Guest Editorial

Smart Grids





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Smart Grids are an essential component of future energy systems, which are characterized by distributed, volatile energy production (solar, wind) and entirely new components (electric vehicles) and operation concepts (virtual power plants). Smart Grids are also a prominent example of Cyber Physical Systems, as they combine wide-area control, computation, and communications. While traditional automation of the power grid makes use of wireline communications (copper, fiber), Smart Grids require wide-area coverage with flexible, cost-efficient, but also very reliable communications networks. Therefore, wireless communication technologies will play an increasingly important role in future deployment scenarios. The investigated options range from cellular networks over satellite systems to wireless mesh networks. Also, the ongoing discussion of future 5G systems is driven by the requirements of Smart Grids as one major use case. Particular challenges for wireless communication options include availability, real-time capabilities for incident mitigation, and resilience. The performance evaluation of Smart Grids calls for new methods, such as the interdisciplinary hybrid simulation of energy and communication networks.

In this special issue these Smart Grid-specific research challenges for wireless networks are addressed from various angles:

The first article, titled "Secure Real-Time Monitoring and Management of Smart Distribution Grid using Shared Cellular Networks," by Jimmy Nielsen *et al.,* focuses on the use of LTE for Smart Grid applications, and illustrates very well the use of wireless technologies in the context of Smart Grids. The article can also be regarded as relevant input for ongoing discussions of massively scalable wireless communications in the context of 5G.

The next article, "Guaranteeing QoS using Unlicensed TV White Spaces for Smart Grid Applications" by Wayes Tushar *et al.,* presents concepts and results of a case study related to the use of White TV Space spectrum for Smart Grid applications. The case study contains measurements in the field as well as simulation results to illustrate the effects of different allocation schemes.

In the third article, "Scalable Route Map for Advanced Metering Infrastructure Based on Optimal Routing of Wireless Heterogeneous Networks," Sandra Cespedes *et al.* introduce a hierarchical communication architecture that leverages multi-radio universal data aggregation points to collect data locally and aggregate it via LTE in a next step.

The important question of how sensors introduced to the Smart Grid can leverage energy harvesting from the electric field is addressed in the article, "Electric-Field Energy Harvesting Wireless Networks," by Oktay Cetinkaya and Ozgur Akan. The contribution is useful for the design of wireless sensor platforms to be introduced to the Smart Grid in a non-intrusive and effective manner.

The following article titled, "Co-Simulation of Wireless/Wireline Communication Technologies for Smart Grids," by Emilio Ghiani *et al.,* discusses co-simulation of Smart Grids by combining an energy system simulator with a corresponding communication system model. Based on a case study, the authors demonstrate how communication failures may affect the effectiveness of Smart Grid control algorithms.

The sixth article, "The Role of Satellite Communications in Smart Grids," by Allessio Meloni and Luigi Atzori, fills an important gap and matches Smart Grid related communication services to different satellite system characteristics, such as orbits or medium access control scheme.

The timely topic of the combination of Big Data analytics and Smart Grids is addressed by the seventh article, "Wireless Big Data Computing in Smart Grid," by Der-Jiunn Deng *et al.* As a case study of the proposed architecture, the authors present a residential storage planning case for the applications of wireless communication technologies in Smart Grid.

Finally, the article "Towards Efficient, Scalable and Coordinated On-the-Move EV Charging Management," by Ran Wang *et al.,* discusses the wireless control of electric vehicles as part of the Smart Grid. Wireless connectivity is ideally suited to manage electric vehicles even before they are connected to the Smart Grid to be recharged. The contribution compares different communication schemes, in particular decentralized and centralized schemes to manage the scheduling of the electric vehicles, leveraging cellular as well as WiFi networks.

Biographies

Christian Wietfeld [M'05, SM'12] (christian.wietfeld@tu-dortmund.de) is currently a full professor and the Head of the Communication Networks Institute, TU Dortmund University, Dortmund, Germany. He received the Dipl.-Ing. and Dr.-Ing. degrees in electrical engineering from RWTH Aachen University, Aachen, Germany, and has held various positions in the wireless networking industry. His research interests are focused on reliable networking for Cyber Physical Systems and the Internet of Things in application areas such as logistics, energy systems, robotics, autonomous vehicles, and emergency response. In these areas he has published over 150 conference papers, journal articles, and patents. He is currently an editor of the *IEEE Wireless*

Communication Magazine, and the co-founder of various start-ups in the area of wireless networking. Since 2008, he has been actively contributing to the research on wireless networks for Smart Grids in research efforts such as SmartC2Net and E-Energy. He has received several best paper awards, one of them in 2012 from the IEEE Smart Grid Communications conference.

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