VTC2021-Spring
Final Program

2021 IEEE 93rd Vehicular Technology Conference
25 – 28 April 2021 • Virtual Event

The flagship conference of IEEE Vehicular Technology Society

IEEE VTS

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Welcome from the General Chair

On behalf of the organizing committee it is my honor to welcome you to VTC2021-Spring. While this is already the third virtual edition of the Vehicular Technology Society flagship conference, we have received a notable amount of high-quality submissions providing a basis for an excellent technical program. On top of the cutting-edge research in vehicular technology presented in technical tracks, we are bringing together in panels, keynotes and tutorials widely acknowledged and valued experts and visionaries. As is known, the Vehicular Technology Conference follows closely the recent progress in both academic and industry research domains, the most visible topics in this spring being 5G and its applications, and emerging ideas for 6G. A very interesting development also takes place in industry verticals while, in parallel, the discussion on the evolution – or revolution – beyond 5G is bringing forward fundamentally new ideas.

Even though being virtual, we are confident that VTC2021-Spring provides the research community a stimulating opportunity for gaining understanding on the recent progress in the field. It is fascinating to see how a conference of this size and tradition can be executed using digital tools. Yet, we also look forward to invite you to an onsite conference in Helsinki when the global pandemic is behind us.

Organizing a world-class conference is possible only with a dedicated team. I thank General Co-Chair Merouane Debbah and Honorary Chair Pertti Lukander. Special recognition for the Technical Program Chair Mikko Valkama and Co-Chairs Rui Dinis and Daniel B. da Costa. I also give my appreciation to other members of the organizing committee and recall that this conference would not be possible without a large number of TPC members and reviewers who dedicate their time to ensure a high-quality review process. Finally, I want to recall an important aspect: Solid and professional support from Vehicular Technology Society have tremendously simplified the work of the Program Committee. Many thanks for conference administrators Rodney C. Keele and Cerry Leffler, Publication Chair James Irvine, and Financial Chair J. R. Cruz.

Welcome to VTC, the flagship conference of the Vehicular Technology Society.

Jyri Hämäläinen
General Chair, IEEE VTC2021-Spring

Welcome from the TPC Co-chairs

On behalf of the Technical Program Committee, we would like to welcome you to the 93rd IEEE Vehicular Technology Conference (VTC2021-Spring) 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, as well as many other emerging topics. We received a total of 653 paper submissions, out of which 387 outstanding papers will be presented in 12 technical tracks and the recent results track that comprise the IEEE VTC2021-Spring technical program. In addition to the regular and recent results sessions, the conference will feature 11 topical workshops, 15 tutorials delivered by the leading experts in the field, a balanced mix from industry and academia of four extraordinary keynote speakers, and two exceptional plenary keynote panels entitled ‘Global View on 6G’ and ‘Connecting the Unconnected’. Additionally, the conference features an exciting and very timely Industry Panel entitled ‘6G Architecture to Connect the Worlds’.

We would like to use this opportunity to thank all co-chairs of the 12 technical tracks 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 was completed smoothly. We also sincerely thank the workshop organizers for putting together the set of very timely workshops and organizing the review process in a professional manner. We would like to thank the members of the IEEE VTC2021-Spring 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. We also sincerely thank the keynote speakers and panelists for contributing to the VTC2021-Spring program. 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 together virtually. Let’s learn, interact, and enjoy!

Mikko Valkama, Rui Dinis and Daniel B. da Costa
TPC Co-chairs, IEEE VTC2021-Spring

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 93rd Vehicular Technology Conference – VTC2021-Spring. The conference alsomarks our third VTC to be held virtually, as a result of continuation of COVID-19 pandemic started in early 2020.

This year's Spring 2021 edition of the Vehicular Technology Conference series will provide attendees with a superb collection of over 450 technical paper presentations,tutorials, plenary talks, and workshops, all in a virtual format. With the current COVID-19 global health crisis, the VTS Board of Governors has decided to convert IEEE VTC2021-Spring, to a fully virtual conference for the original date, 25 – 28 April 2021. We do realize that this formula will not allow to reproduce the professional networking environment that you are used to, but it will allow VTC2021-Spring 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.

This conference marks interesting keynote talks from renowned scientists including Muriel Medard (MIT), Peter Vetter (Nokia), Gerhard Fettweis (Dresden TU), and Wen Tong (Huawei), as well as an evening panel on 6G architecture organized by Volker Ziegler (Nokia Bell Labs), Day 3 Plenary Panel on 6G moderated by Mikko Uusitalo, Matti Latva-Aho (Oulu), David Gesbert (Eurocom), Peiying (Huawei), and finally a Plenary Panel moderated by Slim Alouini (KAUST). The conference will be also complemented by 15 rich Tutorials and 11 Workshops on most important emerging technologies in the field.

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 understand the fact that conferences are important factor in publications of 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-Spring in normal times involves a large and highly dedicated team of volunteers, and with the change from a physical to a 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 Honorary Chair Pertti Lukander, Nokia Bell Labs; General Co-Chairs Merouane Debbah, Huawei and Jyri Hämäläinen, Aalto University; Haris Gacanin, Technical Program Chair Mikko Valkama, Tampere University; Technical Program Vice-Chairs Rui Dinis, Universidade Nova of Lisbon and Daniel B. da Costa, Federal University of Ceará; and the rest of the conference organizing team for their time, effort, dedication, and commitment for making VTC2021-Spring one of the premier "virtual" international events in vehicular technology!

Last but not least, I would like to thank our Platinum sponsors, Huawei and Nokia, for their support for the conference. VTC is at the forefront of mobility technology, and industry involvement is a critical enabler for this.

I am looking forward to the end of pandemic and seeing all of you at the next IEEE VTC, where we will be Connecting the Mobile World together! Enjoy the IEEE VTC2021-Spring and stay safe.

Abbas Jamalipour, *President*
IEEE Vehicular Technology Society

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Zhiqiang Yuan
Hao Yue
Chau Yuen
Yuhao
Tang Yuliang
Noman Zahid
Alenka Zajic
Alberto Zanella
Alessio Zappone
Thomas Zemen
Deze Zeng
Guangyang Zeng
Hao Zeng
Chao Zhai
Andrew Zhang
Chenyu Zhang
Chuan Zhang
Di Zhang
Jin Zhang
Long Zhang
Siwei Zhang
Tingting Zhang
Xinchang Zhang
Xinxiang Zhang
Yao Zhang
Yong Zhang
Yue Zhang
Yunchuan Zhang
Zhaoji Zhang
Haitao Zhao
Kun Zhao
Yifeng Zhao
Yinan Zhao
Jianchao Zheng
Bo Zhou
Guangxia Zhou
Jiafeng Zhou
Ming Zhou
Tao Zhou
Xiangyun Zhou
Xiaohui Zhou
Yi Zhou
Zhou Zhou
Haiting Zhu
Xiaoyuan Zhu
Simone Zocca
Sai Zou
Jasmina Zubaca

Tutorials

A range of tutorials will be held on Sunday 25 April 2021 given by experts from industry and academia.

Sunday, 25 April 2021 13:00-16:00 UTC

T1: Backscatter Communications

Riku Jäntti

Backscatter communications offer a way to develop low-cost sustainable and secure connectivity solution for future IoT systems. This tutorial goes through the basic principles and deployment options of the technology including ambient, interscatter, symbotic, and quantum microwave cases.

Riku Jäntti (M'02 – SM'07) is a Full Professor of Communications Engineering and the head of the department of Communications and Networking at Aalto University School of Electrical Engineering, Finland. He received his M.Sc (with distinction) in Electrical Engineering in 1997 and D.Sc (with distinction) in Automation and Systems Technology in 2001, both from Helsinki University of Technology (TKK). Prior to joining Aalto(formerly known as TKK) in August 2006, he was professor pro tem at the Department of Computer Science, University of Vaasa. Prof. Jäntti is a senior member of IEEE and associate editor of IEEE Transactions on Vehicular Technology. He is also IEEE VTS Distinguished Lecturer (Class 2016). The research interests of Prof. Jäntti include machine type communications, cloud based radio access networks, backscatter communications, quantum communications, and radio frequency inference.

Sunday, 25 April 2021 13:00-16:00 UTC

T2: 5G and Beyond for Robotics and Automation: Challenges and Opportunities

Zhibo Pang, Guodong Zhao and Emma Li

Robotics and automation technologies have extensively developed in the past decades, where advanced robots have been widely used in industry, space exploration, etc. However, remotely operating robots and machines via communication networks still lag behind, where most workers in current pandemic cannot remotely carry out manufacturing and industrial tasks. In this tutorial, we will discuss fundamental technical challenges and potential solutions on teleoperation, which would enable people to remotely operate robots/machines. Specifically, we start from industrial perspective and introduce the basic requirements of wireless communications in Industry 4.0 and remote healthcare, where specific robotic use cases will be provided. Then, from academic perspective, we review the recent advances of Ultra-Reliable and Low-Latency Communications (URLLC) in 5G and discuss the challenges of supporting robotics and automation in 5G and beyond. In particular, we will provide the in-depth discussion of communication control co-design, where AI and digital twin are used to decouple the control loop between operator and robot. As a result, latency, reliable and scalability issues are excepted to be addressed. Finally, we discuss the security issue and solutions, which affect operation safety in robotics and automation.

Dr. Zhibo Pang (M'13, SM'15) received MBA in Innovation and Growth from University of Turku in 2012 and PhD in Electronic and Computer Systems from the Royal Institute of Technology (KTH) in 2013. He is currently a Senior Principal Scientist at ABB Corporate Research Sweden, Adjunct Professor at University of Sydney, and Affiliated Faculty and PhD Supervisor at the Royal Institute of Technology (KTH). Before joined ABB, he was co-founder and CTO of startups such as Ambigua Medito AB. He is a Senior Member of IEEE and Co-Chair of the Technical Committee on Industrial Informatics. He is Associate Editor of IEEE Transactions on Industrial Informatics, IEEE Journal of Biomedical and Health Informatics, and IEEE Journal of Emerging and Selected Topics in Industrial Electronics, and was Guest Editor of Proceedings of the IEEE, IEEE Internet of Things Journal, and IEEE Reviews in Biomedical Engineering, etc.. He was awarded the "2016 Inventor of the Year Award" and "2018 Inventor of the Year Award" by ABB Corporate Research Sweden. He has been working on high performance wireless communications (WirelessHP) for critical control systems with microsecond level packet transmission time and 10e-6 level packet error rate which is 20+ times beyond the start-of-the-art industrial wireless solutions. Another ongoing effort from him is on disruptive communication and computing solution for future mobile robotics in manufacturing and service scenarios.

Dr. Guodong Zhao (SM'16) received his Ph.D. Degree from Beihang University, Beijing, China, in 2011. He visited the Hong Kong University of Science and Technology, Hong Kong, in 2012-2013, and Lehigh University, USA, in 2016. Now, he is a lecturer at University of Glasgow, UK and a member of Scotland 5G Centre, UK. His current research interests are within the areas of wireless communications and robotics. He published over 50 papers in IEEE journals and conferences. In 2012, he received the best paper award from IEEE Global Telecommunication Conference (Globecom 2012) and the best Ph.D. thesis award from Beihang University. He served as a TPC at many international conferences, e.g., ICC and VTC. He also served as a reviewer in many IEEE transactions, e.g., IEEE Transactions on Signal Processing and IEEE Journal on Selected Areas in Communications.

Dr. Emma Li received her Ph.D. Degrees in Electrical Engineering from University of Electronic Science and Technology of China (UESTC) in 2011. She visited Lehigh University, PA, USA, in 2016. In 2011-2019, she worked as an assistant/associate professor with the School of Automation Engineering, University of Electronic Science and Technology of China (UESTC). Now she is a senior lecturer at Northumbria University Newcastle, UK. Her current research interests are within the areas of 5G and 6G communications.

Sunday, 25 April 2021 13:00-16:00 UTC

T3: Cellular Networks for Safe Drone Operations

Aymen Fakhreddine and Evgenii Vinogradov

Small drones are becoming a part of our everyday life. They are used in a wide variety of commercial applications, and the number of drones in the air is steadily growing. We believe that the IEEE VTS community will be interested in a tutorial on this timely and motivating topic. The tutorial consists of two main parts dedicated to i) a general introduction to the wireless support of UAVs conflict management and ii) an experimental analysis of the current cellular networks readiness for ensuring safe UAV use. We start this tutorial with a brief introduction describing the most promising drone-enabled use cases. To guarantee the safe operation of drones, traffic management rules must be designed and implemented by avionics and telecommunication experts. In this tutorial, we describe the common terminology for these two communities. The first part (by E.Vinogradov) is concluded by formulating the main requirements imposed by safe drone operations to the cellular networks. The second part (by A. Fakhreddine) motivates through extensive measurement campaigns the potential of 4G and 5G networks for drones communications while it depicts the challenges that must be addressed to guarantee drones safe operations.

Aymen Fakhreddine holds a doctoral and master degree in telematic engineering from the University Carlos III of Madrid (Spain) with expertise in wireless communications, networking, and localization. He is a senior researcher at Lakeside Labs (Klagenfurt, Austria) working on cellular-connected drone systems. He previously held a similar position at the University of Klagenfurt, worked as a researcher at IMDEA Networks Institute (Madrid, Spain) and a visiting researcher at the Singapore University of Technology and Design. He also holds a master degree in advanced wireless communication systems from École Supérieure d'Électricité (CentraleSupélec) in Paris (France) and an engineering degree in Telecommunications from INPT Rabat.

Evgenii Vinogradov received the Dipl. Engineer degree in Radio Engineering and Telecommunications from Saint-Petersburg Electro-technical University (Russia), in 2009. After several years of working in the field of mobile communications, he joined UCLouvain (Belgium) in 2013, where he obtained his Ph.D. degree in 2017. His doctoral research interests focused on multidimensional radio propagation channel modeling. In 2017, Evgenii joined the electrical engineering department at KU Leuven (Belgium) where he is working on wireless communications with UAVs and UAV detection. He has also authored several tutorials (during ICC'19, EuCAP'19, and IE'19) dedicated to various aspects of wireless communications with drones. Moreover, he actively participated in SESAR (Single European Sky ATM Research) project PercEvite. This resulted in a clear understanding of the regulators' needs and goals.

Sunday, 25 April 2021 13:00-16:00 UTC

T4: Tutorial on Tools and Techniques for URLLC Towards Beyond-5G Systems

Nurul Huda Mahmood and Italo Atzeni

With the increasing digitalization of our society, many machines need to be connected to the network and operate autonomously without

human intervention. Machine-type communications applications can have rather diverse requirements, ranging from stringent quality of service (QoS) demands (in terms of reliability and latency) to massive connectivity. 5G networks are inherently designed to support machine-type communications with two novel dedicated service classes. On the one hand, ultra-reliable low-latency communications (URLLC) target highly reliable data transmissions with very low latencies, which are mainly geared towards mission-critical applications such as vehicle-to-everything (V2X) communications. On the other hand, massive machine-type communications (mMTC) are designed to serve a large number of devices with sporadic traffic.

This tutorial will provide a holistic overview of URLLC, including the implementation and research challenges, the enablers, and the expected evolution towards beyond-5G and 6G wireless systems. After providing a basic introduction of URLLC, we will present the implementation and the research aspects, including the main key performance indicators (KPIs), the fundamental throughput-reliability-latency tradeoff, and the primary challenges. Then, we will discuss the main URLLC enablers, ranging from the system design enhancements introduced by the 5G New Radio (NR) standard to novel solutions driven by communication theory, machine learning, and artificial intelligence. Subsequently, we will detail the most important URLLC solutions enabled by multi-antenna technologies, such as massive MIMO, coordinated multi-point (CoMP), and millimeter wave (mmWave) communications. Finally, we will discuss the expected evolution of URLLC, with special focus on the potential 6G applications.

Dr. Nurul Huda Mahmood was born in Bangladesh. He received the PhD degree in Communications Theory from the Norwegian University of Science and Technology (NTNU), Norway in 2013. In 2012–2018, he was with the Wireless Communications Networks (WCN) section at Aalborg University (AAU), Denmark, involved in teaching and research activities. At AAU, he last held the position of Associate Professor. He also served as an external research contractor with Nokia Bell Labs, Aalborg. Currently, he is a Senior Research Fellow at the Centre for Wireless Communications (CWC), University of Oulu, Finland, where he is part of the Machine-Type Wireless Communications research group and is involved in the 6G Flagship (https://www.oulu.fi/6gflagship/) program. He has authored/co-authored around 70 peer-reviewed publications, including about 20 papers on topics directly related to the contents of this tutorial. He is a co-recipient of the Best Student Paper Award at IEEE VTC Spring 2019. His research interests include resource optimization techniques with focus on URLLC and mMTC, as well as modeling and performance analysis of wireless communication systems.

Dr. Italo Atzeni received the MSc degree (Hons.) in telecommunications engineering from the University of Cagliari, Italy, in 2010, and the PhD degree (Hons.) in signal theory and communications from the Polytechnic University of Catalonia–BarcelonaTech, Spain, in 2014. Since 2019, he is with the Centre for Wireless Communications, University of Oulu, Finland, where he is a Senior Research Fellow and Adjunct Professor. From 2014 to 2017, he was a Researcher with the Mathematical and Algorithmic Sciences Laboratory, Paris Research Center, Huawei Technologies, France. From 2017 to 2018, he was a Research Associate with the Communication Systems Department, EURECOM, France. He has previously held a research appointment at The Hong Kong University of Science and Technology, Hong Kong, in 2013. His primary research interests are in communication and information theory, statistical signal processing, convex and distributed optimization theory, and their applications to decentralized decision making in heterogeneous wireless communication networks. He received the Best Paper Award in the Wireless Communications Symposium at IEEE ICC 2019. He was granted the MSCA-IF grant for the project "Device-Centric Low-Complexity High-Frequency Networks" (DELIGHT) in 2020.

Sunday, 25 April 2021 13:00-16:00 UTC

T5: Terahertz Communications: Myths, Challenges and Opportunities

Josep M. Jornet and Vitaly Petrov

Terahertz (THz)-band (0.1-10 THz) communication is envisioned as a key wireless technology of the next decade. The THz band will help overcome the spectrum scarcity problems and capacity limitations of current wireless networks, by providing an unprecedentedly large bandwidth which can enable applications including Terabit-per-second backhaul systems, ultra-high-definition content streaming among mobile devices, and wireless high-bandwidth secure communications. In addition, the very small wavelength at THz frequencies enables the development of miniature radios, which can be utilized for new networking paradigms such as wireless massive-core computing architectures, wireless nanosensor networks for biomedical applications, and the Internet of Nano-Things.

In this tutorial, the specifics of THz device technology and THz wireless channel are first revealed, debunking some long-established myths through state-of-the-art experimental results. Then, the key aspects of designing the physical layer solutions for THz communication systems are explained. Later, the existing approaches are introduced to build reliable and efficient link-layer solutions for ultra-directional ultra-broadband THz systems. Finally, the recent standardization and regulatory advantages, including THz passive and active service coexistence, are discussed, highlighting the possible opportunities to integrate THz communication systems into a landscape of upcoming beyond-5G and 6G technologies. The tutorial ends up with a discussion of the open problems and research directions in this rising field.

Josep M. Jornet is an Associate Professor in the Department of Electrical and Computer Engineering, the Director of the Ultrabroadband Nanonetworking Laboratory and a member of the Institute for the Wireless Internet of Things 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 Politecnica 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. From August 2013 and August 2019, he was an Assistant Professor with the Department of Electrical Engineering at the University at Buffalo, The State University of New York. His current research interests are in Terahertz-band communication networks, Wireless Nano-bio communication Networks and the Internet of Nano-Things. In these areas, he has co-authored more than 180 peer-reviewed scientific publications, 1 book, and has also been granted 3 US patents, which accumulate over 8,500 citations (h-index of 42) as of October 2020. He is serving as the lead PI 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 and UB.

Vitaly Petrov is a Senior Standardization Specialist and 3GPP RAN1 delegate with Nokia Bell Labs, Helsinki, Finland. He received the Specialist degree (2011) from SUAI University, St. Petersburg, Russia, the M.Sc. degree (2014) from Tampere University of Technology, Finland, and the Dr. Sc. (PhD) degree (2020) from Tampere University, Finland. His research interests are in beyond-5G wireless systems, millimeter wave and terahertz band communication networks. He co-authored more than 40 peer-reviewed scientific publications and several book chapters in this fields that received over 1,500 citations (h-index of 22). Vitaly is the recipient of the Best Student Paper Award at IEEE VTC-Fall'15, Best Student Poster Award at IEEE WCNC'17, and Best Student Journal Paper Award from IEEE Finland, 2018.

Sunday, 25 April 2021 13:00-16:00 UTC

T6: Softwarization and Virtualization in 5G and Beyond Mobile Networks

Fabrizio Granelli and Frank Fitzek

The aim of the tutorial is to illustrate how the emerging paradigms of Software Defined Networking, Network Function Virtualization, and Information Centric Networking will impact on the development of future systems and networks, both from the theoretical/formal as well as from the practical perspective. Main focus will be on mobile networks, i.e. 5G and beyond. 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 ad-hoc Virtual Machine (ComNetsEmu) that can be easily be extended for new experiments. The instructions to download the Virtual Machine will be provided 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, IEEE ComSoc Director for Online Content in 2016-17 and IEEE ComSoc Director for Educational Services in 2018-19. Prof. Granelli is 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 250 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 price. 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.

Sunday, 25 April 2021 13:00-16:00 UTC

T7: Theory and Applications for Joint State Sensing and Communications for Autonomous Vehicles

Kumar Vijay Mishra, M. R. Bhavani Shankar and Mari Kobayashi

In the automotive sector, state sensing and communication are two major tasks enabling future high-mobility applications. This field has, therefore, witnessed concerted and intense efforts towards realizing the joint radar-communications (JRC) systems for efficient utilization of limited spectrum. Most of the modern automotive JRC systems are envisaged to operate at millimeter-wave (mm-Wave). This band is characterized by severe penetration losses, short coherence times, and availability of wide bandwidth. While wide bandwidth is useful in attaining high vehicular communications data rates and high-resolution automotive radar, the losses must be compensated by using a large number of antennas at the transmitter and receiver. In this context, there is also recent research focus on joint multiple-input multiple-output (MIMO)-Radar-MIMOCommunications (MRMC) systems.

These synergistic approaches that exploit the interplay between state sensing and communication are both driving factors and opportunities for many current signal processing and information-theoretic techniques. For example, while there are still many open challenges at mm-Wave JRC, it is already a precursor to sub-mm-Wave or Terahertz (THz) JRC, where futuristic short-range THz communications would coexist with low-THF (.1-1THz) automotive and imaging radars. At present, THz band is witnessing developments such as ultra-massive-MIMO systems which employ thousands of antennas in a few cms of aperture. Imaging with low-THz automotive radar is currently being investigated. Joint sensing and communications is also a growing area for unmanned aerial vehicles (UAVs) such as drones.

This tutorial provides an in-depth overview of the theory and practice of various joint sensing and communications systems for automotive applications.

Kumar Vijay Mishra (S'08-M'15-SM'18) obtained Ph.D. in electrical engineering and M.S. in mathematics from The University of Iowa in 2015, and M.S. in electrical engineering from Colorado State University in 2012, while working on NASA's Global Precipitation Mission Ground Validation (GPM-GV) weather radars. He received his B. Tech. summa cum laude (Gold Medal, Honors) in electronics and communication engineering from the National Institute of Technology, Hamirpur (NITH), India in 2003. He is currently National Academies of Sciences, Engineering and Medicine (NASEM) Harry Diamond Distinguished Fellow at United States Army Research Laboratory (ARL), Adelphi; technical adviser to Singapore-based automotive radar start-up Hertzwell; and honorary Research Fellow at SnT – Interdisciplinary Centre for Security, Reliability and Trust, University of Luxembourg. He had research appointments at Electronics and Radar Development Establishment (LRDE), Defence Research and Development Organisation (DRDO) Bengaluru; at IIHR – Hydroscience & Engineering, Iowa City, IA; Mitsubishi Electric Research Labs, Cambridge, MA; Qualcomm, San Jose; and Technion – Israel Institute of Technology. He is the recipient of Royal Meteorological Society Quarterly Journal Editor's Prize (2017), Viterbi Postdoctoral Fellowship (2015, 2016), Lady Davis Postdoctoral Fellowship (2017), Technion EE Excellent Undergraduate Adviser Award (2017), DRDO LRDE Scientist of the Year Award (2006), NITH Director's Gold Medal (2003), and NITH Best Student Award (2003). He has been an Associate Editor (Radar Systems) of IEEE Transactions on Aerospace and Electronic Systems since 2020. He is a member of IEEE Massive MIMO and Satellite working groups of IEEE International Network Generations Roadmap and Synthetic Aperture Technical Working Group of IEEE Signal Processing Society. His research interests include signal processing, remote sensing, electromagnetics, communications, and deep learning.

M. R. Bhavani Shankar (SM'15) received Masters and Ph. D in Electrical Communication Engineering from Indian Institute of Science, Bangalore in 2000 and 2007 respectively. He was a Post Doc at the ACCESS Linnaeus Centre, Signal Processing Lab, Royal Institute of Technology (KTH), Sweden from 2007 to September 2009. He joined SnT in October 2009 as a Research Associate and is currently a Research Scientist at SnT. He was with Beceem Communications, Bangalore from 2006 to 2007 as a Staff Design Engineer working on Physical Layer algorithms for WiMAX compliant chipsets. He was a visiting student at the Communication Theory Group, ETH Zurich, headed by Prof. Helmut Bölcskei during 2004. Prior to joining Ph. D, he worked on Audio Coding algorithms in Sasken Communications, Bangalore as a Design Engineer from 2000 to 2001. His research interests include Design and Optimization of MIMO Communication Systems, Radar and Array Processing, polynomial signal processing, Satellite communication systems, Resource Allocation, Game Theory and Fast Algorithms for Structured Matrices. He is currently on the Executive Committee of the IEEE Benelux joint chapter on communications and vehicular technology, member of the EURASIP Special Area Team (SAT) on Theoretical and Methodological Trends in Signal Processing and serves as handling editor for Elsevier Signal Processing. He was a co-recipient of the 2014 Distinguished Contributions to Satellite Communications Award, from the Satellite and Space Communications Technical Committee of the IEEE Communications Society. He has co-organized special sessions in ICASSP (2017, 18), SPAWC (2015, 16) and EUSIPCO (2015, 16).

Mari Kobayashi (M'06–SM'15) received the B.E. degree in electrical engineering from Keio University, Yokohama, Japan, in 1999, and the M.S. degree in mobile radio and the Ph.D. degree from École Nationale Supérieure des Télécommunications, Paris, France, in 2000 and 2005, respectively. From November 2005 to March 2007, she was a postdoctoral researcher at the Centre Tecnològic de Telecomunicacions de Catalunya, Barcelona, Spain. In May 2007, she joined the Telecommunications department at Centrale Supélec, Gif-sur-Yvette, France, where she is now a professor. She is the recipient of the Newcom++ Best Paper Award in 2010, and IEEE Comsoc/IT Joint Society Paper Award in 2011, and ICC Best Paper Award in 2019. She was an Alexander von Humboldt Experienced Research Fellow between September 2017 and April 2019 and is currently an August-Wihelm Scheer Visiting Professor at Technical University of Munich (TUM). She organized a number of special sessions and workshops including " Physical Layer Challenges for High-Mobility Networks'' at SPAWC 2019 and "V2X Communications'' at ISWCS 2018. She is a co-chair of special sessions at SPAWC 2021. She is an associate editor for IEEE Transactions on Information Theory. Her research interests include joint state sensing and communication, classification, distributed source coding.

Sunday, 25 April 2021 13:00-16:00 UTC

T8: Intelligent Massive NOMA for Next Generation Wireless Networks

Lajos Hanzo, Zhiguo Ding and Yuanwei Liu

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. Nonorthogonal multiple access (NOMA), which has been recently proposed for the 3GPP-LTE-A, constitutes a promising technology of enhancing the spectral efficiency and achieving massive connectivity challenges by accommodating several users within the same orthogonal resource block, via multiplexing at different power levels. By doing so, significant spectral efficiency enhancement and device connectivity improvement can be attained over conventional orthogonal multiple access (OMA) techniques. As 5G networks have been commercialized, it is natural for the researchers to exploit the potential multiple access techniques in the next generation networks. The main contents of this tutorial is to discuss the possible multiple access techniques in non-orthogonal manner, address research challenges of connecting massive devices, and deliver the state-of-the-art of signal processing advances research such as machine learning approaches for making multiple access in an intelligent manner for the next generation networks.

Lajos Hanzo (http://www-mobile.ecs.soton.ac.uk) FREng, FIEEE, FIET, Fellow of EURASIP, DSc received his degree in electronics in 1976 and his doctorate in 1983. In 2009 he was awarded the honorary doctorate "Doctor Honaris Causa" by the Technical University of Budapest. During his 40-year career in telecommunications he has held various research and academic posts in Hungary, Germany and the UK. Since 1986 he has been with the School of Electronics and Computer Science, University of Southampton, UK, where he holds the chair in telecommunications. He has successfully supervised 119 PhD students, co-authored 18 John Wiley/IEEE Press books on mobile radio communications totalling in excess of 10 000 pages, published 1880 research contributions at IEEE Xplore, acted both as TPC and General Chair of IEEE conferences, presented keynote lectures and has been awarded a number of distinctions. Currently he is directing an academic research team, working on a range of research projects in the field of wireless multimedia communications sponsored by industry, the Engineering and Physical Sciences Research Council (EPSRC) UK, the European IST Programme and the Mobile Virtual Centre of Excellence (VCE), UK. He is an enthusiastic supporter of industrial and academic liaison and he offers a range of industrial courses. He is also a Governor of the IEEE VTS. During 2008 – 2012 he was the Editor-in-Chief of the IEEE Press and since 2009 he has been a Chaired Professor also at Tsinghua University, Beijing. For further information on research in progress and associated publications please refer to http://www-mobile.ecs.soton.ac.uk

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' 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. Before that, He received the B.S. and M.S. degrees from the Beijing University of Posts and Telecommunications in 2011 and 2014, respectively. 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. He has over 150 refereed publications attributed, including contributions to the 80+ IEEE journal papers, 4 book/book Chapters. He has over 10 ESI highly cited papers. He received over 6000 citations in Google Scholar with h-index is 35.

Yuanwei Liu served as a TPC Member, Session Chair for many IEEE conferences, such as GLOBECOM and ICC. He has served as Publicity Cochair for VTC2019-Fall. He currently serves as an Editor of the IEEE Transactions on Communications, the IEEE Communications Letters and the IEEE Access. 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 Tutorials and Invited Presentations Officer for Reconfigurable Intelligent Surfaces Emerging Technology Initiative, the vice-chair Special Interest Group (SIG) Wireless Communications Technical Committee (WTC) on the topic of Reconfigurable Intelligent Surfaces for Smart Radio Environments (RISE).

Sunday, 25 April 2021 13:00-16:00 UTC

T9: On Reinforcement and Deep Learning Performance in Wireless Communication

Haris Gacanin

The fifth generation (5G) of wireless communications has led to many advancements in technologies such as large and distributed antenna arrays, ultra-dense networks, software-based networks and network virtualization. However, the need for a higher level of automation to establish hyper-low latency and hyper-high reliability for beyond 5G applications requires extensive research on machine learning with applications in wireless communications. Thereby, learning techniques will take a central stage in the sixth generation of wireless communications to cope up with the stringent application requirements. This tutorial discusses the practical limitations of reinforcement and deep learning methods in the context of resource management in nonstationary radio environment. Based on the practical limitations we carefully design and propose supervised, unsupervised, and reinforcement learning models to support rate maximization objective under user mobility. We discuss the effects of practical systems such as latency and reliability on the rate maximization with deep learning models. For common testing in the non-stationary environment, we present a generic dataset generation method to benchmark across different learning models versus traditional optimal resource management solutions. We aim to provide with motivation and data computational AI methodology of autonomous agents in the context of self-organization in real time. We elaborate on AI methods that unify sensing, perception, reasoning and learning. We discuss differences between training-based such as deep learning and training-free such as reinforcement learning AI methods for both matching and dynamic problems, respectively. Finally, we introduce the conceptual functions of autonomous agent with knowledge management with a practical case study illustrating the application and achievable performance of a mobile user.

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. From 2020, he is a chair professor 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 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 senior member of the Institute of Electrical and Electronics Engineers (IEEE) and the Institute of Electronics, Information and Communication Engineering (IEICE) and 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 (VTC 2005-Fall) Student Paper Award from IEEE VTS Japan Chapter and the 2004 Institute of IEICE Society Young Researcher Award. He was awarded by the Japanese Government (MEXT) Research Scholarship in 2002.

Sunday, 25 April 2021 13:00-16:00 UTC

T11: On the Design and Implementation of Open RAN Direct RF Sampling Radio Transceiver Architectures

Sassan Ahmadi

In this tutorial, we describe the challenges of the design and implementation of open RAN radio transceivers for 5G and beyond using state-of-the-art semiconductor technologies which allow programmability and computation combined with integrated RF sampling data converters, which allow design of large active antenna arrays with a scalable architecture.

Dr. Ahmadi is a worldwide recognized visionary, technical leader, inventor, and experienced wireless and RF systems architect with over 30 years of experience in design, implementation, and standardization of advanced wireless/cellular technologies, mobile platforms, RF transceivers, baseband SoCs, and products. Technical adviser to wireless industry and a lecturer in Electrical Engineering at Stanford University. Previously held senior positions at Apple, Intel and Nokia and has authored three recent books on advanced wireless communications and published over 100 patents and patent applications.

Sunday, 25 April 2021 13:00-16:00 UTC

T12: The Future of UAV Cellular Communications

Giovanni Geraci and Adrian Garcia-Rodriguez

Drones—a.k.a. UAVs—are taking over many processes requiring efficient, automated, and flexible machines. To guarantee that drones and their whole associated ecosystem take off, the top wireless communications companies and universities are trying to solve the fundamental challenge of providing reliable cellular service to this new class of mobile devices. While the understanding of drone cellular communications has advanced over the past few years, many fundamental challenges remain to be addressed. Indeed, the continuous flow of new drone-related applications demands original solutions to connect swarms of drones with high-capacity millimeter-wave capabilities, while handling their extreme mobility and guaranteeing hyper-reliable command and control links all along.

In this one-of-a-kind tutorial, we blend our academic and industrial views and take a holistic approach to UAV cellular communications:

- Outside the classroom: A fresh and digested look at the 3GPP standardization status and the performance of cellular-connected UAVs in 4G and 5G networks: lessons learnt and essential guidelines.
- Inside the classroom: Analyzing the fundamental tradeoffs in UAV mobility management for UAV-to-ground and direct UAV-to-UAV communications.
- 6G candidate architectures: Cell-free vs. multi-cell vs. mmWave UAV support, aerial channel modelling and deployment design through machine learning.

Giovanni Geraci (SM'19) is an Assistant Professor at University Pompeu Fabra in Barcelona. He was previously a Research Scientist with Nokia Bell Labs and holds a Ph.D. from the UNSW Sydney. He also held research appointments at SUTD Singapore, UT Austin, CentraleSupelec, and Alcatel-Lucent. He is an Editor for the IEEE Trans. on Wireless Commun. and IEEE Commun. Letters, a Guest Editor for the Special Issue on "UAV Communications for Safe Aerial Integration and Spectrum Coexistence" of the IEEE Open Journal of Veh. Tech., and the IEEE ICC'22 Wireless Commun. Symposium co-Chair. He has co-Chaired five workshops on UAV communications at IEEE ICC, IEEE PIMRC, and Asilomar. He has delivered ten between Tutorials, Industry Seminars, and Workshop Keynotes at IEEE ICC, IEEE Globecom, IEEE WCNC, IEEE PIMRC, IEEE VTC, and ACM DroNet. He is co-inventor of a dozen patents and co-Editor of the book "UAV Communications for 5G and Beyond", to be published by IEEE Wiley. On this topic, he has written for the IEEE ComSoc Tech. News and has received international press coverage. He is a "la Caixa" Junior Leader and "Ramon y Cajal" Fellow. He received the Nokia Ireland Certificate of Outstanding Achievement in 2017, the 2018 IEEE ComSoc EMEA Outstanding Young Researcher Award, and the IEEE PIMRC'19 Best Paper Award for his work on UAV-to-UAV Cellular Communications.

Adrian Garcia-Rodriguez is a Senior Research Engineer at Huawei Technologies R&D (France). He received the Ph.D. degree in Electrical and Electronic Engineering from University College London (U.K.), and he was a Research Scientist at Nokia Bell Labs (Ireland) in 2016-2020. Adrian is a co-inventor of 27 filed patent families and has co-authored 40+ IEEE publications on wireless communications and networking with 750+ citations. In top venues such as IEEE ICC or IEEE Globecom, he frequently delivers technical tutorials, organizes workshops and special sessions, and participates in industrial seminars focused the topics of UAV communications and next-generation 802.11 technologies. Adrian was a speaker of the industrial tutorial "Drone Base Stations: Opportunities and Challenges Towards a Truly 'Wireless' Wireless Network", which won the Most Attended Industry Program award at IEEE Globecom'17. He was the recipient of the Best Paper Award in PIMRC'19 for his work on "Cellular UAV-to-UAV Communications". Adrian was also named an Exemplary Reviewer for IEEE Commun. Letters in 2016, and both IEEE Trans. on Wireless Commun. and IEEE Trans. on Commun. in 2017.

Sunday, 25 April 2021 13:00-16:00 UTC

T13: Wireless Channel Charting for Massive MIMO

Maxime Guillaud and Christoph Studer

Channel charting is an emerging framework that enables pseudo-positioning of user equipments (UEs) from channel state information (CSI) only. More concretely, channel charting associates CSI to UE spatial location by means of dimensionality reduction and manifold learning, thus enabling the infrastructure base-stations or wireless access points to perform a number of predictive tasks relevant to emerging wireless networks that depend on UE location. Prominent application examples are localization relative to points-of-interest, UE grouping, cell handover, UE path prediction, predictive rate control, assisted beam-finding, etc. The distinctive characteristic of channel charting with respect to classical positioning techniques resides in its self-supervised nature, i.e., the fact that it relies only on measured CSI and no other information (e.g., from global navigation satellite systems or classical localization anchors) is required.

This tutorial will cover the theoretical and algorithmic foundations of channel charting, discuss its implementation in next-generation (beyond 5G) cellular systems, and showcase applications ranging from predictive radio resource management to positioning. The goal of this tutorial is to provide the audience with an exhaustive overview of the nascent research field of channel charting, which is at the intersection of machine learning, numerical optimization, channel modeling, and communication theory. To this end, this tutorial will (i) introduce a wide range of theoretical and algorithm-level concepts, and (ii) demonstrate its efficacy with real-world results from indoor and outdoor channel measurements.

Dr. Maxime Guillaud is a researcher in Huawei Technologies' Mathematical and Algorithmic Research Lab in Paris, where he heads the signal and information processing group. He has 20 years expertise in the domain of wireless communications, in both academic and industrial research environments. He received his Ph.D. in 2005 from EURECOM, France, and previously held positions at Vienna University of Technology, FTW Telecommunications Research Center Vienna, and Bell Labs. He is an expert in the physical layer of modern wireless communications systems, and has made contributions to channel modeling and reciprocity calibration, Massive MIMO, and more. He has published over 50 journal and conference papers, and holds 8 patents. He is a Senior Member of IEEE and an Associate Editor for the IEEE Transactions on Wireless Communications.

Prof. Dr. Christoph Studer is an Associate Professor at Cornell University and Cornell Tech. He received his Ph.D. degree in Electrical Engineering from ETH Zurich in 2009. In 2005, he was a Visiting Researcher with the Smart Antennas Research Group at Stanford University. From 2006 to 2009, he was a Research Assistant in both the Integrated Systems Laboratory and the Communication Technology Laboratory at ETH Zurich. From 2009 to 2012, Prof. Studer was a Postdoctoral Researcher at CTL, ETH Zurich, and the Digital Signal Processing Group at Rice University. In 2013, he held the position of Research Scientist at Rice University. From 2014 to 2019, Prof. Studer has been an Assistant Professor at Cornell University and an adjunct Assistant Professor at Rice University, TX. Since 2019, Prof. Studer has been an Associate Professor at Cornell University in Ithaca, NY, and at Cornell Tech in New York, NY. His research interests are in the design and analysis of algorithms and hardware designs for future multi-antenna wireless communication systems.

Prof. Studer received ETH Medals for his M.S. and Ph.D. theses in 2006 and 2009, respectively. He received a two-year Swiss National Science Foundation fellowship for Advanced Researchers in 2011 and a US National Science Foundation CAREER Award in 2017. Prof. Studer won a Michael Tien '72 Excellence in Teaching Award from the College of Engineering, Cornell University, in 2016. He shared the Swisscom/ICTnet Innovations Award in both 2010 and 2013, and he received a number of best paper and best demonstration awards in the areas of communication systems and digital integrated circuit design. In 2019, he was the Technical Area Chair for the 53rd Asilomar Conference on Signals, Systems, and Computers, and a Technical Co-Chair for the IEEE International Workshop on Signal Processing Systems. Since 2019, Prof. Studer is an Associate Editor for the IEEE Open Journal on Circuits and Systems.

Sunday, 25 April 2021 13:00-16:00 UTC

T14: User-Centric Cell-Free Massive MIMO: From Foundations to Scalable Implementation

Emil Björnson, Luca Sanguinetti and Özlem Tuğfe Demir

Suppose all the antennas that serve the mobile terminals are distributed over the coverage area instead of co-located in arrays at a few elevated locations as in cellular networks. The ideal operation is that each mobile terminal is served by coherent joint transmission and reception from all the neighboring access points. That effectively leads to a so-called "User-Centric Cell-Free Massive MIMO system". This post-cellular technology has recently attracted much interest from both academia and the industry. Several innovative signal processing and spatial resource allocation algorithms have been developed to make Cell-Free Massive MIMO feasible and practical. Cell-Free Massive MIMO improves the uniformity of the achievable data rates over the coverage area compared to cellular networks. This tutorial starts by giving a background of cellular Massive MIMO in 5G and by identifying the fundamental limits that call for a shift towards the cell-free paradigm. Next, we will introduce the foundations of User-Centric Cell-Free Massive MIMO and explain the benefits of the cell-free operation compared to conventional cellular operation. Signal processing techniques for the operation of User-Centric Cell-Free Massive MIMO will be introduced with a particular emphasis on scalable implementation that guarantees feasible computational complexity and fronthaul in a large network with many mobile terminals. Spatial resource allocation with both optimized and scalable power control algorithms will be provided along with some implementation constraints that possibly lead to the new research problems. The tutorial will be based on a preprint of the presenters' upcoming textbook on the same topic.

Emil Björnson (S'07-M'12-SM'17) is currently a Visiting professor at KTH Royal Institute of Technology, Sweden, and Associate Professor at Linköping University, Sweden. He has authored the textbooks Optimal Resource Allocation in Coordinated Multi-Cell Systems (2013) and Massive MIMO Networks: Spectral, Energy, and Hardware Efficiency (2017). He is dedicated to reproducible research and has made a large amount of simulation code publicly available. He performs research on MIMO communications, radio resource allocation, machine learning for communications, and energy efficiency. Since 2017, he has been on the Editorial Board of the IEEE Transactions on Communications and the IEEE Transactions on Green Communications and Networking since 2016. He has received the 2014 Outstanding Young Researcher Award from IEEE ComSoc EMEA, the 2015 Ingvar Carlsson Award, the 2016 Best Ph.D. Award from EURASIP, the 2018 IEEE Marconi Prize Paper Award in Wireless Communications, the 2019 EURASIP Early Career Award, the 2019 IEEE Communications Society Fred W. Ellersick Prize, and the 2019 IEEE Signal Processing Magazine Best Column Award. He also co-authored papers that received Best Paper Awards at the conferences, including WCSP 2009, IEEE CAMSAP 2011, IEEE WCNC 2014, IEEE ICC 2015, WCSP 2017, and IEEE SAM 2014.

Luca Sanguinetti (SM'15) is currently an Associate Professor with the Dipartimento di Ingegneria dell'Informazione, University of Pisa. He has coauthored the textbook Massive MIMO Networks: Spectral, Energy, and Hardware Efficiency (2017). His expertise and general interests span the areas of communications and signal processing. Dr. Sanguinetti was a recipient of the 2018 Marconi Prize Paper Award in Wireless Communications and coauthored an article that received the Young Best Paper Award from the ComSoc/VTS Italy Section. He was the recipient of the FP7 Marie Curie IEF 2013 "Dense deployments for green cellular networks". He was also a co-recipient of the two best conference paper awards: IEEE WCNC 2013 and IEEE WCNC 2014. He served as an Associate Editor for the IEEE Transactions on Wireless Communications and the IEEE Journal on Selected Areas of Communications (series on Green Communications and Networking) and as a Lead Guest Editor for the IEEE Journal on Selected Areas of Communications Special Issue on "Game Theory for Networks". He is currently serving as an Associate Editor for the IEEE Signal Processing Letters, the IEEE Transactions on Communications. He is also a member of the Executive Editorial Committee of the IEEE Transactions on Wireless Communications.

Özlem Tuğfe Demir received the B.S., M.S., and Ph.D. degrees in Electrical and Electronics Engineering from Middle East Technical University, Ankara, Turkey, in 2012, 2014, and 2018, respectively. She is currently a Post-Doctoral Researcher with Linköping University. Her research interests focus on signal processing and optimization in wireless communications, massive MIMO, deep learning, green communications, and multipleantenna technologies for Beyond 5G. She is a recipient of the IEEE SIU 2015 Conference Student Best Paper Award, the Best Thesis Award for M.S. Program and Graduate Courses Performance Award at the Middle East Technical University.

Sunday, 25 April 2021 13:00-16:00 UTC

T15: Reconfigurable Intelligent Surfaces for Future Wireless Communications

Alessio Zappone, Marco Di Renzo, Shi Jin and Merouane Debbah

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 that holds the potential to meet these demands is that of reconfigurable intelligent surfaces (RISs). A RIS is a nearly-passive planar structure that can be equipped with a number of scatterers significantly higher than the number of antennas in a massive MIMO array. This makes RIS potentially able to provide high data rates with very low energy consumptions. Also, RISs can be programmed in real-time to adjust the phase of the incoming signals to focus the energy toward the intended receiver or to absorb interfering signals. The tutorial will first discuss the most recent standardization activities of 5G networks and then will explain why 5G technologies will not be able to keep the pace with the exponential increase of data connectivity demands by end-users. Then, the fundamentals of RIS will be introduced and the latest results regarding the modeling and design of RIS-based wireless networks, will be presented. Propagation channel models and network deployment approaches for RIS-based systems will be discussed, and the most performing algorithms for the optimization of the radio resources of RIS-based networks will be explained, including optimal power allocation, beamforming strategies, and RIS configuration. The tutorial will also present the latest experimental results on RIS-based wireless communications and will highlight the most relevant future research directions.

Alessio Zappone obtained his Ph.D. degree in electrical engineering in 2011 from the University of Cassino and Southern Lazio, Cassino, Italy. Afterwards, he has been with TU Dresden, Germany, from 2012 to 2016. From 2017 to 2019 he was the recipient of an Individual Marie Curie fellowship for experienced researchers, carried out at CentraleSupelec, Paris, France. He is now a tenured professor at the university of Cassino and Southern Lazio, Italy. He is an IEEE senior member, serves as senior area editor for the IEEE Signal Processing Letters, and served twice as guest editor for the IEEE Journal on Selected Areas on Communications. He chairs the RIS special interest group REFLECTIONS, activated within the Signal Processing for Computing and Communications Technical Committee.

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, CentraleSupelec, 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 2013 IEEE-COMSOC Best Young Researcher Award for Europe, Middle East and Africa; 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. He chairs the RIS special interest group RISE, activated within the Wireless Technical Committee.

Shi Jin received his Ph.D. degree in information and communications engineering from the Southeast University, Nanjing, in 2007. From June 2007 to October 2009, he was a Research Fellow with the Adastral Park Research Campus, University College London, London, U.K. He is currently with the faculty of the National Mobile Communications Research Laboratory, Southeast University. He serves as an Associate Editor for the IEEE Transactions on Wireless Communications, IEEE Communications Letters, IET Communications. Dr. Jin and his coauthors have been awarded the 2011 IEEE Communications Society Stephen O. Rice Prize Paper Award in communication theory and a 2010 Young Author Best Paper Award by the IEEE Signal Processing Society.

Merouane Debbah obtained his Ph.D. from the Ecole Normale Suprieure Paris-Saclay (France). He worked for Motorola (France) from 1999-2002 and Vienna Research Center for Telecommunications (Austria) until 2003. From 2003 to 2007, he joined the Mobile Communications department of Eurecom (France). Since 2007, he is Full Professor at CentraleSupelec (France). Since 2014, he is Vice-President of the Huawei France R&D center and director of the Mathematical and Algorithmic Sciences Lab. He was associate and senior area editor for IEEE Transactions on Signal Processing and IEEE Fellow. He received 19 best paper awards, the 2015 IEEE Communications Society Leonard G. Abraham Prize, 2015 IEEE Communications Society Fred W. Ellersick Prize, 2016 IEEE Communications Society Best Tutorial paper award, 2018 IEEE Marconi Prize Paper Award. He received the Mario Boella award in 2005, the IEEE Glavieux Prize Award in 2011 and the Qualcomm Innovation Prize Award in 2012.

Sunday, 25 April 2021 13:00-16:00 UTC

T16: Rate Splitting Multiple Access for Beyond 5G: Principles, Recent Advances, and Future Research Trends

Bruno Clerckx, Aydin Sezgin and Yijie (Lina) Mao

MIMO has grown beyond the original point-to-point channel and nowadays refers to a diverse range of centralized and distributed deployments. Numerous techniques have been developed in the last decade for MIMO wireless networks, including among others Multiuser-MIMO (MUMIMO), CoMP, Massive MIMO, Non-Orthogonal Multiple Access (NOMA), millimetre wave (mmwave) MIMO. All those techniques rely on two extreme interference management strategies, namely fully decode interference and treat interference as noise. Indeed, while NOMA based on superposition coding with Successive Interference Cancellation (SIC) relies on strong users to fully decode and cancel interference created by weaker users, MU-MIMO/Massive MIMO/CoMP/mmwave MIMO based on linear precoding rely on fully treating any residual multi-user interference as noise. In the presence of imperfect channel state information at the transmitter (CSIT), CSIT inaccuracy results in additional multi-user interference that is treated as noise by all those techniques.

To efficiently cope with the high throughput, reliability, heterogeneity of Quality-of-Service (QoS), and massive connectivity requirements of future multi-antenna wireless networks, multiple access and multiuser communication system design need to depart from two conventional and extreme interference management strategies, namely fully treat interference as noise (as commonly used in 4G, MU-MIMO, CoMP, Massive MIMO, mmwave MIMO) and fully decode interference (as in NOMA).

In this tutorial, we depart from those two extremes and introduce the audience a more general, more robust, and more powerful transmission framework, namely, Rate Splitting Multiple Access (RSMA) based on linearly precoded Rate-Splitting (RS) at the transmitter and SIC receivers to decode part of the interference and treat the remaining part of the interference as noise.

Bruno Clerckx is a (Full) Professor, the Head of the Wireless Communications and Signal Processing Lab, and the Deputy Head of the Communications and Signal Processing Group, within the Electrical and Electronic Engineering Department, Imperial College London, London, U.K. He received the M.S. and Ph.D. degrees in applied science from the Université Catholique de Louvain, Louvain-la-Neuve, Belgium, in 2000 and 2005, respectively. From 2006 to 2011, he was with Samsung Electronics, Suwon, South Korea, where he actively contributed to 4G (3GPP LTE/LTEA and IEEE 802.16m) and acted as the Rapporteur for the 3GPP Coordinated Multi-Point (CoMP) Study Item. Since 2011, he has been with Imperial College London, first as a Lecturer from 2011 to 2015, Senior Lecturer from 2015 to 2017, Reader from 2017 to 2020, and now as a Full Professor. From 2014 to 2016, he also was an Associate Professor with Korea University, Seoul, South Korea.

He has authored two books, 190 peer-reviewed international research papers, and 150 standards contributions, and is the inventor of 80 issued or pending patents among which 15 have been adopted in the specifications of 4G standards and are used by billions of devices worldwide. His research area is communication theory and signal processing for wireless networks. He has been a TPC member, a symposium chair, or a TPC chair of many symposia on communication theory, signal processing for communication and wireless communication for several leading international IEEE conferences. He was an Elected Member of the IEEE Signal Processing Society SPCOM Technical Committee. He served as an Editor for the IEEE Transactions on Communications, the IEEE Transactions on Wireless Communications, and the IEEE Transactions on Signal Processing. He has also been a (lead) guest editor for special issues of the EURASIP Journal on Wireless Communications and Networking, IEEE Access, the IEEE Journal On Selected Areas In Communications and the IEEE Journal Of Selected Topics In Signal Processing. He was an Editor for the 3GPP LTE-Advanced Standard Technical Report on CoMP.

Aydin Sezgin is a Professor of information systems and sciences with the Department of Electrical Engineering and Information Technology, Ruhr-Universität Bochum, Germany. He received the Dipl.Ing. (M.S.) degree in communications engineering from Technische Fachhochschule Berlin (TFH), Berlin, in 2000, and the Dr.Ing. (Ph.D.) degree in electrical engineering from TU Berlin, in 2005. From 2001 to 2006, he was with the Heinrich-Hertz-Institut, Berlin. From 2006 to 2008, he held a postdoctoral position and a Lecturer with the Information Systems Laboratory, Department of Electrical Engineering, Stanford University, Stanford, CA, USA. From 2008 to 2009, he held a postdoctoral position at the Department of Electrical Engineering and Computer Science, University of California at Irvine, Irvine, CA, USA. From 2009 to 2011, he was the Head of the Emmy-Noether- Research Group on Wireless Networks, Ulm University. In 2011, he joined TUDarmstadt, Germany, as a Professor. He is interested in signal processing, communication, and information theory, with a focus on wireless networks. He has published several book chapters over 40 journals and 140 conference papers in his research topics. He has co-authored a book on multiway communications. He has received the ITG-Sponsorship Award, in 2006. He was a first recipient of the Prestigious Emmy-Noether Grant from the German Research Foundation in communication engineering, in 2009. He has co-authored papers that received the Best Poster Award from the IEEE Communication Theory Workshop, in 2011, the Best Paper Award from ICCSPA, in 2015, and the Best Paper Award from ICC, in 2019. He was an Associate Editor of the IEEE Transactions on Wireless Communications, from 2009 to 2014.

Yijie (Lina) Mao is a postdoctoral research associate with the Communications and Signal Processing Group (CSP), Department of the Electrical and Electronic Engineering at the Imperial College London (London, United Kingdom). She received the B.Eng. degree from the Beijing University of Posts and Telecommunications, and the B.Eng. (Hons.) degree from the Queen Mary University of London (London, United Kingdom) in 2014. She received the Ph.D. degree in the Electrical and Electronic Engineering Department from the University of Hong Kong (Hong Kong, China) in 2018. She was a Postdoctoral Research Fellow at the University of Hong Kong (Hong Kong, China) from Oct. 2018 to Jul. 2019. Her research interests include Multiple Input Multiple Output (MIMO) communication networks, rate-splitting and non-orthogonal multiple access. She served as the co-chair for 2020 IEEE International Conference on Communications (ICC) and 2020 IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC) on the workshops of Rate-Splitting and Robust Interference Management for Beyond 5G.

Patrons and Exhibitors

IEEE VTS would like to thank our Platinium partrons, Huawei and Nokia, for their contributions to the success of the conference.

Keynotes

Monday 26 April 2021 13:00 – 15:00 UTC

It's All in the Noise – Universal Noise-centric Decoding

Muriel Médard, *Professor, Massachusetts Institute of Technology (MIT)*

Claude Shannon's 1948 "A Mathematical Theory of Communication" provided the basis for the digital communication revolution. As part of that ground-breaking work, he identified the greatest rate (capacity) at which data can be communicated over a noisy channel. His proposed algorithm used on random codes and a code centric maximum Maximum Likelihood (ML) decoding, where channel outputs are compared to all possible input codewords to select the most likely candidate based on the observed channel output. Despite its mathematical elegance, his code centric decoding algorithm is impractical from a complexity perspective and much work in the intervening 70 years has focused on co-designing codes and decoders that enable reliable communication at high rates.

In collaboration with Ken Duffy and his group, we introduce a new algorithm, Guessing Random Additive Noise Deceasing (GRAND) for a noise-centric, rather than code-centric, ML decoding. The receiver rank orders noise effect sequences from most likely to least likely, and guesses accordingly. When inverting, in decreasing order of likelihood, noise effect sequences from the received signal, the first instance that results in an element of the code-book is the ML decoding. Our results show that, with GRAND, even extremely simple codes, such as CRCs, match or outperform state of the art code/decoder pairs, indicating that the choice of decoder is likely to be more important than that of code.

We illustrate the practical usefulness of our approach and discuss its hardware implementation, done with Rabia Yazicigil and her group. The complexity of the decoding is, for the sorts of channels generally used in commercial applications, quite low, unlike code-centric ML and the chip is able to decode any linear code.

Muriel Médard is the Cecil H. and Ida Green Professor in the Electrical Engineering and Computer Science (EECS) Department at MIT, where she leads the Network Coding and Reliable Communications Group in the Research Laboratory for Electronics at MIT. She obtained three Bachelors degrees (EECS 1989, Mathematics 1989 and Humanities 1991), as well as her M.S. (1991) and Sc.D (1995), all from MIT. She is a Member of the US National Academy of Engineering (elected 2020), a Fellow of the US National Academy of Inventors (elected 2018), and a Fellow of the Institute of Electrical and Electronics Engineers (elected 2008). Muriel was elected president of the IEEE Information Theory Society in 2012, and served on its board of governors for eleven years. She holds an Honorary Doctorate from the Technical University of Munich (2020).

She was co-winner of the MIT 2004 Harold E. Egerton Faculty Achievement Award and was named a Gilbreth Lecturer by the US National Academy of Engineering in 2007. She received the 2017 IEEE Communications Society Edwin Howard Armstrong Achievement Award and the 2016 IEEE Vehicular Technology James Evans Avant Garde Award. She received the 2019 Best Paper award for IEEE Transactions on Network Science and Engineering, the 2018 ACM SIGCOMM Test of Time Paper Award, the 2009 IEEE Communication Society and Information Theory Society Joint Paper Award, the 2009 William R. Bennett Prize in the Field of Communications Networking, the 2002 IEEE Leon K. Kirchmayer Prize Paper Award, as well as eight conference paper awards. Most of her prize papers are co-authored with students from her group.

She has served as technical program committee co-chair of ISIT (twice), CoNext, WiOpt, WCNC and of many workshops. She has chaired the IEEE Medals committee, and served as member and chair of many committees, including as inaugural chair of the Millie Dresselhaus Medal. She was Editor in Chief of the IEEE Journal on Selected Areas in Communications and has served as editor or guest editor of many IEEE publications, including the IEEE Transactions on Information Theory, the IEEE Journal of Lightwave Technology, and the IEEE Transactions on Information Forensics and Security. She was a member of the inaugural steering committees for the IEEE Transactions on Network Science and for the IEEE Journal on Selected Areas in Information Theory.

Muriel received the inaugural 2013 MIT EECS Graduate Student Association Mentor Award, voted by the students. She set up the Women in the Information Theory Society (WithITS) and Information Theory Society Mentoring Program, for which she was recognized with the 2017 Aaron Wyner Distinguished Service Award. She served as undergraduate Faculty in Residence for seven years in two MIT dormitories (2002-2007). She was elected by the faculty and served as member and later chair of the MIT Faculty Committee on Student Life and as inaugural chair of the MIT Faculty Committee on Campus Planning. She was chair of the Institute Committee on Student Life. She was recognized as a Siemens Outstanding Mentor (2004) for her work with High School students. She serves on the Board of Trustees since 2015 of the International School of Boston, for which she is treasurer.

She has over fifty US and international patents awarded, the vast majority of which have been licensed or acquired. For technology transfer, she has co-founded three companies, CodeOn, for which she consults, Chocolate Cloud, on whose board she serves, and Steinwurf, for which she is Chief Scientist.

Monday 26 April 2021 13:00 – 15:00 UTC

6G – The Essential Infrastructure to Augment Human Potential at Scale

Peter Vetter, *Head of Access & Devices Research Lab, Nokia Bell Labs*

5G will increase human productivity thanks to the critical connectivity between man and machines or vehicles. The deployment of sensors and augmented intelligence closes the loop and increasingly automates operations, thereby freeing humans to focus on the tasks that they do well. A digital world that perfectly captures the past and current states of the physical world is emerging, however, the connectivity with the human biological and cognitive worlds still needs to be addressed. We anticipate that in the 6G era, there will be a need to deploy sensors and cognitive technologies at a much larger scale with stringent deterministic connectivity requirements. The 6G era will be defined by the symbiosis of digital, physical, and biological worlds with the goal to augment human potential and well being. And the 6G network will be the essential infrastructure for the integration of these future capabilities.

Peter Vetter is Head of the A-Lab (Access research lab) at Nokia Bell Labs and a Bell Lab Fellow. He is leading an eminent global team with the mission to invent game changing innovations that define the future of mobile and fixed access.

Under his leadership, he and his teams have realized several world-first system demonstrations in access and successfully transferred industry leading concepts into product. He was also co-founder of an internal venture that produced the first FTTH product in Alcatel.

He received the degree of Physics Engineer from Gent University (Belgium) in 1986 and a PhD with Prof. H. Pauwels in 1991. After a post-doctoral fellowship with Prof. T. Uchida at Tohoku University (Japan), he joined the research center of Alcatel (now Nokia) in Antwerp in 1993. Since 2009, he has worked at Bell Labs in Murray Hill, New Jersey, and has been on the senior leadership team of Bell Labs since 2013. He has authored over a hundred international papers and presented keynotes and tutorials at major technical industry events.

Tuesday 27 April 2021 13:00 – 15:00 UTC

6G Research Challenges – Enabling Collaborative Personal Consumer Robotics

Gerhard P. Fettweis, *Professor, Dresden University of Technology*

5G is enabling the beginning of the Tactile Internet for business verticals, and 6G will make this available for consumers, enabling collaborative personal mobile robotics. A vision found in the science fiction literature already 100 years ago!

We have seen the performance of cellular networks increasing over time. This is measured e.g. in increasing data rate, reduced latency, increased reliability, increased spectral efficiency, and increased capacity per area. When addressing 6G, again most white papers think along the same line, again increasing the performance of the KPIs. Does this make sense in light of what we are learning from Tactile Internet applications within the 5G Lab Germany's nine 5G campus network testbeds? In this talk I will therefore take on a different viewpoint.

Firstly, I do not believe that increasing all KPI's performance is unnecessary when taking today's understanding of what we want to achieve with 6G. Secondly, we are missing some major new KPIs to address, as e.g. Trustworthiness, Resilience, and Joint Communications and Sensing,. Thirdly, e.g. requiring an increased energy efficiency of a complete network and simultaneously an increased as spectral efficiency we seem to be out of luck. Given the fact that Moore's law has slowed down, an increased spectral efficiency in bits/s/Hz comes at the cost of requiring higher E_b/N_0, doesn't it?

Therefore this talk touches first thoughts on a differing view compared to "the current industry and sciences standard". But we must not forget, we will need 5 more years of 5G experience to really know what 6G should look like. It is too early to judge which view is correct..

Gerhard P. Fettweis, F'09, earned a Ph.D. under H. Meyr at RWTH Aachen. After a postdoc at IBM Research, San Jose, he joined TCSI, Berkeley. Since 1994 he is Vodafone Chair Professor at TU Dresden. Since 2018 he heads the new Barkhausen Institute. 2019 he was elected into the DFG Senate.

He researches wireless transmission and chip design, coordinates 5GLab Germany, spun-out 17 tech and 3 non-tech startups, and is member of 2 German Academies: Sciences/"Leopoldina", Engineering/"acatech".

Tuesday 27 April 2021 13:00 – 15:00 UTC

The Directions for 6G

Wen Tong, *CTO, Wireless Network, Huawei*

In this talk, we present our view on 6G technologies, its trends and research directions. We highlight the six foundational pillars which will define the emerging 6G wireless. In general, 6G is the next-generation advanced mobile communications system, but it will go far beyond communications. 6G will serve as a distributed neural network that provides communication links to fuse the physical, cyber, and biological worlds, truly ushering in an era in which everything will be sensed, connected, and intelligent. This in turn will a truly societal fabric for Intelligence of Everything in the decades to come. We discuss the 6G innovations and associated research challenges in the following areas:

(1) Native AI: 6G air interface and network designs will leverage E2E AI and machine learning to implement customized optimization and automated O&M. Each 6G network element will natively integrate communication, computing, and sensing capabilities. A distributed machine learning architecture built on deep edge intelligence will be key to meeting the large-scale intelligence requirements

(2) Networked Sensing: 6G communications systems will integrate wireless sensing capabilities to explore the physical world through radio wave transmission, echo, reflection, and scattering. They will also provide high-resolution sensing, localization, imaging, and environment reconstruction capabilities to improve communication performance and support a broader range of network service scenarios.

(3) Extreme Connectivity: 6G will provide universal high-performance wireless connections and ultimate experience with speeds comparable to optical fibers. Tbs peak rate, 10–100 Gbs experienced rate, sub-millisecond level latency, a tenfold increase in the density of 5G connections, centimeter-level localization, millimeter-level imaging, and E2E system reliability.

(4) Integrated Terrestrial and non-Terrestrial Networks: 6G will integrate terrestrial and non-terrestrial networks with mega satellite constellation. These "airborne wireless internet" will provide the ultimate coverage complementary to the terrestrial cellular infrastructure. To provide continuous high-quality services to users anywhere on earth.

(5) Native Trustworthiness: The 6G network will integrate various capabilities such as communication, sensing, computing, and intelligence, making it necessary to redefine the network architecture. The novel network architecture should support native trustworthiness and can be flexibly adapted for tasks such as collaborative sensing and

distributed learning to proliferate AI applications on a large scale. Data, as well as the knowledge and intelligence derived from it, is the driving force behind 6G network architecture redesign, wherein new features will be developed to enable E2E native trustworthiness. These include new data governance architectures supporting data compliance and monetization, as well as advanced privacy protection in the post Quantum era.

(6) Sustainability and Humanity Good: Green and sustainable development are the core requirements for network and terminal designs in 6G. By introducing the green design concept and native AI capability, 6G aims to improve the overall energy efficiency by 100 times across the network, while also ensuring optimal service performance and experience. As the core infrastructure of digital economy, 6G will make unique contributions to the sustainable development of humankind.

The above six directions will be the key technological focus for shaping the 6G and generate a vast space for research and innovations.

Dr. Wen Tong is the CTO, Huawei Wireless. He is the head of Huawei wireless research. In 2011, Dr. Tong was appointed the Head of Communications Technologies Labs of Huawei, currently, he is the Huawei 5G chief scientist and led Huawei's 10-year-long 5G wireless technologies research and development.

Prior to joining Huawei in 2009, Dr. Tong was the Nortel Fellow and head of the Network Technology Labs at Nortel. He joined the Wireless Technology Labs at Bell Northern Research in 1995 in Canada.

Dr. Tong is the industry recognized leader in invention of advanced wireless technologies, Dr. Tong was elected as a Huawei Fellow and an IEEE Fellow. He was the recipient of IEEE Communications Society Industry Innovation Award in 2014, and IEEE Communications Society Distinguished Industry Leader Award for "pioneering technical contributions and leadership in the mobile communications industry and innovation in 5G mobile communications technology" in 2018. He is also the recipient of R.A. Fessenden Medal. For the past three decades, he had pioneered fundamental technologies from 1G to 5G wireless and Wi-Fi with more than 500 awarded US patents.

Dr. Tong is a Fellow of Canadian Academy of Engineering, and he serves as Board of Director of Wi-Fi Alliance.

Panels

Monday 26 April 2021 22:00 – 23:00 UTC

Industry Track Panel: 6G Architecture to Connect the Worlds

Moderator:	**Volker Ziegler**	*CTO, Nokia Bell Labs*
Panelists:	**Eric Hardouin**	*VP Orange Labs*
	Takehiro Nakamura	*VP NTT DoCoMo*
	John Smee	*VP Qualcomm*
	Linus Thrybom	*ABB Corporate Research*

Subsequent to short statements of impulse and direction from each of the panelists, the panel will discuss and explore how 6G architecture will impact and enhance augmentation of human intelligence, creation of new digital worlds and control of automatons. What are the new 6G architectural paradigms of relevance? How will architectural platform concepts enhance and transform value capture and sustainability in the 2030s? How open and standardized will 6G architecture be? Will there be new ways of co-creation across sectors and industries?

Volker Ziegler is an energetic leader with 25+ years of broad and international experience in the telecommunications industry. He is known for his strong commitment to customer and team achievements. Throughout his career he has demonstrated an ability to meet and exceed targets through strong intellectual grasp, excellent leadership skills, and a strong focus on creating new opportunities and business development impact.

In his current role of 6G leadership with Nokia Bell Labs, the industrial research and scientific development arm of Nokia, he leads Nokia digital transformation initiatives aimed at exploring and leveraging innovations with customers and partners in the fledgling ecosystem for the 6G era.

In his previous role as Head of 5G Leadership and Chief Architect of Nokia Mobile Networks, Volker played a key role in defining Nokia e2e 5G offering and positioning Nokia strongly in 5G and associated innovation, technologies and architecture. Prior to this, Volker served in Head of Strategy roles of the company and as Head of the North East region, driving market share gain in many key markets, including Scandinavia, Russia and Turkey.

Eric Hardouin leads the "Ambient Connectivity" research in Orange, which investigates future access and transport networks and technologies, as well as related business models. Eric received a Ph.D. degree in signal processing and telecommunications from Telecom Bretagne and the University of Rennes 1, France, in 2004. Since 2004, he has been with Orange, where he has conducted or supervised research on interference mitigation for mobile networks. Between 2008 and 2013 he represented Orange in the physical layer standardization group of 3GPP (RAN1) for HSPA, LTE and LTE-Advanced. From 2012 to 2015, Eric coordinated the research on wireless networks in Orange. Eric had a leading role in the NGMN 5G White Paper, as co-lead of the work on 5G requirements. Eric is co-author of the book "LTE et les réseaux 4G" (in French).

Takehiro Nakamura joined NTT Laboratories in 1990. He is now SVP and General Manager of the 6G Laboratories in NTT DOCOMO, Inc. Mr. Nakamura has been engaged in R&D and the standardization activities for the W-CDMA, HSPA, LTE/LTE-Advanced 5G and 6G. He has been the Acting Chairman of Strategy & Planning Committee of 5G Mobile Communications Promotion Forum(5GMF) in Japan since October 2014.

Mr. Nakamura has also been contributing to standardization activities in 3GPP since 1999, including as a contributor to 3GPP TSG-RAN as chairman from April 2009 to March 2013. He is also very active in standardization of C-V2X/Connected Car in ARIB and ITS Info-communications Forum in Japan. He is now a leader of Cellular System Task Group of ITS Info-communications Forum.

Dr. John E. Smee is Vice President of Engineering at Qualcomm Technologies Inc., where he is the 5G R&D lead responsible for overseeing all 5G research projects including end-end systems design, standards contributions, and advanced RF/HW/SW prototype implementations in Qualcomm's wireless research and development group. He joined Qualcomm in 2000, holds over 150 U.S. Patents, and has been involved in the design, innovation, standardization, and productization of wireless communications systems such as 5G NR, 4G LTE, 3G CDMA, and IEEE 802.11. He also leads Qualcomm's companywide academic collaboration program across technologies including wireless, semiconductor, multimedia, security, and machine learning. John was chosen to participate in the National Academy of Engineering Frontiers of Engineering program and received his Ph.D. in electrical engineering from Princeton University and also holds an M.A. from Princeton and an M.Sc. and B.Sc. from Queen's University.

Linus Thrybom is manager of the Industrial Networks and Control research team at ABB Corporate Research in Västerås, Sweden. His research interests include industrial communication and 5G, system architecture, distributed real-time systems and Internet of Things. He joined ABB Corporate Research in 2008, where he in 2015 became team manager in the Automation Solutions department.

Since 2015 he has also had a central role in the 5G activities of ABB and starting 2019 he is responsible for the Connected Systems technology area in ABB Corporate Research, as well an ABB delegate in 5G-ACIA. He received the M.Sc. degree in Computer Science from Chalmers University of Technology, Gothenburg, Sweden, in 1991.

Wednesday 28 April 2021 13:00 – 15:00 UTC

Keynote Panel: Global View on 6G

Moderator:	**Mikko Uusitalo**	*Head of Research Department, Nokia Bell Labs Finland*
Panelists:	**Peiying Zhu**	*Senior VP of Wireless Research, Huawei*
	David Gesbert	*Head of the Communications Systems Dept., EURECOM*
	Matti Latva-aho	*Director, 6G Flagship, University of Oulu*
	Stefan Parkvall	*Senior Expert, Ericsson Research*

In 2030 and beyond, the world will face challenges and opportunities with growth and sustainability while proactively tackling the issues of green deal efficiency, digital inclusion, and assurances of health and safety in a post-pandemic world. Wireless technologies are critical for our society and economy today; their importance for growth will continue to increase steadily, enabling new ecosystems and services motivated by strong traffic growth from trillions of devices. This panel will look at the next generation, 6G –the vision, the challenges and expected use cases, as well as the potential enabling technologies.

Mikko Uusitalo is Head of Research Department Wireless Advanced Technologies(WAT) at Nokia Bell Labs Finland. Mikko is leading the European 6G Flagship Hexa-X. He obtained a M.Sc. (Eng.) and Dr.Tech. in 1993 and 1997 and a B.Sc. (Economics) in 2003, all from predecessors of Aalto University. Mikko has been at Nokia since 2000 with various roles, including Principal Researcher and Head of International Cooperation at Nokia Research. Mikko has more than 70 granted patents or patent families and tens of more in the application phase.

Dr. Peiying Zhu, Senior Vice President of Wireless Research, is a Huawei Fellow, IEEE Fellow and Fellow of Canadian Academy of Engineering. She is currently leading 5G and beyond wireless research and standardization in Huawei. The focus of her research is advanced radio access technologies. She is actively involved in 3GPP and IEEE 802 standards development. She has been regularly giving talks and panel discussions on 5G vision and enabling technologies. She led the team to contribute significantly to 5G technologies.

Prior to joining Huawei in 2009, Peiying was a Nortel Fellow and Director of Advanced Wireless Access Technology in the Nortel Wireless Technology Lab. She led the team and pioneered research and prototyping on MIMO-OFDM and Multi-hop relay. Many of these technologies developed by the team have been adopted into LTE standards and 4G products. Dr. Zhu has more than 200 granted patents.

David Gesbert (IEEE Fellow) is Professor and Head of the Communication Systems Department, EURECOM. He obtained the Ph.D degree from Ecole Nationale Superieure des Telecommunications, France, in 1997. From 1997 to 1999 he has been with the Information Systems Laboratory, Stanford University. He was then a founding engineer of Iospan Wireless Inc, a Stanford spin off pioneering MIMO-OFDM (now Intel). Before joining EURECOM in 2004, he has been with the Department of Informatics, University of Oslo as an adjunct professor. D. Gesbert has published about 340 papers and 25 patents, 8 some of them winning Best Paper Award. He has been a Technical Program Co-chair for ICC2017. He was named a Thomson-Reuters Highly Cited Researchers in Computer Science. In 2015, he was awarded the ERC Advanced Grant "PERFUME" on the topic of smart device Communications in future wireless networks. He is a Board member for the OpenAirInterface (OAI) Software Alliance. Since early 2019, he heads the Huawei-funded Chair on Adwanced Wireless Systems Towards 6G Networks. In 2020, he was awarded funding by the French Interdisciplinary Institute on Artificial Intelligence for a Chair in the area of AI for the future IoT.

Matti Latva-aho received the M.Sc., Lic.Tech. and Dr. Tech (Hons.) degrees in Electrical Engineering from the University of Oulu, Finland in 1992, 1996 and 1998, respectively. From 1992 to 1993, he was a Research Engineer at Nokia Mobile Phones, Oulu, Finland after which he joined Centre for Wireless Communications (CWC) at the University of Oulu. Prof. Latva-aho was Director of CWC during the years 1998-2006 and Head of Department for Communication Engineering until August 2014. Currently he serves as Academy of Finland Professor and is Director for National 6G Flagship Programme. His research interests are related to mobile broadband communication systems and currently his group focuses on beyond 5G systems research. Prof. Latva-aho has published close to 500 conference or journal papers in the field of wireless communications. He received Nokia Foundation Award in 2015 for his achievements in mobile communications research.

Stefan Parkvall joined Ericsson in 1999 and is a Senior Expert working with 6G and future radio access. He is one of the key persons in the development of HSPA, LTE and NR radio access, and has been deeply involved in 3GPP standardization for many years. Dr. Parkvall is a fellow of the IEEE and is co-author of several popular books such as 4G – LTE/LTE-Advanced for Mobile Broadband and 5G NR – The Next Generation Wireless Access. Dr. Parkvall has more than 1500 patents in the area of mobile communication and holds a Ph.D. in electrical engineering from the Royal Institute of Technology (KTH) in Stockholm, Sweden.

Wednesday 28 April 2021 13:00 – 15:00 UTC

Keynote Panel: Connecting the Unconnected

Moderator:	**Mohamed-Slim Alouini**	*Professor, King Abdullah University of Science and Technology*
Panelists:	**Michel Masselin**	*VP of Sales, Stratobus*
	Ben Glass	*CEO/CTO and Founder, Altaeros*
	Tyghe Speidel	*Co-founder and Senior VP, Technology & Strategy, Lynk*
	Satya N. Gupta	*Chairman, BLUETOWN, India & BIMSTEC S. Asia*

One of the main reasons attributed to the digital divide is the business cost and return on investment (RoI). In poorer or lower population density regions, the cost of deployment of optical fiber in the backbone network and related infrastructure, in particular a reliable electrical power grid, becomes prohibitively large, whereas the RoI remains marginal at best. In this scenario, a viable solution to cut down on the cost factor is to deploy satellites in the backbone network in order to provide connectivity to far-flung or less populated areas, to passengers in airplanes, ships, and trains, or to disconnected people in areas affected by natural disasters. More specifically, a constellation of satellites can provide worldwide coverage if a sufficient number of those are utilized. For instance, in recent years, different constellations of satellites have been proposed to provide global broadband access to Internet which includes the Starlink supported by SpaceX with 12000 LEO satellites, Amazon's Project Kuiper with 3236 LEO satellites , and Telesat LEO with 300 to 500 satellites. Such a large number of satellites has allowed mass production of components, thereby resulting in a significant reduction in satellite manufacturing costs. Alternatively, if a large footprint on the remote location is not required, a high altitude platform (HAP) or a swarm/cascade of HAP's can be used in the backbone network at a height of about 18–28 kilometers in the sky. The service model envisaged in this regard comprises of two configurations. In the first arrangement, a single HAP functions in a "tower-in-the-air" configuration whereby it relays data obtained from the ground station (uplink) to various service delivery stations (such as base stations) in the downlink. In the second configuration, a swarm/cascade of HAP's is used as both relay nodes and service delivery devices for the local users. The same configuration can also be used in conjunction with LEO or MEO satellites if the area to be covered is significantly large. In this context, this panel aims to go over the recently proposed integrated space-air-terrestrial network solutions to provide high-speed connectivity not only in under-covered/remote/rural areas but also to moving cells in the air (airplanes) and the sea (cruises/ships).

Mohamed-Slim Alouini was born in Tunis, Tunisia. He received the Ph.D. degree in Electrical Engineering from the Califonia Institute of Technology (Caltech) in 1998. He served as a faculty member at the University of Minnesota then in the Texas A&M University at Qatar

before joining in 2009 the King Abdullah University of Science and Technology (KAUST) where he is now a Distinguished Professor of Electrical and Computer Engineering. He is a Fellow of the IEEE as well as of the OSA and he is currently particularly interested in addressing the uneven global distribution, access to, and use of information and communication technologies in far–flung, low-density populations, low-income, and/or hard-to-reach areas.

Michel Masselin is an Engineer from French Engineering school Sup'Aero, and also a Master of Sciences in Aerospace Engineering from University of Southern California

For over 30 years, Michel has worked in defence, aeronautics and telecommunications industries. He commenced his career designing tactical radio networks and ultimately became responsible for the Marketing and Sales towards the French customers of all Thales Communications systems and services which encompass Combat Net Radios, tactical networks, comint products and information systems.

In 2003, he moved to Thales Training & Simulation (TT&S) responsible for very large service bids and programs including full financing packages for the German NH90, the A400M, and Helisim simulator training centers. In addition he also managed large bids for the operation of airborne platforms such as the UK MoD and DFTS Search and Rescue Helicopter programs.

In 2009, he joined Thales's space division, to be responsible for the sale and lease back of the Syracuse 3 (French milsatcom constellation) and, subsequently, the Syracuse 4 satellite offer to the French MoD.

Since 2015, Michel has been responsible for the business development and sales of Stratobus – a new, high altitude platform (HAPS) currently under development in France and in Europe.

Ben Glass is leading the Altaeros team on its journey to bring modern infrastructure to the billions of un-served and under-served people around the world. He is driven by a belief that business and technical innovation are the key to creating positive, scalable impact. At Altaeros, Ben is responsible for setting the company's strategic vision and keeping the whole team moving towards that vision, as well as providing operational direction for the company. Ben originally developed the idea for Altaeros while researching compact, efficient turbomachinery as part of the MIT Gas Turbine Lab. After developing the initial prototypes, Ben co-founded Altaeros in 2010. He holds a BS and MS in Aeronautical and Astronautical Engineering from MIT.

Tyghe Speidel is the Co-founder and SVP, Technology & Strategy at Lynk. Tyghe is the inventor of the company's core IP. Prior to Lynk, Tyghe was the Principal Spacecraft Systems Engineer at NexGen Space, where he was responsible for system design and technology application on NexGen Space technical projects. Tyghe also worked as a Management Consultant for Accenture developing supply chain analytics and simulation capabilities for the DoD. While at Accenture, Tyghe founded and was the global lead for Accenture's commercial space community of practice, which he created to develop a portfolio of projects and clients for the firm in the commercial space sector. Tyghe gained experience in orbital mechanics, satellite navigation and control, and spacecraft systems design as a spacecraft engineer at NASA's Jet Propulsion Laboratory, working on terrestrial satellites and a Mars rover. He holds a BS and M. Eng in Mechanical & Aerospace Engineering from Cornell University.

An International expert in NGN technologies, Regulation, Interconnection and Broadband with 40 years' experience in all aspects of Telecom, including 25 years with Govt. and Regulator, **Satya N. Gupta** is publicly recognized as an Analyst, Author, Advocate and Advisor on ICT related Policies, Projects and Business. After graduation from IISc. Bangalore, he joined ministry of Communication in 1981 and Ministry of railways in 1983. He is recipient of Minister of railways award for

outstanding performance for the digitalisation project. A triple master in Electronics Design Technology, IT Management and Telecom Policy and Regulation, he is globally known as "NGNguru" he is a trainer and coach for telecommunication technologies, policy and regulation and a Regulatory advocate. He authored "Everything over IP-All you want to know about NGN". His recent research-based work, "Long Tail – Walking the Extra Mile on Rural Broadband Business", brings out the innovative business models for rural broadband connectivity. He has also established and mentoring a consulting startup named SAAM CorpAdvisors providing Govt. Affairs as Managed Service.

He is Honorary Secretary General of ITU-APT Foundation of India and VP and Trustee of PTCIF and Chairs BIF committee on Rural Digital Infrastructure. He founded NGN Forum in India to spread awareness and capacity building in the field of emerging technologies. He is first Indian recipient of IPv6 Hall of Fame – 2019 by Global IPv6 Forum and also the Chairman of Bharat IPv6 Forum.

Presently, he is working as Chairman, BLUETOWN, India & BIMSTEC, S. Asia to forge newer partnerships and "Making It Happen" its Vision of "Connecting the Unconnected people living in Rural areas of World".

Workshops

W1: Energy-Efficient Schemes for Beyond 5G

The ongoing deployment of the fifth generation (5G) networks is continuously revealing its inherent limitations as a true carrier of the Internet of Everything (IoE) applications. To overcome these challenges, beyond 5G (B5G) networks have recently attracted a lot interest in the research community with the aim of truly integrating applications ranging from autonomous systems and extended reality. However, common to 5G, B5G will connect massive number of wireless terminals/devices (sensors, drones, cars, etc…) leading to a massive volume of traffic and energy consumption. Energy efficiency has become an important design objective for the successful deployment of B5G wireless networks. Hence, there is a great need to develop energy efficient architectures and transmission techniques/protocols that extend the lifetime of networks and provide significant energy savings under the aegis of green radio communications. In this regard, further efforts are essential in the quest to explore this critical issue in the context of key emerging technologies for B5G such as intelligent reflecting surfaces (IRS), visible light spectra, Terahertz communications, massive machine-type communications (mMTC) just to name a few.

General Co-Chairs:
Alagan Anpalagan, Ryerson University, Canada
Zhiguo Ding, University of Manchester, UK
Octavia Dobre, Memorial University of Newfoundland, Canada

TPC Co-Chairs:
Jules M. Moualeu, University of the Witwatersand, South Africa
Daniel B. da Costa, Federal University of Ceará, Brazil

Sunday, 25 April 2021 13:00 – 16:00 UTC

Program

W1 Welcome
Alagan Anpalagan, Ryerson University

Keynote 1 - Energy Efficient Learning at the Wireless Edge
Deniz Gündüz, Imperial College London

Keynote 2 - Wireless Powered Communications: Overview, Recent Results and Challenges
Ioannis Krikidis, University of Cyprus

1. **Efficient Power Allocation for Cognitive Radio NOMA using Game-Theoretic Based Pricing Strategy**
   Shaima S. Abidrabbu, Huseyin Arslan, Istanbul Medipol University
2. **Floating OFDM-SNM for PAPR and OOBE Reduction**
   Ahmad M. Jaradat, Istanbul Medipol University; Jehad M. Hamamreh, Antalya Bilim University; Huseyin Arslan, Istanbul Medipol University
3. **Threshold-Based Pair Switching Scheme in SWIPT-Enabled Wireless Downlink System**
   Yuan Guo, Christodoulos Skouroumounis, Ioannis Krikidis, University of Cyprus

W1 Closing Remarks
Alagan Anpalagan, Ryerson University

W2: The 2nd International Workshop on Intelligent Communication Network Technologies (ICNET)

The artificial intelligence of things (AIoT) is an emerging communication paradigm where the internet of things (IoT) meets artificial intelligence (AI). In the last two decades and several concepts are derived from IoT for efficient communication networks, smart homes, smart cities, smart health services and so on. Considering the rapid increase in the number of communicating vehicles and the tremendous amount of data exchanged by these vehicles, intelligent transportation system (ITS) with vehicle to vehicle (V2V), vehicle to infrastructure (V2I) and vehicle to everything (V2X), AI and machine learning (ML) based solutions can also provide cheap and efficient solutions in future communication networks. AI due to the self-sustainable nature with self-governing and independent decision-making capabilities appeared as a possible alternative to achieve the aim of full autonomous communication systems. Our aim in organizing this workshop is to explore intelligent communication network technologies to manage the available resources smartly and efficiently. Further, the demand for clean energy and micro-grids can be enabled for saving energy in powerful and deep saving batteries for future use. For this workshop section, we are soliciting high-quality articles covering the topic related to the Intelligent vehicular communication technologies using the internet of energy (IoEg) and IoV concepts with original results and conceptual study. The aim is to bring the novel ideas, concepts, open challenges, issues, from the researchers working the said domain.

Organizers:
Syed Hassan Ahmed, JMA Wireless
Murad Khan
Muhammad Toaha Raza Khan, Kyungpook National University

Sunday, 25 April 2021 13:00 – 16:00 UTC

Program

W2 Welcome
Syed Hassan Ahmed, JMA Wireless

W2 Keynote
Haleem Farman, Islamia College University

1. **Impact of RSU Height on 60 GHz mmWave V2I LOS Communication in Multi-lane Highways**
   Ananya Chattopadhyay, Heritage Institute of Technology; Aniruddha Chandra, National Institute of Technology, Durgapur; Chayanika Bose, Jadavpur University
2. **Multimodal Machine Learning for Pedestrian Detection**
   Mohammed Aledhari, Rehma Razzak, Reza M. Parizi, Kennesaw State University; Gautam Srivastava, Brandon University
3. **Reinforcement Learning Based Mobility Load Balancing with the Cell Individual Offset**
   Muhammad Zeeshan Asghar, University of Jyvaskyla; Metin Ozturk, Ankara Yıldırım Beyazıt University; Jyri Hamalainen, Aalto University

W2 Closing Remarks
Syed Hassan Ahmed, JMA Wireless

W3: Symbiotic Radio Paradigm for Integrated Active and Passive Communications

Future wireless networks are expected to support a variety of emerging services, such as Internet-of-Everything (IoE), holographic telepresence, wireless brain computer interactions, and multisensory augmented and virtual reality. It is thus critical to design spectrum-, energy- and cost-efficient wireless communication technologies. Recently, symbiotic radio (SR) that integrates active and passive communications has emerged as a promising technology to fulfill such demand. SR has a wide range of applications such as E-health, wireless body area networks, smart home, and mobile cellular networks. Specifically, SR enables (secondary) low-cost passive backscattering or reflecting devices to modulate information over ambient (primary) radio-frequency (RF) carriers without using power-hungry RF transmitter. The primary system collaborates with the secondary system. Both systems benefit from each other. That is, the secondary system shares the primary system's infrastructure, RF source and spectrum; while the secondary transmission provides beneficial multipath for the primary system.

This workshop will focus on theoretical and practical design issues for SR, including information-theoretic analysis, transceiver design, signal reprocessing, resource allocation, prototypes, new applications, etc. We aim to bring together researchers, engineers, and individuals working on the related areas to share their new ideas, latest findings, and state-ofthe- art results.

Organisers
Gang Yang
Xiangyun Zhou
Zilong Liu

Steering Committee:
Erik G. Larsson, Linköping Uni., Sweden
Marco Di Renzo, Paris-Saclay Uni.-CNRS, France
Olav Tirkkonen, Aalto Uni., Finland
Zhu Han, Uni. of Houston, USA

Technical Program Committee:
Arumugam Nallanathan, Queen Mary Uni. of London, UK
Riku Jäntti, Aalto Uni., Finland
Francesco Verde, National Inter-Uni. Consortium for Telecommun., Italy
Chau Yuen, Singapore Uni. of Technology & Design, Singapore
Feifei Gao, Tsinghua Uni., China
Salman Durrani, Australian National Uni., Australia
Michael Taynnan Barros, Uni. of Essex, UK
Karim G. Seddik, The American Uni. in Cairo, Egypt
Van-Dinh Nguyen, Uni. of Luxembourg, Luxembourg
Donatella Darsena, Uni. of Napoli Parthenope, Italy
Jingon Joung, Chung-Ang Uni., South Korea
Saman Atapattu Mudiyanselage, Uni. of Melbourne, Australia
Qing Wang, Delft Uni. of Technology, Netherland
Deepak Mishra, Uni. of New South Wales, Australia
Gongpu Wang, Beijing Jiaotong Uni., China
Shimin Gong, Sun Yat-Sen Uni., China
Hoang Dinh, Uni. of Technology Sydney, Australia
Shiying Han, Nankai Uni., China

Sunday, 25 April 2021 13:00 – 16:00 UTC

Program

W3 Welcome
Gang Yang, University of Electronic Science and Technology of China

W3 Keynote
Ying-Chang Liang, University of Electronic Science and Technology of China

1. **Boosting Secret Key Generation for IRS-Assisted Symbiotic Radio Communications**
   Yang Liu, Shenzhen Institutes of Advanced Technology; Meng Wang, Sun Yat-sen University; Jing Xu, Huazhong University of Science and Technology; Shimin Gong, Sun Yat-sen University; Dinh Thai Hoang, University of Technology Sydney; Dusit Niyato, Nanyang Technological University
2. **Energy Efficiency Gains for Wireless Communication Systems Aided by Ambient Backscatter**
   Ying Guo, Gongpu Wang, Beijing Jiaotong University; Guoqing Li, China Academy of Information and Communication Technology; Minzheng Jia, Beijing Polytechnic College; Bo Ai, Beijing Jiaotong University
3. **Energy-efficient Optimization for IRS-assisted Wireless-powered Communication Networks**
   Qianzhu Wang, Zhengnian Gao, Yongjun Xu, Hao Xie, Chongqing University of Posts and Telecommunications
4. **Reconfigurable Intelligent Surface Enhanced Symbiotic Radio over Multicasting Signals**
   Fanyi Shu, Gang Yang, Ying-Chang Liang, University of Electronic Science and Technology of China
5. **Resource allocation algorithm for IoT communication based on ambient backscatter**
   Zhenzhen Chen, Baofeng Ji, Henan University of Science and Technology
6. **Sparse Reconstruction Based Channel Estimation for Underwater Piezo-Acoustic Backscatter Systems**
   Guanjie Hu, Junliang Lin, Gongpu Wang, Ruisi He, Beijing Jiaotong University; Xusheng Wei, VIVO Mobile Company

W3 Closing Remarks
Gang Yang, UESTC

W4: 5G-enabled safety and support services for cooperative, connected and automated mobility

Safety and support services running on top of 5G network infrastructures have a great opportunity to facilitate cooperative, connected and automated mobility (CCAM) for automotive and transport verticals in a variety of road conditions and operational environments. As the rollouts of commercial 5G networks continue all over the world, the increasing coverage and continuously evolving capabilities of the technology make it an ideal connectivity platform for a variety of vehicle-to-everything (V2X) communication scenarios. Critical network-based services enhancing the road traffic safety are able to exploit the ultra-reliable low latency communication (URLLC) services offered by 5G. Other non-critical support services can rely on enhanced mobile broadband (eMBB) and massive machine type communications (mMTC) services provided by 5G networks and facilitate the operation of the intelligent road transport systems as well as the comfort and wellbeing of the drivers and passengers.

The aim of the workshop is to exploit these opportunities from several perspectives. First, the workshop distributes the latest results assessing the suitability of the currently standardised 5G functionalities in a variety of CCAM scenarios. Second, the workshop discusses the gaps identified in the existing 5G capabilities when it comes to the heterogeneous requirements, stemming from these scenarios, and offers new technological solutions to fill the identified gaps. Third, the workshop considers novel services and concepts that 5G networks would enable to improve the safety and performance of CCAM. The workshop is organised by the EU Horizon 2020 5G-HEART (https://5gheart.org/) and Celtic-Next 5G-SAFEPlus (https://5gsafeplus.fmi.fi/) projects.

Organisers: ***Jarno Pinola, Faouzi Bouali and Tiia Ojanperä***

Sunday, 25 April 2021 13:00 – 16:00 UTC

Program

W4 Welcome
Jarno Pinola, VTT Technical Research Centre

1. **5G-enabled Road Safety and Cybersecurity Services for Connected and Automated Vehicles**
   Tiia Ojanperä, VTT Technical Research Centre of Finland; Johan Scholliers, VTT Technical Research Centre of Finland Ltd; Timo Sukuvaara, Finnish Meteorological Institute; Iiro Salkari, Vaisala; Hongwen Zhang, Wedge Networks Inc.; Pekka Eloranta, Sitowise
2. **Anomaly Detection using IoT Sensor-Assisted ConvLSTM Models for Connected Vehicles**
   Ahmed Zekry, Queen's University; Ahmed Sayed, Mohamed Moussa, University of Calgary; M. Elhabiby, Ain Shams University Cairo
3. **C-V2X network slicing framework for 5G-enabled vehicle platooning applications**
   Alexios Lekidis, Intracom Telecom; Faouzi Bouali, Coventry University
4. **Design aspects on physical layer structure for 5G V2X and related issues**
   Mengmeng Liu, Haoyu Deng, Zhenting Li, Yongdong Zhu, Zhejiang Lab
5. **Experimental evaluation of a traffic warning system based on accurate driver condition assessment and 5G connectivity**
   Olli Apilo, Jarno Pinola, VTT Technical Research Centre of Finland; Riikka Ahola, Juhani Kemppainen, Jukka Happonen, Polar Electro
6. **On the potential of multicast in millimeter wave vehicular communications**
   Gereon Mendler, Geert Heijenk, University of Twente
7. **Spectrum Needs of Cooperative, Connected and Automated Mobility**
   Sebastian Euler, Ericsson; Andreas Pfadler, Volkswagen AG; Luis Fernández Ferreira, PSA Groupe; Hongxia Zhao, Volvo Car Corporation

W4 Closing Remarks
Jarno Pinola, VTT Technical Research Centre

W5: Connected Intelligence for IoT and Industrial IoT Applications (C3IA)

Nowadays, industrial enterprises and companies are addressing the challenge of transforming the Industrial IoT (IIoT) ideas, Industry 4.0, Cyber-Physical Systems (CPS), and similar concepts into reality. In the Industry 4.0 era, various data management research challenges have to be addressed. Huge amounts of heterogeneous sensor data have to be processed in real-time to control the production machines. Data processing through smart devices is more significant compared to information processing capacity. Nowadays, data becomes humongous, even coming from a single source. Besides, unstructured data from production reports or external sources must also be integrated to analyze and optimize the production process. Therefore, when data emanates from all heterogeneous sources distributed over the globe, its magnitude makes it harder to process up-to a needed scale. The world has seen many breakthroughs in machine learning and artificial intelligence research. By integrating the advances in smart devices, and big data analysis with the advances in machine learning, the future role of smart systems, networks, and applications is becoming limitless. It's expected to revolutionize the future of the world within the next few years.

Organizers: ***Abdellah Chehri, Gwanggil Jeon, Paul Fortier & Ahmed Awais***

Sunday, 25 April 2021 13:00 – 16:00 UTC

Program

W5 Welcome
Abdellah Chehri, University of Quebec - UQAC

1. **An adaptive uplink resource allocation algorithm in NB-IoT**
   Errong Pei, Zhenmin Wang, Yun Li, ChongQing University of Posts and Telecommunications of China
2. **An Efficient ToA Estimation Technique Based on Phase Correction for 5G mMTC system**
   Xining Yang, Chinese Academy of Sciences; Jinhong Yuan, University of New South Wales; Yiqing Zhou, Jinglin Shi, Chinese Academy of Sciences

3. **Computation-efficient Hybrid Offloading for Backscatter-assisted Wirelessly Powered MEC**
   Jianzhen Lu, Peiran Wu, Minghua Xia, Sun Yat-sen University
4. **Research on Energy Saving Mechanism of NB-IoT Based on eDRX**
   Errong Pei, Ru Zhang, Yun Li, ChongQing University of Posts and Telecommunications of China
5. **Transmission Performance Guaranteed Task Distribution Strategy in Mobile Crowdsensing**
   Yi Lv, Yan Wang, Yaping Cui, Peng He, Dapeng Wu, Ruyan Wang, Chongqing University of Posts and Telecommunications

W5 Closing Remarks
Abdellah Chehri, University of Quebec - UQAC

W6: Technologies and Proof-of-Concept Activities for 5G Evolution & Beyond 5G

The 5th generation (5G) cellular communication systems are just launched in 2019. New technology concepts for the next generation mobile communications including 5G Evolution (5GE) and Beyond 5G (B5G) are about to be investigated in many research entities. On top of that, research and development (R&D) activities for B5G are about to be initiated. This workshop is aiming to provide opportunities to present the latest trials and the proof-of-concept activities for 5GE and new technology concepts for B5G. Distinguished speakers from industry and academia will present their latest R&D results and discuss their perspective regarding the new directions of B5G. The discussion at the workshop is also expected to promote the exchange of new ideas among researchers.

Organizer: *Eiji Okamoto*

Sunday, 25 April 2021 13:00 – 16:00 UTC

Program

W6 Welcome
Eiji Okamoto, Nagoya Institute of Technology

W6 Keynote 1
Yoshihisa Kishiyama, NTT DOCOMO

1. **User Set Elimination in Allocation Sequences of RR Scheduling for Distributed Antenna Transmission**
   Go Otsuru, Yukitoshi Sanada, Keio University
2. **Performance of Enhanced Interference Coordination Using Multi-layered Clustering for 5G Advanced Ultra-dense RAN**
   Ryo Takahashi, Hidenori Matsuo, Fumiyuki Adachi, Tohoku University
3. **Time-Indexed Parallel Spatial Modulation for Large-scale MIMO Systems with Antenna Grouping**
   Taissir Elganimi, University of Tripoli; Khaled Rabie, Manchester Met University
4. **Multidimensional Generalized Quadrature Index Modulation for 5G Wireless Communications**
   Taissir Elganimi, University of Tripoli; Khaled Rabie, Manchester Met University

W6 Keynote 2
Preben Mogensen, Aalborg Universitet

5. **Channel Estimation Using Multi-stage Compressed Sensing for Millimeter Wave MIMO Systems**
   Hadji Baghdad, University of Science and Technology – Houari Boumediene; Abdeldjalil Aissa El Bey, IMT Atlantique; Lamya Fergani, University of Science and Technology – Houari Boumediene; Mustapha Djeddou, Military Polytechnic School, Algiers
6. **Load-Balancing Techniques for 5G Millimeter-Wave Distributed Antenna System**
   Teppei Oyama, Takashi Seyama, Fujitsu
7. **Dynamic Cross-Carrier Enhancement for 5G and B5G**
   Abdellatif Salah, Cheng-Hsun Li, Mohammed Al-Imari, Jozsef Nemeth, Weide Wu, Mediatek Inc
8. **Data Collection Platform for Smart City with Gigabit V2X Communication over 60 GHz Band**
   Kosei Nakano, Panasonic Corporation; Gaius Yao Huang Wee, Panasonic Asia Pacific Pte. Ltd.; Akihiro Egami, Hiroyuki Motozuka, Takenori Sakamoto, Masataka Irie, Kazuaki Takahashi, Panasonic Corporation
9. **A Novel Intelligent SIC Detector for NOMA Systems Based on Deep Learning**
   Jialiang Fu, Yue Xiao, Haoran Liu, Ping Yang, University of Electronic Science and Technology of China; Bo Zhang, National Innovation Institute of Defense Technology

W7: International Workshop on Smart Spectrum (IWSS 2021)

Over the last years, wireless communication networks have faced ever-increasing traffic demands beyond the available capacity, a problem that is expected to worsen in the foreseeable future with the requirement for high data-rate, enhanced Mobile Broadband (eMBB) services and the advent of a myriad of machine-type devices interconnected through the Internet of Things (IoT) for massive Machine Type Communications (mMTC). In order to cope with the forecasted traffic loads, an essential requirement for future wireless communication systems is efficient, flexible and dynamic spectrum utilization. Smart spectrum exploitation techniques have been developed for WRANs in TV white spaces, LTE-LAA mobile networks in ISM bands, CBRS radar systems, and cognitive satellite communications, to mention just a few examples. Spectrum sharing and on-demand spectrum assignment are very hot topics for innovative and sustainable future wireless world and continues to be an active field of research in the academic and industrial communities as well as in spectrum regulation activities. The International Workshop on Smart Spectrum aims to bring together academic researchers and industry practitioners as well as members of standardization bodies and government to meet and exchange ideas on research about smart spectrum for sustainable future wireless world. This workshop aims to stimulate discussion and generation of innovative ideas for smart spectrum exploitation.

Organizers: *Miguel López-Benítez and Kenta Umebayashi*

Sunday, 25 April 2021 13:00 – 16:00 UTC

Program

W7 Welcome
Miguel López-Benítez, University of Liverpool

1. **A Q-learning based Resource Allocation Algorithm for D2D-Unlicensed communications**
   Errong Pei, Bingbing Zhu, Yun Li, ChongQing University of Posts and Telecommunications of China
2. **ECSS: Efficient Cooperative Spectrum Sensing in CBRS based Cognitive Radio System**
   CHetna Singhal, Vaisakh Suresh, IIT,Kharagpur
3. **Effects of RF Imperfections on Interference Rejection Combining Based Black-Space Cognitive Radio**
   Sudharsan Srinivasan, Sener Dikmese, Markku Renfors, Tampere University

4. **Energy Detection for M-QAM Signals**
   Shun Ishihara, Kenta Umebayashi, Tokyo University of Agriculture and Technology; Janne Lehtomäki, University of Oulu
5. **Evaluation of the Impact of Thresholding and Frequency/ Time Resolution on Signal Area Estimation Methods**
   Mohammed M. Alammar, Miguel López-Benítez, University of Liverpool
6. **Modeling and Analyzing LTE Licensed Assisted Access Network with Capture Effect**
   Errong Pei, Lineng Zhou, Bingguang Deng, Yun Li, ChongQing University of Posts and Telecommunications of China
7. **Optimal Utility of Cooperative Spectrum Sensing for CUAVNs**
   Jun Wu, Hangzhou Dianzi University
8. **Performance Evaluation of Carrier Aggregation as a Diversity Technique in mmWave Bands**
   Paul Ushiki Adamu, Miguel López-Benítez, University of Liverpool
9. **Reliable Reporting Mechanism for Hard Combining-based Cooperative Spectrum Sensing**
   Jun Wu, Hangzhou Dianzi University
10. **Signal Statistics based Multiple AP Detection for Smart Spectrum Sharing in LTE-U/Wi-Fi Coexistence**
    Farwa Ahmed, Istanbul Medipol University; Husyein Arslan, University of South Florida

W8: Decentralized Technologies and Applications for IoT (D'IoT) 2021

The D'IoT workshop 2021 will focus on technology advancements and applications of the decentralized technologies aka blockchain for IoT and big data. The submissions are expected in areas such as Theories and applications of Big Data Analytics for IoT, Decentralized applications for Healthcare informatics under IoT, privacy-preserving visualization techniques for data from IoT devices, security and privacy in IoT using decentralized techniques, next-generation decentralized applications for IoT, Decentralized IoT applications in Smart cities, Decentralized applications for FoG and Edge computing driven IoT, Visions on Decentralized Trustless Systems for IoT, and others. The workshop is concerned with inter-disciplinary and cross-domain studies spanning a variety of areas in computer science including enriched IoT data management on Blockchain, mobile computing, information extraction and retrieval, and security, as well as other disciplines such as management information science.

Organisers:
Sandeep Pirbhulal, Norwegian University of Science and Technology, Norway
Ali Hassan Sodhro, Mid-Sweden University, Sweden
Muhammad Muzammal, Bahria University, Pakistan

Technical Program Committee:
Ijaz Ahmad, Technical Research Centre of VTT, Finland
Kashif Nisar, University Malaysia Sabah, Malaysia
Vasileios Gkioulos, Norwegian University of Science and Technology
Kapal Dev Langhani, Trinity College Dublin, Ireland
Nuno Pombo, University of Beira Interior, Portugal,
Eshrat E Alahi, Chinese Academy of Sciences, China.
Victor Hugo C. de Albuquerque, University of Fortaleza, Brazil
Lei Wang, Chinese Academy of Sciences, China
Yacine Ouzrout, University Lumiere Lyon 2, France
Claudio Savagio, University of Calabria, Italy

Sunday, 25 April 2021 13:00 – 16:00 UTC

Program

W8 Welcome
Sandeep Pirbhulal, Norwegian University of Science and Technology

W8 Keynote
Nuno Garcia, University of Beira Interior

1. **An Adaptive Energy Optimization Mechanism for Decentralized Smart Healthcare Applications**
   Noman Zahid, Sukkur IBA University; Ali Hassan Sodhro, Lulea University of Technology, Lulea, Sweden; Sandeep Pirbhulal, UBI; Lei Wang, SIAT, CAS, Shenzhen, China
2. **Blockchain based Content Sharing Management in VANETs**
   Yi Peng, Chongqing University of Posts and Telecommunications
3. **Collision-free Path Planning for UAVs using Efficient Artificial Potential Field Algorithm**
   Praveen Kumar Selvam, University of Applied Sciences Jena; Gunasekaran Raja, Vasantharaj Rajagopal, Anna University; Kapal Dev, Trinity College; Sebastian Knorr, Ernst-Abbe-University
4. **Decentralized Energy Efficient Model for Data Transmission in IoT-based Healthcare System**
   Ali Hassan Sodhro, Lulea University of Technology, Lulea, Sweden; Hina Magsi, Sukkur IBA University, Sukkur, SIndh, Pakistan; Noman Zahid, Sukkur IBA University; Sandeep Pirbhulal, UBI; Kashif Nisar, University of Malaysia Sabah
5. **Deep Reinforcement Learning for Edge Computing Resource Allocation in Blockchain Network Slicing Broker Framework**
   Yu Gong, Beijing University of Posts and Telecommunications
6. **Generic Reliability Analysis Model of IoT: Agriculture use case**
   Fatoumata Thiam, Maïssa Mbaye, University Gaston Berger De Saint-Louis; Alexander Wyglinsky, Worcester Polytechnic Institute
7. **Network Coding-based Data Storage and Retrieval for Kademlia**
   Ali Marandi, Hadi Sehat, Daniel E. Lucani, Saeid Mousavifar, Rune Hylsberg Jacobsen, Aarhus University
8. **Position based Optimization of RF MAC Protocol for Sensing Technology Enabled Applications**
   Suneel Kumar, University of Central Punjab Lahore; Ali Nawaz Khan, COMSATS University Islamabad, Lahore Campus

W8 Closing Remarks
Sandeep Pirbhulal, Norwegian University of Science and Technology

W9: The 10th International Workshop on High Mobility Wireless Communications

The vision of future mobile communication systems is to provide seamless high data rate wireless connections for anyone at anytime and anywhere, including the high mobility scenarios such as high speed trains and highway vehicles. High mobility results in rapidly time-varying channels, which pose significant challenges in the design of practical systems, including channel modeling, fast handover, location management, synchronization, estimation and equalization, anti-Doppler spread techniques, coding and network capacity, capacity-approaching techniques, dedicated network architectures, distributed antenna techniques and etc. In addition, with the development of vehicular networks, more rigorous performance requirements (e.g., ultra-low latency and ultra-high reliability) are also required for advanced

driving applications such as platooning, full automated driving, collective perception of environment and so on, which makes the research and development of wireless systems more challenging. Accordingly, the 10th international workshop on High Mobility Wireless Communications (HMWC) aims at fostering fruitful interactions among interested communication engineers, information theorists and system designers from all over the world, building successful collaborations and bridging the gap between theory and practice.

Organizers: ***Pingzhi Fan, Shanzhi Chen, Yuliang Tang and Huaiyu Dai***

Sunday, 25 April 2021 13:00 – 16:00 UTC

Program

W9 Welcome
Pingzhi Fan, Southwest Jiaotong University

1. **A Collaborative Task Offloading Scheme in Vehicular Edge Computing**
   Muhammad Saleh Bute, Southwest Jiaotong University
2. **A Two-Timescale Resource Allocation Scheme in Vehicular Network Slicing**
   Yaping Cui, Xinyun Huang, Peng He, Dapeng Wu, Ruyan Wang, Chongqing University of Posts and Telecommunications
3. **Analysis of the Maximum Ratio Transmission Precoding under Imperfect Channel State Information with Hardware Impairments in Correlated Channels**
   Yasser Ahmed, Cairo University
4. **IRS-aided Predictable High-Mobility Vehicular Communication with Doppler Effect Mitigation**
   Ke Wang, Chan-Tong Lam, Benjamin K. Ng, Macao Polytechnic Institute
5. **Kalman Filter based NLOS Identification and Mitigation for M2M Communications over Cellular Networks**
   Sree Krishna Das, Trust University; Ratna Mudi, Jahangirnagar University; M Abdus Samad, Trust University
6. **MmWave Massive MIMO Hybrid Precoding Prediction in High Mobility Scenarios**
   Yipai Yan, Honglin Zhao, Jiayan Zhang, Chengzhao Shan, Yongkui Ma, Harbin Institute of Technology
7. **Optimize efficiency of Orchestration in Virtualized Radio Access Network Functions**
   Sai Zou, Guizhou university
8. **Reservation based Resource Allocation Scheme for Internet of Vehicles**
   Jianxin Zhang, Xuanzhi Chen, Yanglong Sun, Tang Yuliang, Lintao Zhang, Xiamen University
9. **Topology-Aware Dynamic Computation Offloading in Vehicular Networks**
   Liuzhang, Zhibin Gao, Xiamen University; Minghui LiWang, University of Western Ontario, London, Canada; Fangzhe Chen, Yilin Wang, Lianfen Huang, Tang Yuliang, Xiamen University
10. **Traffic Statistics and Analysis of Transmitter in C-V2X Communication**
    Yang Mingxi, Jilin University
11. **V2V Test Scenario-Study on Intersection Collision Warning**
    Xu Yaqi, Jilin University
12. **Vehicle Density Oriented V2V Field Test Architecture and Test Procedure Design**
    Yuming Ge, China Academy of Information and Communications Technology; Yunqu Wu, ChongQing University; Lingqiu Zeng, Chongqing University; Hui Zu, Chongqing Vehicle Test and Research Institute; Rundong Yu, China Academy of Information and Communications Technology

W9 Closing Remarks
Pingzhi Fan, Southwest Jiaotong University

W10: 3rd International workshop on Dependable Wireless Communications (DEWCOM)

Dependability is a generic concept that describes the level of trust one can have in the operation of a system. The attributes of dependability denote different properties that can be expected from a dependable system, whose importance can vary between distinct applications such as availability, reliability, safety, integrity and maintainability. During the design of these systems, several means or techniques can be used to attain the various attributes of dependability. In a number of wireless communication based systems, for instance, vehicular environment or industrial environment, dependability attributes are of uttermost importance, since a failure in system's operation can cause severe consequences. These systems present timeliness requirements that are dictated by the environment in which they operate. Since the environment has inherent temporal dynamics, in order to properly interact with it, these systems not only have to produce logically correct solutions but also need to apply them within a specified time interval. The temporal behaviour of the whole system depends on several elements such as the node's software, e.g. running tasks, behaviour and the capacity of the underlying communication system to provide timely delivery of messages. Therefore, communication systems must be capable of delivering messages within specific temporal constraints. For instance, in case of vehicular communications, when an accident occurs the vehicles approaching the location of the hazard should receive a warning message with sufficient time in advance, in order for them to take appropriate measures, avoiding a possible chain collision. If these hard deadlines cannot be met, catastrophic consequences may occur, possibly causing human, economic and environmental losses. Beyond that, this type of safety-critical systems must exhibit a high probability to provide continuous correct service, in order to guarantee that real-time activities are performed within stringent bounds.

Wireless communication technologies have become immensely adopted in various fields, appearing in a plethora of applications ranging from tracking victims, responders and equipment in disaster scenarios to machine health monitoring in networked manufacturing systems etc. Most of these applications demand strictly bounded timing response and are highly dependent on the performance of the underlying wireless communication technology. In most cases, these systems are required to have dependable timeliness requirements since data communication must be conducted within predefined temporal bounds along with fulfilling other requirements such as reliability, security etc. This is mainly because the unfulfillment of these requirements may compromise the expected behaviour of the system and cause economic losses or endanger human lives. In addition, the broadcast nature of wireless communications in an open environment makes it

more vulnerable to unwanted external entities compared to the wired communications. This makes the support of dependable wireless communications in open environments, where multiple devices are contending for the resources, a challenging task. Thus, future wireless communications must tackle these challenging issues such as low communication reliability, real-time support, security, reachability and fault-tolerance.

Therefore, new design aspects in this class of systems considering new architectures, applications, and communication mechanisms based on dependability attributes need to be proposed.

Organizers: ***Joaquim Ferreira, Paulo C. Bartolomeu***

Sunday, 25 April 2021 13:00 – 16:00 UTC

Program

W10 Welcome
Joaquim Ferreira, Telecommunications Institute

W10 Keynote
Gianluca Cena

1. **A User Access Method Based on Game Theory in UDN Considering PLS and NOMA**
   Yanbo Huang, Ming Zhang, Yong Shang, Peking University
2. **Hybrid Routing Mechanism for Wireless Vehicular Networks**
   Mohannad Jooriah, João Almeida, Joaquim Ferreira, Instituto de Telecomunicações, Universidade de Aveiro
3. **Secure Multi-access Edge Computing Assisted Maneuver Control for Autonomous Vehicles**
   Andrea Tesei, Marco Luise, University of Pisa; Paolo Pagano, CNIT; Joaquim Ferreira, Instituto de Telecomunicações, Universidade de Aveiro

W10 Closing Remarks
Joaquim Ferreira, Telecommunications Institute

W12: Wireless Communication Technologies for Future Railway Systems

The increase of information exchange between various stakeholders and the global interconnection of devices are expected to significantly impact future railway systems. This workshop therefore focuses on the theoretical and practical views of wireless communication technologies in the context of future railway systems.

The workshop will cover the following topics:
- Requirements and emerging applications for railway communications
- Theoretical and practical research in automations for future railway systems
- Railway networks, such as wireless train backbone or wireless consist network.
- Antenna requirements and modeling for wireless railway communications
- Spectrum challenges for wireless railway applications (700 MHz to mmWaves)
- Applicability of 5G and Beyond-5G features to future railway systems
- Consist-to-X communications (Intra-consist, Inter-consist, Train-to-Train and Train-to-Ground)
- Channel measurement and modeling for railway communications links
- Cyber-security of railway wireless communications
- Process in standardization.

Organizers: ***Jérôme Härri, Aitor Arriola***

Sunday, 25 April 2021 13:00 – 16:00 UTC

Program

W12 Welcome
Jérôme Härri, EURECOM, Sophia Antipolis

W12 Keynote 1 - Propogation and Channel Modelling for Train-to-Tain Communications
Paul Unterhuber

1. **Radio resource management algorithm for urban rail transit communication system based on Stackelberg game**
   Yingxia Shao, Hailin Jiang, Hongli Zhao, Beijing Jiaotong University
2. **Physics-Based Wireless Channel Modeling and Optimization of Access Points Placement for Communications-Based Train Control Systems**
   Xingqi Zhang, University College Dublin
3. **Zero on site testing of railway wireless systems: the Emulradio4Rail platforms**
   Marion Berbineau, Ali Sabra, Virginie Deniau, Christophe Gransart, Université Gustave Eiffel; Raul Torrego, IKERLAN; Aitor Arriola, Ikerlan; Inaki Val, IK4-Ikerlan; Jose Soler, DTU Fotonik; Ying Yan, Technical University of Denmark; Alessandro Vizzarri, Franco Mazenga, RadioLabs; Sofiane Kharbech, Laurent Clavier, Rhéda Kassi, University of Lille; Juan Moreno García-Loygorri, Metro Madrid

W12 Keynote 2 - Antenna Specifications and Integration Constraints for Next Generation Railway Communication Systems
Divitha Seetharamdoo

W12 Closing Remarks
Jérôme Härri, EURECOM, Sophia Antipolis

VTC2021-Spring Main Conference

Monday, 26 April 2021

Monday, 26 April 2021 15:00-17:00 UTC

Electric Vehicles, Vehicular Electronics, and Intelligent Transportation I

1. **A Pedestrian Evacuation Model for ITS based on Cell Transmission Model and Linear Programming**
   Ruisong Han, Martin Tolan, Frances Cleary, Fan Zhang, Waterford Institute of Technology
2. **Abnormal Driving Behavior Detection System**
   Seyhan Ucar, Toyota Motor North America R&D; Baik Hoh, Kentaro Oguchi, InfoTech Labs Toyota Motor North America R&D
3. **An Intelligent Multi-Speed Advisory System using Improved Whale Optimisation Algorithm**
   Beiran Chen, Trinity College Dublin; Mingming Liu, Dublin City University; Yi Zhang, Trinity College Dublin; Zhengyong Chen, Yingqi Gu, Noel E. O'Connor, Dublin City University
4. **Comprehensive Performance Assessment of Various NN-based Side-Slip Angle Estimators (ANN-SSE)**
   Mohamed G. Essa, Catherine M. Elias, Omar M. Shehata, German University in Cairo
5. **Data Provenance in Vehicle Data Chains**
   Daniel Wilms, BMW Technology Office Israel; Carsten Stoecker, Juan Caballero, Spherity GmbH
6. **Efficient Regenerative Torque Control Method of PMSM Drive**
   Kyoung-Min Choo, Sungkyunkwan University; Jung-Hyo Lee, Kunsan National University
7. **Impact of Deep RL-based Traffic Signal Control on Air Quality**
   Ammar Haydari, Micheal Zhang, Chen-Nee Chuah, Dipak Ghosal, University of California Davis

Monday, 26 April 2021 15:00-17:00 UTC

Green Communications and Networks I

1. **Advanced Sleep Modes to comply with delay constraints in energy efficient 5G networks**
   Michela Meo, Daniela Renga, Zunera Umar, Politecnico di Torino
2. **An Energy Harvesting MAC Protocol for Cognitive Wireless Sensor Networks**
   Arif Obaid, Muhammad Jaseemuddin, Xavier Fernando, Ryerson University
3. **Correlation-Based Device Energy-Efficient Dynamic Multi-Task Offloading for Mobile Edge Computing**
   Siqi Zhang, Na Yi, Yi Ma, University of Surrey
4. **DDPG Based Computation Offloading and Resource Allocation for MEC Systems with Energy Harvesting**
   Jieying Ren, Shaoyi Xu, Beijing Jiaotong University
5. **DNN-Based Resource Allocation for Cooperative CR Networks with Energy Harvesting**
   Han Hu, Cen Yang, Dingguo Wu, Nanjing University of Posts and Telecommunications; Rose Qingyang Hu, Utah State University
6. **Experimental Evaluation on RSSI-based Phase Optimization in Microwave Power Transfer**
   Hayashi Kentaro, Hikaru Hamase, Jiei Kawasaki, Kazuhiro Kizaki, Osaka University; Yuki Tanaka, Panasonic Corporation; Takuya Fujihashi, Shunsuke Saruwatari, Takashi Watanabe, Osaka University

Monday, 26 April 2021 15:00-17:00 UTC

Emerging Applications

1. **Age-Energy Tradeoff in Dual-Hop Status Update Systems with the m-th Best Relay Selection**
   Mangang Xie, Jie Gong, Xiao Ma, Sun Yat-sen University
2. **Exploiting Mobile Carrying to Improve the Capacity of Satellite Networks**
   Zhanwei Wang, Weigang Bai, Min Sheng, Jiandong Li, Xidian University; Runzi Liu, Xi'an University of Architecture and Technology; Yuanyuan Bi, Xidian University
3. **Fast Reinjection for Intermittent MPTCP Connections**
   Ralf Lübben, Flensburg University of Applied Sciences; Sascha Gübner, Philip Wette, Robert Bosch GmbH
4. **Low-latency Sliding-window Recoding**
   Elif Tasdemir, Mate Tomoskozi, Hani Salah, Frank H.P. Fitzek, Technische Universität Dresden
5. **Multi-Antenna Covert Communication With Jamming in the Presence of a Mobile Warden**
   Xinying Chen, Dalian University of Technology; Zheng Chang, University of Jyväskylä; Nan Zhao, Dalian University of Technology; Yunfei Chen, University of Warwick; F. Richard Yu, Carleton University; Timo Hämäläinen, University of Jyväskylä
6. **Multi-hop Routing with Proactive Route Refinement for 60 GHz Millimeter-Wave Networks**
   Chanaka Samarathunga, University of Kansas; Mohamed Abouelseoud, Sony R&D Center US; Kazuyuki Sakoda, Sony R&D Center Japan; Morteza Hashemi, University of Kansas
7. **The Implementation of a SIP-Based Service Platform for 5G IoT Applications**
   I-Fen Yang, Yi-Chun Lin, Shun-Ren Yang, National Tsing Hua University; Phone Lin, National Taiwan University
8. **UAV-Assisted Data Rate Maximization Under 3-D Channel Model**
   Jianzhen Lin, Shenzhen University; Cunhua Pan, Queen Mary University of London; Chunlong He, Shenzhen University; kezhi wang, Northumbria University; Rujun Zhao, Shenzhen University

Monday, 26 April 2021 15:00-17:00 UTC

Positioning, Navigation, and Sensing I

1. **Adaptive Bayesian State Estimation Integrating Non-stationary DGNSS Inter-Agent Distances**
   Simone Zocca, Alex Minetto, Fabio Dovis, Politecnico di Torino
2. **Blind Doppler Tracking from OFDM Signals Transmitted by Broadband LEO Satellites**
   Joe Khalife, Mohammad Neinavaie, Zaher Kassas, University of California, Irvine
3. **Convolutional Neural Networks based Denoising for Indoor Localization**
   Wafa Njima, Marwa Chafii, ETIS, CY Cergy Paris Université, ENSEA, CNRS; Ahmad Nimr, Gerhard Fettweis, Technical University of Dresden
4. **Cooperative Positioning System for Industrial IoT via mmWave Device-to-Device Communications**
   Yi Lu, Mike Koivisto, Jukka Talvitie, Elizaveta Rastorgueva-Foi, Mikko Valkama, Simona Lohan, Tampere University
5. **Cooperative Relative Positioning using Signals of Opportunity and Inertial and Visual Modalities**
   Nicolas Souli, University of Cyprus; Rafael Makrigiorgis, KIOS Research and Innovation Center of Excellence; George Ellinas, University of Cyprus; Panayiotis S Kolios, KIOS Research and Innovation Center of Excellence
6. **Ensembling Multiple Radio Maps with Dynamic Noise in Fingerprint-based Indoor Positioning**
   Joaquin Torres Sospedra, Universitat Jaume I; Fernando J. Aranda, Fernando J. Álvarez, University of Extremadura; Darwin Quezada-Gaibor, Universitat Jaume I; Ivo Silva, Cristiano Pendão, Adriano Moreira, University of Minho

7. **Hybrid Bayesian-based Indoor Localization Mechanisms for Distributed Antenna Systems**
   Leonardo Terças, Carlos Lima, Jani Saloranta, Matti Latva-aho, University of Oulu

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Signal Processing for Wireless Communications I

1. **A Highly-Efficient Amplification Scheme for OFDM Signals**
   Pedro Viegas, Instituto de Telecomunicações, Koala Tech; João Guerreiro, FCT-Universidade Nova de Lisboa, Instituto de Telecomunicações; Rui Dinis, Universidade Nova de Lisboa; Paulo Carvalho, FCT- Universidade Nova de Lisboa; João Pedro Oliveira, FCT-UNL; Ricardo Laires, PDM FC; Pedro Morgado, Koala Tech; Hugo Serra, Instituto de Telecomunicações; Ricardo Madeira, FCT-UNL
2. **A Non-Uniform Multi-Wideband OFDM System for Terahertz Joint Communication and Sensing**
   Yongzhi Wu, Shanghai Jiao Tong University; Filip Lemic, Internet Technology and Data Science Lab, University of Antwerp - imec; Chong Han, Shanghai Jiao Tong University; Zhi Chen, University of Electronic Science and Technology of China
3. **An Efficient and Optimal Detector for Orthogonal Precoding in DFT-based Systems**
   Hikaru Kawasaki, NICT; Takeshi Matsumura, National Institute of Information and Communications Technology; Fumihide Kojima, NICT
4. **Design of DMRS schemes for 5G vehicular communications**
   Juan Riol Martin, University Carlos III de Madrid; Raquel Pérez Leal, Ana García-Armada, Universidad Carlos III de Madrid
5. **Effective Rate Evaluation with Assistance of Mixture Gamma (MG), Mixture of Gaussian (MoG), and Fox's H-Function Distributions**
   Long Kong, University of Luxembourg; Jiguang He, University of Oulu; Yun Ai, Norwegian University of Science and Technology; Symeon Chatzinotas, SnT, University of Luxembourg; Bjorn Ottersten, University of Luxembourg
6. **GLRT-Based Preamble Sequence Detection in OFDM**
   Chieh-Ju Tsai, National Taiwan University; Wei-Chang Chen, National Taipei University of Technology; Fu-Chuan Hung, National Chung-Shan Institute of Science and Technology; Char-Dir Chung, National Taiwan University
7. **Kernel Recursive Least Squares Algorithm for Transmitter-Induced Self-Interference Cancellation**
   Christina Auer, Thomas Paireder, Mario Huemer, Johannes Kepler University Linz
8. **Passive Beamforming Design for Reconfigurable Intelligent Surface-aided OFDM: A Fractional Programming Based Approach**
   Keming Feng, Southeast University; Yijian Chen, ZTE Corporation, Shenzhen, China; Yu Han, Xiao Li, Southeast University; Shi Jin, Southern University

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Cognitive Networks

1. **A Novel Spectrum Partitioning Scheme for Dynamic Heterogeneous Networks**
   Hyunjin Kim, Yonsei University; Hyejin Kim, Jintae Kim, Daesik Hong, Yonsei University
2. **Bandwidth-Efficient Frequency Hopping based Anti-Jamming Game for Cognitive Radio assisted Wireless Sensor Networks**
   Khalid Ibrahim, COMSATS University Islamabad; Ijaz Mansoor Qureshi, Air University, Islamabad; Adqas Naveed Malik, International Islamic University, Islamabad; Soon Xin Ng, University of Southampton
3. **Cellular Network Planning via Local Regularity Optimization**
   Mohsen Abedi, Risto Wichman, Aalto University
4. **Estimation of spectrum valuation for 5G dynamic frequency allocation and auctions**
   Chouayakh, Aurélien Bechler, Orange Labs; Isabel Amigo, Loutfi Nuaymi, Patrick Maillé, IMT Atlantique
5. **Hybrid Joint-Transmission Multi-Point Coordination for Inter-Cell Interference Management**
   Christopher Merlhe, IRISA, Universty of Rennes 1; Cedric Gueguen, University of Rennes 1; Xavier Lagrange, IMT Atlantique, IRISA
6. **Optimal Carrier Sensing Range in Coexisting Wireless Networks**
   Luis Irio, Instituto de Telecomunicações; Rodolfo Oliveira, Universidade Nova de Lisboa/Instituto de Telecomunicações; Daniel Benevides da Costa, Federal University of Ceara (UFC); Ugo Dias, University of Brasilia
7. **Spectrum Access Management of Multi-class Secondary Users in Hybrid Cognitive Radio Networks**
   Ahmed Tayel, Alexandria University; Sherif I. Rabia, Ahmed H. Abd El-Malek, Egypt-Japan University of Science and Technology (E-JUST); Amr M. Abdelrazek, Alexandria University
8. **Transmitter Selection for Secrecy in Cognitive Small-Cell Networks with Backhaul Knowledge**
   Burhan Wafai, Indian Institute of Technology Jammu; Chinmoy Kundu, University College Dublin; Ankit Dubey, Indian Institute of Technology Jammu; Jinghua Zhang, Queen's University Belfast; Mark Flanagan, University College Dublin

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Electric Vehicles, Vehicular Electronics, and Intelligent Transportation II

1. **Inaccurate Prediction Is Not Always Bad: Open-World Driver Recognition via Error Analysis**
   Jianfeng Li, Kaifa Zhao, Hong Kong Polytechnic University; Yajuan Tang, Shantou University; Xiapu Luo, Hong Kong Polytechnic University; Xiaobo Ma, Xi'an Jiaotong University
2. **Isolation of redundant and mixed-critical automotive applications: effects on the system architecture**
   Alessandro Frigerio, Eindhoven University of Technology; Bart Vermeulen, NXP Semiconductors; Kees Goossens, Eindhoven University of Technology
3. **Modeling and Performance Comparison of GaN HEMT and SiC MOSFET for Onboard Charging Application**
   Webster Oluwafemi Adepoju, Indranil Bhattacharya, Muhammad Bima Enagi, Trapa Banik, Tennessee Technological University
4. **Passive Filter Design Algorithm for Transient Stabilization of Automotive Power Systems**
   Martin Baumann, Ali Shoar Abouzari, Christoph Weissinger, BMW Group; Bjorn Gustavsen, SINTEF Energy Research; Hans-Georg Herzog, Technical University of Munich (TUM)
5. **Resilient Shield: Reinforcing the Resilience of Vehicles Against Security Threats**
   Kim Strandberg, Thomas Rosenstatter, Chalmers University of Technology; Rodi Jolak, Chalmers | Gothenburg University; Nasser Nowdehi, Tomas Olovsson, Chalmers University of Technology
6. **UAV-assisted Railway Track Segmentation based on Convolutional Neural Networks**
   Abdelhamid Mammeri, Abdul Jabbar Siddiqui, Yiheng Zhao, National Research Council of Canada
7. **Vehicle Trajectory Prediction based on LSTM Recurrent Neural Networks**
   André Ip, Faculdade de Ciências e Tecnologia,Universidade Nova de Lisboa; Luis Irio, Instituto de Telecomunicações; Rodolfo Oliveira, Universidade Nova de Lisboa/Instituto de Telecomunicações

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IoT

1. **A 256-QAM Backscatter Transponder Architecture using Delta-Sigma Load Modulation for 6G Ultra-Low-Power IoT Devices**
   Tanbir Haque, Hussain Elkotby, Patrick Cabrol, Yupei Zhang, Ravi Pragada, Douglas Castor, Interdigital Communications

2. **Blockchain-based Volunteer Edge Cloud for IoT Applications**
   Ming-Tuo Zhou, Guo-Feng Shen, Tian-Feng Ren, Xin-Yu Feng, Shanghai Institute of Microsystem and Information Technology, CAS
3. **Network Slicing for Massive Machine Type Communication in IoT-5G Scenario**
   Rayner Gomes, UFPI; Dario Vieira, EFREI; Yacine Ghamri-Doudane, University of La Rochelle; Miguel Franklin de Castro, Federal University of Ceará
4. **Novel Network Configuration and its Clustering Scheme for Wireless Powered Sensor Networks**
   Kazuhisa Haraguchi, Kosuke Sanada, Hiroyuki HATANO, Kazuo Mori, Mie University
5. **On the SIR Meta Distribution in Massive MTC Networks with Scheduling and Data Aggregation**
   Nelson Mayedo, Onel Luis Alcaraz López, Hirley Alves, Matti Latva-aho, University of Oulu
6. **Recovering NB-IoT Signal from Legacy LTE Interference via K-means Clustering**
   Yijia Guo, Peiran Wu, Minghua Xia, Sun Yat-sen University
7. **Semi-Persistent Scheduling with Single Shot Transmissions for Aperiodic Traffic**
   Maria Bezmenov, Robert Bosch GmbH; Zoran Utkovski, Fraunhofer Heinrich-Hertz-Institute; Klaus Sambale, Robert Bosch GmbH; Slawomir Stanczak, Fraunhofer Heinrich Hertz Institute

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Positioning, Navigation, and Sensing II

1. **I/Q Density-based Angle of Arrival Estimation for Bluetooth Indoor Positioning Systems**
   Hung-Yi Yen, Zhong-Ting Tsai, Yuan-Ching Chen, Li-Hsiang Shen, Chun-Jie Chiu, Kai-Ten Feng, National Chiao Tung University
2. **Indoor Positioning Based Consecutive Pattern Mining for Pedestrian Flow Analysis**
   Chun-Jie Chiu, Hsiao-Chien Tsai, Kai-Ten Feng, National Chiao Tung University; Po-Hsuan Tseng, National Taipei University of Technology
3. **Iterative ToA-Based Localization of Wireless Transmitters Using Dirichlet-Kernel-Based Range Representation**
   Evert, ULB; François Rottenberg, ULB, UCL; François Quitin, ULB; Luc Vandendorpe, Université cathoique de Louvain; Philippe De Doncker, François Horlin, ULB
4. **MSE Based Resource Optimization in Wireless Localization Networks**
   Cheng Yang, Fan Liu, Tingting Zhang, Harbin Institute of Technology (Shenzhen)
5. **Pedestrian Indoor Localization and Tracking Using Hybrid Wi-Fi/PDR for iPhones**
   Tuan D. Vy, Thu L. N. Nguyen, Yoan Shin, Soongsil University
6. **Performance of NLOS Base Station Exclusion in cmWave 5G Positioning**
   Alda Xhafa, José A. del Peral-Rosado, Gonzalo Seco-Granados, Jose A. Lopez-Salcedo, Universitat Autònoma de Barcelona (UAB)
7. **Target Localization using Bistatic and Multistatic Radar with 5G NR Waveform**
   Ojas Kanhere, New York University; Sanjay Goyal, Mihaela Beluri, InterDigital Communications, Inc.; Theodore S. Rappaport, New York University

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Signal Processing for Wireless Communications II

1. **A Low-Complexity Approach for Max-Min Fairness in Uplink Cell-Free Massive**
   Muhammad Farooq, University College Dublin; Hien Quoc Ngo, Queen's University Belfast; Le-Nam Tran, University College Dublin
2. **A State-space Approach for Efficient Channel Tracking in Hybrid Analog/Digital MIMO Architectures**
   Pedro Pedrosa, Instituto de Telecomunicações; Daniel Castanheira, University of Aveiro; Adão Silva, DETI / Instituto de Telecomunicações / University of Aveiro; Rui Dinis, Universidade Nova de Lisboa; Atilio Gameiro, Universidade Aveiro
3. **Channel Recovery Using History Information for Hybrid Beamforming Systems**
   Yanru Tang, Samsung; Hongbing Cheng, Samsung Electronics; Kee-Bong Song, Samsung Semiconductors Inc.
4. **Improving Analog Zero-Forcing Null Depth with N-bit Vector Modulators in Multi-beam Phased Array Systems**
   Muhammad Yasir Javed, Nuutti Tervo, Rehman Akbar, Bilal Khan, Marko Leinonen, Aarno Pärssinen, University of Oulu
5. **Passive RIS vs. Hybrid RIS: A Comparative Study on Channel Estimation**
   Rafaela Schroeder, Jiguang He, Markku Juntti, University of Oulu
6. **Performance Impact Analysis of Beam Switching in Millimeter Wave Vehicular Communications**
   Ojas Kanhere, New York University; Aditya Chopra, Andrew Thornburg, AT&T Labs; Theodore S. Rappaport, New York University; Saeed S. Ghassemzadeh, AT&T Labs
7. **Queue Analysis with Finite Buffer by Stochastic Geometry in Downlink Cellular Networks**
   Qiong LIU, Univ. Rennes, INSA, IETR, Rennes, France; Jean-Yves Baudais, IETR, CNRS; Philippe Mary, INSA Rennes
8. **Two-Step Random Access in 5G New Radio: Channel Structure Design and Performance**
   Elena Peralta, Nokia Bell Labs; Toni Levanen, Nokia Mobile Networks; Frank Frederiksen, Nokia Bell Labs; Mikko Valkama, Tampere University

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LTE and 5G

1. **Analysis of Outage Latency and Throughput Performance in Industrial Factory 5G TDD Deployments**
   Ali Esswie, Nokia Bell Labs; Klaus Pedersen, Nokia
2. **Efficient Handling of Small Data Transmission for RRC Inactive UEs in 5G Networks**
   Ahlem Khlass, Daniela Laselva, Nokia Bell Labs
3. **Non-Uniform Codebook Configurations for High-Speed Rail Communications**
   Stavros Typos, Simon Armour, Angela Doufexi, University of Bristol
4. **On the Performance of Co-existence between Public eMBB and Non-public URLLC Networks**
   Yanpeng Yang, Ericsson; Kimmo Hiltunen, Ericsson Research; Fedor Chernogorov, Ericsson
5. **Optimisation of Numerology and Packet Scheduling in 5G Networks: To Slice or not to Slice?**
   Maria Raftopoulou, Delft University of Technology; Remco Litjens, TNO
6. **Priority-based Distributed Queuing Random Access Mechanism for mMTC/uRLLC Terminals Coexistence**
   Yifan Chen, University of Chinese Academy of Sciences; Guohui Wang, Shanghai Institute of Microsystem and Information Technology; Huiyue Yi, Wuxiong Zhang, Shanghai Research Center for Wireless Communications
7. **System-Level Analysis of mmWave 5G Systems with Different Multi-Panel Antenna Device Models**
   Fuad Mousse Abinader Junior, Christian Rom, Nokia Bell Labs; Klaus Pedersen, Nokia; Sofonias Hailu, Niko Kolehmainen, Nokia Bell Labs
8. **User mobility inference and clustering through LTE PDCCH data analysis**
   Pau Batlle Franch, Antoni Josep Eritja Olivella, Ramón María García Alarcia, Universitat Politècnica de Catalunya (UPC BarcelonaTech); Paolo Dini, CTTC

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Airborne and Maritime Mobile Systems and Services I

1. **A Fast Gateway Placement Algorithm for Flying Networks**
   Gonçalo Santos, João Martins, André Coelho, INESC TEC and Faculdade de Engenharia, Universidade do Porto; Helder Fontes, INESC TEC; Manuel Ricardo, INESC TEC and Faculdade de Engenharia, Universidade do Porto; Rui Campos, INESC TEC and Faculdade de Engenharia, Universidade do Porto
2. **Collaborative Trajectory Optimization for Outage-aware Cellular-Enabled UAVs**
   Amirahmad Chapnevis, Virginia Commonwealth University; Ismail Guvenc, North Carolina State University; Laurent Njilla, Air Force Research Laboratory; Eyuphan Bulut, Virginia Commonwealth University
3. **Cylindrical Massive MIMO System for HAPS: Capacity Enhancement and Coverage Extension**
   Koji Tashiro, SoftBank Corp.
4. **Decentralized Planning-Assisted Deep Reinforcement Learning for Collision and Obstacle Avoidance in UAV Networks**
   Ju-Shan Lin, Hsiao-Ting Chiu, Rung-Hung Gau, National Chiao Tung University
5. **Efficient method to validate high reliability of 5G URLLC**
   Jorma Kilpi, Heli Kokkoniemi-Tarkkanen, VTT Technical Research Centre of Finland Ltd; Mikko Aleksi Uusitalo, Nokia Bell Labs
6. **Experimental Evaluation of a Wireless LAN Relay System Using Unmanned Aerial Vehicles**
   Hiroki Tanaka, Matsui Nobuo, Chubu Electric Power Co., Inc.; Yuta Watanabe, Hiraku Okada, Masaaki Katayama, Nagoya University
7. **High Altitude Platform Stations (HAPS): Architecture and System Performance**
   Yunchou Xing, New York University; Frank Hsieh, Amitava Ghosh, Nokia Bell Labs; Theodore S. Rappaport, New York University
8. **Modeling and Analysis of LEO Mega-Constellations as Nonhomogeneous Poisson Point Processes**
   Niloofar Okati, Tampere university; Taneli Riihonen, Tampere University
9. **Multi-User MIMO Satellite Communications for Aviation Networks**
   Florian Völk, Robert Schwarz, Andreas Knopp, Bundeswehr University Munich

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Antennas & RF Design

1. **Aggregate Interference Power Characterization for Directional Beamforming Wireless Networks**
   Ayman T. Abusabah, Rodolfo Oliveira, Universidade Nova de Lisboa/Instituto de Telecomunicaçóes
2. **Beam Management in mmWave 5G NR: an Intra-Cell Mobility Study**
   Filipa Fernandes, Aalborg University; Christian Rom, Johannes Harrebek, Nokia Bell Labs; Gilberto Berardinelli, Aalborg University
3. **Digital Linearization for WDM-RoF System**
   Yibo Lyu, Huawei Technologies Co., Ltd.; XU LI, University of Science and Technology of China; Weiwei Zhang, Tianxiang Wang, Huawei Technologies Co., Ltd.
4. **Distributed Antenna System in 3GPP Specified Industrial Environment**
   Muhammad Usman Sheikh, Kalle Ruttik, Riku Jäntti, Jyri Hamalainen, Aalto University
5. **OFDM with Index Modulation in Orbital Angular Momentum Multiplexed Free Space Optical Links**
   El Mehdi Amhoud, Mohammed VI Polytechnic University
6. **On the Design of Quantization Functions for Uplink Massive MIMO with Low-Resolution ADCs**
   Lifu Liu, Songyan Xue, Yi Ma, Na Yi, Rahim Tafazolli, University of Surrey
7. **Performance Evaluation of EVM based Primary User Monitoring in Cognitive Radio Systems**
   Narayan Nepal, Whitecliffe College; Philippa Martin, Desmond Taylor, University of Canterbury; Alan Coulson
8. **Performance of Dual-Hop Relaying for THz-RF Wireless Link**
   Pranay Bhardwaj, Syed Mohammad Zafaruddin, BITS Pilani
9. **Phase offset compensation methods and applications in beam codebook generation**
   Joontae Kim, Hyunseok Yu, Joohyun Do, Inhyoung Kim, Min Goo Kim, Samsung Electronics

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IoV and Ad-Hoc Nets I

1. **A Task Assignment Scheme for Parked-Vehicle Assisted Edge Computing in IoV**
   Qingxia Peng, Yunjian Jia, Chongqing University; Liang Liang, University of Chongqing; Zhengchuan Chen, Chongqing University
2. **Enhanced Energy Harvesting Irregular Repetition Slotted ALOHA for Wireless Sensors Networks**
   Jingrui Su, Guangliang Ren, Bo Zhao, Xidian University; Cong Li, Academy of Space Electronic Information Technology of China
3. **E-PODS: A Fast Heuristic for Data/Service Delivery in Vehicular Edge Computing**
   Akshaj Gupta, Joseph John Cherukara, Deepak Gangadharan, International Institute of Information Technology, Hyderabad; BaekGyu Kim, Toyota Motor North America; Oleg Sokolsky, Insup Lee, University of Pennsylvania
4. **Index coded PSK Modulation in Vehicle to Vehicle Communication**
   Jesy Pachat, National Institute of Technology, Calicut; Nujoom Sageer Karat, Anjana A. Mahesh, Indian Institute of Science, Bangalore; Deepthi P.P., National Institute of Technology, Calicut; B. Sundar Rajan, Indian Institute of Science, Bangalore
5. **Joint Client Association and UAV Scheduling in Cache-Enabled UAV-Assisted Vehicular Networks**
   Shichao Zhu, Lin Gui, Qi Zhang, Xiupu Lang, Shanghai Jiao Tong University
6. **Joint Offloading Decision and Resource Allocation in MEC-enabled Vehicular Networks**
   Lintao Zhang, Yanglong Sun, Tang Yuliang, Hao Zeng, Yuqi Ruan, Xiamen University
7. **Joint Resource Allocation and Power Control for V2V Communication of High-density Vehicle Network**
   Qirui Yan, Binjie Hu, Qingji Wen, South China University of Technology

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Multiple Antennas and Cooperative Communications I

1. **Adaptive Sector Splitting based on Channel Charting in Massive MIMO Cellular Systems**
   Hanan Al-Tous, Olav Tirkkonen, Aalto University; Jing Liang, Huawei Technologies CO., LTD.
2. **Coordinated Massive MIMO with Power Control: An Efficient Solution for MU & SU-MIMO Scheduling**
   Cornelius Van Rensburg, IYAD ALFALUJAH
3. **CSI Quantization for FDD Massive MIMO Communication**
   Roope Vehkalahti, Jialing Liao, Tefjol Pllaha, Aalto University; Wei Han, Huawei, Shanghai; Olav Tirkkonen, Aalto University
4. **Efficient User Grouping for Hybrid Beamforming in Single Carrier Wideband Massive MIMO Channels**
   Emre Kilcioglu, Université catholique de Louvain; Gokhan Muzaffer Guvensen, Middle East Technical University (METU)
5. **FPGA Implementation of the Adaptive Digital Beamforming for Massive Array**
   Felipe F. Lopes, Sérgio N. Silva, Marcelo Fernandes, UFRN

6. **Energy Efficiency of Multiuser Sparse Massive MIMO System using Orthogonalized Hybrid Beamforming**
   Irfan Ahmed, Higher Colleges of Technology
7. **Nonlinear Precoding for Quantized Outphasing RF Chains in Massive MIMO Systems**
   Karthik Upadhya, Nokia Bell Labs, Finland; Stefan Wesemann, Bell Labs, Nokia
8. **On Characterizing the Capacity Region of Massive MIMO Systems with Joint Power Constraints**
   Thuy Pham, Barkhausen Institut; Ronan Farrell, Maynooth University; Holger Claussen, Tyndall National Institute; Mark Flanagan, Le-Nam Tran, University College Dublin
9. **On PAPR Reduction and Transmit Distortion Compensation in Massive MIMO OFDM Systems**
   M. Qurratulain Khan, Muhammad Danish Nisar, Hammad Ahmad Khan, Center for Advanced Studies in Engineering (CASE)

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Radio Access

1. **Cluster Density in Crowdsourced Mobile Network Measurements**
   Sonja Tripkovic, Philipp Svoboda, Vaclav Raida, Markus Rupp, TU Wien
2. **Deep Learning Based Resource Allocation Method to Control System Capacity and Fairness for MU-MIMO THP**
   Yukiko Shimbo, Hirofumi Suganuma, Waseda University; Hiromichi Tomeba, Takashi Onodera, Sharp Corporation; Fumiaki Maehara, Waseda University
3. **Measuring and Assessing the Performance of 5G NR Broadcast Systems at Low Mobility**
   Kiril Kirev, Stefan Schwarz, Stefan Pratschner, TU Wien
4. **On the Coexistence of WiGig and NR-U in 60 GHz Band**
   Seungmo Kim, John Verboom, Georgia Southern University
5. **On The Energy-Efficiency Fairness of Reconfigurable Intelligent Surface-Aided Cell-Free Network**
   Kunzan Liu, Zijian Zhang, Tsinghua University
6. **Performance Analysis and Optimization of Uplink Cellular Networks with Flexible Frame Structure**
   Fatemeh Lotfi, Omid Semiari, University of Colorado - Colorado Springs
7. **Performance analysis of MAC-based beam tracking and failure detection and recovery**
   Sofonias Hailu, Klaus I. Pedersen, Ali Karimidehkordi, Fuad Mousse Abinader Junior, Christian Rom, Niko Kolehmainen, Nokia Bell Labs
8. **QoS Optimization for Distributed Edge Computing System: A Multi-agent State-based Learning Approach**
   Fenghui Zhang, Michael Mao Wang, Southeast University; Xiangqing Wang, Maosheng Fu, Xiancun Zhou, West Anhui University
9. **Reinforcement Learning Approach for Content-Aware Resource Allocation in Hybrid WiFi-VLC Networks**
   Abdulmajeed Alenezi, Khairi Hamdi, University of Manchester
10. **Resource Allocation in URLLC with Online Learning for Mobile Users**
    Jie Zhang, Chengjian Sun, Chenyang Yang, Beihang University
11. **Total Transmission Time Minimization in Wireless Powered Hybrid Passive-Active Communications**
    Yinghui Ye, Xi'an University of Posts & Telecommunications; Liqin Shi, Xidian University; Xiaoli Chu, University of Sheffield; Guangyue Lu, Xi'an University of Posts & Telecommunications

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Vehicle Cooperation and Control, Assisted and Autonomous Driving I

1. **Automatic Generation of Critical Test Cases for the Development of Highly Automated Driving Functions**
   Daniel Baumann, Raphael Pfeffer, Eric Sax, Karlsruhe Institute of Technology
2. **Black-Box Testing for Security-Informed Safety of Automated Driving Systems**
   Martin Skoglund, Rise; Fredrik Warg, RISE Research Institutes of Sweden; Hans Hansson, Sasikumar Punnekkat, MRTC, Mälardalen University
3. **Collective Perception service for Connected Vehicles and Roadside Infrastructure**
   Ameni Chtourou, Oyunchimeg Shagdar, Pierre Merdrignac, VEDECOM Institute
4. **Distance-Based Neural Combinatorial Optimization for Context-based Route Planning**
   Sascha Hamzehi, Technical University Munich
5. **Dynamic Power and Frequency Allocation Scheme for Autonomous Platooning**
   Pawel Sroka, Adrian Kliks, Michal Sybis, Pawel Kryszkiewicz, Poznan University of Technology
6. **Hybrid Connectivity for Autonomous Vehicles: Conceptual View & Initial Results**
   Anastasia Yastrebova, Tiia Ojanperä, Jukka Mäkelä, Marko Höyhtyä, VTT Technical Research Centre of Finland Ltd
7. **Modeling Perception Errors of Automated Vehicles**
   Martin Sigl, Christoph Schütz, Sebastian Wagner, BMW Group; Daniel Watzenig, Graz University of Technology
8. **Real-time Recursive Risk Assessment Framework for Autonomous Vehicle Operations**
   Wei Ming Dan Chia, Singapore Institute of Technology; Sye Loong Keoh, Anna Lito Michala, University of Glasgow; Cindy Goh, University of Glasgow Singapore
9. **Risk Quantification for Automated Driving using Information from V2V Basic Safety Messages**
   Raghvendra V. Cowlagi, Rebecca C. Debski, Alexander Wyglinsky, Worcester Polytechnic Institute

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Airborne and Maritime Mobile Systems and Services II

1. **Particle Swarm Optimization Algorithms for Altitude and Transmit Power Adjustments in UAV-Assisted Cellular Networks**
   Shourya Shukla, Rahul Thakur, IIT Roorkee; Swati Agarwal, BITS Pilani Goa Campus
2. **Root Pair Selection for Two-root Random Access Preamble**
   Chenchen Zhang, Wei Cao, Nan Zhang, Kaibo Tian, Ruyue Li, ZTE
3. **Secure AF Relaying in Power-Constrained UAV Networks**
   Lutfi Samara, Qatar University; Abubakr O. Al-Abbasi, Qualcomm Atheros, Inc; Ahmed El Shafie, Qualcomm Tech. Inc.; Ridha Hamila, Qatar University; Naofal Al-Dhahir, University of Texas at Dallas
4. **The Kuhn-Munkres algorithm for efficient vertical takeoff of UAV swarms**
   Daniel Hernández, José M. Cecília, Technical University of Valencia; Carlos T. Calafate, Juan-Carlos Cano, Pietro Manzoni, Polytechnic University of Valencia
5. **Traffic-aware Gateway Placement for High-capacity Flying Networks**
   André Coelho, INESC TEC and Faculdade de Engenharia, Universidade do Porto, Portugal; Helder Fontes, INESC TEC; Rui

Campos, Manuel Ricardo, INESC TEC and Faculdade de Engenharia, Universidade do Porto, Portugal

6. **UAV Trajectories for Uniform Coverage in Convex Regions**
   Saeede Enayati, Hossein Pishro-Nik, University of Massachusetts
7. **Video Quality and Latency for UAV Teleoperation over LTE: A Study with ns3**
   Antonia Stornig, University of Klagenfurt; Aymen Fakhreddine, Lakeside Labs GmbH & University of Klagenfurt; Hermann Hellwagner, Alpen-Adria-Universität Klagenfurt; Petar Popovski, Aalborg University; Christian Bettstetter, University of Klagenfurt
8. **Visible Light Communication on LED-equipped Drone and Object-Detecting Camera for Post-Disaster Monitoring**
   Hiroki Takano, Daisuke Hisano, Mutsuki Nakahara, Kosuke Suzuoki, Osaka University; Kazuki Maruta, Tokyo Institute of Technology; Yukito Onodera, Ryo Yaegashi, Yu Nakayama, Tokyo University of Agriculture and Technology

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Green Communications and Networks II

1. **Harvest-Then-Transmit-Based TDMA Protocol with Statistical Channel State Information for Wireless Powered Sensor Networks**
   Takeru Terauchi, Katsuya Suto, The University of Electro-Communications; Masashi Wakaiki, Kobe University
2. **Improved Energy Harvesting with One-time Adjusted Solar Panel for BLE Beacon**
   Perm Soonsawad, Kang Eun Jeon, James She, Hong Kong University of Science and Technology
3. **Modeling and Optimization of RF-Energy Harvesting-assisted Quantum Battery System**
   Sumit Gautam, Shree K. Sharma, Symeon Chatzinotas, Bjorn Ottersten, University of Luxembourg
4. **Research on Power Distribution Method of OFDM System with Hybrid Energy Supply under Fast Fading Channel**
   YiPeng Liu, Zhicheng Dong, Wei Xiao, Tibet University; Erdal Panayirci, Kadir Has University
5. **Sensor Fusion for Drone Detection**
   Mohammed Aledhari, Rehma Razzak, Reza M. Parizi, Kennesaw State University; Gautam Srivastava, Brandon University
6. **Simultaneous Wireless Power Transfer and Modulation Classification**
   Rahul Gupta, Ioannis Krikidis, University of Cyprus
7. **Throughput Optimization in Energy Harvesting based Cognitive IoT with Cooperative Sensing**
   Yan Long, Ye Li, Honghao Ju, Rong He, Xuming Fang, Southwest Jiaotong University
8. **Wireless Power Transfer via Intelligent Reflecting Surface-Assisted Millimeter Wave Power Beacons**
   Wei Meng, Beijing University of Post and Telecommunication; Xinxin He, Yuanyang Li, Beijing University of Posts and Telecommunications; Huarui Wu, Beijing Research Center for Information Technology in Agriculture; Changchuan Yin, Beijing University of Posts and Telecommunications

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IoV and Ad-Hoc Nets II

1. **Mobility-Aware QoS Promotion and Load Balancing in MEC-Based Vehicular Networks: A Deep Learning Approach**
   Chih-ho Hsu, Yao Chiang, National Taiwan University; Yi Zhang, Xiamen University; Hung-Yu Wei, National Taiwan University
2. **MU-MIMO Based Cognitive Radio in Internet of Vehicles (IoV) for Enhanced Spectrum Sensing Accuracy and Sum Rate**
   Mohammad Amzad Hossain, Michael Schukat, Enda Barrett, National University of Ireland, Galway
3. **New traffic modeling for IoV/V2X in 5G network based on Data Mining**
   Aymen Ayari, SUPCOM of Tunisia
4. **Proactive RAN Resource Reservation for URLLC Vehicular Slice**
   Nathalie Naddeh, Telecom SudParis; Sana Ben Jemaa, Orange Labs; Salah Eddine Elayoubi, CentraleSupélec; Tijani Chahed, Institut Mines-Telecom,Telecom SudParis,UMR CNRS SAMOVAR,Evry,France
5. **Resource Selection for C-V2X and Simulation Study for Performance Evaluation**
   Kemal Mert Makinaci, Tankut Acarman, Cagdas Yaman, Galatasaray University
6. **SDR-based Open-Source C-V2X Traffic Generator for Stress Testing Vehicular Communication**
   Fabian Eckermann, Christian Wietfeld, TU Dortmund University
7. **Social-Aware Resource Allocation for Vehicle-to-Everything Communications Underlaying Cellular Networks**
   Bintao Hu, Xiaoli Chu, University of Sheffield

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Multiple Antennas and Cooperative Communications II

1. **Beam Management Based Multi-cell Interference Suppression for Millimeter Wave Communications**
   Yaxin Song, Shaoyi Xu, Beijing Jiaotong University
2. **Improved Beam Training with Finite Slots in Millimeter Wave Wireless Communications**
   Yinxiao Zhuo, Wendong Liu, Ziyuan Sha, Zhaocheng Wang, Tsinghua University
3. **Performance Analysis of Millimeter Wave CoMP Networks Under Blockage**
   Behrouz Maham, Nazarbayev University; Tommy Svensson, , Chalmers University of Technology
4. **Symbol Level Beam Selection and Precoding in mm-wave Beamspace MU-MISO Systems**
   Yongin Choi, Jinwoo Oh, Yangsoo Kwon, Joonsung Kim, Jinwon Choi, YoungSeok Jung, Inhyoung Kim, Min Goo Kim, Samsung Electronics
5. **User Association in Millimeter Wave Cellular Networks with Intelligent Reflecting Surfaces**
   Ehsan Moeen Taghavi, University of Oulu; Alireza Alizadeh, Tufts University; Nandana Rajatheva, University of Oulu; Mai Vu, Tufts University; Matti Latva-aho, University of Oulu

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Signal Processing for Wireless Communications III

1. **Applying NOMA to NR V2X: A Graph-based Matching and Cooperative Game Approach**
   Fenghui Zhang, Michael Mao Wang, Southeast University
2. **Channel-Aware Opportunistic NOMA for Random Access in IoT Networks**
   Jinho Choi, Deakin University
3. **Joint uplink PD-NOMA and SCMA for future multiple access systems**
   Xiaotian Fu, Mylene Pischella, Didier Le Ruyet, CNAM Paris
4. **Layered Preambles based on NOMA for MTC with Two Different Types of Devices**
   Jinho Choi, Deakin University
5. **Low-complexity Delay-Doppler Symbol DNN for OTFS Signal Detection**
   Ashwitha Naikoti, A. Chockalingam, Indian Institute of Science, Bangalore
6. **Opportunistic Multi-Layer Transmission over Unknown Channels**
   Ranjitha Gubbi Suresh, Lund University; Leif Wilhelmsson, Ericsson AB; Saeedeh Moloudi, Ericsson Research; Michael Lentmaier, Lund University

7. **Use of Bayesian Changepoint Detection for Spectrum Sensing in Mobile Cognitive Radio**
   Akpaki Steaven Vianney Chede, Université catholique de Louvain; François Rottenberg, University of Southern California; Michel Dossou, Ecole Polytechnique d'Abomey-Calavi (EPAC); Jerome Louveaux, ICTEAM institute, Universite Catholique de Louvain

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Vehicle Cooperation and Control, Assisted and Autonomous Driving II

1. **Adaptive Minimization of Direct Sunlight Noise on V2V-VLC Receivers**
   Kandasamy Illanko, Xavier Fernando, Ryerson University
2. **Automated Driving with Cooperative Perception Using Millimeter-wave V2I Communications for Safe and Efficient Passing Through Intersections**
   Ryuichi Fukatsu, Tokyo Institue of Technology; Kei Sakaguchi, Tokyo Institute of Technology
3. **Evaluation of C-V2X Sidelink for Cooperative Lane Merging in a Cross-Border Highway Scenario**
   Federico Poli, CEA; Benoît Denis, CEA-Leti Minatec; Valérian Mannoni, Vincent Berg, CEA; David Martin-Sacristan, David Garcia-Roger, Universitat Politecnica de Valencia; Jose F. Monserrat, Polytechnic University of Valencia
4. **Impact of LTE-V2X Connectivity on Global Occupancy Maps in a Cooperative Collision Avoidance (CoCA) System**
   Nadia Mouawad, CEA-Leti; Valérian Mannoni, CEA; Benoît Denis, CEA-Leti Minatec; Alex Pereira da Silva, Universite Grenoble Alpes, CEA-Leti
5. **On the Impact of V2X-based Maneuver Coordination on the Traffic**
   Alejandro Correa, Universidad Miguel Hernandez de Elche; Sergei Avedisov, Toyota Motor North America; Miguel Sepulcre, Universidad Miguel Hernandez de Elche (UMH); Ahmed Hamdi Sakr, Toyota Motor North America R&D; Rafael Molina-Masegosa, Universidad Miguel Hernandez de Elche (UMH); Onur Altintas, Toyota North America R&D; Javier Gozálvez, Universidad Miguel Hernandez de Elche (UMH)
6. **Optimizations for Hardware-in-the-Loop-Based V2X Validation Platforms**
   Babak Mafakheri, University of Bologna; Pierpaolo Gonnella, FEV Italia srl.; Alessandro Bazzi, University of Bologna; Barbara M. Masini, CNR-IEIIT; Michele Caggiano, FEV Italia srl.; Roberto Verdone, DEI, University of Bologna
7. **Scenario Detection in Unlabeled Real Driving Data with a Rule-Based State Machine Supported by a Recurrent Neural Network**
   Francesco Montanari, FAU Erlangen-Nürnberg; Haoyu Ren, Technical University of Munich; Anatoli Djanatliev, University of Erlangen-Nürnberg
8. **V2X Attack Vectors and Risk Analysis for Automated Cooperative Driving**
   Oliver Sawade, IAV GmbH; Ilja Radusch, Daimler Center for Automotive IT Innovations; Manfred Hauswirth, TU-Berlin

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Airborne and Maritime Mobile Systems and Services III

1. **A Time-correlated Channel State Model for 5G New Radio Mobility Studies in LEO Satellite Networks**
   Enric Juan, Aalborg University; Mads Lauridsen, Jeroen Wigard, Nokia Bell Labs; Preben Mogensen, Aalborg University
2. **Autonomous Swarm of UAVs for Tracking of Flying Insects with Harmonic Radar**
   Anastasia Lavrenko, University of Twente
3. **Drone-Assisted Cellular Networks: Optimal Positioning and Load Management**
   Tom Pijnappel, Eindhoven University of Technology; Hans van den Berg, TNO Information and Communication Technology; Sem Borst, Eindhoven University of Technology; Remco Litjens, TNO
4. **Joint Trajectory and Power Optimization for UAV Covert Transmission**
   Hongwei Huang, Shidong Zhou, Tsinghua University
5. **Millimeter-wave UAV-based Channel Measurement Setup**
   Vasilii Semkin, Ismo Huhtinen, VTT Technical Research Centre of Finland
6. **On Higher-Order Statistics of the Channel Model for UAV-to-Ground Communications**
   Caslav Stefanovic, University of Pristina; Stefan Panic, University of Nis; Vimal Bhatia, Indian Institute of Technology Indore; Nagendra Kumar, National Institute of Technology Jamshedpur; Sanjeev Sharma, Indian Institute of Technology (BHU)
7. **Optimization of Cell Individual Offset for Handover of Flying Base Station**
   Aida Madelkhanova, Zdenek Becvar, Czech Technical University in Prague
8. **Use of LoRa for UAV Remote ID with Multi-User Interference and Different Spreading Factors**
   Omkar Mujumdar, Haluk Celebi, Ismail Guvenc, Mihail L. Sichitiu, North Carolina State University; Sunghyun Hwang, Kyu-Min Kang, Radio & Satellite Research Division, ETRI

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IoV Networks

1. **Analysis of 5G RAN Configuration to Support Advanced V2X Services**
   Mª Carmen Lucas Estañ, Baldomero Coll-Perales, Universidad Miguel Hernandez de Elche; Takayuki Shimizu, Toyota Motor North America, Inc.; Javier Gozálvez, Universidad Miguel Hernandez de Elche (UMH); Chang-Heng Wang, Toyota Motor North America R&D; Bin Cheng, Toyota InfoTech Labs, Toyota Motor North America, R&D; Miguel Sepulcre, Universidad Miguel Hernandez de Elche (UMH); Sergei Avedisov, Takamasa Higuchi, Onur Altintas, Toyota North America R&D
2. **Elastic Queueing Engine for Time Sensitive Networking**
   Angela Gonzalez, Francesc Fons, Ahmed Gharba, Li Ming, Huawei Technologies; Juan Manuel Moreno Arostegui, Technical University of Catalunya
3. **Enhancing Wi-SUN AMI Network Resilience by using Emergency Gateway with Optimal Placement**
   Amnart Boonkajay, Peng Hui Tan, Lee Kee Goh, Syed Naveen Altaf Ahmed, Sumei Sun, Institute for Infocomm Research
4. **Environment-Adaptive Multiple Access for Distributed V2X Network: A Reinforcement Learning Framework**
   Seungmo Kim, Georgia Southern University; Byung-Jun Kim, Michigan Technological University; Brian Park, University of Virginia
5. **Link-level Performance Evaluations of Sparse Code Multiple Access for PC5-based Cellular-V2X with Heterogeneous Channel Estimation Errors**
   Takeshi Hirai, Nagoya University; Predrag Spasojevic, Rutgers University
6. **Persistent Scheduling with Broadcast Feedback for Cellular V2X Communication**
   Youngjoon Yoon, Junwon Kang, Hyogon Kim, Korea University
7. **V2V communication performance of conformal plastic-embedded side-mount antennas investigated with field-operational tests**
   Jasmeet Singh, Berk Altinel, Christian Bornkessel, Ralf Stephan, Matthias A. Hein, Technische Universität Ilmenau

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Multiple Antennas and Cooperative Communications III

1. **A New Stream Power Allocation Method for SU Beamforming in BICM MIMO-OFDM Systems for IEEE WLAN**
   Minki Ahn, Wookbong Lee, Eunsung Jeon, Sungsoo Kim, Joonsuk Kim, Samsung Electronics

2. **A Study on Optimal Beam Selection Algorithm for Multi-cell Coordinated Beamforming**
   Kenji Hoshino, SoftBank Corp.
3. **An experiment of dual-LTE MPTCP with In-Car Voice Assistant**
   Vu Vu, Institute of Communications Technology - Leibniz Universität Hannover; Mark Akselrod, Leibniz Universität Hannover
4. **Classification-based Optimal Beamforming for NOMA Wireless Relay Networks**
   Rung-Hung Gau, Hsiao-Ting Chiu, Tsung-Che Lu, National Chiao Tung University
5. **Spatial Transmit Diversity for GFDM via Low Complexity Transceiver Design**
   M. Qurratulain Khan, Muhammad Danish Nisar, Center for Advanced Studies in Engineering (CASE)

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Signal Processing for Wireless Communications IV

1. **Direction Aided Multipath Channel Estimation for Millimeter Wave Systems**
   Remun Koirala, CEA Leti; Bernard Uguen, IETR / CNRS / Université Rennes-I; Davide Dardari, University of Bologna; Henk Wymeersch, Chalmers University of Technology; Benoît Denis, CEA-Leti Minatec
2. **K-Means Based Blind Noise Variance Estimation**
   Esteban Selva, Orange Labs, IETR/CentraleSupelec; Apostolos Kountouris, Orange Labs; Yves Louët, CentraleSupelec/IETR
3. **Physical Cell ID Detection Using Joint Estimation of Frequency Offset and SSS Sequence for NR Initial Access**
   Daisuke Inoue, Kyogo Ota, Mamoru Sawahashi, Tokyo City University; Satoshi Nagata, NTT DOCOMO, INC.
4. **Quadrature-Based Exponential-Type Approximations for the Gaussian Q-Function**
   Islam Tanash, Taneli Riihonen, Tampere University
5. **Reinforcement Learning Based Inter-User-Interference Suppression in Full-Duplex Networks**
   Dani Korpi, Mikko Aleksi Uusitalo, Nokia Bell Labs
6. **Remez Exchange Algorithm for Approximating Powers of the Q-Function by Exponential Sums**
   Islam Tanash, Taneli Riihonen, Tampere University
7. **Uplink Performance of LTE and NR with High-Speed Trains**
   Hesham Elgendi, Tampere University; Toni Levanen, Nokia Mobile Networks; Anthony Lo, Elena Peralta, Sari Nielsen, Nokia Bell Labs; Mikko Valkama, Tampere University

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Vehicle Cooperation and Control, Assisted and Autonomous Driving III

1. **A Framework for Minimizing Information Aging in the Exchange of CAV Messages**
   Maria Michalopoulou, University of Cyprus; Panayiotis Kolios, KIOS Research and Innovation Center of Excellence; Christos G. Panayiotou, KIOS Research Center for Intelligent Systems and Networks,; George Ellinas, University of Cyprus
2. **Chain of Interdependent Vehicular Micro Clouds**
   Seyhan Ucar, Takamasa Higuchi, Chang-Heng Wang, Onur Altintas, Toyota Motor North America R&D
3. **Comparing mmWave Channel Simulators in Vehicular Environments**
   Maximilian Lübke, Friedrich-Alexander-Universität Erlangen-Nürnberg; Sigrid Dimce, Max Schettler, Technical University of Berlin; Fabian Lurz, Hamburg University of Technology; Robert Weigel, Friedrich-Alexander-University Erlangen-Nürnberg; Falko Dressler, TU Berlin
4. **Implementation of Range Doppler Migration Synthesis for Radar Target Simulation**
   Axel Diewald, Theresa Antes, Benjamin Nuß, Thomas Zwick, Karlsruhe Institute of Technology
5. **Performance and design of robust platoons under different communication technologies**
   Tiago Rocha Gonçalves, University of Paris-Saclay; Vineeth Satheeskumar Varma, University of Lorraine; Salah Eddine Elayoubi, CentraleSupélec
6. **The Effect of Sound on the Gyroscopes in Your Car**
   Oliver Pöllny, Albert Held, Mercedes-Benz AG; Frank Kargl, Ulm University

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Propagation

1. **5G-Based Measurements and Characterizations of Low-Altitude Tethered Balloon Multipath Channel**
   Ying Zhou, Peng Cheng Laboratory; Xiaoming Huang, China United Network Communication Group Co., Ltd; Dianhui Zhang, Bin Li, Jiasheng Zeng, Feng Wu, Peng Cheng Laboratory
2. **A 2D Non-Stationary Channel Model for Underwater Acoustic Communication Systems**
   Xiuming Zhu, Cheng-Xiang Wang, Southeast University; Ruofei Ma, Harbin Institute of Technology, Wehai
3. **ABER of an FSO Link in Gamma Gamma Turbulence with SSK and SEC**
   Akinchan Das, Banibrata Bag, Haldia Institute of Technology; Chayanika Bose, Jadavpur University; Aniruddha Chandra, National Institute of Technology, Durgapur
4. **Characterising Vehicle Suspension Variations in Millimeter Wave V2I System**
   Khalid A Al Mallak, University of Bristol; Manish Nair, The University of Bristol; Geoffrey Hilton, University of Bristol; Tian H. Loh, National Physical Laboratory; Mark Beach, University of Bristol
5. **Characterization of Urban Radio Channels and Base Station Antenna Correlation in the 3.75 GHz Band**
   Christian Schneider, Technische Universität Ilmenau; Jasmin Breuer, Hochschule Bonn-Rhein-Sieg; Jürgen Beyer, Deutsche Telekom; Gerd Sommerkorn, Martin Käske, Reiner Thomä, Giovanni Del Galdo, Technische Universität Ilmenau
6. **Effects of Inaccuracies of Indoor Environment Databases on Ray Tracing Results**
   Fangyu Wang, Yuxiang Zhang, Pan Tang, Li Yu, Zhang Jianhua, Beijing University of Posts and Telecommunications
7. **Large-Scale Parameters of Spatio-Temporal Short-Range Indoor Backhaul Channels at 140 GHz**
   Sinh Nguyen-Le, Ericsson; Katsuyuki Haneda, Aalto University; Jan Järveläinen, Premix Group Oy; Aki Karttunen, Tampere University; Jyri Putkonen, Nokia Bell Labs
8. **Measurements at 5G Commercial 26 GHz Frequency with Above and on Rooftop Level Antenna Masts in Urban Environment**
   Norshahida Saba, Lauri Mela, Muhammad Usman Sheikh, Kalle Ruttik, Jari Salo, Elisa Oyj; Riku Jäntti, Aalto University
9. **Probabilistic Path Loss Predictors for mmWave Networks**
   Taha Saleh, Aalto University, Nokia; Dmitry Petrov, Nokia Bell Labs; Olav Tirkkonen, Aalto University; Vilho Räisänen, Nokia Bell Labs
10. **The Effective Ray-Tracing Algorithm for Analysis of mm-Wave V2V Propagation Channels**
    Piotr Gorniak, Poznan University of Technology

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Multiple Access, Low-Latency and Edge/AI

1. **An Optimization Scheme for SCMA-Based Multi-Access Edge Computing**
   Pengtao Liu, Jing Lei, Wei Liu, National University of Defense Technology
2. **Index Code Construction via Deep Matrix Factorization**
   Vaisakh M, Lakshmi Narasimhan, IIT Palakkad

3. **Non-Orthogonal Multiple Access and Network Slicing: Scalable Coexistence of eMBB and URLLC**
   Eduardo Noboro Tominaga, Hirley Alves, University of Oulu; Richard Demo Souza, UFSC; João Luiz Rebelatto, UTFPR; Matti Latva-aho, University of Oulu
4. **PARRoT: Predictive Ad-hoc Routing Fueled by Reinforcement Learning and Trajectory Knowledge**
   Benjamin Sliwa, Cedrik Schüler, Manuel Patchou, Christian Wietfeld, TU Dortmund University
5. **QoS-Aware Wireless Sensor Networks: Reliability and Low-Latency for Heterogeneous Industry 4.0**
   Johanna Kruse, Silvio Mandelli, Saeed R. Khosravirad, Nokia Bell Labs
6. **RTTPROBS: A RTT Probing Scheme for RTT Aware Multi-path Scheduling**
   Ralf Lübben, Flensburg University of Applied Sciences; Philip Wette, Sascha Gübner, Robert Bosch GmbH
7. **URLLC Resource Slicing and Scheduling in 5G Vehicular Edge Computing**
   Min Hao, Dongdong Ye, Siming Wang, Beihai Tan, Rong Yu, Guangdong University of Technology

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Multiple Antennas and Cooperative Communications IV

1. **Adding Exploration to Tree-Based MIMO Detectors Using Insights from Bio-Inspired Firefly Algorithm**
   Bastien Trotobas, CentraleSupelec; Youness Akourim, École normale supérieure de Rennes; Amor Nafkha, SCEE/IETR UMR CNRS 6164, CentraleSupélec; Yves Louët, CentraleSupelec/IETR
2. **Efficient System Capacity User Selection Algorithm in MU-MIMO**
   Malo Manini, b-com; Cedric Gueguen, University of Rennes 1; Rodolphe Legouable, b-com; Xavier Lagrange, IMT Atlantique, IRISA
3. **Optimal Coverage Analysis of a CP-OFDM/FBMC based Device-to-Device Communication System**
   Darsi Jaswanth, Sudhir K. Sahoo, Indian Institute of Technology Bhubaneswar; Govind Satapathy, Qualcomm, Hyderabad; Soumya Prakash Dash, Indian Institute of Technology Bhubaneswar
4. **Optimum Performance of Nonlinear MIMO-SVD Schemes**
   João Guerreiro, FCT-Universidade Nova de Lisboa, Instituto de Telecomunicações; Rui Dinis, Universidade Nova de Lisboa; Paulo Carvalho, FCT- Universidade Nova de Lisboa
5. **Performance Analysis of OTFS Modulation with Transmit Antenna Selection**
   Vighnesh S Bhat, A. Chockalingam, Indian Institute of Science, Bangalore
6. **Permutation Channel Modulation: New Index Modulation Mechanism for MIMO**
   Rahmat Faddli Siregar, Nandana Rajatheva, Matti Latva-aho, University of Oulu

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Multiple Antennas and Cooperative Communications V

1. **Age of Information in an URLLC-enabled Decode-and-Forward Wireless Communication System**
   Chathuranga Basnayaka, Sri Lanka Technological Campus; Dushantha Nalin K. Jayakody, National Research Tomsk Polytechnic University; Moises Vidal Ribeiro, Federal University of Juiz de Fora Campus Universitario; Tharindu D. Ponnimbaduge Perera, National Research Tomsk Polytechnic University
2. **Enhanced Precoding with Partial Channel State Information at the Transmitter and Receiver Cooperation**
   Hoil Kim, Jin Ho Kim, Samsung Electronics
3. **Experimental Evaluation of UL-NOMA system with FD-STBC**
   Atsushi Kurosawa, Masafumi Moriyama, Kenichi Takizawa, Fumihide Kojima, National Institute of Information and Communications Technology
4. **Impact of NLPA on SWIPT Enabled Two-Way AF Cooperative Network**
   Deepak Kumar, Indian Institute of Technology Indore; Praveen Kumar Singya, King Abdullah University of Science and Technology; Vimal Bhatia, Indian Institute of Technology Indore
5. **Minimal Overhead ARQ Sharing Strategies for URLLC in Multi-Hop Networks**
   Jaya Goel, Harshan Jagadeesh, Indian Institute of Technology Delhi
6. **Outage Analysis of EH-based Cooperative NOMA Networks over Generalized Statistical Models**
   Orken Omarov, Galymzhan Nauryzbayev, Sultangali Arzykulov, Nazarbayev University; Ahmed M. Eltawil, King Abdullah University of Science and Technology (KAUST); Mohammad S. Hashmi, Nazarbayev University
7. **Outage Analysis of Uplink IRS-Assisted NOMA under Elements Splitting**
   Bashar Tahir, Stefan Schwarz, Markus Rupp, TU Wien
8. **Power Allocation, Relay Selection, and User Pairing for Cooperative NOMA Systems with Rate Fairness**
   Brena Lima, Lusófona University; Daniel Benevides da Costa, Federal University of Ceara (UFC); Rodolfo Oliveira, Universidade Nova de Lisboa/Instituto de Telecomunicações; Rui Dinis, Universidade Nova de Lisboa; Marko Beko, Instituto Superior Técnico, Universidade de Lisboa/COPELABS; Ugo Dias, University of Brasilia
9. **Towards Ultra-Reliable Signature Coding With Multiple Transmit Antennas**
   Roope Vehkalahti, Tefjol Pllaha, Olav Tirkkonen, Aalto University

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Services, Security, Edge and Cloud I

1. **A Process to Facilitate Automated Automotive Cybersecurity Testing**
   Stefan Marksteiner, AVL List; Nadja Marko, Virtual Vehicle Research; Andre, Smulders; Stelios Karagiannis, Beyond Vision; Florian Stahl, AVL Software & Functions; Hayk Hamazaryan, ZF Friedrichshafen; Rupert Schlick, Austrian Institute of Technology; Stefan Kraxberger, SecInto; Alexandr Vasenev, Joint Innovation Centre ESI (TNO)
2. **Attacks Against UDS on DoIP by Exploiting Diagnostic Communications and Their Countermeasures**
   Masaru Matsubayashi, NTT Secure Platform Laboratories
3. **Computation Offloading in Energy Harvesting aided Heterogeneous Mobile Edge Computing**
   Tian Zhang, Shandong Management University; Wei Chen, Tsinghua University
4. **Fraud-resilient Privacy-preserving Crowd-sensing for Dynamic Spectrum Access**
   Erald Troja, Ice Lin, St. John's University
5. **How well can your car be tracked: Analysis of the European C-ITS pseudonym scheme**
   Stephan Escher, TU Dresden; Stefan Köpsell, Barkhausen Institut; Markus Sontowski, TU Dresden
6. **Investigating the eavesdropper attack in physical layer security wireless key generation: a simulation case study**
   Marco Zoli, Andre Noll Barreto, Gerhard Fettweis, Barkhausen Institut
7. **Learning-Assisted Secure Relay Selection with Outdated CSI for Finite-State Markov Channel**
   Jianzhong Lu, Dongxuan He, Zhaocheng Wang, Tsinghua University

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Vehicle Cooperation and Control, Assisted and Autonomous Driving IV

1. **Adaptive Fuzzy Tuning Framework for Autonomous Vehicles: An Experimental Case Study**
   Sergey Samokhin, Sensible 4 Oy; Mohit Mehndiratta, Sensible 4, Oy; Umar Zakir Abdul Hamid, Jari Saarinen, Sensible 4 Oy
2. **An Evolving Ontology for Vehicle Signals**
   Daniel Wilms, BMW Technology Office Israel; Daniel Alvarez-Coello, Adnan Bekan, BMW Research
3. **Evaluation of a Multi-cell and Multi-tenant Capacity Sharing Solution under Heterogeneous Traffic Distributions**
   Irene Vilà Muñoz, Jordi Pérez-Romero, Oriol Sallent, Anna Umbert, Universitat Politecnica de Catalunya (UPC)
4. **iVRLS: In-coverage Vehicular Reinforcement Learning Scheduler**
   Taylan Sahin, Technische Universität Berlin; Mate Boban, Ramin Khalili, Huawei Technologies Duesseldorf GmbH, German Research Center; Adam Wolisz, Technische Universität Berlin
5. **Qualifying 5G SA for L4 Automated Vehicles in a Multi-PLMN Experimental Testbed**
   Giancarlo Pastor, Edward Mutafungwa, Jose Costa-Requena, Xuebing Li, Oussama El Marai, Norshahida Saba, Aziza Zhanabatyrova, Aalto University; Yu Xiao, Aalto University, Finland; Timo Mustonen, Matthieu Myrsky, Lauri Lammi, Umar Zakir Abdul Hamid, Marta Boavida, Sergio Catalano, Hyunbin Park, Pyry Vikberg, Sami Pukkila, Viljami Lyytikainen, Sensible 4
6. **R2-D2D: A Novel Deep Learning Based Content-Caching Framework for D2D Networks**
   Souradeep Chakraborty, Rahul Bajpai, Naveen Gupta, BITS-Pilani K.K. Birla Goa Campus
7. **Robust Centralized Vehicle Coordination Strategies at Road Intersections**
   Langying Chen, Muchen Yu, Gang Chen, Yizhen Wang, Tingting Zhang, Harbin Institute of Technology (Shenzhen)

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Recent Results in Antennas & Propagation

1. **A Sensitivity Analysis on the Potential of 5G Channel Quality Prediction**
   Sabari Nathan Anbalagan, University of Twente; Remco Litjens, Kallol Das, TNO; Alessandro Chiumento, Paul Havinga, University of Twente; Hans van den Berg, University of Twente / TNO
2. **Detectable Area for Single and Multi-antenna Interceptor in the Presence of Jammer**
   Menghan Lin, Wenjie Wang, Xi'an Jiaotong University
3. **Direct Path Interference Suppression Requirements for Bistatic Backscatter Communication System**
   Ritayan Biswas, Tampere University; Muhammad Usman Sheikh, Hüseyin Yigitler, Aalto University; Jukka Lempiäinen, Tampere University; Riku Jäntti, Aalto University
4. **Experimental Characterization of Received 5G Signals Carrier-to-Noise Ratio in Indoor and Urban Environments**
   Zaher Kassas, Ali Abdallah, Joe Khalife, University of California, Irvine
5. **Inter-User Interference Reduction Applying Successive Interference Cancellation for Dynamic-duplex Cellular System**
   Shota Mori, Keiichi Mizutani, Hiroshi Harada, Kyoto University
6. **Propagation-aware Gaussian Process Regression for Signal-Strength Interpolation along Street Canyons**
   Lukas Eller, Philipp Svoboda, Markus Rupp, TU Wien
7. **The Effect of Wall Blockages on Indoor Small Cell Networks with LOS/NLOS User Association Strategies**
   Yunbai Wang, The University of Sheffield; Hui Zheng, Ranplan Wireless Network Design Ltd.; Chen Chen, Xiaoli Chu, University of Sheffield

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Green Communications and Networks III

1. **Concurrent backscatter streaming with batteryless sensors for wireless motion capture applications**
   Jin Mitsugi, Keio University; Yuusuke Kawakita, Kanagawa Institute of Technology; Haruhisa Ichikawa, Keio University
2. **Energy Minimization Task Offloading Mechanism with Edge-Cloud Collaboration in IoT Networks**
   Xunzheng Zhang, Haixia Zhang, Xiaotian Zhou, Dongfeng Yuan, Shandong University
3. **Energy-Efficient Precoding for Multi-User Visible Light Communication with Confidential Messages**
   Son T Duong, Hanoi University of Science and Technology; Thanh V. Pham, University of Aizu; Chuyen T. Nguyen, Hanoi University of Science and Technology; Anh T. Pham, University of Aizu
4. **Hybrid, SWIPT-Based, Green Cooperative Wireless System Design and Performance Analysis**
   Deepak Vasudevan, Sainath Bitragunta, BITS Pilani
5. **Massive MIMO Muting using Dual-polarized and Array-size Invariant Beamforming**
   Pal Frenger, Ke Wang Helmersson, Ericsson AB, Ericsson Research
6. **Study of Paging Enhancements for UE Energy Saving in 5G New Radio**
   Mads Lauridsen, Laura L. Sanchez, Daniela Laselva, Jorma Kaikkonen, Nokia Bell Labs

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Machine Learning and AI for Communications I

1. **5G Air-to-Ground Network Design and Optimization: A Deep Learning Approach**
   Yun Chen, The University of Texas at Austin; Xingqin Lin, Ericsson; Talha Khan, Mehrnaz Afshang, Ericsson Research; Mohammad Mozaffari, Ericsson
2. **Abnormal Signaling SIP Dialogs Detection based on Deep Learning**
   Diogo Pereira, Univ. Nova de Lisboa/Instituto de Telecomunicações; Rodolfo Oliveira, Universidade Nova de Lisboa/Instituto de Telecomunicações; Hyong S. Kim, Carnegie Mellon University
3. **AI4Mobile: Use Cases and Challenges of AI-based QoS Prediction for High-Mobility Scenarios**
   Daniel Fabian Külzer, BMW Group Research, New Technologies, Innovations; Martin Kasparick, Fraunhofer Heinrich Hertz Institute; Alexandros Palaios, Ericsson; Raja Sattiraju, Technical University of Kaiserslautern; Oscar D. Ramos-Cantor, Robert Bosch GmbH; Dennis Wieruch, Fraunhofer Heinrich Hertz Institute; Hugues Narcisse Tchouankem, Robert Bosch GmbH; Fabian Göttsch, Technical University of Dresden; Philipp Geuer, Ericsson Research; Jens Schwardmann, Robert Bosch GmbH; Gerhard Fettweis, TU Dresden; Hans Schotten, University of Kaiserslautern; Slawomir Stanczak, Fraunhofer Heinrich Hertz Institute
4. **Beamforming in Multi-User MISO Cellular Networks with Deep Reinforcement Learning**
   Hongchao Chen, Samsung

5. **BLER-based Adaptive Q-learning for Efficient Random Access in NOMA-based mMTC Networks**
   Duc Dung Tran, Shree K. Sharma, Symeon Chatzinotas, SnT, University of Luxembourg
6. **Compressed Channel Representations for CSI-based Learning Applications**
   Zheda Li, Chenwei Wang, Haralabos Papadopoulos, DOCOMO Innovations
7. **Constrained learning for Multicell Power Control**
   Yinghan Li, Shengqian Han, Chenyang Yang, Beihang University
8. **Deep Contextual Bandits for Fast Initial Access in mmWave Based User-Centric Ultra-Dense Networks**
   Mohamed Ismath Mohamed Insaf, K.B.Shashika Manosha, Samad Ali, Nandana Rajatheva, Matti Latva-aho, University of Oulu

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Positioning, Navigation, and Sensing III

1. **Adaptive Scheduling for Joint CommRadar: Optimizing Tradeoff Among Data Throughput, Queueing Delay, and Detection Opportunities**
   Honghao Ju, Yan Long, Xuming Fang, Rong He, Southwest Jiaotong University
2. **Concentrative Intelligent Reflecting Surface Aided Computational Imaging via Fast Block Sparse Bayesian Learning**
   Junjie Yao, Zhaoyang Zhang, Shao Xiaodan, Chongwen Huang, Caijun Zhong, Xiaoming Chen, Zhejiang University
3. **Deep Learning-Based Range-Doppler Map Reconstruction in Automotive Radar Systems**
   Hao-Wei Hsu, Yu-Chien Lin, Ming-Chun Lee, Chia-Hung Lin, Ta-Sung Lee, National Chiao Tung University
4. **Direction-of-Arrival Estimation With A Vector Sensor Using Deep Neural Networks**
   Jianyuan Yu, William W. Howard, Daniel Tait, R. Michael Buehrer, Virginia Tech
5. **Evaluation on a Drone Classification Method Using UWB Radar Image Recognition with Deep Learning**
   Daiki Kawaguchi, Ryohei Nakamura, Hisaya Hadama, Natonal Defense Academy of Japan
6. **Fusion Approach for Pre-Crash Scenarios based on Lidar and Camera Sensors**
   Daniel Vriesman, TH Ingolstadt; Marcelo Eduardo Paderiva, José Mario De Martino, University of Campinas; Alceu Britto Junior, Pontifical Catholic University of Paraná; Alessandro Zimmer, Thomas Brandmeier, TH Ingolstadt
7. **Local-level Analysis of Positioning Errors in Wi-Fi Fingerprinting**
   Germán M. Mendoza-Silva, Joaquin Torres Sospedra, Joaquín Huerta, Universitat Jaume I
8. **Vehicle-mounted 1-bit SAR Imaging Based On Frequency Shifted Dechirping Echo**
   Yiqian Geng, Bo Zhao, Shenzhen University

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Signal Processing for Wireless Communications V

1. **A Maximum Likelihood Detection Method for NR Sidelink SSS Searcher**
   Sili Lu, Samsung Semiconductor Inc; Hongbing Cheng, Samsung Electronics; Kee-Bong Song, Samsung Semiconductors Inc.
2. **Dynamic Dual Quantization-Domain Decoding for NR LDPC Codes**
   Taehyun Kim, JooSung Park, Samsung Electronics
3. **Energy-Detection based False Alarm Reduction in Polar-Coded Uplink Control Channel Transmission in 5G-NR**
   Hyosang Ju, Eunyoung Cho, Sang-Hyo Kim, Sungkyunkwan University
4. **Experimenting Joint Vehicular Communications and Sensing with Optimized 5G NR Waveform**
   Sahan Damith Liyanaarachchi, Carlos Baquero Barneto, Taneli Riihonen, Mikko Valkama, Tampere University
5. **Fast Simulation of Convolutionally Coded Communication System for Performance Evaluation With A Novel Noise Gauging Method**
   You-Zong Yu, David Lin, Tzu-Hsien Sang, National Chiao Tung University
6. **Multi-link Techniques for New Radio-Unlicensed URLLC in Hostile Environments**
   Roberto Maldonado, Aalborg University; Claudio Rosa, Nokia Bell Labs; Klaus Pedersen, Nokia
7. **The Effect of Coupling Memory and Block Length on Spatially Coupled Serially Concatenated Codes**
   Mojtaba Mahdavi, Muhammad Umar Farooq, Liang Liu, Ove Edfors, Viktor Öwall, Michael Lentmaier, Lund University

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Services, Security, Edge and Cloud II

1. **Machine Learning-Based Intrusion Detection System for Big Data Analytics in VANET**
   Mingyuan Zang, Ying Yan, Technical University of Denmark
2. **On Opportunistic Selection of Common Randomness and LLR generation for Algebraic Group Secret-Key Generation**
   Rohit Joshi, IIT Delhi; Harshan Jagadeesh, IIT Delhi, India
3. **Secrecy Outage Analysis of Artificial-Noise-Aided mmWave Transmissions in the Presence of Blockage**
   Haoyu Wang, Ying Ju, Qingqi Pei, Xidian University; Hui-Ming Wang, Xi'an Jiaotong University
4. **Sidelink Group Resource Scheduling for Platoons in Cellular Vehicle-to-Vehicle Communications**
   Sudeep Hegde, Nokia Bell Labs; Liping Shi, Nestor Hernandez, Aarhus University; Rudraksh Shrivastava, Oliver Blume, Nokia Bell Labs; Rune Hylsberg Jacobsen, Aarhus University
5. **SixPack: Abusing ABS to avoid Misbehavior detection in VANETs**
   Francesco Pollicino, Dario Stabili, Università di Modena e Reggio Emilia; Giampaolo Bella, Univesity of Catania; Mirco Marchetti, Università di Modena e Reggio Emilia
6. **Sliding Window RLNC on Multi-Hop Communication for Low Latency**
   Elif Tasdemir, Juan A. Cabrera, Frank Gabriel, Dongho You, Frank H.P. Fitzek, Technische Universität Dresden
7. **TSSBV: A Conflict-Free Flow Rule Management Algorithm in SDN Switches**
   Qizhao Zhou, Junqing Yu, Dong Li, Huazhong University of Science and Technology

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Emerging Technologies, 5G and Beyond I

1. **A Proxy Signature-Based Drone Authentication in 5G D2D Networks**
   Mai A. Abdel-Malek, Kemal Akkaya, Florida International University; Arupjyoti Bhuyan, Idaho National Laboratory; Ahmed S. Ibrahim, Florida International University
2. **A Sensing Integrated DFT-Spread OFDM System for Terahertz Communications**
   Yongzhi Wu, Shanghai Jiao Tong University; Filip Lemic, University of Antwerp - imec; Chong Han, Shanghai Jiao Tong University; Zhi Chen, University of Electronic Science and Technology of China
3. **Dynamic Resource Assignment for Heterogeneous Services in 5G Downlink Under Imperfect CSI**
   PraveenKumar Korrai, Eva Lagunas, Shree K. Sharma, Symeon Chatzinotas, SnT, University of Luxembourg
4. **Enhancing URLLC Uplink Configured-grant Transmissions**
   Trung Kien Le, EURECOM

5. **FFT-based frequency domain filter design for multi-channel overlap-windowed-DFTs-OFDM signals**
   Motoki Ishibashi, Masahiro Umehira, Xiaoyan Wang, Shigeki Takeda, Ibaraki University
6. **Integrated Service Discovery and Placement in Information-Centric Vehicular Network Slices**
   Xuan-Thuy Dang, DAI-Labor; Fikret Sivrikaya, GT-ARC gGmbH, Berlin, Germany; Sebastian Peters, DAI-Labor, Technische Universität Berlin, Berlin, Germany

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Machine Learning and AI for Communications II

1. **Deep Learning-Based Multi-Tone Interference Suppression for Short Polar Codes**
   Bashar Husain, Hazem Mohamed, Lars Haering, Andreas Czylwik, University of Duisburg - Essen
2. **Deep reinforcement learning for hybrid beamforming in multi-user millimeter wave wireless systems**
   Enrique Mariano Lizarraga, Gabriel Maggio, National University of Cordoba; Alexis Dowhuszko, Aalto University
3. **Forecasting Wireless Demand with Extreme Values using Feature Embedding in Gaussian Processes**
   Schyler Chengyao Sun, Weisi Guo, Cranfield University
4. **Joint Cache Placement and Delivery Design using Reinforcement Learning for Cellular Networks**
   Mohsen Amidzade, Hanan Al-Tous, Olav Tirkkonen, Aalto University; Junshan Zhang, Arizona State University
5. **Joint Detection and Classification of RF Signals Using Deep Learning**
   Adela Vagollari, Friedrich-Alexander-Universität Erlangen-Nürnberg
6. **Learning Distributed Coded Caching Strategy in a Cellular Network**
   Yash Doshi, Lekha Wireless Solutions; B.N.Bharath, IIT Dharwad; Navneet Garg, Heriot-Watt University; Vimal Bhatia, Indian Institute of Technology Indore; Tharmalingam Ratnarajah, The University of Edinburgh
7. **LoRa Signal Demodulation Using Deep Learning, a Time-Domain Approach**
   Kosta Dakic, Bassel Al Homssi, Akram Hourani, Margaret Lech, RMIT University
8. **Mobile Physical-Layer Authentication Using Channel State Information and Conditional Recurrent Neural Networks**
   Ken St. Germain, Frank Kragh, Naval Postgraduate School

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Multiple Antennas and Cooperative Communications VI

1. **Downlink Outage Analysis of Integrated Satellite-Terrestrial Relay Network with Relay Selection and Outdated CSI**
   Hongxin Lin, Cheng Zhang, Yongming Huang, Southeast University; Rui Zhao, Huaqiao University; Luxi Yang, Southeast University
2. **Implementation of D&F Relay Node for Cooperative MIMO Systems through SDR platform**
   Randy Verdecia-Peña, José I. Alonso, Universidad Politécnica de Madrid
3. **Indoor Experimental Evaluation of Ultra-wideband MU-MISO TRDMA**
   Ramin Khayatzadeh, Huawei Paris Research Center
4. **Multi-Cell MIMO User Rate Balancing with Partial CSIT**
   Imène Ghamnia, Dirk T.M. Slock, EURECOM; Yi Yuan-Wu, Orange Labs
5. **Network Slicing for eMBB and mMTC with NOMA and Space Diversity Reception**
   Eduardo Noboro Tominaga, Hirley Alves, Onel Luis Alcaraz López, University of Oulu; Richard Demo Souza, UFSC; João Luiz Rebelatto, UTFPR; Matti Latva-aho, University of Oulu
6. **Stochastic Geometry-based Modelling of Mobile UAV Relay Networks under Realistic Fading**
   François De Saint Moulin, UCLouvain; Charles Wiame, Claude Oestges, Université catholique de Louvain; Luc Vandendorpe, Université cathoique de Louvain
7. **Success-Probability-Based Power Allocation for Downlink PNC in Multi-way Relay Channels**
   Hao Li, Xiao-wen Chang, Benoit Champagne, McGill University
8. **Transmitter Selection for Secrecy in a Frequency Selective Fading Channel with Unreliable Backhaul**
   Shashi Bhushan Kotwal, Indian Institute of Technology Jammu; Chinmoy Kundu, University College Dublin; Sudhakar Modem, Ankit Dubey, Indian Institute of Technology Jammu; Mark Flanagan, University College Dublin

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Positioning, Navigation, and Sensing IV

1. **Dynamic Selective Positioning for High-Precision Accuracy in 5G NR V2X Networks**
   Abdurrahman Fouda, Northwestern University; Ryan Keating, Amitava Ghosh, Nokia Bell Labs
2. **EKF based on Two FDE schemes for GNSS Vehicle Navigation**
   Christophe Combettes, Leti France; Christophe Villien, CEA-Leti
3. **UAV Aided Vehicle Positioning with Imperfect Data Association**
   Tianhao Liang, Jiayan Yang, Tingting Zhang, Harbin Institute of Technology (Shenzhen)
4. **Visible light communication-based monitoring for indoor environments using unsupervised learning**
   Mehmet Ilter, Alexis Dowhuszko, Jyri Hamalainen, Risto Wichman, Aalto University
5. **Visual-Multi-Sensor Odometry with Application in Autonomous Driving**
   Andreas Serov, Joachim Clemens, University of Bremen
6. **WiFi CSI-Based Device-free Multiroom Presence Detection**
   Fang-Yu Chu, Chun-Jie Chiu, An-Hung Hsiao, Kai-Ten Feng, National Chiao Tung University; Po-Hsuan Tseng, National Taipei University of Technology
7. **WiLay: A Two-Layer Human Localization and Activity Recognition System Using WiFi**
   Jinyang Huang, Bin Liu, Hongxing Jin, Nenghai Yu, University of Science and Technology of China
8. **WKNN indoor Wi-Fi localization method using k-means clustering based radio mapping**
   Siyang LIU, Université Paris-Saclay, CNRS, CentraleSupélec

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Signal Processing for Wireless Communications VI

1. **Diversity and PAPR Enhancement in OTFS using Indexing**
   Jickson K Francis, Rose Mary Augustine, A. Chockalingam, Indian Institute of Science, Bangalore
2. **Duration-Squeezing-Aware Communication and Computing for Proactive VR**
   Xing Wei, Chenyang Yang, Shengqian Han, Beihang University
3. **Joint Edge Content Cache Placement and Recommendation: Bayesian Approach**
   Krishnendu S, Indian Institute of Technology Indore; B.N.Bharath, IIT Dharwad; Vimal Bhatia, Indian Institute of Technology Indore
4. **Multiuser Detection of Collided AIS Packets with Accurate Estimates of Doppler Frequencies**
   Kohei Nozaki, Yuyuan Chang, Kazuhiko Fukawa, Tokyo Institute of Technology; Daichi Hirahara, Japan Aerospace Exploration Agency
5. **Quasi-Quantum PCI optimization in 5G Networks**
   Dilip Krishnaswamy, Reliance Jio Platforms

6. **Reliability Enhancement by PDCP Duplication and Combining for Next Generation Networks**
   Abdul Mateen Ahmed, iith; Aaqib Patel, Mohammed Zafar Ali Khan, Indian Institute of Technology Hyderabad
7. **Sequence Design for Frame Detection Based on Autocorrelation**
   Ana Belen Martinez, Atul Kumar, Technische Universität Dresden; Marwa Chafii, ETIS, UMR 8051, CY Cergy Paris Université, ENSEA, CNRS; Gerhard Fettweis, Technische Universität Dresden

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Emerging Technologies, 5G and Beyond II

1. **Low Latency Low Loss Scalable Throughput in 5G Networks**
   Davide Brunello, KTH Royal Institute of Technology; Ingemar Johansson S, Ericsson AB; Mustafa Ozger, Cicek Cavdar, KTH Royal Institute of Technology
2. **Multi-user Stochastic Game for Utility Optimization in Mobile Ad Hoc Cloud**
   Fenghui Zhang, Michael Mao Wang, Liqing Shan, Meng Zhang, Chuntian Xu, Southeast University
3. **Placement of mmWave Base Stations for ServingUrban Drone Corridors**
   Simran Singh, Udita Bhattacherjee, Ender Ozturk, Ismail Guvenc, Huaiyu Dai, Mihail L. Sichitiu, North Carolina State University; Arupjyoti Bhuyan, Idaho National Laboratory
4. **Reducing the Paging Overhead in Highly Directional Systems**
   Sanjay Goyal, Hussain Elkotby, Ravi Pragada, Tanbir Haque, InterDigital Communications, Inc.
5. **Reliability Based Candidate Selection of List Decoding for Polar Code**
   DaeSon Kim, Sehyoung Kim, Inhyoung Kim, Min Goo Kim, Samsung Electronics
6. **Slice-aware energy saving algorithm for 5G networks based on simplicial homology.**
   Aymeric de Javel, Jean-Sébastien Gomez, Philippe Martins, Jean-Louis Rougier, Telecom Paris; Patrice Nivaggioli, Cisco
7. **Towards a new open source 5G development framework: an introduction to free5GRAN**
   Aymeric de Javel, Jean-Sébastien Gomez, Philippe Martins, Jean-Louis Rougier, Telecom Paris; Patrice Nivaggioli, Cisco

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Machine Learning and AI for Communications III

1. **Multi-hop fronthaul offloading in learning-aided fog computing**
   Kameliya Kaneva, Neda Aboutorab, University of New South Wales; George Leu, Defence Science and Technology Group
2. **Near-field localization using machine learning: an empirical study**
   Mikko Laakso, Risto Wichman, Aalto University
3. **Optimal Resource Allocation via Machine Learning in Coordinated Downlink Multi-Cell OFDM Networks under High Mobility**
   Yunan Guo, Harbin Institute of Technology (Shenzhen); Fu-Chun Zheng, Harbin Institute of Technology (Shengzhen) & The University of York; Jingjing Luo, Harbin Institute of Technology (Shenzhen); Xiaoming Wang, Nanjing University of Posts and Telecommunications
4. **Reducing the Latency: Improving Handover Procedure Using Machine Learning**
   Roman Zhohov, Alexandros Palaios, Ericsson; Henrik Ryden, Reza Moosavi, Joel Berglund, Ericsson Research
5. **Reinforcement Learning-based Dynamic Service Placement in Vehicular Networks**
   Anum Talpur, Mohan Gurusamy, National University of Singapore
6. **TC-MIMONet: A Learning-based Transceiver for MIMO Systems with Temporal Correlations**
   Chunhui Chen, Tsinghua University; Zihao Wang, The Hong Kong University of Science and Technology; Yuyi Mao, The Hong Kong Polytechnic University; Hao Wu, Tsinghua University; Bo Bai, Gong Zhang, Huawei Technologies Co., Ltd.
7. **Terminal-Side Data Rate Prediction For High-Mobility Users**
   Daniel Schäufele, Martin Kasparick, Fraunhofer Heinrich Hertz Institute; Jens Schwardmann, Johannes Morgenroth, Robert Bosch GmbH; Slawomir Stanczak, Fraunhofer Heinrich Hertz Institute
8. **The Reinforcement Learning based Interference Whitening Scheme for 5G**
   Kwonyeol Park, Hyungjong Kim, Daecheol Kwon, Haejoon Kim, Hwanmin Kang,, Min-Ho Shin, Jonghan Kim, Woonhaing Hur, Samsung Electronics

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Multiple Antennas and Cooperative Communications VII

1. **1-Bit Precoding for Massive MIMO Downlink with Linear Programming and a Greedy Algorithm Extension**
   Ferhad Askerbeyli, Huawei Munich Research Center / Technical University of Munich; Wen Xu, Huawei Technologies Duesseldorf GmbH; Josef A. Nossek, Technical University of Munich
2. **Adaptive Channel Interpolation in High-Speed Massive MIMO**
   Alexander Osinsky, Roman Bychkov, Andrey Ivanov, Dmitry Yarotsky, Skolkovo Institute of Science and Technology
3. **Beam Selection-Based Hybrid Precoding**
   Mariam Mussbah, Stefan Schwarz, Markus Rupp, TU Wien
4. **Can Massive MIMO Support URLLC?**
   Hangsong, New York University; Alexei Ashikhmin, Hong Yang, Nokia Bell Labs
5. **Data-Driven Beams Selection for Beamspace Channel Estimation in Massive MIMO**
   Roman Bychkov, Alexander Osinsky, Andrey Ivanov, Dmitry Yarotsky, Skolkovo Institute of Science and Technology
6. **Deep Learning Based Channel Prediction for Massive MIMO Systems in High-Speed Railway Scenarios**
   Chen Xue, Tao Zhou, Haitong Zhang, LiuLiu, Cheng Tao, Beijing Jiaotong University
7. **Efficient Numerical Methods for Secrecy Capacity of Gaussian MIMO Wiretap Channel**
   Anshu Mukherjee, University College Dublin; Bjorn Ottersten, University of Luxembourg; Le-Nam Tran, University College Dublin
8. **Experiment on MIMO Communications in Seawater by RF Signals**
   Kenichi Takizawa, Ryotaro Suga, Takashi Matsuda, Fumihide Kojima, NICT
9. **Granting Massive Access by Adaptive Pilot Assignment Scheme for Scalable Cell-free Massive MIMO Systems**
   Manobendu Sarker, Abraham O. Fapojuwo, University of Calgary
10. **Hybrid Beamforming for Bidirectional Massive MIMO Full Duplex Under Practical Considerations**
    Chandan Kumar Sheemar, Dirk Slock, Eurecom
11. **Low-Complexity Joint User and Power Scheduling for Downlink NOMA over Fading Channels**
    Do-Yup Kim, Yonsei University; Hamid Jafarkhani, University of California, Irvine; Jang-Won Lee, Yonsei University

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Multiple Antennas and Cooperative Communications VIII

1. **Machine Learning-Assisted Channel Estimation in Massive MIMO Receiver**
   Dmitry Yarotsky, Andrey Ivanov, Roman Bychkov, Alexander Osinsky, Skolkovo Institute of Science and Technology; Andrey Savinov, Mikhail Trefilov, Vladimir Lyashev, Huawei Technologies
2. **On Understanding of Massive MIMO Beam-forming From Multi-user Joint Transmit-receive Diversity Principle**
   Fumiyuki Adachi, Ryo Takahashi, Tohoku University

3. **One-Bit Window Comparator Based Jamming Detection in Massive MIMO System**
   Mohammed Teeti, East China University of Technology
4. **Performance of Cooperative NOMA with Virtual Full-Duplex based DF Relaying in Nakagami-m Fading**
   Justin Jose, Parvez Shaik, Vimal Bhatia, Indian Institute of Technology Indore
5. **Power Allocation for Multi-user Cooperation: a Multi-Objective and Machine Learning Approach**
   Kezhong Jin, Wenzhou University; Hosung Park, Chonnam National University; Zhenzhou Tang, Wenzhou University
6. **Sum-rate Maximization in NOMA-based mmWave Analog Beamforming under Imperfect CSI**
   Kali Krishna Kota, International Institute of Information Technology, Hyderabad; P. Ubaidulla, International Institute of Information Technology (IIIT), Hyderabad
7. **Throughput Performance of Multiband HetNets using Sectorized Picocells with 3D Beamforming at 28 GHz Band**
   Fumiya Kemmochi, Yuji Omura, Hiroyuki Otsuka, Kogakuin University
8. **Truly Intelligent Reflecting Surface-Aided Secure Communication Using Deep Learning**
   Yizhuo Song, Muhammad RA Khandaker, Heriot-Watt University; Faisal Tariq, University Glasgow; Kai-Kit Wong, University College London; Apriana Toding, Universitas Kristen Indonesia Paulus
9. **TUCKER2-based Hybrid Beamforming Design for mmWave OFDM Massive MIMO Communications**
   Guilherme Martignago Zilli, Wei-Ping Zhu, Concordia University
10. **Turbo-AI, Part I: Iterative Machine Learning Based Channel Estimation for 2D Massive Arrays**
    Yejian Chen, Jafar Mohammadi, Stefan Wesemann, Bell Labs, Nokia; Thorsten Wild, Nokia Bell Labs
11. **Turbo-AI, Part II: Multi-Dimensional Iterative ML-Based Channel Estimation for B5G**
    Yejian Chen, Jafar Mohammadi, Stefan Wesemann, Bell Labs, Nokia; Thorsten Wild, Nokia Bell Labs

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Positioning, Navigation, and Sensing V

1. **Deep Learning based Localization of LTE eNodeBs from Large Crowdsourced Smartphone Datasets**
   Amir Ghasemi, Janaki Parekh, Communications Research Centre Canada
2. **Deployment Optimization in UAV Aided Vehicle Localization**
   Jiayan Yang, Tianhao Liang, Tingting Zhang, Harbin Institute of Technology (Shenzhen)
3. **Design and Implementation of Vehicle Speed Estimation Using Road Marking-based Perspective Transformation**
   Wan-Ping Wu, Ying-Cheng Wu, Chih-Chun Hsu, Jenq-Shiou Leu, Jui-Tang Wang, National Taiwan University of Science and Technology
4. **Improvement of Radio Frequency Fingerprint Portability for Wi-Fi Adaptor Identification**
   Hsin-Chin Liu, National Taiwan University Science and Technology
5. **Location-Free Beam Prediction in mmWave Systems**
   Tushara Ponnada, Hanan Al-Tous, Olav Tirkkonen, Aalto University
6. **Towards Biologically Inspired Decentralized Platooning for Autonomous Vehicles**
   Shesha Sreenivasamurthy, Katia Obraczka, University of California Santa Cruz
7. **Traffic Accident Recognition in First-Person Videos by Learning a Spatio-Temporal Visual Pattern**
   Kyung Ho Park, SOCAR; Dong Hyun Ahn, Huy Kang Kim, Korea University
8. **Travel Time Prediction and Route Performance Analysis in BRTS based on Sparse GPS Data**
   Anand Kakarla, VSKR. Munagala, Indian Institute of Technology; Tetsuhiro Ishizaka, Atsushi Fukuda, Nihon University; Soumya Jana, Indian Institute of Technology

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