



# IEEE Wireless Communications and Networking Conference

25-28 May 2020 // Virtual Conference

*Beyond Connectivity: What Comes After 5G*

# FINAL PROGRAM



SPONSORS



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GENERAL INFORMATION

REGISTRATION AND VIRTUAL CONFERENCE ACCESS

2020 IEEE WCNC registration is required to attend the virtual conference. Access to the virtual conference have been sent by email. Instructions for Participants, Presenters and Session Chairs can be found on the conference website, <https://wcnc2020.ieee-wcnc.org>.

CONFERENCE PROCEEDINGS

The conference proceedings have been published electronically and are available for you to download through the conference website. Access instructions have been sent by email.

ZOOM INFORMATION DESK

A virtually-staffed Zoom Information Desk will be available to assist all participants and answer general questions. Please visit the information desk if you:

- Are unable to locate your password to access to the 2020 IEEE WCNC Virtual Conference
- Want to test or practice your presentation on Zoom
- Have general questions about the 2020 IEEE WCNC Virtual Conference Program or the Zoom Platform

BE CONSIDERATE

Please mute your microphone upon entering the virtual conference each day you participate. The conference committee, the speakers, and your fellow attendees thank you for your consideration and cooperation.

## PROGRAM-AT-A-GLANCE

Monday, 25 May 2020 - Tutorials / Workshops														
Time (KST)	Room 1	Room 2	Room 3	Room 4	Room 5	Room 6	Room 7	Room 8	Room 9	Room 10	Room 11	Room 12	Room 13	Room 14
09:00 - 10:30	TUT1: Federated Learning at the Network Edge	TUT2: Towards Smart and Reconfigurable Environment	TUT3: Machine Learning for Future Wireless Networks	TUT5: Moving Towards Zero-Touch Automation, A Key Enabler for 6G	TUT6: B5G: A New Frontier for Non-Orthogonal Multiple Access	HW51: 5G Remote Health		FWS3: Emerging Tetahertz Technologies for Future Wireless Systems		FWS6: Intelligent Computing and Caching at the Edge		FWS8: NexGen RAN S1: 9:00-9:45 S2: 9:45-11:00	FWS9: RAFNET	
10:30 - 10:45	Break													
10:45 - 12:15	TUT1: Federated Learning at the Network Edge	TUT2: Towards Smart and Reconfigurable Environment	TUT3: Machine Learning for Future Wireless Networks	TUT5: Moving Towards Zero-Touch Automation, A Key Enabler for 6G	TUT6: B5G: A New Frontier for Non-Orthogonal Multiple Access	HW51: 5G Remote Health		FWS3: Emerging Tetahertz Technologies	FWS4: WDN-5G&6G	FWS6: Intelligent Computing and Caching at the Edge		FWS8: NexGen RAN S3: 11:15-12:00 S4: 13:30-14:00	FWS9: RAFNET	
12:15 - 14:00	Lunch													
14:00 - 15:30	TUT4: Wireless Transmission for Advanced Internet of Things	TUT7: UAV Communications in 5G and Beyond	TUT8: OTFS Modulation and Applications	TUT9: URLLC for 5G and Beyond	TUT10: NOMA Based Random Access for Massive MTC in 5G	HW55: FDR Technologies for Next Generation Wireless Communications	HWS10: IWSS (Smart Spectrum)	FWS3: Emerging Tetahertz Technologies	FWS4: WDN-5G&6G	FWS6: Intelligent Computing and Caching at the Edge	FWS7: ICA STARTS AT 13:00	FWS8: NexGen RAN S5: 14:00-15:15	FWS9: RAFNET	HWS2: AERCOMM
15:30 - 15:45	Break													
15:45 - 17:15	TUT4: Wireless Transmission for Advanced Internet of Things	TUT7: UAV Communications in 5G and Beyond	TUT8: OTFS Modulation and Applications	TUT9: URLLC for 5G and Beyond	TUT10: NOMA Based Random Access for Massive MTC in 5G	HW55: FDR Technologies for Next Generation Wireless Communications	HWS10: IWSS (Smart Spectrum)	FWS3: Emerging Tetahertz Technologies	FWS4: WDN-5G&6G	FWS6: Intelligent Computing and Caching at the Edge	FWS7: ICA	FWS8: NexGen RAN S6: 15:45-16:15 S7: 16:30-17:15	FWS9: RAFNET	HWS2: AERCOMM
Tuesday, 26 May 2020 - Main Conference														
Time (KST)	Room 1	Room 2	Room 3	Room 4	Room 5	Room 6	Room 7	Room 8	Room 9	Room 10	Room 11	Room 12	Room 13	Room 14
09:00 - 09:20	Opening (Sponsor Commercial/Opening-General Chair/SC Chair/TPC Report & Best Paper Award)													
09:20 - 10:00	KNTU-S1: Keynote: Next Steps and Challenges of 5G Network													
10:00 - 10:40	KNTU-S2: Keynote: Challenges and Opportunities of 5G Mobile Edge Cloud													
10:40 - 11:00	Break													
11:00 - 12:30	T1-S1: Millimeter-Wave Systems 1	T1-S2: Deep Learning for Wireless Communications 1	T1-S3: Energy Efficiency in 5G and hetNets		T2-S1: Multiple Access	T3-S1: Learning 1	T3-S2: Sensor Network and IoT 1	T3-S3: Fog Computing and Networking		T4-S1: Streaming and Video	T4-S2: Security and Privacy			
12:30 - 14:00	Lunch													
14:00 - 15:30	T1-S4: NOMA (Non-Orthogonal Multiple Access)	T1-S5: NextGeneration Communications	T1-S6: Channel Modeling	T1-S7: Waveform and Modulation	T2-S2: Learning-Assisted Optimization	T3-S4: Localization	T3-S5: Energy Efficiency	T3-S6: Routing		T4-S3: Localization and Tracking				
15:30 - 16:00	Break													
16:00 - 17:30	T1-S8: Low Latency Communications	T1-S9: Deep Learning for Wireless Communications 2	T1-S10: Multiple Access and Interference Management		T2-S3: Scheduling and Radio Resource Management	T3-S7: Learning 2	T3-S8: Sensor Network and IoT 2	T3-S9: Device-to-Device Communication		T4-S4: URLLC	T4-S5: Vehicular Networks			

Conference will be held in Korea Standard Time
TRACK 1: PHY AND FUNDAMENTALS
TRACK 2: MAC AND CROSS-LAYER DESIGN
TRACK 3: WIRELESS NETWORKS
TRACK 4: EMERGING TECHNOLOGIES, ARCHITECTURES AND SERVICES
DEMO SESSION

## PROGRAM-AT-A-GLANCE

Wednesday, 27 May 2020 - Main Conference														
Time (KST)	Room 1	Room 2	Room 3	Room 4	Room 5	Room 6	Room 7	Room 8	Room 9	Room 10	Room 11	Room 12	Room 13	Room 14
09:00 - 09:10	Opening Session (WCNC 2021 Introduction)													
09:10 - 09:50	KNWE-S1: Keynote: 6G - A Step Beyond Stretching 5G													
09:50 - 10:30	KNWE-S2: Keynote: Into the Future Wireless													
10:30 - 11:00	Break													
11:00 - 12:30	T1-S11: Millimeter-Wave Systems 2	T1-S12: Multiantenna System	T1-S13: Information Theory and Capacity		T2-S4: Resource Allocation	T3-S10: Mobile Edge Computing 1	T3-S11: NOMA (Non-Orthogonal Multiple Access)	T3-S12: Vehicular Network 1		T4-S6: Edge Computing and Caching				
12:30 - 14:00	Lunch													
14:00 - 15:30	T1-S14: Signal Processing for Millimeter-Wave and THz Communications	T1-S15: Networking Application	T1-S16: Resource Management and Optimization		T2-S5: Cross-Layer MAC Design	T3-S13: Mesh, Relay, and Ad Hoc Networks	T3-S14: Measurement and Analytics 1	T3-S15: Services and Applications		T4-S7: Learning for Networks	DEMO Session			
15:30 - 16:00	Break													
16:00 - 17:30	T1-S17: 5G Wireless Communications	T1-S18: Signal Detection and Estimation	T1-S19: Energy Efficient Communications		T2-S6: Wireless MAC for 5G	T3-S16: Mobile Edge Computing 2	T3-S17: Measurement and Analytics 2	T3-S18: Vehicular Network 2	T3-S19: 5G	T4-S8: Cellular Networks and 5G				
Thursday, 28 May 2020 - Main Conference														
Time (KST)	Room 1	Room 2	Room 3	Room 4	Room 5	Room 6	Room 7	Room 8	Room 9	Room 10	Room 11	Room 12	Room 13	Room 14
09:00 - 09:05	Opening Session (Best Demo Award)													
09:05 - 09:40	KNTH-S1: Keynote: A Fresh Look at an Old Problem: Network Utility Maximization - Convergence, Delay, and Complexity													
09:40 - 10:20	KNTH-S2: Keynote: Toward One Network Era: Integrated Terrestrial-Satellite Communication													
10:20 - 10:40	Break													
10:40 - 12:10	T1-S20: Massive MIMO 1	T1-S21: Coding Scheme 1	T1-S22: Performance Analysis 1		T2-S7: Scheduling	T3-S20: UAV (Unmanned Aerial Vehicle) 1	T3-S21: Security and Privacy 1	T3-S22: Resource Management and Optimization 1		T4-S9: Recognition and Prediction	T4-S10: Crowdsourcing and Incentive Mechanism			
12:10 - 14:00	Lunch													
14:00 - 15:30	T1-S23: Machine-Type Communications	T1-S24: Polar Code	T1-S25: Performance Analysis 2	T1-S26: Hardware and Implementation		T3-S23: Mobility and Handoff Management	T3-S24: Rate Control and Transport Protocol	T3-S25: Resource Management and Optimization 2		T4-S11: Low Power and IoT	T4-S12: Communications with UAVs			
15:30 - 16:00	Break													
16:00 - 17:30	T1-S27: Massive MIMO 2	T1-S28: Coding Scheme 2	T1-S29: Transceiver Design			T3-S26: UAV (Unmanned Aerial Vehicle) 2	T3-S27: Security and Privacy 2	T3-S28: Resource Management and Optimization 3	T3-S29: Multi-Connectivity	T4-S13: Hybrid Satellite Networks	T4-S14: mmWave and Optical Wireless			
End of Program														

Conference will be held in Korea Standard Time	
TRACK 1: PHY AND FUNDAMENTALS	
TRACK 2: MAC AND CROSS-LAYER DESIGN	
TRACK 3: WIRELESS NETWORKS	
TRACK 4: EMERGING TECHNOLOGIES, ARCHITECTURES AND SERVICES	
DEMO SESSION	



# MESSAGE FROM GENERAL CHAIRS

It is my great honor to welcome you to the IEEE Wireless Communications and Networking Conference (WCNC) 2020 virtual edition. The WCNC 2020 Organizing Committee, with support of IEEE, has been monitoring the evolving COVID-19 pandemic. Since the safety and well-being of all conference participants is a top priority, we have decided to virtually hold the 2020 edition of this conference from the 25th to the 28th of May.

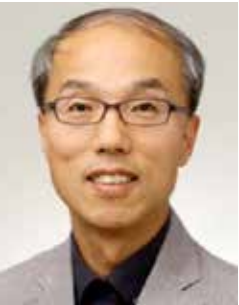
IEEE WCNC is the world premier wireless event that brings together industry professionals, academics, and individuals from government agencies and other institutions. It will provide an opportunity to exchange information and ideas on the advancement of wireless communications and networking technology, especially after the launch of 5G last year. We are proud to continue our tradition with a number of exciting programs at WCNC 2020 under the theme of “Beyond Connectivity: What Comes After 5G”. We are sure you will enjoy our program including keynote speeches, technical sessions, demo sessions, 10 tutorials, and 13 workshops. The keynotes consist of four talks from industrial leaders (Samsung, Huawei, ETRI, and SK Telecom) and two talks from renowned academics.

On behalf of IEEE ComSoc and the WCNC Steering Committee, we would like to take this opportunity to extend our thanks and appreciation to the sponsors for their continued support to the conference, and express our sincere gratitude to the members of the Organizing Committee, TPC members, reviewers, volunteers, and IEEE ComSoc staff for their efforts and contributions to the success of the conference.

South Korea is expected to successfully win first in the big fight against Corona 19. However, we cannot avoid the tunnel of difficulties until the global economy recovers because the world is closely connected. We hope the whole world overcomes this difficult time together. We wish you and your family healthy, and hope to see you all in the face-to-face WCNC 2021 with healthy faces next year.

Sincerely,

**General Chair**  
Saewoong Bahk  
(Seoul National University, Korea)



**Saewoong Bahk**

# MESSAGE FROM TPC CHAIRS

Welcome to the 2020 edition of the IEEE Wireless Communications and Networking Conference (IEEE WCNC 2020)! The spirit of this year’s conference is “Beyond Connectivity: What comes after 5G”.

Thanks to the great support of researchers in the global wireless communications and networking community, the conference has originally received 1,093 papers, of which 400 have eventually been accepted with at least 3 rigorous peer reviews. In more details, Track 1 “PHY and Fundamentals” has 144 papers which are presented in 28 Sessions; Track 2 “MAC and Cross-Layer Design” has 36 papers in 7 Sessions; Track 3 “Wireless Networks” has 148 papers in 29 Sessions; and Track 4 “Emerging Technologies, Architectures and Services” has 72 papers in 14 Sessions. In addition, the program is dotted with exciting workshops and special sessions, panels, tutorials, demos and of course our flagship plenary keynotes. 10 workshops received 207 papers, of which 101 have been accepted.

We would like to express our sincere gratitude to 841 TPC members and all the reviewers for their excellent work and enthusiastic support, delivering more than 2,830 reviews with high quality and in a timely manner. In particular, we would like to thank the TPC Vice Chair for Information Systems: Sangheon Pack, and the TPC Track Chairs: Byonghyo Shim, Lingyang Song, Jemin Lee, Daniel B. da Costa, Changhee Joo, Haijun Zhang, Bo Ji, Jianwei Huang, Jeongyeup Paek, Dongxiao Yu, Carlo Fischione, Tony Quek, Kyunghan Lee, Mianxiong Dong, Walid Saad and Theodoros Salonidis, for their dedication and hard work.

We would also like to thank the authors of all the submitted papers. We encourage all of you to attend the virtual conference and do enjoy the high quality presentations! We are looking forward to an exciting conference with many stimulating discussions over keynotes, panels and technical sessions.

Thank you,

**Song Chong**  
(KAIST, Korea)  
TPC Chair, IEEE WCNC 2020

**Sunghyun Choi**  
(Samsung Research, Korea)  
TPC Chair, IEEE WCNC 2020

**Zhisheng Niu**  
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Seok-Hwan Park (Jeonbuk National University, Korea)  
Kostas Peppas (University of Peloponnese, Greece)

# COMMITTEES

Dimitrie Popescu (Old Dominion University, USA)  
Charly Poulliat (INP - ENSEEIHT Toulouse, France)  
Shankar Prakriya (Indian Institute of Technology, Delhi, India)  
Chenhao Qi (Southeast University, China)  
Tianzhu Qiao (Apple, USA)  
Redha Radaydeh (Texas A&M University-Commerce, USA)  
Vasanthan Raghavan (Qualcomm, Inc., USA)  
Md. Jahidur Rahman (Qualcomm Technologies, Inc., USA)  
B. Sundar Rajan (Indian Institute of Science, India)  
Danda Rawat (Howard University, USA)  
Taneli Riihonen (Tampere University, Finland)  
George Ropokis (CentraleSupélec, France)  
Poompat Saengudomlert (Bangkok University, Thailand)  
Nikos Sagias (University of Peloponnese, Greece)  
Abed Ellatif Samhat (Lebanese University, Lebanon)  
Yukitoshi Sanada (Keio University, Japan)  
Rafael Schaefer (Technische Universität Berlin, Germany)  
Anke Schmeink (RWTH Aachen University, Germany)  
Robert Schober (University of British Columbia, Canada)  
Aydin Sezgin (RUB, Germany)  
Hangguan Shan (Zhejiang University, China)  
Mohammad Shaqfeh (Texas A&M University at Qatar, Qatar)  
Vinod Sharma (Indian Institute of Science, India)  
Wenqian Shen (Beijing Institute of Technology, China)  
Yuan Shen (Tsinghua University, China)  
Hyundong Shin (Kyung Hee University, Korea)  
Oh-Soon Shin (Soongsil University, Korea)  
Wonjae Shin (Pusan National University, Korea)  
Kenneth Shum (Institute of Network Coding, Hong Kong)  
Adão Silva  
(Instituto de Telecomunicações IT/University of Aveiro, Portugal)  
Hing Cheung So (City University of Hong Kong, Hong Kong)  
Paschalis Sofotasios (Khalifa University, Finland)  
Insoo Sohn (Dongguk University, Korea)  
Youngwook Son (Seoul National University, Korea)  
Changick Song (Korea National University of Transportation, Korea)  
Houbing Song (Embry-Riddle Aeronautical University, USA)  
Andreas Springer (Johannes Kepler University Linz, Austria)  
Heidi Steendam (Ghent University, Belgium)  
Li Sun (Xi'an Jiaotong University, China)  
Weiping Sun (Nanyang Technological University, Singapore)  
Youngchul Sung (KAIST, Korea)  
Himal Suraweera (University of Peradeniya, Sri Lanka)  
Tommy Svensson (Chalmers University of Technology, Sweden)  
Hina Tabassum (York University, Canada)  
Stefano Tomasin (University of Padova, Italy)  
Kamel Tourki (Huawei Technologies Co. Ltd, France)  
Theodoros Tsiftsis (Jinan University, China)  
Charalampos Tsimenidis  
(Newcastle University, United Kingdom Great Britain)  
Christos Tsinos (University of Luxembourg, Luxembourg)  
George Tsoulos (University of Peloponnese, Greece)  
Momin Uppal  
(Lahore University of Management Sciences, Pakistan)  
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Mikko Valkama (Tampere University of Technology, Finland)  
Luc Vandendorpe (Université catholique de Louvain, Belgium)  
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Giorgio M. Vitetta (University of Modena and Reggio Emilia, Italy)  
Pascal Vontobel  
(The Chinese University of Hong Kong, Hong Kong)  
Demosthenes Vouyioukas (University of the Aegean, Greece)  
Thang Vu (University of Luxembourg, Luxembourg)  
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Dongming Wang (Southeast University, China)  
Chin-Der Wann (National Kaohsiung University of Science and Technology, Taiwan)  
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Hsiao-Chun Wu (Louisiana State University, USA)  
Yik-Chung Wu (The University of Hong Kong, Hong Kong)  
Dirk Wübben (University of Bremen, Germany)  
Xiang-Gen Xia (University of Delaware, USA)  
Ming Xiao (Royal Institute of Technology, Sweden)  
Chengwen Xing (Beijing Institute of Technology, China)  
Chenyang Yang (Beihang University, China)  
Heecheol Yang (Kumoh National Institute of Technology, Korea)  
H. Birkan Yilmaz (Universitat Politècnica de Catalunya UPC, Spain)  
Makoto Yoshida (Fujitsu Laboratories Ltd., Japan)  
Donghyun Yu (DGIST, Korea)  
Alberto Zanella (Istituto di Elettronica e di Ingegneria dell'Inform. e delle Telecomunicazioni, Italy)  
Honghai Zhang (Google, USA)  
Hongliang Zhang (University of Houston, USA)  
Li Zhang (University of Leeds, United Kingdom Great Britain)  
Ruoyu Zhang (Harbin Institute of Technology, China)  
Shunqing Zhang (Shanghai University, China)  
Wenyi Zhang  
(University of Science and Technology of China, China)  
Yimin Zhang (Temple University, USA)  
Miao Zhao (The Hong Kong Polytechnic University, Hong Kong)  
Fu-Chun Zheng (Harbin Institute of Technology, Shenzhen, China)  
Liang Zhou  
(Nanjing University of Posts and Telecommunications, China)  
Xu Zhu (University of Liverpool, United Kingdom Great Britain)  
Nikola Zogović (University of Belgrade, Serbia)  
Adamu Zungeru (Botswana International University of Science and Technology, Botswana)

.....

**Track 2: MAC and Cross Layer Design**  
Koichi Adachi (The University of Electro-Communications, Japan)  
Iwan Adhicandra (University of Sydney, Australia)  
Hamed Ahmadi (University of York, United Kingdom Great Britain)  
Saba Al-Rubaye  
(Cranfield University, United Kingdom Great Britain)  
Fatih Alagoz (Bogazici University, Turkey)  
Tara Ali Yahiya (University of Kurdistan Hewler, Iraq)  
Onur Altintas  
(Toyota Motor North America R&D, InfoTech Labs, USA)  
Farid Ashtiani (Sharif University of Technology, Iran)  
Giuseppe Avellone (STMicroelectronics, Italy)  
Sibi Raj B Pillai (IIT Bombay, India)  
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Uthman Baroudi  
(King Fahd University of Petroleum and Minerals, Saudi Arabia)  
Mats Bengtsson (KTH Royal Institute of Technology, Sweden)  
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Khaled Boussetta (University of Paris 13, France)  
Manoj Bs (Indian Institute of Space Science and Technology, India)  
Lin Cai (Illinois Institute of Technology, USA)  
Hsi-Lu Chao (National Chiao Tung University, Taiwan)  
Hakima Chaouchi  
(Telecom Sud Paris-Institut Mines Telecom, France)  
Prasanna Chaporkar (IIT Bombay, India)  
Ioannis Chatzigiannakis (Sapienza University of Rome, Italy)  
Chao-Lieh Chen (First Campus, National Kaohsiung University of Science and Technology, Taiwan)

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 Xu Chen (Sun Yat-sen University, China)  
 Yejian Chen (Bell Laboratories, Nokia, Germany)  
 Yi Chen (The Chinese University of Hong Kong, Shenzhen, China)  
 Yung-Fang Chen (National Central University, Taiwan)  
 Chien-Fu Cheng (Tamkang University, Taiwan)  
 Jihwan Choi  
 (Daegu Gyeongbuk Institute of Science and Technology, Korea)  
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 Massimiliano Comisso (University of Trieste, Italy)  
 Felipe Cruz-Pérez (Cinvestav-IPN, Mexico)  
 Swades De (Indian Institute of Technology Delhi, India)  
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 (TOBB University of Economics and Technology, Turkey)  
 M. Cenk Gursoy (Syracuse University, USA)  
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 Jun Huang (Chongqing University of Posts and Telecomm, China)  
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 Han-You Jeong (Pusan National University, Korea)  
 Xiaohong Jiang (Future University-Hakodate, Japan)  
 Ohyun Jo (Chungbuk National University, Korea)  
 Eduard Jorswieck (Technische Universität Braunschweig, Germany)  
 Joseph Kang (Nokia Bell Labs, USA)  
 Ezhan Karasan (Bilkent University, Turkey)  
 Gaurav Kasbekar (Indian Institute of Technology, Bombay, India)  
 Jamil Khan (The University of Newcastle, Australia)  
 Michel Kieffer  
 (L2S - CNRS - SUPELEC - UniversityParis-Sud, France)  
 Hongseok Kim (Sogang University, Korea)  
 Hwangnam Kim (Korea University, Korea)  
 Hyoil Kim (Ulsan National Institute of Science and Technology  
 UNIST, Korea)  
 Joongheon Kim (Korea University, Korea)  
 Song Min Kim (KAIST, Korea)  
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 Ibrahim Korpeoglu (Bilkent University, Turkey)  
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 Witold Krzymień (University of Alberta, Canada)  
 Parag Kulkarni (UAE University, United Arab Emirates)  
 Ko-Chi Kuo (National Sun Yat-sen University, Taiwan)  
 Sungoh Kwon (University of Ulsan, Korea)  
 Howon Lee (Hankyong National University, Korea)  
 Jang-Won Lee (Yonsei University, Korea)

Joohyun Lee (Hanyang University, Korea)  
Chenglin Li (Shanghai Jiao Tong University, China)  
Ruidong Li (National Institute of Information and Communications Technology NICT, Japan)  
Xi Li (Beijing University of Posts and Telecommunications, China)  
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Youjian Liu (University of Colorado at Boulder, USA)  
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Tat Lok (The Chinese University of Hong Kong, Hong Kong)  
Miguel López-Benítez  
(University of Liverpool, United Kingdom Great Britain)  
Kejie Lu (University of Puerto Rico at Mayaguez, Puerto Rico)  
Lu Lu (The Chinese University of Hong Kong, Hong Kong)  
King-Shan Lui (The University of Hong Kong, Hong Kong)  
Petri Mähönen (RWTH Aachen University, Germany)  
Fabio Martignon (University of Bergamo, Italy)  
Chulhong Min (Nokia Bell Labs, United Kingdom Great Britain)  
Hamed Mohsenian-Rad (University of California, Riverside, USA)  
Hassine Moun gla (University of Paris Descartes, France)  
Mohamed M. A. Moustafa (Egyptian Russian University, Egypt)  
Muhammad Naeem  
(COMSATS University Islamabad, Wah Campus, Pakistan)  
Keivan Navaie (Lancaster University, United Kingdom Great Britain)  
Derrick Wing Kwan Ng (University of New South Wales, Australia)  
Petros Nicopolitidis (Aristotle University, Greece)  
Juan Ivan Nieto Hipolito (UABC, Mexico)  
Youngtae Noh (Inha University, Korea)  
Loutfi Nuaymi (IMT Atlantique, France)  
Hiraku Okada (Nagoya University, Japan)  
Frank Oldewurtel  
(RheinMain University of Applied Sciences, Germany)  
Ertan Onur (Middle East Technical University, Turkey)  
Miao Pan (University of Houston, USA)  
Kevin Qixiang Pang (Lakehead University, Canada)  
Symeon Papavassiliou  
(ICCS/National Technical University of Athens, Greece)  
Nikolaos Pappas (Linköping University, Sweden)  
Parth Pathak (George Mason University, USA)  
Tommaso Pecorella (Università degli Studi di Firenze, Italy)  
Raphael Phan (Monash University, Malaysia)  
Pekka Pirinen (University of Oulu, Finland)  
Riccardo Raheli (University of Parma, Italy)  
Nandana Rajatheva (University of Oulu, Finland)  
Heejun Roh (Korea University, Korea)  
Roberto Rojas-Cessa (New Jersey Institute of Technology, USA)  
Nurul Sarkar (Auckland University of Technology, New Zealand)  
Mamoru Sawahashi (Tokyo City University, Japan)  
Boon-Chong Seet  
(Auckland University of Technology, New Zealand)  
Vahid Shah-Mansouri (University of Tehran, Iran)  
Yuan Shen (Tsinghua University, China)  
Chin-Shiuh Shieh (National Kaohsiung University of Science and Technology, Taiwan)  
Kuei-Ping Shih (Tamkang University, Taiwan)  
Shigeru Shimamoto (Waseda University, Japan)  
Sumit Singh (Moseley Wireless Solutions Group, USA)  
Youngwook Son (Seoul National University, Korea)  
Houbing Song (Embry-Riddle Aeronautical University, USA)  
Hui-Kai Su (National Formosa University, Taiwan)  
Masashi Sugano (Osaka Prefecture University, Japan)  
Weiping Sun (Nanyang Technological University, Singapore)  
Yin Sun (Auburn University, USA)  
Yutaka Takahashi (Kyoto University, Japan)  
Liansheng Tan (Central China Normal University, China)

## COMMITTEES

Ravi Tandon (University of Arizona, USA)  
 Danny Tsang (HKUST, Hong Kong)  
 Athanasios V. Vasilakos (Luleå University of Technology, Sweden)  
 Lei Wang (Dalian University of Technology, China)  
 Christian Wietfeld (TU Dortmund University, Germany)  
 Longfei Wu (Fayetteville State University, USA)  
 Qin Xin (University of the Faroe Islands, Faroe Islands)  
 Wen Xu (Huawei Technologies Duesseldorf GmbH, Germany)  
 Lei Yang (University of Nevada, Reno, USA)  
 Sung-Guk Yoon (Soongsil University, Korea)  
 Hao Yue (San Francisco State University, USA)  
 Chau Yuen  
 (Singapore University of Technology and Design, Singapore)  
 Jie Zhang (University of Sheffield, Dept. of Electronic and  
 Electrical Engineering, United Kingdom Great Britain)  
 Liqiang Zhang (Indiana University South Bend, USA)  
 Shunqing Zhang (Shanghai University, China)  
 Nikola Zogović (University of Belgrade, Serbia)  
 Anatolij Zubov (Technische Universität Berlin, Germany)

.....

### Track 3: Wireless Networks

Mohammad Abdel-Rahman (Virginia Tech, USA)  
 Iwan Adhichandra (University of Sydney, Australia)  
 Wessam Afifi (Mavenir Systems, USA)  
 Ramon Aguero (University of Cantabria, Spain)  
 Wessam Ajib (Université du Québec à Montréal, Canada)  
 Anwer Al-Dulaimi (EXFO Inc., Canada)  
 Michele Albano (Aalborg University, Denmark)  
 Onur Altintas  
 (Toyota Motor North America R&D, InfoTech Labs, USA)  
 Gayan Amarasuriya (Southern Illinois University, USA)  
 Santhanakrishnan Anand (New York Institute of Technology, USA)  
 Prasanth Ananth (Nokia Bell Labs, USA)  
 Farid Ashtiani (Sharif University of Technology, Iran)  
 Chadi Assi (Concordia University, Canada)  
 Stefano Avallone (University of Naples, Italy)  
 Seung Baek (Korea University, Korea)  
 Masaki Bandai (Sophia University, Japan)  
 Haythem Bany Salameh (Yarmouk University, Jordan)  
 Uthman Baroudi  
 (King Fahd University of Petroleum and Minerals, Saudi Arabia)  
 Gautam Bhanage (Cisco Systems, USA)  
 Azzedine Boukerche (University of Ottawa, Canada)  
 Khaled Boussetta (University of Paris 13, France)  
 Manoj Bs (Indian Institute of Space Science and Technology, India)  
 Carlos Alberto Campos  
 (Federal University of the State of Rio de Janeiro, Brazil)  
 Qing Cao (University of Tennessee, USA)  
 Filipe Cardoso (IST/NOV INESC/ESTsetubal, Portugal)  
 Marcelo Carvalho (University of Brasília, Brazil)  
 Hsi-Lu Chao (National Chiao Tung University, Taiwan)  
 Ioannis Chatzigiannakis (Sapienza University of Rome, Italy)  
 Periklis Chatzimisios (International Hellenic University, Greece)  
 Kang Chen (Southern Illinois University Carbondale, USA)  
 Yuh-Shyan Chen (National Taipei University, Taiwan)  
 Chien-Fu Cheng (Tamkang University, Taiwan)  
 Stefano Chessa (Università di Pisa, Italy)  
 Mauro Conti (University of Padua, Italy)  
 Pedro d'Orey (Instituto de Telecomunicações, Portugal)  
 Antonio de la Oliva (Universidad Carlos III de Madrid, Spain)  
 Renato de Moraes  
 (Federal University of Pernambuco UFPE, Brazil)  
 Carl Debono (University of Malta, Malta)

Ilker Demirkol (Universitat Politècnica de Catalunya, Spain)  
Soufiene Djahel (Manchester Metropolitan University, United Kingdom Great Britain)  
Mahmoud Doughan (Lebanese University, Faculty of Engineering, Branch 3, Lebanon)  
Falko Dressler (Paderborn University, Germany)  
Qinghe Du (Xi'an Jiaotong University, China)  
Zbigniew Dziong (École de technologie supérieure, University of Quebec, Canada)  
Khalil El-Khatib (University of Ontario Institute of Technology, Canada)  
Jocelyne Elias (Paris Descartes University, France)  
Khaled Elsayed (Cairo University, Egypt)  
Ozgur Ercetin (Sabanci University, Turkey)  
Lorenzo Favalli (University of Pavia, Italy)  
Mauro Femminella (University of Perugia, Italy)  
Stenio Fernandes (Element AI, Canada)  
Huei-Wen Ferng (National Taiwan University of Science and Technology, Taiwan)  
Andres Garcia-Saavedra (NEC Labs Europe, Germany)  
Rosario Garroppo (University of Pisa, Italy)  
Yacine Ghamri-Doudane (University of la Rochelle, France)  
Abolfazl Ghassemi (Iran Telecommunications Research Center, Iran)  
Navid Ghazisaidi (San Jose State University, USA)  
Javier Gozalvez (Universidad Miguel Hernandez de Elche, Spain)  
Marco Gramaglia (Universidad Carlos III de Madrid, Spain)  
Annie Gravey (Independent Expert, France)  
Zhen Guo (MOOG, USA)  
M. Cenk Gursoy (Syracuse University, USA)  
Sami Habib (Kuwait University, Kuwait)  
Yassine Hadjadj-Aoul (University of Rennes 1, France)  
Abdelhakim Hafid (University of Montreal, Canada)  
Gongzheng Han (Chinese Academy of Sciences, China)  
Jun Han (National University of Singapore, Taiwan)  
Tao Han (University of North Carolina at Charlotte, USA)  
Zhu Han (University of Houston, USA)  
Yieh-Ran Haung (Yuan Ze University, Taiwan)  
Ivan Wang-Hei Ho (The Hong Kong Polytechnic University, Hong Kong)  
Pin-Han Ho (University of Waterloo, Canada)  
Cunqing Hua (Shanghai Jiao Tong University, China)  
Shih-Chang Huang (National Formosa University, Taiwan)  
Ganguk Hwang (KAIST, Korea)  
Lillykutty Jacob (National Institute of Technology Calicut, India)  
Abbas Jamalipour (University of Sydney, Australia)  
Seungbeom Jeong (Seoul National University, Korea)  
Yusheng Ji (National Institute of Informatics, Japan)  
Anxiao Andrew Jiang (Texas A&M University, USA)  
Xiaohong Jiang (Future University-Hakodate, Japan)  
Yuming Jiang (Norwegian University of Science and Technology NTNU, Norway)  
Yurong Jiang (HP Labs, USA)  
Ohyun Jo (Chungbuk National University, Korea)  
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Holger Karl (Paderborn University, Germany)  
Gaurav Kasbekar (Indian Institute of Technology, Bombay, India)  
Ahmed Khattab (Cairo University, Egypt)  
Donghyun Kim (Kennesaw State University, USA)  
Florian Klingler (Paderborn University, Germany)  
JeongGil Ko (Yonsei University, Korea)  
R. Prasad Kodaypak (AT&T Labs, USA)  
Linghe Kong (Shanghai Jiao Tong University, China)  
Peng-Yong Kong (Khalifa University, United Arab Emirates)



## COMMITTEES

Charalampos Konstantopoulos (University of Piraeus, Greece)  
 Georgios Kormentzas (University of the Aegean, Greece)  
 Tian Lan (George Washington University, USA)  
 Gilsoo Lee (Virginia Tech, USA)  
 Howon Lee (Hankyong National University, Korea)  
 HyungJune Lee (Ewha Womans University, Korea)  
 Jack Y. B. Lee (The Chinese University of Hong Kong, Hong Kong)  
 Kyungmin Lee (Facebook, USA)  
 Zander Zhongding Lei  
 (Huawei Singapore Research Center, Singapore)  
 Ka-Cheong Leung  
 (Harbin Institute of Technology, Shenzhen, China)  
 Chenglin Li (Shanghai Jiao Tong University, China)  
 Wenjia Li (New York Institute of Technology, USA)  
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 Maria Luisa Merani (University of Modena and Reggio Emilia, Italy)  
 Chulhong Min (Nokia Bell Labs, United Kingdom Great Britain)  
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 Kevin Qixiang Pang (Lakehead University, Canada)  
 Symeon Papavassiliou  
 (ICCS/National Technical University of Athens, Greece)  
 Nikolaos Pappas (Linköping University, Sweden)  
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Tommaso Pecorella (Università degli Studi di Firenze, Italy)  
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Andrej Stefanov (IBU Skopje, Macedonia, the former Yugoslav Republic of Macedonia)  
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Marcos Vieira (Universidade Federal de Minas Gerais, Brazil)  
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Wei Yuan  
(Huazhong University of Science and Technology, China)  
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Qiang Zeng (University of South Carolina, USA)

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IEEE WCNC 2020 13

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KEYNOTE SPEAKERS

TUESDAY, 26 MAY 2020 • 9:20 am – 10:40 am



**YOUNG LEE**  
Head of Network Architecture, Samsung

*Next Steps And Challenges of 5G Network Evolution*

On April 2019, the world-first 5G network was launched commercially in South Korea. The early stage of 5G roll-out was targeted only to enhanced Mobile BroadBand (eMBB) service, and its control depended on LTE as an anchor. The real 5G will come with more enhanced features to support higher capacity, Integrated Access & Backhaul (IAB), Ultra-Reliable and Low Latency Communications (URLLC), Industrial IoT, Vehicle-to-everything (V2X), and AR/VR. 5G Stand-alone (SA) deployment is a first step to show full potential of 5G as 5G SA brings the foundation for end-to-end (E2E) service pipeline across different domains –Radio Access Network (RAN), Core Network (CN), Transport Network (TN), and Data Network (DN) – to accelerate innovations of Mobile Network Operators (MNO). While innovations are important, network monetization and Operating Expenditure (OPEX)/ Capital Expenditure (CAPEX) reduction are key concerns of Mobile Network Operators (MNOs) to justify huge investment costs. In this regard, the benefits from virtualization, network slicing and automation are driving forces for 5G network evolution. This talk explores the technological challenges from trending areas such as virtualized RAN, E2E network slicing, and network automation. In addition, this talk presents a view on the central role of virtualization and cloudification towards technological innovation and cost reduction.

**Biography:** Young Lee has been in telecommunication industry over 30 years. His specialty includes network architecture, SDN/NFV, network orchestration, 5G transport and core network design, network control and management. He is currently Head of Network Architecture at Samsung Electronics Networks Business where he is leading network architecture evolution and strategy to transform various elements such as RAN, Core, Transport with AI/NFV/SDN and Orchestration into integrated solutions. At Huawei US Research center in Texas USA (2006-2019) he was Technical Senior Director and Distinguished Engineer and led several key technology concept developments, standardization and evangelization in the areas of optical control plane, path computation, transport SDN, network cloud platform and orchestration. At Ceterus Network (2001-2006), he was Co-Founder and Chief Network Architect and led a large-scale packet switching system development. At AT&T Labs (1995-2000), He was Principal Member of Technical Staff where he led various systems engineering projects including AT&T next generation router evolution, AT&T common IP/MPLS backbone routing and management, etc. At AT&T Bell Labs (1987-1995), he was Member of Technical Staff and led several routing and switching system engineering projects and network traffic management system development. He received B.A. in Applied Mathematics from U.C. Berkeley (1986), M.S. in Operations Research from Stanford University (1987), and Ph.D. in Decision Science and Engineering Systems from Rensselaer Polytechnic Institute (1996) via AT&T Bell Labs’ doctoral support program.



**KANG-WON LEE**  
Vice President and Head of Cloud Labs of SK Telecom

*Challenges and Opportunities of 5G Mobile Edge Cloud*

The 5G services require a network with “high bandwidth and ultra-low latency.” High bandwidth can be enabled by wider frequency bands. To achieve ultra-low latency, however, network operators have come up with the concept of “mobile edge.” By leveraging mobile edge, we can deliver novel 5G applications that can benefit from sub 10msec latency, such as cloud XR, cloud gaming, connected cars, cloud robots. While providing ultra-low latency itself is useful, this does not fully justify the cost of deployment of numerous edge sites. In fact, it is not difficult to see mobile edge provides a couple of additional benefits: (1) huge volumes of data (that may be generated by, for example, connected cars) can be processed at the edge instead of sending them to a remote data center, which is extremely costly; (2) mission-critical and sensitive data from a smart factory or hospital can be processed at the edge without leaving the site. By enabling edge data processing and local security, mobile edge provides a unique opportunity for mobile service providers to bring new values to its B2C and B2B customers. In this keynote, I propose that mobile edge should be “programmable” and “cloud native.” This does not mean just running a few VMs at the edge site. At SKT we are developing its mobile edge as a fully functioning cloud. SKT’s MEC or “mobile edge cloud” will provide virtualized infrastructure with Kubernetes, serverless, and service mesh support. We are also pairing our MEC with public clouds so that our users have options to quickly build new applications using widely understood cloud APIs and services. In addition, we will provide our unique service assets, such as telco APIs, natural language processing, real-time data processing, etc. “as a service” to developers so they can quickly build something that was truly not possible before. I will conclude this talk by presenting several early use cases that we are developing on 5G MEC with our partners.

**Biography:** As Vice President and Head of Cloud Labs of SK Telecom, Dr. Kang-Won Lee has been leading the research and development of cloud technologies to expand the company’s 5G service portfolio and strengthen its leadership. He is currently developing innovative technologies aimed at enhancing customer’s experience and value. They include 5G MEC, telco cloud infrastructure to provide next-generation 5G services, such as cloud gaming, autonomous driving or 5G robots. Before joining SK Telecom, he worked at IBM Watson Research Center in New York for 14 years leading a number of R&D projects as Research Manager, and successfully applied his R&D results to IBM’s main products, such as Informix and Tivoli. He received his bachelor and master’s degrees from Seoul National University and a doctor’s degree in Computer Science from University of Illinois Urbana-Champaign (UIUC).



# KEYNOTE SPEAKERS

WEDNESDAY, 27 MAY 2020 • 9:10 am – 10:30 am



**GERHARD FETTWEIS**

Vodafone Chair Professor, Technische Universität Dresden

## **6G – A Step Beyond Stretching 5G**

The initial vision of cellular communications was to deliver ubiquitous voice communications to anyone anywhere. However, only 2G delivered this promise. It also initiated the appetite for cellular data, for which 3G was designed. However, we needed 4G to deliver energy efficient broadband cellular data. With 5G the promise is to start the Tactile Internet, controlling real and virtual objects in real-time via cellular. It seems, that we need to stretch 5G to the next step, 6G. We seem to need 2 generations to bring a new service to fruition, with odd generations initiating and even ones making it happen. The physical air interface also has 2 generations of technology ripening, however even ones initiating it and odd completing it (CDMA: 2G and 3G, OFDM: 4G and 5G). If generations stay the same, we are ready for a revolution in air interface to happen with 6G, to “stretch the goals of 5” such that 6G can deliver the promises made. However, here we will also show new opportunities ahead, going far beyond stretching goals, as e.g. increasing data rate and reducing latency. With some first experimental results, this talk shall deliver a vision as well as some validation of what could become possible. In particular, we will discuss using the physical layer also for sensing, expanding the current focus of cellular one big step forward. Also, the current cellular network comprising 2 basic functions, i.e. service delivery via layer 1-7, and network management, must be expanded by adding a third layer for delivering integrity. Finally, today’s data traffic is dominated by video delivery. Will this stay that way?

**Biography:** Prof. Gerhard P. Fettweis, F’09, earned a Ph.D. under H. Meyr at RWTH Aachen. After a postdoc at IBM Research, San Jose, he joined TCSI, Berkeley. Since 1994 he is Vodafone Chair Professor at TU Dresden. Since 2018 he heads the Barkhausen Institute. 2019 he was elected into the DFG Senate. He researches wireless transmission and chip design, and coordinates e.g. the 5GLab Germany, has spun-out 17 startups, and is member the German Academy of Sciences “Leopoldina”, and German Academy of Engineering “acatech”.



**JIANMIN LU**

Executive Director, Huawei Wireless Technology Lab

## **Into the Future Wireless**

The 5G has already been commercially deployed since last year and people, especially Korean customers, enjoy the benefit of 2C business. Although the standard of 3GPP R16 will be released shortly in 2020 and this will be the full formal 5G, i.e. IMT2020 compliant, the research and standard to evolve 5G will not stop. While 5G is opening the door of digital transformation of many aspects of our life, industry, business and even the whole society, the future of wireless is yet to be discovered. Since the first generation of mobile technology, the mobile industry has experienced significant growth driven by ‘subscription dividend’ and ‘traffic dividend’. The next dividend is believed to be the “connection dividend” or even “intelligence dividend”. In addition, sensing (including accurate positioning, imaging etc.) will be a novel capability of future network, enabling “everything sensing”, “everything connected” and “everything intelligent”. On the other hand, the sheer number of connected devices and objects will not only create unprecedented growth of data traffic and massive connections, but also create a substantial increase in energy consumption across all parts of the network. Energy efficiency in wireless networks is now a growing concern for network operators to not only reduce the network operation costs, but also as a social obligation, to reduce greenhouse gas emissions. Moreover, higher frequency (mmWave and THz) band provides abundant spectrum for Tbps data rate, while it also brings about paradigm shift in the whole system design. The research challenges and technology breakthroughs required to deliver the vision for future wireless will be presented in this talk.

**Biography:** Jianmin Lu joined the Huawei Technologies in 1999. During the last two decades, he conducted various researches on wireless communications especially on physic layer and MAC layer and developed 3G, 4G and 5G products. He received more than 50 patents during the research. He was deeply involved in 3GPP2 (EVDO/UMB), WiMAX/802.16m and 3GPP (LTE/NR) standardization and contributed several key technologies such as flexible radio frame structure, radio resource management and MIMO. His current research interest is in the area of signal processing, protocol and networking for the next generation wireless communication. He is currently Executive Director of Huawei Wireless Technology Lab.

# KEYNOTE SPEAKERS

THURSDAY, 28 MAY 2020 • 9:05 am – 10:20 am



**NESS B. SHROFF**

Ohio Eminent Scholar in Networking and Communications,  
Chaired Professor of ECE and SCE, The Ohio State University

## **A Fresh Look at an Old Problem: Network Utility Maximization – Convergence, Delay, and Complexity**

Network Utility Maximization has been studied for resource allocation problems in communication networks for nearly two decades. Nonetheless, a major challenge that continues to remain open is how to develop a distributed congestion control and routing algorithm that can simultaneously provide utility optimality, fast convergence speed, and low delay. To address this challenge we take a fresh perspective on this old problem and develop a new algorithm that offers the fastest known convergence speed, vanishing utility optimality gap with finite queue length, and low routing complexity. Our key contributions in this work are: i) the design of a new joint congestion control and routing algorithm based on a type of inexact Uzawa method in the Alternating Directional Method of Multiplier; ii) a new theoretical path to prove global and linear convergence rate without requiring the full rank assumption of the constraint matrix; and iii) a clear path for implementing the proposed method in a fully distributed fashion.

**Biography:** Ness Shroff received the Ph.D. degree in electrical engineering from Columbia University in 1994. He joined Purdue University immediately thereafter as an Assistant Professor with the School of Electrical and Computer Engineering. At Purdue, he became a Full Professor of ECE and the director of a university-wide center on wireless systems and applications in 2004. In 2007, he joined The Ohio State University, where he holds the Ohio Eminent Scholar Endowed Chair in networking and communications, in the departments of ECE and CSE. He holds or has held visiting (chaired) professor positions at Tsinghua University, Beijing, China, Shanghai Jiaotong University, Shanghai, China, and IIT Bombay, Mumbai, India. He has received numerous best paper awards for his research and is listed in Thomson Reuters’ on The World’s Most Influential Scientific Minds, and has been noted as a Highly Cited Researcher by Thomson Reuters in 2014 and 2015. He currently serves as the steering committee chair for ACM Mobihoc and Editor at Large of the IEEE/ACM Transactions on Networking. He received the IEEE INFOCOM Achievement Award for seminal contributions to scheduling and resource allocation in wireless networks.



**WOO-JIN BYUN**

Assistant Vice President, Radio Satellite Research Division, ETRI

## **Toward One Network Era: Integrated Terrestrial-Satellite Communication**

With the development of mobile communication technology, wireless data transmission speed is increasing, but the communication range is narrowing. In particular, millimeter wave 5G is expected to provide Gbps data services mainly in the hot spot area. Despite the development of mobile communication networks, there are still many coverage holes which mobile communication cannot provide data services. Covering all these shaded areas with a mobile communication network would be expensive. Moreover, people want to be provided with high-quality data services on airplanes and cruise ships. To this end, satellite and terrestrial communication networks are being integrated. Satellites have traditionally served to provide telecommunications services to disaster areas where terrestrial networks have collapsed. In addition, it has been providing broadcasting and communication services to marine areas and island-mountainous areas that do not reach the ground network. Terrestrial-Satellite communication network will be able to provide much higher quality services. In this talk, I would like to point out the development direction of terrestrial-satellite communication technology. In addition, the main technologies in the field of terrestrial-satellite communication required for the 5G+ / 6G era will be explained.

**Biography:** Woo-Jin Byun received Ph.D. degrees in electrical engineering from the Korea Advanced Institute of Science and Technology, (KAIST) Daejeon, Korea, in 2000. In 1999, he joined Samsung Electro-Mechanics Company, Suwon, Korea, where he developed mobile communication devices such as power amplifiers and radio modules from 1999 to 2004. Since 2004, he has been a member of researchers in ETRI. He has received best paper award at ETRI Journal, best researcher from KIEES and certificate of the Minister of Science and ICT (Korea Government). He serves as a member of Editorial Committee at ETRI Journal. He was with the ATHENA group at Georgia Institute of Technology as a visiting scholar from 2015 to 2016. He is currently serving as Assistant Vice President for Radio Satellite Research Division at ETRI.



Tuesday, 26 May 2020  
11:00 - 12:30 • Room 01

**T1-S1: Millimeter-Wave Systems 1**  
**Chair:** Seungnyun Kim  
(Seoul National University, South Korea)

**An Analytical Model for Efficient Indoor THz Access Point Deployment**  
Rohit Singh and Doug Sicker  
(Carnegie Mellon University, USA)

**Opportunistic Hybrid Beamforming Based on Adaptive Perturbation for mmWave Multi-User MIMO Systems**  
Thuan Van Le and Kyungchun Lee (Seoul National University of Science and Technology, South Korea)

**Maximum Sub-Array Diversity for mmWave Network Under RF Power Leakage and Distortion Noises**  
Leila Tiebaldiyeva and Behrouz Maham  
(Nazarbayev University, Kazakhstan)  
Olav Tirkkonen (Aalto University, Finland)

**Enabling Massive Connections Using Hybrid Beamforming in Terahertz Micro-Scale Networks**  
Hang Yuan (Beijing Institute of Technology, China)  
Nan Yang (The Australian National University, Australia)  
Kai Yang (Beijing Institute of Technology, China)  
Chong Han (Shanghai Jiao Tong University, China)  
Jianping An (Beijing Institute of Technology, China)

**Particle Swarm Optimization Inspired Low-Complexity Beamforming for mmWave Massive MIMO Systems**  
Lina Hou (Inner Mongolia University, China)  
Yang Liu (Institute of Electronic Information Engineering, Inner Mongolia University, China)  
Xuehui Ma and Yuting Li (Inner Mongolia University, China)  
Shun Na (Institute of Electronic Information Engineering, Inner Mongolia University, China)  
Minglu Jin (Dalian University of Technology, China)

Tuesday, 26 May 2020  
11:00 - 12:30 • Room 02

**T1-S2: Deep Learning for Wireless Communications 1**  
**Chair:** Wonjae Shin (Pusan National University, South Korea)

**Adversarial Jamming Attacks on Deep Reinforcement Learning Based Dynamic Multichannel Access**  
Chen Zhong, Feng Wang, M. Cenk Gursoy and Senem Velipasalar (Syracuse University, USA)

**Multi-Agent Deep Reinforcement Learning for Secure UAV Communications**  
Yu Zhang (Tsinghua University, China)  
Zirui Zhuang (Beijing University of Posts and Telecommunications, China)  
Feifei Gao (Tsinghua University, China)  
Jingyu Wang  
(Beijing University of Posts and Telecommunications, China)  
Zhu Han (University of Houston, USA)

**Autoencoder Based Friendly Jamming**  
Bui Minh Tuan  
(University of Engineering and Technology, Vietnam)  
Duc-Tuyen Ta (LRI, Université Paris Saclay, France and University of Engineering & Technology, VNU-HN, Vietnam)  
Nguyen Linh Trung  
(Vietnam National University, Hanoi, Vietnam)  
Nguyen Viet Ha (VNU Ha Noi, Vietnam)

**Exploiting a Low-Cost CNN with Skip Connection for Robust Automatic Modulation Classification**  
Thien Huynh-The  
(Kumoh National Institute of Technology, South Korea)  
Cam-Hao Hua (Kyung Hee University, South Korea)  
Jae Woo Kim, Seung-Hwan Kim and Dong Seong Kim  
(Kumoh National Institute of Technology, South Korea)

**A Linear Bayesian Learning Receiver Scheme for Massive MIMO Systems**  
Alva Kosasih, Wibowo Hardjawana and Branka Vucetic  
(The University of Sydney, Australia)  
Chao-Kai Wen (National Sun Yat-sen University, Taiwan)

Tuesday, 26 May 2020  
11:00 - 12:30 • Room 03

**T1-S3: Energy Efficiency in 5G and hetNets**  
**Chair:** Wan Choi  
(Seoul National University & KAIST, South Korea)

**Energy Harvesting-Enabled Full-Duplex DF Relay Systems with Improper Gaussian Signaling**  
Jhe-Yi Lin and Ronald Y. Chang (Academia Sinica, Taiwan)  
Hen-Wai Tsao and Hsuan-Jung Su  
(National Taiwan University, Taiwan)

**Low-Complexity Hybrid Precoding and Combining Scheme Based on Array Response Vectors**  
Kyungchun Lee and Eduard Bahingayi (Seoul National University of Science and Technology, South Korea)

**Energy Efficiency Optimization for Beam-space Massive MIMO Systems with Low-Resolution ADCs**  
Hualian Sheng and Xihan Chen (Zhejiang University, China)  
Kaiming Shen (University of Toronto, Canada)  
Xiongfei Zhai (Guangdong University of Technology, China)  
An Liu and Minjian Zhao (Zhejiang University, China)

**Energy-Efficient Design for Massive Access in B5G Cellular Internet of Things**  
Xiaoming Chen and Feiyan Tian (Zhejiang University, China)

**Energy Efficient Ultra-Dense Network Using Long Short-Term Memory**  
Junwon Son, Seungnyun Kim and Byonghyo Shim  
(Seoul National University, South Korea)

Tuesday, 26 May 2020  
11:00 - 12:30 • Room 05

**T2-S1: Multiple Access**  
**Chair:** Minseok Choi (Jeju National University, USA)

**LiSCAN: Visible Light Uni-Directional Control Channel for Uplink Radio Access**  
Sharan Naribole (Samsung Semiconductor, Inc., USA)  
Edward W. Knightly (Rice University, USA)

**A Joint Angle and Distance Based User Pairing Strategy for Millimeter Wave NOMA Networks**  
Xiaolin Lu and Yong Zhou (ShanghaiTech University, China)  
Vincent W.S. Wong (University of British Columbia, Canada)

**An Adapted RFID Anti-Collision Algorithm in a Dynamic Environment**  
Weiping Zhu and Mingzhe Li (Wuhan University, China)  
Jiannong Cao  
(Hong Kong Polytechnic University, Hong Kong)  
Xiaohui Cui (Wuhan University, China)

**A Simple Novel Idle Slot Prediction and Avoidance Scheme Using Prediction Bits for DFSA in RFID**  
Gan Luan  
(Beijing University of Posts and Telecommunications, China)  
Norman C Beaulieu (Beijing University of Posts and Telecommunications BUPT, China)

**ML Estimation and MAP Estimation for Device Activity in Grant-Free Massive Access with Interference**  
Dongdong Jiang (Shanghai Jiao Tong University, China)  
Ying Cui (Shanghai Jiaotong University, China)

Tuesday, 26 May 2020  
11:00 - 12:30 • Room 06

**T3-S1: Learning 1**  
**Chair:** Jeongyeup Paek (Chung-Ang University, South Korea)

**Robust Federated Learning Under Worst-Case Model**  
Fan Ang (University of Science & Technology of China, China)  
Chen Li (University of Science & Technology of China, China)  
Weidong Wang  
(University of Science & Technology of China, China)

**SADroid: A Deep Classification Model for Android Malware Detection Based on Semantic Analysis**  
Dali Zhu (Institute of Information Engineering, Chinese Academy of Sciences, China)  
Tong Xi (Institute of Information Engineering, Chinese Academy of Sciences & School of Cyber Security, University of Chinese Academy of Sciences, China)  
Pengfei Jing (Institute of Information Engineering, Chinese Academy of Sciences, China)  
Qing Xia  
(Institute of Software, Chinese Academy of Sciences, China)  
Di Wu and Yiming Zhang (Institute of Information Engineering, Chinese Academy of Sciences, China)

**Semi-Federated Learning**  
Zhikun Chen, Daofeng Li, Ming Zhao, Sihai Zhang and Jinkang Zhu (University of Science and Technology of China, China)

**Optimization-Driven Hierarchical Deep Reinforcement Learning for Hybrid Relaying Communications**  
Yuze Zou  
(Huazhong University of Science and Technology, China)  
Yutong Xie  
(Shenzhen Institutes of Advanced Technology, China)  
Canhui Zhang and Shimin Gong  
(Sun Yat-sen University, China)  
Hoang Thai Dinh  
(University of Technology Sydney (UTS), Australia)  
Dusit Niyato (Nanyang Technological University, Singapore)

**Auction Based Incentive Design for Efficient Federated Learning in Cellular Wireless Networks**  
Huong Tra Le (Kyung Hee University, South Korea)  
Nguyen H. Tran (The University of Sydney, Australia)  
Yan Kyaw Tun (Kyung Hee University, South Korea)  
Zhu Han (University of Houston, USA)  
Choong Seon Hong (Kyung Hee University, South Korea)

Tuesday, 26 May 2020  
11:00 - 12:30 • Room 07

**T3-S2: Sensor Network and IoT 1**  
**Chair:** Wei Liu (Chongqing University of Technology, China)

**Impact of Packet Routing Scheme on Post-Failure Industrial Wireless Sensor Networks**  
Rajith M Bandarage, Geoffrey G. Messier and Abraham O Fapojuwo (University of Calgary, Canada)

**Wireless Backhaul Strategies for Real-Time High-Density Seismic Acquisition**  
Varun Amar Reddy and Gordon Stüber  
(Georgia Institute of Technology, USA)  
Suhail Al-Dharrab, Ali H Muqaibel and Wessam Mesbah  
(King Fahd University of Petroleum & Minerals, Saudi Arabia)

Asymmetric Wake-Up Scheduling-Based on Block Designs in Wireless Sensor Networks

Teuk-Seob Song (Mokwon University, South Korea)  
Woosik Lee (SSIS, South Korea)  
Jong-Hoon Youn (University of Nebraska - Omaha, USA)

On the Coverage Performance of Boolean-Poisson Cluster Models for Wireless Sensor Networks

Kaushlendra Pandey  
(Indian Institute of Technology, Kanpur, India)  
Abhishek K Gupta  
(Indian Institute of Technology Kanpur, India)

FMUCR: Fuzzy-Based Multi-Hop Unequal Cluster Routing for WSN

Lu Sixu, Wu Muqing and Min Zhao  
(Beijing University of Posts and Telecommunications, China)

Tuesday, 26 May 2020  
11:00 - 12:30 • Room 08

T3-S3: Fog Computing and Networking

Chair: Byung-Seo Kim (Hongik University, South Korea)

A Collaborative Task Offloading Scheme in D2D-Assisted Fog Computing Networks

Nanxin Fan and Xiaoxiang Wang (Beijing University of Posts and Telecommunications, China)  
Dongyu Wang (Beijing University of Posts and Telecommunications & Key Laboratory of Universal Wireless Communications, Ministry of Education, China)  
Yanwen Lan and Junxu Hou (Beijing University of Posts and Telecommunications, China)

An Energy-Efficient Mixed-Task Paradigm in Resource Allocation for Fog Computing

Xincheng Chen (Xi'an Jiaotong University, China)  
Yuchen Zhou (Xidian University, China)  
Long Yang  
(Xidian University, China & University of Alberta, Canada)  
Lu Lv (Xidian University, China)

Latency Minimization with Optimum Workload Distribution and Power Control for Fog Computing

Saman Atapattu (University of Melbourne, Australia)  
Chathuranga Weeraddana (University of Moratuwa, Sri Lanka)  
Minhua Ding  
(Sri Lanka Institute of Information Technology, Sri Lanka)  
Hazer Inaltekin (Macquarie University, Australia)  
Jamie S Evans (University of Melbourne, Australia)

Mobility Prediction-Based Joint Task Assignment and Resource Allocation in Vehicular Fog Computing

Xianjing Wu, Shengjie Zhao and Rongqing Zhang  
(Tongji University, China)  
Liuqing Yang (Colorado State University, USA)

Distributed V2V Computation Offloading Based on Dynamic Pricing Using Deep Reinforcement Learning

Jinming Shi (Tsinghua University, China)  
Jun Du (Tsinghua University, Beijing, China)  
Jian Wang and Jian Yuan (Tsinghua University, China)

Tuesday, 26 May 2020  
11:00 - 12:30 • Room 10

T4-S1: Streaming and Video

Chair: Youngbin Im (UNIST, South Korea)

Distributed Video Analysis for Mobile Live Broadcasting Services

Yuanqi Chen  
(Nanjing University Of Science and Technology, China)  
Yongjie Guan (UNC Charlotte, USA)  
Tao Han (University of North Carolina at Charlotte, USA)

Optimal Buffering for High Quality Video Streaming in D2D Underlay Networks

Suvadip Batabyal (BITS Pilani, Hyderabad Campus, India)  
Ozgur Ercetin (Sabanci University, Turkey)

Joint Quality Selection and Caching for SVC Video Services in Heterogeneous Networks

Jianwen Meng, Hancheng Lu and Jinxue Liu  
(University of Science and Technology of China, China)

Reducing Latency in Interactive Live Video Chat Using Dynamic Reduction Factor

YangXin Zhao, Anfu Zhou  
(Beijing University of Posts and Telecommunications, China)  
Xiaojiang Chen (Alibaba Group, China)

QFR: A QoE-Driven Fine-Grained Routing Scheme for Virtual Reality Video Streaming Over SDN

Xiaoyu Liu, Yumei Wang and Yu Liu  
(Beijing University of Posts and Telecommunications, China)

Tuesday, 26 May 2020  
11:00 - 12:30 • Room 11

T4-S2: Security and Privacy

Chair: Hyang-Won Lee (Konkuk University, South Korea)

Blockchain and Stackelberg Game Model for Roaming Fraud Prevention and Profit Maximization

Cong Thanh Nguyen (Ho Chi Minh City University of Technology, VNU-HCM, Vietnam)  
Diep N. Nguyen (University of Technology Sydney, Australia)  
Hoang Thai Dinh  
(University of Technology Sydney (UTS), Australia)  
Hoang-Anh Pham  
(Ho Chi Minh City University of Technology & Vietnam National University Ho Chi Minh City, Vietnam)  
Nguyen Huynh Tuong  
(Faculty of Computer Science & Engineering, Ho Chi Minh City University of Technology, Vietnam)  
Eryk Dutkiewicz (University of Technology Sydney, Australia)

Weighted Trustworthiness for ML Based Attacks Classification

Zina Chkirkbene  
(Qatar University & Electrical Engineering, Qatar)  
Aiman Erbad, Ridha Hamila, Ala Gouissem, Amr Mohamed and Mohsen Guizani (Qatar University, Qatar)  
Mounir Hamdi (Hamad Bin Khalifa University, Qatar)

Wearable Proxy Device-Assisted Authentication Request Filtering for Implantable Medical Devices

Ziting Zhang  
(Beijing University of Posts and Telecommunications, China)  
Xiaodong Xu  
(Beijing University of Posts and Telecommunications & Wireless Technology Innovation Institute, China)  
Shujun Han and Yacong Liang  
(Beijing University of Posts and Telecommunications, China)  
Cong Liu (China Mobile Research Institute, China)

A New Privacy-Preserving Framework Based on Edge-Fog-Cloud Continuum for Load Forecasting

Shiming Hou and Hongjia Li  
(Chinese Academy of Sciences, China)  
Chang Yang (Institute of Information Engineering, Chinese Academy of Sciences, China)  
Liming Wang (Chinese Academy of Sciences, China)

Tuesday, 26 May 2020  
14:00 - 15:30 • Room 01

T1-S4: NOMA (Non-Orthogonal Multiple Access)

Chair: Wonjae Shin (Pusan National University, South Korea)

Covert Non-Orthogonal Multiple Access

Hien Ta and Sang Wu Kim (Iowa State University, USA)

Finite-Alphabet Signature Design for Grant-Free NOMA Using Quantized Deep Learning

Hanxiao Yu, Fei Zesong, Zhong Zheng and Neng Ye  
(Beijing Institute of Technology, China)  
Sen Wang (China Mobile Research Institute, China)

Physical Layer Secrecy of NOMA-Based Hybrid Satellite-Terrestrial Relay Networks

Vinay Bankey, Vibhum Singh and Prabhat Kumar Upadhyay  
(Indian Institute of Technology Indore, India)

Performance Analysis of the Virtual Full-Duplex Non-Orthogonal Multiple Access Systems

Yafang Zhang and Suili Feng  
(South China University of Technology, China)

Compressive Sensing Based User Activity Detection and Channel Estimation in Uplink NOMA Systems

Yuanchen Wang  
(University of Liverpool, United Kingdom (Great Britain))  
Xu Zhu (University of Liverpool, United Kingdom (Great Britain) & Harbin Institute of Technology, Shenzhen, China)  
Eng Gee Lim (Xi'an Jiaotong-Liverpool University, China)  
Zhongxiang Wei (University College London & School of EE and CS, United Kingdom (Great Britain))  
Yujie Liu  
(University of Liverpool, United Kingdom (Great Britain))  
Yufei Jiang (Harbin Institute of Technology, Shenzhen, China)

Tuesday, 26 May 2020  
14:00 - 15:30 • Room 02

T1-S5: Next-Generation Communications

Chair: Yo-Seb Jeon (POSTECH, South Korea)

Chemical Reactions-Based Detection Mechanism for Molecular Communications

Trang N Cao (University of Melbourne, Australia)  
Vahid Jamali (Friedrich-Alexander-University Erlangen-Nürnberg, Germany)  
Wayan Wicke (Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany)  
Phee Lep Yeoh (University of Sydney, Australia)  
Nikola Zlatanov (Monash University, Australia)  
Jamie S Evans (University of Melbourne, Australia)  
Robert Schober (Friedrich-Alexander University Erlangen-Nuremberg, Germany)

Generalized Dimming Control Scheme with Optimal Dimming Control Pattern for VLC

Congcong Wang, Yang Yang, Caili Guo, Zhimin Zeng and Chunyan Feng (Beijing University of Posts and Telecommunications, China)



Characterization for High-Speed Railway Channel  
Enabling Smart Rail Mobility at 22.6 GHz

Lei Ma, Ke Guan, Dong Yan, Danping He and Bo Ai  
(Beijing Jiaotong University, China)  
Junhyeong Kim and Hee Sang Chung (ETRI, South Korea)

Transmit Laser Selection for Dual Hop Decode and  
Forward UOWC Cooperative Communication

Anirban Bhowal and Rakhesh Singh Kshetrimayum  
(Indian Institute of Technology Guwahati, India)

Hybrid Multiplexing in OFDM-Based VLC Systems

Cheng Chen  
(University of Edinburgh, United Kingdom (Great Britain))  
Iman Tavakkolnia (University of Edinburgh & LiFi Research  
and Development Centre, United Kingdom (Great Britain))  
Mohammad Dehghani Soltani and Majid Safari  
(University of Edinburgh, United Kingdom (Great Britain))  
Harald Haas  
(The University of Edinburgh, United Kingdom (Great Britain))

Tuesday, 26 May 2020

14:00 - 15:30 • Room 03

T1-S6: Channel Modeling

Chair: Inkyu Bang (Hanbat National University, South Korea)

Joint Channel Equalization and Symbol Detection for  
IoT Devices in Severe Multipath Channels

Shusen Jing, Joseph Hall, Yahong Rosa Zheng and  
Chengshan Xiao (Lehigh University, USA)  
Zhiquan Deng (Pacific Northwest National Laboratory, USA)

A Novel Massive MIMO Beam Domain Channel Model

Fan Lai (Southeast University, China)  
Cheng-Xiang Wang  
(Southeast University & Heriot-Watt University, China)  
Jie Huang and Xiqi Gao (Southeast University, China)  
Fu-Chun Zheng (University of York, United Kingdom (Great  
Britain) & Southeast University, China)

Geometry Based Stochastic Channel Modeling Using  
Ambit Processes

Rakesh R. T. and Emanuele Viterbo  
(Monash University, Australia)

A Practical Non-Stationary Channel Model for  
Vehicle-to-Vehicle MIMO Communications

Weidong Li and Qiuming Zhu  
(Nanjing University of Aeronautics and Astronautics, China)  
Cheng-Xiang Wang  
(Southeast University & Heriot-Watt University, China)  
Fei Bai, Xiao-min Chen and Xu Dazhuan  
(Nanjing University of Aeronautics and Astronautics, China)

Effects On Polarization Characteristics of  
Off-Body Channels with Dynamic Users

Kenan Turbic (INESC-ID / IST, University of Lisbon, Portugal)  
Luis M. Correia  
(IST/INESC-ID - University of Lisbon & INESC, Portugal)

Tuesday, 26 May 2020

14:00 - 15:30 • Room 04

T1-S7: Waveform and Modulation

Chair: Joon Ho Cho (Pohang University of Science and  
Technology (POSTECH), South Korea)

Cancellation Symbol Insertion for Spectrally Compact  
OFDM Pilot Waveform

Char-Dir Chung (National Taiwan University, Taiwan)  
Wei-Chang Chen  
(National Taipei University of Technology, Taiwan)  
Jia-Ling Jiang (MediaTek Inc., Taiwan)

Low Complexity Iterative Rake Detector for Orthogonal  
Time Frequency Space Modulation

Tharaj Thaj and Emanuele Viterbo  
(Monash University, Australia)

The Impact of CFO on OFDM Based Physical-Layer  
Network Coding with QPSK Modulation

Ling Fu Xie (Faculty of EECS, Ningbo University, China)  
Ivan Wang-Hei Ho and Zhenhui Situ  
(The Hong Kong Polytechnic University, Hong Kong)  
Peiya Li (Jinan University, China)

A Novel Hybrid MSK Modulation Scheme for  
Additional Data Transmission

Zhengguang Xu  
(Huazhong University Of Science and Technology, China)

Performance Analysis of Various Waveforms and  
Coding Schemes in V2X Communication Scenarios

Waqar Anwar (Technische Universität Dresden, Germany)  
Anton Krause (TU Dresden, Germany)  
Atul Kumar, Norman Franchi and Gerhard P. Fettweis  
(Technische Universität Dresden, Germany)

Tuesday, 26 May 2020

14:00 - 15:30 • Room 05

T2-S2: Learning-Assisted Optimization

Chair: Jeongho Kwak (DGIST, South Korea)

Buffer-Aware Wireless Scheduling Based on  
Deep Reinforcement Learning

Chen Xu and Jian Wang (Huawei Technologies Co., Ltd., China)  
Tianhang Yu (Huawei Technologies Co., Ltd., China)  
Chuilu Kong, Yourui Huangfu and Rong Li  
(Huawei Technologies Co., Ltd., China)  
Yiqun Ge (Huawei Technologies Canada Inc, Canada)  
Jun Wang (Huawei Technologies Co., Ltd., China))

Jointly Sparse Signal Recovery via Deep  
Auto-Encoder and Parallel Coordinate Descent Unrolling

Shuaichao Li and Wanqing Zhang  
(Shanghai Jiao Tong University, China)  
Ying Cui (Shanghai Jiaotong University, China)

Deep Reinforcement Learning Based Indoor Air  
Quality Sensing by Cooperative Mobile Robots

Zhiwen Hu (Peking University, China)  
Tiankuo Song (Beijing 101 Middle School, Beijing, China)  
Kaigui Bian and Lingyang Song (Peking University, China)

Learning Cooperation Schemes for Mobile Edge  
Computing Empowered Internet of Vehicles

Jiayu Cao, Ke Zhang, Fan Wu and Supeng Leng (University  
of Electronic Science and Technology of China, China)

Distributed Deep Reinforcement Learning with  
Wideband Sensing for Dynamic Spectrum Access

Umuralp Kaytaz (Koc University, Turkey)  
Seyhan Ucar  
(Toyota Motor North America R&D, InfoTech Labs, USA)  
Baris Akgun and Sinem Coleri (Koc University, Turkey)

Tuesday, 26 May 2020

14:00 - 15:30 • Room 06

T3-S4: Localization

Chair: Jiguang He (University of Oulu, Finland)

Wimager: Crowd Sensing Based Heterogeneous  
Information Fusion for Indoor Localization

Fangmin Li (Shenzhen Institutes of Advanced Technology  
Chinese Academy of Science, China)  
Yubin Zhao (Shenzhen Institutes of Advanced Technology,  
Chinese Academy of Sciences, China)  
Xiaofan Li  
(The State Radio Monitoring Center & Testing Center, China)  
Cheng-Zhong Xu (University of Macau, China)

Flight Path Optimization for UAVs to Provide Location  
Service to Ground Targets

Youpeng Wang and Xiaojun Zhu  
(Nanjing University of Aeronautics and Astronautics, China)  
Lijie Xu  
(Nanjing University of Posts & Telecommunications, China)

Cooperative Localization in Wireless Sensor Networks  
with AOA Ranging Measurements

Xianbo Jiang  
(Beijing University of Posts and Telecommunications, China)  
Shengchu Wang  
(Beijing University of Posts and Telecommunications, China)

Depthwise Separable Convolution Based Passive  
Indoor Localization Using CSI Fingerprint

Wenjing Xun, Lijuan Sun, Chong Han, Zhaoxiao Lin and  
Jian Guo  
(Nanjing University of Posts and Telecommunications, China)

Packet Corruption Tolerant Localization for  
Underwater Acoustic Sensor Networks

Keyong Hu, Xianglin Song and Zhongwei Sun  
(Qingdao University of Technology, China)  
Hanjiang Luo  
(Shandong University of Science and Technology, China)  
Zhongwen Guo (Ocean University of China, China)

On the Localization of Unmanned Aerial Vehicles with  
Cellular Networks

Irshad A. Meer, Mustafa Ozger and Cicek Cavdar  
(KTH Royal Institute of Technology, Sweden)

Tuesday, 26 May 2020

14:00 - 15:30 • Room 07

T3-S5: Energy Efficiency

Chair: Rong Chai (Chongqing University of Posts and  
Telecommunications, China)

Energy and Spectral Efficiency Tradeoff in OFDMA  
Networks via Antenna Selection Strategy

Ata Khalili (Sharif University of Technology, Iran)  
Derrick Wing Kwan Ng  
(University of New South Wales, Australia)

Heterogeneity-Based Energy-Efficient Transmission in  
Dense Small Cell Networks

Shie Wu (Yantai University, P.R. China)  
Rui Yin (School of Information and Electrical Engineering,  
Zhejiang University City College, Hangzhou, China)  
Ningfei Dong (Yantai University, China)  
Xia Liu (Yantai University, P.R. China)

Dynamic Load Adjustments for Small Cells in  
Heterogeneous Ultra-Dense Networks

Qi Zhang  
(Beijing University of Posts and Telecommunications, China)  
Xiaodong Xu (Beijing University of Posts and  
Telecommunications & Wireless Technology Innovation  
Institute, China)  
Jingxuan Zhang and Xiaofeng Tao  
(Beijing University of Posts and Telecommunications, China)  
Cong Liu (China Mobile Research Institute, China)

Energy Efficient Joint Resource Allocation and  
Clustering Algorithm for M2M Communication Systems

Changzhu Liu, Rong Chai and Ahmad Zubair (Chongqing  
University of Posts and Telecommunications, China)

Energy Efficient Bidirectional Relaying Network Coded HARQ Transmission Scheme for S-IoT

Zilin Ni (Harbin Institute of Technology, China)  
Jian Jiao (Harbin Institute of Technology - Shenzhen, China)  
Shiqi Liu (Harbin Institute of Technology (Shenzhen), China)  
Shaohua Wu (Harbin Institute of Technology, China)  
Qinyu Zhang (Shenzhen Graduate School, Harbin Institute of Technology, China)

Tuesday, 26 May 2020  
14:00 - 15:30 • Room 08

T3-S6: Routing  
Chair: Yichao Jin (Toshiba Research Europe Ltd, United Kingdom (Great Britain))

A Three-Level Routing Hierarchy in Improved SDN-MEC-VANET Architecture  
Xuefeng Ji, Wenquan Xu, Chuwen Zhang and Bin Liu (Tsinghua University, China)

NIHR: Name/ID Hybrid Routing in Information-Centric VANET  
Wenquan Xu, Xuefeng Ji, Chuwen Zhang and Bin Liu (Tsinghua University, China)

FNTAR: A Future Network Topology-Aware Routing Protocol in UAV Networks  
Jianfei Peng (Nanjing University of Aeronautics and Astronautics, China)  
Hang Gao and Liang Liu (Colleage of Computer Science and Technology, Nanjing University of Aeronautics and Astronautics, China)  
Xiangyu Xu (Nanjing University Of Aeronautics and Astronautics, China)

Exploiting Mobile Contact Patterns for Message Forwarding in Mobile Opportunistic Networks  
Mohd Yaseen Mir and Chih-Lin Hu (National Central University, Taiwan)

Reliable and Power Confined Routing in Large and Densely Deployed 6TiSCH Mesh Networks  
Yichao Jin (Toshiba Research Europe Ltd, United Kingdom (Great Britain))  
Michael Baddeley (Toshiba Research Europe Ltd., United Kingdom (Great Britain))  
Usman Raza (Toshiba Research Europe Ltd., United Kingdom (Great Britain))  
Aleksandar Stanoev (Toshiba Research Europe Ltd, United Kingdom (Great Britain))  
Mahesh Sooriyabandara (Toshiba Research Europe Limited, United Kingdom (Great Britain))

Tuesday, 26 May 2020  
14:00 - 15:30 • Room 11

T4-S3: Localization and Tracking  
Chair: Jin-Ho Chung (Ulsan National Institute of Science and Technology, South Korea)

NLOS-Aware VLC-Based Indoor Localization: Algorithm Design and Experimental Validation  
Chuanxi Huang (Institut Supérieur d'Electronique de Paris (ISEP), France)  
Xun Zhang (Institut Supérieur d'Electronique de Paris, France)  
Fen Zhou (Institut Supérieur d'Electronique de Paris (ISEP) & University of Avignon, France)  
Zhan Wang and Lina Shi (ISEP, France)

ROLATIN: Robust Localization and Tracking for Indoor Navigation of Drones  
Alireza Famili and Jung-Min (Jerry) Park (Virginia Tech, USA)

Indoor Localization with Particle Filter in Multiple Motion Patterns  
Qiao Li, Xuewen Liao and Zhenzhen Gao (Xi'an Jiaotong University, China)

An Enhanced Direction Calibration Based on Reinforcement Learning for Indoor Localization System  
Qiao Li, Xuewen Liao and Zhenzhen Gao (Xi'an Jiaotong University, China)

TLS-Regularization Framework for Target Tracking Under Perturbations  
Mostafizur Laskar (Indian Institute of Technology Kharagpur, India)  
Debarati Sen (Indian Institute of Technology Kharagpur, India)

Tuesday, 26 May 2020  
16:00 - 17:30 • Room 01

T1-S8: Low Latency Communications  
Chair: Jemin Lee (Daegu Gyeongbuk Institute of Science and Technology (DGIST), South Korea)

Cross-Link Interference Suppression By Orthogonal Projector for 5G Dynamic TDD URLLC Systems  
Ali Esswie (Nokia Bell Labs, Denmark)  
Klaus Pedersen (Nokia - Bell Labs, Denmark)

Robust Integration of Computation and Communication in B5G Cellular Internet of Things  
Qiao Qi (ZheJiang University, China)  
Xiaoming Chen, Caijun Zhong and Zhaoyang Zhang (Zhejiang University, China)

Dynamic HARQ with Guaranteed Delay  
Mahyar Shirvanimoghaddam (University of Sydney, Australia)  
Hossein Khayami (Sharif University of Technology, Iran)  
Yonghui Li and Branka Vucetic (University of Sydney, Australia)

On Error Rate Analysis for URLLC Over Multiple Fading Channels  
Jinho Choi (Deakin University, Australia)

Fast Cross Layer Authentication Scheme for Dynamic Wireless Network  
ZhiYuan Zhang, Na Li, Shida Xia and Xiaofeng Tao (Beijing University of Posts and Telecommunications, China)

Tuesday, 26 May 2020  
16:00 - 17:30 • Room 02

T1-S9: Deep Learning for Wireless Communications 2  
Chair: Junil Choi (KAIST, South Korea)

Deep Learning Based Fast Downlink Channel Reconstruction for FDD Massive MIMO Systems  
Mengyuan Li and Yu Han (Southeast University, China)  
Chao-Kai Wen (National Sun Yat-sen University, Taiwan)  
Xiao Li and Shi Jin (Southeast University, China)

Deep Learning Based Low-Rank Channel Recovery for Hybrid Beamforming in Millimeter-Wave Massive MIMO  
Nuan Song, Chenhui Ye and Xiaofeng Hu (Nokia Bell Labs China, China)  
Tao Yang (Nokia Shanghai Bell, China)

IMNet: A Learning Based Detector for Index Modulation Aided MIMO-OFDM Systems  
Jinxue Liu and Hancheng Lu (University of Science and Technology of China, China)

Blind Packet-Based Receiver Chain Optimization Using Machine Learning  
Mohammed Radi (TU Dresden, Germany)  
Emil Matus and Gerhard P. Fettweis (Technische Universität Dresden, Germany)

Neural Network MIMO Detection for Coded Wireless Communication with Impairments  
Omer Sholev (Ben Gurion University, Israel)  
Haim H Permuter (Ben-Gurion University of the Negev, Israel)  
Eilam Ben-Dror (Huawei Technologies Ltd., Israel)  
Wenliang Liang (China)

Tuesday, 26 May 2020  
16:00 - 17:30 • Room 03

T1-S10: Multiple Access and Interference Management  
Chair: Sang-Woon Jeon (Hanyang University, South Korea)

Multiplexing More Data Streams in the MU-MISO Downlink by Interference Exploitation Precoding  
Ang Li (Xi'an Jiaotong University, China)  
Christos Masouros (University College London, United Kingdom (Great Britain))  
Xuewen Liao (Xi'an Jiaotong University, China)  
Yonghui Li and Branka Vucetic (University of Sydney, Australia)

Intelligent Reflecting Surface Assisted Non-Orthogonal Multiple Access  
Gang Yang, Xinyue Xu and Ying-Chang Liang (University of Electronic Science & Technology of China, China)

Bit Error Probability for Asynchronous Channel Access with Interference Cancellation and FBMC  
Maxim Penner and Sami Akin (Leibniz Universität Hannover, Germany)  
Martin Fuhrwerk (Baker Hughes, Germany)  
Jürgen Peissig (Leibniz Universität Hannover, Germany)

Full Duplex Based Digital Out-of-Band Interference Cancellation for Collocated Radios  
Thomas Ranström (Swedish Defense Research Agency, Sweden)  
Erik Axell (Swedish Defence Research Agency, Sweden)

Adaptive Threshold Detection and ISI Mitigation in Mobile Molecular Communication  
Amit Kumar Shrivastava and Debanjan Das (International Institute of Information Technology, Naya Raipur, India)  
Rajarshi Mahapatra (IIIT Naya Raipur, India)

Tuesday, 26 May 2020  
16:00 - 17:30 • Room 05

T2-S3: Scheduling and Radio Resource Management  
Chair: Jianwei Huang (The Chinese University of Hong Kong, Hong Kong)

Novel QoS Control Framework for Automotive Safety-Related and Infotainment Services  
Daniel Fabian Külzer (BMW Group Research and Technology, Germany)  
Slawomir Stanczak (Technische Universität Berlin & Fraunhofer Heinrich Hertz Institute, Germany)  
Mladen Botsov (BMW Group, Germany)

A Coalition Game for Backscatter-Aided Passive Relay Communications in Wireless-Powered D2D Networks  
Xiaozheng Gao (Beijing Institute of Technology, China)  
Dusit Niyato (Nanyang Technological University, Singapore)  
Kai Yang and Jianping An (Beijing Institute of Technology, China)



Proportional Fairness Through Dual Connectivity in Heterogeneous Networks

Pradnya Kiri Taksande and Prasanna Chaporkar (IIT Bombay, India)  
Pranav Jha (Indian Institute of Technology Bombay, India)  
Abhay Karandikar (IIT Bombay, India)

On Optimizing Signaling Efficiency of Retransmissions for Voice LTE

Chia-An Hsu and Kate Ching-Ju Lin (National Chiao Tung University, Taiwan)  
Yi Ren (University of East Anglia, United Kingdom (Great Britain))  
Yu-Chee Tseng (National Chiao-Tung University, Taiwan)

Joint Optimization of Control and Resource Management for Wireless Sensor and Actuator Networks

Zhuwei Wang, Yuehui Guo, Yang Sun, Chao Fang and Wenjun Wu (Beijing University of Technology, China)

Physical Layer Security in Multi-Tag Ambient Backscatter Communications - Jamming vs. Cooperation

Ji Yoon Han, Mi Ji Kim, Junsu Kim and Su Min Kim (Korea Polytechnic University, South Korea)

Tuesday, 26 May 2020  
16:00 - 17:30 • Room 06

T3-S7: Learning 2

Chair: Anis Elgabli (University of Oulu, Finland)

End-Edge Coordinated Inference for Real-Time BYOD Malware Detection Using Deep Learning

Xinrui Tan (State Key Laboratory of Information Security & Institute of Information Engineering, China)  
Hongjia Li, Liming Wang and Zhen Xu (Chinese Academy of Sciences, China)

MSDF: A Deep Reinforcement Learning Framework for Service Function Chain Migration

Ruoyun Chen and Hancheng Lu (University of Science and Technology of China, China)  
Yujiao Lu (USTC, China)  
Jinxue Liu (University of Science & Technology of China, China)

L-FGADMM: Layer-Wise Federated Group ADMM for Communication Efficient Decentralized Deep Learning

Anis Elgabli (University of Oulu, Finland)  
Jihong Park (Deakin University, Australia)  
Sabbir Ahmed (University of Oulu, Finland)  
Mehdi Bennis (Centre of Wireless Communications, University of Oulu, Finland)

Root Cause Analysis of Noisy Neighbors in a Virtualized Infrastructure

Hedi Bouattour (ORANGE, France)  
Yosra Ben Slimen (Orange Labs Belfort, France)  
Marouen Mechtri and Hanane Biallach (Orange Labs Networks, France)

Federated Learning Under Channel Uncertainty: Joint Client Scheduling and Resource Allocation

Madhusanka Dinesh Weeraratne Manimel Wadu and Sumudu Samarakoon (University of Oulu, Finland)  
Mehdi Bennis (Centre of Wireless Communications, University of Oulu, Finland)

Tuesday, 26 May 2020  
16:00 - 17:30 • Room 07

T3-S8: Sensor Network and IoT 2

Chair: Wei Liu (Chongqing University of Technology, China)

On the Age of Information for Multicast Transmission with Hard Deadlines in IoT Systems

Jie Li and Yong Zhou (ShanghaiTech University, China)  
He Chen (The Chinese University of Hong Kong, Hong Kong)

Exact Algorithms for Barrier Coverage with Line-Based Deployed Rotatable Directional Sensors

Zijing Ma, Shuangjuan Li and Dong Huang (South China Agricultural University, China)

Genetic Algorithm-Based Periodic Charging Scheme for Energy Depletion Avoidance in WRSNs

Huong Thi Tran (Ha Noi University of Science, Vietnam)  
Phi Le Nguyen (Hanoi University of Science and Technology, Vietnam)  
Huynh Thi Thanh Binh (HUST, Vietnam)  
Kien Nguyen (Chiba University, Japan)  
Minh Hai Ngo (Hanoi University of Science and Technology, Vietnam)  
Vinh Le (Vietnam National University, Vietnam)

Simplified Theoretical Model Based Self-Adaptive Packet Reception Rate Estimation in Sensor Networks

Wei Liu (Chongqing University of Technology, China)  
Yu Xia (Nanjing University of Aeronautics and Astronautics, China)  
Jian Xie (Chongqing University of Technology, China)

Decision Triggered Data Transmission and Collection in Industrial Internet of Things

Jiguang He (University of Oulu, Finland)  
Long Kong (Interdisciplinary Centre for Security, Reliability and Trust (SnT) & University of Luxembourg, Luxembourg)  
Tero Frondelius (R&D and Engineering, Wärtsilä, Vaasa, Finland)  
Olli Silvén and Markku Juntti (University of Oulu, Finland)

Tuesday, 26 May 2020  
16:00 - 17:30 • Room 08

T3-S9: Device-to-Device Communication

Chair: You-Chiun Wang (National Sun Yat-Sen University, Taiwan)

Distributed Deep Learning Power Allocation for D2D Network Based on Outdated Information

Jiaqi Shi, Qianqian Zhang, Ying-Chang Liang and Xiaojun Yuan (University of Electronic Science and Technology of China, China)

Efficient Load Rearrangement of Small Cells with D2D Relay for Energy Saving and QoS Support

You-Chiun Wang (National Sun Yat-Sen University, Taiwan)  
Zong-Han Lin (National Sun Yat-sen University, Taiwan)

Intelligent Bluetooth Device to Device Connection Shift

Praneeth Juturu, Veerabhadrapa Chilakanti and Gowtham Babu (Samsung R&D Institute Bangalore, India)

Contextual Multi-Armed Bandit Based Pricing Scheme for Cooperative D2D Communications

Yue Meng and Zhaowei Wang (China Academy of Electronics and Information Technology (CAEIT), China)

D2D Assisted Beamforming for Coded Caching

Hamidreza Bakhshzad Mahmoodi (University of Oulu, Finland)  
Jarkko Kaleva (Solmu Technologies, Finland)  
Pooya Shariatpanahi (Institute for Research in Fundamental Sciences (IPM), Iran)  
Antti Tölli (University of Oulu, Finland)

Tuesday, 26 May 2020  
16:00 - 17:30 • Room 10

T4-S4: URLLC

Chair: Hu Jin (Hanyang University, South Korea)

Low-Complexity Centralized Multi-Cell Radio Resource Allocation for 5G URLLC

Ali Karimi (Aalborg University, Denmark)  
Klaus I. Pedersen (Nokia-Bell Labs, Aalborg University, Denmark)  
Preben Mogensen (Nokia–Bell Labs, Research Center Aalborg, Sweden)

A Fully Coordinated New Radio-Unlicensed System for Ultra-Reliable Low-Latency Applications

Roberto Maldonado Cuevas (Aalborg University, Denmark)  
Claudio Rosa (Nokia, Denmark)  
Klaus Pedersen (Nokia - Bell Labs, Denmark)

Analysis of High-Reliable and Low-Latency Communication Enablers for New Radio Unlicensed

Roberto Maldonado Cuevas (Aalborg University, Denmark)  
Claudio Rosa (Nokia, Denmark)  
Klaus Pedersen (Nokia - Bell Labs, Denmark)

Robust URLLC Packet Scheduling of OFDM Systems

Jing Cheng and Chao Shen (Beijing Jiaotong University, China)  
Shuqiang Xia (ZTE Corporation, China)

Efficient and Reliable Wireless Communications Through Multi-Connectivity and Rateless Coding

Philipp Schulz (Technische Universität Dresden, Germany)  
Andre N Barreto (Barkhausen Institut gGmbH, Germany & Universidade de Brasilia, Brazil)  
Gerhard Fettweis (Barkhausen Institut, Germany)

Transceiver Design for Full-Duplex Ultra-Reliable Low-Latency Communications with Finite Blocklength

Keshav Singh (National Sun Yat-sen University, Kaohsiung, Taiwan)  
Sudip Biswas (Indian Institute of Information Technology, Guwahati, India)  
Meng-Lin Ku (National Central University, Taiwan)  
Mark Flanagan (University College Dublin, Ireland)

Tuesday, 26 May 2020  
16:00 - 17:30 • Room 11

T4-S5: Vehicular Networks

Chair: Yeongjin Kim (Inha University, South Korea)

Energy-Efficient Power Control and Resource Allocation for V2V Communication

Lei Gao (Beijing University of Posts & Telecommunications, China)  
Yanzhao Hou, Xiaofeng Tao and Min Zhu (Beijing University of Posts and Telecommunications, China)

Vehicle Platooning Schemes Considering V2V Communications: A Joint Communication / Control Approach

Tiago Rocha Goncalves (CentraleSupélec, France)  
Vineeth S Varma (CRAN & CNRS, France)  
Salah Eddine Elayoubi (CentraleSupélec, France)

Maximization of Con-Current Links in V2V Communications Based on Belief Propagation

Xunchao Wu, Yanzhao Hou and Xiaofeng Tao (Beijing University of Posts and Telecommunications, China)  
Xiaosheng Tang (BeiJing University of Posts & Telecommunications, China)

**Analytical Performance Evaluation of the Collective Perception Service in IEEE 802.11p Networks**  
Florian Alexander Schiegg (Leibniz University of Hanover & Robert Bosch GmbH, Germany)  
Daniel Bischoff (Technical University Darmstadt & Opel Automobile GmbH, Germany)  
Johannes Ruben Krost (Robert Bosch Car Multimedia GmbH, Germany)  
Ignacio Llatser (Robert Bosch GmbH, Germany)

**Path Optimization for Flying Base Stations in Multi-Cell Networks**  
Jongyul Lee and Vasilis Friderikos (King's College London, United Kingdom (Great Britain))

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**Wednesday, 27 May 2020**  
**11:00 - 12:30 • Room 01**

**T1-S11: Millimeter-Wave Systems 2**  
**Chair:** Jiho Song (University of Ulsan, South Korea)

**Hybrid Multi-User Precoding for mmWave Massive MIMO in Frequency-Selective Channels**  
Shijian Gao (Colorado State University, USA)  
Xiang Cheng (Peking University, China)  
Liuqing Yang (Colorado State University, USA)

**Secrecy Rate Analysis of mmWave MISO Ad Hoc Networks with Null Space Precoding**  
Ahmed F Darwesh and Abraham O Fapojuwo (University of Calgary, Canada)

**SINR Coverage Analysis of Dense HetNets Over Fox’s H-Fading Channels**  
Imene Trigui (University of Toronto, Canada)  
Sofiene Affes (INRS-EMT, Canada)  
Marco Di Renzo (Paris-Saclay University / CNRS, France)  
Dushantha Nalin K. Jayakody (National Research Tomsk Polytechnic University & Sri Lanka Technological Campus, Russia)

**Coverage Analysis of Relay Assisted Millimeter Wave Cellular Networks with Spatial Correlation**  
Simin Xu (Australian National University, Australia)  
Nan Yang (The Australian National University, Australia)  
Biao He (MediaTek USA Inc., USA)  
Hamid Jafarkhani (University of California, Irvine, USA)

**Performance Analysis of Opportunistic Millimeter Wave Cloud-RAN with Nakagami-Blockage Channels**  
Behrouz Maham (Nazarbayev University, Kazakhstan)

**Wednesday, 27 May 2020**  
**11:00 - 12:30 • Room 02**  
  
**T1-S12: Multi-Antenna System**  
**Chair:** Daeyoung Park (Inha University, South Korea)

**Time Switching Protocol for Multi-Antenna SWIPT Systems**  
Seowoo Kang (Korea University, South Korea)  
Hoon Lee (Pukyong National University, South Korea)  
Sangwon Hwang and Inkyu Lee (Korea University, South Korea)

**Adaptive Antenna Array with Weight and Antenna Space Control**  
Kenta Umebayashi and Yoshimasa Kimoto (Tokyo University of Agriculture and Technology, Japan)  
Antti Tölli (University of Oulu, Finland)

**Channel Correlation Cancelation-Based Hybrid Beamforming for Massive Multiuser MIMO Systems**  
Xinbo Wang, Li Guo, Chao Dong and Xidong Mu (Beijing University of Posts and Telecommunications, China)

**IRS-Enhanced Wideband MU-MISO-OFDM Communication Systems**  
Hongyu Li, Rang Liu, Ming Li, Qian Liu and Xuanheng Li (Dalian University of Technology, China)

**MF-Based Dimension Reduction Signal Compression for Fronthaul-Constrained Distributed MIMO C-RAN**  
Fred Wiffen and Angela Doufexi (University of Bristol, United Kingdom (Great Britain))  
Mohammud Z Bocus (Toshiba Research Europe Ltd, United Kingdom (Great Britain))  
Woon Hau Chin (Toshiba Research Europe Limited, United Kingdom (Great Britain))

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**Wednesday, 27 May 2020**  
**11:00 - 12:30 • Room 03**  
  
**T1-S13: Information Theory and Capacity**  
**Chair:** Sang-Woon Jeon (Hanyang University, South Korea)

**How Does Channel Coding Affect the Design of Uplink SCMA Multidimensional Constellations?**  
Monirosharieh Vameghestahbanati, Ian D. Marsland, Ramy Gohary and Halim Yanikomeroglu (Carleton University, Canada)  
Javad Abdoli (Huawei Technologies Canada Co., Ltd., Canada)

**Capacity Analysis of Time-Indexed Media-Based Modulation**  
Bharath Shamasundar (Indian Institute of Science, India)  
Lakshmi Narasimhan Theagarajan (Indian Institute of Technology, Palakkad, India)  
A. Chockalingam (Indian Institute of Science, India)

**Average Secrecy Capacity of SIMO κ-μ Shadowed Fading Channels with Multiple Eavesdroppers**  
Jiangfeng Sun and Hongxia Bie (Beijing University of Posts and Telecommunications, China)  
Xingwang Li (Henan Polytechnic University, China)  
Khaled M. Rabie and Rupak Kharel (Manchester Metropolitan University, United Kingdom (Great Britain))

**LDPC-Staircase Codes for Soft Decision Decoding**  
Viduranga Wijekoon, Emanuele Viterbo and Yi Hong (Monash University, Australia)

**On the Construction of -coset Codes for Parallel Decoding**  
Xianbin Wang, Huazi Zhang, Rong Li and Jiajie Tong (Huawei Technologies, Co. Ltd., China)  
Yiqun Ge (Huawei Technologies Canada Inc., Canada)  
Jun Wang (Huawei Technologies Co. Ltd, China)

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**Wednesday, 27 May 2020**  
**11:00 - 12:30 • Room 05**

**T2-S4: Resource Allocation**  
**Chair:** Bo Ji (Temple University, USA)

**Effective Capacity Based Resource Allocation for An Integrated Radar and Communications System**  
Yunfeng Liu, Zhiqing Wei and Zhiyong Feng (Beijing University of Posts and Telecommunications, China)  
Gordon Stüber (Georgia Institute of Technology, USA)

**Traffic-Aware Beam Selection and Resource Allocation for 5G NR**  
Yu-Hsuan Liu and Kate Ching-Ju Lin (National Chiao Tung University, Taiwan)

**POET: An Energy-Efficient Resource Management Mechanism for One-to-Many D2D Communications**  
Jun Huang (Chongqing University of Posts and Telecomm, China)  
Guohuan Wang (Chongqing Univ of Posts and Telecom & School of Commu. and Info. Eng., China)  
Cong-cong Xing (Nicholls State University, USA)

**Cross-Layer Resource Allocation in NOMA Systems with Dynamic Traffic Arrivals**  
Huiyi Ding (The University of Hong Kong, Hong Kong)  
Ka-Cheong Leung (Harbin Institute of Technology, Shenzhen, China)

**Joint Power Allocation and Beam-Forming Design for Dual-Connectivity Wireless Networks**  
Minh Thang Nguyen, Jiho Song and Sungoh Kwon (University of Ulsan, South Korea)  
Kyung Sook Kim (ETRI, South Korea)

**Wednesday, 27 May 2020**  
**11:00 - 12:30 • Room 06**  
  
**T3-S10: Mobile Edge Computing 1**  
**Chair:** Shengheng Liu (Southeast University & Purple Mountain Laboratories, China)

**Joint Computation Offloading, SFC Placement, and Resource Allocation for Multi-Site MEC Systems**  
Phuong-Duy Nguyen (INRS - University of Quebec, Canada)  
Long Bao Le (INRS, University of Quebec, Canada)

**Task Offloading for End-Edge-Cloud Orchestrated Computing in Mobile Networks**  
Chuan Sun, Hui Li, Xiuhua Li, Wen Junhao and Qingyu Xiong (Chongqing University, China)  
Xiaofei Wang (Tianjin University, China)  
Victor C.M. Leung (University of British Columbia, Canada)

**MeFILL: A Multi-Edged Framework for Intelligent and Low Latency Mobile IoT Services**  
Ruichun Gu, Lei Yu and Junxing Zhang (Inner Mongolia University, China)

**MEC-Enabled Wireless VR Video Service: A Learning-Based Mixed Strategy for Energy-Latency Tradeoff**  
Chong Zheng (School of Information Science and Engineering, Southeast University, China)  
Shengheng Liu (Southeast University, P.R. China)  
Yongming Huang and Luxi Yang (Southeast University, China)

**Learning Based Fluctuation-Aware Computation Offloading for Vehicular Edge Computing System**  
Zhitong Liu, Xuefei Zhang, Jian Zhang, Dian Tang and Xiaofeng Tao (Beijing University of Posts and Telecommunications, China)

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**Wednesday, 27 May 2020**  
**11:00 - 12:30 • Room 07**

**T3-S11: NOMA (Non-Orthogonal Multiple Access)**  
**Chair:** Hangguan Shan (Zhejiang University, China)

**Online Maneuver Design for UAV-Enabled NOMA Systems via Reinforcement Learning**  
Yuwei Huang (University of Science and Technology of China, China)  
Xiaopeng Mo (GDUT, China)  
Jie Xu (The Chinese University of Hong Kong, Shenzhen, China)  
Ling Qiu (University of Science and Technology of China, China)  
Yong Zeng (Southeast University, China)



**NOMA Based VR Video Transmission Exploiting User Behavioral Coherence**

Ping Xiang, Hangguan Shan, Zhaoyang Zhang and Yu Lu (Zhejiang University, China)  
Tony Q. S. Quek (Singapore University of Technology and Design, Singapore)

**Joint User Association and Resource Allocation for NOMA-Based MEC: A Matching-Coalition Approach**

Guangyuan Zheng, Chen Xu and Liangrui Tang (North China Electric Power University, China)

**User Scheduling and Energy Management with QoS Provisioning for NOMA-Based M2M Communications**

Chunhui Feng and Qinghai Yang (Xidian University, China)  
Meng Qin (School of Electronics and Computer Engineering, Peking University, China)  
Kyung Sup Kwak (Inha University, South Korea)

**Joint Reflection Coefficient Selection and Subcarrier Allocation for Backscatter Systems with NOMA**

Farhad Dashti Ardakani (The University of British Columbia, Canada)  
Vincent W.S. Wong (University of British Columbia, Canada)

Wednesday, 27 May 2020  
11:00 - 12:30 • Room 08

**T3-S12: Vehicular Network 1**

**Chair:** Anis Zarrad (University of Birmingham, United Arab Emirates)

**C2RC: Channel Congestion-Based Re-Transmission Control for 3GPP-Based V2X Technologies**

Gaurang Naik and Jung-Min (Jerry) Park (Virginia Tech, USA)  
Jonathan Ashdown (United States Air Force, USA)

**A User Association Policy for UAV-Aided Time-Varying Vehicular Networks with MEC**

Bingqing Hang, Biling Zhang and Li Wang (Beijing University of Posts and Telecommunications, China)  
Jingjing Wang and Yong Ren (Tsinghua University, Beijing, China)  
Zhu Han (University of Houston, USA)

**Delay Sensitive Large-Scale Parked Vehicular Computing via Software Defined Blockchain**

Yuanyuan Cao and Yinglei Teng (Beijing University of Posts and Telecommunications, China)  
F. Richard Yu (Carleton University, Canada)  
Victor C.M. Leung (University of British Columbia, Canada)  
Ziqi Song and Mei Song (Beijing University of Posts and Telecommunications, China)

**Resource Allocation for AoI-Constrained V2V Communication in Finite Blocklength Regime**

Shuai Gao and Meixia Tao (Shanghai Jiao Tong University, China)

**A Spectrum Aware Mobility Pattern Based Routing Protocol for CR-VANETs**

Sharmin Akter and Nafees Mansoor (University of Liberal Arts Bangladesh, Bangladesh)

Wednesday, 27 May 2020  
11:00 - 12:30 • Room 10

**T4-S6: Edge Computing and Caching**

**Chair:** Youngbin Im (UNIST, South Korea)

**Overlay Coded Multicast for Edge Caching in 5G-Satellite Integrated Networks**

Xinmu Wang, Hewu Li, Tianming Lan and Qian Wu (Tsinghua University, China)

**An EPEC Analysis Among Mobile Edge Caching, Content Delivery Network and Data Center**

Yue Yu (Southeast University, China)  
Xiao Tang (Northwestern Polytechnical University, China)  
Yiyong Zha and Yunfei Zhang (Tencent, China)  
Tiecheng Song (National Mobile Communications Research Laboratory, Southeast University, China)  
Zhu Han (University of Houston, USA)

**Design and Implementation on a LoRa System with Edge Computing**

Zhiming Liu, Qihao Zhou and Lu Hou (Beijing University of Posts and Telecommunications, China)  
Rongtao Xu (Beijing Jiaotong University, China)  
Kan Zheng (Beijing University of Posts & Telecommunications, China)

**Collaborative Edge Computing and Caching in Vehicular Networks**

Zhuoxing Qin and Supeng Leng (University of Electronic Science and Technology of China, China)  
Jihua Zhou (Institute of Computing Technology, Chinese Academy of Sciences, China)  
Sun Mao (University of Electronic Science and Technology of China, China)

**Latency Guaranteed Edge Inference via Dynamic Compression Ratio Selection**

Xiufeng Huang and Sheng Zhou (Tsinghua University, China)

Wednesday, 27 May 2020  
14:00 - 15:30 • Room 01

**T1-S14: Signal Processing for Millimeter-wave and THz Communications**

**Chair:** Namyoon Lee (POSTECH, South Korea)

**Measurement of 2x2 LoS Terahertz MIMO Channel**

Suresh Singh, Thanh Le and Ha Tran (Portland State University, USA)

**Precoding with the Assistance of Attitude Information in Millimeter Wave MIMO System**

Shiyu Zhou (University of Science and Technology of China, China)  
Chen Li (University of Science and Technology of China, China)  
Weidong Wang (University of Science and Technology of China, China)

**A Novel 3D Space-Time-Frequency Non-Stationary Channel Model for 6G THz Indoor Communication Systems**

Jun Wang (Southeast University, China)  
Cheng-Xiang Wang (Southeast University & Heriot-Watt University, China)  
Jie Huang and Haiming Wang (Southeast University, China)

**Measurement-Based Characterization of 73GHz Propagation Channels in Scatterer-Rich Environments**

Zeyu Huang, José Rodríguez-Piñeiro, Xuefeng Yin and Yejian Lv (Tongji University, China)  
Haowen Wang (Shanghai Research Center for Wireless Communications, China)

**Frequency-Selective Analog Beam Probing for Millimeter Wave Communication Systems**

Christoph Jans (Technische Universität Dresden, Germany)  
Xiaohang Song (Technical University of Dresden, Germany)  
Wolfgang Rave (Dresden University of Technology, Germany)  
Gerhard P. Fettweis (Technische Universität Dresden, Germany)

Wednesday, 27 May 2020  
14:00 - 15:30 • Room 01

**T1-S15: Networking Application**

**Chair:** Yunquan Dong (Nanjing University of Information Science and Technology, China)

**Practical Framework for Beam Feature-Based Physical Layer Identification in 802.11 ad/ay Networks**

Shreya Gupta (University at Buffalo, USA)  
Zhi Sun (State University of New York at Buffalo, USA)  
Pu Wang (University of North Carolina at Charlotte, USA)  
Arupjyoti (Arup) Bhuyan (INL, USA)

**Caching and Pricing Based on Blockchain in a Cache-Delivery Market**

Yuanzhuo Lin (Beijing University of Posts and Telecommunications, China)  
Hui Tian (Beijing University of Posts and Telecommunications, China)  
Jiazhi Ren and Shaoshuai Fan (Beijing University of Posts and Telecommunications, China)

**Network Formation Model of Bio-Nanomachines Based on Directed Migration and Adhesion**

Kazuki Yonekura, Tadashi Nakano, Yutaka Okaie, Takahiro Hara and Kaname Harumoto (Osaka University, Japan)

**Optimizing Caching Policy and Bandwidth Allocation Towards User Fairness**

Pengyu Cong and Chengjian Sun (Beihang University, China)  
Dong Liu (University of Southampton, United Kingdom (Great Britain))  
Chenyang Yang (Beihang University, China)

**Clustering-Based Scenario-Aware LTE Grant Prediction**

Peter Brand, Muhammad Sabih and Joachim Falk (Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany)  
Jonathan Ah Sue (Intel Deutschland Gmbh, Germany)  
Jürgen Teich (Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany)

Wednesday, 27 May 2020  
14:00 - 15:30 • Room 03

**T1-S16: Resource Management and Optimization**

**Chair:** Yo-Seb Jeon (POSTECH, South Korea)

**Joint Subcarrier and Power Allocation in D2D Communications Underlying Cellular Networks**

Caihong Kai, Yan Wu, Xinyue HU and Wei Huang (Hefei University of Technology, China)

**Cache Allocations for Consecutive Requests of Categorized Contents: Service Provider's Perspective**

Minseok Choi (Jeju National University, USA)  
Andreas Molisch (University of Southern California, USA)  
Dong-Jun Han (KAIST, South Korea)  
Joongheon Kim (Korea University, South Korea)  
Jaekyun Moon (KAIST, South Korea)

**Multi-BS Association and Pilot Allocation via Pursuit Learning**

Naufan Raharya (University of Sydney, Australia)  
Wibowo Hardjawana (The University of Sydney, Australia)  
Obada Al-Khatib (University of Wollongong in Dubai, United Arab Emirates)  
Branka Vucetic (University of Sydney, Australia)

**Group-Based Multi-User Tracking in Mobile Millimeter-Wave Networks**

Peng-Yu Lai (Novatek, Taiwan)  
Kuang-Hao (Stanley) Liu (National Cheng Kung University, Taiwan)

**Spectrum Trading in Hybrid RF/FSO Communications: A Stackelberg Game Approach**

Shenjje Huang (Univiersity of Edinburgh, United Kingdom (Great Britain))  
Majid Safari (University of Edinburgh, United Kingdom (Great Britain))

Wednesday, 27 May 2020  
14:00 - 15:30 • Room 05

**T2-S5: Cross-Layer MAC Design**  
**Chair:** Kyung-Joon Park (DGIST, South Korea)

**Simultaneous Transmit-Receive Multi-Channel Operation in Next Generation WLANs**  
Sharan Naribole, Wook Bong Lee, Srinivas Kandala and Ashok Ranganath (Samsung Semiconductor, Inc., USA)

**A Differentially Private Classification Algorithm with High Utility for Wireless Body Area Networks**  
Xianwen Sun and Lingyun Shi (North China Electric Power University, China)  
Longfei Wu (Fayetteville State University, USA)  
Zhitao Guan (North China Electric Power University, China)  
Xiaojiang Du (Temple University, USA)  
Mohsen Guizani (Qatar University, Qatar)

**Throughput Performance Study of Smart Antenna System in WiFi Networks**  
Hsin-Li Chiu, Sau-Hsuan Wu and Hsi-Lu Chao (National Chiao Tung University, Taiwan)

**Resource Allocation and Throughput Maximization in Decoupled 5G Heterogeneous Networks**  
Humayun Zubair Khan (National University of Sciences and Technology & MCS CAMPUS, Pakistan)  
Mudassar Ali (University of Engineering and Technology Taxila, Pakistan)  
Muhammad Naeem (COMSATS University Islamabad, Wah Campus, Pakistan & Ryerson University, Canada)  
Imran Rashid (National University of Sciences and Technology, Pakistan)  
Adil Siddiqui (Military College of Signals, National University of Sciences and Technology, Pakistan)  
Muhammad Imran (National University of Sciences and Technology, Pakistan)  
Shahid Mumtaz (Instituto de Telecomunicações, Portugal)

**Cross-Layer Analysis of Distributed Passive RFID Systems Over Faded Backscattering Links**  
Roberto Valentini, Piergiuseppe Di Marco and Roberto Alesii (University of L'Aquila, Italy)  
Fortunato Santucci (University of l'Aquila, Italy)

Wednesday, 27 May 2020  
14:00 - 15:30 • Room 06

**T3-S13: Mesh, Relay, and Ad Hoc Networks**  
**Chair:** Wei Liu (Chongqing University of Technology, P.R. China)

**Multi-Channel Delay Sensitive Scheduling for Convergecast Network**  
Daoud Burghal (University of Southern California, USA)  
Kyeong Jin Kim (Mitsubishi Electric Research Laboratories (MERL), USA)  
Jianlin Guo (Mitsubishi Electronic Research Laboratories, USA)  
Philip Orlik (Mitsubishi Electric Research Laboratories, USA)  
Toshinori Hori (Mitsubishi Electric Corporation, Japan)  
Takenori Sumi (Mitsubishi Electric Corporation, Japan)  
Yukimasa Nagai (Mitsubishi Electric Research Laboratories, USA)

**Secure Routing Protocol in Wireless Ad Hoc Networks via Deep Learning**  
Feng Hu and Bing Chen (Nanjing University of Aeronautics and Astronautics, China)  
Dian Shi and Xinyue Zhang (University of Houston, USA)  
Haijun Zhang (University of Science and Technology Beijing, China)  
Miao Pan (University of Houston, USA)

**Multi-Layer Function Computation in Disorganized Wireless Networks**  
Fangzhou Wu (University of Science and Technology of China, China)  
Chen Li (University of Science & Technology of China, China)  
Guo Wei (University of Science & Technology of China, China)

**Cognitive Two-Way Relaying with Adaptive Network Coding**  
Szu-Liang Wang (Chinese Culture University, Taiwan & Quanzhou Institute of Equipment Manufacturing, Haixi Institutes, Chinese Academy of Sciences, China); Tsan-Ming Wu (Chung Yuan Christian University, Taiwan)

**End-to-End Throughput Optimization in Multi-Hop Wireless Networks with Cut-Through Capability**  
Liu Shengbo and Liqun Fu (Xiamen University, China)

**SourceShift: Resilient Routing in Highly Dynamic Wireless Mesh Networks**  
Andreas Ingo Grohmann (TU Dresden, Germany)  
Frank Gabriel and Sandra Zimmermann (Technische Universität Dresden, Germany)  
Frank H.P. Fitzek (Technische Universität Dresden & ComNets - Communication Networks Group, Germany)

Wednesday, 27 May 2020  
14:00 - 15:30 • Room 07

**T3-S14: Measurement and Analytics 1**  
**Chair:** Sihai Zhang (University of Science and Technology of China, P.R. China)

**Real Entropy Can Also Predict Daily Voice Traffic for Wireless Network Users**  
Sihai Zhang, Junyao Guo, Tian Lan, Rui Sun and Jinkang Zhu (University of Science and Technology of China, China)

**Identifying Cell Sector Clusters Using Massive Mobile Usage Records**  
Zhe Chen and Emin Aksehirli (DataSpark Pte Ltd, Singapore)

**SEdroid: A Robust Android Malware Detector Using Selective Ensemble Learning**  
Ji Wang, Qi Jing, Jianbo Gao and Xuanwei Qiu (Peking University, China)

**Fine-Grained Analysis and Optimization of Flexible Spatial Difference in User-Centric Network**  
Danyang Wu (Beijing University of Posts and Telecommunications, China)  
Hongtao Zhang (Beijing University of Posts and Telecommunications & Key Lab of Universal Wireless Communications, Ministry of Education, China)

**Capacity Analysis of Distributed Computing Systems with Multiple Resource Types**  
Pengchao Han (Northeastern University, China)  
Shiqiang Wang (IBM T. J. Watson Research Center, USA)  
Kin K. Leung (Imperial College, United Kingdom (Great Britain))

Wednesday, 27 May 2020  
14:00 - 15:30 • Room 08

**T3-S15: Services and Applications**  
**Chair:** Ronald Y. Chang (Academia Sinica, Taiwan)

**Deep Adaptation Networks Based Gesture Recognition Using Commodity WiFi**  
Zijun Han and Lingchao Guo (Beijing University of Posts and Telecommunications, China)  
Zhaoming Lu (BUPT, China)  
Xiangming Wen (Beijing University of Posts and Telecommunications, China)  
Wei Zheng (BUPT, China)

**Non-Intrusive Leak Monitoring System for Pipeline Within a Closed Space by Wireless Sensor Network**  
Fang Wang and Weiguo Lin (Beijing University of Chemical Technology, China)  
Zheng Liu (University of British Columbia Okanagan, Canada)  
Liang Kong and Xianbo Qiu (Beijing University of Chemical Technology, China)

**Smart Shopping Carts Based on Mobile Computing and Deep Learning Cloud Services**  
Muhmmad Atif Sarwar (National Chiao Tung University, Taiwan)  
Yousef-Awwad Daraghmi (Palestine Technical University Kadoorie, Palestine)  
Kuan-Wen Liu, Hong-Chuan Chi, Tsi-Uí Ik and Yih-Lang Li (National Chiao Tung University, Taiwan)

**CRED: Credibility-Enabled Social Network Based Q&A System for Assessing Answers Correctness**  
Imad Ali (Academia Sinica and National Tsing Hua University, Taiwan)  
Ronald Y. Chang (Academia Sinica, Taiwan)  
Cheng-Hsin Hsu (National Tsing Hua University, Taiwan)

**Maximizing Clearance Rate by Penalizing Redundant Task Assignment in Mobile Crowdsensing Auctions**  
Maggie E. Gendy and Ehab F. Badran (Arab Academy for Science, Technology and Maritime Transport, Egypt)  
Ahmad Al-Kabbany (Arab Academy for Science and Technology, Egypt)

Wednesday, 27 May 2020  
14:00 - 15:30 • Room 10

**T4-S7: Learning for Networks**  
**Chair:** Sung Whan Yoon (Korea Advanced Institute of Science and Technology, South Korea)

**QLACO: Q-Learning Aided Ant Colony Routing Protocol for Underwater Acoustic Sensor Networks**  
Zhengru Fang, Jingjing Wang and Chunxiao Jiang (Tsinghua University, Beijing, China)  
Biling Zhang (Beijing University of Posts and Telecommunications, China)  
Chuan Qin (Tsinghua University, China)  
Yong Ren (Tsinghua University, Beijing, China)

**DeepCReg: Improving Cellular-Based Outdoor Localization Using CNN-Based Regressors**  
Karim Elawaad, Mohamed Ezzeldin and Marwan Torki (Alexandria University, Egypt)

**Environmental Sensitivity Evaluation of Neural Networks in Unmanned Vehicle Perception Module**  
Yuru Li (Peking University, China)  
Dongliang Duan (University of Wyoming, USA)  
Chen Chen and Xiang Cheng (Peking University, China)  
Liuqing Yang (Colorado State University, USA)

**Task Allocation for Mobile Crowdsensing with Deep Reinforcement Learning**  
Xi Tao and Wei Song (University of New Brunswick, Canada)



**Edge Caching Replacement Optimization for D2D Wireless Networks via Weighted Distributed DQN**  
Ruibin Li, Yiwei Zhao, Chenyang Wang and Xiaofei Wang (Tianjin University, China)  
Victor C.M. Leung (University of British Columbia, Canada)  
Xiuhua Li (Chongqing University, China)  
Tarik Taleb (Aalto University, Finland)  
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**Wednesday, 27 May 2020**  
**16:00 - 17:30 • Room 01**

**T1-S17: 5G Wireless Communications**  
**Chair:** Jiho Song (University of Ulsan, South Korea)

**Popularity Prediction with Federated Learning for Proactive Caching at Wireless Edge**  
Kaiqiang Qi and Chenyang Yang (Beihang University, China)

**Ambient Backscatters-Friendly 5G Networks: Creating Hot Spots for Tags and Good Spots for Readers**  
Romain Fara (Orange Labs, France)  
Dinh-Thuy Phan-Huy (Orange-France Telecom, France)  
Marco Di Renzo (Paris-Saclay University / CNRS, France)

**A Simple Cell-Specific Beamforming Technique for Multi-Antenna Wireless Communications**  
Maksym A. Girnyk (Ericsson Research, Sweden)  
Sven O. Petersson (Ericsson AB, Sweden)

**Wireless Fingerprint Aided Spectrum Sensing in Cellular Cognitive Radio Networks**  
Xin Wang and Siji Chen (Chongqing University of Posts and Telecommunications, China)  
Bin Shen (Chongqing University of Posts and Telecommunications (CQUPT), China)  
Taiping Cui (Chongqing University of Posts and Telecommunications, China)  
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**Wednesday, 27 May 2020**  
**16:00 - 17:30 • Room 02**

**T1-S18: Signal Detection and Estimation**  
**Chair:** Wonjun Kim (Seoul National University, South Korea)

**Reconstruction Algorithm for Primary Channel Statistics Estimation Under Imperfect Spectrum Sensing**  
Ogeen Toma and Miguel López-Benítez (University of Liverpool, United Kingdom (Great Britain))  
Dhaval Karshanbhai Patel (School of Engineering and Applied Science-Ahmedabad University, India)  
Kenta Umabayashi (Tokyo University of Agriculture and Technology, Japan)

**Methods for Fast Estimation of Primary Activity Statistics in Cognitive Radio Systems**  
Miguel López-Benítez and Ogeen Toma (University of Liverpool, United Kingdom (Great Britain))  
Dhaval Karshanbhai Patel (School of Engineering and Applied Science-Ahmedabad University, India)  
Kenta Umabayashi (Tokyo University of Agriculture and Technology, Japan)

**Applying Deep Neural Networks for Duty Cycle Estimation**  
Ahmed Al-Tahmeesschi, Kenta Umabayashi and Hiroki Iwata (Tokyo University of Agriculture and Technology, Japan)  
Miguel López-Benítez (University of Liverpool, United Kingdom (Great Britain))  
Janne Lehtomäki (University of Oulu, Finland)

**Channel Estimation for Intelligent Reflecting Surface Assisted Multiuser Communications**  
Zhaorui Wang (The Hong Kong Polytechnic University, China)  
Liang Liu (The Hong Kong Polytechnic University, China)  
Shuguang Cui (The Chinese University of Hong Kong, Shenzhen & Shenzhen Research Institute of Big Data, China)

**Dynamic Model Based Malicious Collaborator Detection in Cooperative Tracking**  
Wang Pi and Pengtao Yang (Peking University, China)  
Dongliang Duan (University of Wyoming, USA)  
Chen Chen and Xiang Cheng (Peking University, China)  
Liuqing Yang (Colorado State University, USA)  
.....

**Wednesday, 27 May 2020**  
**16:00 - 17:30 • Room 03**

**T1-S19: Energy Efficient Communications**  
**Chair:** Seok-Ho Chang (Konkuk University, South Korea)

**Minimization of Sum Inverse Energy Efficiency for Multiple Base Station Systems**  
Zijian Wang (Université Catholique de Louvain, Belgium)  
Luc Vandendorpe (Université Catholique de Louvain, Belgium)  
Mateen Ashraf (University Catholique de Louvain, Louvain-la-Neuve, Belgium)  
Yuting Mou and Nafiseh Janatian (Université Catholique de Louvain, Belgium)

**Joint Optimization for PS-Based SWIPT Multiuser Systems with Non-linear Energy Harvesting**  
Thang X. Vu, Symeon Chatzinotas, Sumit Gautam and Eva Lagunas (University of Luxembourg, Luxembourg)  
Björn Ottersten (University of Luxembourg, Luxembourg)

**A Novel Low-Complexity Power-Allocation Algorithm for Multi-Tone Signals for Wireless Power Transfer**  
Boules Mouris (KTH Royal Institute of Technology, Sweden)  
Henrik Forssell (KTH, Sweden)  
Ragnar Thobaben (KTH Royal Institute of Technology, Sweden)

**Towards Power-Efficient Aerial Communications via Dynamic Multi-UAV Cooperation**  
Lin Xiang, Lei Lei and Symeon Chatzinotas (University of Luxembourg, Luxembourg)  
Björn Ottersten (University of Luxembourg, Luxembourg)  
Robert Schober (Friedrich-Alexander University Erlangen-Nuremberg, Germany)

**Energy Efficiency Optimization for Secure Transmission in a MIMO-NOMA System**  
Miao Zhang and Kanapathippillai Cumanan (University of York, United Kingdom (Great Britain))  
Wei Wang (Nantong University, China)  
Alister G. Burr (University of York, United Kingdom (Great Britain))  
Zhiguo Ding (University of Manchester, United Kingdom (Great Britain))  
Sangarapillai Lambotharan (Loughborough University, United Kingdom (Great Britain))  
Octavia A. Dobre (Memorial University, Canada)  
.....

**Wednesday, 27 May 2020**  
**16:00 - 17:30 • Room 05**

**T2-S6: Wireless MAC for 5G**  
**Chair:** Joohyun Lee (Hanyang University, South Korea)

**UAV-Assisted Data Collection with Non-Orthogonal Multiple Access**  
Weichao Chen, Shengjie Zhao and Rongqing Zhang (Tongji University, China)  
Liuqing Yang (Colorado State University, USA)

**HMC: A Hopping-Based Multi-Channel Coordination Scheme for URLLC in Unlicensed Spectrum**  
Hsueh-Yi Chen, Pei-Feng Lee and Te-Wei Chiang (National Central University, Taiwan)  
Sheng-Shih Wang (Lunghwa University of Science and Technology, Taiwan)  
Shiann-Tsong Sheu (National Central University, Taiwan)

**Graph-Based File Dispatching Protocol with D2D-Aided UAV-NOMA Communications in Large-Scale Networks**  
Baoji Wang (Peking University, China)  
Rongqing Zhang (Tongji University, China)  
Chen Chen and Xiang Cheng (Peking University, China)  
Liuqing Yang (Colorado State University, USA)

**MDP-Based Resource Allocation for Uplink Grant-Free Transmissions in 5G New Radio**  
Thilina Weerasinghe, Indika A. M. Balapuwaduge and Frank Y. Li (University of Agder, Norway)  
Vicente Casares-Giner (Universitat Politècnica de València, Spain)

**Semi-Static Radio Frame Configuration for URLLC Deployments in 5G Macro TDD Networks**  
Ali Esswie (Nokia Bell Labs, Denmark)  
Klaus Pedersen (Nokia - Bell Labs, Denmark)  
Preben Mogensen (Nokia–Bell Labs, Research Center Aalborg, Sweden)  
.....

**Wednesday, 27 May 2020**  
**16:00 - 17:30 • Room 06**

**T3-S16: Mobile Edge Computing 2**  
**Chair:** Qi Zhang (Aarhus University, Denmark)

**Resource Allocation for Multi-Access Edge Computing with Coordinated Multi-Point Reception**  
Jian-Jyun Hung and Wanjiun Liao (National Taiwan University, Taiwan)  
Yi-Han Chiang (Osaka Prefecture University, Japan)

**Joint Offloading and Resource Allocation for Time-Sensitive Multi-Access Edge Computing Network**  
Jun-jie Yu, Mingxiong Zhao, Wen-tao Li and Di Liu (Yunnan University, China)  
Shao Wen Yao (National Pilot School of Software, YunNan University, China)  
Wei Feng (Hangzhou Dianzi University, China)

**Computation Resource Allocation for Heterogeneous Time-Critical IoT Services in MEC**  
Jianhui Liu and Qi Zhang (Aarhus University, Denmark)

**Location-Privacy-Aware Service Migration in Mobile Edge Computing**  
Weixu Wang, Shuxin Ge and Xiaobo Zhou (Tianjin University, China)

**Adaptive Task Partitioning at Local Device or Remote Edge Server for Offloading in MEC**  
Jianhui Liu and Qi Zhang (Aarhus University, Denmark)  
.....

**Wednesday, 27 May 2020**  
**16:00 - 17:30 • Room 07**

**T3-S17: Measurement and Analytics 2**  
**Chair:** Konstantin Mikhaylov (University of Oulu, Finland)

**Mutation Testing Framework for Ad-hoc Networks Protocols**  
Anis Zarrad (University of Birmingham, United Arab Emirates)  
Izzat Alsmadi (Texas A&M San Antonio, USA)





Symbol-Level Precoding Design for IRS-Assisted MU-MISO Systems

Rang Liu, Hongyu Li, Ming Li and Qian Liu  
(Dalian University of Technology, China)

Protograph-Based LDPC-Hadamard Codes

Pengwei Zhang and Francis C.M. Lau  
(The Hong Kong Polytechnic University, Hong Kong)  
Chiu Wing Sham (The University of Auckland, New Zealand)

Stopping Criterion for NR LDPC Decoder Based on PEXIT Chart Analysis

Taehyun Kim (Samsung Electronics, South Korea)  
Joo Sung Park (SAMSUNG Electronics, USA)  
Jun Heo (Korea University, South Korea)

Decoding Orders and Power Allocation for Untrusted NOMA: A Secrecy Perspective

Sapna Thapar (Indian Institute of Technology Jammu, India)  
Deepak Mishra  
(University of New South Wales (UNSW) Sydney, Australia)  
Ravikant Saini (Indian Institute of Technology Jammu, India)  
.....

Thursday, 28 May 2020  
10:40 - 12:10 • Room 03

T1-S22: Performance Analysis 1

Chair: Taesoo Kwon (Seoul National University of Science and Technology, South Korea)

Performance Analysis of Distributed Beamforming With Random Phase Offsets

Justin Kong and Fikadu Dagefu  
(US Army Research Laboratory, USA)  
Brian Sadler (Army Research Laboratory, USA)

Performance of Raptor Codes on the BIAWGN Channel in the Presence of SNR Mismatch

Amrit Kharel (Qualcomm Inc., USA)  
Hussein Fadhel (University of Mississippi, USA)  
Lei Cao (The University of Mississippi, USA)

On Age and Value of Information in Status Update Systems

Peng Zou, Omur Ozel and Suresh Subramaniam  
(George Washington University, USA)

A Low-Complexity Algorithm for Cell Identity Detection in NB-IoT Physical Layer

Hung-Ying Chang, Jian-Bin Chang and Chao-Yu Chen  
(National Cheng Kung University, Taiwan)

A Novel Coordinated Multi-Point Downlink Transmission Scheme for Ultra-Dense Networks

Sudarshan Mukherjee  
(Indian Institute of Technology Guwahati, India)  
Dongsun Kim, Hewon Cho and Jemin Lee  
(Daegu Gyeongbuk Institute of Science and Technology (DGIST), South Korea)

Thursday, 28 May 2020  
10:40 - 12:10 • Room 05

T2-S7: Scheduling

Chair: Changhee Joo (Korea University, South Korea)

Co-Optimizing Performance and Fairness Using Weighted PF Scheduling and IAB-Aware Flow Control

Yingjie Zhang (University of California, Davis, USA)  
Vishwanath Ramamurthi (Verizon Wireless, USA)  
Zhiyi Huang and Dipak Ghosal  
(University of California, Davis, USA)

Scheduling Stochastic Real-Time Jobs in Unreliable Workers

Yu-Pin Hsu (National Taipei University, Taiwan)  
Yu-Chih Huang (National Chiao Tung University, Taiwan)  
Shin-Lin Shieh (National Taipei University, Taiwan)

Exception of Dominant Interfering Beam: Low Complex Beam Scheduling in mmWave Networks

Eunkyung Kim (Electronics and Telecommunications Research Institute (ETRI), South Korea)  
Jeongho Kwak (DGIST, South Korea)  
Song Chong (KAIST, South Korea)

Age of Information in Scheduled Wireless Relay Networks

Masoumeh Moradian (IPM, Iran)  
Aresh Dadlani (Nazarbayev University, Kazakhstan)  
.....

Thursday, 28 May 2020  
10:40 - 12:10 • Room 06

T3-S20: UAV (Unmanned Aerial Vehicle) 1

Chair: Yao Sun (University of Electronic Science and Technology of China, China)

UAV Trajectory and Sub-channel Assignment for UAV Based Wireless Networks

Nguyen Minh Dat  
(INRS-EMT & University of Quebec, Canada)  
Tai Manh Ho (École de Technologie Supérieure ÉTS, Canada)  
Long Bao Le (INRS, University of Quebec, Canada)  
Andre Girard (INRS-EMT and GERAD, Canada)

Flight Scheduling and Trajectory Control in UAV-Based Wireless Networks

Minh Tri Nguyen (EMT-INRS, University of Quebec, Canada)  
Long Bao Le (INRS, University of Quebec, Canada)

Distributed Topology Control Based on Swarm Intelligence in Unmanned Aerial Vehicles Networks

Qianyi Zhang, Gang Feng, Shuang Qin and Yao Sun  
(University of Electronic Science and Technology of China, China)

Trajectory Design and Generalization for UAV Enabled Networks: A Deep Reinforcement Learning Approach

Xuan Li  
(Beijing University of Posts and Telecommunications, China)  
Qiang Wang  
(Beijing University of Posts and Telecommunications, China)  
Jie Liu  
(Beijing University of Post and Telecommunications, China)  
Wenqi Zhang  
(Beijing University of Posts and Telecommunications, China)

Performance Analysis of Temporal Correlation in Finite-Area UAV Networks with LoS/NLoS

Ruixin Jin  
(Beijing University of Post and Telecommunications, China)  
Liyun Yang  
(Beijing University of Posts and Telecommunications, China)  
Hongtao Zhang (Beijing University of Posts and Telecommunications & Key Lab of Universal Wireless Communications, Ministry of Education, China)  
.....

Thursday, 28 May 2020  
10:40 - 12:10 • Room 07

T3-S21: Security and Privacy 1

Chair: J Harshan (Indian Institute of Technology Delhi, India)

Bloom Filter Based Low-Latency Provenance Embedding Schemes in Wireless Networks

J Harshan, Amogh Vithalkar, Naman Jhunjunwala, Manthan Kabra and Prafull Manav  
(Indian Institute of Technology Delhi, India)  
Yih-Chun Hu  
(University of Illinois at Urbana-Champaign, USA)

Ergodic Secrecy Rate of K-User MISO Broadcast Channel with Improved Random Beamforming

Ye Fan, Xuewen Liao and Zhenzhen Gao  
(Xi'an Jiaotong University, China)

A Secure Authentication Scheme for Remote Diagnosis and Maintenance in Internet of Vehicles

Ruhui Ma and Jin Cao (Xidian University, China)  
Dengguo Feng  
(State Key Laboratory of Cryptology, Beijing, China)  
Hui Li (Xidian University, China)  
Ben Niu (Institute of Information Engineering, Chinese Academy of Sciences, China)  
Fenghua Li (State Key Laboratory of Information Security, Institute of Information Engineering, CAS, China)  
Lihua Yin (Guangzhou University, China)

WiRE: Security Bootstrapping for Wireless Device-to-Device Communication

Yinrong Tao, Sheng Xiao and Bin Hao  
(Hunan University, China)  
Qingquan Zhang  
(University of Illinois, Urbana Champaign, USA)  
Ting Zhu (University of Maryland, Baltimore County, USA)  
Zhuo Chen (Office of Ecology Protection, Management and Construction Hunan Province, China)

Utility-Aware Exponential Mechanism for Personalized Differential Privacy

Ben Niu (Institute of Information Engineering, Chinese Academy of Sciences, China)  
Yahong Chen (Institute of Information Engineering, CAS & School of Cyber Security, UCAS, China)  
Boyang Wang (University of Cincinnati, USA)  
Jin Cao (Xidian University, China)  
Fenghua Li (Institute of Information Engineering, CAS School of Cyber Security, UCAS, P.R. China)  
.....

Thursday, 28 May 2020  
10:40 - 12:10 • Room 08

T3-S22: Resource Management and Optimization 1

Chair: Bheemarjuna Reddy Tamma (IIT Hyderabad, India)

QoS-Driven Stochastic Analysis for Heterogeneous Cognitive Radio Networks

Muyu Mei, Qinghai Yang and Meng Qin  
(Xidian University, China)  
Kyung Sup Kwak (Inha University, South Korea)  
Ramesh R. Rao (UCSD, USA)

Joint User-Centric Clustering and Frequency Allocation in Ultra-Dense C-RAN

Qiang Liu, Sun Songlin and Hui Gao  
(Beijing University of Posts and Telecommunications, China)

Trading Based Service-Oriented Spectrum-Aware RAN-Slicing Under Spectrum Sharing

Kajia Jiao and Xuanheng Li  
(Dalian University of Technology, China)  
Miao Pan (University of Houston, USA)  
Fan Jiang  
(Xian University of Posts and Telecommunications, China)  
Ming Li (Dalian University of Technology, China)

Throughput Analysis in Cache-Enabled Millimeter Wave HetNets with Access and Backhaul Integration

Chenwu Zhang, Hao Wu, Hancheng Lu and Jinxue Liu  
(University of Science and Technology of China, China)

Jointly Optimizing Helpers Selection and Resource Allocation in D2D Mobile Edge Computing

Yang Li, Gaochao Xu and Jiaqi Ge (Jilin University, China)  
Peng Liu (Northeast Forestry University, China)  
Xiaodong Fu (Jilin University, China)  
Zhenjun Jin (Changchun University of Technology, China)







**UAV-Based Air-to-Ground Channel Modeling for Diverse Environments**  
Muhammad Usaid Akram, Usama Saeed and Syed Ali Hassan  
(National University of Sciences & Technology, Pakistan)  
Haejoon Jung (Incheon National University, South Korea)

**Optimizing Transmission and Propulsion Powers for Flying Base Stations**  
Mohammdsaleh Nikooroo and Zdenek Becvar  
(Czech Technical University in Prague, Czech Republic)  
.....  
**Thursday, 28 May 2020**  
**16:00 - 17:30 • Room 01**

**T1-S27: Massive MIMO 2**  
**Chair:** Junil Choi (KAIST, South Korea)

**Limits of Transmit and Receive Array Gain in Massive MIMO**  
Tobias Laas (Huawei Technologies Duesseldorf GmbH and Technical University of Munich, Germany)  
Josef A. Nossek (Technical University of Munich, Germany and Federal University of Cear , Brazil)  
Wen Xu (Huawei Technologies Duesseldorf GmbH, Germany)

**A Study on Unique-Word Based Synchronization for MIMO Systems Over Time-Varying Channels**  
Shahab Ehsanfar  
(Technische Universit t Dresden, Germany)  
Marwa Chafii (ENSEA, France)  
Gerhard P. Fettweis  
(Technische Universit t Dresden, Germany)

**ACS-Based Beam Selection for Massive MIMO Interfering Broadcast Channels with Hybrid Precoding**  
Meng Qi (Shanghai Jiao Tong University, China)  
Gui Lin (ShangHai JiaoTong University, China)  
Ling Zhang (Shanghai Jiao Tong University, China)

**Max-Min Fair Wireless-Powered Cell-Free Massive MIMO for Uncorrelated Rician Fading Channels**  
 zlem Tu fe Demir and Emil Bj rnson  
(Link ping University, Sweden)

**Low Complexity Iterative Parallel Interference Cancellation Algorithms for Massive MIMO System**  
Bin Shen and Hebiao Wu (Chongqing University of Posts and Telecommunications (CQUPT), China)  
Shufeng Zhao and Taiping Cui (Chongqing University of Posts and Telecommunications, China)

**Thursday, 28 May 2020**  
**16:00 - 17:30 • Room 02**  
  
**T1-S28: Coding Scheme 2**  
**Chair:** SongNam Hong (Ajou University, South Korea)

**On the Error Probability of Interference Exploitation Precoding with Power Allocation**  
Abdelhamid Salem (UCL, United Kingdom (Great Britain))  
Christos Masouros  
(University College London, United Kingdom (Great Britain))

**A Low-Complexity Dual Trellis Decoding Algorithm for High-Rate Convolutional Codes**  
Vinh Hoang Son Le, Charbel Abdel Nour and Catherine Douillard (IMT Atlantique, France)  
Emmanuel Boutillon (Universit  de Bretagne Sud, France)

**A Modified Rejection-Based Architecture to Find the First Two Minima in Min-Sum-Based LDPC Decoders**  
Alireza Hasani (Brandenburg University of Technology Cottbus-Senftenberg & IHP GmbH - Innovations for High Performance Microelectronics, Germany)  
Lukasz Lopacinski (IHP, Germany)  
Steffen B chner (Brandenburgische Technische Universit t Cottbus-Senftenberg, Germany)  
J rg Nolte (BTU Cottbus, Germany)  
Rolf Kraemer (IHP Microelectronics, Frankfurt/Oder & BTU-Cottbus, Germany)

**Space-Time Coding for Orbital Angular Momentum Multiplexed Free-Space Optical Systems**  
El Mehdi Amhoud  
(Mohammed VI Polytechnic University, Morocco)  
Ghaya Rekaya-Ben Othman (TELECOM ParisTech, France)

**Space-Time Waveform Coding for Joint Radar and Wireless Communications (RadCom) Applications**  
Jan Mietzner  
(Hamburg University of Applied Sciences (HAW), Germany)  
Avik Santra (Infineon Technologies AG, Germany)  
.....

**Thursday, 28 May 2020**  
**16:00 - 17:30 • Room 03**  
  
**T1-S29: Transceiver Design**  
**Chair:** Jun Won Choi (Hanyang University, South Korea)

**A Distance-Detection Receiver for Ambient Backscatter Communications with MPSK RF Source**  
Youyou Zhang (UESTC, China)  
Ying-Chang Liang (University of Electronic Science and Technology of China, China)  
Pooi-Yuen Kam (National University of Singapore, Singapore)

**On the Information Transfer Rate of SPAD Arrays**  
Elham Sarbazi and Majid Safari  
(University of Edinburgh, United Kingdom (Great Britain))  
Harald Haas  
(The University of Edinburgh, United Kingdom (Great Britain))

**Defeating Smart and Reactive Jammers with Unlimited Power**  
Huynh Van Nguyen  
(University of Technology Sydney, Australia)  
Hoang Thai Dinh  
(University of Technology Sydney (UTS), Australia)  
Diep N. Nguyen and Eryk Dutkiewicz  
(University of Technology Sydney, Australia)  
Markus Dominik Mueck (Intel Deutschland GmbH, Germany)

**Filter Bank Multicarrier Transmission Based on the Discrete Hartley Transform**  
Chin-Liang Wang, Hong-Shiuann Pan and Chia-Tung Tuan  
(National Tsing Hua University, Taiwan)

**Distributed Detection with Non-Identical Sensors: Fusion in the Air or at the Receiver?**  
Smruti Ranjan Ranjan Panigrahi (University of G vle & KTH Royal Institute of Technology, Sweden)  
Niclas Bj rsell (University of G vle, Sweden)  
Mats Bengtsson (KTH Royal Institute of Technology, Sweden)  
.....  
**Thursday, 28 May 2020**  
**16:00 - 17:30 • Room 06**

**T3-S26: UAV (Unmanned Aerial Vehicle) 2**  
**Chair:** Oktay Cetinkaya  
(University of Southampton, United Kingdom (Great Britain))

**Reducing Energy Consumed by Repositioning of Flying Base Stations Serving Mobile Users**  
Zdenek Becvar, Pavel Mach and Mohammadsaleh Nikooroo  
(Czech Technical University in Prague, Czech Republic)

**Efficient Deployment of UAV-Powered Sensors for Optimal Coverage and Connectivity**  
Oktay Cetinkaya and Geoff V Merrett  
(University of Southampton, United Kingdom (Great Britain))

**Multi-UAV Collaborative Data Collection for IoT Devices Powered by Battery**  
Yue Wang  
(Beijing University of Posts and Telecommunication, China)  
Xiang Ming Wen  
(Beijing University of Posts and Telecommunications, China)  
Zhiqun Hu (Hubei University, China)  
Zhaoming Lu (BUPT, China)  
Jiansong Miao and Chuazhi Sun  
(Beijing University of Posts and Telecommunications, China)  
Hang Qi (Beijing University of Posts and Telecommunications & BUPT, China)

**Resource Allocation for UAV Assisted Wireless Networks with QoS Constraints**  
Weihang Ding (Kings College London, China)  
Zhaohui Yang  
(King's College London, United Kingdom (Great Britain))  
Mingzhe Chen (Princeton University, USA)  
Jiancao Hou and Mohammad Shikh-Bahaei  
(King's College London, United Kingdom (Great Britain))

**Trajectory Design for Energy Harvesting UAV Networks: A Foraging Approach**  
Xuanlin Liu, Sihua Wang and Changchuan Yin  
(Beijing University of Posts and Telecommunications, China)  
Mingzhe Chen (Princeton University, USA)  
Walid Saad (Virginia Tech, USA)  
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**Thursday, 28 May 2020**  
**16:00 - 17:30 • Room 07**  
  
**T3-S27: Security and Privacy 2**  
**Chair:** Aarti Agarkar  
(Sinhgad College of Engineering, Pune, India)

**Post Quantum Security Solution for Data Aggregation in Wireless Sensor Networks**  
Aarti Agarkar (Sinhgad College of Engineering, Pune)  
Mandar Karyakarte  
(Vishwakarma Institute of Information Technology, India)  
Himanshu Agrawal  
(Swinburne University of Technology, Australia)

**Rogue Access Point Localization Leveraging Compressive Sensing via Kernel Optimization**  
Qiaolin Pu and Joseph Kee-Yin Ng  
(Hong Kong Baptist University, Hong Kong)  
Shijie Deng and Fawen Zhang (Chongqing University of Posts and Telecommunications, China)

**MalPortrait: Sketch Malicious Domain Portraits Based on Passive DNS Data**  
Zhizhou Liang and Zang Tianning  
(Institute of Information Engineering, Chinese Academy of Sciences, China)  
Yuwei Zeng (University of Chinese Academy of Sciences & Institute of Information Engineering, China)

**Revisiting Compressive Sensing Based Encryption Schemes for IoT**  
Gajraj Kuldeep and Qi Zhang (Aarhus University, Denmark)

**Robust Self-Protection Against Application-Layer (D) DoS Attacks in SDN Environment**  
Chafika Benzaid, Mohammed Boukhalfa and Tarik Taleb  
(Aalto University, Finland)



Thursday, 28 May 2020  
16:00 - 17:30 • Room 08

**T3-S28: Resource Management and Optimization 3**  
**Chair:** Hamed Mirghasemi  
(Université Catholique de Louvain-la-Neuve, Belgium)

**An Efficient QoS-Aware Computational Resource Allocation Scheme in C-RAN**  
Mojgan Barahman  
(Instituto Superior Técnico/ University of Lisbon, Portugal)  
Luis M. Correia  
(IST/INESC-ID - University of Lisbon & INESC, Portugal)  
Lúcio Studer Ferreira  
(ISTEC / ULHT COPELABS / INESC-ID, Portugal)

**Maximum Allowable Transfer Interval Aware Scheduling for Wireless Remote Monitoring**  
Mounssif Krouka and Anis Elgabli (University of Oulu, Finland)  
Mehdi Bennis (Centre of Wireless Communications, University of Oulu, Finland)

**User Association in Software-Defined Wi-Fi Networks for Enhanced Resource Allocation**  
Blas Gómez (University of Castilla-La Mancha, Spain)  
Estefania Coronado (Fondazione Bruno Kessler, Italy)  
José Villalón (UCLM, Spain)  
Roberto Riggio (Fondazione Bruno Kessler, Italy)  
Antonio Garrido (University of Castilla-La Mancha, Spain)

**Traffic Aware Beamformer Design for Integrated Access and Backhaul with Flexible TDD**  
Laddu Praneeth Roshan Jayasinghe, Antti Tölli, Jarkko Kaleva and Matti Latva-aho (University of Oulu, Finland)

**Online Optimal Resource Allocation for SWIPT-Based Mobile Edge Computing Systems**  
Hamed Mirghasemi  
(Université Catholique de Louvain-la-Neuve, Belgium)  
Luc Vandendorpe (Université Catholique de Louvain, Belgium)  
Mateen Ashraf (University Catholique de Louvain, Louvain-la-Neuve, Belgium)

Thursday, 28 May 2020  
16:00 - 17:30 • Room 09

**T3-S29: Multi-Connectivity**  
**Chair:** Aimin Tang (Shanghai Jiao Tong University, China)

**Design and Analysis for Dual Connectivity and Raptor Codes Assisted Handover in Vehicular Networks**  
Mingcheng He, Cunqing Hua and Pengwenlong Gu (Shanghai Jiao Tong University, China)

**Mesh Architecture for Efficient Integrated Access and Backhaul Networking**  
Bangzhao Zhai, Mengxin Yu, Aimin Tang and Xudong Wang (Shanghai Jiao Tong University, China)

**Evaluation of Multi-Connectivity Schemes for URLLC Traffic Over WiFi and LTE**  
Marie-Theres Suer  
(TU Braunschweig & Robert Bosch GmbH, Germany)  
Christoph Thein and Hugues Tchouankem (Robert Bosch GmbH, Germany)  
Lars C Wolf (Technische Universität Braunschweig, Germany)

**Online Control of Traffic Split and Distributed Cell Group State Decisions for Multi-Connectivity**  
Sunghoon Jung and Saewoong Bahk  
(Seoul National University, South Korea)

**Multi-Connectivity for Reliable Wireless Industrial Communications: Gains and Limitations**  
Ali Haider Mahdi (Technische Universität Dresden, Germany)  
Tom Hößler (TU Dresden & Barkhausen Institut, Germany)  
Norman Franchi and Gerhard P. Fettweis (Technische Universität Dresden, Germany)

Thursday, 28 May 2020  
16:00 - 17:30 • Room 10

**T4-S13: Hybrid Satellite Networks**  
**Chair:** Hyoil Kim (Ulsan National Institute of Science and Technology (UNIST), South Korea)

**Content Delivery for High-Speed Railway via Integrated Terrestrial-Satellite Networks**  
Xinmu Wang, Hewu Li, Wenbing Yao, Tianming Lan and Qian Wu (Tsinghua University, China)

**Switching Algorithm Based On Monte Carlo-Markov Decision Under Space-Air-Ground Integrated Network**  
Zhuoran Zhou, Ke Wang, Zhongliang Deng and Wenliang Lin (Beijing University of Posts and Telecommunications, China)  
Yun Liu (The 54th Research Institute of China Electronics Technology Group Corporation, China)

**How Capacity is Influenced by Ultra-Dense LEO Topology in Multi-Terminal Satellite Systems?**  
Ruoqi Deng (Peking University, China)  
Boya Di (Imperial College London, United Kingdom (Great Britain) & Peking University, China)  
Lingyang Song (Peking University, China)

**Patch Antenna Arrays Beam Steering for Enhanced LEO Nanosatellite Communications**  
Néstor J. Hernández Marcano and Hannes Bartle (Aarhus University, Denmark)  
Rune Hylsberg Jacobsen (Aarhus University & Electrical and Computer Engineering, Denmark)

**Collaborative Transmission in Hybrid Satellite-Terrestrial Networks: Design and Implementation**  
Yinan Jia and Jiaxin Zhang  
(Beijing University of Posts and Telecommunications, China)  
Peng Wang and Liangjingrong Liu  
(Beijing University of Post and Telecommunications, China)  
Xing Zhang and Wenbo Wang  
(Beijing University of Posts and Telecommunications, China)

**Underlay Cognitive Hybrid Satellite-Terrestrial Networks with Cooperative-NOMA**  
Vibhum Singh, Prabhat Kumar Upadhyay and Vinay Bankey (Indian Institute of Technology Indore, India)

Thursday, 28 May 2020  
16:00 - 17:30 • Room 11

**T4-S14: mmWave and Optical Wireless**  
**Chair:** Hoon Lee (Pukyong National University, South Korea)

**Performance Evaluation of Spectrum Sharing in mmWave Cellular Networks Using Ray-Tracing**  
Constantinos Vrontos  
(University of Bristol, United Kingdom (Great Britain))  
Federico Boccardi (Ofcom, United Kingdom (Great Britain))  
Simon Armour and Evangelos Mellios  
(University of Bristol, United Kingdom (Great Britain))  
Joe Butler (Ofcom, United Kingdom (Great Britain))

**Studies of Flatness of LiFi Channel for IEEE 802.11bb**  
Ardimas Andi Purwita  
(University of Edinburgh, United Kingdom (Great Britain))  
Harald Haas  
(The University of Edinburgh, United Kingdom (Great Britain))

**IQ-WDM for IEEE 802.11bb-Based LiFi**  
Ardimas Andi Purwita  
(University of Edinburgh, United Kingdom (Great Britain))  
Harald Haas  
(The University of Edinburgh, United Kingdom (Great Britain))

**A Novel E-Band Testbed for Polarization MIMO-OFDM Systems with Wideband IQ Imbalance Compensation**  
Daisuke Uchida, Tamio Kawaguchi, Daiki Yoda and Makoto Sano (Toshiba Corporation, Japan)  
Koji Akita (Toshiba Corp, Japan)  
Magnus Sandell  
(Toshiba TRL, United Kingdom (Great Britain))  
Evgeny Tsimbalo  
(Telecommunications Research Laboratory of Toshiba Research Europe Ltd., United Kingdom (Great Britain));  
Seifallah Jardak (Toshiba Research Europe Limited, United Kingdom (Great Britain))  
Ichiro Seto (Toshiba corporation, Japan)

**SoftFG: A Dynamic Load Balancer for Soft Reconfiguration of Wireless Data Centers**  
Amer AlGhadhban (KAUST, Saudi Arabia)  
Abdulkadir Celik (King Abdullah University of Science & Technology, Saudi Arabia)  
Basem Shihada (KAUST, Saudi Arabia)  
Mohamed-Slim Alouini (King Abdullah University of Science and Technology (KAUST), Saudi Arabia)

HALF DAY WORKSHOPS

HWS1: 5G and Beyond Technology-enabled Remote Health Systems (5G Remote Health)

Monday, 25 May 2020 • 09:00 - 12:15 • Room 06

Workshop Organizer and Session Chair: Di Zhang (Zhengzhou University, China)

High-quality hospitals and health resources are mostly in big cities. Villages and remote areas are lack of such medical institutions and resources. Rapid siphon effect of big city makes the remote area's health conditions even worse. Technology development is to make the social process and human life more convenient, but not to distinguish its people according to their living places or any other characters. In order to alleviate the difference, health services with a purpose of providing people of remote areas with high-quality health services, are thus of great significance, such as the 5G and beyond technology-enabled remote health systems (5G remote health). In literature, 5G remote health enables the doctor in big cities to remotely diagnose and treat their patients via reliable high speed and low latency 5G wireless connections. Patients living in remote areas thus can share the high-quality medical resources without actually moving or traveling to big cities. On the other hand, 5G remote health can play an important role for the rescue and relief work while encountering some emergency conditions or disasters. 5G remote health can also improve the service quality of in-hospital tasks, e.g., 5G remote health can relief the frequent ward rounds.

Currently, studies on 5G remote health are still limited, and the existing technologies are still not enough for the implementation of 5G remote health. For instance, according to our test, only about 7ms latency is achieved by the current 5G networks, which is almost non-applicable for some remote health applications with ultra-reliable low latency communications (URLLC) requirements such as remote surgery. Additionally, the health information protection and the secured transmission are also important issues for the 5G remote health. Some legislations and ethics issues from the government are also required. Currently, less attentions or endeavors have been put on these topics.

The 5G and Beyond Technology-enabled Remote Health Systems (5G Remote Health) workshop is co-organized by Zhengzhou University, China, Federal University of Piauí (UFPI), Brazil, Instituto de Telecomunicações, Portugal, National Telemedicine Center and National Engineering Laboratory for Internet Medical Systems and Applications, China, and the University of Tokyo, Japan.



9:00 AM — 10:30 AM: 5G and Beyond Technology-Enabled Remote Health Systems I

Keynote: How 5G Will Affect Healthcare?

Haesik Kim (VTT Research Center, Finland)

Random Access Preamble Design and Detection for 5G Remote Health via Satellite Communications

Teng Sun (Xi'an University of Posts & Telecommunications, China)

Li Zhen (Xi'an University of Posts and Telecommunications, China)

Guangyue Lu

(Xi'an University of Posts & Telecommunications, China)

Keping Yu (Waseda University, Japan)

Modulation Division Based User Grouping Transmission in Massive SIMO Systems

Linxin Zhang, Jingjie Zong, Gangtao Han, Shuangzhi Li and

Xiaomin Mu (Zhengzhou University, China)

10:45 AM — 12:15 PM: 5G and Beyond Technology-Enabled Remote Health Systems II

Prioritizing Health Care Data Traffic in a Congested IoT Cloud Network

Sara Beitelspacher, Kedir Mamo Beshir, Mohammed Zamshed Ali

and Mohammad Mubashir (University of Texas at Dallas, USA)

Uplink Pilot Power Allocation for MA-MIMO-HetNet Remote Health Systems

Yabo Guo and Zhengyu Zhu (Zhengzhou University, China)

Xinhua Lu

(Zhengzhou University & Institute of Nanyang Technology, China)

Zhongyong Wang and Wanming Hao (Zhengzhou University, China)

Ali Kashif Bashir (Manchester Metropolitan University, United

Kingdom (Great Britain))

Glioma Segmentation Strategies in 5G Teleradiology

Xiangchuan Gao, Lei Ma and Jin Jin (Zhengzhou University, China)

Junmin Li

(The First Affiliated Hospital of Zhengzhou University, China)

Zhenxia Ma (ZhengZhou University, China)

Yunkai Zhai (Zhengzhou University, China)

Xingwang Li (Henan Polytechnic University, China)

Multi-Channel Lightweight Convolutional Neural Network for Remote Myocardial Infarction Monitoring

Yangjie Cao, Tingting Wei and Nan Lin

(Zhengzhou University, China)

Di Zhang (Zhengzhou Univerisity, China)

Joel J. P. C. Rodrigues (Federal University of Piauí (UFPI), Brazil

& Instituto de Telecomunicações, Portugal)

HWS2: Aerial Communications (AERCOMM)

Monday, 25 May 2020 • 14:00 - 17:15 • Room 14

Workshop Organizer: Seong-Lyun Kim (Yonsei University, South Korea)

Session Chair: Edward Mutafungwa (Aalto University, Finland)

In the last decade or so, the use of Unmanned Aerial Vehicles (UAVs), also commonly referred to as drones, has received significant attention from various industry sectors and research communities. This is mostly attributed to the broad of range of UAV-enabled use cases in agriculture, public protection and disaster relief (PPDR), logistics, media production, mapping, and so on. The transformation of UAVs into distributed aerial communications and computing platforms is gathering pace by leveraging research advancements in 5G/6G technologies, edge computing, machine learning, and so on. This transformation promises exciting and high impact use cases and innovations far beyond legacy UAV solutions. The transformation further requires efficient integration of unmanned aerial systems traffic management (UTM) with more conventional air traffic management for an orderly air space with when UAVs are adopted in large numbers. The AERCOMM workshop collocated with IEEE WCNC 2020 aims to provide a venue for exchanging of latest developments between (but not limited to) academic researchers, vendors, operators, verticals and regulators.



14:00 – 15:20: Session 1 - Invited Speakers (Part 1)

Challenges and Benefits of 5G in Urban Air Mobility (Air Taxis and Logistics)

Gokul Srinivasan (Robots.expert, Finland)

TERAWAY Project: THz Technology for Ultra-Broadband and Ultra-Wideband Operation of BH and FH Links in Systems with SDN Management of Network and Radio Resources

Maria Massaouti (National Technical University of Athens, Greece)

15:20 - 16:30: Session 2 - Aerial Communications in 5G and Beyond Networks

Time-Weighted Coverage of Integrated Aerial and Ground Networks for Post-Disaster Communications

Xiaoli Xu and Yong Zeng (Southeast University, China)

Joint Trajectory Optimization and Time Slot Allocation for Buffer-Aided UAV Mobile Relaying

Yili Liu, Ning Wang, Lingfeng Shen, Zhengyu Zhu and Xiaomin Mu

(Zhengzhou University, China)

Robust AN-Aided Secure Beamforming Design for A2G Communication Networks with UAV Jitter

Yang Wen, Huici Wu, Hanjie Li and Xiaofeng Tao

(Beijing University of Posts and Telecommunications, China)

A Public Safety Framework for Immersive Aerial Monitoring through 5G Commercial Network

Sejin Seo, Seunghwan Kim and Seong-Lyun Kim

(Yonsei University, South Korea)

Energy-Efficient UAV Communications with Interference Management: Deep Learning Framework

Fayezeh Ghavimi

(Aalto University School of Electrical Engineering, Finland)

Riku Jäntti (Aalto University, Finland)

16:30 – 17:20: Session 3 - Invited Speakers (Part 2)

Keynote: Intelligent Sensing in the IoT Using Data-Aided Sensing

Jinho Choi (Deakin University, Australia)

NFV in the Air

Fabrizio Granelli (University of Trento, Italy)

17:20 - 18:00: Session 4 - Panel Discussion





FULL DAY WORKSHOPS

FWS3: Emerging Terahertz Technologies for Future Wireless Systems

Monday, 25 May 2020 • 09:00 - 17:15 • Room 08

Workshop Organizer: Juho Lee (Samsung Electronics. Co., Ltd, South Korea)

Session Chairs: Juho Lee (Samsung Electronics. Co., Ltd, South Korea)

Byonghyo Shim (Seoul National University, South Korea)

With the start of commercial deployments of 5G communication systems, many people are wondering what is going to happen with 5G and whether 5G will be able to create meaningful business impacts. Those include the provisioning of new media experiences such as augmented reality (AR) and virtual reality (VR) over mobile networks, the support of new vertical services such as connected vehicles and smart factories, etc. While the mobile industry is mainly focusing on the realization of 5G technologies, we can see that initial consideration about the next generation of mobile communication beyond 5G, i.e., 6G, is already happening. Considering the general trend of introducing new services with higher requirements over different generations of communication systems, 6G would need to support much higher data rate and much lower latency than 5G. While more studies are needed to define proper requirements for 6G, initial investigation already suggests rough estimates such as 1 Tbps peak rate, 10 Gbps user-experienced data rate, and 0.1 ms air latency.

Use of terahertz (THz) spectrum, i.e., from 100 GHz to 3,000 GHz, is getting much attention as a way to provide the data rate of up to 1 Tbps. For example, in March 2019, Federal Communications Commission (FCC) opened the spectrum between 95 GHz and 3,000 GHz for experimental use and unlicensed applications to encourage the development of new wireless communication technologies. Moreover, 5G New Radio (NR) standard developed by 3rd generation partnership project (3GPP) is expected to be extended for application for bands between 52.6 GHz and 114.25 GHz.

There are several hurdles that need to be overcome in order to utilize terahertz spectrum: severe path loss, atmospheric absorption, inefficiency of radio frequency (RF) devices such as power amplifier, switch, and mixer, and development of efficient high-speed analog-to-digital converters (ADCs). With this workshop, we aim to bring together leading researchers of the field, both from academia and industry, to share their recent findings and views on technical challenges in utilizing terahertz spectrum. In addition, the workshop will also address terahertz channel modeling as well as key technologies such as waveform, MIMO, channel coding, modulation, multiple access scheme etc. that are essential to develop efficient communication systems for terahertz spectrum. Challenges and key technologies for extending 5G NR standard to the higher frequency spectrum can also be discussed.



9:00 - 10:30: Session 1 - Keynotes and Industry Activity

100-300GHz Wireless: Applications, Systems, ICs, and Transistors

Mark Rodwell (University of California, Santa Barbara, USA)

Channel Measurements and Modeling for 0.1-0.5 THz

Andy Molisch (University of Southern California, USA)

Design Considerations for Terahertz Wireless Communication Systems

Jeongho Jeon, Khurram Muhammad, Joonyoung Cho and Gary Xu

(Samsung Research America, USA)

Ilju Na (Samsung Electronics, South Korea)

Jianzhong Zhang (Samsung, USA)

From sub-Terahertz to Terahertz: Challenges & Design Considerations

Daewon Lee (Intel Corporation, USA)

Alexei Davydov (Intel Corp., Russia)

Bishwarup Mondal (Intel, USA)

Gang Xiong (Intel Corporation, USA)

Gregory Morozov (Intel Corp., Russia)

Jiwoo Kim (Intel Corporation, USA)

10:45 - 12:15: Session 2 - Measurements, RFIC, and Optical Methods

Measurement of Directionally Resolved Radar Cross Section of Human Body for 140 and 220 GHz Bands

Naveed Ahmed Abbasi and Andreas Molisch

(University of Southern California, USA)

Charlie Zhang (Samsung Telecommunications America, USA)

LOS Channel Response Measurement at 300-GHz for Short-Range Wireless Communication

Ho-Jin Song (POSTECH, South Korea)

A 140GHz Two-Channel CMOS Transmitter Using Low-Cost Packaging Technologies

Arda Simsek (University of California Santa Barbara, USA)

Ahmed S. H. Ahmed (UCSB, USA)

Ali A Farid (University of California, Santa Barbara, USA)

Utku Solyu (UCSB, USA)

Mark J W Rodwell (University of California, Santa Barbara, USA)

Providing 5G Coverage Using Optical Methods for Terahertz Frequencies

Suresh Singh (Portland State University, USA)

14:00 - 15:30: Session 3 - Metasurface, Lens, and OAM

Polarization Dependent Beam Steerable Thin Lens Employing Spatial Filter Arrays

Yeong Myeong Park (Seoul National University, South Korea)

Inseop Yoon (Samsung Electronics, South Korea)

Jungsuek Oh (Seoul National University, South Korea)

Metasurface-Enhanced Antenna System for Terahertz Band Wireless Communications

Jaehyun Lee

(Samsung Research & Samsung Electronics, South Korea)

Hyojin Lee (Samsung Research, South Korea)

Rotman Lens-Fed Antenna for Generating Multiple Orbital Angular Momentum Modes

Zhiya Zhang (Xidian University, China)

Bin Yu (Samsung Electronics, China)

Dan Wu, Yongyan Mao and Chengbin Zhang (Xidian University, China)

Orbital Angular Momentum Multiplexing for a Wireless Backhaul Communication System

EunMi Choi (UNIST, South Korea)

15:45 - 17:15: Session 4 - Channel Sounder, Antenna Array, and MIMO

THz Channel Sounding: Design and Validation of a High Performance Channel Sounder at 300 GHz

Mathis Schmieder and Wilhelm Keusgen

(Fraunhofer Heinrich Hertz Institute, Germany)

Michael Peter (Fraunhofer Institute for Telecommunications, Heinrich

Hertz Institute, Germany)

Sven Wittig (Fraunhofer Heinrich Hertz Institute, Germany)

Thomas Merkle, Sandrine Wagner and Michael Kuri

(Fraunhofer IAF, Germany)

Taro Eichler (Rohde & Schwarz, Germany)

Monday, 25 May 2020 • 09:00 - 17:15 • Room 08 (Continued)

Nanoantenna Array Design on Grounded Dielectric Substrate for High Field Enhancement and Absorption

Sangjo Choi (University of Ulsan, South Korea)

Mohamad Khoirul Anam (University of Ulsan & Indonesian Institute of

Sciences (LIPI), South Korea)

Taylor Expansion Aided Gradient Descent Schemes for IRS-Enabled Terahertz MIMO Systems

Zhi Chen (University of Electronic Science and Technology of China, China)

Wenjie Chen

(University Of Electronic Science and Technology Of China, China)

Xinying Ma, Zhuoxun Li and Yaojia Chi

(University of Electronic Science and Technology of China, China)

Chong Han (Shanghai Jiao Tong University, China)



FWS4: 13th International Workshop on Evolutional Technologies & Ecosystems for Beyond 5G and 6G (WDN-5G&6G)

Monday, 25 May 2020 • 10:45 - 17:15 • Room 09

Workshop Organizers: Emilio Calvanese Strinati (CEA, France) and Ilgyu Kim (ETRI, South Korea)

Chair: Ilgyu Kim (ETRI of KOREA, South Korea)

Governments and policy makers have recognised the economic and societal importance of future digital services. Forecasts predict that the huge increase in consumer demand for data services driven by access to ever smarter and powerful devices is expected to continue beyond 2020. Accordingly, many academic, industrial and policy initiatives have been working on the development of 5G mobile networks and the capabilities they will require to meet the future demands e.g. higher data rates, widespread connectivity, flexible service creation and low latency. 5G will be the integration of multiple networks serving diverse sectors, domains and applications, such as multimedia, virtual reality (VR) / augmented reality (AR), Machine-to-Machine (M2M) / Internet of Things (IoT), automotive, Smart City etc.

Current research efforts on 5G Radio Access Networks (RAN) strongly focus on millimeter-wave (mmWave) access for addressing a critical weakness of deployed cellular systems, i.e. the capacity to realize enhanced mobile broadband (eMBB) services, as discussed at the World Radio-communication Conference 2015 (WRC-2015). Forseeing a new market, the FCC in US also opened up in total nearly 11 GHz of spectrum above 27.5 GHz to 5G, including unlicensed spectrum at 64-71 GHz. Aside, mmWave technologies have reached a significant degree of maturity and their state-of-the-art products, operated in the 60GHz unlicensed band, are already in the market. Wireless engineers and business planners now consider how to efficiently introduce and operate mmWave in 5G and beyond, where the answers to the question depend on scenarios/use cases/services to be deployed. For example, the forthcoming 5G Phase II, taken care by the planned 3GPP Release 16, is particularly interested to a new class of services called ultra-High Speed Low Latency Communications (uHSLLC) e.g. mmWave V2X. To realize such requirements, it is essential to combine mmWave with Mobile Edge Computing (MEC), a technology allocating storage and computation resources at the edge of the network to reduce latency. However, how to combine them effectively has not been fully discussed, especially for critical applications of strict latency constraints foreseen in 5G networks. Another critical issue in terms of cost is how to backhauling the mmWave smallcell networks, knowing that it is impossible to provide Gigabit Ethernet backhaul everywhere. One of the solution is to introduce self-backhauling technique using mmWave in combination with Software Defined Network (SDN) technology to reduce OPEX/CAPEX. However, detailed discussions e.g. interference management or implementation issues should be investigated thoroughly in practice.

For 5G and beyond, mmWave and MEC will play important roles for a diverse set of applications that require both ultra-high data rate and low latency communications. The main objective of the workshop is to offer an opportunity for academic and industrial researchers to discuss on evolutional technologies and killer ecosystems for the realization of 5G Phase II, taking into account the combination of mmWave and MEC, under the support of MEC/SDN technologies. The 13th WDN-5G workshop will be a progression of the previous successful editions providing again an opportunity for information exchange.



10:45 – 12:15: Session 1 - Access and Core Technologies: Part I

Network Selection in 5G Networks Based on Markov Games and Friend-or-Foe Reinforcement Learning

Alessandro Giuseppe (University of Rome Sapienza, Italy)

Emanuele De Santis (University of Rome “La Sapienza”, Italy)

Francesco Delli Priscoli (University of Rome, “La Sapienza”, Italy)

Seok Ho Won (ETRI, South Korea)

Taesang Choi

(Electronic and Telecommunications Research Institute, South Korea)

Antonio Pietrabissa (Università di Roma La Sapienza, Italy)

Probabilistic Shaping in Faster-Than-Nyquist System

Weimin Kang (Beijing University of Posts and Telecommunications, China)

Zhanji Wu (BUPT, China)

Design of Protograph-Based Quasi-Cyclic Spatially Coupled LDPC Codes

Shuoshuo Wang (Beijing University of Posts & Telecommunications, China)

Zhanji Wu (BUPT, China)

An Energy-Efficient Hybrid Precoding Based on MPBIL Algorithm for mmWave Massive MIMO Systems

Yang Liu (Institute of Electronic Information Engineering, Inner Mongolia University, China)

Lina Hou and Lei Liu (Inner Mongolia University, China)

Yinghui Zhang (Institute of Electronic Information Engineering, Inner

Mongolia University, China)

Minglu Jin (Dalian University of Technology, China)







FWS8: Open-RAN: Open Road to Next Generation Mobile Networks

Monday, 25 May 2020 • 09:00 - 18:00 • Room 12

Workshop Organizer: Nawab M. F. Qureshi (Sungkyunkwan University, South Korea)

Chair: Intaik Park (Samsung Electronics, South Korea)

Mr. Avinash Bhat (Samsung R&D India-Bangalore)

NextGenRAN is an international workshop event that highlights new trends and findings in hot topics related to Next Generation Radio Access Networks (RAN). This first edition will be held in conjunction with IEEE Wireless Communications and Networking Conference (WCNC), on 6th-9th April 2020, in the soul of Asia, Seoul, South Korea on the theme OPEN-RAN: Open Road to Next Generation Mobile Networks.

With the acceleration of 5G commercialization and 6G research picking up across the globe, various mobile operators and service providers are moving towards disaggregated and open reference architecture that utilizes open components with standard APIs from a multi-vendor ecosystem. By leveraging Software Defined Network (SDN) and Network Function Virtualization (NFV), mobile operators and service providers have successfully designed competitive and open core networks. RAN has evolved a lot with the advent of Virtual Radio Access Network (vRAN) and Cloud Radio Access Network (CRAN) but the proprietary implementation of these cost-effective options did not provide enough research opportunities. This lead to the emergence of Open RAN which considers building up of standard open interfaces that help mobile operators and service providers to avail Base Band Unit (BBU) and Remote Radio Unit (RRU) hardware from various vendors to deploy multi-vendor networks (multi-vendor interoperability). Additionally, Open RAN also aims at automating mobile networks and build intelligent SDN. It also makes network programmable and autonomous to cope up with the growth in ML, AI, automation and low latency applications. Open RAN helps in enabling the flexibility and robustness in advanced 5G and beyond networks with the use of a standard open interface, which are used to communicate with other network components as well which is a key for the inheritance of cloud-scale economies in RANs. While saving on CAPEX and Operating Expenses (OPEX), Open RAN also offers a space for creating a wide range of RAN applications that will make RAN open and intelligent than ever before. Besides standardization of open fronthaul, Open RAN has several more key open research areas, such as overall and use cases, RAN Intelligence Controller and applications, and virtualization and cloudification enhancements to name a few.

Thus, Open RAN can be perceived as power for unlocking advanced 5G and 6G networks by investing and researching on open networks and open standards to explore the interoperable multi-vendor business model. Open RAN brings in the opportunity to combine advancements in open mobile networks, spectrum availability, and intelligent network applications to stimulate rapid innovation in delivering profitable business for mobile network operators and service providers across the globe.

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**9:00 - 9:30: Invited Keynote Speaker - 1**  
**Bringing Cloud-Native Principles to Radio Access Networks**  
Kaustubh Joshi (AT&T Labs, USA)

**9:45 - 11:00: Session 2 - Open-RAN Infrastructure**  
**Chairs:** Prof. Nawab Muhammad Faseeh Qureshi (Sungkyunkwan University, South Korea)  
Dr. Sukhdeep Singh (Samsung R&D India-Bangalore)

**RAN Slice Selection Mechanism Based on Satisfaction Degree**  
Xuanzhi Chen, Yuliang Tang and Mingyu Zhang (Xiamen University, China)

**MEC Enabled Cell Selection for Micro-Operators Based 5G Open Network Deployment**  
Sridharan Natarajan (Samsung Research Institute Bangalore & IIITB, India)  
Tarun Khandelwal and Mohit Mittal (Samsung R&D Institute India Bangalore Private Limited, India)

**Optimized Controller Placement for Soft Handover in Virtualized 5G Network**  
Deborsi Basu (Indian Institute of Technology, Kharagpur & IEEE Student Member, India)  
Abhishek Jain and Raja Datta (Indian Institute of Technology Kharagpur, India)  
Uttam Ghosh (Vanderbilt University, USA)

**Method and System for Reduction of Insignificant KPI Data in a Heterogeneous RAN and Core Network**  
Abhishek Chaturvedi (Samsung Research & Development Institute, India)

**11:00 - 12:00: Session 3 - Invited Keynote Speakers - 2**

**How Open Are Open Standards**  
Satish Jamadagni (Reliance Jio, India)

**Evolution in RAN and xHAUL Architectures for 5G**  
Subodh Gajare (Cisco, India)

**13:30 - 14:00: Session 4 - Invited Keynote Speaker - 3**

**An Application of Grassmann Clustering in Massive MIMO**  
Harpreet Singh Dhillon (Virginia Tech, USA)

**14:00 - 15:15: Session 5 - Open-RAN Modeling and Analysis**  
**Chairs:** Prof. Nawab Muhammad Faseeh Qureshi (Sungkyunkwan University, South Korea)  
Dr. Sukhdeep Singh (Samsung R&D India-Bangalore)

**A Neural Network for Estimating CQI in 5G Communication Systems**  
Satya Kumar Vankayala (Samsung R&D Institute Bangalore, India)  
Konchady Gautam Shenoy (Indian Institute of Science (IISC), India)

Monday, 25 May 2020 • 09:00 - 18:00 • Room 12 (Continued)

**Anomaly Detection in Mobile Networks**  
Anish Nediyanath, Chirag Singh, Harman Jit Singh, Himanshu Mangla, Karan Mangla, Saravanan Balasubramanian, Seema Pareek and Shwetha S (Samsung R&D Institute India - Bangalore, India)  
Manoj Kiran Sakhala (Samsung Electronics & Samsung R&D Institute Bangalore, India)

**Open5G: A Software-Defined Networking Protocol for 5G Multi-RAT Wireless Networks**  
Pradnya Kiri Taksande, Pranav Jha, Abhay Karandikar and Prasanna Chaporkar (IIT Bombay, India)

**Dimension Expansion of OFDM System for the Spectral Efficiency Improvement**  
Changyoung An and Heung-Gyoon Ryu (Chungbuk National University, South Korea)

**15:45 - 16:15: Session 6 - Invited Keynote Speaker - 4**  
**Chairs:** Dr. Intaik Park (Samsung Electronics, South Korea)  
Mr. Avinash Bhat (Samsung R&D India-Bangalore)  
**Keynote:** Renuka Bhalerao (Facebook, USA)

**16:30 - 18:00: Session 7 - Open-RAN Intelligent ML/AI Evaluations**  
**Chairs:** Prof. Nawab Muhammad Faseeh Qureshi (Sungkyunkwan University, South Korea)  
Dr. Sukhdeep Singh (Samsung R&D India-Bangalore)

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**FWS9: 8th IEEE International Workshop on Research Advancements in Future Networking Technologies (RAFNET)**  
**Monday, 25 May 2020 • 09:00 - 17:15 • Room 13**  
**Chair:** Safdar Hussain Bouk (DGIST, South Korea)

Recently, a lot of research efforts have been carried out by the researchers from academia and industry side to foster various new and emerging network paradigms. The main driving forces behind this paradigm shift are the research outcomes of the last few decades that has clearly portrayed that the current internet architecture was originally designed for end-to-end host-centric communications. However, the principal objective of the networks is to communicate the content itself. Subsequently, we have witnessed new architectures such as an Information-Centric Network (ICN) with various extensions like -Centric Networking (CCN), Named Data Networking (NDN), Data-Oriented Network Architecture (DONA), and so forth. On the other hand, numerous efforts in cellular networks have also been made for the improvement of the user experience and as a result, today, we are able to use LTE-A and other networks.

In this context, the upcoming 5G networking architectures, whose ongoing research is focused on the networking mechanisms regarding the massive increase in the number of connected devices, bandwidth requirements, reduced latency, and the deployment of supporting operational mechanisms such as network virtualization, cloud-based deployments, mobile edge computing, and storage and new utilization scenarios. Moreover, these modern technologies are being applied in other networking domains as well, including VANETs, Smart Grid, Smart Cities, Internet of Things, Big Data, etc. Research Advancements in Future Networking Technologies (RAFNET) workshop aims to bring together all the researchers working on all the aforementioned research areas.

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**9:00 – 10:30: Session 1 - Mobile Wireless Networks**

**Velocity Based Reliable Forwarding Strategy Towards Disconnect Link Avoidance in NDN-VANETs**  
Muhammad Burhan and Rana Asif Rehman (National University of Computer and Emerging Sciences, Pakistan)  
Byung-Seo Kim (Hongik University, South Korea)

**The Evolution of Radio Access Network Towards Open-RAN: Challenges and Opportunities**

Sameer Kumar Singh, Rohit Singh and Brijesh Kumbhani (IIT Ropar, India)

**RAN Resource Slicing and Sharing with NOMA for Latency Reduction in Uplink URLLC Networks**  
Nadia Jaya and Md. Farhad Hossain (Bangladesh University of Engineering & Technology (BUET), Bangladesh)

**Data-Driven Semi-Supervised Anomaly Detection Using Real-World Call Data Record**

Shan Jaffry (Dongguan University of Technology & IEEE ComSoc, China)  
Syed Faraz Hasan (Massey University, New Zealand)  
Syed Tariq Shah (Sungkyunkwan University, South Korea & Balochistan University of Information Technology, Engineering, and Management Sciences, Pakistan)

**ONAP Based Pro-Active Access Discovery and Selection for 5G Networks**  
Rahul Banerji, Naman Gupta, Suman Kumar and Sukhdeep Singh (Samsung R&D India - Bangalore, India)  
Seungil Yoon (Samsung Electronics, South Korea)  
Avinash Bhat (Samsung R&D, India)  
Bharat J.R. Sahu (ITER, Siksha `O` Anusandhan University, India)



## WORKSHOPS

**Monday, 25 May 2020 • 09:00 - 17:15 • Room 13**

## Performance Evaluation of Ad-Hoc Routing Protocols in (FANETs)

Anas Alkhatieb (Umm Al-Qura University, Saudi Arabia)  
Emad Felemban (Umm Al Qura University, Saudi Arabia)  
Atif Naseer (Umm Al-Qura University, Saudi Arabia)

# Joint Optimal Allocation of Wireless Resource and MEC Computation Capability in Vehicular Network

Min Zhu, Yanzhao Hou, Xiaofeng Tao and Tengfei Sui  
(Beijing University of Posts and Telecommunications, China)  
Lei Gao (Beijing University of Posts & Telecommunications, China)

## 10:45 – 12:15: Session 2 - Future Networking Technologies

## Minimizing Content-Store Data Access Time Using Two-Tier Tree Architecture for NDN-Based WSNs

Muhammad Mudasar Qazi and Rana Asif Rehman  
(National University of Computer and Emerging Sciences, Pakistan)  
Byung-Seo Kim (Hongik University, South Korea)

## Mitigating Interference and Energy Issues in Smart Homes Using Internet of Things

Murad Khan (Kyungpook National University, Daegu, South Korea)  
Muhammad Toaha Raza Khan and Dongkyun Kim  
(Kyungpook National University, South Korea)

### Network Function Placement for Service Chains with Server Maintenance Cost

Zhuangyi Tan (Sun Yat-Sen University, China)  
Jinbei Zhang (Sun Yat-sen University, China)

## Multi-Band Multi-Hop WLANs for Disaster Relief and Public Safety Applications

Asad Ali (BUIITEMS, Pakistan)  
Fatima Hussain (Royal Bank of Canada, Canada)  
Rasheed Hussain  
(Innopolis University & Networks and Blockchain Lab, Russia)  
Adil Mehmood Khan (Innopolis University, Russia)  
Alex Ferworn (Ryerson University, Canada)

**14:00 - 15:30: Session 3 - Intelligent Communication Technologies**

## Intelligent Reflecting Surface Assisted Wireless Powered Communication Networks

Bin Lyu (Nanjing University of Posts & Telecommunications, China)  
Hoang Thai Dinh (University of Technology Sydney (UTS), Australia)  
Shimin Gong (Sun Yat-sen University, China)  
Zhen Yang  
(Nanjing University of Posts and Telecommunications, China)

# NoViSec: Novel Virtual Network Mapping Framework for Secure Software-Defined Networking

Haotong Cao  
(Nanjing University of Posts and Telecommunications, China)  
Yue Hu  
(China Mobile Communications Group Jiangsu Co., Ltd., China)  
Shengchen Wu  
(Nanjing University of Posts and Telecommunications, China)  
Jianbo Du (Xi'an University of Posts & Telecommunications, China)  
Feng Tian  
(Nanjing University of Posts and Telecommunications, China)  
Gagangeet Singh Aujla  
(Newcastle University, United Kingdom (Great Britain))  
Longxiang Yang  
(Nanjing University of Posts and Telecommunications, China)

## Resource Allocation Based Performance Analysis for 5G Vehicular Networks in Urban Areas

Minglong Zhang (Auckland University of Technology, New Zealand)  
Arun Kumar (NIT Rourkela, India)  
Peter Han Joo Chong  
(Auckland University of Technology, New Zealand)  
Henry Chan (Hong Kong Polytechnic University, Hong Kong)  
Boon-Chong Seet (Auckland University of Technology, New Zealand)

## True Detect: Deep Learning-Based Device-Free Activity Recognition Using WiFi

Muhammad Sulaiman  
(National University of Sciences and Technology, Pakistan)  
Syed Ali Hassan  
(National University of Sciences and Technology, Pakistan)  
Haejoon Jung (Incheon National University, South Korea)

### 15:45 - 17:15: Session 4 - Communication Techniques

## Waveform Design of Low Complexity WR-OTFS System for the OOB Power Reduction

Md. Najmul Hossain, Yosuke Sugiura and Tetsuya Shimamura  
(Saitama University, Japan)  
Heung-Gyoon Ryu (Chungbuk National University, South Korea)

## Joint Energy Beamforming and Optimization for Intelligent Reflecting Surface Enhanced Communications

Yuze Zou (Huazhong University of Science and Technology, China)  
Shimin Gong (Sun Yat-sen University, China)  
Jing Xu (Huazhong University of Science and Technology, China)  
Hoang Thai Dinh (University of Technology Sydney (UTS), Australia)  
Dusit Niyato (Nanyang Technological University, Singapore)  
Wenqing Cheng  
(Huazhong University of Science and Technology, China)

**Comprehensive Study on CC-LDPC, BC-LDPC and Polar Code**  
Kun Zhu (Beijing University of Posts & Telecommunications, China)

Zhanji Wu (BUPT, China)

## Joint Admission Control and Association for the Downlink of a mmWave Vehicular Network

Akila Anuradha Ekanayake (Nokia, Finland)  
Kapuruhamy Badalge Shashika Manosha  
(Centre for Wireless Communications, University of Oulu, Finland)  
Nandana Rajatheva and Matti Latva-aho  
(University of Oulu, Finland)

## TUTORIALS

**Monday, 25 May 2020**

**9:00 - 12:15 • Room 01**

**TUT01 - Federated Learning at the Network Edge: Fundamentals, Key Technologies, and Future Trends**

**Presenters:**

Howard Yang (Singapore University of Technology and Design, Singapore)  
Zhongyuan Zhao (Beijing University of Posts and Telecommunications, China)  
Tony Q. S. Quek (Singapore University of Technology and Design, Singapore)

The burgeoning advances from machine learning and wireless technologies are forging a new paradigm for future networks, which are expected to possess higher degrees of intelligence via the inference from vast data set and being able to respond to local events in a prompt manner. Due to the sheer volume of data generated by the end devices, as well as the increasing concerns about sharing private information, a new branch of machine learning model, namely the federated learning, has emerged from the intersection of artificial intelligence and edge computing. In contrast to the conventional machine learning methods, federated learning brings the models directly to the device for training, where only the resultant parameters shall be sent to the edge servers. The local copies of the model on the devices bring along great advantages of eliminating the network latency and preserving data privacy. Nevertheless, to make federated learning possible, one needs to tackle new challenges that require a fundamental departure from the standard methods designed for distributed optimizations. In this tutorial, we deliver a comprehensive introduction of the federated learning. Specifically, we first survey the basis of federated learning, including its distinct features from conventional machine learning models, the fundamental theories that ensure the successful operation of federated learning, and the algorithms to avail an effective adoption. We then enumerate several critical issues associated with the deployment of federated learning in a wireless network, and show how technologies from different perspectives, ranging from algorithmic design, on-device training, to communication resource management, shall be jointly integrated to facilitate the full implementation. Finally, we conclude by shedding light on future works.

### Biographies:

**Howard H. Yang** (S'13–M'17) received the B.Sc. degree in Communication Engineering from Harbin Institute of Technology (HIT), China, in 2012, and the M.Sc. degree in Electronic Engineering from Hong Kong University of Science and Technology (HKUST), Hong Kong, in 2013. He earned the Ph.D. degree in Electronic Engineering from Singapore University of Technology and Design (SUTD), Singapore, in 2017. From Aug. 2015 to Mar. 2016, he was a visiting student in the WNCG under supervisor of Prof. Jeffrey G. Andrews at the University of Texas at Austin. Dr. Yang is now a Postdoctoral Research Fellow with Singapore University of Technology and Design in the Wireless Networks and Decision Systems (WNDS) group led by Prof. Tony Q. S. Quek. He has held a visiting research appointment at Princeton University from September 2018 to April 2019. His research interests cover various aspects of wireless communications, networking, and signal processing, currently focusing on the modeling of modern wireless networks, high dimensional statistics, graph signal processing, and machine learning. He received the IEEE WCSP Best Paper Award in 2014 and the IEEE WCSP 10-Year Anniversary Excellent Paper Award in 2019.

**Zhongyuan Zhao** (M'14) received the B.S. degree in applied mathematics and the Ph.D. degree in communication and information systems from Beijing University of Posts and Telecommunications (BUPT), Beijing, China, in 2009 and 2014, respectively. He is currently an associate professor with BUPT. His research interests include fog computing/edge computing, content caching, and edge intelligence in wireless networks. Dr. Zhao serves as an editor of IEEE COMMUNICATIONS LETTERS (since 2016), and received Exemplary Editors Award twice (2017 and 2018). He was also a guest editor of IEEE ACCESS. He was the recipient of the Best Paper Awards at the IEEE CIT 2014 and WASA 2015.

**Tony Q. S. Quek** (S'98-M'08-SM'12-F'18) received the B.E. and M.E. degrees in electrical and electronics engineering from the Tokyo Institute of Technology, Tokyo, Japan, in 1998 and 2000, respectively, and the Ph.D. degree in electrical engineering and computer science from the Massachusetts Institute of Technology, Cambridge, MA, USA, in 2008. Currently, he is the Cheng Tsang Man Chair Professor with Singapore University of Technology and Design (SUTD). He also serves as the Acting Head of ISTD Pillar, Sector Lead of the SUTD AI Program, and the Deputy Director of the SUTD-ZJU IDEA. His current research topics include wireless communications and networking, network intelligence, internet-of-things, URLLC, and big data processing. Dr. Quek has been actively involved in organizing and chairing sessions, and has served as a member of the Technical Program Committee as well as symposium chairs in a number of international conferences. He is currently serving as an Editor for the IEEE Transactions on Wireless Communications, the Chair of IEEE VTS Technical Committee on Deep Learning for Wireless Communications as well as an elected member of the IEEE Signal Processing Society SPCOM Technical Committee. He was an Executive Editorial Committee Member for the IEEE Transactions on Wireless Communications, an Editor for the IEEE Transactions on Communications, and an Editor for the IEEE Wireless Communications Letters. Dr. Quek was honored with the 2008 Philip Yeo Prize for Outstanding Achievement in Research, the 2012 IEEE William R. Bennett Prize, the 2015 SUTD Outstanding Education Awards -- Excellence in Research, the 2016 IEEE Signal Processing Society Young Author Best Paper Award, the 2017 CTTC Early Achievement Award, the 2017 IEEE ComSoc AP Outstanding Paper Award, and the 2016-2019 Clarivate Analytics Highly Cited Researcher. He is a Distinguished Lecturer of the IEEE Communications Society and a Fellow of IEEE.

# TUTORIALS

**Monday, 25 May 2020**  
**9:00 - 12:15 • Room 02**

**TUT02 - Towards Smart and Reconfigurable Environment: Intelligent Reflecting Surface Aided Wireless Networks**

**Presenters:** Rui Zhang (National University of Singapore, Singapore)

In this tutorial, we introduce a new wireless communication paradigm by employing a massive number of low-cost passive reflecting elements with independently controllable amplitude and phase, named intelligent reflecting surface (IRS), which is able to smartly reconfigure the wireless signal propagation and realize 3D reflect beamforming for signal enhancement and/or interference suppression. We first present the signal and channel models of IRS by taking into account its hardware implementation constraints in practice. We then illustrate the main applications of IRS in achieving spectrum and energy efficient as well as secure and sustainable wireless networks, and highlight its cost and performance advantages as compared to other existing technologies such as small-cell network, massive MIMO, and active relaying. We also report the state-of-the-art results based on recently conducted experiments from both industry and academia. Next, we focus on discussing the main challenges in analyzing, designing and implementing IRS-aided wireless networks, including capacity characterization, joint active and passive beamforming optimization, channel acquisition, IRS deployment, hardware imperfections, and so on. This is then followed by several selected case studies of IRS-aided wireless system design to show its practical performance gains and draw useful insights. Finally, we discuss other extensions and point out promising directions for future research and investigation.

### Biography:

**Dr. Rui Zhang** (IEEE Fellow) received the B.Eng. (First-Class Hons.) and M.Eng. degrees from National University of Singapore, and the Ph.D. degree from Stanford University, Stanford, CA USA, all in electrical engineering. From 2007 to 2009, he worked as a researcher at the Institute for Infocomm Research, ASTAR, Singapore. Since 2010, he has joined the Department of Electrical and Computer Engineering of National University of Singapore, where he is now a Professor in the Faculty of Engineering. His current research interests include UAV/satellite communication, wireless power transfer, reconfigurable MIMO, and optimization methods. He has published over 370 papers, which have been cited more than 30,000 times. He has been listed as a Highly Cited Researcher by Thomson Reuters/Clarivate Analytics since 2015. He was the recipient of the 6th IEEE Communications Society Asia-Pacific Region Best Young Researcher Award in 2011, and the Young Researcher Award of National University of Singapore in 2015. He was the co-recipient of the IEEE Marconi Prize Paper Award in Wireless Communications in 2015, the IEEE Communications Society Asia-Pacific Region Best Paper Award in 2016, the IEEE Signal Processing Society Best Paper Award in 2016, the IEEE Communications Society Heinrich Hertz Prize Paper Award in 2017, the IEEE Signal Processing Society Donald G. Fink Overview Paper Award in 2017, and the IEEE Technical Committee on Green Communications & Computing (TCGCC) Best Journal Paper Award in 2017. His co-authored paper also received the IEEE Signal Processing Society Young Author Best Paper Award in 2017. He served for over 30 international conferences as the TPC Co-Chair or an Organizing Committee Member, and as the guest editor for 3 special issues in IEEE Journal of Selected Topics in Signal Processing and IEEE Journal on Selected Areas in Communications. He served as an elected member of the IEEE Signal Processing Society SPCOM and SAM Technical Committees, and the Vice Chair of the IEEE Communications Society Asia-Pacific Board Technical Affairs Committee. He served as an editor for the IEEE Transactions on Wireless Communications, IEEE Journal on Selected Areas in Communications (Green Communications and Networking Series), and IEEE Transactions on Signal Processing. He is now an editor for the IEEE Transactions on Communications, and IEEE Transactions on Green Communications and Networking. He serves as a member of the Steering Committee of the IEEE Wireless Communications Letters. He is a Distinguished Lecturer of IEEE Signal Processing Society and IEEE Communications Society.

# TUTORIALS

**Monday, 25 May 2020**  
**9:00 - 12:15 • Room 03**

**TUT03 - Machine Learning for Future Wireless Networks**

**Presenters:** Kwang-Cheng Chen (University of South Florida, USA)

With amazing advances of machine learning technology, a new technological paradigm emerges. This tutorial presents a holistic comprehension about machine learning knowledge and the methodology to apply machine learning to assist, enhance, and enable wireless networking functionalities. It further introduces a new research area about wireless networking for smart machines of artificial intelligence. Future network architecture to fully utilize the machine learning capacity serves the closing focus of this tutorial. This tutorial is organized in a vertical manner by introducing machine learning techniques, while showing examples to apply after each machine learning technique and orienting criterion/conditions to apply each machine learning technique.

### Biography:

**Kwang-Cheng Chen** has been a Professor at the Department of Electrical Engineering, University of South Florida, since 2016. From 1987 to 2016, Dr. Chen worked with SSE, Communications Satellite Corp., IBM Thomas J. Watson Research Center, National Tsing Hua University, HP Labs., and National Taiwan University in mobile communications and networks. He visited TU Delft (1998), Aalborg University (2008), Sungkyunkwan University (2013), and Massachusetts Institute of Technology (2012-2013, 2015-2016). He founded a wireless IC design company in 2001, which was acquired by MediaTek Inc. in 2004. He has been actively involving in the organization of various IEEE conferences and serving editorships with a few IEEE journals (most recently as a series editor on Data Science and AI for Communications in the IEEE Communications Magazine), together with various IEEE volunteer services to the IEEE, Communications Society, Vehicular Technology Society, and Signal Processing Society, such as founding the Technical Committee on Social Networks in the IEEE Communications Society. Dr. Chen also has contributed essential technology to various international standards, namely IEEE 802 wireless LANs, Bluetooth, LTE and LTE-A, 5G-NR, and ITU-T FG ML5G. He has authored and co-authored over 300 IEEE publications, 4 books published by Wiley and River (most recently, Artificial Intelligence in Wireless Robotics, 2019), and more than 24 granted US patents. Dr. Chen is an IEEE Fellow and has received a number of awards including 2011 IEEE COMSOC WTC Recognition Award, 2014 IEEE Jack Neubauer Memorial Award, 2014 IEEE COMSOC AP Outstanding Paper Award. Dr. Chen's current research interests include wireless networks, artificial intelligence and machine learning, IoT/CPS, social networks and data analytics, and cybersecurity.



# TUTORIALS

**Monday, 25 May 2020**  
**9:00 - 12:15 • Room 04**

## ***TUT05 - Moving Towards Zero-Touch Automation, A Key Enabler for 6G: The Challenges & Opportunities***

**Presenters:** Ali Imran (University of Oklahoma, USA)  
Muhammad Ali Imran (University of Glasgow, United Kingdom (Great Britain))

Compounding operational complexity, diverging service requirements and exploding degrees of freedom in hybrid terrestrial and aerial architecture being conceived for 6G combined with steadily shrinking profit margins, hinge the technical and financial viability of future mobile networks on achieving zero touch automation. However, despite the recent success of AI for enabling automation in other domains, in mobile networks attempts towards AI powered zero touch automation are hampered by two fundamental challenges: 1) Sparsity of the training data in mobile networks: unlike many other native applications of AI, real cellular data for training AI is generally both scarce and sparse. This is because operators generally do not test a wide range of parameters on live network, and whatever data they have cannot be extracted and shared easily. This limits the utility of some of the most powerful AI tools such as DNN for solving many practical problems in mobile networks; 2) Hyper parameterization native to mobile networks: even before the training can begin, designing and tuning the hyperparameters of an AI model to deliver reliable performance in presence of dynamics that are hallmark of mobile networks remains more of an art than science. In bulk of AI based solutions for mobile networks in literature, hyper-parameterization is either done through hit and trial based human effort or simply already hyper-parameterized models are borrowed from other domains and then trained on mobile network data. Furthermore, current approach to hyper-parameterization requires advanced expertise both in mobile network domain knowledge and machine learning, making it a generally unachievable task for an expert in either domain. Without addressing these two challenges explicitly and timely, despite the hype and hopes, full potential of AI cannot be harnessed for mobile networks. The goal of this tutorial is to first introduce the zero-touch automation framework and then provide an in-depth analysis of sparsity and hyper-parameterization problems and their multi-faceted implications on the performance of AI based solutions in mobile networks. Leveraging insights and latest results from several ongoing projects focused on zero touch automation, the rest of the tutorial then focuses on a set of promising approaches for addressing the data sparsity and hyper-parameter design challenges in mobile networks. Some of the approaches to be discussed include, one shot learning, inductive transfer learning, transductive transfer learning, unsupervised transfer learning, leveraging different types of network geometries, use of generative adversarial networks (GANs) and novel methods for realistic synthetic data generation to address the sparsity challenge. Auto-ML techniques such as Neuro-Evolutionary Algorithm to design and tune DNN, Reinforcement Learning to design and tune DNN, Federated Learning and Bayesian optimization as a tool to solve hyper-parameterization problem will be discussed. The tutorial will conclude with introduction of new real problems of mobile industry interest that require AI based solutions and potential solution approaches and opportunities therein to trigger the much-needed focused research effort in mobile network native AI to ultimately enable zero touch automation.

### Biographies:

**Dr. Ali Imran** is founding director of AI4Networks Research Centre ([www.ai4networks.com](http://www.ai4networks.com)) at the University of Oklahoma. AI4networks is the first academic centre in the world exclusively created for research on zero touch deep network automation. The centre is host to TurboRAN, a purpose-built cellular testbed for enabling experimental research on zero touch automation—and numerous multinational R&D projects on AI for wireless networks. Dr. Imran is also co-founder of a start-up AISON ([www.aison.co](http://www.aison.co)) that has launched world's first deep AI enabled RAN automation and performance optimization solution currently being evaluated by several operators around the world for its game changing gains over current SON paradigm. Dr Imran's research on network automation has played pioneering role in this area and has been supported by over \$4M in nationally and internationally competitive research grants. On this topic, he has published over 100 refereed journal and conference papers and has several patents granted and pending. His work includes some of the most influential publications in the area of mobile network automation. The impact of his work on network automation has been recognized by several prestigious awards such as VPR Outstanding International Impact Award at the University of Oklahoma, 2018, IEEE Green ICT YP International award 2017, and best paper award IEEE CAMAD 2013. In 2019 he has been named William H. Barkow Presidential Professor at the University of Oklahoma for his contributions to this field. Dr. Imran is routinely invited to serves as an advisor to key stakeholder in cellular network eco-system and as a speaker and a panellist on international industry fora and academic conferences on this topic. He is an Associate Fellow of Higher Education Academy (AFHEA), UK; president of ComSoc Tulsa Chapter; Senior Member IEEE, Member of Advisory Board for Special Technical Community on Big Data at IEEE Computer Society, and board member of ITERA. For more detailed bio of Dr. Imran see: [www.ali-imran.org](http://www.ali-imran.org).

**Dr. Muhammad Imran** received his M.Sc. (Distinction) and Ph.D. degrees from Imperial College London, UK, in 2002 and 2007, respectively. He is currently a Chair Professor at the University of Glasgow and visiting Professor at 5GIC Surrey. He is the founding director of the Communications Sensing and Imaging Research labs and a regular invited speaker on several 5G related talks, industrial panels and policy events for wireless communication technology. He has a global collaborative research network spanning both academia and key industrial players in the field of wireless communications. He has led a number of multimillion pounds international research projects encompassing the areas of Internet of Things (IoT), energy efficiency, fundamental performance limits, sensor networks and self-organizing cellular networks. He led the physical layer research for 5G innovation centre at Surrey (an outdoor cellular testbed developed at University of Surrey with a grant of above \$50m). He has supervised 40+ successful Ph.D. graduates and published over 400 peer-reviewed research papers including more than 30 IEEE transactions. He is associate editor of IEEE Transactions on Communications, IEEE Access, IEEE Communications Letters and guest editor of several special issues in IEEE journals. He is a chair for several tracks in highly reputed international conferences and workshops including forthcoming IEEE ICC 2020 (co-chair for Next Generation Networking Symposium). He has been awarded IEEE Comsoc's Fred Ellersick award 2014 and FEPS Learning and Teaching award 2014. He has also been shortlisted for Wharton-QS Stars Reimagine Education Awards 2014. He is a senior member of IEEE, Fellow of IET and a Senior Fellow of Higher Education Academy (SFHEA), UK.

# TUTORIALS

**Monday, 25 May 2020**  
**9:00 - 12:15 • Room 05**

## TUT06 - B5G: A New Frontier for Non-Orthogonal Multiple Access

**Presenter:** Zhiguo Ding (University of Manchester, United Kingdom (Great Britain))

Non-orthogonal multiple access (NOMA) is an essential enabling technology for future wireless networks to meet the heterogeneous demands on low latency, high reliability, massive connectivity, improved fairness, and high throughput. The key idea behind NOMA is to serve multiple users in the same resource block, such as a time slot, subcarrier, or spreading code. The NOMA principle provides a general framework, where various recently proposed 5G multiple access techniques can be viewed as special cases. Recent demonstrations by industry show that the use of NOMA can significantly improve the spectral efficiency of mobile networks. Because of its superior performance, NOMA has been also recently included in 3GPP Releases 14 and 15 for downlink transmission, proposed to Release 16 for uplink transmission, and included into the next generation digital TV standard, e.g. ATSC (Advanced Television Systems Committee) 3.0. This tutorial is to provide an overview of the latest research results and innovations in NOMA technologies as well as their applications. Future research challenges regarding NOMA in B5G and beyond are also presented.

### Biography:

**Zhiguo Ding** (S'03-M'05) received his B.Eng in Electrical Engineering from the Beijing University of Posts and Telecommunications in 2000, and the Ph.D degree in Electrical Engineering from Imperial College London in 2005. From Jul. 2005 to Apr. 2018, he was working in Queen's University Belfast, Imperial College, Newcastle University and Lancaster University. Since Apr. 2018, he has been with the University of Manchester as a Professor in Communications. From Oct. 2012 to Sept. 2018, he has also been an academic visitor in Princeton University. Dr Ding's research interests are B5G networks, game theory, cooperative and energy harvesting networks and statistical signal processing. He is serving as an Editor for IEEE Transactions on Communications, IEEE Transactions on Vehicular Technology, and Journal of Wireless Communications and Mobile Computing, and was an Editor for IEEE Wireless Communication Letters, IEEE Communication Letters from 2013 to 2016. He received the best paper award in IET ICWMC-2009 and IEEE WCSP-2014, the EU Marie Curie Fellowship 2012-2014, the Top IEEE TVT Editor 2017, IEEE Heinrich Hertz Award 2018, IEEE Jack Neubauer Memorial Award 2018.

Monday, 25 May 2020  
14:00 - 17:15 • Room 01

*TUT04 - Wireless Transmission for Advanced Internet of Things: A Unifying Data-Oriented Approach*

**Presenters:** Hong-Chuan Yang (University of Victoria, Canada)  
Mohamed-Slim Alouini (King Abdullah University of Science and Technology (KAUST), Saudi Arabia)

Wireless communication systems will play an essential role in data transmission for future Internet of Things (IoT). The design and optimization of wireless transmission strategies for diverse IoT applications that generate data of variable sizes and dramatically different quality of service requirements are of critical contemporary interest. In this proposed tutorial, we present a unique data-oriented approach for wireless transmission system design, specifically targeting vertical IoT applications that demand ultra-reliable low-latency and extremely high energy efficiency. We introduce novel data-oriented metrics to characterize theoretical performance limits for various transmission scenarios. These performance metrics are also applied to the analysis and design of practical transmission schemes. The analysis is also generalized to cognitive secondary transmission. 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 advanced IoT applications.

**Biographies:**

**Dr. Hong-Chuan Yang** (Senior Member IEEE) 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 co-author of the book Order Statistics in Wireless Communications. He is a registered professional engineer (P.Eng) in British Columbia, Canada.

**Dr. Mohamed-Slim Alouini** (Fellow IEEE) 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 several papers on the above subjects, and he is co-author of the textbook Digital Communication over Fading Channels published by Wiley Interscience. He is a Fellow of the IEEE, a member of the Thomson ISI Web of Knowledge list of Highly Cited Researchers, and a co-recipient of best paper awards in eight IEEE conferences (including ICC, GLOBECOM, VTC, and PIMRC).

Monday, 25 May 2020  
14:00 - 17:15 • Room 02

*TUT07 - UAV Communications in 5G and Beyond: Integration of Sensing, Control, and Learning*

**Presenters:** Lingyang Song (Peking University, China)  
Zhu Han (University of Houston, USA)  
Hongliang Zhang (University of Houston, USA)

The emerging unmanned aerial vehicles (UAVs) have been playing an increasing role in the military, public, and civil applications. Very recently, 3GPP has approved the study item on enhanced support to seamlessly integrate UAVs into future cellular networks. Unlike terrestrial cellular networks, UAV communications have many distinctive features such as high dynamic network topologies and weakly connected communication links. In addition, they still suffer from some practical constraints such as battery power, no-fly zone, etc. As such, many standards, protocols, and design methodologies used in terrestrial wireless networks are not directly applicable to airborne communication networks. Therefore, it is essential to develop new communication, signal processing, and optimization techniques in support of the ultra-reliable and real-time sensing applications, but enabling high data-rate transmissions to assist the terrestrial communications in LTE. Typically, to integrate UAVs into cellular networks, one needs to consider two main scenarios of UAV applications as follows.

First, dedicated UAVs, also called drones, can be used as communication platforms in the way as wireless access points or relays nodes, to further assist the terrestrial communications. This type of applications can be referred to as UAV Assisted Cellular Communications. UAV-assisted cellular communications have numerous use cases, including traffic offloading, wireless backhauling, swift service recovery after natural disasters, emergency response, rescue and search, information dissemination/broadcasting, and data collection from ground sensors for machine-type communications. However, different from traditional cellular networks, how to plan the time-variant placements of the UAVs served as base station (BS)/relay is very challenging due to the complicated 3D propagation environments as well as many other practical constraints such as power and flying speed. In addition, spectrum sharing with existing cellular networks is another interesting topic to investigate.

Second type of application is to exploit UAVs for sensing purposes due to its advantages of on-demand flexible deployment, larger service coverage compared with the conventional fixed sensor nodes, and ability to hover. Specially, UAVs, equipped with cameras or sensors, have come into our daily lives to execute critical real-time sensing tasks, such as smart agriculture, security monitoring, forest fire detection, and traffic surveillance. Due to the limited computation capability of UAVs, the real-time sensory data needs to be transmitted to the BS for real-time data processing. In this regard, the cellular networks are necessarily committed to support the data transmission for UAVs, which we refer to as Cellular assisted UAV Sensing. Nevertheless, to support real-time sensing streaming, it is desirable to design joint sensing and communication protocols, develop novel beamforming and estimation algorithms, and study efficient distributed resource optimization methods.

The aim of this tutorial is to bring together control, signal processing engineers, computer and information scientists, applied mathematicians and statisticians, as well as systems engineers to carve out the role that analytical and experimental engineering has to play in UAV research and development. This proposal will emphasize on UAV technologies and applications for cellular networks. There are four main objectives. The first objective is to provide an introduction to the UAV paradigm, from 5G and beyond communication perspective. The second objective is to introduce the key methods, including optimization, game, and graph theory, for UAV applications, in a comprehensive way. The third objective is to discuss UAV assisted cellular communications. The fourth objective is to present the state-of-the-art for cellular network assisted UAV sensing. Many examples will be illustrated in details so as to provide wide scope for general audiences.

**Biographies:**

**Lingyang Song** received his PhD from the University of York, UK, in 2007, where he received the K. M. Stott Prize for excellent research. He worked as a postdoctoral research fellow at the University of Oslo, Norway, and Harvard University, until rejoining Philips Research UK in March 2008. In May 2009, he joined the School of Electronics Engineering and Computer Science, Peking University, China, as a full professor. His main research interests include cooperative and cognitive communications, physical layer security, and wireless ad hoc/sensor networks. He published extensively, wrote 6 text books, and is co-inventor of a number of patents (standard contributions). He received 9 paper awards in IEEE journal and conferences including IEEE JSAC 2016, IEEE WCNC 2012, ICC 2014, Globecom 2014, ICC 2015, etc. He is currently on the Editorial Board of IEEE Transactions on Wireless Communications and Journal of Network and Computer Applications. He served as the TPC co-chairs for the International Conference on Ubiquitous and Future Networks (ICUFN2011/2012), symposium co-chairs in the International Wireless Communications and Mobile Computing Conference (IWCMC 2009/2010), IEEE International Conference on Communication Technology (ICCT2011), and IEEE International Conference on Communications (ICC 2014, 2015). He is the recipient of 2012 IEEE Asia Pacific (AP) Young Researcher Award. Dr. Song is a senior member of IEEE, and IEEE ComSoc distinguished lecturer since 2015.

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

**Hongliang Zhang** (S’15-M’19) received the B.S. and Ph.D. degrees at the School of Electrical Engineering and Computer Science at Peking University, in 2014 and 2019, respectively. Currently, he is a Postdoctoral Fellow in the Electrical and Computer Engineering Department as well as the Computer Science Department at the University of Houston, Texas. His current research interest includes cooperative communications, Internet-of-Things networks, hypergraph theory, and optimization theory. He has served as a TPC Member for many IEEE conferences, such as Globecom, ICC, and WCNC. He is currently an Editor for IET Communications. He also serves as a Guest Editor for IEEE IoT-J special issue on Internet of UAVs over Cellular Networks.



# TUTORIALS

**Monday, 25 May 2020**  
**14:00 - 17:15 • Room 03**

TUT08 - Orthogonal Time Frequency Space (OTFS) Modulation and Applications

**Presenters:** Emanuele Viterbo and Yi Hong (Monash University, Australia)

Emerging mass transportation systems – such as self-driving cars, high-speed trains, drones, flying cars, and supersonic flight – will challenge the design of future wireless networks due to high-mobility environments: a large number of high-mobility users require high data rates and low latencies. The physical layer modulation technique is a key design component to meet the system requirements of high mobility. Currently, orthogonal frequency division multiplexing (OFDM) is the modulation scheme deployed in 4G long term evolution (LTE) mobile systems, where the wireless channel typically exhibits time-varying multipath fading. OFDM can only achieve a near-capacity performance over a doubly dispersive channel with a low Doppler effect, but suffers heavy degradations under high Doppler conditions, typically found in high-mobility environments. Orthogonal time frequency space (OTFS) modulation has been recently proposed by Hadani et al. at WCNC'17, San Francisco. It was shown to provide significant advantages over OFDM in doubly dispersive channels. OTFS multiplexes each information symbol over a 2D orthogonal basis functions, specifically designed to combat the dynamics of the time-varying multipath channels. As a result, all information symbols experience a constant flat fading equivalent channel. OTFS is only in its infancy, leaving many opportunities for significant developments on both practical and theoretical fronts.

### Biographies:

**Emanuele Viterbo** (F'2011) received his degree (Laurea) in Electrical Engineering in 1989 and his Ph.D. in 1995 in Electrical Engineering, both from the Politecnico di Torino, Torino, Italy. From 1990 to 1992 he was with the European Patent Office, The Hague, The Netherlands, as a patent examiner in the field of dynamic recording and error-control coding. Between 1995 and 1997 he held a post-doctoral position in the Dipartimento di Elettronica of the Politecnico di Torino. In 1997-98 he was a post-doctoral research fellow in the Information Sciences Research Center of AT&T Research, Florham Park, NJ, USA. He became first Assistant Professor (1998) then Associate Professor (2005) in Dipartimento di Elettronica at Politecnico di Torino. In 2006 he became Full Professor in DEIS at University of Calabria, Italy. From September 2010 he is Professor in the ECSE Department and Associate Dean Graduate Research of the Faculty of Engineering at Monash University, Melbourne, Australia. Emanuele Viterbo is a 2011 Fellow of the IEEE, an ISI Highly Cited Researcher and Member of the Board of Governors of the IEEE Information Theory Society (2011-2013 and 2014-2018). He served as Associate Editor of IEEE Transactions on Information Theory, European Transactions on Telecommunications and Journal of Communications and Networks. His main research interests are in lattice codes for the Gaussian and fading channels, algebraic coding theory, algebraic space-time coding, digital terrestrial television broadcasting, and digital magnetic recording.

**Yi Hong** (S'00–M'05–SM'10) is currently a Senior lecturer at the Department of Electrical and Computer Systems Eng., Monash University, Melbourne, Australia. She obtained her Ph.D. degree in Electrical Engineering and Telecommunications from the University of New South Wales (UNSW), Sydney, and received the NICTA-ACoRN Earlier Career Researcher Award at the Australian Communication Theory Workshop, Adelaide, Australia, 2007. Dr. Hong was an Associate Editor for IEEE Wireless Communication Letters and Transactions on Emerging Telecommunications Technologies (ETT). She was the General Co-Chair of IEEE Information Theory Workshop 2014, Hobart; the Technical Program Committee Chair of Australian Communications Theory Workshop 2011, Melbourne; and the Publicity Chair at the IEEE Information Theory Workshop 2009, Sicily. She was a Technical Program Committee member for many IEEE leading conferences. Her research interests include communication theory, coding and information theory with applications to telecommunication engineering.

# TUTORIALS

**Monday, 25 May 2020**  
**14:00 - 17:15 • Room 04**

**TUT09 - URLLC for 5G and Beyond: Physical, MAC and Network Design and Solutions**

**Presenters:** Branka Vucetic, Yonghui Li and Mahyar Shirvanimoghaddam (University of Sydney, Australia)  
Rana Abbas (The University of Sydney, Australia)  
Changyang She (University of Sydney, Australia)

The world is currently witnessing the rise of many mission critical applications such as tele-surgery, intelligent transportation, industry automation, virtual reality and augmented reality, vehicular communications, etc. Some of these applications will be enabled by the fifth-generation of cellular networks (5G), which will provide the required ultra-reliable low-latency communication (URLLC). However, guaranteeing these stringent reliability and end-to-end latency requirements continues to prove to be quite challenging, due to the significant shift in paradigms required in both theoretical fundamentals of wireless communications as well as design principles. In this tutorial, we cover the challenges and potential solutions for 5G and beyond 5G to support URLLC, in terms of error control coding improving reliability, channel access protocols for reducing latency, and multi-connectivity for improving network availability.

### Biographies:

**Branka Vucetic** [F] is an ARC Laureate Fellow and Professor of Telecommunications, Director of the Centre of Excellence in Telecommunications at the University of Sydney. During her career, she has held research and academic positions in Yugoslavia, Australia, UK and China. Her research interests include coding, communication theory and signal processing and their applications in wireless networks and industrial internet of things. Prof Vucetic co-authored four books and more than four hundred papers in telecommunications journals and conference proceedings. She is a Fellow of the Australian Academy of Technological Sciences and Engineering and a Fellow of the IEEE.

**Yonghui Li** [F] received his PhD degree in November 2002 from Beijing University of Aeronautics and Astronautics. Since 2003, he has been with the Centre of Excellence in Telecommunications, the University of Sydney, Australia. He is now a Professor in School of Electrical and Information Engineering, University of Sydney. He is the recipient of the Australian Queen Elizabeth II Fellowship in 2008 and the Australian Future Fellowship in 2012. His current research interests are in the area of wireless communications, with a particular focus on MIMO, millimeter wave communications, machine to machine communications, coding techniques and cooperative communications. He has received three IEEE best paper awards. He is a Fellow of IEEE.

**Mahyar Shirvanimoghaddam** [M] received the B.Sc. degree (1st Class Honours) from the University of Tehran, Iran, in September 2008, the M.Sc. degree (1st Class Honours) from Sharif University of Technology, Iran, in October 2010, and the Ph.D. degree from The University of Sydney, Australia, in January 2015, all in electrical engineering. He then held a postdoctoral research position at the School of Electrical Engineering and Computing at the University of Newcastle, Australia. He is currently an Academic Fellow at the School of Electrical and Information Engineering, The University of Sydney, Australia. His general research interests include channel coding techniques, multiple access techniques, and machine-to-machine Communications.

**Rana Abbas [M]** received the M.E. in 2013 and the Ph.D. degree in 2018, both in electrical engineering from The University of Sydney. She is currently a researcher at the Centre of IoT and Telecommunications, at The University of Sydney. Her research interests include channel coding, random access, machine type communications and IIoT. She is the recipient of the Australian Postgraduate Awards Scholarship and the Norman 1 Price scholarship from the Centre of Excellence in Telecommunications, School of Electrical and Information Engineering, The University of Sydney. She is also the winner of the Best Paper Award at the IEEE PIMRC, 2018.

**Changyang She** [M] received his B. Eng and Ph.D. degrees in Electronics and Information Engineering from Beihang University, Beijing, China in 2012 and 2017, respectively. He was a postdoctoral research fellow with Singapore University of Technology and Design. He is now a postdoctoral research Associate with the University of Sydney. His research interests lie in the areas of ultra-reliable and low- latency communications, tactile internet, big data for resource allocation in wireless networks and energy efficient transmission in 5G systems. He has given three tutorials on ultra-reliable and low-latency communications in IEEE/CIC International Conference on Communications in China (ICCC) 2017, IEEE Vehicular Technology Conference (VTC) Fall 2018, and IEEE Personal, Indoor and Mobile Radio Communications (PIMRC) 2018.







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The IEEE Wireless Communications and Networking Conference (WCNC) is one of the premier annual events of IEEE in the wireless research arena bringing together researchers, academics, and industry professionals. The 2021 edition of this important event will be held in Nanjing, China. WCNC 2021 will include technical sessions, tutorials, workshops, and technology and business panels. You are invited to submit papers, and proposals for panels, tutorials, and workshops, in all areas of wireless communications, networks, services, and applications. The proposals for panels, tutorials, and workshops should be sent to the Chairs listed below. The submissions of technical papers should be made on EDAS. Potential topics include, but are not limited to:

### Track 1: Fundamentals and PHY

- Channel modeling, characterization and estimation
- Modulation, coding, diversity, equalization, synchronization
- Multi-carrier modulation, waveform design
- Wireless Communications through Reconfigurable Intelligent Surfaces
- AI, machine learning and data analytics for wireless communications
- Interference modeling, management, cancellation and alignment
- PHY strategies for low-rate, sporadic and asynchronous communications
- MIMO, massive MIMO and cloud-RAN
- Cooperative, device-to-device and multi-hop communication
- Cognitive radio, spectrum sensing
- Content caching and storage in wireless networks
- PHY layer design for cellular, wireless LAN, ad hoc and sensor networks
- Energy efficient and energy harvesting PHY layer design
- Joint information and energy transmission
- PHY layer security and privacy
- Ultra-wideband, mmWave and sub-THz communication
- Information-theoretic aspects of wireless communications
- Signal processing for wireless communications
- Molecular and nano communications
- Beyond 5G and 6G
- Full duplexing

### Track 3: Wireless Networks

- Software-defined mobile/wireless networks
- Wireless network functions virtualization
- Virtual network management and orchestration
- AI, machine learning and data analytics for wireless networks
- Mobile cloud
- Fog computing and networking
- Mobile edge computing
- Mesh, relay, sensor and ad hoc networks
- Routing and congestion control in wireless networks
- Cognitive radio and networking
- Resource management and optimization
- Mobile big data and network data analytics
- Wireless network security and privacy
- Mobile social networks
- Wireless network measurements and characterization
- Wireless networking for autonomous vehicles
- Wireless networking for smart X (energy, factory, city, etc.)
- IoT wireless networking

### Track 2: MAC and Cross-Layer Design

- Wireless MAC protocols for beyond 5G: design, analysis, and optimization
- AI, machine learning and data analytics for MAC and cross-layer design
- Cognitive and cooperative MAC
- MAC for mesh, ad hoc, relay and sensor networks
- Scheduling and radio resource management
- Cross-layer MAC design
- MAC design for Non-Terrestrial Networks and Aerial Networks
- Software defined radio, RFID MAC
- QoS support and energy efficient MAC
- MAC protocol for energy harvesting wireless networks
- MAC design for multitier cellular/small cell networks
- Multiple access in machine-to-machine communication
- MAC for cloud-RAN
- MAC protocols for molecular and nano networks
- MAC protocols for mmWave networks
- Full-duplex MAC design
- Cross-layer design for massive MIMO and multiuser MIMO networks

### Track 4: Emerging Technologies, Architectures and Services

- Wireless networks empowered by reconfigurable intelligent surfaces
- Age of Information in Real-time Systems and Networks
- Mobile/Wireless network support for vertical industries
- Adaptive content distribution in on-demand services
- Context and location-aware wireless services and applications
- User-centric networks and adaptive services
- Wireless body area networks and e-health services
- Intelligent transportation systems
- Dynamic sensor networks for urban applications
- Wireless emergency and security systems
- Ultra-reliable communication
- Enabling regulations, standards, spectrum management
- Hybrid licensed/unlicensed spectrum access schemes
- Technologies, architectures and enabling business models for rural communications
- Satellite-based mobile access and backhaul
- Non-terrestrial, Aerial and hybrid satellite-terrestrial networks
- Testbed and prototype implementation of wireless services

## IMPORTANT DATES

**Full Paper Submission:** 2 October 2020

**Notification of Acceptance:** 28 December 2020

**Final Manuscript:** 15 January 2021

**Workshop Proposals:** 31 July 2020

**Tutorial Proposals:** 18 September 2020

**Panel Proposals:** 18 September 2020

**Full details of submission procedures**

available at <https://wcnc2021.ieee-wcnc.org/>

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