostafa Fouda**, Idaho State University  
**Youhua Fu**, NJUPT  
**Takeo Fujii**, The University of Electro-Communications  
**Jie Gao**, Marquette University  
**Meilin Gao**, Tsinghua University  
**Tianbao Gao**, NJUPT  
**Yue Gao**, University of Surrey  
**Zhen Gao**, Beijing Institute of Technology  
**Rosario Garroppo**, University of PISA  
**Amjad Gawanmeh**, University of Dubai  
**Alireza Ghasempour**, University of Applied Science and Technology  
**Khanh Tran Gia**, Tokyo Institute of Technology  
**Asaamong godwin**, Lusophone University  
**Ramy H. Gohary**, Carleton University  
**Marco Gomes**, Instituto de Telecomunicações - University of Coimbra  
**Zijun Gong**, University of Waterloo  
**David Grace**, University of York  
**João Guerreiro**, FCT-Universidade Nova de Lisboa  
**Rui Guo**, Toyota Motor North America R&D  
**Yuanxiong Guo**, University of Texas at San Antonio  
**Shulabh Gupta**, Carleton University  
**Nentawe Gurumdimma**, University of Jos  
**Guojun Han**, Guangdong University of Technology  
**Mikio Hasegawa**, Tokyo University of Science  
**Syed Ali Hassan**, National University of Sciences and Technology  
**Sara Hassan**, Lakehead University  
**Md Yeakub Hassan**, TBRHRI  
**Hiroyuki Hatano**, Mie University  
**Kiyohiko Hattori**, Tokyo University of Technology  
**Ryo Hayakawa**, Osaka University  
**Kazunori Hayashi**, Kyoto University  
**Vahideh Hayyolalam**, KoC University  
**Jingchao He**, Xidian University  
**Ruisi He**, Beijing Jiaotong University  
**Prasanna Herath**, InterDigital Communications  
**Kenichi Higuchi**, Tokyo University of Science  
**Ivan Wang-Hei Ho**, The Hong Kong Polytechnic University  
**Hanxu Hou**, Dongguan University of Technology  
**Yu-Pin Hsu**, National Taipei University  
**Chunqiang Hu**, Chongqing University  
**Qiang Hu**, Amazon Lab126  
**Rui Hu**, University of Texas at San Antonio  
**Xu Hu**, Dalian Maritime University  
**Qiang Hua**, University of Liverpool  
**Cheng Huang**, University of Waterloo  
**Chongwen Huang**, Zhejiang University  
**Hao Huang**, Nanjing University of Posts and Telecommunications  
**Yilong Hui**, Xidian University  
**Rasheed Hussain**, Innopolis University  
**Kim Hyunbum**, Incheon National University  
**Augustus Ibhaze**, University of Lagos  
**Shinsuke Ibi**, Doshisha University  
**Amani Ibraheem**, University of Sussex



**Mohamed Ibrahim**, Tennessee Tech University  
**Emmanuel Tashiwa Ibrahim**, Newcastle University  
**Francis Idachaba**, Covenant University  
**Muhammad Ijaz**, Manchester Metropolitan University  
**Augustine Ikpehai**, Sheffield Hallam University  
**Sunday Iliya**, University of Jos  
**Agbotiname Imoize**, University of Lagos  
**Kei Inage**, Tokyo Metropolitan College of Industrial Technology  
**Mamiko Inamori**, Tokai University  
**Lucky A. Ishaku**, Blackpool and The Fylde College/Lancaster University  
**Dauda Ishaya**, Abubakar Tafawa Balewa University  
**Koji Ishibashi**, The University of Electro-Communications  
**Susumu Ishihara**, Shizuoka University  
**Naoki Ishikawa**, Yokohama National University  
**Kentaro Ishizu**, NICT  
**Yusuke Ito**, Tokyo University of Science  
**Nobuhiko Itoh**, Nippon Institute of Technology  
**Hiroki Iwata**, Hitachi Kokusai Electric Inc.  
**Wael Jaafar**, Carleton University  
**Yo-Seb Jeon**, Pohang University of Science and Technology (POSTECH)  
**Shaobo Jia**, Zhengzhou University  
**Fan Jiang**, Xi'an University of Posts and Telecommunications  
**Xu Jiang**, Dalian University of Technology  
**Zhang Jianhua**, Beijing University of Posts and Telecommunications  
**Hu Jin**, Hanyang University  
**Michael Joham**, Munich University of Technology  
**Habila Mormi John**, University of Bath  
**Bang Chul Jung**, Chungnam National University  
**Haejoon Jung**, Incheon Univ.  
**Suguru Kameda**, Hiroshima University  
**Athanasios Kanatas**, University of Piraeus  
**Shigeru Kashihara**, Osaka Institute of Technology  
**Yuichi Kawamoto**, Tohoku University  
**Hafiz Ahmad Khalid**, Beijing University of Posts and Telecommunications  
**Umar F. Khan**, Robert Gordon University  
**Majid Khoshafa**, Memorial University of Newfoundland  
**Hossein Khoshnevis**, Huawei Canada Research Centre  
**Haesik Kim**, VTT Technical Research Centre of Finland  
**Sooyoung Kim**, Chonbuk National University  
**Sunwoo Kim**, Hanyang University  
**Paul Kogeda**, University of the Free State  
**Haris Kremo**, RWTH Aachen University  
**Witold Krzymieñ**, University of Alberta  
**Chinmoy Kundu**, University College Dublin  
**Ernest Kurniawan**, Institute for Infocomm Research  
**Taesoo Kwon**, Seoul National University of Science and Technology  
**Buon Kiong Lau**, Lund University  
**Nguyen Phi Le**, Hanoi University of Science and Technology  
**Byungju Lee**, Kumoh National Institute of Technology  
**Gilsoo Lee**, Nokia Bell Labs  
**Howon Lee**, Hankyong National University  
**Inkyu Lee**, Korea University  
**Janne Lehtomäki**, University of Oulu  
**Aohan Li**, Tokyo University of Science  
**He Li**, Nanyang Normal University  
**Jie LI**, Hefei University of Technology  
**Junling Li**, University of Waterloo  
**Kai Li**, CISTER Research Unit  
**Lixin Li**, Northwestern Polytechnical University  
**Mushu Li**, University of Waterloo  
**Qihao Li**, University of Waterloo  
**Rongpeng Li**, Zhejiang University  
**Shichao Li**, Guilin University of Electronic Technology  
**Song Li**, China University of Mining and Technology  
**Xuran Li**, Shandong Normal University  
**Yue Li**, University of Victoria  
**Yunyi Li**, Hunan University of Science and Technology  
**Huilian Liao**, Sheffield Hallam University  
**Jiachun Liao**, Nanhu Lab Jiaxing  
**Hai Lin**, Osaka Prefecture University  
**Jie Lin**, Huazhong University of Science and Technology  
**Siyu Lin**, Beijing Jiaotong University  
**Yun Lin**, Harbin Engineering University  
**Yun-Wei Lin**, National Yang Ming Chiao Tung University  
**Chen-Feng Liu**, University of Oulu  
**Chun-Hung Liu**, Mississippi State university  
**Chunshan Liu**, Hangzhou Dianzi University  
**Dong Liu**, University of Southampton  
**Dongxiao Liu**, University of Waterloo  
**Fang Liu**, The Chinese University of Hong Kong  
**Huiye Liu**, Georgia Institute of Technology  
**Miao Liu**, Nanjing University of Posts and Telecommunications  
**Pengfei Liu**, Nanjing University of Posts and Telecommunications  
**Qiang Liu**, The University of Nebraska–Lincoln  
**Tingting Liu**, Nanjing Institute of Technology  
**Xin Liu**, Dalian University of Technology  
**Xiqing Liu**, Beijing University of Posts and Telecommunications  
**Yalin Liu**, Macau University of Science and Technology  
**Zhi Liu**, The University of Electro-Communications  
**Zilong liu**, University of Essex  
**Miguel López-Benítez**, University of Liverpool  
**Huali Lu**, Central South University  
**Ning Lu**, Queen's University  
**Changqing Luo**, Virginia Commonwealth University  
**Feng Lyu**, Central South University  
**Runbo Ma**, Shanxi University  
**Naercio Magaia**, Universidade de Lisboa  
**Bomin Mao**, Northwestern Polytechnical University  
**Alexandru Martian**, University Politehnica of Bucharest  
**Kazuki Maruta**, Tokyo Institute of Technology  
**Mousa Marzband**, Northumbria University  
**Daniel Massicotte**, UQTR - Université du Québec a Trois-Rivieres - Canada  
**Michail Matthaïou**, Queen's University Belfast  
**Hope Mauwa**, University of Mpumalanga  
**Mustafa K. Mehmet Ali**, Confordia University  
**Manabu Mikami**, SoftBank Corp.  
**Nobuhiko Miki**, Kagawa University  
**Chulhong Min**, Nokia Bell Labs  
**Teruyuki Miyajima**, Ibaraki University  
**Sanam Moghaddammia**, Türkisch-Deutsche Universität  
**Mohammadali Mohammadi**, Shahrekord University  
**Gad Mohammed**, Lakehead University  
**Kazuya Monden**, Hitachi  
**Hiroaki Morino**, Shibaura Institute of Techonology  
**Mohamed M. A. Moustafa**, Egyptian Russian University  
**Osamu Muta**, Kyushu University  
**Katsuhiro Naito**, Aichi Institute of Technology  
**Keivan Navaie**, Lancaster University

**Kien Nguyen**, Chiba University  
**Luong Nguyen**, Seoul National University  
**Nhat Quang Nhan**, NOKIA Bell Labs  
**Zhengwei Ni**, Zhejiang Gongshang University  
**Toshihiko Nishimura**, Hokkaido University  
**Takayuki Nishio**, Tokyo Institute of Technology  
**Nsikan Nkordeh**, University of Delaware  
**Masakatsu Ogawa**, Sophia University  
**Takeo Ohgane**, University of Hokkaido  
**Shuichi Ohno**, Osaka City University  
**Chikara Ohta**, Kobe University  
**Mai Ohta**, Fukuoka University  
**Hiraku Okada**, Nagoya University  
**Eiji Okamoto**, Nagoya Institute of Technology  
**Kennedy Okokpujie**, Covenant University  
**Godfrey Okorafor**, Novena University  
**Gbenga Abidemi Olarinoye**, Ahmadu Bello University  
**Babatunde Olukotun**, University College London  
**Abayomi Otebolaku**, Sheffield Hallam University  
**Safa Otoum**, University of Ottawa  
**Chia-Ho Ou**, National Pingtung University  
**Teppey Oyama**, Fujitsu Limited  
**Olutayo O. Oyerinde**, University of the Witwatersrand  
**Tudor Palade**, Technical University of Cluj-Napoca  
**Miao Pan**, University of Houston  
**Andra Pastrav**, Technical University Cluj-Napoca  
**Al-Sakib Khan Pathan**, Independent University  
 Bangladesh  
**Naanman Bartholomew Paul**, Kaduna Polytechnic  
**Quoc-Viet Pham**, Pusan National University  
**Virginia Pilloni**, University of Cagliari  
**Dimitrie Popescu**, Old Dominion University  
**Otilia Popescu**, Old Dominion University  
**Petar Popovski**, Aalborg University  
**Alessandro Pozzebon**, University of Siena  
**Emanuel Puschita**, Technical University of Cluj-Napoca  
**Bo Qian**, Nanjing University  
**Kaige Qu**, University of Waterloo  
**Khaled Rabie**, Manchester Met University  
**Gowri Sankar Ramachandran**, Queensland University of  
 Technology  
**Chao Ren**, University of Science and Technology Beijing  
**Olivier Renaudin**, Universitat Autònoma de Barcelona  
**Ismaeel Al Ridhawi**, Kuwait College of Science and  
 Technology  
**Geraldine Rangmoen Rimven**, University of Jos  
**Sandra Roger**, University of Valencia  
**Kay Romer**, TU Graz  
**Bashir Olaniyi Sadiq**, Ahmadu Bello University  
**Ahmed Hamdi Sakr**, University of Windsor  
**Yasir Saleem**, Inria Lille - Nord Europe  
**Julio Cesar Santos dos Anjos**, Federal University of Rio  
 Grande do Sul  
**Koya Sato**, Tokyo University of Science  
**Chan See**, Edinburgh Napier University  
**Lin Shan**, National Institute of Information and  
 Communications Technology (NICT)  
**Feng Shen**, Nanjing University of Aeronautics and  
 Astronautics  
**Li-Hsiang Shen**, National Chiao Tung University  
**Zhengguo Sheng**, University of Sussex  
**Junpeng Shi**, National University of Defense Technology  
**Takuya Shindo**, Nippon Institute of Technology  
**Adão Silva**, DETI / Instituto de Telecomunicações /  
 University of Aveiro  
**Dirk T.M. Slock**, EURECOM  
**Hideya So**, Shonan Institute of Technology  
**Paschalis C. Sofotasios**, Tampere University of  
 Technology/Aristotle University of Thessaloniki  
**Yunchao Song**, NJUPT  
**Alireza Souri**, Islamic Azad University  
**Breno Sousa**, University of Lisbon  
**Nuno Souto**, ISCTE-IUL/Instituto de Telecomunicações  
**Olugbenga Sowande**, University of Ilorin  
**Seshan Srirangarajan**, Indian Institute of Technology Delhi  
**Gautam Srivastava**, Brandon University  
**Mirko Staderini**, UNIFI  
**Giovanni Stea**, University of Pisa  
**Oodo Ogidi Stephen**, University of Abuja  
**Shinya Sugiura**, The University of Tokyo  
**Jin Sun**, Nanjing University of Posts and  
 Telecommunications  
**Jinlong Sun**, Nanjing University of Posts and  
 Telecommunications  
**Xiang Sun**, University of New Mexico  
**Chang Kyung Sung**, CSIRO  
**Himal A. Suraweera**, University of Peradeniya  
**Katsuya Suto**, The University of Electro-Communications  
**Takumi Takahashi**, Osaka University  
**Osamu Takyu**, Shinshu University  
**Fengxiao Tang**, Tohoku University  
**Suhua Tang**, The University of Electro-Communications  
**Tetsuki Taniguchi**, The University of Electro-  
 Communications  
**Ahmed Tarek**, Zewail University  
**Ngatched Telex**, Memorial University  
**Gokulnath Thandavarayan**, Universidad Miguel  
 Hernandez de Elche (UMH)  
**John Thompson**, University of Edinburgh  
**Ang-Hsun Tsai**, National Yang Ming Chiao Tung  
 University  
**Chung-Hsien Tsai**, National Defense University  
**Hsin-Mu Tsai**, National Taiwan University  
**Ming-Fong Tsai**, National United University  
**Po-Hsuan Tseng**, National Taipei University of  
 Technology  
**Theodoros Tsiftsis**, Jinan University  
**George Tsoulos**, University of Peloponnese  
**Akira Uchiyama**, Osaka University  
**Kenta Umabayashi**, Tokyo University of Agriculture and  
 Technology  
**Johanna Vartiainen**, University of Oulu  
**Anna Maria Vegni**, Roma Tre University  
**Fernando J Velez**, Instituto de Telecomunicações-DEM  
**Calin Vladeanu**, University Politehnica of Bucharest  
**Chu-Fu Wang**, National Pingtung University  
**Danyang Wang**, Xidian University  
**Guanghai Wang**, Henan University  
**Jie Wang**, Nanjing University of Posts and  
 Telecommunications  
**Jin Wang**, Xian University of Posts and  
 Telecommunications  
**Jingjing Wang**, Tsinghua University  
**Miao Wang**, Miami University  
**Qiu Wang**, China University of Mining and Technology  
**Qubeijian Wang**, Northwestern Polytechnical University  
**Wei Wang**, Zhejiang University  
**Xiaofei Wang**, Tianjin University  
**Xijun Wang**, Xidian University  
**Xuyu Wang**, California State University

**Yu Wang**, Nanjing University of Posts and Telecommunications  
**Zhaorui Wang**, The Hong Kong Polytechnic University  
**Zijie Wang**, Beihang University  
**Ziran Wang**, Toyota Motor North America R&D  
**Yoshito Watanabe**, NICT  
**Li Wei**, Singapore University of Technology and Design  
**Jinming Wen**, Jinan University  
**Krzysztof Wesolowski**, Poznan University of Technology  
**Celimuge Wu**, The University of Electro-Communications  
**Dehao Wu**, Bournemouth University  
**Fan Wu**, Tsinghua University  
**Haimeng Wu**, Northumbria University  
**Huaqing Wu**, University of Waterloo  
**Tin-Yu Wu**, National Ilan University  
**Wen Wu**, University of Waterloo  
**Xuangou Wu**, Anhui University of Technology  
**Lin Xiang**, TU Darmstadt  
**Chaonong Xu**, China University of Petroleum  
**Yongjun Xu**, Chongqing University of Posts and Telecommunications (CQUPT)  
**Yunting Xu**, NanJing University  
**B. Yahaya**, Ahmadu Bello University  
**Koji Yamamoto**, Kyoto University  
**Hao Yang**, McMaster University  
**Peng Yang**, Huazhong University of Science and Technology  
**Qi Yang**, Xiamen University  
**Shizhao Yang**, Nanjing University of Posts and Telecommunications  
**Kazuto Yano**, ATR  
**Feng Ye**, University of Dayton  
**Qiang Ye**, Minnesota State University  
**Yibin**, Nanjing University of Posts and Telecommunications  
**Wang Yong**, Chongqing University of Posts and Telecommunications  
**Li You**, Southeast University  
**Keping Yu**, Waseda University  
**Peng Yu**, Beijing University of Posts and Telecommunications  
**Weijie Yuan**, Southern University of Science and Technology  
**Chau Yuen**, Singapore University of Technology and Design  
**Bo Zhang**, Zhengzhou University  
**Di Zhang**, Zhengzhou University  
**Hongming Zhang**, Beijing University of Posts and Telecommunications  
**Ning Zhang**, University of Windsor  
**Ruoyu Zhang**, Nanjing University of Science and Technology  
**Shuowen Zhang**, The Hong Kong Polytechnic University  
**Tingping Zhang**, Chongqing Jiaotong University  
**Zhicai Zhang**, Shanxi University  
**Nan Zhao**, Dalian University of Technology  
**Wenwen Zhao**, Johnson Controls Inc  
**Fei Zheng**, Guilin University Of Electronic Technology  
**Conghao Zhou**, University of Waterloo  
**Fanqin Zhou**, Beijing University of Posts and Telecommunications  
**Jianshan Zhou**, Beihang University  
**Lin Zhou**, Beihang University  
**Mu Zhou**, Chongqing University of Posts and Telecommunications  
**Siyang Zhou**, Harbin Institute of Technology  
**Yi Zhou**, Henan University

## Reviewers

Waqas bin Abbas	Nazar Ali	Daniel Benevides da Costa	Ru-Han Chen	Riccardo De Gaudenzi	Zhang Fan	Khanh Tran Gia
Qamar Abbas	Mohammad	Costa	Ruirui Chen	Tommaso de Cola	Fu Fang	Tolga Girici
Amr Abdelnabi	Alibakhshikenari	Salah Berra	Shuo Chen	Christoph Degen	Shih-Hau Fang	Mirza Golam Kibria
Mohammed	Yazeed Alkhrifjah	Pranay Bhardwaj	Tzung-Shi Chen	Thomas Delamotte	Xiaojie Fang	Marco Gomes
Abdelsadek	Ala'a Al-Momani	Swati Bhattacharya	Xianfu Chen	Özlem Tugfe Demir	Xiaojie Fang	Tiago Rocha
Mouhamed Abdulla	Akram Alomainy	Youngang Bian	Xianfu Chen	Yongheng Deng	Zhengru Fang	Conçalves
Nor Fadzilah	Moayad Aloqaily	Li Bingxin	Xiao Chen	Max Mauro Dias Santos	Yashar Zeinyali	Ali Gorcin
Abdullah	Alberto Alvarez	Daniel Bischoff	Yan Chen	Mouhamad Dieye	Farid	Joel Grotz
Philip Abidoeye	Polegre	Yin Bo	Yanli Chen	Cao Ding	Lei feng	Hao Gu
Sylvester Boadi	Haleh Amintoosi	Amnart Boonkajay	Ying Chen	Mengying Ding	Shuying Feng	Shuyin Gu
Aboagye	Muhammad Amjad	Ouns Bouachir	Ying Chen	Rui Dinis	Weiyang Feng	Zhuojia Gu
Fumiyuki Adachi	Nejib Ammar	Sander Bronckers	Yuchao Chen	Arash	Luís Torres	Peiyuan Guan
Koichi Adachi	Miguel Angel	Tim W. C. Brown	Yu-Jia Chen	Moradinegade	Figueroa	João Guerreiro
Abebe Belay Adege	Vazquez	Agustin Bucciarelli	Zheng Chen	Dizqah	Abbas Fotouhi	Guan Gui
Ramoni Adeogun	Marco Anisetti	Romain Bucelle	Cheng Cheng	Quang Vinh Do	Mostafa Fouda	Guan Gui
Adeyinka A.	Kelvin Anoh	Niklas Bulk	Nan Cheng	Octavia A. Dobre	João Francisco Justo	Alessandro Guidotti
Adewale	Kainat Ansar	Berna Bulut	Nan Cheng	Chen Dong	Shu Fu	Frederic Guilloud
Anthony Adoghe	Sudhansu Arya	Wei Cai	Shao-Hung Cheng	Mianxiong Dong	Shu Fu	Wahab Ali Gulzar
Damilola Adu	Megumi Asada	Mario Rodrigo	Shao-Hung Cheng	Xuewen Dong	Takeo Fujii	Mehmet Ali Guney
Mona Ahmed	Bulus Azi Atang	Camana Acosta	Wenchi Cheng	Yuhan Dong	Shunsuke Fujio	Danni Guo
Niaz Ahmed	Aderemi Atayero	Henry Ramiro	Yan Cheng	Konstantinos	Hayato Fukuzono	Qinghua Guo
Hyeongtae Ahn	Sergei Avedisov	Carvajal Mora	Zhipeng Cheng	Dawei Gao	Dawei Gao	Rui Guo
Yongjun Ahn	Wahaj Abbas Awan	Paulo Carvalho	Vlad-Mihai Chiriac	Jie Gao	Jie Gao	Tianhao Guo
Zeinab Akhavan	Babatunde	Dragan Cetenovic	Hao Tse Chiu	Jianbo Du	Mei Gao	Yuanxiong Guo
Muhammad	Awoyemi	Chabalala Chabalala	Moin Chowdhury	Xinwei Du	Mei Gao	Naveen Gupta
Waseem Akhtar	Ferheen Ayaz	Rong Chai	Hyun Kyu Chung	Zhen Du	Meilin Gao	Shulabh Gupta
Mobayode Akinsolu	Bo Bai	Behdad Chalaki	Kishak Zakka	Sijing Duan	Peng Gao	Nentawe
Omer Faruk Akyol	Tong Bai	Tse-Tin Chan	Cinfwat	Xuting Duan	Shang Gao	Gurumdimma
Ismaeel Al Ridhawi	Wushuang Bai	Aniruddha Chandra	Victor Croisfelt	Ankit Dubey	Tianbao Gao	Miguel Gutiérrez
Mahmoud Al	Zhengwei Bai	Huigang Chang	Haibo Dai	Sunday Ekpo	Ying Gao	Gaitán
Ahmed	Saikat Bakshi	Ronald Y. Chang	Hong-Ning Dai	Samy El-Tawab	Yu Gao	Neda
Ziad Qais Al Abbasi	Venkattraman	Aizaz Chaudhry	Yueyue Dai	Timbloudi	Yulan Gao	Haghighatpanah
Nader Alagha	Balasubramanian	Abdellah Chehri	Danjuma Danshik	Enamamu	Carla Estefania	Rami Hamdi
Abdulsahib	Muyiwa Balogun	Binqiang Chen	Dajab	Emmanuel	Garcia Moreta	Carla Han
Albehadili	Salime Bamerni	Chen Chen	Olawande Daramola	Majiyabo Eronu	Amauri Ghellere	Ruisong Han
Antonio Alberto	Wei Bao	Dawei Chen	Tasneem Darwish	Barry Evans	Garcia Miranda	Tao Han
D'Amico	Jose Mairton Barros	Hao Chen	Alexei Davydov	Zubair Fadhullah	Rosario Garroppo	Xu Han
Laha Ale	da Silva Junior	Hongzhi Chen	Andrea De Jesus	Zubair Fadhullah	Ahmad Gendia	Mi Hang
Abdulmajeed	Sara Basharat	Jiayin Chen	Torres	Guanghui Fan	Alireza Ghasempour	Takanori Hara
Alenezi	Ilhan Basturk	Nan Chen	André L. F. de Almeida	Rongfei Fan	Ammar Ghazal	Hasan
Hussam Ali	Edgar Beck	Quan Chen				Mikio Hasegawa

Muneeb Ul Hassan	Yi Jiang	Longguang Li	Ting Ma	Chia-Ho Ou	Feng Shen	Uyuota Uyoata
Hiroyuki Hatao	Yili Jiang	Meiling Li	Xiang Ma	Tepei Oyama	Guanxiong Shen	Rodolfo Valiente
Kiyohiko Hattori	Yu Jiang	Mushu Li	Yiyun Ma	Olutayo O.	Hang Shen	Hiep Vu Van
Ryo Hayakawa	Zhang Jianhua	Qihao Li	Zhangfeng Ma	Oyerinde	Li-Hsiang Shen	Joelana Vartiainen
Kazunori Hayashi	Wu Jiao	Shichao Li	Zhe Ma	Tudor Palade	Tianji Shen	Neelakantam
Kazunori Hayashi	Jihemn	Shuangyang Li	Roberto Magueta	Jiyong Pang	Xu Shen	Venkatarayalu
Vahideh	Hu Jin	Tao Li	Abdalla Mahmoud	Ishaan Paranjape	Zhengguo Sheng	Venkatkumar
Hayyolalam	Xiaoye Jing	Wenfeng Li	Vuong Mai	Seju Park	Zhichao Sheng	Venkatasubramanian
Chao He	Honghao Ju	Xiaohui Li	Naga Manoj	Ju Seong Park	Junchao Shi	Emanuele Viterbo
He He	Bang Chul Jung	Xin Li	Makkena	Chrysanthi Paschou	Junpeng Shi	Calin Vlădeanu
Jiaqi He	Haejoon Jung	Xinyu Li	Asad Waqar Malik	Andra Pastrav	Qian Shi	Peter Vouras
Jingchao He	Md. Mahfujul Kadir	Xu Li	Madhuri Latha	Al-Sakib Khan	Shan Shi	Vuong Quoc Bao
Mingcheng He	Caihong Kai	Xuran Li	Mannedu	Pathan	Weisen Shi	Keisuke Wakao
Mingcheng He	Sanket Kalamkar	Yihao Li	Yijie Mao	Naanman	Wenjuan Shi	Liangtian Wan
Ruisi He	Rafael Kaliski	Yuanbo Li	Zhi Mao	Bartholomew Paul	Oh-Soon Shin	Pengwu Wan
Zhengran He	Rafael Kaliski	Yue Li	Anna Maria Vegni	João Pedro Pavia	Wonjao Shin	Bing Wang
Zhimin He	Mohsin Kamal	Yunyi Li	Paulo Marques	Pedro Pedrosa	Takuya Shindo	Bowen Wang
Robert W. Heath Jr.	Suguru Kameda	Zhaojie Li	Alexandru Martian	Yingting Pei	Morteza	ChangYuan Wang
Takamasa Higuchi	Xinyue Kan	Hongbin Liang	Kazuki Maruta	Yingting Pei	Mohammadi	Chen Wang
Ivan Wang-Hei Ho	Kavin Kang	Wei Shun Liao	Barbara M. Masini	Haixia Peng	Shirkolaei	Chu-Fu Wang
Yi Hong	Salil Kanhere	Xishun Liao	Daniel Massicotte	Yang Peng	Shiyao	Danyang Wang
Kevin Ong Shen	Batuhan Kaplan	Yang Lilin	Toshiki Matsumine	Yang Peng	Ng Jer Shyuan	Danyang Wang
Hoong	Erhan Karakoca	Chunmian Lin	Shikha Maurya	Maxim Penner	Ayesha Siddiqua	Dezhi Wang
Yuta Hori	Shigeru Kashihara	Hai Lin	Hope Mauwa	Felipe Augusto	Adão Silva	Dongyu Wang
Hanxu Hou	Yuichi Kawamoto	Jie Lin	Andrew McGordon	Pereira de	Lion Silva	Feng Wang
Jingze Hou	Rodney Clint Keele	Siyu Lin	Mustafa K. Mehmet	Figueiredo	Keshav Singh	Han Wang
Weihao Hou	Jan M. Kelner	Xiaohui Lin	Ali	Paulo G. Pereira	Mohammad	Hao Wang
An-Hung Hsiao	Hafiz Ahmad	Xu Lin	Niloofer Mehria	Nemanja Perovic	Soliman	Hong Wang
Yu-Pin Hsu	Khalid	Yun Lin	Mudasar Latif	Vitaly Petrov	Yubo Song	Jie Wang
Shen Wen Hsuan	Yasser Khalil	Yun Lin	Memon	Ashkan Pirooz	Yunchao Song	Jie Wang
Dou Hu	Muhammad Ashfaq	Yun-Wei Lin	Wang Miao	Andrea Pizzo	Alireza Souri	Jin Wang
Lei Hu	Khan	Jonathan Ling	David Michelson	Proyash Podder	Breno Sousa	Jinfei Wang
Qiang Hu	Umar F. Khan	Chen-Feng Liu	Manabu Mikami	Michele Polese	Nuno Souto	Jingjing Wang
Qingqing Hu	Irfan Khan	Chun-Hung Liu	Nobuhiko Miki	Otilia Popescu	Olungenga Sowande	Lei Wang
Rui Hu	Md Rayhan Khan	Chunshan Liu	Chulhong Min	Segun Popoola	Seshan	Miao Wang
Shaokang Hu	Muhammad Toaha	Danpu Liu	Alex Minetto	Petar Popovski	Srirangarajan	Qi wang
Xu Hu	Raza Khan	Daqing Liu	Shashwat Mishra	Alessandro	Gautam Srivastava	Qipeng Wang
Zhiqun Hu	Majid Khoshafa	Dong Liu	Teruyuki Miyajima	Pozzebon	Mirko Staderini	Qiu Wang
Chongwen Huang	Hossein Khoshnevis	Dongxiao Liu	Sanam	Sourav Pramanik	Giovanni Stea	Qubeijian Wang
Haiyan Huang	Saad Hassan Kiani	Fang Liu	Moghaddamia	Narayan Prasad	Binbin Su	Ruoxu Wang
Hao Huang	Haesik Kim	Hongwu Liu	Zahra Mokhtari	Ioannis	Chunxia Su	Shaobo Wang
Hao Huang	Jae-Hyun Kim	Huiye Liu	Kazuya Monden	Psaromiligkos	Nanchi Su	Shuffei Wang
Hongjia Huang	Jinhong Kim	Jie Liu	Marco Moretti	Peihan Qi	Mizuki Suga	Weijian Wang
Jiawei Huang	Minseok Kim	Jiuyu Liu	Hiroaki Morino	Kun Qian	Shinya Sugiura	Wenbo Wang
Jie Huang	Sooyoung Kim	Junyu Liu	Masafumi	Meng Qin	Gizem Stümen	Xiaolu Wang
Nuo Huang	Wonjun Kim	Lifu Liu	Moriyama	Guixian Qu	Chen Sun	Xijun Wang
Qiang Huang	Mari Kobayashi	Miao Liu	Alireza Morsali	Kaige Qu	Jin Sun	Xuyu Wang
Xiaojing Huang	Paul Kogeda	Miao Liu	Nadia Mouawad	Kaige Qu	Jinlong Sun	Yang Wang
Yilong Hui	Shun Kojima	Mingliu Liu	Amrita Mukherjee	Jeanne Quimby	Jinlong Sun	Mengying Sun
Matthias Hummert	Shun Kojima	Mingyuan Liu	Mithun Mukherjee	Faheem Qureshi	Ran Sun	Ruijin Sun
Niamat Hussain	Chuili Kong	Peixi Liu	Priyadarshi	Sara Shakil Qureshi	Ahmed Raafat	Yan Sun
Rasheed Hussain	Alva Kosasih	Peng Liu	Mukherjee	Ahmed Raafat	Saadane Rachid	Yanglong Sun
Kim Hyunbum	Haris Kreomo	Pengfei Liu	Shayok	Saadane Rachid	Alvin Ramoutar	Zhiyuan Ren
Augustus Ibhaze	Toshihiro Kujirai	Qiang Liu	Mukhopadhyay	Alvin Ramoutar	Oliver Renaudin	Zhili Sun
Shinsuke Ibi	Michel Kulhandjian	Ru Liu	Takumi Murata	Zhiyuan Ren	Geraldine	Chang Kyung Sung
Amani Ibraheem	Debidas Kundu	Runnan Liu	Osamu Muta	Olivier Renaudin	Rangmoen	Himal A. Suraweera
Mohamed Ibrahim	Gunes Karabulut	Shengli Liu	Qurrat-Ul-Ain	Geraldine	Rimven	Katsuya Suto
Muhammad Ijaz	Kurt	Tingting Liu	Nadeem	Rangmoen	Ian P. Roberts	Takumi Takahashi
Augustine Ikpehai	Daniel Tetey	Xiangguo Liu	Ahmed Naem	Rimven	Ramiro Robles	Osamu Takaya
Agbotiname Imoize	Kwabena	Xin Liu	Katsuhiro Naito	Ian P. Roberts	Sandra Roger	Bo Tan
Kei Inage	Jonathan C. Kwan	Xin Liu	Ryo Nakano	Ramiro Robles	Ciprian Romeo	Yoshinori Tanaka
Mamiko Inamori	Chuan-Chi Lai	Xing Liu	Nasir	Sandra Roger	Comsa	Jie Tang
Muhammad Iqbal	Yiming Lai	Yalin Liu	Ahmed Nasser	Ciprian Romeo	Kay Romer	Ming Tang
Muhammad Shahid	Phi Van Lam	Yi Liu	Bao-Huy Nguyen	Comsa	Maik Röper	Suhua Tang
Iqbal	Ping Lang	Yi Liu	Kien Nguyen	Kay Romer	Matjaz Rozman	Tetsuki Taniguchi
James Irvine	Akinylemi Lateef	Yiliang Liu	Lap Luat Nguyen	Maik Röper	Luca Rugini	Qin Tao
Lucky A. Ishaku	Adesola	Yiming Liu	Luong Nguyen	Matjaz Rozman	Malik Muhammad	Xi Tao
Dauda Ishaya	Buon Kiong Lau	Yingting Liu	Nhat Quang Nhan	Luca Rugini	Saad	Md Nurul Anwar
Koji Ishibashi	Mads Lauridsen	Zhi Liu	Rui Ni	Malik Muhammad	Bashir Olaniyi	Tarek
Susumu Ishihara	Spyros Lavdas	Zhipeng Liu	Yuanzhi Ni	Saad	Sadiq	Muhammad Ashar
Susumu Ishihara	Quang Nhat Le	Zhongyu Liu	Zhengwei Ni	Bashir Olaniyi	Umer Saeed	Tariq
Naoki Ishikawa	Mai T. P. Le	Zilong Liu	Jinhui Ning	Sadiq	Hemant Saggarr	Emmanuel Tashiwa
Kentaro Ishizu	Nguyen Phi Le	Yan Long	Jinhui Ning	Umer Saeed	André Saito	Ibrahim
Md. Mahmudul Islam	Anh Tuyen Le	Miguel López-Benitez	Toshihiko	Hemant Saggarr	Manabu Sakai	Tharaj Thaj
Muhammad Islam	Byungju Lee	Huali Lu	Nishimura	André Saito	Kosuke Sanada	Gokulnath
Shajid Islam	Byungju Lee	Kevin Lu	Takayuki Nishio	Manabu Sakai	Luca Sanguinetti	Thandavarayan
Masaaki Ito	David Lee	Ning Lu	Guanchong Niu	Kosuke Sanada	Paramin	John Thompson
Yusuke Ito	Gilsoo Lee	Ning Lu	Xianhua Niu	Luca Sanguinetti	Sangwongngam	Tianrui
Nobuhiko Itoh	Hyukyeon Lee	Shihang Lu	Masakatsu Ogawa	Paramin	Wiroonsak	Jun Tong
Masashi Iwabuchi	Ying Loong Lee	Xiaozhen Lu	Takeo Ohgane	Sangwongngam	Santipach	Chung-Hsien Tsai
Tatsuhiko Iwakuni	Woongsup Lee	Tom H. Luan	Shuichi Ohno	Wiroonsak	Julio Cesar Santos	Hsin-Mu Tsai
Hiroki Iwata	Janne Lehtomäki	Tom H. Luan	Chikara Ohta	Santipach	dos Anjos	Ming-Fong Tsai
Jacek Izydoreczyk	Cristiano Fernando	Mai Ohta	Mai Ohta	Julio Cesar Santos	Anitha Saravana	Zhong-Ting Tsai
Jalal Jalali	Lewandoski	Hiraku Okada	Hiraku Okada	dos Anjos	Kumar	Po-Hsuan Tseng
Anand Jee	Aohan Li	Eiji Okamoto	Eiji Okamoto	Anitha Saravana	Koya Sato	George Tsoulos
Gwanggil Jeon	Bin Li	Kennedy Okokpujie	Kennedy Okokpujie	Kumar	Mathis Schmieder	Takahiro Tsuchiya
Yo-Seb Jeon	Chenxi Li	Tatsuki Okuyama	Tatsuki Okuyama	Koya Sato	Adrian Schumacher	Manabu Tsukada
Sumin Jeong	Feng Li	Oladejo Sunday	Oladejo Sunday	Mathis Schmieder	Chan See	Shogo Uchida
Xiaodong Ji	Guyue Li	Oladayo	Oladayo	Adrian Schumacher	Daniyal Ali Sehrai	Akira Uchiyama
Zijie Ji	He Li	Gbenga Abidemi	Gbenga Abidemi	Chan See	Chengzhao Shan	Kenta Umebayashi
Shaobo Jia	Jinglin Li	Olarinoye	Olarinoye	Daniyal Ali Sehrai	Lin Shan	Shusaku Umeda
Fan Jiang	Junling Li	Olfa	Olfa	Chengzhao Shan	Hua Shao	Prabhat Kumar
Hao Jiang	Kai Li	Thant Zin Oo	Thant Zin Oo	Lin Shan	Sanjeev Sharma	Upadhyay
Xu Jiang	Ke-Xin Li	Abayomi Otebolaku	Abayomi Otebolaku	Hua Shao		
	Lixin Li	Safa Otoum	Safa Otoum	Sanjeev Sharma		

Yongjun Xu	Ruizhe Yang	Yue Yin	Weijie Yuan	Lihao Zhang	Zhiyu Zhang	Conghao Zhou
Yunting Xu	Sufang Yang	Yue Yin	Chau Yuen	Liye Zhang	Dezong Zhao	Conghao Zhou
Yunting Xu	Sushu Yang	Zhisheng Yin	Alessio Zappone	Min Zhang	Dongmei Zhao	Di Zhou
Fu Xue	Wanting Yang	Daiki Yoda	Shah Zeb	Nannan Zhang	Feiran Zhao	Haibo Zhou
Fu Xue	Xiao Yang	Wang Yong	Li Zecheng	Ning Zhang	Kanglian Zhao	Hao Zhou
Jianzhe Xue	Zhaohui Yang	Jiabao Yu	Dmitry Zelenchuk	Ran Zhang	Lian Zhao	Jing Zhou
Kaiping Xue	Zhaohui Yang	Jiadong Yu	Thomas Zemen	Ronghui Zhang	Lou Zhao	Lin Zhou
Songyan Xue	Halim	Kai Yu	Jun Zeng	Sheng Zhang	Nan Zhao	Mu Zhou
B. Yahaya	Yanikomeroğlu	Keping Yu	Bei Zhang	Siqi Zhang	Peng Zhao	Siyang Zhou
Koji Yamamoto	Kazuto Yano	Peng Yu	Di Zhang	Tingping Zhang	Ruijie Zhao	Yi Zhou
Ryo Yamamoto	Feng Ye	Peng Yu	Gongzheng Zhang	Tingping Zhang	Ruijie Zhao	Yue Zhou
Zhibo Yan	Wentao Ye	Tianhang Yu	Hongbo Zhang	Wence Zhang	Shuyue Zhao	Jia Zhu
Hao Yang	Xuehan Ye	Tzu-Hsu Yu	Hongming Zhang	Xibeng Zhang	Wenwen Zhao	Jia Zhu
Haochen Yang	Yuanfan Ye	Wenjuan Yu	Hongyang Zhang	Xinyu Zhang	Xuanpeng Zhao	Jinle Zhu
Haojun Yang	Phee Lep Yeoh	Yu Yu	Jiayi Zhang	Yao Zhang	Yu Zhao	Lingrui Zhu
Jingyan Yang	Yibin	Zhiyuan Yu	Jingwei Zhang	Yixiao Zhang	Yue Zhao	Yinxiao Zhuo
Jinsong Yang	Cheng Yin	Jinhong Yuan	Jiyuan Zhang	Yongmin Zhang	Zhouqiao Zhao	Zhiqiang Zuo
Mi Yang	Jiaying Yin	Quan Yuan	Junlin Zhang	Yundong Zhang	Fei Zheng	刘威
Mingyuan Yang	Lu Yin	Weijie Yuan	Kehan Zhang	Zeyu Zhang	Wang Zhijie	陈开志
Qi Yang	Sixing Yin	Weijie Yuan	Kexin Zhang	Zhicai Zhang	Yi Zhong	黄毅

## Tutorials

A range of tutorials will be held given by experts from industry and academia.

### T1: Reconfigurable Intelligent Surfaces for Future Wireless Communications

*Alessio Zappone, University of Cassino and Southern Lazio, Italy; Marco Di Renzo, CNRS – Centrale-Supelec – Univ. Paris-Sud, France; Shi Jin, Southeast University, China; Merouane Debbah, Huawei France R&D / Centralesupelec, France*

As 5G networks take their final form, connectivity demands continue to increase exponentially and new services pose more constraints on the performance that end-users expect. A recent technological breakthrough with the potential to meet these demands is that of reconfigurable intelligent surfaces (RIS). This tutorial first elaborates on why present 5G technologies are not enough to keep up with the requirements expected of 6G wireless networks and then introduces the fundamental principles and latest design approaches of RISs for beyond 5G wireless communications, showing how the RIS technology is a very promising technology for 6G wireless networks.

We believe that a tutorial on the principles and latest approaches of reconfigurable intelligent surfaces for beyond 5G wireless communications will be of great value for both academics and industry practitioners. This tutorial is unique of its kind, as it provides a cohesive vision of the emerging field of RIS-based communications, addressing both the theoretical methodologies and more practical issues related to real-world implementation. Therefore, the audience will receive a unique training experience.

*Alessio Zappone obtained his Ph.D. degree in electrical engineering in 2011 from the University of Cassino and Southern Lazio, Cassino, Italy. His Ph.D. studies were focused on distributed algorithms for energy-efficient resource allocation in wireless networks. After obtaining his Ph.D. Alessio has been with the Technische Universität Dresden, Germany, managing the project CEMRIN on energy-efficient resource allocation in wireless networks, funded by the German Research Foundation. From 2017 to 2019 he has been the recipient of the H2020 Individual Marie Curie fellowship for experienced researchers BESMART, carried out in the LANEAS group of CentraleSupélec, Paris, France. He is now a tenured professor at the university of Cassino and Southern Lazio, Italy. He was appointed exemplary reviewer for the IEEE Transactions on Communications and IEEE Transactions on Wireless Communications in 2017. Alessio is an IEEE Senior Member, serves as senior area editor for the IEEE Signal Processing Letters and as guest editor for the IEEE Journal on Selected Areas On Communications (Special Issues on Energy-Efficient Techniques for 5G Wireless Communication Systems and on Wireless Networks Empowered by RIS).*

*Marco Di Renzo received the Ph.D. degree in Electrical and Information Engineering from the University of L'Aquila, Italy, in 2007. Since 2010, he is Associate Professor with Paris-Saclay University –*

*CNRS, CentraleSupélec, Univ. Paris Sud, France. He is a Distinguished Visiting Fellow of the Royal Academy of Engineering (UK), and co-founder of the university spin-off company WEST Aquila s.r.l., Italy. Dr. Di Renzo received the THALES Communications fellowship (2003-2006), University of L'Aquila, Italy; the De rogation pour l'Encadrement de These (2010), University of Paris-Sud, France; the 2012 IEEE CAMAD, 2014 IEEE CAMAD, 2014 IEEE ATC, 2015 IEEE ComManTel Best Paper Awards; the 2013 IEEE- COMSOC Best Young Researcher Award for Europe, Middle East and Africa; the 2015-2018 CNRS Award for Excellence in Research and in Advising Doctoral Students; the 2017 IEEE- SEE Alain Glavieux Award. He serves as Editor in Chief of the IEEE Communications Letters and Editor of the IEEE Transactions on Communications. He is an IEEE Fellow and a Distinguished Lecturer of the IEEE Communications and IEEE Vehicular Technology Societies.*

*Shi Jin is a frequent tutorial/keynote speaker at international conferences, where he gave more than 20 lecture talks. For example, he gave the tutorial Low-Cost Massive MIMO: From Theory to Practice at several renowned IEEE conferences, such as VTC2016-Spring, IEEE GLOBECOM 2016, ICC 2016, ICASSP 2017, and he gave the keynote Model-Driven Deep Learning for Physical Layer Communications at the 2018 International Conference on 5G for Ubiquitous Connectivity. He has also given several invited tutorial talks at several universities in China. He has more than ten years of experience as a university professor with the Southeast University, Nanjing, China, teaching courses at both the Master Degree and Ph.D. level.*

*Merouane Debbah is a frequent tutorial/keynote speaker at international conferences, with more than 50 talks. Recent examples include: Catalonia Distinguished Lecture-ship Program, 2009; Plenary at the Femtocell workshop at Globecom 2010; Newcom++ Spring School on Cognitive Wireless Communication Networks, 2010; Indoor and Outdoor Femto Cells workshop at PIMRC 2010; VTC2011-Spring BeFEMTO keynote workshop speaker; Keynote speaker at ICASSP 2011; Tutorial Random Matrix Theory for Advanced Communication Systems at IEEE WCNC 2012; Tutorial Random Matrix Advances in Signal Processing at SPAWC 2013; Plenary speaker at ISWCS 2014; Plenary speaker at Valuetools 2014; Plenary speaker at the International School on Small Cells and 5G, 2015; Tutorial Speaker Massive MIMO for 5G at ISWCS 2015; Plenary speaker at EUSIPCO 2015.*

### T2: Physical Layer Security: Latest Trends, Threats, and Countermeasures

*Huseyin Arslan, University of South Florida, USA*

Today's wireless services and systems have come a long way since the rollout of the conventional voice-centric cellular systems. The demand for wireless access in voice and multimedia applications has increased tremendously. The trend on the variety and the number of mobile devices along with the mobile applications will certainly continue beyond 5G, creating a wide range of technical challenges. One of the biggest challenges is

the security of the communication beyond the classical crypto based approaches which secure the information. In this talk, security aspects of the physical communication and also physical signal which is called Physical Layer Security (PHY Security) will be discussed. Latest trends, threats, and techniques to improve the security of the physical signal will be discussed.

*Dr. Arslan (IEEE Fellow, IEEE Distinguished Lecturer) has received his BS degree from Middle East Technical University (METU), Ankara, Turkey in 1992; MS and Ph.D. degrees in 1994 and 1998 from Southern Methodist University (SMU), Dallas, TX, USA. From January 1998 to August 2002, he was with the research group of Ericsson Inc., NC, USA, where he was involved with several projects related to 2G and 3G wireless communication systems. Since August 2002, he has been with the Electrical Engineering Dept. of University of South Florida, Tampa, FL, USA, where he is a Professor.*

*Dr. Arslan's research interests are related to advanced signal processing techniques at the physical and medium access layers, with cross-layer design for networking adaptivity and Quality of Service (QoS) control. He is interested in many forms of wireless technologies including cellular radio, wireless PAN/LAN/MANs, fixed wireless access, aeronautical networks, underwater networks, in vivo networks, and wireless sensors networks. His current research interests are on 5G and beyond, physical layer security, interference management (avoidance, awareness, and cancellation), cognitive radio, small cells, powerline communications, smart grid, UWB, multi-carrier wireless technologies, dynamic spectrum access, co-existence issues on heterogeneous networks, aeronautical (High Altitude Platform) communications, in vivo channel modeling and system design, and underwater acoustic communications. He has served as technical program committee chair, technical program committee member, session and symposium organizer, and workshop chair in several IEEE conferences. He is currently a member of the editorial board for the IEEE Surveys and Tutorials and the Sensors Journal. He has also served as a member of the editorial board for the IEEE Transactions on Communications, the IEEE Transactions on Cognitive Communications and Networking (TCCN), the Elsevier Physical Communication Journal, the Hindawi Journal of Electrical and Computer Engineering, and Wiley Wireless Communication and Mobile Computing Journal.*

### **T3: MetaEverything: Intelligent Meta-Material Aided Sensing and Communications**

*Boya Di, Imperial College London, UK; Hongliang Zhang, Princeton University, USA; Lingyang Song, Peking University, China; Zhu Han, University of Houston, USA*

The future wireless networks are exhibiting a trend towards the intelligent communication and sensing system to support a variety of applications requiring high data rates, low hardware cost, and fine-resolution sensing. Fortunately, with the recent development of new materials, reconfigurable intelligent meta-material provides an efficient approach to reshape and control the electromagnetic characteristics of the environment, which can be utilized to enhance the performance of communication and sensing. In this tutorial, we will first provide a general introduction of the intelligent meta-material along with the state-of-the-art research in different areas. We then introduce the unique features of intelligent meta-material which enlighten its broad applications to communication and sensing, in a comprehensive way. Related design, analysis, optimization, and signal processing techniques will be presented. Typical meta-material based applications for both cellular communications and radio frequency sensing as well as localization will be explored. The implementation issues along with our developed prototypes and experiments will also be discussed. Formalized analysis of several up-to-date challenges and technical details on system design will be provided for different applications.

*Boya Di (S'17-M'19) received the B.S. degree from Peking University in 2014, and the Ph.D. degree from Peking University in 2019. Currently she is post-doctoral research associate in Imperial College London, London, UK. Her main research interests include reconfigurable intelligent materials, multi-agent systems, wireless resource allocation and management, edge computing, and optimization theory. She has*

*published over 10 journal papers on the topic of reconfigurable intelligent material aided communications and sensing, including 2 first-author ones. One of her journal papers is currently listed as highly cited papers in Web of Science. She is currently an Editor for IEEE Transactions on Vehicular Technology. She has also served as a reviewer for multiple IEEE journals including IEEE JSAC, TWC, TCOM, etc., and a TPC member for IEEE GLOBECOM and ICC several times.*

*Hongliang Zhang (S'15-M'19) received the B.S. and Ph.D. degrees at the School of Electrical Engineering and Computer Science at Peking University, in 2014 and 2019, respectively. He was a Postdoctoral Fellow in the Electrical and Computer Engineering Department at the University of Houston, Texas from Jul. 2019 to Jul. 2020. Currently, he is a Postdoctoral Associate in the Department of Electrical Engineering at Princeton University, New Jersey. His current research interest includes cooperative communications, Internet-of-Things networks, hypergraph theory, and optimization theory. He received the best doctoral thesis award from Chinese Institute of Electronics in 2019. He has served as a TPC Member for many IEEE conferences, such as Globecom, ICC, and WCNC. He is currently an Editor for IET Communications. He also serves as a Guest Editor for IEEE IoT-J special issue on Internet of UAV's over Cellular Networks.*

*Lingyang Song (S'03-M'06-SM'12-F'19) received his PhD from the University of York, UK, in 2007, where he received the K. M. Stott Prize for excellent research. He worked as a research fellow at the University of Oslo, Norway until rejoining Philips Research UK in March 2008. In May 2009, he joined the School of Electronics Engineering and Computer Science, Peking University, and is now a Boya Distinguished Professor. His main research interests include wireless communications, mobile computing, and machine learning. Dr. Song is the co-author of many awards, including IEEE Leonard G. Abraham Prize in 2016, IEEE ICC 2014, IEEE ICC 2015, IEEE Globecom 2014, and the best demo award in the ACM Mobihoc 2015. He received National Science Fund for Distinguished Young Scholars in 2017, First Prize in Nature Science Award of Ministry of Education of China in 2017. Dr. Song has served as a IEEE ComSoc Distinguished Lecturer (2015-2018), an Area Editor of IEEE Transactions on Vehicular Technology (2019-), Co-chair of IEEE Communications Society Asia Pacific Board Technical Affairs Committee (2020-). He is a Clarivate Analytics Highly Cited Researcher.*

*Zhu Han (S'01-M'04-SM'09-F'14) received the B.S. degree in electronic engineering from Tsinghua University, in 1997, and the M.S. and Ph.D. degrees in electrical engineering from the University of Maryland, College Park, in 1999 and 2003, respectively. From 2000 to 2002, he was an R&D Engineer of JDSU, Germantown, Maryland. From 2003 to 2006, he was a Research Associate at the University of Maryland. From 2006 to 2008, he was an assistant professor in Boise State University, Idaho. Currently, he is a Professor in Electrical and Computer Engineering Department as well as Computer Science Department at the University of Houston, Texas. His research interests include wireless resource allocation and management, wireless communications and networking, game theory, wireless multimedia, security, and smart grid communication. Dr. Han received an NSF Career Award in 2010, the Fred W. Ellersick Prize of the IEEE Communication Society in 2011, the EURASIP Best Paper Award for the Journal on Advances in Signal Processing in 2015, the IEEE Kiyo Tomiyasu Award in 2021, and several best paper awards in IEEE conferences. Dr. Han is top 1% highly cited researcher according to Web of Science since 2017, and AAAS fellow since 2019.*

### **T4: Secure Protocol Designs for Next Generation Wireless Systems**

*Yi Qian, University of Nebraska-Lincoln, USA*

The fifth generation (5G) and the beyond wireless systems are the next generation mobile wireless telecommunications beyond the current 4G/International Mobile Telecommunications Advance Systems. Not only enhanced mobile broadband communications but also ultra-reliable low-latency communications and massive machine-type communications are supported by 5G and beyond wireless networks. New architecture and advanced technologies are applied in 5G wireless systems to support different use cases. New security issues and advanced performance requirements are raised by various use cases and advanced technologies. To provide security services with satisfying service performance

requirements in 5G and beyond systems, new secure protocols need to be designed with new security architectures and flexible security mechanisms such as authentications, key management, confidentiality, and integrity.

In this tutorial, we will overview 5G and beyond wireless systems in terms of new network architectures, advanced technologies, and performance requirements. Major drives of 5G security are presented. Possible solutions in terms of security architecture and flexible security mechanisms are discussed. The proposed tutorial not only covers the history and the lessons learned from 2G and 3G secure protocol designs, but also the current research and development on secure protocol designs for 4G LTE networks, as well as the latest development on secure protocols for 5G and beyond wireless systems, and the unique discussions on the challenges and open research issues in the area, based on the tutorial speaker's own research experience and comprehensive surveys on the subject.

*Yi Qian received a Ph.D. degree in electrical engineering from Clemson University, South Carolina, USA, in May 1996. He is currently a professor in the Department of Electrical and Computer Engineering, University of Nebraska-Lincoln (UNL). Prior to joining UNL, he worked in the telecommunications industry, academia, and government. Some of his previous professional positions include serving as a senior member of scientific staff and a technical advisor at Nortel Networks, a senior system engineer and a technical advisor at several startup companies, an assistant professor at the University of Puerto Rico at Mayaguez, and a senior researcher at the National Institute of Standards and Technology. His research interests include communication networks and systems, and information and communication network security. Prof. Yi Qian is a Fellow of IEEE. He was previously Chair of the IEEE Technical Committee for Communications and Information Security. He was the Technical Program Chair for IEEE International Conference on Communications 2018. He serves on the Editorial Boards of several international journals and magazines, including as the Editor-in-Chief for IEEE Wireless Communications. He was a Distinguished Lecturer for IEEE Vehicular Technology Society. He is currently a Distinguished Lecturer for IEEE Communications Society.*

*Prof. Yi Qian received the Henry Y. Kleinkauf Family Distinguished New Faculty Teaching Award in 2011, the Holling Family Distinguished Teaching Award in 2012, the Holling Family Distinguished Teaching/Advising/Mentoring Award in 2018, and the Holling Family Distinguished Teaching Award for Innovative Use of Instructional Technology in 2018, all from University of Nebraska-Lincoln. Prof. Yi Qian is the principal author of a new textbook, Security in Wireless Communication Networks, published by Wiley in 2021.*

## **T5: Computing in Communication Networks: The Road Ahead**

*Fabrizio Granelli, University of Trento, Italy; Frank Fitzek, Technische Universität Dresden, Germany*

A big step lies ahead, when moving from today's 4G cellular networks to tomorrow's 5G network. Today, the network is used for content delivery, e.g. voice, video, data. Tomorrow, the 5G network (and possibly beyond that) will be fully software-defined and programmable, with new degrees of freedom. The aim of the tutorial is to illustrate how the emerging paradigms of Software Defined Networking and Network Function Virtualization will impact on the development of future systems and networks, both from the theoretical/formal as well as from the practical perspective.

The tutorial will provide a comprehensive overview of the individual building blocks (software defined networking; network function virtualization; information centric networks) enabling the concept of computing in future networks, starting from use cases and concepts over technological enablers (Mininet; Docker) and future innovations (machine learning; network coding; compressed sensing) to implementing all of them on personal computers. Practical hands-on activities will be proposed, with realistic use cases to bridge theory and implementation by several examples, through the usage of a pre-built Virtual Machine (ComNetsEmu) that can be easily be

extended for new experiments. The instructions to download the Virtual Machine will be provided to the attendees in advance of the event. The main objective of the tutorial will be to expose attendees to the most recent technologies in the field of networking and teach them how to use them in a real setup in the "hands-on" session.

*Fabrizio Granelli is Associate Professor at the Dept. of Information Engineering and Computer Science (DISI) of the University of Trento (Italy). From 2012 to 2014, he was Italian Master School Coordinator in the framework of the European Institute of Innovation and Technology ICT Labs Consortium. He was Delegate for Education at DISI in 2015-2016 and he is currently member of the Executive Committee of the Trentino Wireless and Optical Testbed Lab. He was IEEE ComSoc Distinguished Lecturer for 2012-15 and IEEE ComSoc Director for Online Content in 2016-17. Prof. Granelli is IEEE ComSoc Director for Educational Services for 2018-19 and coordinator of the research and didactical activities on computer networks within the degree in Telecommunications Engineering. He was advisor of more than 80 B.Sc. and M.Sc. theses and 8 Ph.D. theses. He is author or co-author of more than 200 papers published in international journals, books and conferences in networking, with particular reference to performance modeling, cross-layering, wireless networks, cognitive radios and networks, green networking and smart grid communications.*

*Frank H. P. Fitzek is a Professor and chair of the communication networks group at Technische Universität Dresden coordinating the 5G Lab Germany. He received his diploma (Dipl.-Ing.) degree in electrical engineering from the University of Technology – Rheinisch-Westfälische Technische Hochschule (RWTH) – Aachen, Germany, in 1997 and his Ph.D. (Dr.-Ing.) in Electrical Engineering from the Technical University Berlin, Germany in 2002 and became Adjunct Professor at the University of Ferrara, Italy in the same year. In 2003 he joined Aalborg University as Associate Professor and later became Professor. He co-founded several start-up companies starting with acticom GmbH in Berlin in 1999. He has visited various research institutes including Massachusetts Institute of Technology (MIT), VTT, and Arizona State University. In 2005 he won the YRP award for the work on MIMO MDC and received the Young Elite Researcher Award of Denmark. He was selected to receive the NOKIA Champion Award several times in a row from 2007 to 2011. In 2008 he was awarded the Nokia Achievement Award for his work on cooperative networks. In 2011 he received the SAPERE AUDE research grant from the Danish government and in 2012 he received the Vodafone Innovation prize. His current research interests are in the areas of wireless and mobile 5G communication networks, mobile phone programming, network coding, cross layer as well as energy efficient protocol design and cooperative networking.*

## **T6: Deep Learning for Wireless Communications**

*Geoffrey Ye Li, Imperial College London, UK; Zhijin Qin, Queen Mary University of London, UK*

In the tutorial, we will provide a comprehensive overview on DL for wireless communications, including physical layer processing, resource allocation, and semantic communications.

We first present progress in DL in physical layer communications. We can categorize the applications of DL in physical layer communications into with and without block processing structures. For DL based communication systems with block structures, we introduce joint channel estimation and signal detection based on a fully connected deep neural network, model-driven DL for signal detection, and some experimental results. For those without block structures, we provide our recent endeavors in developing end-to-end learning communication systems.

In the second part of this tutorial, we will present recent progress in deep learning based wireless resource allocation. Deep learning can help solve optimization problems for resource allocation or can be directly used for resource allocation. We will first introduce how to use deep learning to solve optimization problems for resource allocation. We will then discuss deep reinforcement learning directly for wireless resource allocation with application in vehicular networks.

Enabled by deep learning, semantic communications are promising to further improve the communication system efficiency, which is regarded as the second level of

communications by Shannon and Weaver in addition to typical communications focusing on successful transmission of symbols. Semantic communications aim to realize the successful semantic information exchange rather than receive the transmitted bit sequences or symbols accurately. In this part, we will first introduce the concept of the semantic communication. We then detail the principles and performance metrics of semantic communications. Afterwards, we will present the initial work on deep learning enabled semantic communications and research challenges.

*Dr. Geoffrey Ye Li is currently a Chair Professor in wireless systems with Imperial College London. Before joining Imperial in 2020, he was with Georgia Institute of Technology for 20 years and AT&T (Bell) Labs – Research for about five years. His general research interests include statistical signal processing and machine learning for wireless communications. In the related areas, he has published over 500 journal and conference papers in addition to over 40 granted patents. His publications have been cited by over 40,000 times and he has been recognized as the World’s Most Influential Scientific Mind, also known as a Highly Cited Researcher, by Thomson Reuters almost every year.*

*Dr. Li was awarded IEEE Fellow for his contributions to signal processing for wireless communications in 2005. He won several prestigious awards from IEEE Signal Processing Society (Donald G. Fink Overview Paper Award in 2017), IEEE Vehicular Technology Society (James Evans Avant Garde Award in 2013 and Jack Neubauer Memorial Award in 2014), and IEEE Communications Society (Stephen O. Rice Prize Paper Award in 2013, Award for Advances in Communication in 2017, and Edwin Howard Armstrong Achievement Award in 2019). He also received 2015 Distinguished ECE Faculty Achievement Award from Georgia Tech.*

*Dr. Li has organized and chaired many international conferences and has been involved in editorial activities of many journals, including the founding Editor-in-Chief of IEEE JSAC ML Series.*

*Dr. Zhijin Qin is a lecturer (assistant professor) at Queen Mary University of London. She was with Lancaster University and Imperial College London as a lecturer and research associate, respectively, from 2016 to 2018. Her research interests include semantic communications, end-to-end communications, resource allocation in LoRa. She serves as an area editor of IEEE JSAC Series on Machine learning in Communications and Networks, an associate editor of IEEE Transactions on Communications, IEEE Transactions on Cognitive Communications and Networking, and IEEE Communications Letters. She served as the symposium co-chair for IEEE VTC2019-Fall, Globecom 2020/2021. She received the Best Paper Award from IEEE Globecom 2017, and the IEEE Signal Processing Society Young Author Best Paper Award 2018. Dr Qin has presented the tutorial at IEEE Globecom 2020.*

## **T7: Wireless Distributed Consensus for Blockchain: How Much Communication Resource is Needed?**

*Lei Zhang, University of Glasgow, UK*

Blockchain is built on a peer-to-peer network that relies on frequent communications among the distributively located nodes. In particular, the consensus mechanisms (CMs), which play a pivotal role in blockchain, are communication resource-demanding and largely determines blockchain key performance such as security, transaction throughput, latency and scalability. Most blockchain systems are designed in a stable wired communication network running in advanced devices under the assumption of sufficient communication resource provision. However, it is envisioned that the majority of the blockchain node peers will be connected through a wireless network in the future. Constrained by the highly dynamic wireless channel and scarce frequency spectrum, communication can significantly affect blockchain’s key performance metrics. In this in-depth tutorial, we start from presenting wireless blockchain networks (WBN) under various commonly used CMs and analyzing and demonstrating how much communication resource is needed to run such a network.

*Dr. Lei Zhang is a Senior Lecturer (Associate Professor) at the University of Glasgow. He has academia and industry combined research experience on 3G/4G/5G wireless communications and its*

*applications to IoT, Blockchain, automation, data privacy and security. Dr Zhang is PI or Co-I of 10+ research projects funded by UK Research and Innovation, Scottish government and industry. His 19 patents (including 17 international PCT patents) are granted/filed in 30+ countries/regions including USA/EU/China/Japan etc. He has 100+ peer-reviewed publications, including 3 books. Dr Zhang is an associate editor of IEEE Internet of Things (IoT) Journal, IEEE Wireless Communications Letters and Digital Communications and Networks. He received the IEEE ComSoc TAOS Technical Committee Best Paper Award 2019. Dr Zhang is the founding Chair of Special Interest Group on Wireless Blockchain Networks in IEEE Cognitive Networks Technical Committee (TCCN), and he was Technical Program Chair for 5th International Conference on UCET 2020, Publication and Registration Chair of IEEE SAM 2018, Co-chair of Cyber-C 2019 Blockchain workshop. Dr Zhang’s research is broadly covered by media including BBC and Bloomberg.*

## **T8: Decoupled Radio Access Networks for 6G: Concepts, Methods and Future Directions**

*Haibo Zhou, Nanjing University, China; Jiacheng Chen, Peng Cheng Laboratory, China*

The next generation mobile communications network is envisioned to face both significant user-side paradigm shifts and network-side challenges. On the one hand, trillions of IoT devices will connect to the network, and astronomical amount of data uploading traffic will deplete network bandwidth. Also, users will prefer more personalized service provision so as to satisfy their demands. On the other hand, network costs (e.g., infrastructure deployment and energy costs) are surging, and high-quality spectrum resources have been exhausted. In order to face the above changes, traditional RAN designs have been reconsidered recently, and novel RAN design principles have been proposed from various perspectives, aiming at achieving flexibility, scalability, and cost-efficiency. Most of the recent ideas have the design philosophy of functional decoupling behind them.

This tutorial will first explain the concepts of decoupling in related areas and provide a review on trending methods regarding decoupled RAN. Specifically, the tutorial will introduce control plane/user plane decoupling, uplink/downlink decoupling, decoupling in heterogeneous networks, and decoupling in user-centric cell-free networks. From the above examples and practices, the benefits of decoupling can be better understood. Then, the tutorial will present an introduction to the fully decoupled RAN (FD-RAN) architecture, in which functions of traditional base stations are physically split into three isolated entities, namely control, uplink and downlink base stations, and serve duplex control signaling, simplex uplink and downlink data transmission, respectively. Throughout the tutorial, the necessity of decoupled RAN for 6G will be emphasized.

*Haibo Zhou (M’14-SM’18) received the Ph.D. degree in information and communication engineering from Shanghai Jiao Tong University, Shanghai, China, in 2014. From 2014 to 2017, he was a Postdoctoral Fellow with the Broadband Communications Research Group, Department of Electrical and Computer Engineering, University of Waterloo. He is currently an Associate Professor with the School of Electronic Science and Engineering, Nanjing University, Nanjing, China. He won the 2020 Norbert Wiener Review Award of IEEE/CAA Journal of Automatica Sinica and Best Conference Paper Award of Globecom’2020 and VTC2020-Fall. He was named the 2020 highly cited researcher in cross-field. He was a recipient of the 2019 IEEE ComSoc Asia-Pacific Outstanding Young Researcher Award. He served as an Invited Track Co-Chair for ICC’2019, VTC2020-Fall and a TPC member of many IEEE conferences, including GLOBECOM, ICC, and VTC. He served as an Associate Editor for the IEEE ComSoc Technically Co-Sponsored the Journal of Communications and Information Networks (JCIN) from April 2017 to March 2019, and a Guest Editor for the IEEE Transactions on Vehicular Technology in 2021, the IEEE Internet of Things Journal in 2021, the IEEE Communications Magazine in 2016, the Hindawi International Journal of Distributed Sensor Networks in 2017, and IET Communications in 2017. He is currently an*



Associate Editor of the *IEEE Internet of Things Journal*, *IEEE Network Magazine*, *IEEE Wireless Communications Letter*, and *JCIN*. His research interests include resource management and networking design in vehicular ad hoc networks, 5G/B5G wireless networks and space-air-ground integrated networks.

Jiacheng Chen received his Ph.D. degree in information and communications engineering from Shanghai Jiao Tong University, Shanghai, China, in 2018. From Dec. 2015 to Dec. 2016, he was a visiting scholar at BCCR group, University of Waterloo, Canada. Currently, he is an assistant researcher in Peng Cheng Laboratory, Shenzhen, China. His research interests include future network design, 5G/6G network, and resource management. He has won the *Journal of Communications and Information Networks (JCIN) Best Paper Award* in 2016, and the *Chinese Institute of Electronics (CIE) Best Paper Award in Electronic & Information* in 2020. He has served the guest editors for *IEEE IoTJ* and *JCIN*.

## **T9: Deep Learning Empowered Large-Scale Antenna Systems**

Feifei Gao, *Tsinghua University Beijing, China*; Shun Zhang, *Xidian University, China*; Zhen Gao, *Beijing Institute of Technology, China*

With the depletion of spectrum, wireless communication systems turn to exploit large antenna arrays to achieve the degree of freedom in space domain, such as millimeter wave massive multi-input multi-output (MIMO), and reconfigurable intelligent surface (RIS) assisted communications. Meanwhile, it has been recently admitted that implementing deep learning (DL) into large-scale antenna communications will extensively benefit the system capacity and enhance the robustness to complicated transmission environments. Different from traditional model-driven approaches, DL can help deal with the existing communications and signal processing problems in a data driven perspective by digging the inherent characteristic from the real data. Thus, DL is particularly suitable for large-scale antenna systems under unideal scenarios like modeling mismatching, insufficient resource, hardware impairment, as well as dynamical transmissions. Motivated by this, this tutorial aims to provide the audience a general picture of the recent developments in this exciting area. Specifically, in this interactive presentation we will introduce the merging of DL and large-scale antenna systems, over various topics, including channel acquisition, signal detection, and beam forming design, etc. We will also discuss the challenges of DL empowered large-scale antenna systems and present some interesting future directions.

Feifei Gao (F'20) received the B.Eng. degree from Xi'an Jiaotong University, Xi'an, China, in 2002, the M.Sc. degree from McMaster University, Hamilton, ON, Canada, in 2004, and the Ph.D. degree from the National University of Singapore, Singapore, in 2007. Since 2011, he has been with the Department of Automation, Tsinghua University, Beijing, China, where he is currently an Associate Professor. His research interests include signal processing for communications, array signal processing, convex optimizations, and artificial intelligence assisted communications. He has authored/coauthored more than 150 refereed IEEE journal articles and more than 150 IEEE conference proceeding papers that are cited more than 8800 times in Google Scholar. He has served as a technical committee member for more than 50 IEEE conferences. He has also served as the Symposium Co-Chair of the 2019 IEEE International Conference on Communications (ICC), the 2018 IEEE Vehicular Technology Conference (VTC2018-Spring), the 2015 IEEE International Conference on Communications (ICC), the 2014 IEEE Global Communications Conference (GLOBECOM), and the 2014 IEEE Vehicular Technology Conference (VTC2014-Fall). He has served as an Editor for *IEEE Transactions on Wireless Communications*, *IEEE Transactions on Cognitive Communications and Networking*, *IEEE Wireless Communications Letters*, and *China Communications*, a Lead Guest Editor for *IEEE Journal of Selected Topics in Signal Processing*, and a Senior Editor for *IEEE Signal Processing Letters* and *IEEE Communications Letters*.

Shun Zhang (Senior Member, IEEE) received the B.S. degree in communication engineering from Shandong University, Jinan, China, in 2007, and the Ph.D. degree in communications and signal processing

from Xidian University, Xi'an, China, in 2013. He is currently with the State Key Laboratory of Integrated Services Networks, Xidian University, where he is currently an Associate Professor. His research interests include massive MIMO, millimeter wave systems, RIS assisted communications, deep learning for communication systems, orthogonal time frequency space (OTFS) systems, and multiple access techniques. He is an Editor for *Physical Communication*. He has authored or coauthored more than 80 journal and conference papers, and is the inventor of 16 granted patents (including a PCT patent authorized by US Patent and Trademark Office). He has received two Best Paper Awards in conferences, and two prize awards in natural sciences for research excellence by both China Institute of Communications and Chinese Institute of Electronics.

Zhen Gao (Member, IEEE) received the B.S. degree in information engineering from the Beijing Institute of Technology, Beijing, China, in 2011, and the Ph.D. degree in communication and signal processing with the Department of Electronic Engineering, Tsinghua University, China, in 2016. He is currently an Assistant Professor with the Beijing Institute of Technology. His research interests are in wireless communications, with a focus on multi-carrier modulations, multiple antenna systems, and sparse signal processing. He was a recipient of the IEEE Broadcast Technology Society 2016 Scott Helt Memorial Award (Best Paper), IET Electronics Letters Premium Award (Best Paper) 2016, UCET 2020 Best Paper Award, and the Young Elite Scientists Sponsorship Program (2018–2020) from China Association for Science and Technology.

## **T10: OTFS Modulation for Robust Wireless Communication in Next Generation High Mobility Scenarios: From Invention to Practice**

Ronny Hadani, *University of Texas at Austin, USA*; Ananthanarayanan Chockalingam, *Indian Institute of Science, India*; Saif Khan Mohammed, *Indian Institute of Technology Delhi, India*

The recently introduced Orthogonal Time Frequency Space (OTFS) modulation has been shown to be significantly robust to mobility induced Doppler spread when compared to multi-carrier modulation, which makes OTFS a key waveform candidate for high mobility scenarios in next generation wireless communication systems. This tutorial by the inventor of OTFS modulation and leading researchers, aims to introduce the audience to recent new results on OTFS modulation which would enable its practical deployment in next generation high mobility use cases like V2X, high-speed-train, UAV/Drones and also in mm-wave communication systems where mobility induced Doppler spread is high due to high carrier frequency. OTFS modulation multiplexes the information symbols in the delay-Doppler (DD) domain, whereas multi-carrier modulation schemes multiplex symbols in the time-frequency domain. The main advantage of multiplexing information symbols in the DD domain is that even in rapidly time-varying channels, the effective DD domain wireless channel exhibits slow variations and is sparse. Slow variations reduce the channel estimation overhead in rapidly time-varying channels and the sparse nature of the effective DD domain channel allows for low-complexity joint demodulation of all information symbols multiplexed in the DD domain. Joint demodulation helps in achieving robustness towards mobility induced Doppler spread. The key objectives of this tutorial are to introduce OTFS modulation, highlight the theory behind OTFS waveform design in the DD domain, present algorithms for signal detection, channel estimation and multiuser communication in the DD domain, and explain the reason behind the superior performance of OTFS compared to OFDM in high-mobility scenarios.

Ronny Hadani serves as the Chief Science Officer at Cohere Technologies. He also serves as an associate professor in the Mathematics Department of the University of Texas at Austin. Before that, he was a Dickson postdoctoral fellow in the Mathematics Department of the University of Chicago. He holds a PhD in pure mathematics from Tel-Aviv University and a master's degree in applied mathematics from The Weizmann Institute of Science in Israel. His field

of expertise is representation theory, harmonic analysis, and signal processing.

A. Chockalingam (S'92–M'93–SM'98) received the B.E. (Hons.) degree in electronics and communication engineering from the P. S. G. College of Technology, Coimbatore, India, in 1984, the M.Tech. degree in electronics and electrical communications engineering (with specialization in satellite communications) from the Indian Institute of Technology, Kharagpur, India, in 1985, and the Ph.D. degree in electrical communication engineering (ECE) from the Indian Institute of Science (IISc), Bengaluru, India, in 1993. From 1986 to 1993, he was at the Transmission R&D Division, Indian Telephone Industries Limited, Bengaluru. From 1993 to 1996, he was a Post-Doctoral Fellow and an Assistant Project Scientist at the Department of Electrical and Computer Engineering, University of California at San Diego. From 1996 to 1998, he was at Qualcomm, Inc., San Diego, CA, USA, as the Staff Engineer/Manager of the Systems Engineering Group. In 1998, he joined the faculty of the Department of ECE, IISc, where he is currently a Professor, working in wireless communications and networking. He is a fellow of the Indian National Academy of Engineering; the National Academy of Sciences, India; the Indian National Science Academy; and the Indian Academy of Sciences. He is a recipient of the Swarnajayanti Fellowship from the Department of Science and Technology, Government of India. He has served as an Associate Editor for the *IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY*, and as an Editor for the *IEEE TRANSACTIONS ON WIRELESS COMMUNICATIONS*. He has served as a Guest Editor for the *IEEE Journal on Selected Areas in Communications (Special Issue on Multiuser Detection for Advanced Communication Systems and Networks)*, and for the *IEEE Journal of Selected Topics in Signal Processing (Special Issue on Soft Detection on Wireless Transmission)*. He is an author of the book on 'Large MIMO Systems' published by Cambridge University Press.

Saif Khan Mohammed (Senior Member, IEEE) is currently an Associate Professor with the Department of Electrical Engineering, Indian Institute of Technology Delhi (IIT Delhi). His main research interests include wireless communication using large antenna arrays, coding and signal processing for wireless communication systems, information theory, and statistical signal processing. He currently serves as an Editor for *IEEE Transactions on Wireless Communications* and has served as an Editor for *IEEE Wireless Communications Letters* and *Physical Communication journal (Elsevier)*. He received the B.Tech. degree in computer science and engineering from IIT Delhi, New Delhi, India, in 1998, and the Ph.D. degree from the Electrical and Communication Engineering Department, Indian Institute of Science, Bangalore, India, in 2010. From 2000 to 2003, he was with Ishoni Networks, Inc., Santa Clara, CA, USA, as a Senior Chip Architecture Engineer. He was a Systems and Algorithm Designer with the Wireless Systems Group, Texas Instruments, Bangalore, India, from 2003 to 2007. From 2010 to 2011, he was a Post-Doctoral Researcher at Commsys. He was an Assistant Professor with the Communication Systems Division (Commsys), Electrical Engineering Department (ISY), Linköping University, Sweden, from September 2011 to February 2013. He holds four granted U.S. patents in multi-user detection and precoding for multiple-input multiple-output (MIMO) communication systems. He received the 2017 NASI Scopus Young Scientist Award and the Teaching Excellence Award at IIT Delhi for the year 2016–2017. He was also a recipient of the Visvesvaraya Young Faculty Fellowship from the Ministry of Electronics and IT, Government of India, from 2016 to 2019, and the Young Indian Researcher Fellowship from the Italian Ministry of University and Research (MIUR) from 2009 to 2010. He holds the Prof. Kishan Gupta and Prof. Pramila Gupta Chair at IIT Delhi. He is also a fellow of the Institution of Electronics and Telecommunication Engineers, India.

## T11: Application of NOMA in 6G Networks: Future Vision and Research Opportunities for Next Generation Multiple Access

Zhiguo Ding, University of Manchester, UK; Yuanwei Liu, Queen Mary University of London, UK

User data traffic, especially large amount of video traffic and small-size internet-of-things (IoT) packets, has dramatically increased in recent years with the emergence of smart devices, smart sensors and various new applications such as virtual reality and autonomous driving. It is hence crucial to increase network capacity and user access to accommodate these bandwidth consuming applications and enhance the massive connectivity. As a prominent member of the next generation multiple access (NGMA) family, non-orthogonal multiple access (NOMA) has been recognized as a promising multiple access candidate for the sixth-generation (6G) networks. The main contents of this tutorial is to discuss the so-called "One Basic Principle plus Four New" concept. Starting with the basic NOMA principle to explore the possible multiple access techniques in non-orthogonal manner, the advantages and drawbacks of both the channel state information based successive interference cancellations (SIC) and quality-of-service based SIC are discussed. Then, the application of NOMA to meet the new 6G performance requirements, especially for massive connectivity, is explored. Furthermore, the integration of NOMA with new physical layer techniques is considered, followed by introducing new application scenarios for NOMA towards 6G. Finally, the application of machine learning in NOMA networks is investigated, ushering in the machine learning empowered NGMA era, for making multiple access in an intelligent manner for the next generation networks.

Zhiguo Ding received his B.Eng in Electrical Engineering from the Beijing University of Posts and Telecommunications in 2000, and the Ph.D degree in Electrical Engineering from Imperial College London in 2005. From Jul. 2005 to Apr. 2018, he was working in Queen's University Belfast, Imperial College, Newcastle University and Lancaster University. Since Apr. 2018, he has been with the University of Manchester as a Professor in Communications. From Sept. 2012 to Sept. 2020, he has also been an academic visitor in Princeton University.

Dr Ding's research interests are 5G networks, game theory, cooperative and energy harvesting networks and statistical signal processing. He has been serving as an Editor for *IEEE Transactions on Communications*, *IEEE Transactions on Vehicular Networks*, and *Journal of Wireless Communications and Mobile Computing*, and served as an editor for *IEEE Wireless Communication Letters* and *IEEE Communication Letters*. He was the TPC Co-Chair for the 6th IET International Conference on Wireless, Mobile & Multimedia Networks (ICWMMN2015), Symposium Chair for International Conference on Computing, Networking and Communications (ICNC 2016), and the 25th Wireless and Optical Communication Conference (WOCC), and Co-Chair of WCNC-2013 Workshop on New Advances for Physical Layer Network Coding. He received the best paper award in IET Comm. Conf. on Wireless, Mobile and Computing, 2009 and the 2015 International Conference on Wireless Communications and Signal Processing (WCSP 2015), IEEE Communication Letter Exemplary Reviewer 2012, the EU Marie Curie Fellowship 2012-2014, IEEE TVT Top Editor 2017, 2018 IEEE Communication Society Heinrich Hertz Award, 2018 IEEE Vehicular Technology Society Jack Neubauer Memorial Award, and 2018 IEEE Signal Processing Society Best Signal Processing Letter Award. He is a Web of Science Highly Cited Researcher and a Fellow of the IEEE.

Yuanwei Liu (S'13, M'16, SM'19) received the Ph.D. degree in Electrical Engineering from the Queen Mary University of London, U.K., in 2016. He has been a Lecturer (Assistant Professor) with the School of Electronic Engineering and Computer Science, Queen Mary University of London, since 2017. He was with the Department of Informatics, King's College London, from 2016 to 2017, where he was a Post-Doctoral Research Fellow. His research interests include non-orthogonal multiple access, 5G/6G, RIS, UAV communications, stochastic geometry, and matching theory.

Dr. Liu is the recipient of the 2020 IEEE ComSoc Outstanding Young Researcher Award IEEE ComSoc – Signal Processing and Computing

for Communications (SPCC) Technical Committee. Dr. Liu is currently an Editor on the Editorial Board of the IEEE Transactions on Wireless Communications, the IEEE Transactions on Communications, and IEEE Communications Letters. He serves as the leading Guest Editor for IEEE JSAC special issue on Next Generation Multiple Access, a Guest Editor for IEEE JSTSP special issue on Signal Processing Advances for Non-Orthogonal Multiple Access in Next Generation Wireless Networks. He has served as a TPC Member for many IEEE conferences, such as GLOBECOM and ICC. He received IEEE ComSoc Outstanding Young Researcher Award for EMEA in 2020. He has served as the Publicity Co-Chair for VTC2019-Fall. He is the leading contributor for “Best Readings for Non-Orthogonal Multiple Access (NOMA)” and the primary contributor for “Best Readings for Reconfigurable Intelligent Surfaces (RIS)”. He serves as the chair of Special Interest Group (SIG) in Signal Processing and Computing for Communications (SPCC) Technical Committee on the topic of signal processing Techniques for next generation multiple access (NGMA), the vicechair of SIG Wireless Communications Technical Committee (WTC) on the topic of Reconfigurable Intelligent Surfaces for Smart Radio Environments (RISE), and the Tutorials and Invited Presentations Officer for Reconfigurable Intelligent Surfaces Emerging Technology Initiative.

## **T12: Data-driven and Light-weight ML based strategies for Smart IoT**

Swades De, Indian Institute of Technology Delhi, India

In this tutorial we will first give a quick overview of classical approach of analyzing context-specific data traffic and optimizing the system performance. In most of the research studies of communication systems, stationarity of traffic is assumed, and the associated processes are approximated to some known “standard” distributions. We will motivate that, while such assumptions on stationarity and traffic distributions are useful for developing tractable analytical frameworks, at times such assumptions prove to be quite strong and do not necessarily result in predicting accurate performance trends. Next, we will demonstrate through examples that in modern-day IoT communications more precise context-specific optimizations are necessary. From the networked system performance optimization perspective, we will delve into application context-specific supervised as well as unsupervised learning aided dynamic system characterization and optimizations on sensing, processing, and communication strategies. Deep cross-layer interactions will be discussed, and novel research directions will be outlined on incorporating intelligence at the appropriate stages of the IoT networks, involving fog intelligence, multi-access edge computing (MEC), and smart cloud connectivity. Subsequently, from energy sustainability and green perspectives, we will investigate state-of-the-art and future directions on energy harvesting-aided and dual-powered smart IoT communications, towards converged communication and power grid networks. A few example application use-cases, namely, cognitive radio channel access, smart power grid, and smart city monitoring, will be taken to demonstrate how data-driven strategies aid in more precise performance optimization. The presentation will draw lessons from our real-life field experiments and implementations, wherever possible, and outline future research and technology trends.

Dr. Swades De received his B. Tech degree in radio physics and electronics from the University of Calcutta, Calcutta, India, in 1993, M. Tech degree in optoelectronics and optical communication from Indian Institute of Technology Delhi, New Delhi, India, in 1998, and PhD degree in electrical engineering from State University of New York at Buffalo, Amherst, NY, USA, in 2004. He is currently a full Professor of Electrical Engineering at IIT Delhi (IITD), where he holds an Institute Chair Professor position and leads the Communication Networks Research Group (IITD-CNRG). He was a tenure-track Assistant Professor of Electrical and Computer Eng. at New Jersey Institute of Technology (2004-2007). He worked as a post-doctoral researcher at ISTI-CNR, Pisa, Italy (2004), and has nearly 5 years industry experience in India on telecom hardware and software development (1993-1997, 1999). His research interests broadly in communication networks, with emphasis on performance modeling and analysis. Current directions

include energy harvesting communication networks, broadband wireless access and routing, cognitive/white-space access networks, IoT communications, smart grid networks, UAVs and millimeter-wave communications.

Dr. De is a fellow of The National Academy of Sciences (India), Indian National Academy of Engineering, The Institute of Engineers, India, and The Institution of Engineering and Technology, UK, respectively. His recent professional distinctions include Om Prakash Bhasin Award for Science and Technology (2020), Ram Lal Wadhwa Award (2019), Exemplary Editor Award, IEEE Communications Letters (2018), Exemplary Reviewer Award, IEEE Communications Letters (2015). Dr. De serves as an Area Editor for IEEE Communications Letters and Elsevier Computer Communications, and an Associate Editor for IEEE Transactions on Vehicular Technology, IEEE Wireless Communications Letters, and IEEE Networking Letters. He has been involved in organizing several recent conferences in various capacities such as Workshop Co-Chair (IEEE ICDCN 2013), Symposium Chair (NCC 2013), TPC Co-Chair (IEEE ANTS 2014), Symposium Co-Chair (IEEE ICNC 2015), Symposium Co-Chair (IEEE WCNC 2015), General Co-Chair (COMSNETS 2020), Track Chair (IEEE CCNC 2021), and Lead Workshop Co-Chair (IEEE ICC 2021 Workshop on Green Solutions for Smart Environment). Dr. De currently serves as a vice-chair of the SIG on Green Cellular Networks in IEEE ComSoc TCGCC, a member of the IEEE ComSoc Educational Services Board, and a member of the IEEE TV Society ad hoc committee on AI Wireless. He is also on a few upcoming conference committees, namely, Mobile and Wireless Networks Symposium Co-Chair in IEEE ICC 2022, TPC Chair in NCC 2022, and Research Exhibits Co-Chair in IEEE GLOBECOM 2022.

## **T14: Terahertz Communications for 6G and Beyond Era**

Nan Yang, Australian National University, Australia; Chong Han, Shanghai Jiao Tong University, China; Josep Miquel Jornet, Northeastern University, USA

Terahertz (THz) communications is envisioned as an enabling and highly promising wireless technology for the sixth generation (6G) and beyond wireless systems. In particular, the ultra-wide THz band ranging from 0.1 to 10 THz offers enormous potential to alleviate the spectrum scarcity and break the capacity limitation of emerging wireless systems (such as 4G-LTE and 5G). This will undoubtedly support the epoch-making wireless applications that demand ultra-high quality of service requirements and multi-terabits per second data transmission in the 6G and beyond era, such as terabit-per-second backhaul systems, ultra-high-definition content streaming among mobile devices, virtual/augmented reality, and wireless high bandwidth secure communications.

As 5G wireless networks are deployed and commercialized globally, the THz band is where fundamental scientific and engineering breakthroughs are expected to occur over the next decade. It is highlighted that THz technology has been identified by the Defense Advanced Research Projects Agency as “one of the four major research areas that could eventually have an impact on our society larger than that of the Internet itself”. Moreover, THz communications has recently been identified by the IEEE Communication Society as one of the nine communication technology trends to follow. Accordingly, rapidly increasing research endeavors have been devoted to THz communications over the past few years.

Against this background, this tutorial will introduce the fundamental knowledge, present the state-of-the-art progress, and discuss future research directions of THz communications, uniquely and significantly supporting the design and development of THz communications for the next generation wireless systems.

Nan Yang received his Ph.D. degree in Electronic Engineering from Beijing Institute of Technology in 2011. Since July 2014, he has been with the Australian National University, Canberra, Australia, where he is currently an Associate Professor at the School of Engineering and the Head of the Emerging Communications Laboratory. He received the Top Editor Award from the Transactions on Emerging

*Telecommunications Technologies in 2017, the Exemplary Reviewer Certificate of the IEEE Transactions on Communications in 2016 and 2015, the Top Reviewer Award from the IEEE Transactions on Vehicular Technology in 2015, the IEEE ComSoc Asia-Pacific Outstanding Young Researcher Award and the Exemplary Reviewer Certificate of the IEEE Wireless Communications Letters in 2014, and the Exemplary Reviewer Certificate of the IEEE Communications Letters in 2013 and 2012. Also, he is the co-recipient of Best Paper Awards at the IEEE Globecom 2016 and the IEEE VTC2013-Spring. He is currently serving on the Editorial Board of IEEE Transactions on Wireless Communications, IEEE Transactions on Molecular, Biological, and Multi-Scale Communications, IEEE Transactions on Vehicular Technology, and two other journals. He has also served as the Guest Editor of eight special issues in international leading journals, symposium/track chair at international flagship conferences such as IEEE ICC and IEEE Globecom, TPC co-chairs of eight workshops. He is a Senior Member of the IEEE. His current research interests include terahertz and millimetre wave communications, ultra-reliable and low-latency communications, cyber-physical security, massive multiple-antenna systems, collaborative and distributed signal processing, and molecular communications.*

*Chong Han has been with Shanghai Jiao Tong University, Shanghai, China since June 2016, where he is currently an Associate Professor and the Head of the Terahertz Wireless Communications (TWC) Laboratory. He obtained the Master of Science and the Ph.D. degrees in Electrical and Computer Engineering from Georgia Institute of Technology, Atlanta, GA, USA, in 2012 and 2016, respectively. He received 2019 Distinguished TPC Member Award, IEEE International Conference on Computer Communications (INFOCOM) and 2018 Elsevier NanoComNet (Nano Communication Network Journal) Young Investigator Award, 2018 Shanghai Chenguang Funding Award, and 2017 Shanghai Yangfan Funding Award. He is an editor of Nano Communication Networks (Elsevier) Journal and IEEE Access. He is a TPC Co-Chair or General Co-Chair for the 1st–4th International Workshop on Terahertz Communications, in conjunction with IEEE ICC 2019, Globecom 2019, ICC 2020, and ICC 2021. His current research interests include terahertz communications and electromagnetic nanonetworks. He is a Member of the IEEE.*

*Josep M. Jornet is an Associate Professor in the Department of Electrical and Computer Engineering at Northeastern University, in Boston, MA. He received the B.S. in Telecommunication Engineering and the M.Sc. in Information and Communication Technologies from the Universitat Politècnica de Catalunya, Barcelona, Spain, in 2008. He received the Ph.D. degree in Electrical and Computer Engineering from the Georgia Institute of Technology, Atlanta, GA, in 2013. His research interests are in terahertz-band communication networks, wireless nanobio-communication networks, and the Internet of Nano- Things. In these areas, he has co-authored more than 160 peer-reviewed scientific publications, 1 book, and has also been granted 4 US patents. These works have been cited over 9,700 times (h-index of 44). Since July 2016, he is the Editor-in-Chief of Elsevier's Nano Communication Networks Journal. He is serving as the lead principal investigator on multiple grants from U.S. federal agencies including the National Science Foundation, the Air Force Office of Scientific Research and the Air Force Research Laboratory. He is a recipient of the National Science Foundation CAREER award and of several other awards from IEEE, ACM, UB and NU. He is a Senior Member of the IEEE and Member of the ACM.*

### **T15: Code-Domain NOMA for 5G and Beyond: Principles, Recent Advances and Future Directions**

*Lie-liang Yang, University of Southampton, UK; Pei Xiao, University of Surrey, UK; Zilong Liu, University of Essex, UK*

Wireless networks have been rapidly evolving towards providing machine-centric data services. Against an increasingly congested and fragmented spectrum, a major research theme nowadays for 5G and beyond (B5G) networks is how to design efficient multiple access protocols to support explosive growth of communication devices. These devices, widely present in a broad range of vertical industries such as factories of future, intelligent refineries and chemical plants, vehicle-to-everything networks, may be densely deployed in certain areas for a highly diverse range of data collection and/or control operations.

This tutorial will provide a systematic introduction on code-domain non-orthogonal multiple access (CD-NOMA) which is a disruptive technique for efficient enabling of massive and ubiquitous connectivity in future machine-type communication networks. The audience will gain insights on basic principles, recent advances, and comparisons of various NOMA schemes as well as their future directions in B5G networks.

*Lie-Liang Yang received his BEng degree in communications engineering from Shanghai TieDao University, Shanghai, China in 1988, and his MEng and PhD degrees in communications and electronics from Northern (Beijing) Jiaotong University, Beijing, China in 1991 and 1997, respectively. He has been with the University of Southampton, UK, since 1997, where he is the professor of Wireless Communications in the School of Electronics and Computer Science. He has research interest in wireless communications, wireless networks and signal processing for wireless communications, as well as molecular communications and nano-networks. He has published over 400 research papers in journals and conference proceedings, authored/co-authored three books and also published several book chapters. The details about his research publications can be found at <https://www.ecs.soton.ac.uk/people/llyang>. He is a fellow of both the IEEE and the IET, and was a distinguished lecturer of the IEEE VTS. He served as an associate editor to the IEEE Trans. on Vehicular Technology and Journal of Communications and Networks (JCN), and is currently an associate editor to the IEEE Access and a subject editor to the Electronics Letters.*

*Prof. Pei Xiao (Senior Member, IEEE) is with the Institute for Communication Systems, Home of 5G/6G Innovation Centre (5GIC/6GIC), University of Surrey. He is the Technical Manager of 5GIC, leading the research team in the new physical layer work area, and coordinating/supervising research activities across all the work areas. Prior to this, he worked at Newcastle University and Queen's University Belfast. He also held positions at Nokia Networks in Finland. He has published extensively in the fields of communication theory, RF and antenna design, and signal processing for wireless communications. He is an inventor on over ten recent 5GIC patents addressing bottleneck problems in 5G systems.*

*Zilong Liu a Lecturer at the School of Computer Science and Electronics Engineering, University of Essex. He received his PhD (2014) from School of Electrical and Electronic Engineering, Nanyang Technological University (NTU, Singapore), Master Degree (2007) in the Department of Electronic Engineering from Tsinghua University (China), and Bachelor Degree (2004) in the School of Electronics and Information Engineering from Huazhong University of Science and Technology (HUST, China). From Jan. 2018 to Nov. 2019, he was a Senior Research Fellow at the Institute for Communication Systems (ICS), Home of the 5G Innovation Centre (5GIC), University of Surrey. Prior to his career in UK, he spent nine and half years in NTU, first as a Research Associate (Jul. 2008 to Oct. 2014) and then a Research Fellow (Nov. 2014 to Dec. 2017). His PhD thesis "Perfect and Quasi-Complementary Sequences", focusing on fundamental limits, algebraic constructions, and applications of complementary sequences in wireless communications, has settled a few long-standing open problems in the field. His research lies in the interplay of coding, signal processing, and communications, with a major objective of bridging theory and practice as much as possible. He is a Senior Member of IEEE and an Associate Editor of IEEE Wireless Communications Letters, IEEE Access, and Frontiers in Communications and Networks. He is a General Co-Chair of the 10th International Workshop on Signal Design and its Applications in Communications (IWSDA'2022) and a TPC Co-Chair of the 2020 IEEE International Conference on Advanced Networks and Telecommunications Systems (ATTS'2020). Details of his research can be found at: <https://sites.google.com/site/zilongliu2357>.*

## T16: Cellular V2X for Connected Automated Driving

Toktam Mahmoodi, King's College London, UK; Tommy Svensson, Chalmers University of Technology, Sweden; Mikael Fallgren, Ericsson Research; Markus Dillinger, Huawei European Research Centre

5G technologies and beyond enable road users and vehicles to be connected to the networks as well as to communicate directly with each other ensuring ultra-high reliability and ultra-low latency. Enabling such kind of connectivity will leverage disruptive new applications, such as cooperative manoeuvre among vehicles, and awareness of and interaction with vulnerable road users, to improve driving experience and boost road safety. This tutorial elaborates on the role of 5G and beyond technologies for the connected vehicles, and various technological advances that foster advances in connected automated driving. The tutorial is shaped primarily based on the outcome of the EC-funded 5GPPP 5GCAR project results, which are presented in numerous academic venues and industry forums and published in peer-reviewed journals and conferences, as well as recent advances. This work is one of the first studies that brought together academia, telecom and automotive industry, from science, technology, business and regulatory perspectives.

*Toktam Mahmoodi [S'06, M'09, SM'16] is Director of the Centre for Telecommunications Research (CTR) in King's College London, where she has been member of the academic faculty since 2011. Previously, she was visiting research scientist at F5 Networks, research associate in Imperial College London, Mobile VCE researcher, and telecom R&D engineer. Toktam is and has been involved in number of European FP7 and H2020 projects on 5G mobile networks, vehicular communications, and Software-defined Networking. Her research focuses on the areas of mobile and cloud networking, and includes ultra-low latency network networking, network virtualization, mobility management, network modelling and optimization. She is executive editor of Transactions on Emerging Telecommunications Technologies, series guest editor of JSAC on network softwareization, and area editor of IEEE Communications Standard Magazine on management & orchestration. Toktam is general chair of ICT 2021, and has been technical committee member of various IEEE ComSoc conferences.*

*Tommy Svensson [S'98, M'03, SM'10] is full Professor in Communication Systems at Chalmers University of Technology in Gothenburg, Sweden, where he is leading the Wireless Systems research on air interface and wireless backhaul networking technologies for future wireless systems. He received a Ph.D. in Information theory from Chalmers in 2003, and he has worked at Ericsson AB with core networks, radio access networks, and microwave transmission products. He was involved in the European WINNER and ARTIST4G projects that made important contributions to the 3GPP LTE standards, the EU FP7 METIS and the EU H2020 5GPPP mmMAGIC and 5GCar projects towards 5G and currently the Hexa-X, RISE-6G and SEMANTIC projects towards 6G, as well as in the ChaseOn antenna systems excellence center at Chalmers targeting mmwave and (sub)-THz solutions for 5G/6G access, backhaul/fronthaul and V2X scenarios. His research interests include design and analysis of physical layer algorithms, multiple access, resource allocation, cooperative systems, moving networks, and satellite networks. He has co-authored 5 books, 96 journal papers, 130 conference papers and 54 public EU projects deliverables. He is Chairman of the ten-fold awards winning IEEE Sweden joint Vehicular Technology/ Communications/ Information Theory Societies chapter, founding editorial board member and editor of IEEE JSAC Series on Machine Learning in Communications and Networks, has been editor of IEEE Transactions on Wireless Communications, IEEE Wireless Communications Letters, Guest editor of several top journals, organized several tutorials and workshops at top IEEE conferences, and served as coordinator of the Communication Engineering Master's Program at Chalmers.*

*Mikael Fallgren is Senior Researcher at Ericsson Research, Stockholm, Sweden. He was project manager of 5GCAR (<https://5gcar.eu/>), while also serving as chairman of the 5G PPP Automotive Working Group and vice chair of the 5G PPP Steering Board. He has been involved in several other European Projects, including EU FP7 EARTH on energy efficiency, EU FP7 METIS and EU*

*H2020 5GPPP METIS-II on and EU H2020 5GPPP 5GCroCo. He has received a M.Sc. degree in engineering physics and a Ph.D. degree in applied and computational mathematics from KTH (the Royal Institute of Technology), Stockholm, and a B.Sc. degree in business administration from Stockholm University (SU), and a M.Sc. degree in upper secondary education from KTH and SU. His research interests include V2X and wireless access networks. In 2017 he was an invited keynote speaker in the 6th International Workshop on Emerging Technologies for 5G and Beyond Wireless and Mobile Networks (ET5GB) at IEEE Globecom. He has organized the 5G Connected Cars: Vehicular-to-Everything Communications workshop in the In the 13th IEEE International Symposium on Broadband Multimedia Systems and Broadcasting (BMSB) 2018, and also organized and hosted 5GCAR booths at events such as MWC 2018 and 2019, EuCNC 2018 and 2019, as well as at ICT 2018 Exhibition 5G PPP stand 2018. He has participated in V2X and automotive related panels in events such as the 7th Global 5G Event 2019, Smart Transportation and Mobility conference 2019, 15th International Symposium on Wireless Communication Systems (ISWCS) 2018, Interactive Symposium on Research & Innovation for Connected and Automated Driving in Europe (EUCAD) 2018, IEEE Wireless Communications and Networking Conference (WCNC) 2018, and the TU-Automotive Europe 2017.*

*Markus Dillinger received his Diplom-Ing. degree in telecommunications in 1990 from the University of Kaiserslautern, Germany. In 1991 he joined the Mobile Network Division at Siemens for development of GSM base stations. From 1995 on, he was working on the definition of the third mobile radio generation in the European research projects. From 2000 he led Software Defined Radio research activities within the Siemens network division. He was leading several EU research programmes. From 2005 onwards he was director for mobile broadband solutions and later for enterprise solutions dealing with railway projects. In 2010 he joined Huawei Germany and was director for enterprise solutions for smart grid. In 2013 he has joined Huawei European Research Centre as Head of Wireless Internet Technologies where he runs private and public R&D programmes for e.g. car-to-car and automation supporting 3GPP standardization and normative work for the vertical industry. He is Steering Board member of EATA, was Technical Manager of 5GCar project and initiator of 5GPP 5GCroCo project under Horizon Europe research programme. In September 2016 he was appointed as Executive Committee member for the 5GAA and re-assigned in following years. These 3 Executive Committee members are responsible for the 5GAA operation. He was the initiator of 5GAA and leads the Munich team for their technical contributions to Working Groups in 3GPP / 5GAA and other initiatives. He has given numerous talks, served as panellist and panel organiser at industry and academic events in 2021 and before. Moreover, he edited two academic books on V2X and software defined radios. He is also patent holder for several wireless concepts and solutions.*

## T17: AI-based Network Management for High-quality Services in Wireless Networks

Haris Gacanin, RWTH Aachen University, Germany; Song Ci, Tsinghua University, China

With the fast development of radio and networking technologies, modern communication systems have become more and more complex. On the other hand, the overall communication infrastructure needs to satisfy various QoS (Quality of Service) requirements posed by various users and application scenarios. The shift from managing network nodes and devices to managing functions that are part of services provided to users will be addressed. These functions are mostly related to the end-to-end user experience and directly coupled with different network management strategies. This tutorial gives an overview of multi-disciplinary research related to user experience and network management with their components and design challenges. We address the shortcomings of contemporary rule-based optimization protocols and re-thinking our operations and management for boosting the network performance. Specifically, a paradigm shift toward the confluence of computer science and communication engineering would be necessary to embrace and study interactions between network design and user experience. To design user-centric communication network, the following major design challenges have to be overcome: 1) provide end-to-end application-oriented

QoS for connecting users, 2) design end-to-end communication connectivity infrastructure to autonomously adapt to dynamic changes of QoS requirements and 3) respond to various operational dynamics existing in both physical and user domains in an agile fashion. The overarching goal of this tutorial is to elaborate on the feasibility of applications of artificial intelligence in communication network management for application-oriented end-to-end QoS provisioning.

*Haris Gačanin received his Dipl.-Ing. degree in Electrical engineering from the University of Sarajevo in 2000. In 2005 and 2008, respectively, he received MSc and Ph.D. from Tohoku University in Japan. He was with Tohoku University from 2008 until 2010 first as a Japan Society for the Promotion of Science (JSPS) postdoctoral fellow and later, as an Assistant Professor. He joined Alcatel-Lucent Bell (now Nokia Bell) in 2010 as a Physical-layer Expert and later as Department Head at Nokia Bell Labs. From 2020, he is a full professor at RWTH Aachen University where he is head of Chair for Distributed Signal Processing and a co-director of the Institute for Communication Technologies and Embedded Systems at RWTH Aachen University. His professional interests are related to broad areas of digital signal processing and artificial intelligence with applications in wireless communications. He has 200+ scientific publications (journals, conferences, and patent applications) and invited/tutorial talks. He is a fellow of IEEE and Distinguished Lecturer of IEEE Vehicular Technology Society. He served as an Associate Editor of IEEE Communications Magazine, the editor of IEICE Transactions on Communications and IET Communications. He acted as a general chair and technical program committee member of various IEEE conferences. He is a recipient of several Nokia innovation awards, IEICE Communication System Study Group Best Paper Award (joint 2014, 2015, 2017), The 2013 Alcatel-Lucent Award of Excellence, the 2012 KDDI Foundation Research Award, the 2009 KDDI Foundation Research Grant Award, the 2008 JSPS Postdoctoral Fellowships for Foreign Researchers, the 2005 Active Research Award in Radio Communications, 2005 Vehicular Technology Conference (VTC2005-Fall) Student Paper Award from IEEE VTS Japan Chapter and the 2004 Institute of IEICE Society Young Researcher Award.*

*Song Ci received his B.S. from Shandong University, M.S. from Chinese Academy of Sciences, and Ph.D. from University of Nebraska-Lincoln, in 1992, 1998, and 2002, respectively, all in Electrical Engineering. He is a Professor with Electrical Engineering Department, Tsinghua University, China. Before joining Tsinghua University, he was a Tenured Associate Professor with the ECE Department, University of Nebraska-Lincoln, USA. He was an assistant engineer in Shandong P&T Engineering Co. Ltd. from 2002 to 2005 and a R&D engineer in 3COM Corporation in 2001. He is the founder of Nova Greentech, Inc. His current research interests include large-scale dynamic complex system modeling and optimization, energy Internet and distributed energy management, sustainable ICT. He has authored more than 300 peer-reviewed articles in those areas. He is a senior member of IEEE and a member of ACM. He has served as an Editor or a Guest Editor in many journals and served on TPCs of numerous international conferences.*

## **T18: Towards Global Connectivity Using Aerial and Space Networks**

*Mustafa Kishk, Mohamed-Slim Alouini, King Abdullah University of Science and Technology, Saudi Arabia*

The United Nations (UN) has defined a set of sustainable development goals (SDGs) targeted for 2030 that include ending poverty, hunger, and inequalities, establishing high quality of education and medical services, to name a few. Achieving such goals requires advancement in many industries, which includes the internet and communication technology (ICT) sector. In particular, establishing high quality internet service provides opportunities to stimulate economy in poor communities, access to remote learning, access to digital records and remote patient monitoring, and help farmers improve productivity. In this context, and as the standardization of the fifth generation (5G) of wireless communication systems (WCSs) has been completed, and 5G networks are in their early stage of deployment, the research visioning and planning of the sixth generation (6G) of WCSs are being initiated. However, it is well-known that urbanized regions have been the major beneficiaries of the advances in the previous generations of WCSs. Hence, it is important to carry research with the focus on ensuring digital inclusion of rural and remote areas, which currently lack stable access to internet connectivity. In this talk, we focus on (i) possible network architectures to establish backhaul connectivity in rural and remote areas, with emphasis on satellite-based solutions, (ii) current challenges facing internet access in rural areas, (iii) possible solutions to enhance internet access in rural areas, with emphasis on drone-based architectures, and (iv) existing solutions to improve the flight duration of drones and ensure stable coverage in rural areas.

*Mustafa A. Kishk is a postdoctoral research fellow in the communication theory lab at King Abdullah University of Science and Technology (KAUST). He received his B.Sc. and M.Sc. degree from Cairo University in 2013 and 2015, respectively, and his Ph.D. degree from Virginia Tech in 2018. His current research interests include stochastic geometry, energy harvesting wireless networks, UAV-enabled communication systems, and satellite communications.*

*Mohamed-Slim Alouini was born in Tunis, Tunisia. He received the Ph.D. degree in Electrical Engineering from the California Institute of Technology (Caltech), Pasadena, CA, USA, in 1998. He served as a faculty member in the University of Minnesota, Minneapolis, MN, USA, then in the Texas A&M University at Qatar, Education City, Doha, Qatar before joining King Abdullah University of Science and Technology (KAUST), Thuwal, Makkah Province, Saudi Arabia as a Professor of Electrical Engineering in 2009. His current research interests include the modeling, design, and performance analysis of wireless communication systems.*

---

## Keynotes

*Tuesday 27 September 2021 09:00 EDT*

### **6GEM – 6G Wireless with Connected Intelligence: Open, Efficient and Secure**

**Haris Gacanin**, *RWTH Aachen University*

This talk is about a holistic vision of open, efficient/resilient, and secure 6G wireless networks as a foundation of novel experience-rich services. The 6GEM project recently approved by BMBF created a research area to reach this goal. 6GEM is supported by the four large universities of Aachen (RWTH), Bochum (RUB), Dortmund (TUD), and Duisburg-Essen (UDE) and non-university research institutions such as Fraunhofer (FhI IML, FhI IMS, FhI FHR) and Max Plank Institute (MPI SP). The talk will outline 6GEM technological vision and highlight some of the relevant technologies.

**Haris Gačanin** received his Dipl.-Ing. degree in Electrical engineering from the University of Sarajevo in 2000. In 2005 and 2008, respectively, he received MSc and Ph.D. from Tohoku University in Japan. He was with Tohoku University from 2008 until 2010 first as Japan Society for the Promotion of Science (JSPS) postdoctoral fellow and later, as an Assistant Professor. He joined Alcatel-Lucent Bell (now Nokia Bell) in 2010 as a Physical-layer Expert and later as Department Head at Nokia Bell Labs. Since April 2020, he joined RWTH Aachen University. He is a head of the Chair for Distributed Signal Processing and co-director of the Institute for Communication Technologies and Embedded Systems. His professional interests are related to broad areas of digital signal processing and artificial intelligence with applications in wireless communications. He has 200+ scientific publications (journals, conferences and patent applications) and invited/tutorial talks. He is a Distinguished Lecturer of IEEE Vehicular Technology

Society and an Associate Editor of IEEE Communications Magazine, while he served as the editor of IEICE Transactions on Communications and IET Communications. He is a fellow of IEEE and a senior member of the Institute of Electronics, Information and Communication Engineering (IEICE). He acted as a general chair and technical program committee member of various IEEE conferences. He is a recipient of several Nokia innovation awards, IEICE Communications Society Best Paper Award in 2021, IEICE Communication System Study Group Best Paper Award (joint 2014, 2015, 2017), The 2013 Alcatel-Lucent Award of Excellence, the 2012 KDDI Foundation Research Award, the 2009 KDDI Foundation Research Grant Award, the 2008 JSPS Postdoctoral Fellowships for Foreign Researchers, the 2005 Active Research Award in Radio Communications, VTC2005-Fall Student Paper Award from IEEE VTS Japan Chapter and the 2004 Institute of IEICE Society Young Researcher Award.

### **A Perspective of Mobility Management Innovation in Mega Satellite Constellation Era**

**Min Sheng**, *Xidian University*

Mega satellite constellation (MSC) era will bring new visions for the future global seamless coverage and ubiquitous services. In order to guarantee the service continuity, considering the spatio-temporal characteristics of MSC, innovative mobility management techniques are necessary. To this end, this talk starts from the key mobility management challenges in the integrated mobility management architecture and the handover strategy in MSC. Some interesting findings among mobility management structure, network performance and satellite constellation scale are investigated. Finally, insights and guidelines on the design of handover strategy, constellation configuration, and satellite beams are obtained.

**Min Sheng** joined Xidian University in 2000, where she is currently a Full Professor and Director of the State Key Laboratory of Integrated Services Networks. She is the Vice Chair of IEEE Xi'an Section and an Associate Editor for IEEE Vehicular Technology Magazine. She has published over 200

refereed papers in international leading journals and key conferences in the area of wireless communications and networking. Her current research interests include space-terrestrial integration networks, intelligent wireless networks, and mobile ad hoc networks..

*Wednesday 28 September 2021 09:00 EDT*

### **6G: Towards the Next Hyper-Connected Experience for All**

**Sunghyun Choi**, *Samsung Electronics*

Since its first commercial launches in 2019, 5G technology is being applied to the core infrastructure of a wide range of industries, and is utilized to support everything from high-quality communications services to smart factories, vehicle-to-vehicle communication, and a raft of other new services. Some of the issues identified during 5G deployments and how they will be dealt with within 3GPP will be addressed. While 5G commercialization is still in progress, both academia and industry are initiating research activities to shape the next-generation communication system, namely 6G. In this talk, I will introduce comprehensive overview of various aspects including technical and societal trends, services, requirements, and candidate technologies for 6G. In 6G era, both humans and machines are the main users and many advanced services will be provided such as truly immersive extended reality, high-fidelity mobile hologram, and digital replica. These new services will require a tremendous amount of real-time data processing, a hyper-fast data rate, and extremely low latency. The key candidate technologies to realize them include THz communication and advanced duplex technologies. Some of the recent progresses made within Samsung will be also introduced in this talk.

**Sunghyun Choi** is a Senior Vice President and Head of the Advanced Communications Research Center at Samsung Research, Samsung Electronics, Seoul, Korea. He was a professor at the Department of Electrical and Computer Engineering, Seoul National University (SNU) from Sept. 2002 to Aug. 2019, and served as a Vice Dean for Academic Affairs, College of Engineering during the last two years. Before joining

SNU, he was with Philips Research USA, as a Senior Member Research Staff. He was also a visiting associate professor Stanford University from June 2009 to June 2010. He received his B.S. (summa cum laude) and M.S. degrees in electrical engineering from KAIST in 1992 and 1994, respectively, and received Ph.D. at the The University of Michigan, Ann Arbor in September 1999.

---

He is currently heading researches and standardization for 6G, B5G, and IoT connectivity at Samsung Research. He co-authored over 250 technical papers and a book “Broadband Wireless Access and Local Networks: Mobile WiMAX and WiFi,” Artech House, 2008 (with B. G. Lee). He holds over 160 patents, and numerous patents pending. He has served as a General Co-Chair of COMSWARE 2008, a Program Committee Co-Chair of IEEE WCNC 2020, IEEE DySPAN 2018, ACM Multimedia 2007, and IEEE WoWMoM 2007. He has also served on program and organization committees of numerous leading wireless and networking conferences including ACM MobiCom, IEEE INFOCOM, IEEE SECON, and IEEE WoWMoM. He has served as a division editor of Journal of Communications and Networks, and as an editor of IEEE Transactions on Wireless Communications, IEEE Transactions on Mobile Computing, IEEE Wireless Communications Magazine, ACM SIGMOBILE Mobile Computing and Communications Review, Computer Networks, and Computer Communications. He has served as a guest editor for IEEE

Journal on Selected Areas in Communications, IEEE Wireless Communications, IEEE Transactions on Cognitive Communications and Networking, and ACM Wireless Networks. From 2000 to 2007, he was an active contributor to IEEE 802.11 WLAN Working Group.

He has received numerous awards including KICS Dr. Irwin Jacobs Award (2013), Shinyang Scholarship Award (2011), Presidential Young Scientist Award (2008), IEEE/IEEE Joint Award for Young IT Engineer (2007), Outstanding Research Award (2008) and Best Teaching Award (2006), both from the College of Engineering, Seoul National University, the Best Paper Award from IEEE WoWMoM 2008, and Recognition of Service Award (2005, 2007) from ACM. Dr. Choi was a recipient of the Korea Foundation for Advanced Studies (KFAS) Scholarship and the Korean Government Overseas Scholarship during 1997-1999 and 1994-1997, respectively. He was named IEEE fellow in 2014..

## **How to Define 6G?**

**Guangyi Liu, China Mobile**

5G’s global commercialization stimulates the research on 6G. 5G will facilitate the application of AI, IoT, cloud, big data and edge computing and accelerate the digitalization of the society. The vision of 2030 society is digital twin and ubiquitous intelligence. The digitalization of the society will create a digital world, the digital twin technology will be applied to create a digital-twin world, in which the physical world is mirrored to the digital world and the prevention to the physical world could be conducted based on the simulation and forecast from the digital world. That means we can forecast and change the future of the physical world. Meanwhile, intelligence will be provided as an enabler anywhere and anytime to make everything intelligent. Besides the traditional use cases supported by legacy mobile networks, many new use cases, e.g. holographic interaction, Synaesthesia internet, digital twin human, intelligence exchanging, super transportation, intelligent manufacturing, intelligent agriculture, etc. To support these use cases well, a comprehensive set of capabilities are required for different uses cases. On one hand, the traditional communication performance indicators, e.g. peak data rate, user experienced data rate, latency and reliability is demanded to be improved greatly, on the other hand, new dimension of the network capabilities are demanded, e.g. sensing, intelligence, security, trustworthy, computing, etc. To provide these capabilities on demand, 6G network will be designed with features of on demand fulfillment, soft, lite, native AI, native security and digital twin. Besides the aspects above, the other aspects referred to the 6G definition are also discussed in details, candidate spectrum and its utilization technology, space-air-ground integrated coverage, integrated sensing and communication, radio interface, autonomous network based on digital twin network and network architecture.

**Dr. Guangyi Liu** received his PhD. from Beijing University of Posts and Telecommunications in 2006. He joined China Mobile since 2006, now he is the leading specialist and 6G director of China Mobile Group. Before he joined China Mobile, he has worked for Shanghai Bell and Siemens (Now Nokia) for 3 years. He has led the standardization and industrialization of 4G and 5G in China mobile from 2007 to 2019. Now he is leading the

research of 6G. He is also acting as the vice chair of THz and mm-wave industry alliance, and has acted as the chair of spectrum working group and coordinator of 5G eMBB program in Global TD-LTE Initiative (GTI). He has been granted more than 150 patents, and authored and coauthored more than 8 books and published more than 150 papers in IEEE journal and conference.

*30 September 2021 09:00*

## **C-V2X, Industrial 5G**

**Markus Dillinger, Huawei**

Markus Dillinger will underline the importance of industry eco-system building consisting of mobile network or campus operators, private operators, road operators, vertical industry stakeholders and end-users. A summary of 5G requirements, 3GPP status and spectrum requirements will be discussed, and market deployments with business and product aspects will be outlined with complementing technical aspects. In addition, building blocks for 5G-Advanced and future visions for 6G will be presented. This includes the first new 6G paradigms, KPIs, spectrum views, basic technical enablers like AI, Integrated Sensing and Communications, Non-Terrestrial Networks, new trust concepts and expected time line for standardization and market introduction.

## **On-Demand 6G for Resilient and Ubiquitous Networking**

**Chair:** **Mohamed-Slim Alouini** *King Abdullah University of Science and Technology, Saudi Arabia*  
**Panelists:** **Vanessa Gray** *International Telecommunication Union (ITU), Switzerland*  
**Ronald Raulefs** *German Aerospace Center (DLR), Germany*  
**Sofie Pollin** *KU-Leuven, Belgium*  
**Yunfei Chen** *University of Warwick, UK*



---

This panel focuses on the theme: On-Demand 6G for Resilient and Ubiquitous Networking targeting particularly the following user cases:

- 1) Access on demand: Ships on the ocean, expeditions in the mountain, and festivals in the field require network access only during the concerned activities. For these applications, one-off infrastructure is far more attractive than permanent infrastructure.
- 2) Emergency communications: Network resilience is seriously threatened by unexpected incidents. Natural disasters could bring down base stations. Hardware/software malfunctioning could cause network failure. In these cases, fast-deployable solution is crucial to provide emergency coverage.
- 3) Traffic off-loading. Network is designed to accommodate limited traffic, while traffic changes with time and location. Consequently, in some areas or during certain time (like Pandemics), the traffic requirement may exceed the designed capacity, leading to poor services. Flexible off-loading is required in this case.

## Industry Panel 1

28 September 2021 10:00

### **Mobility 4.0 - National Integrated Intelligent Infrastructure**

<b>Chair:</b>	<b>Ken Stewart</b>	<i>CEO, Northeast UAS Airspace Integration and Research</i>
<b>Panelists:</b>	<b>Jeff DeCoux</b>	<i>Autonomy Institute of Technology</i>
	<b>Rakesh Kushwaha</b>	<i>Managing Director at MITRE Corp, /Open Gen</i>
	<b>Matt Metcalfe</b>	<i>Managing Director at Deloitte, Mobility and Aviation</i>

Investment in a 21st-century Intelligent & Autonomous Infrastructure is among the highest priorities for stimulating economic expansion, national security, and job growth." Major technological innovation around autonomy is driving substantial industry and policy changes around the globe. These technological innovations are changing the way we think about infrastructure this panel will discuss what will it take to realize Mobility 4.0, from various perspectives and industries.

## Industry Panel 2

29 September 2021 10:00

### **Next Generation Mobile Radio: the transition from 5G to 6G**

<b>Chair:</b>	<b>Valerio Frascolla</b>	<i>Director Research and Innovation, Intel, Germany</i>
<b>Panelists:</b>	<b>Thorsten Wild</b>	<i>Head of Next Generation Wireless, Nokia, Germany</i>
	<b>Maziar Nekovee</b>	<i>Dean of AI Institute, University of Sussex, UK</i>
	<b>Dan Warren</b>	<i>Director of Network Research, Samsung, UK</i>
	<b>David Soldani</b>	<i>University of NSW, Australia</i>

While 5G systems are being deployed worldwide, making use of the 3GPP defined Phase 1 and Phase 2 feature-sets, standardization bodies have started to work on the definition of the so called '5G Advanced' system in the 3GPP Release 18, to be frozen before the end of 2021. If the finalization of the feature-set that will shape 5G Advanced is a matter of months, what comes next is a matter of speculation. Several white papers have recently appeared with the aim of shaping the content of the forthcoming 6G system, which will be started to be defined in standards bodies not before 2025. Therefore, there's a gap between the time windows of the definition of 5G Advanced and the forthcoming 6G. This panel focuses on that gap, discussing some key ingredients that can clarify what is in front of the intelligent transport system ecosystem moving towards 6G. Renown experts, mainly from industry but also from the academia, will pitch on selected interesting research topics like the impact in mobility of the O-RAN paradigm, of Artificial Intelligence, and of cellular communications, also touching on security aspects.

**Dr Valerio Frascolla** is Director of Research and Innovation at Intel in Munich and had been working in different roles at Ancona University, Comneon, Infineon, as reviewer for the European Commission, and as independent evaluator for the Portuguese Foundation for Science and Technology. He is in the advisory board of the projects LIPS, ULTRAWAVE, FORTE, and INTERCONNECT, and served in different roles in other 17 funded research projects.

Valerio has expertise in wireless systems architecture and requirements management, standards bodies attendance (3GPP, ETSI, IEEE), business aspects, project and program management, and coaching. He is author of 70+ publications, his main research interest being 5G advanced system design, with focus on spectrum management, AI, and edge technologies. He serves as reviewer for 30+ journals, has participated in the TPC of 80+ conferences, is Associated Editor of IET Quantum

Communication, Managing Editor of ELSEVIER 2021 Optical Fiber Technology (Special Issue on "Fiber Optic for 5G"), Guest Editor of MDPI Sensors (Special Issue on 'Experimentation in 5G and beyond networks: State of the art and the way forward'), and has a track record as organizer of Special Sessions, Workshops, and Panels at international conferences.

Valerio represents Intel in several associations of the European ecosystem, being Board of Directors member of the BDVA association, serving in different leadership roles in 5G-IA, NetworkEurope, AIOTI, and the German Bitkom association.

### **V2X and cellular aspects of mobility**

**Thorsten Wild, Nokia, Germany**

Thorsetn Wild's bio was not available at time of going to press.

## AI in mobile networks: implications on Intelligent transport system

Maziar Nekovee, *University of Sussex, UK*

5G with its well-known ITU 2020 triangle of new capabilities, which not only include ultra-high speeds but also ultra-low latency, ultra-high reliability, and massive connectivity promise to expand the applications of mobile communications to entirely new and previously unimagined “vertical industries” and markets such as self-driving cars, smart cities, industry 4.0, remote robotic surgery, smart agriculture, and smart energy grids. The mobile communications system is already one of the most complex engineering systems in the history of humankind. As 5G network penetrates deeper and deeper into the fabrics of the 21st century society, we can also expect an exponential increase in the level of complexity in design, deployment, and management of future mobile communication networks. Breakthroughs in Artificial Intelligence (AI) and Machine Learning (ML), including deep neural networks and probability models, are creating paths for computing technology to perform tasks that once seemed out of reach. AI, therefore, offers many new opportunities but also challenges to meet the enormous new challenges of design, deployment, and management of future mobile communication networks in the era of 5G and beyond, as we illustrate below using a number of current and emerging scenarios.

**Prof. Maziar Nekovee** is Dean of the AI Institute and Head of Centre for Advanced Communications, Mobile Technology and IoT at University of Sussex, UK. His current research focuses on AI and THz communication for beyond 5G/6G and the applications of 5G/6G and AI in the automotive, health and

other verticals.. Prior to joining U. Sussex in 2017, he was Head of Samsung’s European research and collaboration in 5G, where he developed new radio access technologies operating in millimetre-wave bands. Prior to Samsung he was with BT, where he worked on a range of fixed and wireless technologies, including cognitive radio/dynamic spectrum sharing, WiFi-based V2X, peer-to-peer and IP multicast. Maziar is the author of 120+ highly cited papers, 15 patents and one book. He has a PhD in Physics and a first degree in EEE, both from the Netherlands. He is chair of NetWorld Europe ETP, WG on Enabling Technologies and Verticals.

## O-RAN and the importance of the open-X paradigm

Dan Warren, *Samsung, UK*

**Dan Warren** is Director of Advanced Network Research at Samsung Research UK. He leads a team of researchers working on cutting-edge mobile telecoms technology innovation, in the fields of 5G, Beyond 5G and the application of Artificial Intelligence. Dan applies his broad experience in the industry across technical, commercial, strategic and regulatory topics to steer Research towards relevant and commercially viable solutions. Dan is currently Chair of the Steering Board of the European Commission 5G-PPP, a Board member of 5GIA and a member of a number of External Advisory Boards for academic research projects.

Prior to joining Samsung, Dan held senior roles at Capita, GSMA, Vodafone and Nortel. Dan is a widely respected authority on Telecoms, having been included in Global Telecoms Business Magazine ‘Top 40 Under 40’ list for three years, and in Capacity Magazine’s ‘20 Innovators to Watch’ in 2018. Dan holds a Ph. D. in Applied Mathematics from Brunel University.

**David Soldani**’s bio was not available at time of going to press.

## Industry Panel 3

30 September 2021 10:00

### State-of-the-Art in Connected, Autonomous and Electric Vehicles

<b>Chair:</b>	<b>Alvin Chin</b>	<i>BMW Group Technology Corporation, USA</i>
<b>Panelists:</b>	<b>Onur Altintas</b>	<i>Toyota North America R&amp;D Info Tech Labs</i>
	<b>Yue-Yun Wang</b>	<i>General Motors</i>
	<b>Adam Langton</b>	<i>BMW of North America</i>

As vehicles are becoming more connected, autonomous and electric, what are the trends and state-of-the-art in these areas? How are the vehicle manufacturers addressing this? What more needs to be done to achieve this vision? In this panel, speakers from industry will discuss about how industry is tackling this and what consumers may expect in the near future.

**Dr. Alvin Chin** is AI and Emerging Technology Researcher at BMW Technology Corporation in Mountain View, USA where his research involves exploring AI and emerging technologies for potential use cases in production at BMW. Previously, he was Senior Machine Learning Researcher at BMW Technology Corporation in Chicago where he worked on big data and machine learning for improving driving behaviour and enabling intelligent driving, studying user behavior in driving and in social networks, mining big data from the car data, and creating recommendations of items based on user profiling and context such as predicted destinations and trips, to provide intelligent user and car experiences. Prior to BMW, he was Senior Researcher at Microsoft and Nokia in Beijing working on big data and analytics for browsing behavior in Xpress Browser, and Senior Researcher at Nokia Research Center working on mobile social networking in particular proximity social networks for inferring social activity, collaboration and recommendation in real physical environments. Dr. Chin has authored more than 30 publications and 10 patents including those pending. He has a Bachelors and Masters degrees in Computer Engineering from

the University of Waterloo and a PhD in Computer Science from the University of Toronto. Dr. Chin is a member of various program committees such as ACM KDD, ACM Hypertext, IEEE CPSCOM, ACM Ubicomp, ACM CSCW, and IEEE VTC. He is an ACM Senior Member and IEEE Senior Member. Dr. Chin is also active in the Chicago community, as Chair of ACM Chicago, Chair of the IEEE VTS Chicago Chapter, and Chair of the IEEE Computer Society Chicago Chapter. He is the Publicity Co-Chair for IEEE Vehicular Technology Conference-Fall 2020 and Secretary of the IEEE VTS/Automated Vehicles Standards Committee. Alvin can be reached at [alvin.chin@ieee.org](mailto:alvin.chin@ieee.org) and his website is <http://www.alvinychin.com>.

### Automation with Cooperation

**Onur Altintas**, *Toyota North America R&D Info Tech Labs*

---

## Smart EV Energy Management for Enhanced User Experiences

Yue-Yun Wang, *General Motors*

## BMW ChargeForward: Sustainability and Electric Vehicle Charging

Adam Langton, *BMW of North America*

BMW developed its smart charging program, ChargeForward, to help BMW drivers use more renewable energy in their electric vehicle charging. BMW

announced this spring that it is scaling this pilot with Pacific Gas and Electric (PG&E) and beginning to expand to other utilities in the US. Using the vehicle telematics system, BMW is able to scale smart charging as a digital product, that requires no hardware and can provide load shifting functionality anywhere a driver plugs in their vehicle – home, work or on the go. This project is a demonstration of how automakers can create digital tools that expand the sustainability benefits of electric vehicles and leverage advanced digital capabilities to provide services beyond the transportation sector.

# VTC2021-Fall Program

## Tuesday, 28 September 2021

28 September 2021 11:00

### Advances in Machine Communications I

#### 1 A Game Theoretical Approach To Model Vehicular Broadcast Communication

Muhammd Jafer, M. Arif Khan, Sabih ur Rehman, Charles Sturt University, Australia; Tanveer A. Zia, Naif Arab University for Security Sciences, Saudi Arabia

#### 2 A Novel Index Modulation Based Chirp Spreading Modulation Scheme for Wireless Communications Systems

Rami Hamdi, Marwa Qaraq, Hamad Bin Khalifa University, Qatar

#### 3 Cooperative Routing and Transmission over Multi-hop Network of RFID Tags

Yanyan Liu, Pinyi Ren, Qinghe Du, Xi'an Jiaotong University, China

#### 4 Energy-Optimal Short Packet Transmission for Time-Critical Control

Kilian Kiekenap, Andrea Ortiz, Anja Klein, TU Darmstadt, Germany

#### 5 Enhanced Convex Hull based Clustering for High Population Density Avoidance under D2D Enabled Network

Vishaka Basnayake, Femto-St/DISC, Universite Bourgogne Franche Comte, France; Hakim Mabed, Femto-St/DISC, Universite Bourgogne Franche Comte, France; Philippe Canalda, Femto-ST/DISC, Universite Bourgogne Franche Comte, France; Dushantha Jayakody, School of Computer Science and Robotics, Tomsk Polytechnic University, Russia

#### 6 Execution Delay Optimization-based Cooperative Task Process in Cellular MEC Systems

Rong Chai, Mingzhu Li, Jinhong Li, Chongqing University of Posts and Telecommunications, China

#### 7 Implementation of MRC diversity reception over Nakagami-m fading channel for ns-3 simulator

Juan Pablo Astudillo León, Departamento de Electrónica, Telecomunicaciones y Redes de Información, Escuela Politécnica Nacional, Ecuador; Freddy Alexander Torres Manobanda, Departamento de Electrónica, Telecomunicaciones y Redes de Información, Escuela Politécnica Nacional, Ecuador; Diego Javier Reinoso-Chisaguano, Departamento de Electrónica, Telecomunicaciones y Redes de Información, Escuela Politécnica Nacional, Ecuador; Luis Urquiza-Aguilar, Departamento de Electrónica, Telecomunicaciones y Redes de Información, Escuela Politécnica Nacional, Ecuador

#### 8 Label Design-based ELM network for Timing Synchronization in OFDM Systems with Nonlinear Distortion

Chaojin Qing, Shuhai Tang, Chuangui Rao, Qing Ye, Xihua University, China; Jiafan Wang, R & D, Synopsys Inc., United States; Chuan Huang, Chinese University of Hong Kong, China

28 September 2021 11:00

### Coding and Modulation

#### 1 Blind Joint Timing and Carrier Phase Estimation in Burst-Type CPM

Andreas Lang, Berthold Lankl, Bundeswehr University Munich, Germany

#### 2 Deep Learning for Adaptive Modulation and Coding with Payload Length in Vehicle-to-Vehicle Communications Systems

Yuxin Ji, Nanjing University of Posts and Telecommunications, China; Guohua Zhang, BOCO Inter-Telecom Co. Ltd., China; Jiawei Huang, Jie Yang, Guan Gui, Nanjing University of Posts and Telecommunications, China; Hikmet Sari, Nanjing University of Posts and Telecommunications, France

#### 3 Lowering the Error-Floor of CRC-Concatenated Polar Codes with Improved Partial Protection

Hyosang Ju, Jisang Park, Min-Young Chung, Sang-Hyo Kim, Sungkyunkwan University, South Korea

#### 4 Performance Comparison of GDMA, LDS-CDMA, and SCMA for Transmissions over Rayleigh Fading Channels

Cheng-Yen Chang, National Taiwan University, Taiwan; Shih-Kai Lee, Yuan Ze University, Taiwan; Mao-Chao Lin, National Taiwan University, Taiwan

#### 5 Sparse Coding with Enhanced Atom Selection for FDD Massive MIMO Channel Estimation

Mahmoud Nazzal, Istanbul Medipol University, Turkey; Mehmet Ali Aygul, Istanbul Technical University; Vestel, Turkey; Huseyin Arslan, Istanbul Medipol University/University of South Florida, Turkey

#### 6 Subcarrier and Permutation Index Modulation Multiple Access with Rotation Code

Ming-En Chen, Jen-Ming Wu, National Tsing Hua University, Taiwan

28 September 2021 11:00

### Deep Learning

#### 1 A Deep Learning-Based Detector for IM-MIMO-OFDM

Mohamad A. Alawad, Khairi A. Hamdi, The University of Manchester, United Kingdom

#### 2 A Deep Reinforcement Learning Approach for Point Cloud Video Transmissions

Hai Lin, Bo Zhang, Yangjie Cao, Zhengzhou University, China; Zhi Liu, The University of Electro-Communications, Japan; Xianfu Chen, VTT Technical Research Centre of Finland, Finland

#### 3 An Intelligent Routing Algorithm for LEO Satellites Based on Deep Reinforcement Learning

Peiliang Zuo, Chen Wang, Ze Yao, BESTI, China; Shaolong Hou, College of Communication Engineering, XIDIAN University, China; Hua Jiang, BESTI, China

#### 4 Deep Learning Approach for Wireless Signal and Modulation Classification

Bhargava B C, Electronics and Communication, NITK-Surathkal, India; Ankush Deshmukh, Electronics and Communication, NITK-Surathkal, India; M Venkata Rupa, Electronics and Communication, NITK-Surathkal, India; Rajendra Prasad Sirigina, School of computer science and engineering, Nanyang Technological University, Singapore; Satya Kumar Vankayala, Networks S/W R&D Group, Samsung R&D Institute, India; A V Narasimhadhan, Electronics and Communication, NITK-Surathkal, India

#### 5 Deep Learning-Based Signal Detection with Soft Information for MISO-NOMA Systems

Pan Zhu, Xiaoming Wang, Xia Jia, Youyun Xu, Nanjing University of Posts and Telecommunications, China

#### 6 Deep Radio Fingerprint ResNet for Reliable Lightweight Device Identification

Tiantian Zhang, School of Information and Communications Engineering, Xi'an Jiaotong University, China; Pinyi Ren, School of Information and Communications Engineering, Xi'an Jiaotong University, China; Zhanyi Ren, School of Information and Communications Engineering, Xi'an Jiaotong University, China

#### 7 Distributed Deep Reinforcement Learning Resource Allocation Scheme For Industry 4.0 Device-To-Device Scenarios

Jesús Burgueño, Universidad de Málaga, Spain; Ramoni Adeogun, Rasmus Liborius Bruun, C. Santiago Morejón García, Aalborg University, Denmark; Isabel de-la-Bandera, Raquel Barco, Universidad de Málaga, Spain

#### 8 End-to-End Deep Learning IRS-assisted Communications Systems

Mohamad A. Alawad, Mutasem Q. Hamdan, Khairi A. Hamdi, The University of Manchester, United Kingdom

#### 9 Reconfigurable Intelligent Surface-Enhanced Broadband OFDM Communication Based on Deep Reinforcement Learning

Wenting Huang, Southeast University, China; Yijian Chen, State Key Laboratory of Mobile Network and Mobile Multimedia Technology, ZTE Corporation, China; Jue Wang, School of Information Science and Technology, Nantong University, China; Xiao Li, Southeast University, China; Shi Jin, Southeast University, China

#### 10 Trajectory Design and Bandwidth Assignment for UAVs-enabled Communication Network with Multi-Agent Deep Reinforcement Learning

Weijian Wang, Yun Lin, Harbin Engineering University, China

#### 11 Vision-Aided Beam Tracking: Explore the Proper Use of Camera Images with Deep Learning

Yu Tian, Chenwei Wang, DOCOMO Innovations, Inc., United States

28 September 2021 11:00

### Electric Vehicles & Vehicular Electronics

#### 1 EV-Road-Grid: Enabling Optimal Electric Vehicle Charging Path Considering Wireless Charging and Dynamic Energy Consumption

Yanyu Zhang, Henan University, China; Shukui Zhou, Henan University, China; Xinpeng Rao, Henan University, China; Yi Zhou, Henan University, China

#### 2 Investigation of Missing Data Resilience of In-Operando Impedance Estimation

Marian Patrik Felder, Information Processing Lab, TU Dortmund University, Germany; Jürgen Götz, Information Processing Lab, TU Dortmund University, Germany

#### 3 Modeling and Simulation of Electric Vehicles Using Simulink and Simscape

Joshua Slough, Morgan Belcher, Tony Tsui, Sylvia Bhattacharya, Kennesaw State University, United States

#### 4 Research on the transient current distribution of bogies considering the lifting or dropping pantograph of EMU

Xuechang Zhang, Guodong Wang, Dan Zhang, Jinbao Zhang, Beijing Jiaotong University, China

28 September 2021 11:00

### MIMO and Massive MIMO I

#### 1 A 3D Geometry-Based Non-Stationary MIMO Channel Model for RIS-Assisted Communications

Guiqi Sun, State Key Laboratory of Rail Traffic Control and Safety, Beijing Jiaotong University, China; Ruisi He, State Key Laboratory of Rail Traffic Control and Safety, Beijing Jiaotong University, China; Zhangfeng Ma, State Key Laboratory of Rail Traffic Control and Safety, Beijing Jiaotong University, China; Bo Ai, State Key Laboratory of Rail Traffic Control and Safety, Beijing Jiaotong University, China; Zhangdui Zhong, State Key Laboratory of Rail Traffic Control and Safety, Beijing Jiaotong University, China

#### 2 Array Placement in Distributed Massive MIMO for Power Saving considering Radiation Pattern

Yi-Hang Zhu, Laura Monteyne, Gilles Callebaut, François Rottenberg, Liesbet Van der Perre, KU Leuven, Belgium

#### 3 High-isolation of close located elements of the compact MIMO antenna array for Imaging Radar

Gennady Evtuyshkin, Elena Shepeleva, Samsung Research Russia, Russia; Tsuyoshi Sugiura, Samsung Research Japan, Japan; Jongseok Kim, Samsung Advanced Institute of Technology, South Korea; Artem Nikishov, Anton Lukyanov, Sensor Solution Team, Samsung Research Russia, Russia

#### 4 Massive MIMO System Level Performance Results of a Dense Antenna Array

Zhengxiang Ma, Wireless Research, Futurewei Technologies, United States; Leonard Piazza, Wireless Research, Futurewei Technologies, United States; Huairen Yi, Wireless Research, Futurewei Technologies, United States; Hady Moussa, Wireless Research, Futurewei Technologies, United States; Renjian Zhao, Wireless Research, Futurewei Technologies, United States

#### 5 Ultra-wide scanning topology of the MIMO antenna array for Imaging Radar

Artem Nikishov, Gennady Evtuyshkin, Elena Shepeleva, Anton Lukyanov, Samsung Research Russia, Russia; Jongseok Kim, Samsung Advanced Institute of Technology, South Korea; Tsuyoshi Sugiura, Samsung Research Japan, Japan

28 September 2021 11:00

### Satellite and Maritime Communications

#### 1 Joint Route Selection and Time-Slot Allocation for Energy Consumption Optimization in Satellite Communication Systems

Yin Wang, Jinhong Li, Minglong Chen, Rong Chai, Chongqing University of Posts and Telecommunications, China

#### 2 Long-Range Broadband Wireless System for Maritime Communications in the 3.5 GHz band

Patrick Rosson, Jérémy Estavoyer, Laurent Lombard, Benoit Miscopein, Xavier Popon, Jean-Baptiste Doré, Dimitri Kténas, Université Grenoble Alpes, CEA-Leti, France; Vincent Coquen, Ronan Jegou-Lebris, Brittany Ferries, France

#### 3 Space-Time-Domain Adaptive Equalizer Employed Successive Interference Cancellation for Underwater Acoustic Communication

Kosuke Suzuoki, Daisuke Hisano, Osaka University, Japan; Kazuki Maruta, Academy for Super Smart Society, Tokyo Institute of Technology, Japan; Yoshiaki Inoue, Graduate School of Engineering, Osaka University, Japan; Yuko Hara-Azumi, Dept. of Information and Communications Engineering, Tokyo Institute of Technology, Japan; Yu Nakayama, Institute of Engineering, Tokyo University of Agriculture and Technology, Japan

#### 4 Time-correlated Geometrical Radio Propagation Model for LEO-to-Ground Satellite Systems

Enric Juan, Ignacio Rodriguez, Preben Mogensen, Aalborg University, Denmark; Jeroen Wigard, Mads Lauridsen, Nokia, Denmark

#### 5 Time-Extended Pathfinding Optimization in Mobile LEO Satellite Communication Networks

Feng Wang, Zhihao Wang, University of Electronic Science and Technology of China, China; Haibin Lv, North China Sea Offshore Engineering Survey Institute, Ministry Of Natural Resources North Sea Bureau, China; Zhihan Lv, Qingdao University, China; Dingde

Jiang, University of Electronic Science and Technology of China, China

28 September 2021 13:00

### Advances in Machine Communications II

#### 1 LIBRO: A Location Information Based Routing Protocol for Multi-Hop WSN Applications

Mohamad Rida Mortada, LabSTICC, Ensta-Bretagne, France

#### 2 Mobility-aware Pre-cache and Incentive Mechanism Design for Efficient D2D Data Offloading

Yiting Luo, Chengkai Lou, Fen Hou, University of Macau, China; Hongwei Ding, Bo Li, Yunnan University, China

#### 3 Multi-Task Assignment Strategy for Vehicular Crowdsensing with Clustering Characteristic

Fan Li, Xidian University, China; Yuchuan Fu, Xidian University, China; Pinan Zhao, Xidian University, China; Sha Liu, Xidian University, China; Changle Li, Xidian University, China

#### 4 Neighbor Discovery and MAC Protocol for Joint Automotive Radar-Communication Systems

Ceyhun Deniz Ozkaptan, Eylem Ekici, The Ohio State University, United States; Chang-Heng Wang, InfoTech Labs, Toyota Motor North America R&D, United States; Onur Altintas, InfoTech Labs, Toyota Motor North America R&D, United States

#### 5 Online Optimal Algorithm Design for Mobile Crowdsensing with Dual-role Users

Yanhua Pei, Guoying Zhang, Fen Hou, University of Macau, China; Guanghua Yang, Jinan University, China

#### 6 Optimal User-Selection for User Cooperative Mobility Control in Ad Hoc Networks

Takumi Anjiki, Imfomatics, Nagoya University, Japan; Tutomu Murase, Imfomatics, Nagoya University, Japan

#### 7 Self-Diagnosis of Radar System State in RSU Applications

Chia-Hsing Yang, Ming-Chun Lee, Ta-Sung Lee, National Yang Ming Chiao Tung University, Taiwan

#### 8 Stackelberg-Game-Based Mechanism For Offloading Fog Nodes Selection

Chengcheng Lv, Fei Shen, Shanghai Institute of Microsystem and Information Technology, China; Feng Yan, Southeast University, China; Zhiyong Bu, Shanghai Institute of Microsystem and Information Technology, China

28 September 2021 13:00

### Antennas

#### 1 A Low-sidelobe 24G-automotive radar antenna array with multi-mode excitation

Zongyu Zhang, Jiawang Li, Jianyi Zhou, Southeast University, China

#### 2 Assessing the Range of Radio Maritime Links in Different Waterbodies: Effect of Antenna height and Band Diversities

Ahmed Abdelmoaty, Resilient Machine learning Institute (ReMI) of ETS, Canada; Ghassan Dahman, Specialist, Mobility Simulations, ReMI and Ultra Intelligence & Communications, Canada; Gwenael Poitou, Chief Technology Officer, ReMI and Ultra Intelligence & Communications, Canada; Francois Gagnon, Professor, 'Ecole de Technologie Sup'erieure ('ETS), University of Quebec, Canada

#### 3 Design of a Simple Feeding Network for 5G Multidirectional Antennas

Giovanni Maria Schettino, Department of Engineering and Architecture, University of Trieste, Italy; Giulia Buttazzoni, Department of Engineering and Architecture, University of Trieste, Italy; Fulvio Babich, Department of Engineering and Architecture, University of Trieste, Italy

#### 4 mmWave Antenna Array Unit for Imaging Radar

Artem Nikishov, Sensor Solution Team, Samsung Research Russia, Russia; Gennady Evtushkin, Sensor Solution Team, Samsung Research Russia, Russia; Anton Lukyanov, Sensor Solution Team, Samsung Research Russia, Russia; Jaesup Lee, Multimedia Lab, Samsung Advanced Institute of Technology, South Korea; Jongseok Kim, Machine Learning Team, Samsung Advanced Institute of Technology, South Korea; Tsuyoshi Sugiura, H/W Lab, Samsung Research Japan, Japan

28 September 2021 13:00

### Intelligent Transportation I

#### 1 A semi-decentralized security framework for Connected and Autonomous Vehicles

Ivan Carvajal-Roca, Tsinghua University, China; Jian Wang, Tsinghua University, China

#### 2 A 5G-Based Vehicular Network Architecture to Enhance Road Safety Applications

Shashank K. Gupta, Jamil Y. Khan, Duy T. Ngo, The University of Newcastle, Australia

#### 3 A Greedy Techno-Economic Approach for Selection of C-ITS Roadside Unit Locations along Highways

Thibault Degrande, Information Technology, Ghent University-imec, Belgium; Frederic Vannieuwenborg, Information Technology, Ghent University-imec, Belgium; Didier Colle, Information Technology, Ghent University-imec, Belgium; Sofie Verbrugge, Information Technology, Ghent University-imec, Belgium

#### 4 A Time-Efficient and Attention-Aware Deployment Strategy for UAV Networks Driven by Deep Reinforcement Learning

Jinyue Wu, Xiang Cheng, Xiaoyong Ma, Wei Li, Yi Zhou, Henan University, China

#### 5 Brain-Based Indicators of Passenger Trust During Open-Road Driving

Karen DSouza, Thomas Dang, Kennesaw State University, United States; Jason Metcalfe, US DEVCOM Army Research Laboratory, United States; Sylvia Bhattacharya, Kennesaw State University, United States

#### 6 Human Interaction Safety Analysis Method for Agreements with Connected Automated Vehicles

Fredrik Warg, Dependable Transport Systems, RISE Research Institutes of Sweden, Sweden; Martin Skoglund, Dependable Transport Systems, Rise Research Institutes of Sweden, Sweden; Matthew Sassman, n/a, Semcon Sweden AB, Sweden

#### 7 Wireless Communications in High Speed Vacuum trains environment for Vehicular Technology Conference

Ali Tavsanoglu, Cesar Briso, Diego Carmena Cabanillas, Rafael Boris Arancibia Banda, Technical University of Madrid, Spain

28 September 2021 13:00

### Millimeter Wave Communication

#### 1 A New Channel Estimation Method for Millimeter Wave Systems Under High Mobility

Ali Mohebbi, Electrical and Computer Engineering, Concordia University, Canada; Hamed Abdzadeh-Ziabari, Electrical and Computer Engineering, McGill University, Canada; Wei-Ping Zhu, Electrical and Computer Engineering, Concordia University, Canada; M. Omair Ahmad, Electrical and Computer Engineering, Concordia University, Canada

#### 2 Blind Denoiser-based Beamspace Channel Estimation with GAN in Millimeter-Wave Systems

Yinghui Zhang, Zhenyu Zhang, Yuxing Zhang, Inner Mongolia University, China; Tiankui Zhang, Beijing University of Posts and Telecommunications, China

#### 3 Demonstration of High-Speed 4096QAM Millimeter-Wave Signal Wireless Transmission at E and D-bands

Yuxuan Tan, Fudan University, China; Kaihui Wang, Fudan University, China; Li Zhao, Fudan University, China; Junjie Ding, Fudan University, China; Jianjun Yu, Fudan University, China

#### 4 Hybrid Antenna Array Predistorter for 5G mm Band

Alexander Lozhkin, Japan; Tomoya Ota, Ken Tamanoi, Hiroyoshi Ishikawa, Takurou Nishikawa, Fujitsu Ltd., Japan

#### 5 Subcarrier Grouping with Linear Time-Domain Compensation for Low-Complexity Millimeter Wave OFDM Multiuser Systems

Zekai Liang, Gerd Ascheid, Institute for Communication Technologies and Embedded Systems, RWTH Aachen University, Germany

#### 6 True-Time-Delay-Based Fast Beam Training for Millimeter-Wave Communication Systems

Liang Zhou, Takashi Dateki, Fujitsu Limited, Japan

28 September 2021 13:00

## MIMO and Massive MIMO II

### 1 AI-enhanced Codebook-based CSI Feedback in FDD Massive MIMO

Jijia Guo, Southeast University, China; Chao-Kai Wen, Institute of Communications Engineering, National Sun Yat-sen University, China; Muhan Chen, Southeast University, China; Shi Jin, Southeast University, China

### 2 Joint User Scheduling and Transmit Precoder Selection Based on DDPG for Uplink Multi-User MIMO Systems

Hongchao Chen, Yupu Liu, Zhe Zheng, Huiyang Wang, Xiaohui Liang, Yi Zhao, Junwei Ren, Samsung Research, China

### 3 Multi-Rate Compression for Downlink CSI Based on Transfer Learning in FDD Massive MIMO Systems

Yuting Wang, Jinlong Sun, Jie Wang, Jie Yang, Nanjing University of Posts and Telecommunications, China; Bamidele Adebisi, Manchester Metropolitan University, United Kingdom; Tomoaki Ohtsuki, Keio University, Japan; Haris Gacanin, RWTH Aachen University, Germany

### 4 Transmit-Antenna Number Detection for MIMO Systems with Non-Gaussian Interference

Junlin Zhang, State Key Laboratory of Integrated Service Networks, Xidian University, China; Mingqian Liu, State Key Laboratory of Integrated Service Networks, Xidian University, China; Qinghai Yang, State Key Laboratory of Integrated Service Networks, Xidian University, China

28 September 2021 13:00

## Security I

### 1 Analysis of Physical Layer Security Based on Correlated Channels in Opportunistic Beamforming Technology

Xinwu Chen, Shuai Han, Jinming Wang, Harbin Institute of Technology, China

### 2 Artificial Noise-Assisted Beamforming and Power Allocation for Secure D2D-Enabled V2V Communications

Yiliang Liu, Xian Jiaotong University, China; Zhou Su, Xian Jiaotong University, China; Yuntao Wang, Xian Jiaotong University, China

### 3 Improvement of Radio Environment Map under Data Falsification Attack

Ying GAO, Advanced Wireless and Communication research Center, The University of Electro-Communications, Japan; Takeo FUJII, Advanced Wireless and Communication research Center, The University of Electro-Communications, Japan

### 4 Intrusion Detection for High-speed Railway System: A Faster R-CNN Approach

Xiao Xiao, State Key Laboratory of Integrated Services Networks, xidian university, China; Xinrui Ma, State Key Laboratory of Integrated Services Networks, xidian university, China; Yilong Hui, State Key Laboratory of Integrated Services Networks, xidian university, China; Zhisheng Yin, School of Cyber Engineering, xidian university, China; Tom H. Luan, School of Cyber Engineering, xidian university, China; Yu Wu, The Key Lab of Optical Fiber Sensing and Communications, University of Electronic Science and Technology of China, China

### 5 Nullification of Multiple Correlated Jammers

Linh Hoang, Andrew Zhang, Diep Nguyen, University of Technology Sydney, Australia; Asanka Kekirigoda, Kin-Ping Hui, University of Technology Sydney, Australia

### 6 On the RIS Manipulating Attack and Its Countermeasures in Physical-layer Key Generation

Lei Hu, Guyue Li, Hongyi Luo, Aiqun Hu, Southeast University, China

### 7 Physical Layer Security for High Data Rate Communications in the CathLab Environment

João Madeira, João Guerreiro, Rui Dinis, NOVA School of Science and Technology, Portugal

28 September 2021 15:00

## Blockchain in Communications

### 1 A Blockchain-Empowered Platoon Communication Scheme for Vehicular Safety Applications

Liu Cao, Hao Yin, University of Washington, United States

### 2 Age-Critical Blockchain Resource Allocation over Satellite-based Internet of Things

Bingzheng Wang, Jian Jiao, Harbin Institute of Technology, China; Weiqiang Wu, Shenzhen Polytechnic, China; Shaohua Wu, Qinyu Zhang, Harbin Institute of Technology, China

### 3 Computation Offloading and User Association for Blockchain-enabled Heterogeneous Cellular Networks

Yiping Zuo, Shi Jin, Southeast University, China; Shengli Zhang, Shenzhen University, China

### 4 Resource Allocation and Task Offloading in Blockchain-Enabled Fog Computing Networks

Huang Xiaoge, Liu Xin, Chen Qianbin, Chongqing University of Posts and Telecommunications, China; Zhang Jie, The University of Sheffield, United Kingdom

### 5 Security Analyze with Malicious Nodes in Sharding Blockchain Based Fog Computing Networks

Huang Xiaoge, Wang Yongsheng, Chen Qianbin, Chongqing University of Posts and Telecommunications, China; Zhang Jie, The University of Sheffield, United Kingdom

28 September 2021 15:00

## Intelligent Transportation II

### 1 A Blockchain-Based Cooperative Perception in Internet of Vehicles

Xinghao Li, Chenchen Tan, Deakin University, Australia; Minghao Liu, Tom Luan, Xidian University, China; Longxiang Gao, Youyang Qu, Deakin University, Australia

### 2 Assessing the impact of road traffic constraints on pollution

José D. Padrón, Marcos Terol, Jorge Luis Zambrano-Martinez, Carlos T. Calafate, Juan-Carlos Cano, Pietro Manzoni, Universitat Politècnica de València, Spain

### 3 Collective Perception Messages: New Low Complexity Fusion and V2X Connectivity Analysis

Nadia Mouawad, Valerian Mannoni, Leti DSYS, CEA, France

### 4 Traffic Incident Duration Prediction using BERT Representation of Text

Prashansa Agrawal, Antony Franklin, Digvijay Pawar, Sriyith PK, Indian Institute of Technology, Hyderabad, India

28 September 2021 15:00

## Propagation and RF Design

### 1 A hybrid OCC-LiFi system with dimming capability

Trang Nguyen, Mohamed Sufyan Islam, Harald Haas, University of Strathclyde, United Kingdom

### 2 A Near-Field-based TPMS Solution for Heavy Commercial Vehicle Environment

Ahmad Rida Tawakuli, Ridha Soua, Thomas Engel, University of Luxembourg, Luxembourg

### 3 Empirical Path-loss Models for Automated Warehouses

Ognen Ognenoski, Di Kong, Boyan Ivanov, Yu An, Adam Green, Ocado Technology, United Kingdom

### 4 Evaluation of TPMS Signal Propagation in a Heavy Commercial Vehicle Environment

Ahmad Rida Tawakuli, Ridha Soua, Thomas Engel, University of Luxembourg, Luxembourg

### 5 Experimental Evaluation of Data-driven Signal Level Estimation in Cellular Networks

Melisa López, Troels B. Sørensen, Aalborg University, Denmark; István Z. Kovács, Jeroen Wigard, Nokia, Denmark; Preben Mogensen, Aalborg University, Denmark

### 6 Omnidirectional Small-Scale Fading Models in an Airport Environment at Millimeter-Wave Frequency Bands: 73 and 81 GHz

Changyu Guo, Mahfuza Khatun, Tiffany Berntsen, Hani Mehrpouyan, Boise State University, United States

## 7 On the Impact of Buildings on the LoS Evaluation in System-Level V2I/N Simulations

Thomas Deinlein, Alexander Brummer, Reinhard German, Anatoli Djanatliev, University of Erlangen-Nürnberg, Germany

## 8 Path Loss in Urban LoRa Networks: A Large-Scale Measurement Study

Michael Rademacher, CAD, Fraunhofer FKIE, Germany; Hendrik Linka, Computer Science, Hochschule Bonn-Rhein-Sieg, Germany; Thorsten Horstmann, Computer Science, Hochschule Bonn-Rhein-Sieg, Germany; Martin Henze, CAD, Fraunhofer FKIE, Germany

## 9 Radio Interference Measurements for Urban Cooperative Intelligent Transportation Systems

Stephan Sand, Paul Unterhuber, Dina Bousdar Ahmed, Fabian de Ponte Müller, Andreas Lehner, Ibrahim Rashdan, Martin Schmidhammer, Rostislav Karásek, Benjamin Siebler, Oliver Heirich, Christian Gentner, Michael Walter, Susanna Kaiser, Markus Ulmschneider, Marius Schaab, Luis Wientgens, Thomas Strang, Institute of Communications and Navigation, German Aerospace Center (DLR), Germany

## 10 Spectral Efficient and High Performance LiFi Color Dimming

Trang Nguyen, Mohamed Sufyan Islam, Cheng Chen, Harald Haas, University of Strathclyde, United Kingdom

28 September 2021 15:00

### Recent Results I

#### 1 An In-Vehicle Speed Advisories HMI for Driving Safety and Fuel Economy Improvement

Wushuang Bai, Liming Gao, Evan Pelletier, Guangwei Zhou, Sean Brennan, The Pennsylvania State University, United States

#### 2 An IOTA-Based Micropayment System for Air Quality Monitoring Application

Ryota Nakada, Chiba University, Japan; Zhetao Li, Tingrui Pei, Xiangtan University, China; Kien Nguyen, Hiroo Sekiya, Chiba University, Japan

#### 3 A Novel Frame Design for Integrated Communication and Sensing based on Position Modulation

Saira Rafique, Huseyin Arslan, Istanbul Medipol University, Turkey

#### 4 A XGBoost Based Wireless Interference Relation Mining and Performance Prediction Method

Han Liu, Beijing University of Posts and Telecommunications, China; Tao Peng, Beijing University of Posts and Telecommunications, China; Yichen Guo, Beijing University of Posts and Telecommunications, China; Yachen Wang, Beijing University of Posts and Telecommunications, China; Gonglong Chen, Beijing University of Posts and Telecommunications, China; Feng Yang, Beijing University of Posts and Telecommunications, China; Wei Chen, Beijing University of Posts and Telecommunications, China

#### 5 Bayesian Synthetic Likelihood for Calibration of Stochastic Radio Channel Model

Ramoni Adeogun, Claus M. Larsen, Dennis Sand, Holger Bovbjerg, Peter Fisker, Tor Gjerde, Aalborg University, Denmark

#### 6 Blind-Spot Visualization via AR Glasses using Millimeter-Wave V2X for Safe Driving

Kazuki Maruta, Miyuu Takizawa, Ryuichi Fukatsu, Yue Wang, Zongdian Li, Kei Sakaguchi, Tokyo Institute of Technology, Japan

#### 7 Underlay Hybrid Satellite-Terrestrial Relay Networks under Realistic Hardware and Channel Conditions

Yerassyl Akhmetkazyev, Galymzhan Nauryzbayev, Nazarbayev University, Kazakhstan; Sultangali Arzykulov, King Abdullah University of Science and Technology, Saudi Arabia; Khaled Rabie, Manchester Metropolitan University, United Kingdom; Xingwang Li, Henan Polytechnic University, China; Ahmed Eltawil, King Abdullah University of Science and Technology, Saudi Arabia

#### 8 Deep Reinforcement Learning for Dynamic Band Switch in Cellular-Connected UAV

Gianluca Fontanesi, Anding Zhu, University College Dublin, Ireland; Hamed Ahmadi, University of York, United Kingdom

## 9 Dynamic Adjustment of Scheduling Period in Mobile Networks Based on C-RAN

Mohammed Elfiky, Zdenek Becvar, Pavel Mach, Czech Technical University in Prague, Czech Republic

## 10 Edge Computing Dynamic Resource Management: Tradeoffs Between Security and Application QoE

Wei-Chun Chang, Yao Chiang, National Taiwan University, Taiwan; Yi Zhang, Xiamen University, China; Hung-Yu Wei, National Taiwan University, Taiwan

## 11 Efficient Signal Detection for MIMO-SIM-OFDM Systems

Xianbing Zou, Shiwen Fan, Hao Chen, Yue Xiao, University of Electronic Science and Technology of China, China

## 12 Enabling Large Scale Deep Learning on Smart Device by Exploiting Edge-Cloud Computational Paradigm

Tryan Aditya Putra, Syahidah Izza Rufaida, Jenq-Shiou Leu, National Taiwan University of Science and Technology, Taiwan

## 13 Energy-Efficient Uplink Power Allocation in Ultra-Dense Network Through Multi-agent Reinforcement Learning

Yujie Zhao, Tao Peng, Yichen Guo, Wenbo Wang, Beijing University of Posts and Telecommunications, China

28 September 2021 15:00

### Security II

#### 1 Physical Layer Security in Power-Domain NOMA Using Improper Gaussian Signals

Mariani Sfredo, Evelio Garcia, Federal University of Parana, Brazil; Henry Carvajal, Universidad de Las Américas, UDLA, Ecuador

#### 2 Physical Layer Security of Untrusted UAV-enabled Relaying NOMA Network Using SWIPT and the Cooperative Jamming

Tianyi Hu, Fangshu Ma, Yong Shang, Yuxin Cheng, Peking University, China

#### 3 Rapid Network Planning of Temporary Private 5G Networks with Unsupervised Machine Learning

Caner Bektas, Stefan Böcker, Benjamin Sliwa, Christian Wietfeld, TU Dortmund University, Germany

#### 4 Robust Positioning-based Verification Scheme for Enhancing Reliability of Vehicle Platoon Control

Lan-Huong Nguyen, Thai Nguyen University of Information and Communication Technology, Vietnam; Ren-Hung Hwang, Po-Ching Lin, National Chung Cheng University, Taiwan; Van Linh Nguyen, Thai Nguyen University of Information and Communication Technology, Vietnam; Jian-Jhih Kuo, National Chung Cheng University, Taiwan

#### 5 Robust Sybil Attack Detection in Vehicular Networks

Halit Bugra Tulay, Can Emre Koksall, The Ohio State University, United States

#### 6 Spoofing Attack Detection Approaches based on Indoor Channel Continuity in IEEE 802.11 Wireless Local Area Networks

Ziming He, Fei Tong, Samsung Electronics, United Kingdom

#### 7 Toward Physical Layer Security via Two-dimensional Weighted Fractional Fourier Transform Based Spatial Modulation

Yongxin Huang, Harbin Institute of Technology, China; Xiaojie Fang, Science and Technology on Communication Networks Laboratory, China; Xuejun Sha, Harbin Institute of Technology, China; Weizhi Wang, Peng Cheng Laboratory, China; Ning Zhang, University of Windsor, Canada

28 September 2021 15:00

### Signal Processing

#### 1 A Novel Joint Radar and Communications Technique based on Frequency Permutation

Rajitha Senanayake, University of Melbourne, Australia; Peter Smith, Victoria University of Wellington, New Zealand; Jamie Evans, William Moran, Robin Evans, University of Melbourne, Australia

- 2 A Novel Multibeam Digital Predistorter Suppressing Intercarrier Interference**  
Tomoya Ota, Mobile System Business Unit, Fujitsu Limited, Japan; Alexander N. Lozhkin, Mobile System Business Unit, Fujitsu Limited, Japan; Ken Tamanoi, Mobile System Business Unit, Fujitsu Limited, Japan; Hiroyoshi Ishikawa, Mobile System Business Unit, Fujitsu Limited, Japan; Takuro Nishikawa, Mobile System Business Unit, Fujitsu Limited, Japan
- 3 A Novel Waveform Scheme for THz Communications**  
Yu Xin, Tong Bao, Jian Hua, Guanghui Yu, ZTE Corporation, China
- 4 Double deep Q-learning network-based path planning in UAV-assisted wireless powered NOMA communication networks**  
Ming Lei, Shannxi Normal University, China; Scott Fowler, Linköping University, Sweden; Juzhen Wang, Wuhan University, China; Xingjun Zhang, Bocheng Yu, Xi'an Jiaotong University, China; Bin Yu, Xidian University, China

- 5 Spectrally Efficient FDM System with Probabilistic Shaping**  
Xinyue Liu, Izzat Darwazah, University College London, United Kingdom; Nader Zein, NEC Laboratories Europe, NEC Europe, United Kingdom; Eisaku Sasaki, 1st Wireless Access Solutions Division, NEC Corporation, Japan
- 6 Two Efficient Bayesian Multiuser Detection Algorithms for Machine-Type Communications**  
Xiaoxu Zhang, Pingzhi Fan, Li Hao, Southwest Jiaotong University, China; Jiaqi Liu, China Electronics Technology Group Corporation Avionics Company Ltd., China
- 7 Weight Adjustment in Channel Estimation using Gibbs Sampling for MIMO Systems**  
Kenshiro Chuman, Yukitoshi Sanada, Keio University, Japan

## Wednesday, 29 September 2021

29 September 2021 11:00

### Advances in Communications

- 1 2-Step Prediction for Detecting Attacker in Vehicle to Vehicle Communication**  
Nur Cahyono Kushardianto, IEMN-DOAE, Polytechnic University of the Hauts de France (UPHF), France; Yassin El Hillali, IEMN-DOAE, Polytechnic University of the Hauts de France (UPHF), France; Charles Tatkeu, COSYS-LEOST, Univ Gustave Eiffel, IFSTTAR, France
- 2 A Relay Selection Algorithm in Energy Harvesting Ad-hoc Networks with Interference Constraints**  
Guangzhen Si, Zheng Dou, Yun Lin, Meiyu Wang, Harbin Engineering University, China
- 3 An Ensembled Approach to Time Series Prediction for Vehicle Communication**  
Vivekanandh Elangovan, Sheng Liu, United States; Weidong Xiang, University of Michigan Dearborn, United States
- 4 Artificial Neuronal Networks for Empowering Radio Transceivers: Opportunities and Challenges**  
Hossein Mohammadi, Vuk Marojevic, Mississippi State University, United States
- 5 Autoencoder Based PAPR Reduction for OTFS Modulation**  
Mengxue Liu, Ming-Min Zhao, Ming Lei, Min-Jian Zhao, Zhejiang University, China
- 6 Channel Prediction with Liquid Time-Constant Networks: An Online and Adaptive Approach**  
Hao Yin, University of Washington, United States; Yaohai Zhou, Huazhong University of Science and Technology, China; Liu Cao, University of Washington, United States; Yifei Xu, Huazhong University of Science and Technology, China
- 7 CNN-Based Underwater Acoustic OFDM Communications over Doubly-Selective Channels**  
Jie Liu, Fei Ji, Hao Zhao, Jie Li, Miaowen Wen, South China University of Technology, China
- 8 Fast Beamforming Design Method for IRS-Aided MISO Systems**  
Zhengran He, Hao Huang, Jie Yang, Guan Gui, Nanjing University of Posts and Telecommunications, China; Tomoaki Ohtsuki, Keio University, Japan; Bamidele Adebisi, Manchester Metropolitan University, United Kingdom; Haris Gacanin, RWTH Aachen University, Germany
- 9 Investigation of Input Signal Representation to CNN for Improving SNR Classification Accuracy**  
Shun Kojima, Utsunomiya University, Japan
- 10 Joint multi-channel multi-step spectrum prediction algorithm**  
Yulong Gao, Chunyan Zhao, Ning Fu, Harbin Institute of Technology, China

### 11 Lightweight Network Design Based on ResNet Structure for Modulation Recognition

Xiao Lu, Mengyuan Tao, Xue Fu, Guan Gui, Nanjing University of Posts and Telecommunications, China; Ohtsuki Tomoaki, Keio University, Japan; Hikmet Sari, Nanjing University of Posts and Telecommunications, France

### 12 Secret Key Generation for FDD Systems Based on Complex-Valued Neural Network

Xinwei Zhang, Southeast University, China; Guyue Li, Southeast University, China; Zongyue Hou, Southeast University, China; Aiqun Hu, School of Information Science and Engineering, Southeast University, China

29 September 2021 11:00

### Edge Computing

- 1 A Run-time Dynamic Computation Offloading Strategy in Vehicular Edge Computing**  
Duc Nguyen, University of Tokyo, Japan; Shunsuke Aoki, National Institute of Informatics, Japan; Yuuki Nishiyama, Kaoru Sezaki, University of Tokyo, Japan
- 2 An Edge Intelligent Framework for O-RAN based IoT Networks**  
Yu-Kai Huang, Hon Hai Research Institute, Taiwan; Ai-Chun Pang, National Taiwan University, Taiwan; Jen-Ming Wu, National Tsing Hua University, Taiwan
- 3 Efficient Computation Offloading for Edge-cloud Collaborative Networks**  
Bocheng Yu, XingJun Zhang, Xi'an Jiaotong University, China; Juzhen Wang, Wuhan University, China; Ming Lei, Shaanxi Normal University, China
- 4 Retransmission Edge Computing System Conducting Adaptive Image Compression Based on Image Recognition Accuracy**  
Mutsuki Nakahara, Daisuke Hisano, Osaka University, Japan; Mai Nishimura, Yoshitaka Ushiku, OMRON SINIC X Corporation, Japan; Kazuki Maruta, Tokyo Institute of Technology, Japan; Yu Nakayama, Tokyo University of Agriculture and Technology, Japan
- 5 Vehicular Edge Offloading based on Anticipated Value of Computational Tasks**  
Takamasa Higuchi, Seyhan Ucar, Chang-Heng Wang, Onur Altintas, Toyota Motor North America R&D, United States

29 September 2021 11:00

### Emerging Technology I

- 1 A New Approach for User Selection and Resource Management in Intelligent Reflected Surface Assisted Cellular Networks**  
Majd Aryan, Lebanese University, Lebanon; Hussein Al Haj Hassan, AUST, Lebanon; Abbass Nasser, AUCE, Lebanon; Loutfi Nuaymi, IMT Atlantique, France



## 2 Context-Based MEC Platform for Augmented-Reality Services in 5G Networks

Yue Wang, Tao Yu, Kei Sakaguchi, Tokyo Institute of Technology, Japan

## 3 Deep Learning-Based Intelligent Reflecting Surface Phase Shift Control

Hyunsoo Kim, Jiao Wu, Seoul National University, South Korea; Yosub Park, Samsung Electronics, South Korea; Seungnyun Kim, Byonghyo Shim, Seoul National University, South Korea

## 4 Reconfigurable Intelligent Surface Assisted Spreading and CDMA Wireless Communications

Teng Ma, Yue Xiao, Xia Lei, Wenhui Xiong, University of Electronic Science and Technology of China, China

## 5 Secrecy Rate Maximization for Intelligent Reflecting Surface-Assisted Device-to-Device Communications System

Gongbin Qian, Yuping Zheng, Wenyu Chen, Chunlong He, Shenzhen University, China

## 6 XDD: Cross Division Duplex in 5G-Advanced

Hyoungju Ji, Younsun Kim, Samsung Electronics, South Korea; Khurram Muhammad, Chance Tarver, Matthew Tonnemacher, Samsung Electronics, United States; Seongmok Lim, Jaeyeon Shim, Jaemin Kim, Samsung Electronics, South Korea; Bin Yu, Samsung Electronics, China; Gary Xu, Samsung Electronics, United States

29 September 2021 11:00

### Massive MIMO III

#### 1 Effect of Antenna Distribution on Spectral and Energy Efficiency of Cell-Free Massive MIMO

Masaaki Ito, Issei Kanno, Takeo Ohseki, Kosuke Yamazaki, Yoji Kishi, KDDI Research, Inc., Japan; Thomas Choi, Andreas F. Molisch, Ming Hsieh University of Southern California, United States

#### 2 Improving Cell-Free Massive MIMO Detection Performance via Expectation Propagation

Alva Kosasih, Vera Miloslavskaya, Wibowo Hardjawana, The University of Sydney, Australia; Victor Andrean, National Taiwan University of Science and Technology, Taiwan; Branka Vucetic, The University of Sydney, Australia

#### 3 On the Performance Limitations of Realistic Massive MIMO Deployments in 5G mmWave Wireless Cellular Networks

Spyros Lavdas, Neapolis University, Cyprus; Panagiotis Gkonis, Panagiotis Trakadas, Lambros Sarakis, National and Kapodistrian University of Athens, Greece

#### 4 Optimal but Low-Complexity Optimization Method for Nonsquare Differential Massive MIMO

Yuma Katsuki, Naoki Ishikawa, Yokohama National University, Japan

#### 5 Out-of-Band Distortion in Massive MIMO: What to expect under realistic conditions?

Laura Monteyne, Gilles Callebaut, KU Leuven, Belgium; Björn Sahlbom, Huawei Technologies, Sweden; Liesbet Van der Perre, KU Leuven, Belgium

#### 6 Quantized Precoding for Out-of-Band Radiation Reduction in Massive MU-MIMO-OFDM

Taichi Yamakado, Riki Okawa, Yukitoshi Sanada, Keio University, Japan

#### 7 Residual CFO Effect on Uplink Sum-Rate of Cell Free Massive MIMO Systems

Zahra Mokhtari, University of Tehran, Iran; Rui Dinis, Institute de Telecomunicacoes, Portugal

#### 8 Simple Framework of ZF Precoding Analysis for Full-Dimensional Massive MIMO Systems

Harsh Tataria, Ericsson AB, Sweden; Mansoor Shafi, Spark New Zealand, New Zealand

#### 9 Weighted-Beam Superposition for mmWave Massive MIMO-NOMA Systems

Hanyue Dai, Yue Yin, Hao Huang, Jie Yang, Nanjing University of Posts and Telecommunications, China; Tomoaki Ohtsuki, Keio

University, Japan; Hikmet Sari, Nanjing University of Posts and Telecommunications, China; Fumiyuki Adachi, Tohoku University, Sendai, Japan

29 September 2021 11:00

### UAVs

#### 1 Antenna Grouping Assisted Spatial Modulation for mmWave-based UAV-BS

Xingxuan Zuo, Zhengzhou University, China; Jiankang Zhang, Bournemouth University, United Kingdom; Gangtao Han, Xiaomin Mu, Zhengzhou University, China

#### 2 End-to-End Performance Measurements of Drone Communications in 5G Cellular Networks

Andreas Festag, Shrivatsa Udupa, Technische Hochschule Ingolstadt, Germany; Lourdes Garcia, Ericsson, Spain; Ralf Wellens, Ericsson, Germany; Matthias Hecht, Pierre Ulfig, Quantum-Systems GmbH, Germany

#### 3 Field Trials and Design Insights of Cellular-Connected Drones

Samira Homayouni, Mario Paier, Christian Benischek, Gerhard Pernjak, Matthias Reichelt, Christoph Fuchsjaeger, Hutchison Drei Austria, Austria

#### 4 Genetic Algorithm enabled Particle Swarm Optimization for Aerial Base Station Deployment

Bo Zhang, Jimpeng Song, Zhengzhou University, China; Zhi Liu, The University of Electro-Communications, Japan; Kunhao Yang, Zhengzhou University, China

#### 5 Joint Clustering and UAV Trajectory Planning Algorithm in UAV-Assisted WSNs with Data Collection Time Minimization

Lanxin Zhao, Rong Chai, Chongqing University of Posts and Telecommunications, China; Ruijin Sun, Xidian University, China

#### 6 Multi-User UAV Channel Modeling With Massive MIMO Configuration

Hengtai Chang, Shandong University, China; Cheng-Xiang Wang, Southeast University, China; Yubei He, Zhiquan Bai, Jian Sun, Wensheng Zhang, Shandong University, China

#### 7 Open-Source Software Radio Performance for Cellular Communications Research with UAV Users

Aly Sabri Abdalla, Andrew Yingst, Keith Powell, Vuk Marojevic, Mississippi State University, United States

#### 8 Outage Performance Evaluation for Drone Assisted Three-Dimensional Heterogeneous Networks

Yixuan Guo, Xiangdong Jia, Shengnan Cao, Northwest Normal University, China

#### 9 Trajectory Design of UAV Aided Wireless Information and Energy Provision

Bo Zhang, Jie Hu, Qin Yu, Kun Yang, University of Electronic Science and Technology of China, China

#### 10 Trajectory Optimization for Age of Information Minimization in UAV Communication Systems

Baolin Yin, Xinmin Li, Xiaoqiang Zhang, Lili Wei, SWUST, China

29 September 2021 11:00

### Wireless Communications I

#### 1 A Model and Data Hybrid Driven Detection Scheme for IRS-Assisted Massive MIMO Systems

Meng Ge, Fei Li, Ting Li, Wei Ji, Yan Liang, Nanjing University of Posts and Telecommunications, China

#### 2 A Novel Malware Traffic Classification Method using Semi-Supervised Learning

Jinhui Ning, Yu Wang, Jie Yang, Nanjing University of Posts and Telecommunications, China; Haris Gacanin, RWTH Aachen University, Germany; Song Ci, Tsinghua University, China

#### 3 A Study of Hardware Complexity for PSSS Systems Based on Real-Valued Spreading Sequences

Lukasz Lopacinski, Nebojsa Maletic, Jesus Gutiérrez, Eckhard Grass, Alireza Hasani, IHP, Germany

#### 4 A Study on Link Adaptation Techniques for IEEE 802.11bd Based eV2X Communications

Waqar Anwar, Technische Universität Dresden, Germany; Norman Franchi, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany; Gerhard Fettweis, Technische Universität Dresden, Germany

#### 5 Adaptive N+1 Color Shift Keying for Optical Camera Communication

Yukito Onodera, Tokyo University of Agriculture and Technology, Japan; Hiroki Takano, Daisuke Hisano, Osaka University, Japan; Yu Nakayama, Tokyo University of Agriculture and Technology, Japan

#### 6 An Effective Radar Signal Recognition Method Using Neural Architecture Search

Min Zhang, Nanjing University of Posts and Telecommunications, China; Wang Luo, NARI Group Co, China; Yu Wang, Jinlong Sun, Jie Yang, Nanjing University of Posts and Telecommunications, China; Tomoaki Ohtsuki, Keio University, Japan

#### 7 Channel Reconstruction with Limited Feedback in Intelligent Surface aided Communications

Narayan Prasad, Radio Algorithms Research, Futurewei Tech., United States; Md Moin Uddin Chowdhury, ECE, NCSU, United States; Xiao-Feng Qi, Radio Algorithms Research, PSI, United States

#### 8 Computationally-Efficient Preamble Design Appropriate for Random Access Achieving Multi-Packet Reception

Kou Watanuki, Graduate School of Science and Technology, Tokyo University of Science, Japan; Kenichi Higuchi, Graduate School of Science and Technology, Tokyo University of Science, Japan

29 September 2021 13:00

### Autonomous Vehicles

#### 1 A Multi-Factor Authenticated Blockchain-Based OTA Update Framework for Connected Autonomous Vehicles

Sadia Yeasmin, Anwar Haque, Western University, Canada

#### 2 An Edge-Controlled Outdoor Autonomous UAV for Colorwise Safety Helmet Detection and Counting of Workers in Construction Sites

Susanta Sharma, Computer Science, National Yang Ming Chiao Tung University, Taiwan; Allumallu Veera Venkata Susmitha, Computer Science, National Yang Ming Chiao Tung University, Taiwan; Lan-Da Van, Computer Science, National Yang Ming Chiao Tung University, Taiwan; Yu-Chee Tseng, Computer Science, National Yang Ming Chiao Tung University, Taiwan

#### 3 Efficient Mandatory Lane Changing of Connected and Autonomous Vehicles

Shang-Chien Lin, Chia-Chu Kung, Lee Lin, Chung-Wei Lin, Iris Hui-Ru Jiang, National Taiwan University, Taiwan

#### 4 GPS Location Spoofing Attack Detection for Enhancing the Security of Autonomous Vehicles

Mohsin Kamal, KIOS Research and Innovation Center of Excellence, University of Cyprus, Cyprus; Arnab Barua, KIOS Research and Innovation Center of Excellence, University of Cyprus, Cyprus; Christian Vitale, KIOS Research and Innovation Center of Excellence, University of Cyprus, Cyprus; Christos Laoudias, KIOS Research and Innovation Center of Excellence, University of Cyprus, Cyprus; Georgios Ellinas, KIOS CoE and Department of Electrical & Computer Engineering, University of Cyprus, Cyprus

#### 5 Kalman Filtering to Track Changes in Pupil Size for Automated Driving Systems

Prarthana Pillai, University of Windsor, Canada; Balakumar Balasingam, University of Windsor, Canada; Arunita Jaekel, School of Computer Science, University of Windsor, Canada; Francesco Biondi, Department of Kinesiology, University of Windsor, Canada

#### 6 Roadside-assisted Cooperative Planning using Future Path Sharing for Autonomous Driving

Mai Hirata, Graduate School of Information Science and Technology, The University of Tokyo, Japan; Manabu Tsukada, Graduate School of Information Science and Technology, The University of Tokyo, Japan; Keisuke Okumura, School of Computing, Tokyo Institute of Technology, Japan; Yasumasa Tamura, Tokyo Institute of Technology, School of Computing, Japan; Hideya Ochiai, The University of Tokyo, Graduate School of Information Science and

Technology, Japan; Xavier Défago, Tokyo Institute of Technology, School of Computing, Japan

#### 7 Secrecy Outage Probability and Secrecy Capacity for Autonomous Driving in a Cascaded Rayleigh Fading Environment

Yuqing Zhao, Abraham Fapojuwo, University of Calgary, Canada

#### 8 Train Velocity Measurement and Positioning System Based on Spatial Filter

Xiaoyong Wang, Tongji University, China; Haigui Xu, CASCO signal Ltd, China; Decun Dong, Dongxiu Ou, Tongji University, China

29 September 2021 13:00

### Emerging Technology II

#### 1 A Progressive Single Channel Reservation Scheme for URLLC in Unlicensed Band

Sheng-Shih Wang, Lunghwa University of Science and Technology, Taiwan; Wei-Kang Chen, Yu-Cheng Chen, Mu-Cheng Chiang, Li-Ling Huang, Shiann-Tsong Sheu, National Central University, Taiwan

#### 2 Deep Reinforcement Learning Based Admission Control for Throughput Maximization in Mobile Edge Computing

Yitong Zhou, Qiang Ye, Hui Huang, Dalhousie University, Canada; Hongwei Du, Harbin Institute of Technology, China

#### 3 Machine Learning Based mmWave Orchestration for Edge Gaming QoE Enhancement

Hao Luo, Hung-Yu Wei, National Taiwan University, Taiwan

#### 4 Outage Performance Analysis of Underlay CR-NOMA Network with Coordinated Direct and Relay Transmissions

Kunming Dong, Bin Shen, Huilin Jiang, Chongqing University of Posts and Telecommunications, China; Huaiwen Xu, Chongqing University, China

#### 5 Performance Analysis of Full Duplex Cooperative NOMA System with Imperfect SIC

Huilin Jiang, Bin Shen, Kunming Dong, Chongqing University of Posts and Telecommunications, China; Huaiwen Xu, Chongqing University, China

#### 6 Power Minimization Transmission Design for IRS-Assisted Uplink NOMA Systems

Haochun Ma, Nanjing University of Posts and Telecommunications, China

#### 7 Subband Random Sensing Grant Free Uplink for URLLC in Unlicensed Spectrum

Yonghong Zeng, Communication and network, Agency for Science, Technology and Research (A\*STAR), Singapore, Singapore; Yuhong Wang, Communication and network, Agency for Science, Technology and Research (A\*STAR), Singapore, Singapore; Sumei Sun, Communication and network, Agency for Science, Technology and Research (A\*STAR), Singapore, Singapore; Yugang Ma, Communication and network, Agency for Science, Technology and Research (A\*STAR), Singapore, Singapore

#### 8 URLLC Performance Evaluation of IMT-2020 Candidate Technology: DECT-2020 New Radio

Maxim Penner, Institute of Communications Technology, Leibniz Universität Hannover, Germany; Muhammad Nabeel, Institute of Communications Technology, Leibniz Universität Hannover, Germany; Jürgen Peissig, Institute of Communications Technology, Leibniz Universität Hannover, Germany

29 September 2021 13:00

### IoT

#### 1 EEU-RPL: An Energy Efficient Routing for UAVs in IoT Applications

Zhutian Yang, Hanze Liu, Harbin Institute of Technology, China; Wei Yang, Weiqiang Zhu, Nanjing Electronic Equipment Institute, China

#### 2 Empirical IIoT Data Traffic Analysis and Comparison to 3GPP 5G Models

Rasmus Mogensen, Ignacio Larrad, Gilberto Berardinelli, Aalborg University, Denmark; Guillermo Pocovi, Troels Kolding, Nokia Bell Labs, Denmark

- 3 Latency of Concatenating Unlicensed LPWAN with Cellular IoT: An Experimental QoE Study**  
Alvin Ramoutar, Zohreh Motamedi, Mouhamed Abdulla, Sheridan Institute of Technology, Canada
- 4 On the Design of an Information-Centric Networking Extension for IoT APIs**  
Dennis Grewe, Marco Wagner, Uthra Ambalavanan, Liming Liu, Naresh Nayak, Sebastian Schildt, Robert Bosch GmbH, Germany
- 5 Performance Analysis of NR based Vehicular IoT System with OTFS Modulation**  
Ch Santosh Reddy, Debarati Sen, Chetna Singhal, IIT Kharagpur, India
- 6 Performance of Channel Access Mechanisms for 5G Industrial-IoT over Unlicensed Bands**  
Sungjin Park, Hyunseok Ryu, Younsun Kim, Jin-kyu Han, Samsung Electronics Co., Ltd., South Korea
- 7 TRIDENT Schemes for Small Data Transmission in Industrial IoT System**  
Qi Xiong, Min Wu, Bin Yu, Feifei Sun, Chen Qian, Chengjun Sun, Samsung Research Institute China, China

29 September 2021 13:00

### MIMO III

- 1 Efficient Soft-Output Demodulation for mmWave Hybrid-MIMO Systems with Low-Resolution ADCs**  
Hyukyeon Lee, Donghan Lee, Heumpil Cho, Kijoon Hong, Jungwon Lee, Samsung Electronics, South Korea
- 2 Graph Coloring-based Interference Coordination for Ultra-dense Cellular Network with Distributed MU-MIMO**  
Chang Ge, Sijie Xia, Qiang Chen, Fumiyuki Adachi, Tohoku University, Japan
- 3 MIMO Throughput Performance Analysis in LEO Communication Scenario**  
Hlib Cheporniuk, Robert T. Schwarz, Thomas Delamotte, Andreas Knopp, Bundeswehr University Munich, Germany
- 4 On Sum-Rate and Fairness of MIMO Downlink Communications**  
Hsiao-feng Lu, National Yang Ming Chiao Tung University, Taiwan
- 5 Optimal Power Allocation for Cluster-wise Distributed MU-MIMO System**  
Sijie Xia, Chang Ge, Qiang Chen, Fumiyuki Adachi, Tohoku University, Japan
- 6 Overloaded MIMO Detection Based on Two-Stage Belief Propagation with MMSE Pre-Cancellation**  
Risa Shioi, Takashi Imamura, Yukitoshi Sanada, Keio University, Japan

29 September 2021 13:00

### Positioning, Navigation, and Sensing I

- 1 A CSI-based Object Detection Scheme using Interleaved Subcarrier Selection in Wireless LAN Systems with Distributed Antennas**  
Kazuki Noguchi, Osamu Muta, Kyushu University, Japan; Tomoki Murakami, Shinya Otsuki, NTT Corporation, Japan
- 2 A Full-Factorial Study of Sensor Fusion for Advanced Driver Assistance Systems**  
Nikola Janevski, Brian Woerner, West Virginia University, United States
- 3 A Low Complexity Estimation Algorithm for Coherent Distributed Sources**  
Qiaosen Bai, Yongzhen Bai, Rongchen Sun, Zhiguo Sun, Harbin Engineering University, China
- 4 A Novel 3-D Localization Scheme Using 1-D AOA and TDOA Measurements**  
Qiong Hu, Yixun Peng, Qun Wan, Zepeng Hu, University of Electronic Science and Technology of China, China; Zongquan Wang, Yujun Zhu, 081 Electronics Group Co., Ltd., China

- 5 Activity Monitoring at an Intersection Using a Sub-GHz Wireless Sensor Network**  
Jalal Jalali, Abdil Kaya, Maarten Weyn, Rafael Berkvens, University of Antwerp - imec, Belgium
- 6 Bayesian Inference of Sector Orientation in LTE Networks based on End-User Measurements**  
Lukas Eller, Philipp Svoboda, Markus Rupp, TU Wien, Austria
- 7 Capon Root-MUSIC-like Direction of Arrival Estimation Based on Real Data**  
Nizar Tayem, Srdan Budimir, Vinay Veramareddy, Texas A & M University, United States; Ahmed Hussain, Prince Mohammad University, Saudi Arabia
- 8 Computationally Efficient Forward/backward Averaged DOA Estimation of Coherent Sources in Pairs**  
Ahmed Hussain, Prince Mohammad University, Saudi Arabia; Nizar Tayem, Texas A & M University, United States; Abdel-Hamid Soliman, Staffordshire University, United Kingdom

29 September 2021 13:00

### Wireless Communications II

- 1 Contention-based Grant-free Transmission with Extremely Sparse Orthogonal Pilot Scheme**  
Zhifeng Yuan, Zhigang Li, Weimin Li, Yihua Ma, Chulong Liang, ZTE Corporation, China
- 2 Decentralized Learning-based Scenario Identification Method for Intelligent Vehicular Communications**  
Yaru Zhou, Yu Wang, Pengfei Liu, Jie Yang, Nanjing University of Posts and Telecommunications, China; Tomoaki Ohtsuki, Keio University, Japan; Hikmet Sari, Nanjing University of Posts and Telecommunications, China
- 3 Design of Robust LoS MIMO Systems with UCAs**  
Michail Palaiologos, Mario H. Castañeda Garcia, Richard A. Stirling-Gallacher, Huawei Technologies Duesseldorf GmbH, Germany; Giuseppe Caire, CTechnische Universität Berlin, Germany
- 4 Distributed RIS-based Dual-hop Mixed FSO-RF Systems With RIS-Aided Jammer**  
Aman Sikri, Indian Institute of Technology-Delhi, India; Aashish Mathur, Gyandeep Verma, Indian Institute of Technology Jodhpur, India; Georges Kaddoum, University of Quebec, ETS, Canada
- 5 Efficient PBCH DMRS Sequence Detection for Fast Synchronization Process of 5G NR Systems**  
Dahae Chong, SystGunyoung Ko, Beom-Kon Kim, Joo-Hyun Do, Jungwon Lee, Samsung Electronics, South Korea
- 6 Investigation of Transmitter Filtering Method for Random Access with Channel Identifier Linked Receiver Beamforming**  
Shogo Uchida, Tokyo University of Science, Japan; Nobuhide Nonaka, NTT DOCOMO, INC., Japan; Kenichi Higuchi, Tokyo University of Science, Japan

- 7 Joint Multislice and Cooperative Detection Aided Residual Network for Scenario Identification in Vehicle-to-Vehicle Communication Systems**  
Jiawei Huang, Yuxin Ji, Jie Yang, Miao Liu, Nanjing University of Posts and Telecommunications, China; Hikmet Sari, Nanjing University of Posts and Telecommunications, France

- 8 MPPP-HARQ: A HARQ Scheme with Multi-Packet Retransmission and Packet-wise Polarization**  
Shan Jin, Zhaoyang Zhang, Yuzhou Shang, Jue Wang, Zhejiang University, China

29 September 2021 15:00

### Emerging Technology III

- 1 Asymmetric Full-Duplex MAC Protocol Utilizing the Divergence Feature of OAM Beams**  
Kecheng Zhang, Bin Zhou, Zhiyong Bu, Shanghai Institute of Microsystem and Information Technology, China; Shaomin Wang, China Telecom Co., Ltd. Research Institute, China
- 2 Bidirectional Approximate Message Passing for RIS-Assisted Multi-User MISO Communications**  
Li Wei, Singapore University of Technology and Design, Singapore; Chongwen Huang, Zhejiang University, China; Qinghua Guo,

University of Wollongong, Australia; Zhaoyang Zhang, Zhejiang University, China; Mérouane Debbah, Lagrange Mathematics and Computing Research Center, France; Chau Yuen, Singapore University of Technology and Design, Singapore

### 3 **BloomyCAN: Probabilistic Data Structures for Software-defined Controller Area Networks**

Dennis Grewe, Naresh Nayak, Deeban Babu, Wenwen Chen, Sebastian Schildt, Clemens Schroff, Bosch Research, Robert Bosch GmbH, Germany

### 4 **Coverage and Rate Improvement Using Hybrid Reverse Frequency Allocation (RFA) Schemes in Three Region Non-Uniform HCN**

Wania Anoosh, Shahryar Saleem, Air University, Pakistan; Waqas Ahmed, PIEAS, Pakistan; Saleem Shahid, Air University, Pakistan

### 5 **Joint Resource Allocation and User Scheduling Scheme for Federated Learning**

Jinglong Shen, Xidian University, China; Nan Cheng, Xidian University, China; Zhisheng Yin, School of Cyber Engineering, Xidian University, China; Wenchao Xu, Department of Computing, The Hong Kong Polytechnic University, China

29 September 2021 15:00

## **Learning Algorithms**

### 1 **A New Frequency Hopping Strategy Based on Federated Reinforcement Learning for FANET**

Yuanfan Ye, Ming Lei, Minjian Zhao, Zhejiang University, China

### 2 **A Transmission and Backoff Method Based on Deep Reinforcement Learning for Statistical Priority-based Multiple Access Network**

Xiaohao Zhang, Ming Lei, Chan Wang, Minjian Zhao, Zhejiang University, China

### 3 **Deep-Learning Aided Consensus Problem Considering Network Centrality**

Shoya Ogawa, Koji Ishii, Kagawa University, Japan

### 4 **Federated Learning Model Training Method Based on Data Features Perception Aggregation**

Yan Zeng, Zhongyi Yan, JiLin Zhang, NaiLiang ZhaoYongJian Ren, Jian Wan, Jun Yu, Hangzhou Dianzi University, China

### 5 **Towards Machine Learning-Enabled Context Adaption for Reliable Aerial Mesh Routing**

Cedrik Schüler, Benjamin Sliwa, Christian Wietfeld, TU Dortmund University, Germany

29 September 2021 15:00

## **Positioning, Navigation, and Sensing II**

### 1 **Curve Fitting based CSI Compression and Reconstruction for Indoor Positioning**

Meng Gao, Xiaolong Yang, Mu Zhou, Chongqing University of Posts and Telecommunications, China

### 2 **End-to-End Multi-View Fusion for Enhanced Perception and Motion Prediction**

Yasser Khalil, Hussein Mouftah, University of Ottawa, Canada

### 3 **High Resolution Joint Angle and Delay Estimation Using IEEE 802.11ac**

Ziqiang Wang, Qun Wan, UESTC, China; Zongquan Wang, Yujun Zhu, 081 Electronics Group Co., Ltd, China

### 4 **HSRRS Classification Method Based on Deep Transfer Learning And Multi-Feature Fusion**

Ziteng Wang, Nanjing University of Posts and Telecommunications, China; Zhaojie Li, Keio University, Japan; Yu Wang, Nanjing University of Posts and Telecommunications, China; Wenmei Li, School of Geographic and Biologic Information, Nanjing University of Posts and Telecommunications, China; Jie Yang, Nanjing University of Posts and Telecommunications, China; Tomoaki Ohtsuki, Keio University, Japan

### 5 **Intelligent Reflecting Surface Aided Computational Imaging Exploiting Reed-Muller Sequences**

Yao Tian, Zhaoyang Zhang, Chongwen Huang, Xiaoming Chen, Caijun Zhong, Zhejiang University, China

### 6 **Positioning Performance of VDES R-Mode**

Markus Wirsing, Armin Dammann, Ronald Rauléfs, German Aerospace Center, Germany

### 7 **Quantitative Comparison of LiDAR Point Cloud Segmentation for Autonomous Vehicles**

Bhaskar Anand, Department of Electrical Engineering, Indian Institute of Technology Hyderabad, India; Vivek Barsaiyan, Department of Electrical Engineering, Indian Institute of Technology Hyderabad, India; Mrinal Senapati, Department of Electrical Engineering, Indian Institute of Technology Hyderabad, India; Rajalakshmi P, Department of Electrical Engineering, Indian Institute of Technology Hyderabad, India

29 September 2021 15:00

## **Recent Results II**

### 1 **Frequency-Hopping Based SCMA for Massive Connectivity in Multi-cell Networks**

Qi Zeng, Sichuan University, China; Zilong Liu, University of Essex, United Kingdom; Xing Liu, Jun Zhong, Sichuan University, China; Pei Xiao, University of Surrey, United Kingdom

### 2 **Generalized Spatial Modulation based Orthogonal Time Frequency Space System**

Bingxin Li, Zhiqian Bai, Jianing Guo, Yingchao Yang, Mengmeng Yan, Shandong University, China; Xinhong Hao, Beijing Institute of Technology, China

### 3 **HARQ Using Hierarchical Tree-Structured Physical Channel Identifiers in NOMA-Based Random Access for Multi-packet Reception**

Megumi Asada, Graduate School of Science and Technology, Tokyo University of Science, Japan; Nobuhide Nonaka, 6G-IOWN Promotion Department, NTT DOCOMO, INC., Japan; Kenichi Higuchi, Graduate School of Science and Technology, Tokyo University of Science, Japan

### 4 **Highly Efficient Demodulation Scheme for In-band Full-duplex Using Heterogeneous Wireless Communication Schemes**

Yudai Morikawa, Graduate School of Informatics, Kyoto University, Japan; Keiichi Mizutani, Graduate School of Informatics, Kyoto University, Japan; Hiroshi Harada, Graduate School of Informatics, Kyoto University, Japan

### 5 **Indoor Propagation Effects in D2D Communication: 5G Applications and Coverage Analysis**

Sandeep Joshi, Birla Institute of Technology and Science Pilani, India; Michael Hamra, EM Simulation Systems Pty. Ltd., EM Simulation Systems Pty. Ltd., Australia

### 6 **Inter-Carrier Interference Cancellation for 5G System Applying Simplified Universal Time-domain Windowed OFDM**

Yuu Ichikawa, Keiichi Mizutani, Hiroshi Harada, Kyoto University, Japan

### 7 **Investigation of Three-Arc Contour Prediction Algorithm on KITTI LiDAR Raw Data Set**

Gerald Joy Sequeira, Technische Hochschule Ingolstadt, Germany; Bhuvan Harlapur, Hochschule Ravensburg- Weingarten, Germany; Robert Lugner, Thomas Brandmeier, Technische Hochschule Ingolstadt, Germany

### 9 **Joint Optimization of IRS Location and its Phase Shift for Received Power Maximization**

Jyotsna Rani, National Institute of Technology Silchar, India; Deepak Mishra, UNSW Sydney, Australia; Ganesh Prasad, National Institute of Technology Silchar, India; Zizhen Si, Hubei Sanfeng Robot, China; Ashraf Hossain, National Institute of Technology Silchar, India

### 10 **Joint Transmit Beamforming and Antenna Selection Design for MISO-NOMA Systems Based on Improper Gaussian Signaling**

Hao-Tse Chiu, Fumiaki Maehara, Waseda University, Japan

---

**11 Machine learning applied to network traffic for vehicular applications to predict the vehicle context**

Tiago Do Vale Saraiva, Rosario Girardi, Carlos Alberto Vieira Campos, Federal University of State of Rio de Janeiro (UNIRIO), Brazil

**12 Machine Learning Scaled Belief Propagation for Short Codes**

Matthias Hummert, Dirk Wübben, Armin Dekorsy, University of Bremen, Germany

**13 NOMA-Based Highly-Efficient Low-Latency HARQ Method for URLLC**

Ryota Kobayashi, Tokyo University of Science, Japan; Yasuaki Yuda, Panasonic Corporation, Japan; Kenichi Higuchi, Tokyo University of Science, Japan

**14 Non-Orthogonal Multiple Access (NOMA) in IoT Non-Terrestrial Network for GNSS Buoy Array in the Ocean**

Kenichi Takizawa, Shin-ichi Yamamoto, NICT, Japan; Yukihiro Terada, Kochi College, National Institute of Technology, Japan; Teruyuki Kato, Taisho University, Japan

29 September 2021 15:00

**Relaying**

**1 Joint Relay Clustering and Beamforming Design for Cooperative Relay Networks**

Yupeng Huang, Liyan Li, Ming-Min Zhao, Min-Jian Zhao, Zhejiang University, China

**2 Machine Learning-assisted Node Scheduling in Multi-user Network-coded Relay Networks**

Yuhui Sun, Chao Wang, Ping Wang, Fuqiang Liu, Department of Information and Communication Engineering, Tongji University, China

**3 Performance Comparisons between Reconfigurable Intelligent Surface and Full/Half-duplex Relays**

Gu Qi, Future Research Lab, China Mobile Research Institute, China; Dan Wu, Future Research Lab, China Mobile Research Institute, China; Xin Su, Future Research Lab, China Mobile Research Institute, China; Jing Jin, Future Research Lab, China Mobile Research Institute, China; Yifei Yuan, Future Research Lab, China Mobile Research Institute, China; Jiangzhou Wang, School of Engineering and Digital Arts, University of Kent, United Kingdom

**4 Reactive Opportunistic Hybrid Relaying Protocol for Two-way Relaying Communication Systems**

Min-Kuan Chang, Guu-Chang Yang, National Chung Hsing University, Taiwan

**5 Selective Relaying Strategy for Vehicular Communication with Big-Vehicle Shadowing**

Yongkang Zhao, Xiaoli Xu, Southeast University, China; Yumeng Gao, Nanyang Technological University, Singapore

**6 System-Level Analysis of D2D Relaying for Ultra-Reliable and Low-Latency Wireless Control**

Dong Li, Bell Labs, Nokia, China; Saeed Khosravirad, Bell Labs, Nokia, United States; Yong Liu, Bell Labs, Nokia, China; Tao Tao, Bell Labs, Nokia, China

29 September 2021 15:00

**Wireless Communications III**

**1 On the Performance of the IEEE 802.11p/bd Sensing Procedure Under Co-channel C-V2X Interference**

Babak Mafakheri, DEL, University of Bologna, CNIT, Italy; Stefania Bartoletti, IEIIT, CNR, Italy; Omid Semiari, ECE Department, University of Colorado, United States; Alessandro Bazzi, DEL, University of Bologna, CNIT, Italy

**2 Performance Analysis of Base Station Association Strategies in Industrial 5G Networks**

Zheng Hui Ernest Tan, A\*STAR, Singapore; A S Madhukumar, Nanyang Technological University, Singapore

**3 Physical Effect of In-Phase and Quadrature Imbalance in Delay-Doppler Domain**

Armed Tusha, Istanbul Medipol University, Turkey; Seda Dogan-Tusha, Texas A&M University at Qatar, Qatar; Ferkan Yilmaz, Yildiz Technical University, Turkey; Saud Althunibat, Al-Hussein Bin Talal University, Jordan; Khalid Qaraqe, Texas A&M University at Qatar, Qatar; Huseyin Arslan, University of South Florida, United States

**4 QoS-aware Low-complexity User Pairing Based on Compressed Sensing in Downlink NOMA**

Tomofumi Makita, Graduate School of Information Science and Electrical Engineering, Kyushu University, Japan; Osamu Muta, Center for Japan-Egypt Cooperation in Science and Technology, Kyushu University, Japan

**5 Recurrent Sparse MIMO Detection Network Based on Modified Projected Gradient Descent Method**

Lanxin He, Nanjing University of Aeronautics and Astronautics, China; Zheng Wang, Southeast University, China; Tao Liu, Nanjing University of Aeronautics and Astronautics, China

**6 Secrecy Performance Enhancement of Artificial Noise Injection Scheme-based FSO Systems**

Aman Sikri, Indian Institute of Technology-Delhi, India; Aashish Mathur, Gyandeep Verma, Indian Institute of Technology Jodhpur, India

**7 The Achievable Distortion of Point-to-Point Channel With One Bit Feedback**

Omid Saatlou, Queen's University, Canada

**8 Time Offsets Format for NOMA System**

Xing Hao, Yuteng Wu, Yu Xiao, Ziru Chen, G. E. Atkin, Illinois Institute of Technology, United States

**9 Uplink Transmission in MU Multi-Cell Massive MIMO-FBMC Systems over Ricean Fading**

Shivani Singh, Prem Singh, Saurabh Sahu, Indian Institute of Technology, Kanpur, India; Himanshu Mishra, IIT Dhanbad, India; Vasudevan Kasturi, Indian Institute of Technology, Kanpur, India

---

**Thursday, 30 September 2021**

30 September 2021 11:00

**Emerging Technology IV**

**1 Discrete Fourier Transform with Neural Networks**

Jabran Akhtar, Norwegian Defence Research Establishment (FFI), Norway

**2 Performance Analysis of HAPS Assisted Dual-Hop Hybrid RF/FSO System**

Rima Deka, Sanya Anees, Vishesh Mishra, IIITG, India; Imtiaz Ahmed, Howard University, American Samoa; Md Sahabul Alam, IIITG, Canada

**3 Performance Evaluation of Transmission Schemes for High-Speed Train Communications**

Afshin Haghighat, Zeeshan Sattar, InterDigital Inc., Canada; Senay Negusse, InterDigital Inc., Sweden; Prasanna Herath, InterDigital Inc., Canada; Frank Lasita, InterDigital Inc., United States

**4 Power Allocation for Cross-Media Communications with Hybrid VLC/RF**

Yufeng Han, Yue Xiao, Yulan Gao, University of Electronic Science and Technology of China, China; Xianfu Lei, Southwest Jiaotong University, China; Binhong Dong, University of Electronic Science and Technology of China, China; George K. Karagiannidis, Aristotle University of Thessaloniki, China

**5 TGT-HC: A Time-Aware Shaper Scheduled Hyperchannel Protocol for Wireless Time Sensitive Networks (TSNs)**  
Raymond Jayaraj Jayabal, David Tung Chong Wong, Communications & Networks, Chin Ming Pang, Sumei Sun, Bo Jin, Yugang Ma, Leng Meng Goh, Wang Cho Cheng, Institute for Infocomm Research (I<sup>2</sup>R), A\*STAR, Singapore

**6 Topology Inference for Consensus-based Cooperation under Time-invariant Latent Input**  
Qing Jiao, Yushan Li, Jianping He, Shanghai Jiao Tong University, China

*30 September 2021 11:00*

### **Modeling and Control of Vehicles**

**1 Deep Reinforcement Learning based Adaptive Transmission Control in Vehicular Networks**  
Mingyuan Liu, Wei Quan, Chengxiao Yu, Xue Zhang, Deyun Gao, Beijing Jiaotong University, China

**2 Distributed Mission and Charging Scheduling for UAV Swarm to Maximize Service Coverage**  
Chung-I Li, Li-Hsing Yen, Min-Chun Cho, National Yang Ming Chiao Tung University, Taiwan

**3 Edge Learning of Vehicular Trajectories at Regulated Intersections**  
Dinesh Cyril Selvaraj, Politecnico di Torino, Italy; Christian Vitale, Tania Panayiotou, Panayiotis Kolios, University of Cyprus, Cyprus; Carla Fabiana Chiasserini, Politecnico di Torino, Cyprus; Georgios Ellinas, University of Cyprus, Cyprus

**4 Improvements on the Maximum Allowable Transmission Interval in String Stable Estimator-Enhanced Cooperative Adaptive Cruise Control**  
Andres Villamil, Arturo Gonzalez, Gerhard Fettweis, TU Dresden, Germany

**5 Multi-robot Target Search under Multi-peak Distribution: A Dynamic Approach based on High Confidence Area**  
Qing Jiao, Yushan Li, Shanghai Jiao Tong University, China; Xiaoming Duan, University of Texas, United States; Jianping He, Jiao Tong University, China; Qing-Guo Wang, Beijing Normal University-Hong Kong Baptist University, China

**6 Pedestrian Crossing Intention Prediction via Spatio-Temporal Visual Data in Urban Traffic Scenes**  
Mohamed Manzour, Omar M. Shehata, Elsayed I. Morgan, German University in Cairo, Egypt

**7 SA-SGAN: A Vehicle Trajectory Prediction Model Based on Generative Adversarial Networks**  
Danyang Zhou, Huxiao Wang, Wei Li, Yi Zhou, Henan University, China; Nan Cheng, Xidian University, China; Ning Lu, Queen's University, Canada

**8 Spatial-Temporal Graph Convolutional Networks for Parking Space Prediction in Smart Cities**  
Xiao Xiao, Zhiling Jin, Yilong Hui, Nan Cheng, Tom H. Luan, Xidian University, China

**9 STOG: A Traffic Prediction Scheme Based on Spatio-Temporal Optimized Graph Neural Networks**  
Shuting Hu, Ze Yu, Danyang Zhou, Yi Zhou, Henan University, China; Nan Cheng, Xidian University, China; Ning Lu, Queen's University, Canada

**10 Techno-economic and Simulation Study of a V2I-based Cooperative Manoeuvring Case in a Cross-border Scenario**  
Asma Chiha Ep Harbi, IMEC-Ghent University, Belgium; Federico Poli, Benoit Denis, CEA-Leti, France; Frederic Vannieuwenborg, IMEC-Ghent University, Belgium; David Garcia-Roger, Jose Francisco Monserrat, Universitat Politècnica de Valencia, Spain; Walter Aigner, HiTec, Austria

**11 The YASE Framework: Holistic Scenario Modeling with Behavior Trees**  
Max Bauer, Anthony Ngo, Robert Bosch GmbH, Germany; Micheal Resch, University of Stuttgart, Germany

*30 September 2021 11:00*

### **Positioning, Navigation, and Sensing III**

**1 Rigid Body Localization and Environment Sensing with 5G Millimeter Wave MIMO**  
Biwei Li, Xianbin Wang, Western University, Canada

**2 Robust MDS-BP Collaborative Localization in GPS-Challenged Environments**  
Ting Guo, Rui Chen, Bin Yang, Xidian University, China; Bin Li, Shaanxi Key Laboratory of Integrated and Intelligent Navigation, China electronic science and technology group no.20 institute, China

**3 Slow-Time Waveform Randomization Performance under Incoherent FMCW Radar Interference**  
Sian Jin, Jun Hyeon Park, Sumit Roy, University of Washington, United States

**4 Systematic Design of Radar Detection Under IEEE 802.11ad Framework**  
Linglin Liu, Honghao Ju, Xuming Fang, Yan Long, Rong He, Southwest Jiaotong University, China

**5 Towards a Camera-Based Road Damage Assessment and Detection for Autonomous Vehicles: Applying Scaled-YOLO and CVAE-WGAN**  
Pascal Fassmeyer, Felix Kortmann, Paul Drews, Burkhardt Funk, Leuphana University Lüneburg, Germany

*30 September 2021 11:00*

### **Radio Access and Services I**

**1 A Pair-Wise and System-Level Fairness Framework for Non-Orthogonal Multiple Access**  
Fernando Moya Caceres, Kandeepan Sithamparanathan, RMIT University, Australia; Sumei Sun, Agency for Science Technology and Research (A\*STAR), Institute for Infocomm Research, Singapore

**2 An Enhanced Cell Reselection Scheme for Dual SIM Dual Standby User Equipment in 5G Networks**  
Sangtae Kim, Jaehyung Lee, Youngyong Lee, Byoung-Jae Bae, Woonhaing Hur, Jonghan Kim, Samsung Electronics, South Korea

**3 Attribution Macro Cell Switching in Distributed Antenna Transmission**  
Takahito Tsukamoto, Go Otsuru, Yukitoshi Sanada, Keio University, Japan

**4 Channel Allocation for LoRaWAN Considering Intra-System and Inter-System Interferences**  
Shinichiro Kakuda, Yudai Yamazaki, Keita Katagiri, Takeo Fujii, Koichi Adachi, The University of Electro-Communications, Japan; Osamu Takyu, Shinshu University, Japan; Mai Ohta, Fukuoka University, Japan

**5 Evaluating Handover Performance for End-to-End LTE Networks with OpenAirInterface**  
Rodolphe Bertolini, Mickael Maman, DSYS, CEA-Leti, France

**6 Freshness-Critical Transmission Scheme with IR-HARQ over Multi-Hop Satellite-LoT**  
Jing Ding, Jian Jiao, Shiqi Liu, Shaohua Wu, Qinyu Zhang, Harbin Institute of Technology (Shenzhen), China

**7 IEEE 802.11be: Performance of Chase Combining HARQ Protocol with LDPC over Channels with Doppler Spread and Feedback Delay**  
Roger Hoefel, UFRGS, Brazil

**8 Impact of Mobility on the Estimation of Primary Channel Activity Statistics**  
Shreyansh Shah, Dhaval K. Patel, Brijesh Soni, Ahmedabad University, India; Miguel Lopez Benitez, University of Liverpool, UK, United Kingdom; Sagar Kavaiya, Ahmedabad University, India

**9 Impact of the RAN Architecture and Macro-diversity Techniques on Latency**  
Tania Alhaji, Xavier Lagrange, SRCD, IMT Atlantique, France

30 September 2021 11:00

## V2X

- 1 MoReV2X - A New Radio Vehicular Communication Module for ns-3**  
Luca Lusvardi, Maria Luisa Merani, University of Modena and Reggio Emilia, Italy
- 2 Socially-Aware V2X QoS for NOMA Dual-Connectivity**  
Rafael Kaliski, Yue-Hua Han, National Taiwan University of Science and Technology, Taiwan
- 3 Supporting Sporadic DENM Traffic over 5G-V2X Sidelink in the Autonomous Mode**  
Francesco Romeo, Paris-Saclay University, France; Claudia Campolo, Antonella Molinaro, Università Mediterranea di Reggio Calabria, Italy; Antoine O. Berthet, Paris-Saclay University, France; Alessandro Bazzi, Università di Bologna, Italy
- 4 Traffic-Aware Sensing-Based Semi-Persistent Scheduling for High Efficacy of C-V2X Networks**  
Anshika Chourasia, Bheemarjuna Reddy Tamma, Antony Franklin A., Indian Institute of Technology Hyderabad, India
- 5 V2X-based Vehicle Speeding Enforcement System**  
Daewon Kim, Kyungtae Kim, Dongyoon Kwon, Ji-Woong Choi, Daegu Gyeongbuk Institute of Science and Technology, South Korea

30 September 2021 13:00

## Cooperative Communications I

- 1 A Novel Sparse Linear Array Design by Using Two-dimension Particle Swarm Optimization**  
Chenhao Zhang, Wenjie Wang, Xi Hong, Xian Jiaotong University, China
- 2 Beamformed Energy Detection in the Presence of an Interferer for Cognitive mmWave Network**  
Madhuri Latha Mannedu, Sai Krishna Charan Dara, Sachin Chaudhari, SPCRC, IIIT, India; Neeraj Varshney, NIST, United States
- 3 Estimation of the Primary User's Beam Width Using Cooperative Secondary Users**  
Zeinab Kteish, Université de Bretagne Occidentale, France; Jad Abou Chaaya, Lebanese University, Lebanon; Abbas Nasser, American University of Culture and Education, Lebanon; Koffi-Clément Yao, Université de Bretagne Occidentale, France; Ali Mansour, ENSTA-Bretagne, France
- 4 Impact of Fading Correlation on Multiuser Joint Transmit-receive Diversity**  
Fumiyuki Adachi, Ryo Takahashi, Tohoku University, Japan
- 5 MAC Layer Beamforming: Rate Loss due to Beam Cusping**  
Krishan Kumar Tiwari, Fraunhofer IZM, Germany; David Laurenson, The University of Edinburgh, United Kingdom; Eckhard Grass, Humboldt-Universität zu Berlin, IHP, Germany; John Thompson, The University of Edinburgh, United Kingdom; Ivan Ndip, Michael Kaiser, Fraunhofer IZM, Germany
- 6 Machine Learning Inspired Energy-Efficient Hybrid Precoding with Fully-Adaptive-Connected Structure**  
Yang Huang, Xiang Li, Wei Heng, Jing Wu, Southeast University, China
- 7 Millimeter-Wave Handover Experiment in 293 km/h Mobility Environment using Position Estimated from Wireless Communication Signal**  
Tatsuhiko Iwakuni, Daisei Uchida, Shuki Wai, Naoki Kita, NTT Corporation, Japan
- 8 Multi-Antenna Covert Communications with Delay Constraint**  
Yuda Lin, Liang Jin, Kaizhi Huang, Feihu Wang, PLA Strategic Support Force Information Engineering University, China; Jinmei Yang, Purple Mountain Laboratories: Networking, Communications and Security, China

30 September 2021 13:00

## Energy Efficient Communications

- 1 Artificial Neural Networks-based Ambient RF Energy Harvesting with Environment Detection**  
Jonathan Kwan, University of Calgary, Canada; Jesse Chaulk, Acuspire, Canada; Abraham Fapojuwo, University of Calgary, Canada
- 2 Cooperative User Selection with Non-Linear Energy Harvesting in IoT Environment**  
Prabhat Sharma, Sravani Kurma, Visvesvaraya National Institute of Technology, India; Vaijyanti Panse, IIIT Nagpur, India; Keshav Singh, NSUYSU, Taiwan
- 3 Distributed Resource Allocation for Maximizing Energy Efficiency in D2D-U Enabled NR Network**  
Zheyi Wu, Zhejiang University, China; Jiantao Yuan, Rui Yin, Zhejiang University City College, China; Xianfu Chen, VTT Technical Research Centre of Finland, Finland; Celimuge Wu, University of Electro-Communications, Japan
- 4 Energy Consumption Optimization for UAV Assisted Private Blockchain-based IIoT Networks**  
Xinhua Lin, Jing Zhang, Huazhong University of Science and Technology, China; Lin Xiang, Technische Universität Darmstadt, Germany; Xiaohu Ge, Huazhong University of Science and Technology, China
- 5 Energy Efficiency Optimization for Hybrid NOMA based Beyond 5G Heterogeneous Networks**  
Umar Ghafoor, Military College of Signals, NUST, Pakistan; Mudassar Ali, UET, Pakistan; Humayun Zubair Khan, Adil Masood Siddiqui, Military College of Signals, NUST, Pakistan; Muhammad Naeem, COMSATS University, Pakistan; Imran Rashid, Military College of Signals, NUST, Pakistan
- 6 Energy-Efficient Wireless Powered Communications with NOMA in Multi-UAV Aided Networks**  
Saif Najmeddin, Concordia University, Canada; Sonia Aïssa, Institut National de la Recherche Scientifique (INRS), Canada; Sofiene Tahar, Concordia University, Canada
- 7 Joint Spectrum Sensing, Bandwidth Allocation and Energy Consumption Optimization in Cognitive IoT**  
Yan Long, Ye Li, Yongfan Long, Southwest Jiaotong University, China; Lu He, Shanghai Aerospace Electronics Company Limited, China; Honghao Ju, Southwest Jiaotong University, China
- 8 Optical Throughput of the Full-duplex Two-way Relay System with Energy Harvesting**  
Kaiqi Zhong, Liqun Fu, Xiamen University, China

30 September 2021 13:00

## Federated Learning in Communications

- 1 Blockchain-Enabled Clustered Federated Learning in Fog Computing Networks**  
Huang Xiaoge, Chen Zhi, Chen Qianbin, Chongqing University of Posts and Telecommunications, China; Zhang Jie, The University of Sheffield, United Kingdom
- 2 Federated Deep Learning for Collaborative Intrusion Detection in Heterogeneous Networks**  
Segun Popoola, Manchester Metropolitan University, United Kingdom; Guan Gui, Nanjing University of Posts and Telecommunications, China; Bamidele Adebisi, Mohammad Hammoudeh, Manchester Metropolitan University, United Kingdom; Haris Gacanin, RWTH Aachen University, Germany
- 3 Federated Learning-based Power Control and Computing for Mobile Edge Computing System**  
Tianlong Yang, Xinmin Li, SWUST, China; Hua Shao, USTB, China
- 4 Optimized Edge Aggregation for Hierarchical Federated Learning**  
Bo Xu, Wenchao Xia, Nanjing University of Posts and Telecommunications, China; Wanli Wen, Chongqing University, China; Haitao Zhao, Hongbo Zhu, Nanjing University of Posts and Telecommunications, China

## 5 User Scheduling for Federated Learning Through Over-the-Air Computation

Xiang Ma, Utah State University, United States; Haijian Sun, University of Wisconsin-Whitewater, United States; Qun Wang, Rose Qingyang Hu, Utah State University, United States

30 September 2021 13:00

## Radio Access and Services II

### 1 Joint Node-Link Embedding Algorithm based on Genetic Algorithm in Virtualization Environment

Khoa Nguyen, Qiao Lu, Changcheng Huang, Carleton University, Canada

### 2 Maximum-Throughput Grant-Free Random Access For Correlated IoT Traffic

Federico Moretto, Alessandro Brighente, Stefano Tomasin, Dept. Information Engineering, University of Padova, Italy

### 3 Network Reconfiguration via Diversity: Theoretical Foundation and Algorithm Design

Lin Chen, CSE, Sun Yat-sen University, China; Raphael Phan, Information Technology, Monash University, Malaysia

### 4 Online Probabilistic Activation Control of Base Stations Utilizing Temporal System Throughput and Activation States of Neighbor Cells

Junya Tani, Graduate School of Science and Technology, Tokyo University of Science, Japan; Kenichi Higuchi, Graduate School of Science and Technology, Tokyo University of Science, Japan

### 5 Power Allocation for D2D NOMA in Cache-Aided Networks

Kevin Shen, Daniel So, University of Manchester, United Kingdom

### 6 Pushing the Limits: Resilience Testing for Mission-Critical Machine-Type Communication

Christian Arendt, Manuel Patchou, Stefan Böcker, Janis Tiemann, Christian Wietfeld, TU Dortmund University, Germany

### 7 Stochastic Channel Modeling for Deep Neural Network-aided Sparse Code Multiple Access Communications

Dongbo Li, Min Jia, Liang Zhang, Qing Guo, Xuemai Gu, Harbin Institute of Technology, China

### 8 Towards Delay-Optimal Multi-Connectivity Traffic Management for Edge Networks

Jingwen Bai, Shu-ping Yeh, Shilpa Talwar, Intel Corporation, United States

30 September 2021 13:00

## Vehicular and Cellular Networks

### 1 A Proposed Resource-Aware Time-Constrained Scheduling Mechanism for DSME based IoV Networks

Nikumani Choudhury, Birla Institute of Technology & Science, Pilani, Hyderabad, India; Moustafa Nasralla, Prince Sultan University, Riyadh, Saudi Arabia

### 2 A QoS-Aware Hybrid V2I and V2V Data Offloading for Vehicular Networks

Yasir Saleem, Nathalie Mitton, Valeria Loscri, Inria Lille - Nord Europe, France

### 3 Call Admission and Assignment in Cellular Networks with Vehicular Relay Nodes

Ran Levy, Hanoch Levy, Tel Aviv University, Israel

### 4 Coverage Analysis of Fog-Enabled Vehicular Networks with User Mobility

Minghan Jiao, Chenxi Liu, Mugen Peng, Beijing University of Posts and Telecommunications, China

### 5 Practical Performance Evaluation of Multi-User Interleaved Chirp Spreading LoRa Networks

Phoebe Edward, Dareen Behiry, Mohamed Mandour, Tallal Elshabrawy, German University in Cairo, Egypt

30 September 2021 13:00

## Vehicular Communication

### 1 A Collision-free Coordination Framework for Mixed-Vehicle Intersections

Yixiao Zhang, Rui Hao, Harbin Institute of Technology, Shenzhen, China; Bo Gao, Shenzhen Institute of Information Technology,

China; Zepeng Xie, Harbin Institute of Technology, Shenzhen, China; Ming Liu, Shenzhen Institute of Information Technology, China; Tingting Zhang, Harbin Institute of Technology, Shenzhen, China

### 2 An Accurate Vehicle-to-Vehicle Instant Alert System Using Directional Antennas

Chia-Yu Lin, Yuan Ze University, Taiwan; Fu-Ming Kang, Po-Min Hsu, Jen-Jee Chen, Yu-Chee Tseng, National Yang Ming Chiao Tung University, Taiwan

### 3 Digital Twin Based Remote Resource Sharing in Internet of Vehicles using Consortium Blockchain

Chenchen Tan, Xinghao Li, Deakin University, Australia; Tom Luan, Xidian University, China; Bruce Gu, Victoria University, Australia; Youyang Qu, Longxiang Gao, Deakin University, Australia

### 4 Learning Effective Multi-Vehicle Cooperation at Unsignalized Intersection via Bandwidth-Constrained Communication

Ziyan Li, Quan Yuan, Guiyang Luo, Jinglin Li, Beijing University of Posts and Telecommunications, China

### 5 LETT: An Execution Model for Distributed Real-Time Systems

Wojciech Baron, Anna Arestova, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany; Christoph Sippl, Audi AG, Germany; Kai-Steffen Hielscher, Reinhard German, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

### 6 Securing vehicular computation offloading: a distributed ledger-based approach

Domenico Lattuca, University of Pisa/CNIT, Italy; Luca Di Mauro, CNIT, Italy; Francesco Bisconti, -, CNIT, Italy; Federico Civerchia, Sma-RTy Italia Srl, Italy; Andrea Tesei, University of Pisa/CNIT, Italy; Paolo Pagano, CNIT, Italy; Joaquim Ferreira, Instituto de Telecomunicações, Universidade de Aveiro, Portugal

### 7 Shock Wave Mitigation in Multi-lane Highways using Vehicle-to-Vehicle Communication

Nilesh Suriyarachchi, John Baras, of Maryland, United States

### 8 Validation and Analysis of the Propagation Channel at 60 GHz for Vehicular Communication

Maximilian Lübke, Jonas Fuchs, Anand Dubey, Hussein Hamoud, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany; Falko Dressler, Technische Universität Berlin, Germany; Robert Weigel, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany; Fabian Lurz, Hamburg University of Technology, Germany

30 September 2021 15:00

## Cooperative Communications II

### 1 Multi-Frequency Wireless Channel Measurements and Characteristics Analysis in Indoor Corridor Scenarios

ZiHao Zhou, Li Zhang, XinYue Chen, ChengXiang Wang, Jie Huang, Southeast University, China

### 2 On the Effects of Blockage on Load Modeling in Millimeter-Wave Cellular Networks

Muhammad Saad Zia, Douglas M. Blough, Mary Ann Weitnauer, Georgia Institute of Technology, United States

### 3 Outdoor Experimental Trials of 28 GHz Band Base Station Cooperation in High-Mobility Environment of Multiple Mobile Stations

Tatsuki Okuyama, Satoshi Suyama, Nobuhide Nonaka, Takahiro Asai, NTT DOCOMO, INC., Japan

### 4 Performance of Large Intelligent Surface-enabled Cooperative Networks Over Nakagami-m Channels

Madi Makin, Galymzhan Nauryzbayev, Nazarbayev University, Kazakhstan; Sultangali Arzykulov, King Abdullah University of Science and Technology, Saudi Arabia; Mohammad Hashmi, Nazarbayev University, Kazakhstan

### 5 Scheduling and Resource Allocation for Multi-Hop URLLC Network in 5G Sidelink

Hao Yin, Liu Cao, University of Washington, United States; Xun Deng, Huazhong University of Science and Technology, China



**6 Sparse Array Beampattern Synthesis via Majorization-Based ADMM**  
Tong Wei, Bhavani Shankar M. R., Linlong Wu, University of Luxembourg, Luxembourg

**7 Weighted Cooperative Spectrum Sensing for Cognitive Vehicular Networks**  
Shreyansh Shah, Dhaval K. Patel, Brijesh Soni, Ahmedabad University, India; Miguel Lopez Benitez, University of Liverpool, UK, United Kingdom; Sagar Kavaiya, Ahmedabad University, India

*30 September 2021 15:00*

### **Green Communications**

**1 A Slotted Batteryless Massive Access Protocol Based on Sparse Code for Wireless Powered Communication Networks**  
Yang Li, Xiaofeng Lu, Xidian University, China; Jie Hu, Kun Yang, University of Electronic Science and Technology of China, China

**2 A Stochastic Stackelberg Game Framework for Demand-side Participation in the Reserve Market**  
Shibo Chen, Wenjie Liu, Haoyu Miao, Southern University of Science and Technology, China; Zhenwei Guo, Zhejiang University, China; Zaiyue Yang, Southern University of Science and Technology, China

**3 Age of Information in Decode-and-Forward Aided Wireless Powered Two-Hop Sensor Network**  
Yali Zheng, Jie Hu, Kun Yang, University of Electronic Science and Technology of China, China

**4 Performance of a Cooperative NOMA/OMA Scheme with Energy Buffer-Aided Near-User**  
Dileep Bapatla, Shankar Prakriya, IIT Delhi, India

**5 STeP-UNet: Prediction of Moving and Communication Behaviors of Vehicles**  
Daojun Liang, Haixia Zhang, Xiaotian Zhou, Dongyang Li, Dongfeng Yuan, Minggao Zhang, Shandong University, China

**6 Throughput Maximization in Full-Duplex Relay Network with Simultaneous Wireless Information & Power Transfer**  
Qi Gu, Dan Wu, Jing Jin, Qixing Wang, China Mobile Research Institute, China

**7 WUS Mapping Scheme on DRX Mechanism**  
Yu Zhou, Yuehong Gao, Xin Zhang, Ziyang Zhang, Beijing University of Posts and Telecommunications, China; Yanhua Li, Beijing Xiaomi Mobile Software CO., Ltd, China

*30 September 2021 15:00*

### **Learning Enhancements in Communications**

**1 A Hybrid Intrusion Detection System Based on Machine Learning under Differential Privacy Protection**  
Jibo Shi, Yun Lin, Zherui Zhang, Harbin Engineering University, China; Shui Yu, University of Technology Sydney, Australia

**2 Channel Prediction Based on A Novel Physics-Inspired Generative Learning Structure**  
Zhuoran Xiao, College of Information Science and Electronic Engineering, Zhejiang University, China

**3 Machine learning based signal strength and uncertainty prediction for MEC mobility management**  
Shangbin Wu, Yue Wang, Samsung Research UK, United Kingdom; Tiezhu Zhao, Junwei Ren, Samsung Research China, China

**4 Supervised Learning of Channel Delay Spreads for Cyclic-Prefix Free OFDM Systems**  
Jami Hema Ganesh, Jen-Ming Wu, National Tsing Hua University, Taiwan

**5 Task-oriented Resource Allocation for Mobile Edge Computing with Multi-Agent Reinforcement Learning**  
Yue Zou, Fei Shen, Chinese Academy of Sciences, China; Feng Yan, Southeast University, China; Liang Tang, Chinese Academy of Sciences, China

*30 September 2021 15:00*

### **Recent Results III**

**1 OTFS Modulation in Dual-LED Indoor Visible Light Communication Systems**  
Sujata Sinha, Ananthanarayanan Chockalingam, Indian Institute of Science, India

**2 Outdoor Neighbor-Assisted Localization Algorithm for Massive MIMO Systems**  
Amal Sellami, Supcom, Sup'Com, Tunisia; Leila Nasraoui, Supcom, Sup'Com, Tunisia; Leila Najjar, Supcom, Sup'Com, Tunisia

**3 PAPR Reduction Using Null Space in MIMO Channel for MIMO-OFDM Signals in Multiple-Antenna AF Relay Transmission**  
Yuki Sekiguchi, Tokyo University of Science, Japan; Nobuhide Nonaka, NTT DOCOMO, INC., Japan; Kenichi Higuchi, Tokyo University of Science, Japan

**4 Performance Analysis and Optimization of Multi-Level ASK Constellation in a Receive Diversity Noncoherent PLC System**  
Abhishek Kumar, Soumya Prakash Dash, Indian Institute of Technology Bhubaneswar, India

**5 Performance Analysis on Access Collision in Semi-Persistent Scheduling of C-V2X Mode 4**  
Xin Gu, Jun Peng, Yijun Cheng, Xiaoyong Zhang, Weirong Liu, Zhiwu Huang, Central South University, China; Lin Cai, University of Victoria, Canada

**6 Performance of a CDRT based Underlay NOMA With Combining at the Near User**  
Deepali Johari, Anand Jee, Kamal Agrawal, Shankar Prakriya, Indian Institute of Technology, Delhi, India

**7 Reinforcement Learning-Based Joint Cooperation Clustering and Content Caching in Cell-Free Massive MIMO Networks**  
Ronald Chang, Sung-Fu Han, Academia Sinica, Taiwan; Feng-Tsun Chien, National Yang Ming Chiao Tung University, Taiwan

**8 Spatial Denoising for Sparse Channel Estimation in Coherent Massive MIMO**  
Alexander Osinsky, Andrey Ivanov, Dmitry Yarotsky, Skolkovo Institute of Science and Technology, Russia

**9 Synchronization Signal Design Using Single-Carrier Waveform for Physical-Layer Cell ID Detection**  
Daisuke Inoue, Kyogo Ota, Mamoru Sawahashi, Tokyo City University, Japan; Satoshi Nagata, NTT DOCOMO INC., Japan

**10 Transmission Experiment of IEEE 802.11ad under FMCW Radar Interference Environment in Vehicle**  
Kotaro Ikeda, Kentarou Kobayashi, Yuya Kaneko, Tadahide Kunitachi, Yazaki Corporation, Japan; Kenichi Takizawa, Ryotaro Suga, Huan-Bang Li, Fumihide Kojima, NICT, Japan

**11 UAV-Assisted Hybrid Communication System with NOMA and Nonlinear Energy Harvesting**  
Sandeep Kumar Singh, National Sun Yat-sen University, Kaohsiung, Taiwan; Kamal Agrawal, Delhi, India; Keshav Singh, Chih-Peng Li, National Sun Yat-sen University, Kaohsiung, Taiwan

**12 UE Measurements Relaxation for UE Power Saving in 5G New Radio**  
Daniela Laselva, Laura L. Sanchez, Faranaz Sabouri-S, Nokia, Denmark; Qiyang Zhao, Nokia, France; Jorma Kaikkonen, Lars Dalsgaard, Pasi Et. Kinnunen, Nokia, Finland

**13 Uniquely Decomposable Constellation Group-based Sparse Vector Coding for Short Packet Communications**  
Ganyu Qin, Zhengzhou University, China; Hongyang Chen, Zhejiang Lab, China; Xuewan Zhang, SZhengzhou University, China; Takuro Sato, Waseda University, Japan; Di Zhang, Zhengzhou University, China

30 September 2021 15:00

## Spectrum Access and Management

- 1 A Reference Design for a Spectrum Misbehavior Authority for Connected Vehicle Environments**  
Hamed Noori, Akhil Prabhu, David Michelson, University of British Columbia, Canada; Mohsen Razlighi, Monash University, Australia
- 2 Blockchain-based Hierarchical Spectrum Sharing Architecture and Resource Allocation Algorithm for CBRS System**  
Hang Hu, Rong Chai, Chongqing University of Posts and Telecommunications, China
- 3 Considerations for spectrum sharing between RLANs and incumbents in the 13 GHz band**  
Nadia Yoza Mitsuishi, Peter Mathys, University of Colorado Boulder, United States
- 4 Deep Reinforcement Learning With Bidirectional Recurrent Neural Networks for Dynamic Spectrum Access**  
Peng Chen, Shizeng Guo, Yulong Gao, Harbin Institute of Technology, China
- 5 Efficient Spectral Access in Distributed Cooperative Cognitive Radio Networks**  
Syed Muhammad Tayyab Shah, Moqbel Ali Mohammed Hamood, Huseyin Arslan, Istanbul Medipol University, Turkey
- 6 Enhanced Game Theoretical Spectrum Sharing Method Based on Blockchain Consensus**  
Peiyan Wu, Wenbin Chen, Hualin Wu, Ke Qi, Miao Liu, Guangzhou University, China

## 7 Spectrum Allocation in IAB Networks: A Hierarchical Auction-based Approach

Prasanna Chaporkar, Pranav Jha, Indu Yadav, Indian Institute of Technology Bombay, India; Abhay Karandikar, Indian Institute of Technology Kanpur, India

## 8 Spectrum assignment for industrial radio cells based on selective subgraph constructions

Gilberto Berardinelli, Ramoni Adeogun, Aalborg University, Denmark

30 September 2021 15:00

## Vehicular Platooning

- 1 Efficient Multi-maneuver Platooning Framework for Autonomous Vehicles on Multi-lane Highways**  
Yun-Hao Ye, Zhi-Yang Lin, Chih-Chiung Yao, Lan-Huong Nguyen, Jian-Jhih Kuo, Ren-Hung Hwang, National Chung Cheng University, Taiwan
- 2 Energy-Based Analysis of String Stability in Heterogeneous Platoons**  
Chiedu Mokogwu, Keyvan Hashtrudi-zaad, Queen's University, Canada
- 3 Impact of Communication Loss on MPC based Cooperative Adaptive Cruise Control and Platooning**  
Mahdi Razzaghpour, Shahriar Shahram, Rodolfo Valiente, Yaser P. Fallah, University of Central Florida, United States
- 4 Joint Optimization of Resource Scheduling and Mobility for UAV-Assisted Vehicle Platoons**  
Yang Liu, Jianshan Zhou, Daxin Tian, Beihang University, China; Zhengguo Sheng, University of Sussex, United Kingdom; Xuting Duan, Guixian Qu, Beihang University, China; Dezhong Zhao, University of Glasgow, United Kingdom
- 5 Platoon-based Vehicle Coordination Scheme for Resolving Sudden Traffic Jam in the IoV Era**  
Ren-Hung Hwang, Van-Linh Nguyen, Chia-Che Tsai, Po-Ching Lin, National Chung Cheng University, Taiwan

## Workshops

All workshops start at 9:00 on 27 September 2021

### W1 - 3rd Workshop on Connected Intelligence for IoT and Industrial IoT Applications- C3IA

- 1 Opening / Welcome**  
Abdellah Chehri, University of Quebec in Chicoutimi- UQAC; Gwanggil Jeon, Incheon National University; Paul Fortier, University Laval; Marco Anisetti, University of Milan
- 2 A Secure and Privacy Preserving Incentive Mechanism for Vehicular Crowdsensing with Data Quality Assurance**  
Fan Li, Xiaoru Li, Yuchuan Fu, Pinan Zhao, Sha Liu, Xidian University, China
- 3 Fed-BEV: A Federated Learning Framework for Modelling Energy Consumption of Battery Electric Vehicles**  
Mingming Liu, Dublin City University, Ireland
- 4 Towards a 5G Mobile Edge Cloud Planner for Autonomous Mobile Robots**  
Taus Raunholt, Ignacio Rodriguez, Preben Mogensen, Aalborg University, Denmark; Morten Larsen, Mobile Industrial Robots, Denmark
- 5 Video-Text Embedding based Multimedia Recommendation for Intelligent Vehicular Environments**  
Taekeun Hong, Chosun University, South Korea; Kiho Lim, William Paterson University of New Jersey, United States; Pankoo Kim, Chosun University, South Korea
- 6 Closing Remarks**  
Abdellah Chehri, University of Quebec in Chicoutimi- UQAC; Gwanggil Jeon, Incheon National University; Paul Fortier, University Laval; Marco Anisetti, University of Milan

### W2 - Workshop on Optical Wireless Communication (OWC)

- 1 Opening / Welcome**  
Xu Li, Huawei Technologies Co. Ltd; Chen Gong, University of Science and Technology of China; Fang Yang, Tsinghua University; Julian Cheng, University of British Columbia
- 2 W2 Keynote**  
Zhengyuan Xu, University of Science and Technology of China
- 3 A Dual-Band Radio-Over-Fiber Link for Future 5G Communication System**  
Fangjing Shi, Yangyu Fan, Xinyuan Wang, Yongsheng Gao, Northwestern Polytechnical University, China
- 4 A Method of Fast M-type Approximation on Probabilistic Shaping for Optical Communication**  
Jiangnan Zhu, Southern University of Science and Technology, China; Li Xu, Yibo Lv, Huawei Technologies Co., Ltd, China; Tao Ye, Southern University of Science and Technology, China

---

### 5 Efficient Line Coding for Low-Power Optical Wireless Communications

Volker Jungnickel, Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute, Germany; Markus Nölle, Hochschule für Technik und Wirtschaft Berlin, Germany; Malte Hinrichs, Ronald Freund, Benjamin Poddig, Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute, Germany

### 6 Indoor 3D Visible Light Positioning With Millimeter Accuracy Based on Dual Cameras

Jiaqi He, Xianqing Jin, Chen Gong, Nuo Huang, Zhengyuan Xu, University of Science and Technology of China, China

### 7 Information Theoretic Limits of Improved ACO-OFDM Receivers

Xiaozhen Liu, Jing Zhou, Nuo Huang, Wenyi Zhang, University of Science and Technology of China, China

### 8 Large Spurious-free Dynamic Range RoF Link with Tunable CSR

Ruiqiong Wang, Yangyu Fan, Jiajun Tan, Yongsheng Gao, Northwestern Polytechnical University, China

### 9 Preliminary Investigation of Air-to-Water Visible Light Communication Link Under Strong Ambient Light

Nuo Huang, Chen Gong, Chunfang Fu, Tianjian Wei, Zhengyuan Xu, University of Science and Technology of China, China

### 10 Throughput and Delay Performance of Cooperative HARQ in Satellite-HAP-Vehicle FSO Systems

Hung Nguyen, Hanoi University of Science and Technology, Vietnam; Hoang Le, The University of Aizu, Japan; Chuyen Nguyen, Hanoi University of Science and Technology, Vietnam; Anh Pham, The University of Aizu, Japan

### 11 Closing Remarks

Xu Li, Huawei Technologies Co. Ltd; Chen Gong, University of Science and Technology of China; Fang Yang, Tsinghua University; Julian Cheng, University of British Columbia

---

## W3 - Beyond Massive MIMO – What is next?

### 1 Opening / Welcome

Luca Sanguinetti, University of Pisa; Merouane Debbah, Technology Innovation Institute

### 2 W3 Keynote

Thomas Marzetta, NYU

### 3 Channel Estimation for Massive MIMO Systems with Lens Antenna Array via Sparse Bayesian Learning

Feng Zhang, Ling Qiu, University of Science and Technology of China, China

### 4 Efficient Power Allocation for MIMO CR-NOMA Networks

Shaima Abidrabba, Huseyin Arslan, Istanbul Medipol University, Turkey

### 5 Fundamental Limits of Wave Control in Smart Environment

Rui Ni, Huawei, China; Merouane Debbah, Huawei, France; Qian Zhu, Xu Li, Ganghua Yang, Huawei, China

### 6 Knowledge-distillation-aided Lightweight Neural Network for Massive MIMO CSI Feedback

Huaze Tang, Jiajia Guo, Southeast University, China; Michail Matthaiou, Queen's University Belfast, United Kingdom; Chao-Kai Wen, National Sun Yat-sen University, China; Shi Jin, Southeast University, China

### 7 Reconfigurable Intelligent Surface for 5G NR Uplink Coverage Enhancement

Visa Tapio, University of Oulu, Finland; Arman Shojaeifard, Ibrahim Hemadeh, Alain Mourad, InterDigital Europe, Ltd, United Kingdom; Markku Juntti, University of Oulu, Finland

### 8 Closing Remarks

Luca Sanguinetti, University of Pisa; Merouane Debbah, Technology Innovation Institute

---

## W4 - 5th IEEE VTC Workshop on 5G Millimeter-Wave Channel Measurement, Models, & Systems

### 1 Opening / Welcome

David G Michelson, University of British Columbia

### 2 5G System-Level Performance Analysis of Uplink Multi-Panel Transmission in mm-Wave Frequencies

Ali Karimidehkordi, Nokia, Germany; Klaus I. Pedersen, Nokia, Denmark

### 3 A method for Forecasting Available Spectrum Resources with Location-dependent Error Margin for Dynamic Spectrum Access

Tatsuya Nagao, Takahiro Hayashi, Yoshiaki Amano, KDDI Research, Inc., Japan

### 4 Channel Measurements and Large Scale Parameter Estimation in a Production Hall

Mathis Schmieder, Fraunhofer Heinrich Hertz Institute, Germany; Henrik Klessig, Robert Bosch GmbH, Germany; Sven Wittig, Alper Schultze, Michael Peter, Fraunhofer Heinrich Hertz Institute, Germany; Wilhelm Keusgen, Technische Universität Berlin, Germany

### 5 Closed-Form Hybrid Beamforming Solution for Spectral Efficiency Upper Bound Maximization in mmWave MIMO-OFDM Systems

Mengyuan Ma, Nhan Nguyen, Markku Juntti, University of Oulu, Finland

### 6 Distributed Channel Estimation Algorithm for mmWave Massive MIMO Communication Systems

Chenyu Zuo, Haoge Deng, Jiyan Zhang, Yuan Qi, Beijing University of Posts and Telecommunications, China

### 7 Measurement-based Analysis and Modeling of Channel Characteristics in an Industrial Scenario at 28 GHz

Yujie Wang, Tao Jiang, Pan Tang, Qidu Song, Xinyu Zhao, Lei Tian, Jianhua Zhang, Baoling Liu, Beijing University of Posts and Telecommunications, China

### 8 Multipath Clusters Observed in Outdoor Open Square Environments at 60 GHz

Minseok Kim, Keiichiro Kumakura, Shuaiqin Tang, Hibiki Tsukada, Niigata University, Japan

### 9 Over-the-Air Verification of Angle-of-Arrival Estimation in Millimeter-Wave Channel Sounders

Sven Wittig, Alper Schultze, Michael Peter, Fraunhofer Heinrich Hertz Institute, Germany; Wilhelm Keusgen, Technische Universität Berlin, Germany

### 10 Closing Remarks

David G Michelson, University of British Columbia

---

---

## W5 - Workshop on Artificial Intelligence for Autonomous Vehicular Mobile Networks

### 1 Opening / Welcome

Yu-Jia Chen, National Central University; Zehui Xiong, Singapore University of Technology and Design; Chun-Hung Liu, Mississippi State University; Ying Loong Lee, University Tunku Abdul Rahman; Zhijin Qin, Queen Mary University of London

### 2 W5 Keynote: Deep Learning in Physical Layer Communications

Geoffrey Ye Li, Imperial College London

### 3 Peak Age of Information Minimization in UAV-assisted Cognitive Relay Networks

Shengnan Cao, Xiangdong Jia, Yixuan Guo, Northwest Normal University, China

### 4 Towards Cost-efficient Reliable Vehicle-MEC Connectivity for B5G Mobile Networks: Challenges and Future Directions

Priyanka Pathak, Riccardo Trivisonno, Huawei Technologies, Germany; Marius Pesavento, Technische Universität Darmstadt, Germany; Clarissa Cassales Marquezan, Huawei Technologies, Germany

### 5 Closing Remarks

Yu-Jia Chen, National Central University; Zehui Xiong, Singapore University of Technology and Design; Chun-Hung Liu, Mississippi State University; Ying Loong Lee, University Tunku Abdul Rahman; Zhijin Qin, Queen Mary University of London

---

## W6 - The 3rd International Workshop on Intelligent Communication Network Technologies (ICNET-3)

### 1 Opening / Welcome

Syed Hassan Ahmed, JMA Wireless; Yalew Zelalem Jembre, Keimyung University; Muhammad Toaha Raza Khan, Kyungpook National University

### 2 An Enhanced Multi-Carrier Waveform for Downlink Short-Packet Communication

Siyang Lv, Sen Wang, Jing Jin, Qixing Wang, Yifei Yuan, Guangyi Liu, China Mobile Research Institute, China

### 3 A Two-layer Collaborative Vehicle-Edge Intrusion Detection System for Vehicular Communications

Parya Haji Mirzaee, Mohammad Shojafar, Hamidreza Bagheri, Tsz Hin Chan, Haitham Cruickshank, Rahim Tafazolli, University of Surrey, United Kingdom

### 4 Discernible Effect of Video Quality for Distorted Vehicle Detection using Deep Neural Networks

Muhammad Altaf, Fasih Ur Rehman, Omer Chughtai, COMSATS University Islamabad, Pakistan

### 5 Hardware Testbed based Analytical Performance Modelling for Mobile Task Offloading in UAV Edge Cloudlets

Gaurang Bansal, National University of Singapore, Singapore; Abhishek Tyagi, Vishnu Narayanan, Vinay Chamola, Birla Institute of Technology, India

### 6 Optimal Routing Protocol For Efficient Communication in a Social Vehicular Content-Centric Network

Ayesha Siddiq, Shahnaila Rahim, Kyungpook National University Daegu, Korea, South Korea; Hafsa Maryam, University of Cyprus, Cyprus; Madiha Umar, National University of Computer and Emerging Sciences, Pakistan

### 7 Closing Remarks

Syed Hassan Ahmed, JMA Wireless; Yalew Zelalem Jembre, Keimyung University; Muhammad Toaha Raza Khan, Kyungpook National University

---

## W7 - Workshop on Integrated Sensing and Communication towards 6G

### 1 Opening / Welcome

Weijie Yuan, Southern University of Science and Technology; Yuanhao Cui, Qixun Zhang, Beijing University of Posts and Telecommunications; Qing Wang, Tianjin University

### 2 Design of NOMA Sparse Signature Matrix for 6G Integrating Sensing and Communications Networks

Kun Lu, Hongwen Yang, Beijing University of Posts and Telecommunications, China

### 3 Embedding the Radio Imaging in 5G Networks: Signal Processing and an Airport Use Case

Bo Sub, Bo Tan, Wenbo Wang, Mikko Valkama, Elena-Simona Iohan, Tampere University, Finland

### 4 Exploitation Analysis of Byzantine attack for Cooperative Spectrum Sensing

Jipeng Gan, Jun Wu, Hangzhou Dianzi University, China

### 5 Joint Neighbor Discovery and Positioning for Unmanned Aerial Vehicle Networks

Qi Wu, Zhiqing Wei, Beijing University of Posts and Telecommunications, China; Chengkang Pan, Jianjun Liu, China Mobile Research Institute, China; Jinyu Wang, Beijing University of Posts and Telecommunications, China; Ailing Wang, China Mobile Research Institute, China

### 6 Joint Radar and Communication based Blind Signal Separation using a New Non-Linear Function for Fast-ICA

Ahmed Naeem, Huseyin Arslan, Istanbul Medipol University, Turkey

### 7 Millimeter Wave Integrated Sensing and Communication with Hybrid Architecture in Vehicle to Vehicle Network

Siyuan Wang, Risheng Chen, Lou Zhao, Chunshan Liu, Hangzhou Dianzi University, China

### 8 Particle Filter based Predictive Beamforming for Integrated Vehicle Sensing and Communication

Zhihao Ying, Yuanhao Cui, Junsheng Mu, Xiaojun Jing, Beijing University of Posts and Telecommunications, China

### 9 Symbiotic Sensing and Communications Towards 6G: Vision, Applications, and Technology Trends

Zhiqin Wang, Kaifeng Han, Jiamo Jiang, China Academy of Information and Communications Technology, China; Zhiqing Wei, Beijing University of Posts and Telecommunications, China; Guangxu Zhu, Shenzhen Research Institute of Big Data, China; Zhiyong Feng, Beijing University of Posts and Telecommunications, China; Jianmin Lu, Huawei Technologies Co., Ltd., Shenzhen, China; Chunwei Meng, Beijing University of Posts and Telecommunications, China

---

**10 UAV Aided Integrated Sensing and Communications**

Kexin Zhang, Chao Shen, Beijing Jiaotong University, China

**11 Waveform-Defined Privacy: A Signal Solution to Protect Wireless Sensing**

Tongyang Xu, University College London, United Kingdom

**12 WirelessID: Device-Free Human Identification Using Gesture Signatures in CSI**

Ronghui Zhang, Sheng Wu, Beijing University of Posts and Telecommunications, China; Chunxiao Jiang, Tsinghua University,

China; Yuanhao Cui, Xiaojun Jing, Beijing University of Posts and Telecommunications, China

**13 Closing Remarks**

Weijie Yuan, Southern University of Science and Technology; Yuanhao Cui, Qixun Zhang, Beijing University of Posts and Telecommunications; Qing Wang, Tianjin University

---

## W8 - Emerging Physical-layer Security Technologies and Applications for B5G and 6G

**1 Opening / Welcome**

Eduard Axel Jorswieck, Technische Universitaet Braunschweig; Guyue Li, Southesast University; Junqing Zhang, University of Liverpool

**2 W8 Keynote**

Xianbin Wang, Western University

**3 A Lightweight Protocol for Validating Proximity in UHF RFID Systems**

Chrysanthi Paschou, Oliver Johnson, University of Bristol, United Kingdom; Ziming Zhu, Toshiba Europe Ltd, United Kingdom; Angela Doufexi, University of Bristol, United Kingdom

**4 Virtual Private Mobile Network with Multiple Gateways for B5G Location Privacy**

Stefano Tomasin, Javier German Luzon Hidalgo, University of Padova, Italy

**5 Data desensitization mechanism of Android application based on differential privacy**

Xinzhao Jiang, Yubo Song, Rui Song, Aiqun Hu, Southeast University, China

**6 ROLIG3A: Protecting Group Secret Key Generation Procedures against Malicious Attackers**

Mengyi Zhang, Yan Zhang, Zijie Ji, Kun Lin, Zunwen He, School of Information and Electronics, Beijing Institute of Technology, China

**7 On the Security of RIS-assisted Manipulating Attack in MISO systems**

Hongyi Luo, Guyue Li, Lei Hu, Southeast University, China

**8 Secure UAV-enabled OFDMA Communications**

Jie Sun, Zhichao Sheng, Shanghai University, China; Ali Arshad Nasir, King Fahd University of Petroleum and Minerals, Saudi Arabia; Hao Wei, ZTE Cooperation, China; Yong Fang, Shanghai University, China; Ali Hussein Muqaibel, King Fahd University of Petroleum and Minerals, Saudi Arabia

**9 CSI Measurement and Reciprocity Evaluation Method Based on Embedded Platform**

Chenlu Li, China; Yu Jiang, Aiqun Hu, Southeast University, China

**10 Closing Remarks**

Eduard Axel Jorswieck, Technische Universitaet Braunschweig; Guyue Li, Southesast University; Junqing Zhang, University of Liverpool

---

## W9 - High Mobility Wireless Communications and Applications

**1 Opening / Welcome**

Xiaoqing Huang, University of Technology, Sydney; Jinhong Yuan, University of New South Wales; Yi Hong, Monash University

**2 Comparing Precoded MC-CDMA and OTFS for High-Speed V2X Communications**

Dibyajyoti Basak, S. Sruti, K. Giridhar, Indian Institute of Technology Madras, India

**3 Doppler Shift Estimation Based Channel Estimation for Orthogonal Time Frequency Space System**

Yixiao Li, Beijing University of Posts and Telecommunications, China; Sen Wang, Jing Jin, China Mobile Research Institute, China; Wei Xiang, La Trobe University, Australia; Hang Long, Beijing University of Posts and Telecommunications, China

**4 Frequency Domain Pilot-Aided Channel Estimation for OTFS over Fast Fading Channels**

Hongyang Zhang, Xiaoqing Huang, Andrew Zhang, University of Technology Sydney, Australia

**5 Joint Iterative Channel Estimation and Symbol Detection for Orthogonal Time Frequency Space Modulation**

Ge Guo, Zengyuan Jin, Xiaoying Zhang, Jibo Wei, School of Electronic Science and Engineering, National University of Defense Technology, China

**6 OFDM with Enhanced Layered Index Modulation**

Xiaoyan Ning, Bo Zhang, Zhenduo Wang, Harbin Engineering University, China

**7 Signal Detection of Universal Filtered Multicarrier Modulation in Rapidly Time Varying Channels**

Fuping Si, Jianping Zheng, Changju Chen, State Key Lab of ISN, Xidian University, China

**8 Why is OTFS better than OFDM for High Mobility Scenarios?**

Saif Khan Mohammed, Indian Institute of Technology Delhi

**9 Closing Remarks**

Xiaoqing Huang, University of Technology, Sydney; Jinhong Yuan, University of New South Wales; Yi Hong, Monash University

---

## W10 - Autonomous Vehicular Networking (WAVN)

**1 Opening / Welcome**

Jie Gao, Marquette University; Tom H. Luan, Xidian University; Hongbin Liang, Southwest Jiaotong University; Lian Zhao, Ryerson University

**2 Keynote Speaker 1**

Zhiyong Feng, BUPT

**3 Keynote Speaker 2**

Richard Yu, Carleton University

**4 An Efficient Lightweight Anonymous Authentication Scheme for V2G Using Physical Unclonable Function**

Jiang Zhizhong, Zhou Zheng, Xiong Ling, Xihua University, China; Zhou Limengnan, University of Electronic Science and Technology of China, China

---

---

**5 BACPPA: An Effective Blockchain-Assisted Conditional Privacy-Preserving Authentication Scheme for Vehicular Ad Hoc Networks**

Xingyu He, Xihua University, China; Xianhua Niu, Xihua University/University of Electronic Science and Technology of China, China; Ling Xiong, Yangpeng Wang, Xihua University, China

**6 Deep Learning Based Traffic Flow Prediction for Autonomous Vehicular Mobile Networks**

Syed Ammad Ali Shah, Xavier Fernando, Kandasamy Illanko, Ryerson University, Canada

**7 Efficient Authentication for Vehicular Digital Twin Communications**

Jing Xu, Chao He, Tom.H Luan, Xidian University, China

**8 Taxi Dispatch and AEV Management in AEV Taxi Services**

Dafei Zhao, Binod Vaidya, Hussein Mouftah, University of Ottawa, Canada

**9 Closing Remarks**

Jie Gao, Marquette University; Tom H. Luan, Xidian University; Hongbin Liang, Southwest Jiaotong University; Lian Zhao, Ryerson University

---

## W11 - Evolution of Non-Terrestrial Networks toward 6G

**1 Opening / Welcome**

Wen Tong, Huawei Technologies Co., Ltd.; Halim Yanikomeroglu, Carleton University; Jun Wang, Huawei Technologies Co., Ltd.

**2 W11 Keynote: Making Massive MIMO Easy for Broadband Satellite Access: From Theory to Practice**

Riccardo De Gaudenzi, ESA/ESTEC; Petar Popovski, Aalborg University

**3 Application of HBF with Adaptive Port Mapping for LEO Satellite Communication Systems**

Roman Semernya, Vladimir Lyashev, Huawei Technologies, Co. Ltd., Russia

**4 Beam Switching Solutions for Beam-Hopping Based LEO System**

Shaohui Sun, Liming Hou, Deshan Miao, China Academy of Telecommunications Technology (CATT), China

**5 Centralized Gateway Concept for Precoded Multi-beam GEO Satellite Networks**

Steven Kisseleff, Eva Lagunas, Jevgenij Krivochiza, Jorge Querol, Nicola Maturò, Liz Martinez Marrero, Juan Merlano-Duncan, Symeon Chatzinotas, University of Luxembourg, Luxembourg

**6 Deep Reinforcement Learning Based Power Allocation for High Throughput Satellites**

Nuoyi Dai, Di Zhou, Jiandong Li, Xidian University, China

**7 Exploiting Edge Computing in Internet of Space Things Networks: Dynamic and Static Server Placement**

Zhibo Yan, Nanjing University, China; Tomaso Cola, German Aerospace Center, Germany; Kanglian Zhao, Wenfeng Li, Sidan Du, Nanjing University, China; Hong Yang, China Academy of Space Technology, China

**8 W11 Keynote:**

**Enhance 6G Satellite System Service Coverage**  
Jiandong Li, Xidian University

**9 W11 Keynote:**

**Evolution of Non-Terrestrial Networks Towards 6G**  
Nicolas Chuberre, Thales Alenia Space

**10 Key Competence Analysis of Non-Terrestrial Network-Based Cellular Backhaul**

Tianyang Cao, Yaoming Huang, Jing Wang, Tianxiang Ji, Songtao Huang, Shuangbo Zhou, China Mobile Group Design Institute, China

**11 Massive MIMO Downlink Transmission for LEO Satellite Communications**

Ke-Xin Li, Li You, Jiaheng Wang, Xiqi Gao, Southeast University, China; Christos G. Tsinos, Symeon Chatzinotas, Björn Ottersten, University of Luxembourg, Luxembourg

**12 On the beamforming of LEO earth fixed cells**

Feiran Zhao, Ying Chen, Rong Li, Jun Wang, Huawei, China

**13 Resource Scheduling and Offloading Strategy Based on LEO Satellite Edge Computing**

Kaixiang Wei, Qingqing Tang, Jing Guo, Ming Zeng, Zesong Fei, Beijing Institute of Technology, China; Qimei Cui, Beijing University of Posts and Telecommunications, China

**14 Techno-Economic Design Aspects of Satellite Mega-Constellations for 6G Services**

Kevin T. Li, Christian A. Hofmann, Florian Völk, Andreas Knopp, Universität der Bundeswehr München, Germany

**15 Closing Remarks**

Hejia Luo, Huawei

---

## W12 - Workshop on V2X Technology Evolution towards 5G-Advanced (5.5G V2X)

**1 Opening / Welcome**

Shaobo Wang, Huawei Technologies; Lajos Hanzo, University of Southampton; Robert W. Heath Jr., North Carolina State University; Shaoshi Yang, Beijing University of Posts and Telecommunications

**2 W12 Keynote**

Wei Ye, Huawei Technologies

**3 Asymptotic Performance Analysis for mmWave V2X Cellular Networks**

Yi Zhang, Zhengzheng Xiang, Lei Lu, Huawei Technologies Co., Ltd., China; Shuai Han, Weixiao Meng, Harbin Institute of Technology, China

**4 A Task Partitioning and Offloading Scheme in Vehicular Edge Computing Networks**

Wen Qi, Xu Xia, Heng Wang, Yanxia Xing, China Telecom Research Institute, China

**5 Device Selection of Distributed Primal-Dual Algorithms Over Wireless Networks**

Zhaohui Yang, University College London, United Kingdom; Chongwen Huang, Zhejiang University, China; Hao Xu, Technical

University of Berlin, Germany; Wei Xu, Southeast University, China; Yue Cao, Wuhan University, China

**6 Multi-Path Routing Protocol for the Video Service in UAV-Assisted VANETs**

Caijin Zhao, Qingwei Zeng, Yuliang Tang, Xiamen University, China; Bo Yang, Shanghai Jiao Tong University, China

**7 Resource Allocation Based on Three-Sided Matching Theory in Cognitive Vehicular Networks**

Shuhui Wen, Wei Liang, Northwestern Polytechnical University, China; Jingjing Cui, University of Southampton, United Kingdom; Dawei Wang, Lixin Li, Northwestern Polytechnical University, China

**8 Variable Frame Splitting for Polar Coded MIMO E-SDM in Fast Fading Channel**

He He, Chiba University, Japan; Shun Kojima, Utsunomiya University, Japan; Kazuki Maruta, Tokyo Institute of Technology, Japan; Kentaro Yonei, Chiba University, Japan

---





**VTC2021-Fall**  
**ONLINE**  
Connecting the Mobile World



**IEEE**

