



WSA 2024

27th International
Workshop on Smart Antennas

March 17–19, 2024 | Dresden, Germany

wsa2024.org

Conference Handbook



Welcome Note



Prof. Rafael Schaefer



Prof. Gerhard Fettweis

On behalf of the organization committee, it is our great pleasure to welcome you to the 27th edition of the Workshop on Smart Antennas (WSA) at Technische Universität Dresden in Dresden, Germany.

Expanding upon the tradition and success of previous WSAs, this workshop offers an exciting program spanning two and a half days. This includes keynote and invited talks, regular sessions with oral and poster presentations, a dedicated track on 6G research, and demo sessions showcasing cutting-edge wireless technology testbeds.

Special recognition is owed to the chairs of the Technical Program Committee (TPC) Peter Rost and Norman Franchi and their team of TPC members for ensuring a thorough and timely review process that resulted in an engaging technical program and high-quality proceedings. The technical program covers topics including wireless channel modeling and prediction, security and privacy, one-bit quantization, signal processing techniques, beamforming and antenna arrays, networks, machine learning, and resource allocation and scheduling. Additionally, there is a dedicated track on 6G research in Germany highlighting key research activities from the German 6G Platform and 6G Research Hubs.

Enormous thanks go to the local organization team from the Chair of Information Theory and Machine Learning at TU Dres-

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den including its core team Martin Mittelbach, Daniel Seifert and Thomas Uhle, as well as Rico Radeke from the 5G Lab Germany. Special thanks go further to the Honorary Chairs Wolfgang Utschick and Josef Nossek for their help, advice, and guidance, to our industry sponsors Rohde & Schwarz, Ericsson, and NI (now part of Emerson) for their generous contributions, and also of course to the administration of TU Dresden for their help and support.

Finally, we extend our gratitude to our authors, speakers, exhibitors, and attendees for contributing to the success of this WSA. We trust that you will find value in the presentations and interactions with your peers on the latest scientific findings, as well as the chance to interact with friends and colleagues.

Welcome to WSA 2024!

March 2024

Prof. Rafael Schaefer and Prof. Gerhard Fettweis
TU Dresden, Germany

Agenda

12:30 Registration & Welcome Coffee

13:00 Track on 6G Research in Germany

Introduction to 6G Platform Germany

Norman Franchi (FAU Erlangen-Nürnberg)

13:30 Track on 6G Research in Germany – Talk 1

Reconfigurable Intelligent Surfaces (RIS) for 6G

Aydin Sezgin (Ruhr-Universität Bochum)

14:30 Track on 6G Research in Germany – Talk 2

Some Highlights from the 6G Research and Innovation Cluster

Sławomir Stańczak (TU Berlin, Fraunhofer HHI, Berlin)

15:30 Coffee Break

16:00 Track on 6G Research in Germany – Talk 3

Research Highlights from 6G-life

Frank Fitzek (TU Dresden)

17:00 Track on 6G Research in Germany – Talk 4

Open6GHub Germany – Multiband Massive MIMO Testbed

Norman Franchi, Lukas Witte (FAU Erlangen-Nürnberg)

18:00 Welcome Reception

Track on 6G Research in Germany

Talk 1: Reconfigurable Intelligent Surfaces for 6G From Concepts to Applications and to Experiments

The talk starts with introducing the 6G research hub 6GEM. The 6GEM consortium combines scientific excellence and mobile communications expertise with large-scale test fields in North Rhine-Westphalia and is coordinated by the RWTH Aachen with academic project partners such as Ruhr-Universität Bochum, TU Dortmund, and Universität Duisburg-Essen as well as several Fraunhofer institutes and the Max Planck Institute for Security and Privacy. Next, the talk highlights the research on reconfigurable intelligent surfaces (RIS) within 6GEM, one of the main disrupting technologies for 6G from the fundamental and experimental level and addresses on how to bridge the gap between theory and practice.



Aydin Sezgin received the Dr.-Ing. (Ph.D.) degree from TU Berlin in 2005. From 2001–2006, he was with the Heinrich Hertz Institute, Berlin. From 2006–2008, he held a postdoctoral position with Stanford University. From 2008–2009, he held a postdoctoral position with University of California, Irvine. From 2009–2011, he was the Head of the Emmy Noether Group on Wireless Networks, Universität Ulm. He is currently a professor with the Ruhr-Universität Bochum. He is interested in signal processing, communications, and information theory, with a focus on wireless networks. He has published several book chapters, more than 240 papers and he is co-author of the textbook on multi-way communications. He has received Best Poster / Paper Awards at the IEEE CTW in 2011, at ICCSPA in 2015, at IEEE ICC in 2019, and at IEEE ISAP in 2023. Since 2023, he is editor-in-chief for the Springer Journal on Wireless Personal Communications.

Talk 2: Some Highlights from the 6G Research and Innovation Cluster

In this talk, we will report on selected research highlights from the 6G Research and Innovation Cluster (6G-RIC). In particular, we address the following key question: How can throughput and energy consumption be optimally balanced at moderate cost? In this concept, we discuss some promising research directions, including cell-less massive MIMO, analog processing, reconfigurable intelligent surfaces (RIS), and semantic and goal-oriented communication. By exploring these research directions, we aim to foster advances that will lead to more energy-efficient and sustainable 6G technologies.



Sławomir Stanczak is Professor of Network Information Theory at the Technische Universität Berlin and Head of the Wireless Communications and Networks Department at the Fraunhofer Heinrich Hertz Institute (HHI). He is co-author of two books and more than 200 peer-reviewed journal articles and conference papers in the field of information theory, wireless communications, signal processing, and machine learning. He received research grants from the German Research Foundation and the Best Paper Award from the German Society for Telecommunications in 2014. He was an associate editor of the IEEE Transactions on Signal Processing from 2012 to 2015 and chair of the ITU-T

Focus Group on Machine Learning for Future Networks including 5G from 2017 to 2020. Since 2020 he is chairman of the 5G Berlin association and since 2021 he is coordinator of the projects 6G-RIC (Research and Innovation Cluster) and CampusOS.

Talk 3: Research Highlights from 6G-life

The talk will introduce the 6G-life project. TU Dresden and TU München have joined forces to form the 6G-life research hub to drive cutting-edge research for future 6G communication networks with a focus on human-machine collaboration. The merger of the two universities of excellence combines their world-leading preliminary work in the field of Tactile Internet in the Cluster of Excellence CeTI, 5G communication networks, quantum communication, post-Shannon theory, artificial intelligence methods, and adaptive and flexible hardware and software platforms.



Frank H. P. Fitzek, Professor of the Deutsche Telekom Chair of Communication Networks at TU Dresden, leads at the forefront of telecommunications research in Germany. As the spokesperson for the DFG Cluster of Excellence CeTI and the 6G-life hub, his contributions have significantly shaped the field of communication networks. Educationally, he completed his diploma in electrical engineering at RWTH Aachen, Germany, in 1997, followed by a Ph.D. in Electrical Engineering from the Technische Universität Berlin in 2002. That same year, he embarked on his professorial journey at the Università degli Studi di Ferrara, Italy, and further expanded his academic influence to Aalborg University

in 2003 as a professor. As entrepreneurial spirit, he co-founded over ten startups, beginning with acticom GmbH in 1999. His global research footprint includes prestigious institutions like MIT, VTT, and Arizona State University. His groundbreaking work in MIMO MDC earned him the YRP award in 2005, alongside the Danish Young Elite Researcher Award. His innovative contributions were recognized with the NOKIA Champion Award annually from 2007 to 2011, the Nokia Achievement Award in 2008 for cooperative networks, the SAPERE AUDE research grant in 2011, and the Vodafone Innovation prize in 2012. In 2015, he was honored with the “Doctor Honoris Causa” degree from BUTE. His research ambitiously spans 5G/6G communication networks, in-network computing, network coding, compressed sensing, post-Shannon theory, quantum and molecular communication, and immersive human-machine interaction in virtual environments.

Talk 4: Open6GHub Germany Multiband Massive MIMO Testbed

Massive multiple-input multiple-output (MIMO) and joint communication and sensing (JCAS) are two promising technologies for future wireless networks. Massive MIMO can provide significant gains in spectral efficiency and link reliability, while JCAS can enable new applications and services. The talk presents a reconfigurable testbed system for massive MIMO and JCAS. The testbed system is flexible and scalable, allowing for the evaluation of a wide range of algorithms and techniques. This talk presents the key components and modules of the system, providing an idea of its capabilities.

Norman Franchi is full professor at the Friedrich-Alexander-Universität (FAU) Erlangen-Nürnberg, Germany, where he heads the Chair of Electrical Smart City Systems. He holds a Dr.-Ing. (Ph.D.E.E., 2015) and Dipl.-Ing. (M.S.E.E., 2007) degree in Electrical, Electronic and Communications Engineering (EEI), both from FAU. From 2007 to 2011, he worked in the automotive R&D sector as system and application engineer for advanced networked control system design. From 2012 to 2015, he was research assistant at the Institute for Electronics Engineering, FAU, focused on software-defined radio based V2X communications. From 2015 to 2021, he was with Gerhard Fettweis' Vodafone Chair at TU Dresden where he was senior research group leader for resilient mobile communication systems and 5G industrial campus networks. From 2019 to 2020, he was managing director of the 5G Lab GmbH, Germany. In 2020, he founded the company Advancing Individual Networks (AIN) GmbH, Germany, a technology start-up for design, optimization, and operation of IIoT and 5G campus networks. He is member of the IEEE ISAC initiative, and 5G⁺⁺ Lab Germany, and the coordinator of the JCAS research activities in the Open6GHub Germany as well as of the working groups ROADMAP and TRUST in the 6G Platform Germany. Furthermore, he is advisory board member of the Industrial Radio Lab Germany (IRLG) and the KI Park e.V., Germany.



Lukas Witte is a junior research assistant at the Institute for Microwaves and Photonics since June 2023 under the supervision of Professor Martin Vossiek.

Track on 6G Research in Germany

His primary research focus is on the Massive MIMO testbed within the Open6GHub project. Prior to joining the institute, he obtained his Master's degree in Electrical Engineering from Friedrich-Alexander-Universität Erlangen-Nürnberg in April 2023 where he specialized in micro- and millimeter-wave hardware design. His additional research interests lie in the area of Integrated Communication and Sensing / Joint Communication and Sensing for next-generation communication systems. He is particularly interested in exploring the broad spectrum of use cases that these capabilities would potentially enable.



Welcome Reception



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Barkhausen Building and Heinz Schönfeld Lecture Hall

On Sunday evening, we invite you to a welcome reception in the foyer of the Heinz Schönfeld Lecture Hall at TU Dresden. This is the perfect place to meet old and new colleagues in a casual, nice and pleasant atmosphere, and to enjoy delicious finger food and have some refreshing beverages from GenussManufaktur Dresden. For freshly tapped beer, we have Lohrmanns Brew for you, the brewery at TU Dresden.

In Brief

📅 March 17, 2024

🕒 18:00–20:30

📍 Foyer of Heinz Schönfeld Lecture Hall, Barkhausen Building,
TU Dresden, Georg-Schumann-Straße 11, 01069 Dresden

🍽️ Finger Food & Beverages

Agenda

8:30 Morning Coffee

9:00 Conference Opening

Are there Remaining 6G Research Opportunities?

Gerhard Fettweis, Rafael Schaefer (TU Dresden)

9:30 Keynote Talk 1

Antenna Systems for the 5th and 6th Generation of Mobile Networks

Philipp K. Gentner (Ericsson Antenna Systems)

10:00 Coffee Break

10:30 Session 1: Wireless Channel Modelling & Prediction

From Technology to Products: The Role of Standardization (Invited Talk)

Michael Meyer (Ericsson Eurolab, Aachen)

Wireless Channel Prediction via Gaussian Mixture Models

Nurettin Turan (TU München)

Modelling of Wireless Links with Reconfigurable Intelligent Surfaces Using Multiport Network Analysis

Josef A. Nossek (TU München)

Insights into the Near-Field Characteristics of mm-wave Massive MIMO Arrays using EM Lagrangian Density and Poynting Vector

Debdeep Sarkar (Indian Institute of Science, Bangalore)

12:00 Lunch & Coffee Break

13:00 Session 2-A: Security & Privacy

Smart, Adaptive, Context Aware Physical Layer Security for 6G: Announcing the First PLS Security Challenge (Invited Talk)

Arsenia Chorti (ENSEA, ETIS Lab, Cergy)

Secret Key Generation Rates for Line of Sight Multipath Channels in the Presence of Eavesdroppers

Amitha Prakasha Mayya (Barkhausen Institut, Dresden)

Comparison of Optimization Criteria for Preprocessing for Physical-Layer Security in Multi-Carrier-THz-MIMO Systems

Rebekka Schulz (Universität Ulm)

14:00 Session 2-B: One-bit Quantization

Time Instance Zero-Crossing Precoding for mmWave Channels Employing 1-bit Quantization and Oversampling

Diana M. Viveros Melo (Pontifícia Universidade Católica do Rio de Janeiro)

On the Timing Synchronization for Receivers with Temporally Oversampled 1-bit Quantization

Stephan Zeitz (TU Dresden)

14:30 Keynote Talk 2

Shaping the Future of Communication: An In-depth Look into Directional Transmission Systems

Luca Steinweg, Raimon Göritz (Rohde & Schwarz, Berlin)

15:00 **Extended Coffee Break**
Demo & Poster Session

16:30 **Session 3: Signal Processing Techniques**

Low Earth Orbit Satellite Constellations: Communications and Distributed Learning
(Invited Talk)

Bho Matthiesen (Universität Bremen)

PRACH Signal Design and Detection for LEO Satellite Systems with Imperfect UE Positioning

Màrius Caus (Centre Tecnològic de Telecomunicacions de Catalunya CTTC - CERCA)

Modified Hierarchical Modulation for Hybrid RF-FSO Satellite Communication

Marc Moreno Amay (Centre Tecnològic de Telecomunicacions de Catalunya CTTC - CERCA, Universitat Politècnica de Catalunya)

Real-World OTFS Channel Estimation Performance Evaluation on mmWave Vehicular Channels

Roman Maršálek (Vysoké Učení Technické v Brně)

19:00 **Social Event**

Gala Dinner at Schloss Albrechtsberg

Are there Remaining 6G Research Opportunities?

As standardization for 6G is rushing ahead, we can capture some main learnings of industry's thinking. Most ideas rather indicated that 6G will be an evolutionary step beyond 5G and not very revolutionary. Hence, it could generate the question if 6G is just a better 5G? But better in what — really serving customers' needs and generating a platform for 6G to become an economic success for our industry? If we define 6G from what is needed for the customers point of view, as well as for the wireless industry, it turns out that there are many open challenges which could be addressed nicely in research and standardization. We shall point out some main radio access network chances. It is research that now can drive the future as it provides answers possibly not being prominently addressed by industry today.

Gerhard Fettweis earned his Ph.D. under H. Meyr's supervision from RWTH Aachen in 1990. After one year at IBM Research in San Jose, CA, he joined TCSI Inc., Berkeley, CA. Since 1994, he has been Vodafone Chair Professor at TU Dresden, Germany. Since 2018, he has also been the founding Director/CEO of the Barkhausen Institute. His team spun out 19 tech, and three non-tech startups. He initiated four platform companies. He is IEEE Fellow, member of the German Academy of Sciences (Leopoldina) and the German Academy of Engineering (acatech), coordinates 5G⁺⁺ Lab Germany and the German Cluster-for-Future SEMECO, and his most recent award is the Stuart Meyer Memorial Award from IEEE VTS. He has helped organizing IEEE conferences, most notably as TPC Chair of ICC 2009 and of TTM 2012, and as General Chair of VTC Spring 2013 and DATE 2014. His research interests include wireless transmission and chip design.



Keynote Talk 1

Antenna Systems for the 5th and 6th Generation of Mobile Networks

This talk gives an overview on the architectures and challenges for future antenna systems. Beginning with the state of the art deployed antennas for mobile communication, the electrical and mechanical key metrics are presented to enable a wireless network. With this foundation, the commonly discussed 6G use cases and the crucial role of antennas will be derived. Sustainability, efficiency as well as modularity are the main drivers for the antenna solutions for every deployment scenario in the 6th generation of mobile communication.



Philipp Karl Gentner was born in Laupheim, Germany, in January 1980. He received his diploma in Electrical Engineering in 2006 at the Universität Ulm. In 2013, he received his Dr. techn. degree from the Institute of Telecommunications in Vienna, Austria. He gained a lot of practical experience during his studies by working for Siemens Mobile Phones and later BenQ-Siemens. As a system test engineer for Ubidyne he was responsible for the System Test Laboratory and the definition and implementation of RF test cases for the first active antenna systems. Since 2014, he is working on antenna architectures for future communication systems at Ericsson Antenna Systems, Germany. Currently he holds a senior researcher position, and his research interests are in the computer aided engineering (digital twining) of antenna systems and new methodologies for antenna element design such as characteristic mode analysis.

Session 1: Invited Talk

From Technology to Products The Role of Standardization

The talk will look at the innovation cycle from early research to products and, in particular, the role that standardization plays in that cycle. In particular for mobile communication systems, standardization has been key to establish a global market with economy of scale creating room for various business roles like operators, infrastructure or handset vendors or chipset makers. Standardization is key to build an industry consensus on viable technologies in an environment with heterogenous business interests. In the presentation, it will be also explained how the standardization process works and how the planned timeline towards the first 6G specification looks like.

Dr. Michael Meyer joined the Research Department at the Ericsson Eurolab in Herzogenrath close to Aachen after obtaining a Ph.D. degree at the Universität Paderborn in Communications Engineering in 1996. He was active in various roles in development of 3G and 4G. Since 2011, he is heading the Research Department at the Eurolab. In the corporate organization Ericsson Research, he is responsible for the area Radio Network Concepts with teams in Germany and Sweden. His focus areas are the development of concepts for future mobile radio networks and their standardization as well as the application of mobile technologies for industry verticals, e.g., production environments or automotive applications. He is serving in several advisory boards, e.g., 6G-RIC or the supervisory board of the FNS Program in the Netherlands (Dutch 6G program).



Session 2: Invited Talk

Smart, Adaptive, Context Aware Physical Layer Security for 6G Announcing the First PLS Security Challenge

Smart, adaptive security is envisioned for future, heterogeneous networks of highly diverse KPIs (delays, energy consumption, massive connectivity / scalability, computational power, etc.). In parallel, the integration of communications and sensing along with embedded artificial intelligence can provide the foundations for building autonomous and adaptive security protocols. In this talk, we will shed some light on how physical layer security (PLS) is naturally adaptive and will further discuss a roadmap for its incorporation in 6G. To command the confidence of the academic and entrepreneurial communities as well as of the end users, we will present the first ever PLS security challenge for secret key generation (SKG) schemes in indoor environments, mirroring well established practices in the crypto community. Finally, a comprehensive list of countermeasures is presented for the majority of known active attacks on SKG, e.g., spoofing and man-in-the-middle.



Arsenia Chorti is a professor at the École Nationale Supérieure de l'Électronique et de ses Applications (ENSEA) at the ETIS Lab UMR 8051, research fellow of the Barkhausen Institute and a visiting scholar at Princeton University. Her research spans the areas of wireless communications and wireless systems security for 5G and 6G, with a particular focus on physical layer security. Current research topics include context aware security, multi-factor authentication protocols, IoT anomaly detection, 5G / 6G, machine learning for communications, new multiple access techniques and scheduling. She is a Senior IEEE Member, associate editor-in-chief of the IEEE ComSoc Best Readings, IEEE Distinguished Lecturer (24-25), member of the IEEE INGR on Security, chair of the IEEE Focus Group on Physical Layer Security and a member of various ITU Working Groups including on Security of the Metaverse. She has participated in the reduction of the ITU report M.2516-0 on "Future technology trends of terrestrial International Mobile Telecommunications systems towards

Session 2: Invited Talk

2030 and beyond” (sections on trustworthiness). Finally, she has served in the IEEE P1940 Standardization Workgroup on Standard Profiles for ISO 8583 authentication services and at the IEEE Teaching Awards Committee.

Keynote Talk 2

Shaping the Future of Communication An In-depth Look into Directional Transmission Systems

Join us as we delve into the transformational realm of directional transmissions, a paradigm shift from the traditional omni-directional communication approach. This talk is designed for leading researchers, radio frequency developers, and industry representatives seeking innovative advancements in the field.

We start with an exploration of the central motivations for this evolution, and why the future of communications leans towards directional approaches. Listen to a discussion about the inherent benefits from a technological perspective and understand the significant role they play in efficiency, ever higher data rates, and range extension. We dissect different directional antenna hardware architectures, focusing particularly on hybrid arrays. We explore the practical technical challenges such as multi-beam, multi-band and multi-service functionalities. Furthermore, we discuss strategies to advanced tracking, steering algorithms, including beam steering and angle of arrival in highly mobile platforms. The talk concludes with a prognosis on practical applications of the proposed systems.

This presentation does not only impart the advantages and challenges of directional communications but reinforces Rohde & Schwarz's commitment to stay ahead of the curve in providing high-performing communication systems globally. Join the discussion on possible solutions along the path to practical directional services!

Raimon Göritz has a distinguished 17-year span of professional experience with Rohde & Schwarz GmbH & Co. KG. Starting as a working student, he has climbed the professional ladder, stepping into the role of Director of Development in July 2016 and become a Senior Development Expert in 2020. In terms of academics, he has earned a distinguished Dipl.-Ing. in Electrical Engineering with honors from TU Berlin. This achievement, coupled with his active association with the VDE, underlines his commitment to continuous learning. He participated in the Erasmus program at Cardiff University / Prifysgol Caerdydd, where he broadened his academic pursuits to include not only Electrical Engineering

Keynote Talk 2

but also Psychology and British History. As part of his studies, he undertook a project involving the development of a real-time solution for speech and native speaker recognition using Matlab. In addition to this, Raimon delved into the technical complexities of broadband amplifiers as well as body area networks, demonstrating his versatility and eagerness to explore cutting-edge technology. He also conducted rigorous studies on split-ring resonators, specifically focusing on their applications in the medical field. These diverse and in-depth academic forays not only embellished his understanding but also cemented his status as a well-rounded and multi-disciplinary professional.

Today he focuses on the Future Combat Air System and is responsible for the next generation antennas. His numerous patents highlight his innovation and influence in the electronic and technological sectors. He holds patents that stretch from 2012 to 2023, covering diverse areas like amplifier operation, directional coupler production, and broadband high-power amplifiers. These patents were granted in a broad spectrum of locations, such as the USA, Germany, Japan, and Europe, emphasizing his wide-reaching innovative contributions.



Luca Steinweg was born in Bad Säckingen, Germany, in 1994. He received the Dipl.-Ing. degree in Electrical Engineering from TU Dresden, Germany, in 2019. His diploma thesis was done in co-operation with Rohde & Schwarz, where he investigated broadband power detectors. He received his Ph.D. degree at the Chair of Circuit Design and Network Theory, TU Dresden, in 2023. His research interests included millimeter-wave wireless transmitters in SiGe-BiCMOS technology focusing on phased array applications. In 2023, he joined Rohde & Schwarz in the position of antenna architect within the European Future Combat Air System (FCAS).



Demo & Poster Session

Exhibition

WSA 2024 features an interactive exhibition where demonstrators such as wireless simulation tools, testbeds and prototypes are presented. We are pleased to welcome the following exhibitors to the conference.



Poster Presentations

We think that due to the limited time that we have on stage for the oral presentations of the papers, usually there is not much room to have a thorough discussion and get meaningful feedback. Moreover, we find that the latter may be better achieved in one-on-one conversations with people who are really interested in your work. In order to provide all authors with an additional opportunity for longer discussions, we encourage them to prepare and present a poster at our exhibition. The posters are displayed throughout the day of their talk, leaving more time for discussion during all coffee breaks.

Session 3: Invited Talk

Low Earth Orbit Satellite Constellations Communications and Distributed Learning

Large-scale satellite constellations deployed in low Earth orbit (LEO) are essential to achieve truly ubiquitous connectivity. With proper constellation design and the necessary communication and processing capabilities, LEO constellations have the ability of providing global coverage, even for low latency internet services. Because of this, dense constellations of hundreds or even thousands of small satellites flying in LEO are currently under deployment. While their integration into terrestrial mobile networks has begun in 5G Release 17, achieving a full integration and fully exploiting the processing power and the inference capabilities at LEO are major milestones for the next generation of mobile networks (6G) towards highly resilient 3D networking. In this talk, we will cover some fundamentals of LEO satellite constellations for communications, discuss challenges in the radio access, and review recent results from the areas of communications, distributed learning, and signal processing for satellite communications.

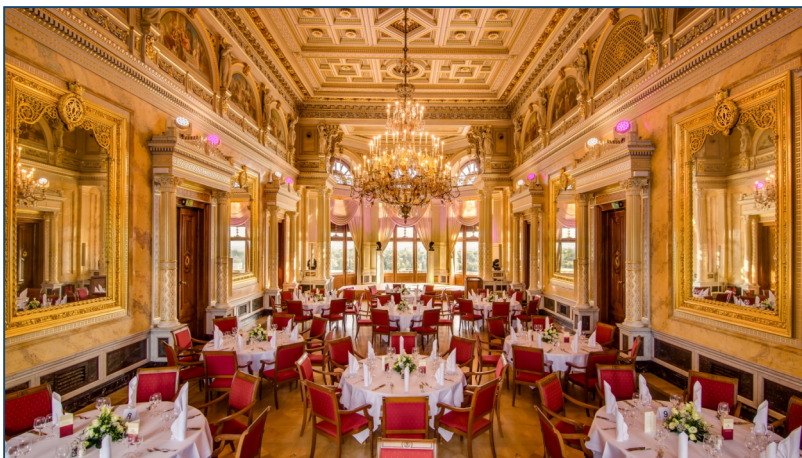
Bho Matthiesen is a research group leader and lecturer at the Universität Bremen, Germany. He received the Dipl.-Ing. (M.Sc.) degree in Electrical Engineering from TU Dresden, Germany, in 2012, and the Ph.D. degree (with distinction) in Electrical Engineering from TU Dresden in 2019. He is principal investigator of DFG project “Communication-efficient federated optimization in deterministic spatio-temporal networks” (grant number 518671822), received a best paper award at the 17th IEEE International Conference on Industrial and Information Systems (ICIIS) in 2023, is an Exemplary Reviewer 2020 and 2021 of the IEEE Wireless Communications Letters, was an invited speaker at the 2nd 6G Wireless Summit 2020, and a tutorial presenter at IEEE VTC2020-Fall, IEEE ICC 2021, IEEE ICASSP 2021, and IEEE ICC 2023. He served as a publication co-chair for the International Symposium on Wireless Communication Systems (ISWCS) 2021 and for the International ITG 26th Workshop on Smart Antennas and 13th Conference on Systems, Communications, and Coding (WSA



Session 3: Invited Talk

& SCC 2023). He is an associate editor for the EURASIP Journal on Wireless Communications and Networking, Springer Wireless Personal Communications, and an editorial board member for Scientific Reports (Nature Portfolio). His research interests are in communication theory, wireless communications, and optimization theory.

Social Event



© Messe Dresden, Schloss Albrechtsberg

Crown Hall at Schloss Albrechtsberg

On Monday evening, we would like to take you to a festive gala dinner at Schloss Albrechtsberg. After a welcome with sparkling wine, there is a buffet with excellent food and beverages in the Crown Hall. You will be enchanted by its lavishly restored, richly decorated interior. Surrounded by an idyllic park on the Elbe river, this castle is the fairy tale backdrop for an unforgettable evening.

In Brief

- 📅 March 18, 2024 ⌚ 19:00–23:00
- 📍 Schloss Albrechtsberg, Bautzner Straße 130, 01199 Dresden
- 🚌 Bus stop "Elbschlösser" 🚏 Bus EV11
- 🕒 Gala Dinner (welcome: 19:30, buffet: 20:00)
- 🗺️ After the last session, you can meet in front of the Barkhausen Building, TU Dresden, for a guided tour by public transport.

Agenda

8:30 Morning Coffee

9:00 Session 4: Beamforming & Antenna Arrays

*Energy-efficient Radio Unit Design for the Next Generation of MIMO Systems
(Invited Talk)*

Stefan Wesemann (Nokia Bell Labs, Stuttgart)

Improving the Spatial Correlation Characteristics of Antenna Arrays using Linear Operators and Wide-band Modelling

Marc Miranda (TU Ilmenau)

Clustered Robust Linear Precoding for Cell-Free MU-MIMO Systems

Rodrigo C. de Lamare (Pontificia Universidade Católica do Rio de Janeiro, University of York)

Joint Beamforming and Trajectory Optimization for UAV-Aided ISAC with Dipole Antenna Array

Mustafa Burak Yilmaz (TU Darmstadt)

Dual-band Endfire Phased Array Antenna for mmWave 5G NR Bands Applications

Mohammad Alibakhshikenari (Universidad Carlos III de Madrid)

**10:30 Extended Coffee Break
Demo & Poster Session**

11:30 Session 5: Networking

Data-driven Modelling and Optimization of Green Future Mobile Networks: From Machine Learning to Generative AI (Invited Talk)

Antonio De Domenico (Huawei, Paris)

Predictive Handover Optimization

Vahid Rajabi (Fraunhofer HHI, Berlin)

Distributed Fixed-Point Algorithms for Dynamic Convex Optimization over Decentralized and Unbalanced Wireless Networks

Navneet Agrawal (TU Berlin)

A New Spatio-Temporal Model for Data Rate Distributions in Mobile Networks

Florian Gast (TU Dresden)

12:45 Lunch & Coffee Break

13:45 Demo & Poster Session

14:15 Session 6: Machine Learning

Toward Digital Twin Networks: Tools and Early Results (Invited Talk)

Fayçal Ait Aoudia (NVIDIA, Paris)

GAN-based Massive MIMO Channel Model Trained on Measured Data

Florian Euchner (Universität Stuttgart)

Variational Autoencoder for Channel Estimation: Real-World Measurement Insights

Michael Baur (TU München)

Channel Estimation and Equalization for SC-FDMA Using Machine Learning

Ömer Karakas (Fraunhofer IIS, Erlangen)

Loss Design for Single-carrier Joint Communication and Neural Network-based Sensing

Charlotte Muth (Karlsruhe Institute of Technology KIT)

15:45 **Coffee Break**

16:15 **Session 7: Resource Allocation & Scheduling**

Real-Time Algorithms for Combined eMBB and URLLC Scheduling

Tano Bischoff (Fraunhofer HHI, Berlin)

Improving NOMA Performance by Application of Autoencoders and Equidistant Power Allocation

Niklas Bulk (Universität Bremen)

Duality-Based Joint Clustering and Precoding for Cell-Free Distributed MIMO

Martin Schubert (Huawei, München)

17:00 **Conference Closing**

Presentation of the Best Paper Award

Session 4: Invited Talk

Energy-efficient Radio Unit Design for the Next Generation of MIMO Systems

Energy efficiency (EE) will be an important metric for the next generation cellular networks, at least as important as the traditional performance metrics such as throughput, latency, reliability, and scalability. While 5G massive MIMO improved over 4G substantially in terms of the bits/joule metric at peak load, it is inefficient during lightly loaded conditions. An important requirement for the next generation (extreme MIMO) radio units (RUs) should be to ensure that energy consumption scales down gracefully with traffic, approaching zero energy at zero traffic. With more than a ten-fold capacity increase expected at peak loads, extreme MIMO RUs should leverage various technology advances to reduce overall average energy consumption by 50% and to improve the bits/joule metric by five times at peak load and by 20 times on average, as compared to 5G. This talk will discuss various functional elements and hardware components of the radio unit that will help us to reach that ambitious goal. Key elements are EE-aware scheduling / link-adaption methods, advanced power amplifier concepts and enhanced component deactivation schemes.



Stefan Wesemann is head of the Transceiver Research Department Germany & France in Nokia Bell Labs. He received the Dipl.-Ing. (M.Sc.) in 2006 and the Dr.-Ing. (Ph.D.) in 2014, both from TU Dresden. In between, he worked for the startup Signalion GmbH (now National Instruments). Since joining Nokia Bell Labs in 2014, he has worked on massive MIMO algorithms and system design, and supported the productization of those. His current research focus is on novel transceiver technologies, extreme & distributed MIMO design, and disruptive PHY concepts for improved energy efficiency. He is a Bell Labs Distinguished Member of Technical Staff.

Data-driven Modelling and Optimization of Green Future Mobile Networks From Machine Learning to Generative AI

The fifth generation (5G) of radio technology is revolutionizing our everyday lives, by enabling a high degree of automation, through its larger capacity, massive connectivity, and ultra-reliable low-latency communications. Moreover, 5G technology is allowing for the first time to expand cellular systems into new ecosystems, thus impacting every industry. Despite its unprecedented capabilities, however, 5G networks can—and must—further improve in certain key technology areas, such as that of energy efficiency. While current third generation partnership projects (3GPP) new radio (NR) deployments provide an improved energy efficiency of around four times w.r.t. 3GPP long term evolution (LTE) ones, they still consume up to three times more energy. This is mostly due to the more processing required to handle the wider bandwidth and the more antennas, and is resulting in increased carbon emissions and electricity bills for operators. Even if the 3GPP NR specification provides a rich set of tools to meet IMT-2020 energy efficiency requirements, such as carrier, channel and symbol shutdown, among others, it is important to note that one of the main energy consumption challenges of 5G networks is the complexity of their optimization in wide-area deployments: a large-scale, stochastic, non-convex and non-linear optimization problem. In light of the increasing interest in this field, this talk shares the author's industrial and academic views on this 5G energy efficiency problem. In more details, the talk provides an overview at energy efficiency enabling technologies in 3GPP NR, in particular, massive MIMO, carrier aggregation, the lean carrier design and different shutdown methods. By leveraging on the concepts of big data and machine learning, the talk presents practical scenarios in which data collected from thousands of base stations can be successfully used to derive accurate machine learning models for the main building blocks of the energy efficiency optimization problem. Furthermore, it explores the possibility of a

Session 5: Invited Talk

future where generative AI plays a central role in autonomously generating explainable models, thus advancing the quest for energy-efficient networks. In this context, the talk delves into the adoption of large language models (LLMs) in the industry and the need for foundational telecom models and specific evaluation frameworks for generative AI.



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include research and standardization activities on future wireless networks, machine learning, and green communications. He is currently leading the Network Energy Efficiency Working Group in the NGMN Alliance and he is currently an editor of Wireless Communications and Mobile Computing.

Session 6: Invited Talk

Toward Digital Twin Networks Tools and Early Results

Digital Twin Networks (DTNs) are digital replicas of physical wireless networks. They allow for the design and operation of future wireless networks such as 6G. Their applications range from use as “gyms” for training of environment specific communication schemes over network monitoring and control to “what-if” analyses. In this talk, we discuss the required steps and tools to create physically accurate and environmentally specific DTNs. We show how scene geometries can be accurately captured and how ray tracing allows to model radio propagation. Furthermore, we propose differentiable ray tracing as a method to automatically learn electromagnetic material properties from channel measurements. Finally, we demonstrate the benefits of training neural receivers for a specific environment and conclude the talk by a discussion of open challenges in the field of DTNs.

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