

Guest Editorial

Smart Grid Communications

Nada Golmie, Anna Scaglione, Lutz Lampe, Edmund Yeh, Sean Smith, and Lang Tong

IN THIS SECOND 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 received a total number of 73 papers, and after a thorough review and careful deliberations, we have accepted 15 articles. This issue tackles important challenges with respect to smart grid communications, such as interference mitigation in powerline communications, information exchange for wide area management systems, energy service interface deployment, load balancing, energy pricing, security, and privacy.

In “Impulsive Noise Mitigation in Powerline Communications Using Sparse Bayesian Learning,” J. Lin, M. Nassar, B. L. Evans consider the use of narrowband power line communications (PLC) in the distribution part of a smart electricity grid. The authors present a suite of noise mitigation methods and discuss their effectiveness based on simulation results.

“Robust Decentralized State Estimation and Tracking for Power Systems via Network Gossiping,” X. Li and A. Scaglione, proposes a distributed and adaptive state estimation scheme for power systems based on message passing, using hybrid measurements from the Supervisory Control and Data Acquisition (SCADA) system and Wide-Area Measurement System (WAMS).

In “Energy Service Interface: Accessing to Customer Energy Resources for Smart Grid Interoperation,” E. K. Lee, R. Gadh, and M. Gerla, focus on the building and deployment of two Energy Service Interface (ESI) testbeds, addressing fundamental functional requirements.

In “nPlug: An Autonomous Peak Load Controller,” T. Ganu, D. P. Seetharam, V. Arya, J. Hazra, D. Sinha, R. Kunnath, L. C. De Silva, S. A. Husain, and S. Kalyanaraman discuss the design, implementation and performance of a device, n-Plug, that can be used to turn off deferrable energy loads during peak usage.

In “Bidirectional Energy Trading and Residential Load Scheduling with Electric Vehicles in the Smart Grid,” B.-G. Kim, S. Ren, M. van der Schaar, and J.-W. Lee, investigate distributed and game-theoretic approaches for load scheduling that jointly considers appliances and EV energy trading.

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S. Low is the J-SAC Board Representative for this issue of IEEE Journal on Selected Areas in Communications.

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“Electric Power Allocation in a Network of Fast Charging Stations,” by I. S. Bayram, G. Michailidis, M. Devestikiotis, and F. Granelli, introduces methods to balance the electrical load among different charging stations while considering their optimal placement.

“The Role of Aggregators in Smart Grid Demand Response Markets,” by L. Gkatzikis, I. Koutsopoulos, and T. Salonidis proposes a layered market structure to implementing demand response.

“Heterogeneous Delay Tolerant Task Scheduling and Energy Management in the Smart Grid with Renewable Energy,” S. Chen, N. B. Shroff, and P. Sinha, examines cost minimization for an end-user, when equipped with energy storage and energy harvesting devices.

“Demand Response Management via Real-Time Electricity Price Control in Smart Grids,” by L. P. Qian, Y. J. Zhang, J. Huang, and Y. Wu, proposes a real-time pricing scheme that reduces the peak-to-average load ratio through demand response management in smart grid systems.

“GreenCharge: Managing Renewable Energy in Smart Buildings,” by A. Mishra, D. Irwin, P. Shenoy, J. Kurose, and T. Zhu proposes a system architecture and optimization algorithm, called GreenCharge, which combines market-based electricity pricing models with on-site renewables and energy storage to promote distributed generation.

The article by J. Kim and L. Tong titled “On Topology Attack of a Smart Grid: Undetectable Attacks and Countermeasures” investigates conditions and countermeasures for undetectable attacks on a smart grid network topology.

“Sparse Attack Construction and State Estimation in the Smart Grid: Centralized and Distributed Models,” by M. Ozay, I. Esnaola, F. T. Y. Vural, S. Kulkarni, and H. V. Poor, presents and evaluates a number of techniques for smart meter intrusion detection and for energy theft prevention.

“A Multi-Sensor Intrusion and Energy Theft Detection Framework for Advanced Metering Infrastructures,” by S. McLaughlin, B. Holbert, A. Fawaz, R. Berthier, and S. Zonouz, presents and evaluates a number of techniques for smart meter intrusion detection and for energy theft prevention.

“Increasing Smart Meter Privacy Through Energy Harvesting and Storage Devices,” from O. Tan, D. Gündüz, and H. V. Poor, uses an information theoretic approach to preserving energy consumption information and user privacy.

“Distributed Privacy-Preserving Aggregation of Metering Data in Smart Grids,” by C. Rottondi, G. Verticale, and C. Krauß, describes an interface between electric meters and external entities to collect user information without compromising privacy.

We thank the authors who responded in larger numbers to our call for papers and contributed their work to the second edition of this series. We are also indebted to the many reviewers who took the time to provide insightful reviews. We are grateful to Sue Lange and Laurel Greenridge for handling the advertisement and publication details, Steven Low and Martha Streenstrup for their 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 her Ph.D. in computer science from the University of Maryland at College Park. Since 1993, she has been a research engineer in the advanced networking technologies division at the National Institute of Standards and Technology (NIST). She is currently the manager of the emerging and mobile network technologies group.

Her research in media access control and protocols for wireless networks led to over 100 technical papers presented at professional conferences, journals, and contributed to international standard organizations and industry led consortia. She is the author of *Coexistence in Wireless Networks: Challenges and System-level Solutions in the Unlicensed Bands*, published by Cambridge University Press (2006). She has served as a member and sometimes chaired several IEEE sponsored conference program technical committees, including ICC, Globecom, Smart Grid Communications. She is the lead editor for IEEE JSAC series on Smart Grid communications. She has served as vice-chair for the IEEE 802.15.2 Task Group on Coexistence. She is a member of the IEEE ComSoc Standards Development Board and she is currently the chair of the NIST/SGIP Priority Action Plan on Wireless Communications.



Anna Scaglione (F11) received her Ph.D. degree in 1999 from the University of Rome, La Sapienza. She is currently Professor in Electrical and Computer Engineering at University of California at Davis, where she joined in 2008. She was previously at Cornell University, Ithaca, NY, from 2001 where became Associate Professor in 2006; prior to joining Cornell she was Assistant Professor in the year 2000-2001, at the University of New Mexico. She has held several editorial posts and currently serves as Editor in Chief for the *Signal Processing Letters*

and guest editor for the *Journal on Selected Areas in Communications*, for a series of special issues on Smartgrid. Dr. Scaglione received the 2000 IEEE *Signal Processing Transactions Best Paper Award* the NSF Career Award in 2002 and she is co-recipient of the Ellersick Best Paper Award (MILCOM 2005). Her expertise is in the broad area of signal processing for communication systems and networks. Her current research focuses on decentralized network processing and sensors systems for monitoring and energy management. Dr. Scaglione is a Fellow of the IEEE.



Lutz Lampe [M02, SM08] received his Diplom (Univ.) and Ph.D. degrees in electrical engineering from the University of Erlangen, Germany, in 1998 and 2002, respectively. Since 2003 he has been with the Department of Electrical and Computer Engineering at the University of British Columbia, where he is a full professor. His research interests are broadly in theory and application of wireless and power line communications, including communications for Smart Grid. He is (co-)recipient of a number of Best Paper Awards, including awards at the 2006 IEEE International Conference on Ultra-Wideband (ICUWB), 2010 IEEE International Communications Conference (ICC) and 2011 IEEE International Conference on Power Line Communications (ISPLC). He was awarded the Friedrich Wilhelm Bessel Research Award by the Alexander von Humboldt Foundation in 2009. He is currently an Associate Editor for the IEEE *Wireless Communications Letters* and the IEEE *Communications Surveys and Tutorials*, and has served as Associate and Guest Editor for several IEEE *Transactions* and journals. He was the General Chair of ISPLC 05 and ICUWB 09. He is the Chair of the IEEE Communications Society Technical Committee on Power Line Communication.



Edmund M. Yeh received his B.S. in Electrical Engineering with Distinction from Stanford University in 1994, M.Phil in Engineering from the University of Cambridge in 1995, and Ph.D. in Electrical Engineering and Computer Science from MIT in 2001. He is currently an Associate Professor of Electrical and Computer Engineering at Northeastern University, Boston, Massachusetts. Previously, he was Assistant and Associate Professor of Electrical Engineering, Computer Science, and Statistics at Yale University, New Haven, Connecticut. He has been visiting faculty at MIT, Princeton University, University of California at Berkeley, and Swiss Federal Institute of Technology, Lausanne. Dr. Yeh is a recipient of the Humboldt Research Fellowship from the Alexander von Humboldt Foundation (2010), the Army Research Office Young Investigator Program Award (2003), the Winston Churchill Scholarship (1994), the National Science Foundation and Office of Naval Research Fellowships (1994) for graduate study, the Frederick E. Terman Award from Stanford University (1994) and the Barry M. Goldwater Scholarship from the United States Congress (1993). Dr. Yeh is a Senior Member of IEEE, a member of Phi Beta Kappa and Tau Beta Pi. He serves as an Associate Editor for IEEE *Transactions on Mobile Computing*. His expertise is in the areas of information theory, communication, and networking.



Sean Smith has been working on how building trustworthy systems in the real world since before there was a Web; at Los Alamos, at IBM, and (since 2000) at Dartmouth College. His book *Trusted Computing Platforms: Design and Applications* (Springer, 2005) provides a deeper presentation of this research journey; his book *The Craft of System Security* (Addison-Wesley, 2007) resulted from the educational journey. Sean has published over ninety refereed papers; been granted over a dozen patents; and advised over three dozen Ph.D., M.S., and senior honors theses.



Lang Tong (S'87,M'91,SM'01,F'05) is the Irwin and Joan Jacobs Professor in Engineering at Cornell University, Ithaca, New York. He is also the Cornell site director of the Power System Engineering Research Center (PSERC). Lang Tong's current research focuses on inference, optimization, and economic problems in energy and power systems. He received the B.E. degree in Automation from Tsinghua University, Beijing, China, in 1985, and M.S. and Ph.D. degrees in electrical engineering in 1987 and 1991, respectively, from the University of

Notre Dame, Notre Dame, Indiana. 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. Lang Tong received the 1993 Outstanding Young Author Award from the IEEE Circuits and Systems Society, the 2004 best paper award from IEEE Signal Processing Society, and the 2004 Leonard G. Abraham Prize Paper Award from the IEEE Communications Society. He is also a coauthor of seven student paper awards. He received Young Investigator Award from the Office of Naval Research. He was a Distinguished Lecturer of the IEEE Signal Processing Society.