Guest Editorial for the Special Series on Smart Grid Communications

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IN this third edition of the IEEE JSAC Smart Grid series, we continue to explore advances in communication technologies that have the potential for improving energy efficiency and realizing the smart grid vision. We have accepted 16 articles out of 57 papers submitted. The articles in this issue tackle important challenges with respect to smart grid communications and include a wide range of topics such as electric load models, electric vehicle charging, models for demand response, power management optimization and storage, pricing, and security.

In "Empirical Characterization, Modeling, and Analysis of Smart Meter Data," Sean K Barker, Sandeep Kalra, David Irwin and Prashant Shenoy develop models to characterize appliance loads based on data collected over two years.

In "Grouping Based MAC Protocols for EV Charging Data Transmission in Smart Metering Network," Yue Yang and Sumit Roy propose and analyze a wireless architecture for gathering electric vehicle charging requests in a residential neighborhood.

In the paper "Mobility-Aware Coordinated Charging for Electric Vehicles in VANET-Enhanced Smart Grid," Miao Wang, Hao Liang, Ran Zhang, Ruilong Deng, and Sherman Shen have introduced a VANET-enhanced smart grid with the functionalities of real-time vehicle information collection. The authors also propose a mobility-aware coordinated EV charging strategy to maximize the energy utilization while avoiding overload conditions.

"On Optimally Reducing Power Loss in Micro-Grids with Power Storage Devices," by Chao Wei, Zubair Fadlullah, Nei Kato, and Ivan Stojmenovic, a novel theoretic coalition formulation for smart grid power management is presented. This scheme is capable to optimally minimize the power losses by making coalitions with neighboring micro-grids that make autonomous decisions whether to charge or discharge their power storage devices.

"Optimization Decomposition of Resistive Power Networks with Energy Storage," by Xin Lou and Chee Wei Tan, makes a novel contribution in the optimization methodology to develop optimal power flow (OPF) for resistive power network where each power bus has energy storage. In this way power flow load and power consumption can be evenly balanced.

In the article "Cooperation and Storage Tradeoffs in Power-Grids With Renewable Energy Resources," Subhash Lakshminarayana, Tony Q. S. Quek, and H. Vincent Poor consider an approach for combating the uncertainty and intermittent nature of renewable energy supply through joint battery management and micro-grid cooperation.

In "Direct Electricity Trading in Smart Grid: A Coalitional Game Analysis," Woongsup Lee, Lin Xiang, Robert Schober, and Vincent W.S. Wong, apply coalition game design for direct trading of electricity by a group of small generators and consumers.

"Demand Side Management in Smart Grids Using a Repeated Game Framework," by Linqi Song, Yuanzhang Xiao, and Mihaela van der Schaar, consider a mechanism design problem for demand response within the critical peak pricing framework.

In "Network Coordinated Power Point Tracking for Grid-Connected Photovoltaic Systems," Xudong Wang, Yibo Pi, Wenguang Mao, and Hua Huang propose a scheme for coordinating the power points of a set of photo-voltaic arrays that are connected to the grid.

In "Optimal Residential Demand Response in Distribution Networks," Wenbo Shi, Na Li, Xiaorong Xie, Chi-Cheng Chu, and Rajit Gadh look at demand response for the distribution grid and formulate an optimal power flow problem that is cognizant of constraints imposed by the underlying network topology.

The paper "Network Theory and Smart Grid Distribution" by Stephen Bush explores the relationship between the power grid and communication network topology, with relation to the hypothesis that nodes that are weakly connected in the power grid should be strongly connected in the communication grid, for effective support of latency-constrained applications.

In "Data Framing Attack on State Estimation," Jinsub Kim, Robert Thomas, and Lang Tong present a novel attack method to perturb state estimation by an arbitrary degree while controlling half of the critical set of meters.

"Using Covert Topological Information for Defense Against Malicious Attacks on DC State Estimation," by Suzhi Bi and Ying Jun (Angela) Zhang, investigates new countermeasures using covert topological information against false-data attacks on power system state estimators.

In "A Game Theoretical Analysis of Data Confidentiality Attacks on Smart Grid AMI," Ziad Ismail, Jean Leneutre, David Bateman, and Lin Chen consider the problem of confidentiality

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Digital Object Identifier 10.1109/JSAC.2014.2332011

in advanced metering infrastructure networks. A game theoretical model of security investments and attack strategies is formulated, and the equilibrium strategies are computed.

The paper "Security of Fully Distributed Power System State Estimation: Detection and Mitigation of Data Integrity Attacks," by Ognjen Vuković and György Dán, presents a potential mechanism of a denial-of-service (DoS) attack on distributed state estimation (DSE) and a mitigation strategy.

"Cyber–Physical Device Authentication for Smart Grid Electric Vehicle Ecosystem," by Aldar Chun-Fai Chan and Jianying Zhou, addresses the issue of authenticating electric vehicles to the smart grid, as well as how to build a cyber–physical two-factor authentication system to defeat substitution attacks.

We thank all the authors who responded to our call for papers and contributed their work to the third edition of this series. We are also indebted to the many reviewers who took the time to provide insightful reviews. We are grateful to Laurel Greenridge and Lauren Briede for handling the advertisement and publication details and to Steven Low, Martha Streenstrup, and Muriel Medard for their continued guidance and invaluable advice. We hope that you will enjoy reading this selection of papers and invite you to contribute to future issues of our series.

Nada Golmie received the Ph.D. degree in computer science from the University of Maryland, College Park, MD, USA. Since 1993, she has been a Research Engineer at the Advanced Networking Technologies Division, National Institute of Standards and Technology (NIST), Gaithersburg, MD. She is currently the Manager of the Emerging and Mobile Network Technologies Group.

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Sean Smith received the B.A. degree in mathematics from Princeton University, Princeton, NJ, USA and the M.S. and Ph.D. degrees in Computer Science, from Carnegie Mellon University, Pittsburgh, PA, USA. He has been working on how to build trustworthy systems in the real world since before there was a Web at Los Alamos, at IBM, and, since 2000, at Dartmouth College, Hanover, NH, USA.

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Lang Tong (S'87–M'91–SM'01–F'05) received the B.E. degree in automation from Tsinghua University, Beijing, China, in 1985 and the M.S. and Ph.D. degrees in electrical engineering from the University of Notre Dame, Notre Dame, IN, USA, in 1987 and 1991, respectively. He is the Irwin and Joan Jacobs Professor in Engineering at Cornell University, Ithaca, NY, USA. He is also the Cornell Site Director of the Power System Engineering Research Center. His current research focuses on inference, optimization, and economic problems in energy and power systems. He was a Postdoctoral Research Affiliate at the Information Systems Laboratory, Stanford University, in 1991. He was the 2001 Cor Wit Visiting Professor at the Delft University of Technology and had held visiting positions at Stanford University and the University of California at Berkeley. He is also a coauthor of seven student paper awards. Dr. Tong was a Distinguished Lecturer of the IEEE Signal Processing Society. He was a recipient of the Young Investigator Award from the Office of Naval Research, the 1993 Outstanding Young Author Award from the IEEE Circuits and Systems Society, the 2004 Best Paper Award from the IEEE Signal Processing Society, and the 2004 Leonard G. Abraham Prize Paper Award from the IEEE Communications Society.

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