

Tutorial T-16: The Path Towards 5G – Essential Technologies, Protocols and Tools for Enabling 5G Mobile Communications

Presenters: Marco Di Renzo (French National Center for Scientific Research, France), Christos Verikoukis (Telecommunications Technological Centre of Catalonia, Spain), Erik G. Larsson (Linköping University, Sweden), Eduard Jorswieck (TU Dresden, Germany), Cheng-Xiang Wang (Heriot-Watt University, UK)

Tutorial Overview

The fifth-generation (5G) is coming. Quo vadis 5G? What architectures, network topologies and technologies will define 5G? Are methodologies to the analysis, design and optimization of current cellular networks still applicable to 5G? The proposed tutorial is intended to offer a comprehensive and in depth crash course to communication professionals and academics. It is aimed to critically illustrate and discuss essential and enabling transmission technologies, communication protocols and architectures that are expected to make 5G mobile communications a reality.

At the end of the tutorial, the audience will receive a thorough understanding of state-of-the-art, current research activities, theoretical & practical issues, and opportunities for research & development of essential elements for 5G communications. The topics that will be discussed include: 5G requirements, potential architectures and network topologies, large-scale multi-antenna systems, millimeter-wave communications and wideband channel modeling, decentralized cell-less cellular architectures, hyper-dense cellular network deployments and related tools to their analysis, design and optimization.

Detailed Tutorial Outline:

1. The Path Towards 5G Communications (15-20 minutes – Speaker: Christos Verikoukis)
 - a. 5G requirements
 - b. 5G worldwide research activities
 - c. 5G potential architectures and network topologies
 - d. 5G standardization efforts
2. Massive MIMO (40 minutes – Speaker: Erik G. Larsson)
 - a. What is Massive MIMO and how does it work?
 - b. Propagation in massive MIMO
 - c. Research challenges and opportunities
 - d. Common myths and misconceptions
3. 5G Channel Models (40 minutes – Speaker: Cheng-Xiang Wang)
 - a. 5G channel model requirements
 - b. Massive MIMO and mmWave channel models
 - c. Channel models for high-mobility wireless systems
 - d. A unified 5G channel model framework
4. Energy-Efficient Distributed Cellular Systems (40 minutes – Speaker: Eduard Jorswieck)
 - a. Energy-efficiency optimization

- b. Non-cooperative games and distributed implementation
 - c. Resource allocation for energy-efficient single-hop MIMO interference channels
 - d. Resource allocation for energy-efficient multi-hop multi-user multi-antenna interference networks
5. Ultra-Dense Heterogeneous Cellular Networks Modeling and Analysis (40 minutes – Speaker: Marco Di Renzo)
- a. From the grid to point processes: Why stochastic geometry modeling of ultra-dense cellular networks?
 - b. Enabling mathematical tools and fundamental results
 - c. Stochastic geometry modeling and analysis of μ Wave MIMO-aided cellular networks
 - d. Stochastic geometry modeling and analysis of mmWave MIMO-aided cellular networks

Presenter Biographies

Marco Di Renzo received the Ph.D. degree in Electrical and Information Engineering from the University of L'Aquila, Italy, in January 2007. Since January 2010, he has been a Tenured Academic Researcher with the French National Center for Scientific Research (CNRS), as well as a faculty member of the Laboratory of Signals and Systems (L2S), CNRS, SUPELEC, and the University of Paris-Sud XI, Paris, France. His main research interests are in the area of wireless communications theory and stochastic geometry.

Christos Verikoukis received his Ph.D. from the Technical University of Catalonia in 2000. He is currently the Head of the SMARTECH department at CTTC and an adjunct associate professor at Barcelona University. His area of expertise is in the design of energy efficient layer 2 protocols and RRM algorithms.

Erik G. Larsson is a Professor and the Head of the Division for Communication Systems in the Department of Electrical Engineering (ISY) at Linköping University (LiU) in Linköping, Sweden. He joined LiU in September 2007. His main professional interests are within the areas of wireless communications and signal processing.

Eduard Jorswieck received his Doktor-Ingenieur (Ph.D.) degree from the Technische Universität Berlin, Germany, in 2004. Since February 2008, he has been the head of the Chair of Communications Theory and Full Professor at Technical University Dresden, Germany. Dr. Jorswieck's main research interests are in the area of signal processing for communications and networks.

Cheng-Xiang Wang received the PhD degree in Wireless Communications from Aalborg University, Denmark, in 2004. He has been with Heriot-Watt University, UK, since 2005, and became a Professor of Wireless Communications in 2011. His main research interests are in the area of channel modeling for 5G cellular systems, with special emphasis on mmWave communications.