ISWCS 2019

27-30 AUGUST OULU FINLAND

ISWCS'19

Technically Co-sponsored by IEEE ComSoc, VTS and EURASIP

6G FLAGSHIP
UNIVERSITY OF OULU

Oulu Capital of Northern Scandinavia
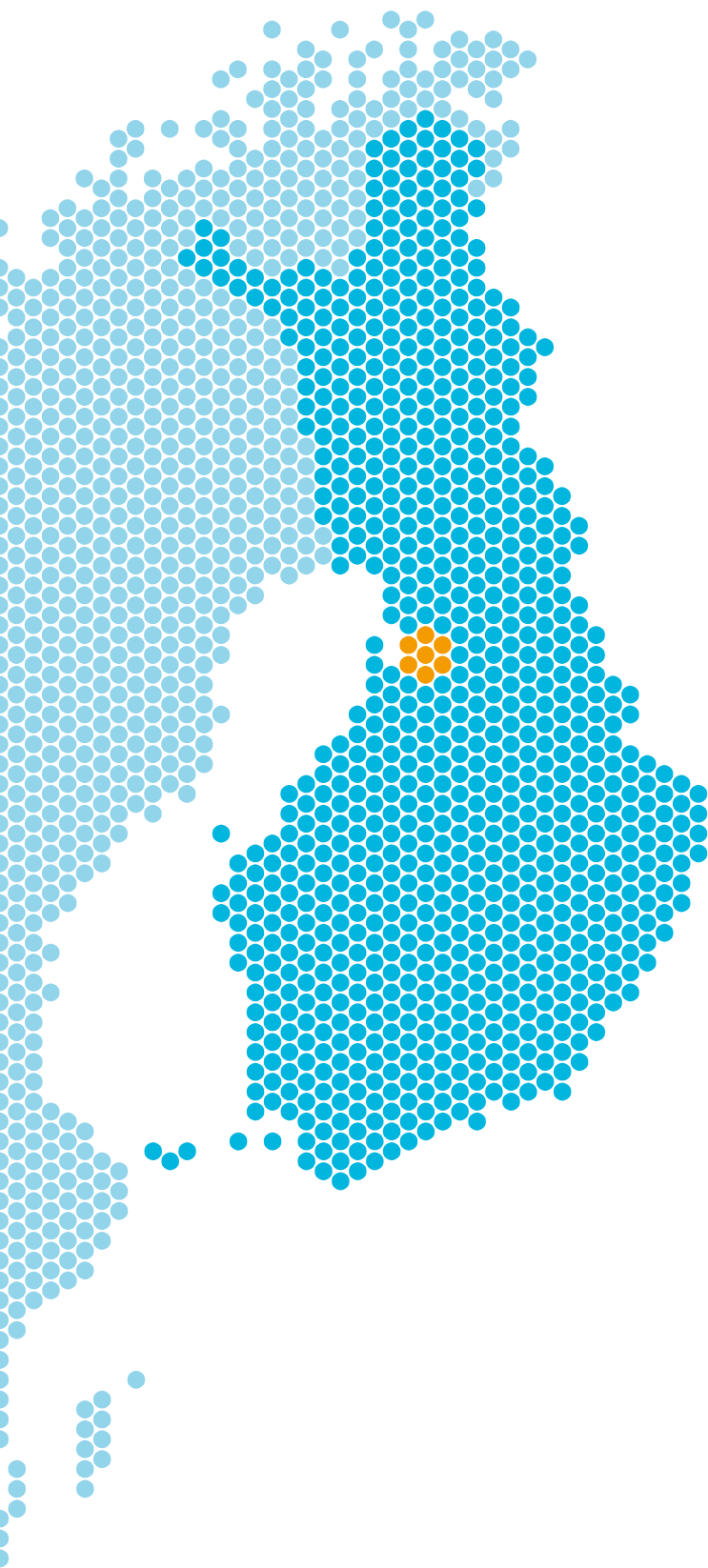
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ISWCS '19 PROGRAMME AT A GLANCE

	Tuesday 27.8.	Wednesday 28.8.	Thursday 29.8.	Friday 3O.8.
8:OO		ISWCS '19 Registration and Info Desk		
8:45		Opening Session		
9:OO		Keynote: Larsson	Keynote: Popovski	SS12, TS13, TS14, TS15, TS16
9:3O	T1, T3, WSO1, WSO2			
1O:OO		Coffee	Coffee	
1O:3O	Coffee	SSO1, TSO1, TSO2, TSO3, PSO1	SSO8, SSO4, TSO7, TSO8, SS1O	Coffee
11:OO				SSO6, TS17, TS18, TS19, TS2O
11:3O	T1, T3, WSO1, WSO2			
12:OO		Lunch	Lunch	
12:3O	Lunch			Lunch
13:3O	WSO1, T2, T4, WSO3	Keynote: Hanzo	Keynote: Oksanen	Panel: Regulations
14:OO				
14:3O		SSO3, TSO4, TSO5, TSO6, SSO9	SS11, SSO2, TSO9, TS1O, PSO2	Closing Session
15:OO	Coffee			
15:3O				Coffee
16:OO	T2, T4, WSO3	Coffee	Coffee	
16:3O			SS11, SSO2, TS11, TS12, PSO3	
17:OO		Panel: 6G		
17:3O				
18:OO				
18:3O				
19:OO	City Reception	Banquet Dinner		

Message from the General Chairs

It is a great pleasure to welcome you to International Symposium on Wireless Communications Systems (ISWCS'2019), the 16th edition in the series. Undoubtedly this conference will be an enjoyable and memorable event.

Oulu is worldwide known as one of the leading hubs in wireless technology being first on analog NMT network, GSM and WCDMA calls. Besides, Oulu hosts the first open 5G test network, and moreover the first flagship framework on 6G wireless communications, the 6G Flagship! Such rich history evinces the innovative and visionary culture inherent in Oulu academic and industrial's communities.

Over the years, ISWCS has grown into a truly global event that brings together the leading academics worldwide and representatives from major ICT organizations. ISWCS is held at University of Oulu, hosted by the Centre for Wireless Communications under the 6G Flagship, thus being he perfect host for this 16th edition at the dawn of 6G research. ISWCS program will enlighten and inspire you: there are keynotes, panels, workshops and tutorials from the leading experts in the field, and an exhibition area where functioning prototypes will be showcased. Yet it is not all work! There are also many social events during the conference to keep you well entertained.

Welcome to Oulu – the home of mobile communications!
We wish you a thrilling conference.

ISWCS General Chairs Matti Latva-aho and Hirley Alves

Matti Latva-aho
Academy Professor
6G Flaghsip
University of Oulu

Hirley Alves
Assistant Professor
6G Flagship
University of Oulu

CONFERENCE SCHEDULE ON 27-28 AUGUST

	Tuesday 27 AUGUST Day 1				Wednesday 28 AUGUST Day 2				
8:00	Registration and Info Desk								
8:45					ISWCS '19 Opening Session				
9:00	**T1**	**T3**	**WSO1**	**WSO2**	Keynote: Erik G. Larsson				
	IT112	IT105	IT106	IT138	IT116				
10:00					Coffee				
10:30	Coffee				**SSO1**	**TSO1**	**TSO2**	**TSO3**	**PSO1**
11:00	**T1**	**T3**	**WSO1**	**WSO2**	IT138	IT105	IT106	IT112	IT113
	IT112	IT105	IT106	IT138					
12:00									
12:30	Lunch				Lunch				
13:00									
13:30	**T2**	**T4**	**WSO1**	**WSO3**	Keynote: Lajos Hanzo				
	IT112	IT105	IT106	IT138	IT116				
14:30					**SSO3**	**TSO4**	**TSO5**	**TSO6**	**SSO9**
15:00	Coffee				IT138	IT105	IT106	IT112	IT113
15:30	**T2**	**T4**		**WSO3**					
16:00	IT112	IT105		IT138	Coffee				
16:30					Panel: 6G				
17:00					IT116				
18:00									
19:00	Welcome Reception				Banquet Dinner				

CONFERENCE SCHEDULE ON 29-30 AUGUST

	Thursday 29 AUGUST Day 3					Friday 30 AUGUST Day 4				
8:00	Registration and Info Desk									
9:00	Keynote: Petar Popovski IT116					**SS12** IT138	**TS13** IT105	**TS14** IT106	**TS15** IT112	**TS16** IT113
10:00	Coffee									
10:30	**SS08** IT138	**SS04** IT105	**TS07** IT106	**TS08** IT112	**SS10** IT113	Coffee				
11:00						**SS06** IT138	**TS17** IT105	**TS18** IT106	**TS19** IT112	**TS20** IT113
12:00	Lunch									
12:30						Lunch				
13:30	Keynote: Lauri Oksanen IT116					Panel: Regulations to promote new 5G business opportunities IT116				
14:30	**SS11** IT138	**SS02** IT105	**TS09** IT106	**TS10** IT112	**PS02** IT113	ISWCS '19 Closing Session IT116				
15:30						Coffee				
16:00	Coffee									
16:30-18:00	**SS11** IT138	**SS02** IT105	**TS11** IT106	**TS12** IT112	**PS03** IT113					

KEYNOTES

WEDNESDAY AUGUST 28
&
THURSDAY AUGUST 29

WEDNESDAY, 9:00 - 10:00 | ROOM: IT116

Erik G. Larsson, Linköping University, Sweden

Physical layer for Next Generation Wireless: Lessons Learned from 5G and Directions for 6G

Abstract: *The performance and quality-of-service bottleneck of wireless networks will always remain at the physical layer. The main physical-layer technology component for sub-6 GHz in 5G, Massive MIMO, improves performance over conventional wireless access by orders of magnitude. In this talk, I will explain how in the last decade, massive MIMO evolved from a wild academic idea to a vibrant research topic to a main component of 5G. I will also talk about some important lessons learned from the development of the fundamental theory behind this technology, and some misconceptions that still prevail. Furthermore I will discuss future directions and visions for 6G technology, especially scalable cell-free massive MIMO and grant-free random access for massive machine-type communications.*

Erik G. Larsson is Professor at Linköping University, Sweden, and a Fellow of the IEEE. He co-authored Fundamentals of Massive MIMO (Cambridge, 2016) and Space-Time Block Coding for Wireless Communications (Cambridge, 2003). Recent service includes membership of the IEEE Signal Processing Society Awards Board (2017- 2019), the IEEE Signal Processing Magazine editorial board (2018-2020), and the IEEE Transactions on Wireless Communications steering committee (2019-2022). He received the IEEE Signal Processing Magazine Best Column Award twice, in 2012 and 2014, the IEEE ComSoc Stephen O. Rice Prize in Communications Theory 2015, the IEEE ComSoc Leonard G. Abraham Prize 2017 and the IEEE ComSoc Best Tutorial Paper Award 2018.

WEDNESDAY, 13:30 - 14:30 | ROOM: IT116

Lajos Hanzo, University of Southampton, UK

When Quantum-Signal Processing & Communications Meet

Abstract: *The marriage of ever-more sophisticated signal processing and wireless communications has led to compelling 'tele-presence' solutions - at the touch of a dialing key... However, the 'quantum' leaps both in digital signal processing theory and in its nano-scale based implementation is set to depart from classical physics obeying the well-understood laws revealed by science. We embark on a journey into the weird & wonderful world of quantum-physics, where the traveler has to obey the sometimes strange new rules of the quantum-world. Hence we ask the judicious question: can the marriage of applied signal processing and communications extended beyond the classical world into the quantum world?*

Lajos Hanzo is a Foreign Member of the Hungarian Academy of Science, Fellow of the Royal Academy of Engineering, of the IEEE, of the IET and of the EURASIP. He is also a Wolfson Fellow of the Royal Society. During his 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 ECS, University of Southampton, UK, where he holds the Chair in Telecommunications.

His current research interests are featured at (http://www-mobile.ecs.soton.ac.uk).

THURSDAY, 9:00 - 10:00 | ROOM: IT116

Petar Popovski, Aalborg University, Denmark

Three Stories on IoT (Internet-of-Things) Connectivity: Ultra-Reliability, Massiveness, and Blockchains

Abstract: *The future wireless landscape will feature multiple types of connectivity for the Internet of Things (IoT). The two generic IoT classes associated with 5G are Ultra-Reliable Low-Latency Communication (URLLC), and massive Machine Type Communication (mMTC). However, this initial classification undergoes a revision to accommodate new types of requirements, such as broadband transmissions or trusted data exchanges. This talk will speak about three different aspects of IoT connectivity. The first story is related to mission-critical IoT and explains why ultra-reliability is a feature that must be treated with the tools of statistical machine learning. The second story is related to massive IoT connectivity, where we revise the common assumption used in random access protocols, according to which the activation and the data of each IoT device is independent from the other devices. It is shown how massive IoT can be transformed into an ultra-reliable system when the devices transmit correlated data. The third story is dedicated to the challenges that occur when the autonomous interactions among the IoT devices are powered by distributed ledger technology (DLT), blockchain, and smart contracts. It is shown how blockchains transform the IoT traffic patterns, as well as what are the challenges that the combination blockchain-IoT poses to the communication architecture.*

Petar Popovski is a Professor of Wireless Communications at Aalborg University, Fellow of the IEEE and a Visiting Excellence Chair at the University of Bremen. He received his Dipl.-Ing and Magist.-Ing. degrees in communication engineering from the University of Sts. Cyril and Methodius in Skopje and the Ph.D. degree from Aalborg University in 2005. He has over 300 publications in journals, conference proceedings, and edited books. He is featured in the list of Highly Cited Researchers 2018, compiled by Web of Science. He holds over 30 patents and patent applications. He received an ERC Consolidator Grant (2015), the Danish Elite Researcher award (2016), IEEE Fred W. Ellersick prize (2016) and IEEE Stephen O. Rice prize (2018). He is currently a Member at Large at the Board of Governors in IEEE Communication Society. Prof. Popovski is a Steering Committee Member of IEEE SmartGridComm and IEEE TRANSACTIONS ON GREEN COMMUNICATIONS AND NETWORKING. He previously served as a Steering Committee Member of the IEEE INTERNET OF THINGS JOURNAL. He is currently an Area Editor of the IEEE TRANSACTIONS ON WIRELESS COMMUNICATIONS. Prof. Popovski is the General Chair for IEEE SmartGridComm 2018 and IEEE Communication Theory Workshop 2019. His research interests are in the area of wireless communication and communication theory.

THURSDAY, 13:30 | 14:30, ROOM: IT116

Lauri Oksanen, Nokia, Finland

5G and the Future of Communications

Abstract: *Future of communications is driven by evolving human needs and multiple different technical and economical developments. Demanding new services and use cases require system level solutions and holistic architecture. 5G is an important piece but there are also many other areas of the networks we need to evolve to provide truly new services. These include transport and distributed clouds but most importantly end-to-end management and orchestration utilizing analytics and AI. We will look at the evolution of different, connected areas within the framework of the Future X architecture and what may lie further in the future.*

Lauri Oksanen is Vice President for Research and Technology in Nokia. He heads The Industry Standards Group in Nokia Bell Labs, responsible for all industry activities in Nokia. He started his industrial career 30 years ago in fiber optics in Nokia. Then Lauri moved to mobile networks where he has worked with all major wireless technologies from GSM to 5G. Lauri has worked in various advanced technology management positions covering fixed and wireless access, core, management and services, including also the HW and SW platforms and cloud and security technologies. Lauri has Master's and Licentiate degrees in Telecommunications from Helsinki University of Technology (now Aalto), where he also worked as a researcher before joining Nokia.

TUTORIALS

TUESDAY AUGUST 27

T1: Ultra Reliable Low Latency Communications (URLLC): Resource Allocation, Scheduling & Multi-Connectivity

TUESDAY, 9:00-12:30 | ROOM: IT112

Eduard Jorswieck, TU-Dresden, Germany

Abstract: *5G is expected to support Ultra Reliable Low Latency Communications (URLLC) based services, such as industrial control, remote surgery, tactile internet, etc. These are also the most challenging services to implement because they require a new network design and control methodology, in order to satisfy their requirements and enable their co-existence with other types of services that 5G and beyond systems need to deliver. The tutorial addresses the signal processing and optimization aspects of URLLC for 5G and beyond networks. The tutorial will cover a novel system design framework, state of the art signal processing and optimization techniques; resource allocation and scheduling, as well as multi-connectivity approaches for ultra-reliability. Wireless reliability is understood as successfully transmitting a desired amount of data within a given time. Diversity techniques, such as multi-connectivity, are potential solutions to achieve stringent reliability requirements. Spatial, temporal, spectral diversity and multi-connectivity are well understood from a capacity perspective. In this keynote, we will go one step beyond this traditional point of view and consider the impact of the statistical dependencies of the underlying random channel variables on the latency and reliability of the resulting URLLC links. We characterize the best- and worst-case dependencies for different use cases based on the concept of copulas and show that independence is neither the best nor the worst case.*

Eduard A. Jorswieck was born in 1975 in Berlin, Germany. Since February 2008, he has been the head of the Chair of Communications Theory and Full Professor at Dresden University of Technology (TUD), Germany. He is PI in the new excellence cluster CeTI (centre for Tactile Internet with Human-in-the-loop: ceti.one). Eduard's main research interests are in the area of signal processing for communications and networks, applied information theory, and communications theory. He has published more than 100 journal papers, 3 monographs, 11 book chapter, and some 250 conference papers on these topics. Dr. Jorswieck is senior member of IEEE. Since 2017, he is Editor-in-Chief of the Springer EURASIP Journal on Wireless Communications and Networking. He was member of the IEEE SPCOM Technical Committee (2008-2013) and is member of the IEEE SAM TC (since 2015). Since 2011, he acts as Associate Editor for IEEE Transactions on Signal Processing. Since 2008, continuing until 2013, he has served as an Associate Editor and Senior Editor for IEEE Signal Processing Letters. Since 2016, he serves as Associate Editor for IEEE Transactions on Information Forensics and Security. Since 2013, he serves as Associate Editor for IEEE Transactions on Wireless Communications. In 2006, he received the IEEE Signal Processing Society Best Paper Award.

T3: Future Evolution of 5G NR (rel 16, 17)

TUESDAY, 9:00-12:30 | ROOM: IT105

Stefan Parkvall, Ericsson, Sweden

Abstract: *With the completion of the first release (Rel-15) of the 3GPP fifth-generation (5G) NR specifications, the focus of the research community is now being directed towards the next step in the evolution of wireless mobile communication. Similar to earlier generations, it can be expected that the next ten years will see a gradual evolution of NR, introducing new innovative technology components and further enhancing the capabilities and expanding the scope of 5G wireless access. The first step of the NR evolution is already ongoing in 3GPP in release 16 with features such as Integrated Access Backhaul (IAB), operation in unlicensed spectrum (NR-U), and vechicle-to-vechile communication. The scope of the second step in the evolution, release 17, is currently under discussion and may include for example include operation in higher frequencies and enhancements to better support machine learning and artificial intelligence. In this presentation, the evolution of 5G NR will be discussed with particular focuis on teh rel-16 and rel-17.*
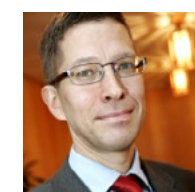
Stefan Parkvall [F] is a Senior Expert at Ericsson Research, working with 5G and future radio access. He is one of the key persons in the development of HSPA, LTE and NR radio access and has been deeply involved in 3GPP standardization for many years. Dr Parkvall is a fellow of the IEEE and served as an IEEE Distinguished lecturer 2011-2012. He is co-author of the popular books "3G Evolution - HSPA and LTE for Mobile Broadband", "HSPA evolution - the Fundamentals for Mobile Broadband", "4G - LTE/LTE-Advanced for Mobile Broadband", "4G, LTE Advanced Pro and the Road to 5G", and "5G NR - The Next Generation Wireless Access". Dr. Parkvall has more than 2000 patents in the area of mobile communication. In 2005, he received the Ericsson "Inventor of the Year" award, in 2009 the Swedish government's Major Technical Award for contributions to the success of HSPA, and in 2014 he and Ericsson colleagues were among the finalists for the European Inventor Award for their contributions to LTE. Dr Parkvall holds a Ph.D. in electrical engineering from the Royal Institute of Technology (KTH) in Stockholm, Sweden. Previous positions include assistant professor in communication theory at KTH, and visiting researcher at University of California, San Diego, USA.

T2: Wireless Communications for Big Data and IoT: a Data-Oriented Approach

TUESDAY, 13:30-17:00 | ROOM: IT112

Hong-Chuan Yang, University of Victoria, Canada; Mohamed-Slim Alouini, KAUST, Saudi Arabia

Abstract: *Wireless communication systems play an essential role in the generation and transmission of big data. The design and optimization of wireless transmission strategies for big data application are of critical current interest. In this tutorial, we present a unique data-oriented approach for the design and analysis of wireless transmission strategies, specifically targeting at big data transmission. Novel data-oriented performance metrics are proposed and applied to the analysis of wireless transmission strategies in the information theoretical and practical transmission settings. We also develop analytical frameworks to accurately characterize the data transmission time in both cognitive and non-cognitive environments. Compared to conventional analytical approach, the data-oriented approach offers important new insights and leads to interesting new research directions. Through this tutorial, the attendees can obtain a brand-new perspective to the analysis and optimization of wireless transmission technologies for big data applications.*

Dr. Hong-Chuan Yang received the Ph.D. degree in electrical engineering from the University of Minnesota in 2003. He is a professor of the Department of Electrical and Computer Engineering at the University of Victoria, Canada. From 1995 to 1998, He was a Research Associate at the Science and Technology Information Center (STIC) of the Ministry of Posts & Telecomm. (MPT), Beijing, China. His current work mainly focuses on different aspects of wireless communications, with special emphasis on channel modeling, diversity techniques, system performance evaluation, cross-layer design, and energy efficient communications. He has published over 200 journal and conference papers. He is the author of the book Introduction to Digital Wireless Communications by IET press and the coauthor of the book Order Statistics in Wireless Communications by Cambridge University

Mohamed-Slim Alouini received the Ph.D. degree in electrical engineering from the California Institute of Technology (Caltech) in 1998. He also received the Habilitation degree from the Universite Pierre et Marie Curie in 2003. Dr. Alouini started his academic career at the University of Minnesota in 1998. In 2005, he joined Texas A&M University at Qatar, Doha, and in 2009, he was appointed as Professor of Electrical Engineering at KAUST, Thuwal, Mekkah Province, Saudi Arabia, where he is responsible for research and teaching in the areas of Communication Theory and Applied Probability. More specifically, his research interests include design and performance analysis of diversity combining techniques, MIMO techniques, multi-hop/cooperative communications systems, cognitive radio systems, and multi-resolution, hierarchical and adaptive modulation schemes. Dr. Alouini has published many papers on the above subjects, and he is co-author of the textbook Digital Communication over Fading Channels published by Wiley Interscience. Dr. Alouini is a (i) Fellow of the Institute of Electrical and Electronics Engineers (IEEE), (ii) IEEE Distinguished Lecturer for the IEEE Communication Society and IEEE Vehicular Technology Society, (iii) member for several times in the annual Thomson ISI Web of Knowledge list of Highly Cited Researchers as well as the Shanghai Ranking/Elsevier list of Most Cited Researchers, and (iv) co-recipient of best paper awards in eleven IEEE conferences (including ICC, GLOBECOM, VTC, PIMRC, ISWCS, and DySPAN).

T4: Robust Online Machine Learning in 5G Radio Access Networks: Requirements, Challenges, Theory and Promising Approaches

TUESDAY, 13:30-17:00 | ROOM: IT105

Slawomir Stanczak and Renato Cavalcante, Fraunhofer, Germany

Abstract: *Wireless communications poses fundamental challenges to machine learning (ML). Wireless links are subject to fading and may be exposed to strong interference. Since wireless resources are scarce, this may severely limit the capacity of wireless links, thus requiring distributed ML solutions that efficiently use the wireless resources. Moreover, ML methods need to provide robust results based on small uncertain data*

sets and under strict latency constraints. Current signal processing algorithms for wireless transceivers are typically based on models that assume, for example, ideal linear amplifiers, perfect channel state information, and knowledge of interference patterns. In practice, however, these assumptions are unrealistic because many parameters have to be estimated, so it is often unclear how well the idealized models can capture the true behavior of real communication systems. As a result, in recent years a great deal of effort has been devoted to replacing many of the building blocks of the radio access network by few machine learning algorithms, with the intent to reduce drastically the number of assumptions and the number of complex estimation techniques. However, this reduction in model knowledge brings many technical challenges. In particular, in the physical layer, the wireless environment can be considered roughly constant only for few milliseconds, which can be all the time available for acquisition of training sets and for the training procedure. As a result, computationally simple learning techniques that can cope with small training sets, or that are able to extract largely time-invariant features of the wireless signals (so that traditional learning tools can be employed), have been in great demand. In this tutorial, we will review online machine learning algorithms for these tasks.

The first part of the tutorial includes a mathematical introduction to machine learning and is based on two courses given to graduate students at the TU Berlin. The content includes topics like learning model, stochastic inequalities and concentration of measure, Markov chains, the concept of VC dimension, fundamentals of reproducing kernel Hilbert spaces and kernel-based learning, convex learning as well as regularization, dimensionality reduction and compressive sensing. We will complete this part with mathematical introduction to deep learning and (deep) reinforcement learning. In the second part, we introduce online machine learning methods based on projections in Hilbert spaces that can be used to realize selected RAN functions.

A special attention will be attached to applications such as localization, beamforming in MIMO systems and load/QoS prediction. Meeting the latency requirements of 5G networks requires massive parallelization. Therefore we will also discuss how to parallelize and map these algorithms to GPU architectures to achieve orders-of-magnitude acceleration. We will complete the tutorial by reviewing recent results on the design of neural networks. Our tutorial will also use findings of the ITU-T focus group on machine learning for 5G to discuss the impact of machine learning on future network architectures.

Slawomir Stanczak studied electrical engineering with specialization in control theory at the Wroclaw University of Technology and at the Technical University of Berlin (TU Berlin). He received the Dipl.-Ing. degree in 1998 and the Dr.-Ing. degree (summa cum laude) in electrical engineering in 2003, both from TU Berlin; the Habilitation degree (venialegendi) followed in 2006. Since 2015, he has been a Full Professor for network information theory with TU Berlin and the head of the Wireless Communications and Networks department. Prof. Stanczak is a co-author of two books and more than 200 peer-reviewed journal articles and conference papers in the area of information theory, wireless communications, signal processing and machine learning. He served as an Associate Editor of the IEEE Transactions on Signal Processing between 2012 and 2015. Since February 2018 Prof. Stanczak has been the chairman of the ITU-T focus group on machine learning for future networks including 5G.

Renato Luis Garrido Cavalcante received the electronics engineering degree from the Instituto Tecnologico de Aeronautica (ITA), Brazil, in 2002, and the M.E. and Ph.D. degrees in Communications and Integrated Systems from the Tokyo Institute of Technology, Japan, in 2006 and 2008, respectively. From April 2003 to April 2008, he was a recipient of the Japanese Government (MEXT) Scholarship. He is currently a Research Fellow with the Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute, Berlin, Germany, and a lecturer at the Technical University of Berlin. Previously, he held appointments as a Research Fellow with the University of Southampton, Southampton, U.K., and as a Research Associate with the University of Edinburgh, Edinburgh, U.K. Dr. Cavalcante received the Excellent Paper Award from the IEICE in 2006 and the IEEE Signal Processing Society (Japan Chapter) Student Paper Award in 2008. He also co-authored a study that received a best student paper award at the 13th IEEE International Workshop on Signal Processing Advances in Wireless Communications (SPAWC) in 2012. His current interests are in signal processing for distributed systems, multiagent systems, convex analysis, machine learning, and wireless communications.

WORKSHOPS

TUESDAY AUGUST 27

WSO1: 5G for Remote Areas including the Arctic (5G-RAA)

TUESDAY, 9:OO-15:OO | ROOM: IT1O6

TUESDAY, 9:OO - 9:45 | ROOM: IT1O6

WSO1: Keynote

Full Coverage in Sweden — Making Digital Inclusion a Reality — *Elmar Trojer, PhD, MBA - Research Leader, Ericsson Research, Sweden*

Elmar Trojer joined Ericsson in 2OO5 and is currently working as a research leader on fronthaul networking technologies for 5G and beyond. He has been active on both fixed and mobile broadband technologies such as VDSL2, G.fast, GPON and mobile fronthaul/ backhaul technologies for 4G and 5G. His current focus lies on 5G and beyond indoor small cells, fixed-wireless access, integrated access and backhaul, and extreme coverage solutions. He holds a Ph.D. in electrical engineering from the Vienna University of Technology, and an MBA from the University of Vienna, Austria.

TUESDAY, 9:45 — 1O:3O | ROOM: IT1O6

WSO1: Technical Session I

Time-Frequency FTN Signaling for GFDM
Mariana Melo and Luciano Leonel Mendes (Inatel, Brazil)

CDL-based Channel Model for 5G MIMO Systems in Remote Rural Areas
Alexandre M Pessoa (Federal University of Ceará - UFC, Brazil); Bruno Sokal, Carlos Filipe Moreira e Silva and Tarcisio F. Maciel (Federal University of Ceará, Brazil); André de Almeida (Federal University of Ceará & Wireless Telecom Research Group - GTEL, Brazil); Diego Aguiar Sousa (Federal University of Ceará & Wireless Telecommunications Research Group, Brazil); Yuri C. B. Silva (Federal University of Ceará & Wireless Telecom Research Group (GTEL), Brazil); Francisco R. P. Cavalcanti (Federal University of Ceará & GTEL - Wireless Telecom Research Group, Brazil).

TUESDAY, 11:OO - 11:45 | ROOM: IT1O6

WSO1: Keynote

Satellite networks and 5G integration — *Dr Pouria Sayyad Khodashenas, Deputy Director, Software Networks, i2CAT Foundation, Barcelona, Spain*

Dr. Pouria Sayyad Khodashenas finished the Electronics Engineering B.Sc. in the state University of Guilan, Iran, in 2OO5. He received the M.Sc. degree in Optoelectronics from the state University of Tabriz, Iran, in 2OO8. In 2O14, he defended his Ph.D. in Optical Telecommunications at Universitat Politècnica de Catalunya (UPC), Barcelona, Spain. His PhD thesis has been honoured with the UPC special doctorate award for the academic year of 2O13 - 2O14. He joined Athens Information Technology (AIT), Athens, Greece, in the same year where he collaborated in the EU funded projects: FP7 FOX-C, FP7 INSPACE and H2O2O ACINO. Since October 2O15, he is working as the deputy director of software networks area at i2Cat Foundation, Barcelona, Spain, collaborating in EU funded projects such as 5GPPP H2O2O SESAME, 5GPPP H2O2O SaT5G, 5GPPP H2O2O 5G ESSENCE and FP7 DOLFIN. He is the coordinator of H2O2O CARAMEL project. He also contributed on Plan Nacional I+D+i projects such as ONOFRE and ONOFRE II. Pouria is author/co-author of 5O+ scientific publications including 3 books. His current research interests include: all optical communication systems, 5G, routing and resource allocation, techno-economic studies, NFV, SDN, heuristic algorithms.

TUESDAY, 11:45 - 12:3O | ROOM: IT1O6

WSO1: Technical Session II

Iterative Receiver for Non-Orthogonal Waveforms Based on the Sum-Product Algorithm
Ivo Bizon Franco de Almeida (Vodafone Chair Mobile Communications Systems - Technische Universität Dresden, Germany); Guilherme Pedro Aquino(Instituto Nacional de Telecomunicações, Brazil); Luciano Leonel Mendes (Inatel, Brazil)

Wireless Connectivity for Remote and Arctic Areas - Food for Thought
Pekka Pirinen and Harri Saarnisaari (University of Oulu, Finland); Jaap van de Beek (Luleå University of Technology, Sweden); Marja Matinmikko-Blue (University of Oulu, Finland); Rickard Nilsson (Luleå University of Technology, Sweden); Matti Latva-aho (University of Oulu, Finland)

TUESDAY, 13:3O - 15:OO | ROOM: IT1O6

WSO1: Technical Session III

Performance of WIBA Energy Detector in Rural and Remote Area Channel
Johanna Vartiainen (Centre for Wireless Communications, Finland); Marja Matinmikko-Blue (University of Oulu, Finland); Alexandre M Pessoa (Federal University of Ceará - UFC, Brazil); Heikki Karvonen (University of Oulu, Centre for Wireless Communications, Finland); Luciano Leonel Mendes (Inatel, Brazil); Carlos Filipe Moreira e Silva (Federal University of Ceará, Brazil)

Spectrum Sharing and Operator Model for Rural and Remote Area Networks
Johanna Vartiainen (Centre for Wireless Communications, Finland); Marja Matinmikko-Blue and Heikki Karvonen (University of Oulu, Centre for Wireless Communications, Finland); Luciano Leonel Mendes (Inatel, Brazil)

A Tool for Developing Collaborative Sensing and Cognitive MAC Layer Solutions for 5G in Rural Areas
Gabriel C Ferreira and Priscila Solis (Universidade de Brasilia, Brazil); Marcos Fagundes Caetano (University of Brasilia, Brazil); Eduardo Adilio Pelinson Alchieri(Universidade de Brasília, Brazil); Johanna Vartiainen (Centre for Wireless Communications, Finland); Heikki Karvonen and Marja Matinmikko-Blue (University of Oulu, Centre for Wireless Communications, Finland); Jorge Seki (Unicamp & Fundação CPqD, Brazil)

A Recurrent Neural Network MAC Protocol Towards to Opportunistic Communication in Wireless Networks
Marcos Fagundes Caetano, Mariana Makiuchi, Silas Fernandes, Marcus V. Lamar and Jacir Luiz Bordim (University of Brasilia, Brazil); Priscila Solis (Universidade de Brasilia, Brazil)

WSO2: Workshop on Error-Correction Codes for Future Wireless Communication Networks

TUESDAY, 9:00 - 12:30 | ROOM: IT138

TUESDAY, 9:00 - 10:30 | ROOM: IT138

A Distributed Digital Codec for Jointly Sparse Correlated Signals
Xuechen Chen and Fan Li (Sun Yat-Sen University, P.R. China); Xingcheng Liu (Sun Yat-sen University & Xinhua College of SYSU, P.R. China)

Optimization of Protograph LDPC Codes based on High-Level Energy Models
Mohamed Yaoumi (IMT Atlantique, France); François Leduc-Primeau (Polytechnique Montreal, Canada & IMT Atlantique, France); Elsa Dupraz and Frederic Guilloud (IMT Atlantique, France)

Neighbor-Cell-Information Based Detection for LDPC Coded MLC NAND Flash Memory
Yanfu Li, Guojun Han, Zishuai Peng, Guofa Cai and Yi Fang (Guangdong University of Technology, P.R. China)

TUESDAY, 11:00 - 12:30 | ROOM: IT138

Polar-coded Chaos-based Multi-access Transmission System
Jianhui Ou, Zhaopeng Xie, Jiayue Chen and Pingping Chen (Fuzhou University, P.R. China)

Decoding Wave Velocity Analysis for SC-LDPC Ensembles on BMS Channels using Interpolation
Kexin Zhang (Shanghai University, P.R. China); Mingjun Dai (Shenzhen University, P.R. China); Dan Zeng and Zhonghao Zhang (Shanghai University, P.R. China)

Low-delay Software Design for HEVC CABAC Encoder
Deshan Zhuo Deshan (Fuzhou University, P.R. China)

WSO3 - Full Duplex Radio Communications for 5G and Beyond (FDB5G)

TUESDAY, 13:30-17:00 | ROOM: IT138

TUESDAY, 13:30 - 14:15 | ROOM: IT138

WSO3: Keynote

Sriram Vishwanath, University of Texas, Austin, USA

Prof. Sriram Vishwanath received the B. Tech. degree in Electrical Engineering from the Indian Institute of Technology (IIT), Madras, India in 1998, the M.S. degree in Electrical Engineering from California Institute of Technology (Caltech), Pasadena USA in 1999, and the Ph.D. degree in Electrical Engineering from Stanford University, Stanford, CA USA in 2003. He is currently a Professor in the Department of Electrical and Computer Engineering at The University of Texas, Austin, USA. His research interests include network information theory, wireless systems and mobile systems. He has served on the board of directors and/or co-founded several startups, including M87 Inc., Lynx Laboratories Inc., Azul Mobile Inc., Agilux Systems Inc., Accordion Health Inc., Sunfish Inc., and GenXComm; and was the 2014 University of Texas Entrepreneur of the Year. Sriram received the NSF CAREER award in 2005, the ARO Young Investigator Award in 2008, and the Longhorn Entrepreneurship Agency 2014 Entrepreneur of the Year award. He is the co-recipient of the 2005 IEEE Joint Information Theory Society and Communications Society best paper award. He has served as the general chair of IEEE Wireless Network Coding Conference (WiNC) in 2010, the general co-chair of the IEEE Information Theory School in 2011, the local arrangements chair of ISIT 2010 and the guest editor-in-chief of an IEEE Transactions on Information Theory special issue on interference networks.

TUESDAY, 14:45 - 15:00 | ROOM: IT138

WSO3: Technical Session I

Towards Massive MIMO In-Band Full Duplex Radio
Patrick Rosson (Cea Leti Minatec, France); Chandan Kumar Sheemar (EURECOM, France); Neharika Valecha (Eurécom, France); Dirk Slock (EURECOM, France)

An Analysis on Caching in Full-Duplex Enabled mmWave IAB HetNets
Sudip Biswas (University of Edinburgh, United Kingdom (Great Britain)); Tong Zhang and Tharmalingam Ratnarajah (The University of Edinburgh, United Kingdom (Great Britain))

TUESDAY, 15:30 - 17:00 | ROOM: IT138

WSO3: Technical Session II

Characteristic Mode Theory to Enhance the Isolation Level for Full-Duplex 5G in Mobile Handsets
Mohammad Fakih (Université Côte d'Azur & University of Saint Joseph, France); Aliou Diallo (Université Côte d'Azur- LEAT-CNRS, France); Philippe Le Thuc (Université Côte d'Azur, CNRS, LEAT, France); Robert Staraj (Universite Cote d'Azur, CNRS, LEAT, France); Oumar Mourad and Elias Rachid (USJ, Lebanon)

Beamformer design for Full-Duplex Amplify-and-Forward Millimeter Wave relays
Roberto López-Valcarce (Universidad de Vigo, Spain); Nuria González-Prelcic (The University of Texas at Austin, USA)

Full-duplex Multi-cell Networks with Interference Alignment
Huasen He, Paula Aquilina and Tharmalingam Ratnarajah (The University of Edinburgh, United Kingdom (Great Britain))

Multi-Stage/Hybrid BF under Limited Dynamic Range for OFDM FD Backhaul with MIMO SI Nulling
Christo Kurisummoottil Thomas, Chandan Kumar Sheemar and Dirk Slock (EURECOM, France)

TUESDAY, 15:30 - 17:00 | CITY HALL

Welcome Reception

TECHNICAL SESSIONS

WEDNESDAY AUGUST 28

THURSDAY AUGUST 29

FRIDAY AUGUST 30

WEDNESDAY, 8:45 - 9:00 | ROOM: IT116

Opening Session

WEDNESDAY, 9:00 - 10:00 | ROOM: IT116

Keynote: Physical Layer for Next Generation Wireless: Lessons Learned from 5G and Directions for 6G

Erik G. Larsson, Linköping University, Sweden

Erik G. Larsson is Professor at Linköping University, Sweden, and a Fellow of the IEEE. He co-authored Fundamentals of Massive MIMO (Cambridge, 2016) and Space-Time Block Coding for Wireless Communications (Cambridge, 2003). Recent service includes membership of the IEEE Signal Processing Society Awards Board (2017-2019), the IEEE Signal Processing Magazine editorial board (2018-2020), and the IEEE Transactions on Wireless Communications steering committee (2019-2022). He received the IEEE Signal Processing Magazine Best Column Award twice, in 2012 and 2014, the IEEE ComSoc Stephen O. Rice Prize in Communications Theory 2015, the IEEE ComSoc Leonard G. Abraham Prize 2017 and the IEEE ComSoc Best Tutorial Paper Award 2018.

10:00 - 10:30

Coffee Break

WEDNESDAY, 10:30 - 12:00 | ROOM: IT113

PSO1: Poster Session

WEDNESDAY, 10:30 - 12:00 | ROOM: IT138

SSO1: Multi-Link and Multi-Connectivity Solutions for Ultra Reliable Communications

Matching-Based Resource Allocation for Multi-User URLLC in Unlicensed Frequency Bands
Tom Hößler (TU Dresden & Barkhausen Institut, Germany); Meryem Simsek (International Computer Science Institute, USA); Gerhard P. Fettweis (Technische Universität Dresden, Germany)

Reliability and Error Burst Length Analysis of Wireless Multi-Connectivity
Jimmy J Nielsen, Israel Leyva-Mayorga and Petar Popovski (Aalborg University, Denmark)

Dynamic Multi-Connectivity Activation for Ultra-Reliable and Low-Latency Communication
Nurul Huda Mahmood and Hirley Alves (University of Oulu, Finland)

WEDNESDAY, 10:30 - 12:00 | ROOM: IT105

TSO1: Modern Waveforms, Modulation and Coding I

Orthogonalization of Parallel Sequence Spread Spectrum Codes for High Order Modulation
Wolfgang Endemann, Ruediger Kays and Elias Peter (TU Dortmund University, Germany)

An Overlap-Windowed-OQAM-DFTs-OFDM Scheme to Achieve Low PAPR and ACLP
Mizuki Imai, Takuya Okamoto, Takahiro Okano, Masahiro Umehira and Xiaoyan Wang (Ibaraki University, Japan)

Look-Up Table Based Implementation of Ultra-Low Complexity Narrowband OFDM Transmitters
AlaaEddin Loulou and Juha Yli-Kaakinen (Tampere University of Technology, Finland); Toni A Levanen (Tampere University, Finland); Vesa K Lehtinen (Tampere University of Technology, Finland); Frank Schaich and Thorsten Wild (Nokia Bell Labs, Germany); Markku K. Renfors and Mikko Valkama (Tampere University of Technology, Finland)

HPA Linearization for FBMC-OQAM Signals with Fast Convergence-Digital Predistortion
Sri Satish Krishna Chaitanya Bulusu and Prasanna Maddila (Mahindra Ecole Centrale, India); Daniel Roviras (Cnam, France); Hmaied Shaiek (CNAM, France)

QSM based NOMA for Multi-User Wireless Communication
Rahmat Faddli Siregar, Nandana Rajatheva and Matti Latva-aho (University of Oulu, Finland)

WEDNESDAY, 10:30 - 12:00 | ROOM: IT106

TSO2: Non-Orthogonal Multiple Access

Grouped NOMA Multicast Transmission for F-RAN With Wireless Fronthaul and Edge Caching
Junbeom Kim and Daesung Yu (Chonbuk National University, Korea); Sung-Hyun Moon (ETRI, Korea); Seok-Hwan Park (Chonbuk National University, Korea)

Performance Analysis Framework for NOMA Systems over Non-Identical Nakagami-m Fading Channels
Anderson Tregancini, Jr (São Paulo State University (UNESP), Brazil); Carlos Héracles Morais de Lima (Universirty of Oulu, Finland); Edgar Eduardo Benitez Olivo (São Paulo State University (UNESP), Brazil); Hirley Alves (University of Oulu, Finland)

On Gaussian Approximation Algorithms for SCMA
Xiaotian Fu, Mylene Pischella and Didier Le Ruyet (CNAM, France)

On the Performance of NOMA Power Control Scheme in Cognitive Radio Networks
Pablo Palacios (Universidad de Chile, Chile); Samuel Montejo (Universidad Tecnológica Metropolitana, Chile); Milton Roman (Universidad de Las Americas, Ecuador); Samuel Baraldi (National Institute of Telecommunications, Brazil); Cesar Azurdia (Universidad de Chile, Chile)

Outage Probability of Ultra High Frequency and Millimeter Wave Based HetNets with NOMA
Pragya Swami (Indian Institute of Technology Indore, India); Mukesh Kumar Mishra (Samrat Ashok Technological Institute, Vidisha, India); Vimal Bhatia (Indian Institute of Technology Indore, India); Tharmalingam Ratnarajah (The University of Edinburgh, United Kingdom (Great Britain))

WEDNESDAY, 10:30 - 12:00 | ROOM: IT112

TSO3: Machine Learning for Communications

RSSI-based Methods for LOS/NLOS Channel Identification in Indoor Scenarios
Fabrizio Carpi, Luca Davoli, Marco Martalò and Antonio Cilfone (University of Parma, Italy); Yingjie Yu and Yi Wang (Huawei Technologies Co., Ltd, P.R. China); Gianluigi Ferrari (University of Parma, Italy)

Deep Learning Assisted Rate Adaptation in Spatial Modulation Links
Anxo Tato (AtlanTTic Research Center, University of Vigo, Spain); Carlos Mosquera (University of Vigo, Spain)

Neural Network Based Successive Cancellation Decoding Algorithm for Polar Codes in URLLC
Ruiyi Zhang, Fangfang Liu, Zhimin Zeng, Shulun Zhao and Qingqing Shang (Beijing University of Posts and Telecommunications, P.R. China)

Multi-Armed Bandit Learning for Full-Duplex UAV Relay Positioning for Vehicular Communications
Pouya Pourbaba and Samad Ali (University of Oulu, Finland); Kapuruhamy Badalge Shashika Manosha (Centre for Wireless Communications, University of Oulu, Finland); Nandana Rajatheva (University of Oulu, Finland)

WEDNESDAY, 12:00-13:30 LUNCH BREAK

Real Time VR Observation Demo: Operation Room Powered by 5G and AR

Demo set up hosted by 6G Flagship (original version created with Nokia) **at the conference lobby** during Wednesday afternoon.

WEDNESDAY, 13:30 - 14:30 | ROOM: IT116

Keynote: When Quantum-Signal Processing & Communications Meet

Lajos Hanzo, University of Southampton

Lajos Hanzo is a Foreign Member of the Hungarian Academy of Science, Fellow of the Royal Academy of Engineering, of the IEEE, of the IET and of the EURASIP. He is also a Wolfson Fellow of the Royal Society. During his 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 ECS, University of Southampton, UK, where he holds the Chair in Telecommunications.

WEDNESDAY, 14:30 - 16:00 | ROOM: IT138

SSO3: Multiple Antenna Systems with Low-Precision Hardware for 5G and Beyond

Channel Estimation under Hardware Impairments: Bayesian Methods versus Deep Learning
Özlem Tuğfe Demir and Emil Björnson (Linköping University, Sweden)

Energy Efficient Downlink Massive MIMO: Is 1-bit Quantization a Solution?
Inbar Fijalkow (ETIS / ENSEA - University Cergy-Pontoise - CNRS, France); Alexandre Marcastel (ETIS / ENSEA - University Cergy Pontoise - CNRS, France); Lee Swindlehurst (University of California at Irvine, USA)

Millimeter Wave Hybrid Beamforming with Rotman Lens: Performance with Hardware Imperfections
Muhammad Ali Babar Abbasi (Queen›s University Belfast & The Institute of Electronics, Communications and Information Technology (ECIT), United Kingdom (Great Britain)); Vincent Fusco and Michail Matthaiou (Queen›s University Belfast, United Kingdom (Great Britain))

On the Performance of Distortion-Aware Linear Receivers in Uplink Massive MIMO Systems
Sina Rezaei Aghdam and Thomas Eriksson (Chalmers University of Technology, Sweden)

WEDNESDAY, 14:30 - 16:00 | ROOM: IT113

SSO9: UAV for Future Wireless Communications

Drone Base Station Positioning and Power Allocation using Reinforcement Learning
Rafaela de Paula Parisotto and Richard Demo Demo Souza (Federal University of Santa Catarina, Brazil); Paulo Valente Klaine and Joao Nadas (University of Glasgow, United Kingdom (Great Britain)); Glauber Brante (Federal University of Technology - Paraná (UTFPR), Brazil); Muhammad Ali Imran (University of Glasgow, United Kingdom (Great Britain))

A Performance Evaluation Tool for Drone Communications in 4G Cellular Networks
Christian Raffelsberger and Raheeb Muzaffar (Lakeside Labs GmbH, Austria); Christian Bettstetter (University of Klagenfurt, Austria)

Risk assessment of SDR-based attacks with UAVs
Frédéric Le Roy (ENSTA Bretagne, France); Christian Roland (Université de Bretagne Sud & Lab-STICC, France); Denis Le Jeune (ENSTA Bretagne, France); Jean-Philippe Diguet (Lab-STICC / CNRS, France)

Efficiency of MQTT Based Platform for UAV Controlling
Christian Mailer (Universidade Federal de Santa Catarina, Brazil); Adao Boava (Universidade Federal de Santa Catarina & UFSC, Brazil); Alex Pinto (UFSC, Brazil); Kalinka Branco (USP - University of São Paulo, Brazil)

Opportunities for Autonomous UAV in Harsh Environments
Rodrigo La Scalea (University of São Paulo, Brazil); Mariana Rodrigues (ICMC/USP, Brazil); Diana Pamela Moya Osorio (Federal University of São Carlos, Brazil); Carlos Héracles Morais de Lima (Universirty of Oulu, Finland); Richard Demo Souza (Federal University of Santa Catarina, Brazil); Hirley Alves (University of Oulu, Finland); Kalinka Branco (USP - University of São Paulo, Brazil)

WEDNESDAY, 14:30 - 16:00 | ROOM: IT105

TSO4: Radio Resource Management and Networking

Interference Measurement Methods in 5G NR: Principles and Performance
Hesham Elgendi and Mikko Mäenpää (Wireless System Engineering Finland Ltd., Finland); Toni A Levanen (Tampere University, Finland); Tero Ihalainen (Nokia Bell Labs, Finland); Sari Nielsen (Nokia, Finland); Mikko Valkama (Tampere University, Finland)

Complexity Reduction in Multicast Beamforming for D2D Assisted Coded Caching
Hamidreza Bakhshzad Mahmoodi, Jarkko Kaleva and Antti Tölli (University of Oulu, Finland)

On the Performance of Alternative 5G Micro-Operator Deployments in 3.6 GHz and 26 GHz Bands
Kapuruhamy Badalge Shashika Manosha (Centre for Wireless Communications, University of Oulu, Finland); Kimmo Hiltunen (Ericsson Research, Oy L M Ericsson Ab, Finland); Marja Matinmikko-Blue (University of Oulu, Centre for Wireless Communications, Finland); Matti Latva-aho (UoOulu, Finland)

Resource Virtualization with Edge Caching and Latency Constraint for Local B5G Operator
Tachporn Sanguanpuak (University of Oulu, Finland); Dusit Niyato (Nanyang Technological University, Singapore); Nandana Rajatheva (University of Oulu, Finland); Mehdi Bennis (Centre of Wireless Communications, University of Oulu, Finland); Matti Latva-aho (UoOulu, Finland)

WEDNESDAY, 14:30 - 16:00 | ROOM: IT106

TSO5: Wireless Communications for Moving Objects

Flight Time Minimization via UAV's Trajectory Design for Ground Sensor Data Collection
Jiaying Zong, Chao Shen and Jing Cheng (Beijing Jiaotong University, P.R. China); Jie Gong (Sun Yat-sen University, P.R. China); Tsung-Hui Chang (The Chinese University of Hong Kong, Shenzhen, P.R. China); Lei Chen (University of Birmingham, United Kingdom (Great Britain)); Bo Ai (Beijing Jiaotong University, P.R. China)

Unscented Kalman Filter Based Beam Tracking for UAV-enabled Millimeter Wave Massive MIMO Systems
Yao Ge, Zhimin Zeng and Tiankui Zhang (Beijing University of Posts and Telecommunications, P.R. China); Yan Sun (Queen Mary University, United Kingdom (Great Britain))

Prediction of Packet Inter-Reception Time for Platooning using Conditional Exponential Distribution
Guillaume Jornod (Volkswagen AG & TU Braunschweig, Germany); Ahmad El Assaad (Volkswagen, Germany); Andreas Kwoczek (Volkswagen AG, Germany); Thomas Kürner (Technische Universität Braunschweig, Germany)

On the Feasibility of Remote Driving Application over Dense 5G Roadside Networks
Umar Saeed and Jyri Hämäläinen (Aalto University, Finland); Mario Garcia-Lozano (Universitat Politècnica de Catalunya, Spain); David Gonzalez G. (Continental Automotive, Germany)

Target Detection in Joint Frequency Modulated Continuous Wave (FMCW) Radar-Communication System
Saumya Dwivedi (Barkhausen Institut gGmbH, Germany); Andre Noll Barreto (Barkhausen Institut gGmbH, Germany & Universidade de Brasilia, Brazil); Padmanava Sen (Research Group Leader, Barkhausen Institut gGmbH, Germany); Gerhard Fettweis (Barkhausen Institut, Germany)

WEDNESDAY, 14:30 - 16:00 | ROOM: IT112

TSO6: MIMO and Massive MIMO Systems

Hybrid Precoder Design for mmWave Massive MIMO with Low-Resolution Phase Shifters
Yipu Yuan (Quanzhou Normal University, P.R. China); Li-Hsin Lee and Jung-Lang Yu (Fu Jen Catholic University, Taiwan); Biling Zhang (Beijing University of Posts and Telecommunications, P.R. China)

Buffer-Aided Max-Link Relay Selection for Two-Way Cooperative Multi-Antenna Systems
Flavio Duarte (Centre for Telecommunications Studies (CETUC), Pontifical Catholic University of Rio de Janeiro, Brazil); Rodrigo C. de Lamare (Pontifical Catholic University of Rio de Janeiro & University of York, Brazil)

Channel Estimation Algorithms for Hybrid Antenna Arrays: Performance and Complexity
Visa Tapio, Mubarak Aminu, Janne Lehtomäki and Markku Juntti (University of Oulu, Finland)

Multi-User MIMO Max-Min User Rate via Weighted MSE Balancing
Imène Ghamnia (Eurecom & Orange, France); Dirk Slock (EURECOM, France); Yi Yuan-Wu (Orange Labs, France)

Efficient Algorithms for Sum Rate Maximization in Fronthaul-Constrained C-RANs
Kien-Giang Nguyen and Quang-Doanh Vu (University of Oulu, Finland); Le-Nam Tran (University College Dublin, Ireland); Markku Juntti (University of Oulu, Finland)

WEDNESDAY, 16:00 - 16:30 | COFFEE BREAK

WEDNESDAY, 16:30 - 18:00 | ROOM: IT116

Panel 1: 6G

Abstract: *Our future society will be increasingly digitised, hyper-connected and globally data-driven. Many widely anticipated future services, including eHealth and autonomous vehicles, will be critically dependent on instant, virtually unlimited wireless connectivity. Mobile communication technologies are expected to progress far beyond anything seen so far in wireless-enabled applications, making everyday lives smoother and safer and dramatically improving the efficiency of businesses.*
As 5G research is maturing towards a global standard, the research community must focus on the development of beyond-5G solutions and 2030 era, i.e. 6G. It is not clear yet what 6G will entail. It will include relevant technologies considered too immature for 5G or which are outside the defined scope of 5G. More specifically, the way in which data are collected, processed, transmitted and consumed within the wireless network will be a key driver for 6G. This panel is focusing on discussing the key research drivers, most promising technical enablers as well as needs from various application for 6G. The key questions are: what frequency bands we should look at, what are technical targets for key performance indicators and what other KPIs would be needed for the future global sustainability goals.

Moderator

Prof. Latva-aho, Director of 6G Flagship, University of Oulu Finland

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 is Professor of Digital Transmission Techniques at the University of Oulu. He serves as Academy of Finland Professor in 2017 – 2022. His research interests are related to mobile communication systems and currently his group focuses on 5G and beyond systems research. Prof. Latva-aho is Director for 6G Wireless Flagship in Finland (www.6genesis.org) in 2018 – 2026. Prof. Latva-aho has published 350+ conference or journal papers in the field of wireless communications. He received Nokia Foundation Award in 2015 for his achievements in mobile communications research.

Panelists

Mikko Uusitalo, Head of Research Department Wireless Advanced Technologies, Nokia Bell Labs, Finland.

Mikko Uusitalo is Head of Research Department Wireless Advanced Technologies at Nokia Bell Labs Finland. 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 is a founding member of the CELTIC EUREKA and WWRF, the latter one he chaired for 2004-2006. Mikko is a WWRF Fellow. Mikko has about 50 granted patents or patent families.

Janne Peisa, Ericsson

Janne Peisa is responsible for coordinating Ericsson's research on 5G Evolution and Beyond 5G activities. He has been working at Ericsson in the research and development of 3G, 4G and 5G systems since 1998. Previously, he has coordinated Ericsson's radio-access network standardization activities in 3GPP, and lead Ericsson Research 5G program. In 2001, he received the Ericsson Inventor of the Year award. He has authored several publications and patents and holds both an M.SC. and a Ph.D. from the University of Helsinki, Finland.

Prof. Kari Leppänen, 6G Flagship, University of Oulu

Kari Leppänen received the M.Sc. and Ph.D. degrees from Helsinki University of Technology, Finland, in 1992 and 1995, respectively, majoring in space technology and radio engineering. He has worked in National Radio Astronomy Observatory, USA, Helsinki University of Technology, Finland, Joint Institute for VLBI in Europe, The Netherlands, Nokia Research Center, Finland, and Huawei Finland. Currently he holds a position at Oulu University and is also the CEO of his own technology start-up. His research interests include wireless autonomous systems, ultra-dense wireless networks with sensing capabilities and radio positioning.

Jaap van de Beek, IEEE Fellow, Luleå University of Technology, Sweden

Jaap van de Beek is chaired professor of Signal Processing with Luleå University of Technology, Sweden, and a Fellow of the IEEE. Prior to returning to academia in 2013, he spent over two decades in industry, in telecommunications research labs with Telia Research, Nokia Networks, and for more than twelve years with Huawei Technologies. In different roles he has been involved in three generations of mobile cellular communications systems. He developed base station receiver algorithms for GSM evolution systems. He was among those pioneering OFDM as an access scheme for cellular radio in a standard proposal for the third-generation systems in 1997, and while with Huawei, he has been contributing to the preparation and specification of 3GPP's fourth generation LTE standard, for which he holds a number of essential patents. More recently, he has been developing methods that efficiently reduce spectral interference of radio transmitters, work for which he received the IEEE Communications Society Heinrich Hertz award. Since 2012, Jaap engages in improving Internet access, wireless network connectivity and cellular radio coverage in rural and remote regions.

WEDNESDAY, 19:00- 22:30 | MAIKKULA MANSION

Banquet Dinner

THURSDAY 29 AUGUST

THURSDAY, 9:OO - 1O:OO | ROOM: IT116

Keynote: Three Stories on IoT (Internet-of-Things) Connectivity: Ultra-Reliability, Massiveness, and Blockchains

Petar Popovski, Aalborg University, Denmark

Abstract: *The future wireless landscape will feature multiple types of connectivity for the Internet of Things (IoT). The two generic IoT classes associated with 5G are Ultra-Reliable Low-Latency Communication (URLLC), and massive Machine Type Communication (mMTC). However, this initial classification undergoes a revision to accommodate new types of requirements, such as broadband transmissions or trusted data exchanges. This talk will speak about three different aspects of IoT connectivity. The first story is related to mission-critical IoT and explains why ultra-reliability is a feature that must be treated with the tools of statistical machine learning. The second story is related to massive IoT connectivity, where we revise the common assumption used in random access protocols, according to which the activation and the data of each IoT device is independent from the other devices. It is shown how massive IoT can be transformed into an ultra-reliable system when the devices transmit correlated data. The third story is dedicated to the challenges that occur when the autonomous interactions among the IoT devices are powered by distributed ledger technology (DLT), blockchain, and smart contracts. It is shown how blockchains transform the IoT traffic patterns, as well as what are the challenges that the combination blockchain-IoT poses to the communication architecture.*

Petar Popovski is a Professor of Wireless Communications at Aalborg University, Fellow of the IEEE and a Visiting Excellence Chair at the University of Bremen. He received his Dipl.-Ing and Magist.-Ing. degrees in communication engineering from the University of Sts. Cyril and Methodius in Skopje and the Ph.D. degree from Aalborg University in 2OO5. He has over 3OO publications in journals, conference proceedings, and edited books. He is featured in the list of Highly Cited Researchers 2O18, compiled by Web of Science. He holds over 3O patents and patent applications. He received an ERC Consolidator Grant (2O15), the Danish Elite Researcher award (2O16), IEEE Fred W. Ellersick prize (2O16) and IEEE Stephen O. Rice prize (2O18). He is currently a Member at Large at the Board of Governors in IEEE Communication Society. Prof. Popovski is a Steering Committee Member of IEEE SmartGridComm and IEEE TRANSACTIONS ON GREEN COMMUNICATIONS AND NETWORKING. He previously served as a Steering Committee Member of the IEEE INTERNET OF THINGS JOURNAL. He is currently an Area Editor of the IEEE TRANSACTIONS ON WIRELESS COMMUNICATIONS. Prof. Popovski is the General Chair for IEEE SmartGridComm 2O18 and IEEE Communication Theory Workshop 2O19. His research interests are in the area of wireless communication and communication theory.

THURSDAY, 1O:OO-1O:3O COFFEE BREAK

THURSDAY, 1O:3O - 12:OO | ROOM: IT1O5

SSO4: Localization and Navigation for Future Wireless Networks

Positioning and Tracking of High-speed Trains with Non-linear State Model for 5G and Beyond Systems
Jukka Talvitie, Toni A Levanen and Mike Koivisto (Tampere University, Finland); Mikko Valkama (Tampere University of Technology, Finland)

Collaborative Positioning Mechanism Using Bayesian Probabilistic Models for Industry Verticals
Carlos Héracles Morais de Lima (Universirty of Oulu, Finland); Jani Saloranta and Matti Latva-aho (University of Oulu, Finland)

Overview of Positioning in 5G New Radio
Ryan Keating (Nokia Bell Labs, USA); Mikko Säily, Jari Hulkkonen and Juha Karjalainen (Nokia Bell Labs, Finland)

THURSDAY, 1O:3O - 12:OO | ROOM: IT138

SSO8: RF Solutions Towards 5G and Beyond

Digital Predistortion Concepts for Linearization of mmW Phased Array Transmitters
Nuutti Tervo (University of Oulu, Finland); Markku Jokinen (University of Oulu & Centre for Wireless Communications, Finland); Marko E Leinonen and Janne P Aikio (University of Oulu, Finland); Olli Kursu (Centre for Wireless Communications, University of Oulu, Finland); Timo Rahkonen and Aarno Pärssinen(University of Oulu, Finland)

5G Antenna Challenges and Opportunities
Ville Viikari (Aalto University & School of Electrical Engineering, Finland); Rasmus Luomaniemi and Juha Ala-Laurinaho (Aalto University, Finland); Joni Kurvinen (Aalto University School of Electrical Engineering, Finland); Henri Kähkönen, Anu Lehtovuori and Mikko Leino (Aalto University, Finland)

RF Front-End Impairments for Ultra-Broadband Wireless Communication above 2OO GHz
Pedro Rodriguez-Vazquez (Bergische Uuniversität Wwuppertal, Germany); Janusz Grzyb and Ullrich Pfeiffer (University of Wuppertal, Germany)

Decorrelation-based Piecewise Digital Predistortion: Operating Principle and RF Measurements
Mahmoud Abdelaziz (Zewail City of Science and Technology); Lauri Anttila, Alberto Brihuega, Markus Allén and Mikko Valkama (Tampere University, Finland)

THURSDAY, 1O:3O - 12:OO | ROOM: IT113

SS1O: Visible Light Communications for the Industry 4.O

Visible Light Positioning for Location-Based Services in Industry 4.O
Emily W Lam (Boston University, USA); Thomas DC Little (Boston University & NSF Smart Lighting ERC, USA)

Cooperative Transmission Scheme to Address Random Orientation and Blockage Events in VLC Systems
Borja Genovés Guzmán (Universidad Carlos III de Madrid, Spain); Alexis Alfredo Dowhuszko (Centre Tecnològic de Telecomunicacions de Catalunya (CTTC), Spain); Víctor P. Gil Jiménez (University Carlos III of Madrid, Spain); Ana Pérez-Neira (CTTC, Spain)

Characterization of the Visible Light Communications during the Construction of Tunnels
Máximo Morales-Céspedes and Ana Garcia Armada (Universidad Carlos III de Madrid, Spain)

LiFi Opportunities and Challenges
Harald Haas (The University of Edinburgh, United Kingdom (Great Britain)); Tezcan Cogalan (University of Edinburgh, United Kingdom (Great Britain))

THURSDAY, 1O:3O - 12:OO | ROOM: IT1O6

TSO7: Ultra-Reliable Low Latency Communications I

Full-Duplex Relay in High-Reliability Low-latency Networks Operating with Finite Blocklength Codes
Yulin Hu (RWTH Aachen University, Germany); Eduard Jorswieck (TU Dresden, Germany); Anke Schmeink (RWTH Aachen University, Germany)

Ultra-Reliable Multi-Connectivity With Negatively Dependent Fading Channels
Eduard Jorswieck and Pin-Hsun Lin (TU Dresden, Germany)

5G URLLC Performance Analysis of Dynamic Point Selection Multi User Resource Allocation
Ali Karimi (Aalborg University, Denmark); Klaus I. Pedersen (Nokia-Bell Labs, Aalborg University, Denmark); Preben Mogensen (Nokia−Bell Labs, Research Center Aalborg, Sweden)

Low-Latency Communication with Computational Complexity Constraints
Hasan Basri Celebi (KTH Royal Institude of Technology, Sweden); Antonios Pitarokoilis and Mikael Skoglund (KTH Royal Institute of Technology, Sweden)

Early Detection for Optimal-Latency Communications in Multi-Hop Links
Diego Barragán (Universidad Técnica Particular de Loja, Ecuador & École de Technologie Supérieure, Canada); Minh Au (Hydro-Québec's Research Institute (IREQ), Canada); Ghyslain Gagnon (ETS, Canada); Francois Gagnon and Pascal Giard (Ecole de Technologie Superieure, Canada)

THURSDAY, T1O:3O - 12:OO | ROOM: IT112

TSO8: Modern Waveforms, Modulation and Coding II

M-QAM Modulation Symbol-Level Precoding for Power Minimization: Closed-Form Solution
Jevgenij Krivochiza, Juan Duncan and Symeon Chatzinotas (University of Luxembourg, Luxembourg); Björn Ottersten (University of Luxembourg, Luxembourg)

USRP Testbed and Performance Analysis of New Reconfigurable LDACS In Presence of DME Interference
Niharika Agrawal (Indraprasth Institute of Information Technology, Delhi, India); Himani Joshi and Sumit Jagdish Darak (IIIT-Delhi, India); Faouzi Bader(CentraleSupélec, France)

PAPR Reduction of BF-OFDM Waveform Using DFT-Spread Technique
Khaled Tahkoubit (University of Sciences and Technology of Oran, Mohammed Boudiaf (USTO-MB) & Laboratory of Coding LACOSI, Algeria); Adda Ali Pacha(Universté des Sciences et de la Technologie Oran, Algeria); Hmaied Shaiek (CNAM, France); Daniel Roviras (Cnam, France)

On the Uplink Spectral Efficiency of the FBMC-OQAM Transceiver
Davide Mattera (Università degli Studi di Napoli Federico II, Italy); Mario Tanda (Università di Napoli Federico II, Italy)

GFDM-Based Cooperative Relaying Networks with Wireless Energy Harvesting
Dick Carrillo Melgarejo (Lappeenranta University of Technology, Finland); Jules M. Moualeu (University of the Witwatersrand, South Africa); Pedro Henrique Juliano Nardelli (Lappeenranta University of Technology & University of Oulu, Finland); Gustavo Fraidenraich (Unicamp & Communication Department, Brazil); Daniel Benevides da Costa (Federal University of Ceara (UFC) & Area: Telecommunications, Brazil)

THURSDAY, 12:OO-13:3O LUNCH BREAK

THURSDAY, 13:3O - 14:3O | ROOM: IT116

Keynote: 5G and the Future of Communications

Lauri Oksanen, Vice President for Research and Technology, Nokia

Lauri Oksanen is Vice President for Research and Technology in Nokia. He heads The Industry Standards Group in Nokia Bell Labs, responsible for all industry activities in Nokia. He started his industrial career 3O years ago in fiber optics in Nokia. Then Lauri moved to mobile networks where he has worked with all major wireless technologies from GSM to 5G. Lauri has worked in various advanced technology management positions covering fixed and wireless access, core, management and services, including also the HW and SW platforms and cloud and security technologies. Lauri has Master's and Licentiate degrees in Telecommunications from Helsinki University of Technology (now Aalto), where he also worked as a researcher before joining Nokia.

THURSDAY, 14:3O - 16:OO | ROOM: IT113

PSO2: Poster Session II

THURSDAY, 14:3O - 16:OO | ROOM: IT1O5

SSO2: Terahertz Wireless Communication for Beyond 5G

Performance Evaluation of the Initial Access Procedure in Wireless THz Systems
Alexandros-Apostolos A Boulogeorgos and Angeliki Alexiou (University of Piraeus, Greece)

D-Band Radio Solutions for Beyond 5G Reconfigurable Meshed Cellular Networks
Vladimir Ermolov (VTT Technical Research Centre of Finland, Finland); Mario Giovanni Luigi Frecassetti (NOKIA, Italy); Antti E. I. Lamminen (VTT Technical Research Centre of Finland, Finland); Pascal Roux (Nokia-Bell-Labs/III-V Lab, France); Jussi Säily (VTT Technical Research Centre of Finland, Finland); Juan F Sevillano and David del Río (CEIT and TECNUN, Spain)

Experimental Validation of Coherent DSP for Combined Fibre-Optical / Terahertz-Wireless Links
Colja Schubert (Fraunhofer Heinrich-Hertz-Institut, Germany); Robert Elschner (Fraunhofer Heinrich-Herz-Institut, Germany); Carlos Castro (Fraunhofer Heinrich Hertz Institute, Germany); Thomas Merkle (Fraunhofer IAF, Germany)

THURSDAY, 16:3O - 18:OO | ROOM: IT1O5

Wireless Communication Systems in the 24O GHz Band: Applications, Feasibility, and Challenges
Nebojsa Maletic (IHP - Leibniz-Institut fuer Innovative Mikroelektronik, Germany); Vladica Sark and Mohamed Hussein Eissa (IHP, Germany); Jesús Gutiérrez(IHP - Leibniz-Institut für Innovative Mikroelektronik, Germany); Eckhard Grass (IHP & Humboldt-University Berlin, Germany); Olivier Bouchet (Orange Labs, France)

LOS and NLOS Channel Models for Indoor 3OO GHz Communications
Joonas Kokkoniemi, Janne Lehtomäki and Markku Juntti (University of Oulu, Finland)

Time Domain Channel Model for the THz Band
Kazuhiro Tsujimura and Kenta Umebayashi (Tokyo University of Agriculture and Technology, Japan); Joonas Kokkoniemi and Janne Lehtomäki (University of Oulu, Finland)

THURSDAY, 14:3O - 16:OO | ROOM: IT138

SS11: Wearable and Implant Communication

Graphene-based Textile Ultra Wideband Antennas for Integrated and Wearable Applications
Isidoro Labiano, Akram Alomainy and Syeda Fizzah Jilani (Queen Mary University of London, United Kingdom (Great Britain)); Elif Ozden-Yenigun (Royal College of Art, United Kingdom (Great Britain)); Muhammed Said Ergoktas and Coskun Kocabas (University of Manchester, United Kingdom (Great Britain))

Remote Monitoring of Absorbable Cardiovascular Stents using Millimetre Waves
Hasan Abbas and Qammer H Abbasi (University of Glasgow, United Kingdom (Great Britain)); Lilia Aljihmani (Texas A&M University, Qatar); Younes Boudjemline and Ziyad Hijazi (Sidra Medicine, Qatar); Bilal Mansoor (Texas A&M University at Qatar, Qatar); Khalid A. Qaraqe (Texas A&M University at Qatar, USA)

AI-supported Health Coaching Model for Patients with Chronic Diseases
Dena Al-Thani and Mohammed Tahri Sqalli (Hamad Bin Khalifa University, Qatar)

THURSDAY, 16:3O - 18:OO | ROOM: IT138

In-Body Power Distribution for Abdominal Monitoring and Implant Communications Systems
Mariella Särestöniemi (Erkki Koiso-Kanttilan katu 1 & Center for Wireless Communication, University of Oulu, Finland); Carlos Pomalaza Raez (Purdue University, USA); Markus Berg (University of Oulu & Excellant LTd., Finland); Chaïmaâ Kissi (Ibn Tofail University & National School of Applied Sciences (ENSA), Morocco); Matti Hämäläinen and Jari Iinatti (University of Oulu, Finland)

Channel Prediction based Enhanced Throughput and Channel Aware MAC in SmartBAN Standard
Rida Khan (Tallinn University of Technology, Estonia & Istanbul Technical University, Turkey); Muhammad Mahtab Alam (Tallinn University of Technology, Estonia); Alar Kuusik (Tallinn University of Technology & Motionmon OU, Estonia)

Wireless Power Transfer for Implantable Biomedical Microelectronics Devices
Hadi Heidari, Qammer H Abbasi, Rami Ghannam and Mengyao Yuan (University of Glasgow, United Kingdom (Great Britain))

THURSDAY, 14:3O - 16:OO | ROOM: IT1O6

TSO9: Massive Machine-type Communications

Design and Performance of Unlicensed NB-IoT
Rongrong Sun (Beijing University of Posts and Telecommunications, P.R. China); Chang Wenting (University of Tsinghua, P.R. China); Salvatore Talarico (Intel Corporation, USA); Huaning Niu (Intel, USA); Hongwen Yang (Beijing University of Posts and Telecommunications, P.R. China)

Fixed Rate Statistical QoS Provisioning for Markovian Sources in Machine Type Communication
Fahad Qasmi (University of OULU, Finland); Mohammad Shehab, Hirley Alves and Matti Latva-aho (University of Oulu, Finland)

Feasibility of Alarm Events upon Smart Metering in LoRaWAN Networks
Francisco Candido, Filho (Federal University of Ceara, Brazil); Plinio Santini Dester (University of Campinas, Brazil); Elvis M. G. Stancanelli (Federal University of Ceará, Brazil); Paulo Cardieri (University of Campinas, Brazil)

On the System-level Performance Evaluation of Bluetooth 5 in IoT: Open Office Case Study
Behnam Badihi and Fayezeh Ghavimi (Aalto University, Finland); Riku Jäntti (Aalto University School of Electrical Engineering, Finland)

THURSDAY, 14:3O - 16:OO | ROOM: IT112

TS1O: Massive MIMO

Coordinated Beam Selection for Training Overhead Reduction in FDD Massive MIMO
Flavio Maschietti (Eurecom, France); Gabor Fodor (Ericsson Research & Royal Institute of Technology (KTH), Sweden); David Gesbert (Eurecom Institute, France); Paul de Kerret (EURECOM, France)

Enhanced Low-Complexity Matrix Inversion Method for Massive MIMO Systems
Yasser Naguib (Cairo univ, Egypt)

Aggressive RF Circuit Reduction Techniques in Millimeter Wave Cellular Systems
Muhammad Ali Babar Abbasi (Queen›s University Belfast & The Institute of Electronics, Communications and Information Technology (ECIT), United Kingdom (Great Britain)); Harsh Tataria (Lund University, Sweden); Vincent Fusco and Michail Matthaiou (Queen›s University Belfast, United Kingdom (Great Britain)); George C. Alexandropoulos (University of Athens, Greece)

Power Allocation for Multipair Massive MIMO FD Relay Systems with Low Resolution ADCs

Mengxue Tang (University of Sheffield, United Kingdom (Great Britain)); Mikko Vehkapera (Aalto University, Finland); Xiaoli Chu (University of Sheffield, United Kingdom (Great Britain)); Risto Wichman (Aalto University School of Electrical Engineering, Finland)

Low-Rank Tensor MMSE Equalization

Lucas N Ribeiro (Federal University of Ceará, Brazil); André de Almeida (Federal University of Ceará & Wireless Telecom Research Group - GTEL, Brazil); Joao Cesar Moura Mota (UFC, Brazil)

THURSDAY, 16:00-16:30 COFFEE BREAK

THURSDAY, 16:30 - 18:00 | ROOM: IT113

PSO3: Poster Session III

THURSDAY, 16:30 - 18:00 | ROOM: IT106

TS11: Modern Waveforms, Modulation and Coding III

BER Improvement Using the Better than Double-Jump 2 Pulse in OFDM Schemes Prone to Frequency Offset

David Zabala-Blanco (Universidad Católica del Maule, Chile); Cesar Azurdia (Universidad de Chile, Chile); Shaharyar Kamal (Air University Islamabad, Pakistan); Ali Dehghan Firoozabadi and Samuel Montejo-Sánchez (Universidad Tecnológica Metropolitana, Chile)

Bit Error Probability for Asynchronous Channel Access in Feedback-Less MTC with FBMC-OQAM

Maxim Penner (Leibniz Universität Hannover, Germany); Martin Fuhrwerk (RFmondial GmbH, Germany); Jürgen Peissig (Leibniz Universität Hannover, Germany)

Ergodic H-S/MRC Mutual Information

Zeliang Ou, Chongjun Ouyang, Pei Yang, Lu Zhang, Sheng Wu and Hongwen Yang (Beijing University of Posts and Telecommunications, P.R. China)

An Asymmetric Adaptive SCL Decoder Hardware for Ultra-Low-Error-Rate Polar Codes

Jiajie Tong and Huazi Zhang (Huawei Technologies, Co. Ltd., P.R. China); Lingchen Huang (Huawei Technologies, Co. Ltd, P.R. China); Xiaocheng Liu (Huawei Technologies, P.R. China); Jun Wang (Huawei Technologies Co. Ltd, P.R. China)

Non-Uniform Channel Polarization and Design of Rate-Compatible Polar Codes

Robert Mota Oliveira (PUC-RIO, Brazil); Rodrigo C. de Lamare (Pontifical Catholic University of Rio de Janeiro & University of York, Brazil)

THURSDAY, 16:30 - 18:00 | ROOM: IT112

TS12: mmWave Communications

Impact of Concrete Moisture on Radio Propagation: Fundamentals and Measurements of Concrete Samples

Ari Asp (Tampere University, Finland); Arto Hujanen (VTT Technical Research Centre of Finland, Finland); Ismo Huhtinen (VTT, Finland); Tuomo Hentilä, Jussa Pikkuvirta and Mikko Valkama (Tampere University, Finland)

Millimeter-Wave Channel Measurements at 28 GHz in Digital Fabrication Facilities

Dmitrii Solomitckii and Markus Allén (Tampere University, Finland); Davit Yolchyan and Hrayr Hovsepyan (National Instruments, Armenia); Mikko Valkama and Evgeny Kucheryavy (Tampere University, Finland)

Average Linearization of Phased Array Transmitters Under Random Amplitude and Phase Variations

Bilal Khan, Nuutti Tervo, Aarno Pärssinen and Markku Juntti (University of Oulu, Finland)

A Differential Reflection Type Phase Shifter Based on CPW Coupled-Line Coupler in 45nm CMOS SOI

Rana Azhar Shaheen, Timo Rahkonen, Rehman Akbar, Alok Sethi, Aarno Pärssinen and Janne P Aikio (University of Oulu, Finland)

A Fully Differential Single-Stage Four-way mmWave Power Combiner for Phased Array 5G Systems

Rana Azhar Shaheen, Timo Rahkonen, Rehman Akbar, Alok Sethi and Aarno Pärssinen (University of Oulu, Finland)

FRIDAY 30 AUGUST

FRIDAY, 9:00 - 10:30 | ROOM: IT138

SS12: Statistical Challenges of Wireless Powered Communications

Non-Linear Energy Harvesting Based Cooperative Spectrum Sharing Networks

Sourabh Solanki and Prabhat Kumar Upadhyay (Indian Institute of Technology Indore, India); Daniel Benevides da Costa (Federal University of Ceara (UFC) & Area: Telecommunications, Brazil); Haiyang Ding (School of Information and Communications, National University of Defense Technology & State Key Lab. of ISN, Xidian University, P.R. China); Jules M. Moualeu (University of the Witwatersrand, South Africa)

Green CR-NOMA: A New Interweave Energy Harvesting Transmission Scheme for Secondary Access

Nikolaos I. Miridakis (University of Piraeus, Greece & Jinan University, Zhuhai, P.R. China); Sultangali Arzykulov (Nazarbayev University, Kazakhstan); Theodoros Tsiftsis and Guanghua Yang (Jinan University, P.R. China); Galymzhan Nauryzbayev (Nazarbayev University, Kazakhstan)

On the Secrecy Capacity of a Full-Duplex Wirelessly Powered Communication System

Ivana Nikoloska and Nikola Zlatanov (Monash University, Australia); Zoran Hadzi-Velkov (Ss. Cyril and Methodius University in Skopje, Macedonia, the former Yugoslav Republic of); Rui Zhang (National University of Singapore, Singapore)

FRIDAY, 9:00 - 10:30 | ROOM: IT105

TS13: Compressive Sensing

Design of Sub-Nyquist Receiver for Sparse and Localized UWB Signals

Sanjeev Sharma (Monash University, Clayton Campus, Melbourne, Australia); Vimal Bhatia (Indian Institute of Technology Indore, India); Anubha Gupta(Indraprastha Institute of Information Technology Delhi, India); Kuntal Deka (IIT Goa, India)

Power Allocation for Distributed Compressive Sensing with 1-Bit Quantization over Noisy Channels

Jiguang He, Markus Leinonen and Kien-Giang Nguyen (University of Oulu, Finland); Yong Li (Chongqing University, P.R. China); Olli Silvén and Markku Juntti(University of Oulu, Finland)

Concatenated Beam- and Antenna-domain Layered Belief Propagation for Large MIMO Detection

Takumi Takahashi (Osaka University, Japan); Antti Tölli (University of Oulu, Finland); Shinsuke Ibi (Doshisha University, Japan); Seiichi Sampei (Osaka University, Japan)

FRIDAY, 9:00 - 10:30 | ROOM: IT106

TS14: Ultra-Reliable Low Latency Communications II

Strategies to Meet the Configured Repetitions in URLLC Uplink Grant-Free Transmission

Trung-Kien Le (EURECOM, France); Umer Salim (TCL, France); Florian Kaltenberger (Eurecom, France)

An Efficient Model for Mobile Network Slice Embedding under Resource Uncertainty

Andrea Fendt (Nokia Bell Labs & University of Augsburg, Germany); Christian Mannweiler (Nokia Bell Labs, Germany); Lars Christoph Schmelz (Nokia, Germany); Bernhard Bauer (University of Augsburg, Germany)

Uplink Grant-Free Access Solutions for URLLC services in 5G New Radio

Nurul Huda Mahmood (University of Oulu, Finland); Renato Barbosa Abreu (Aalborg University, Denmark); Ronald Boehnke (Huawei European Research Center, Germany); Martin Schubert (Huawei Technologies Duesseldorf GmbH, Munich Office, Germany); Gilberto Berardinelli (Aalborg University, Denmark); Thomas Haaning Jacobsen (Nokia Bell Labs & Device / Modems Standardization Research Expert, Denmark)

FRIDAY, 9:00 - 10:30 | ROOM: IT112

TS15: Wireless Networking

Worst Case Analysis of Age of Information in a Shared-Access Channel

Mohammad Moltafet, Markus Leinonen and Marian Codreanu (University of Oulu, Finland)

Cake-Cutting Approach for Privacy-Enhanced Base Station Sharing in a Linear Model of User Assignment

David Csercsik (Pázmány Péter Catholic University, Faculty of Information Technology and Bionics, Hungary); Balázs Sziklai (Centre for Economic and Regional Studies of the Hungarian Academy of Sciences & Corvinus University of Budapest, Hungary); Sándor Imre (Technical University of Budapest, Hungary)

Traversing Virtual Network Functions from the Edge to the Core: An End-to-End Performance Analysis

Emmanouil Fountoulakis (Linköping University, Sweden); Qi Liao (Nokia Bell Labs, Germany); Manuel Stein (NOKIA Bell Labs, Germany); Nikolaos Pappas(Linköping University, Sweden)

A Generic Clique Based Distributed Caching Approach for Wireless IoT Networks

Mustafa Najmuldeen and Sedat Gormus (Karadeniz Technical University, Turkey)

FRIDAY, 9:00 - 10:30 | ROOM: IT113

TS16: Energy Harvesting and Backscatter Communications

Physical Layer Security for Dual-hop SWIPT-Enabled CR Networks

Mounia Bouabdellah (Mohammed V University, Morocco); Faissal El Bouanani (ENSIAS, Mohammed V University in Rabat, Morocco); Paschalis C. Sofotasios(Khalifa University & Tampere University, Finland); Daniel Benevides da Costa (Federal University of Ceara (UFC) & Area: Telecommunications, Brazil); Kahtan Mezher (Khalifa University, United Arab Emirates); Hussain Ben-azza (ENSAM-Meknes, Morocco); Sami Muhaidat (Khalifa University, United Arab Emirates); George K. Karagiannidis (Aristotle University of Thessaloniki, Greece)

Low-Complexity Sequential Information and Energy Reception

Sotiris A. Tegos and Panagiotis D. Diamantoulakis (Aristotle University of Thessaloniki, Greece); Koralia N. Pappi (Aristotle University of Thessaloniki & Intracom S.A. Telecom Solutions, Greece); Paschalis C. Sofotasios (Khalifa University & Tampere University, Finland); Sami Muhaidat (Khalifa University, United Arab Emirates); George K. Karagiannidis (Aristotle University of Thessaloniki, Greece)

NOMA Enhanced Backscatter Communication for Green IoT Networks

Shah Zeb, Qamar Abbas and Syed Ali Hassan (National University of Sciences and Technology, Pakistan); Aamir Mahmood (Mid Sweden University, Sweden); Rafia Mumtaz (National University of Sciences and Technology, Pakistan); Muhammad Zaidi (National University of Sciences & Technology, Pakistan); Syed Ali Raza Zaidi (University of Leeds, United Kingdom (Great Britain)); Mikael Gidlund (Mid Sweden University, Sweden)

FRIDAY, 10:30-11:00 COFFEE BREAK

FRIDAY, 11:00 - 12:30 | ROOM: IT138

SSO6: IoT in Energy Systems and Industrial Environments

Energy Efficient WSN: a Cross-layer Graph Signal Processing Solution to Information Redundancy

Alessandro Chiumento (Trinity College Dublin, Ireland & Katholieke Universiteit Leuven, Belgium); Nicola Marchetti and Irene Macaluso (Trinity College Dublin, Ireland)

Designing High-Speed Directional Communication Capabilities for Unmanned Surface Vehicles

Zeinab Khosravi, Mikhail Gerasimenko and Jani Urama (Tampere University, Finland); Alexander Pyattaev (YL Verkot, Finland); Jose Villa Escusol (Tampere University, Finland); Jiri Hosek (Brno University of Technology, Czech Republic); Sergey Andreev (Tampere University, Finland); Yevgeni Koucheryavy (Tampere University of Technology, Finland)

Framework for the Identification of Rare Events via Machine Learning and IoT Networks

Pedro Henrique Juliano Nardelli (Lappeenranta University of Technology & University of Oulu, Finland); Constantinos B. Papadias (Athens Information Technology, Greece); Charalampos Kalalas (CTTC, Spain); Hirley Alves (University of Oulu, Finland); Ioannis Christou (Athens Information Technology, Greece); Irene Macaluso and Nicola Marchetti (Trinity College Dublin, Ireland); Raul Palacios-Trujillo (SEAT S.A., Spain); Jesus Alonso-Zarate (Centre Tecnologic de Telecomunicacions de Catalunya - CTTC, Spain)

Avoiding the Hay for the Needle in the Stack: Online Rule Pruning in Rare Events Detection

Ioannis Christou (Athens Information Technology, Greece)

FRIDAY, 11:00 - 12:30 | ROOM: IT105

TS17: Security at Physical Layer

Adaptive Secure Rate Allocation via TAS/MRC under Multi-Antenna Eavesdroppers

Irfan Muhammad, Onel Luis López and Hirley Alves (University of Oulu, Finland); Diana Pamela Moya Osorio (Federal University of São Carlos, Brazil); Edgar Eduardo Benitez Olivo (São Paulo State University (UNESP), Brazil); Matti Latva-aho (University of Oulu, Finland)

Intercept Probability Analysis over the Cascaded Fisher-Snedecor F Fading Wiretap Channels

Long Kong (ETS & University of Quebec, Canada); Yun Ai (Norwegian University of Science and Technology, Norway); Jiguang He and Nandana Rajatheva (University of Oulu, Finland); Georges Kaddoum (ETS Engineering School, University of Québec, Canada)

Statistical Method for Spoofing Detection at Mobile GNSS Receivers

Ziya Gulgun and Erik G. Larsson (Linköping University, Sweden); Panagiotis Papadimitratos (KTH, Sweden)

Digitally Assisted Analog Mitigation of Narrowband Periodic Interference

Karel Pärlin (Rantelon Ltd, Estonia); Taneli Riihonen (Tampere University, Finland)

FRIDAY, 11:00 - 12:30 | ROOM: IT106

TS18: Analog and Hybrid Beamforming

Approximate Expressions for BER Performance in Downlink mmWave MU-MIMO Hybrid Systems

Alvaro Ortega (Pontifícia Universidade Católica de Rio de Janeiro, Brazil); Raimundo Sampaio-Neto (Cetuc-Puc-Rio, Brazil); Rodrigo David (INMETRO, Brazil)

Analog Beamforming for Full-Duplex Millimeter Wave Communication

Roberto López-Valcarce (Universidad de Vigo, Spain); Nuria González-Prelcic (The University of Texas at Austin, USA)

Beamforming and Transceiver Optimization with Phase Noise for mmWave and THz Bands

Mubarak Aminu, Janne Lehtomäki and Markku Juntti (University of Oulu, Finland)

FRIDAY, 11:00 - 12:30 | ROOM: IT112

TS19: Wireless Networks and Applications

Network Slicing Management Technique for Local 5G Micro-Operator Deployments

Idris Badmus (Centre for Wireless Communications, University of Oulu, Finland); Marja Matinmikko-Blue (University of Oulu, Centre for Wireless Communications, Finland); Jaspreet Singh Walia (Aalto University, Finland)

On Emerging Contractual Relationships for Local 5G Micro Operator Networks

Bidushi Barua (University of Oulu, Finland); Marja Matinmikko-Blue (University of Oulu, Centre for Wireless Communications, Finland); Matti Latva-aho (University of Oulu, Finland)

Cooperative Mobile Sensing for Dynamic Spectrum Access in Community Cellular Networks

Adrian Vidal (University of the Philippines, Diliman, Philippines); Neil Irwin Bernardo (University of the Philippines Diliman, Philippines); Joel Joseph Jr. S. Marciano (University of the Philippines & Wireless Communications Engineering Laboratory, Philippines)

Towards 6G: Getting Ready for the Next Decade

Marcos D Katz and Pekka Pirinen (University of Oulu, Finland); Harri Posti (Centre for Wireless Communications, Finland)

FRIDAY, 11:00 - 12:30 | ROOM: IT113

TS20: Antenna and Analog MIMO

High Gain Dual-Polarized Non-uniform Spacing Stacked Patch Yagi-Uda Type Antenna

Muhammad Nazrul Islam (Oulu University, Finland); Markus Berg (University of Oulu & Excellant LTd., Finland); Erkki T. Salonen (University of Oulu, Finland)

Leaky Coaxial Cable with Enhanced Radiation Performance for Indoor Communication Systems

Zeeshan Siddiqui (University of Oulu & Centre for Wireless Communications, Finland); Marko Sonkki, Sami Myllymaki and Marko Tuhkala (University of Oulu, Finland)

Analog MIMO Radio-over-Copper: Prototype and Preliminary Experimental Results

Andrea Matera (Politecnico di Milano, Italy); Vittorio Rampa (IEIIT - CNR, Italy); Marcello Donati (Politecnico di Milano, Italy); Armando Colamonico (ABC Progetti, Italy); Andrea F. Cattoni (Keysight Technologies, Denmark); Umberto Spagnolini (Politecnico di Milano, Italy)

FRIDAY, 12:30-13:30 LUNCH BREAK

FRIDAY, 13:30 - 15:00 | ROOM: IT116

Panel 2: Regulations to Promote new 5G Business Opportunities

Abstract: *5G networks are expected to transform industries and ecosystems through a variety of wireless services provided at gigabit speeds, milli-second latencies, and by supporting novel applications connecting devices and objects. The biggest changes in the 5G mobile market arise from the potential emergence of a large number local 5G operators for serving vertical specific needs and the ability to provide differentiated service levels for different user groups obtained through network slicing. These developments could promote innovation and competition in the market in unforeseen ways, but their emergence is dependent on the telecommunication regulation especially regarding 5G spectrum access models and the net neutrality. This panel brings together leading experts from industry, regulation and academia to discuss what new business opportunities could arise with 5G and how regulations could promote or hinder their emergence.*

Moderator

Dr. Marja Matinmikko-Blue, Senior Research Fellow, University of Oulu, Finland.

Marja Matinmikko-Blue is Adjunct Professor in Spectrum Management at Centre for Wireless Communications (CWC), University of Oulu. She holds a Dr. Sc. degree in Communications Engineering and a Ph.D. degree in Industrial Engineering and Management from University of Oulu. She conducts inter-disciplinary research on future mobile communication networks from business, technical, and regulatory perspective in close collaboration with industry, academia, and regulators. Currently, she is Research Coordinator of 6G Flagship — the world's first 6G research programme. She has published over 120 scientific papers and prepared 100 contributions to spectrum regulatory forums in Europe (CEPT) and globally (ITU).

Panelists

Dr. Seppo Yrjölä, Principal Engineer, Nokia, Finland

Seppo Yrjölä is a Principal Engineer at Nokia Enterprise, in Finland. He holds a Dr.Sc. (Tech.) degree in Telecommunications Engineering from University of Oulu. Seppo's been with Nokia for 30 years. Previously as head of wireless technology for the Networks division at Nokia, his role required him to look beyond the product roadmap and identify what new trends, technologies and tools were on the horizon, and determine and validate how those future opportunities fit into the Nokia pipeline. His current research is focused in the areas of digital automation and future radios with cognitive network business opportunities and potential disruptions as an important aspect to scout. He incubates and steers opportunities externally with customers, partners and governments with the purpose of driving growth by innovating holistically from technology to business models. Special topic recently is to explore and understand how and why platform-based ecosystemic business models can emerge in the future wireless systems context.

Dr. Petri Ahokangas, Senior Research Fellow, Oulu Business School, Finland

Petri Ahokangas received his Doctor of Science (Business Administration) in 1998 from University of Vaasa, Finland. Currently he is Senior research fellow and leader of FUTURALIS research group at Martti Ahtisaari Institute of Oulu Business School at the University of Oulu, Finland. FUTURALIS focuses on future digital business models and ecosystems. He is also adjunct professor of international software entrepreneurship at the University of Oulu. His research interests are in how innovation and technological change influence international business creation, transformation, and strategies in highly technology-intensive or software-intensive business domains. He is co-editor-in chief of Journal or Business Models, and he has over 150 publications in scientific journals, books, conference proceedings, and other reports. He is actively working in several ICT-focused research consortia leading the business research activities. Prior to his academic career, he worked in the telecommunications software industry. He is a serial entrepreneur and active consultant in the field on digitalization, strategy and internationalization.

Dr. Raimo Kantola, Professor, Aalto University, Finland

After about 15 years at Nokia switching in different positions from SW developed to T&K, product marketing and Research manager, in 1996 Kantola joined Helsinki University of Technology (now Aalto University) as professor in Networking technology and was tenured in 2005. Kantola has held many positions of trust at the University and is a pioneer of International education. His recent research is on Cooperative security, trust, privacy and on Software Defined Networking.

Dr. Heidi Himmanen, Chief Advisor, Finnish Transport and Communications Agency - Traficom, Finland

Heidi Himmanen is a Chief Advisor at the Finnish Transport and Communications Agency Traficom working in the 5G Momentum ecosystem project. 5G Momentum promotes new services and innovations based on 5G technology through trials to make Finland number one in 5G, brings together the needs and ideas of different actors, encourages cooperation, develops Finnish digital society and makes Finnish 5G-knowledge visible. Heidi has previously worked as a head of spectrum supervision and radio networks units at the spectrum department at Finnish Communications Regulatory Authority (now Traficom). She holds a Dr. Sc. degree in Communications Engineering from University of Turku and a M. Sc. degree in Communications Engineering from Helsinki University of Technology.

FRIDAY, 15:00 - 15:15 | ROOM: IT116

Closing Session and Coffee

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