



Special section on smart grids: A hub of interdisciplinary research

Mubashir Husain Rehmani, Melike Erol-Kantarci, Abderrezak Rachedi, Radenkovic, Milena, Martin Reisslein

► To cite this version:

Mubashir Husain Rehmani, Melike Erol-Kantarci, Abderrezak Rachedi, Radenkovic, Milena, Martin Reisslein. Special section on smart grids: A hub of interdisciplinary research : IEEE ACCESS Special section editorial smart grids: A hub of interdisciplinary research . IEEE access, 2015, <10.1109/ACCESS.2016.2516158>. <hal-01261010>

HAL Id: hal-01261010

<https://hal-upec-upem.archives-ouvertes.fr/hal-01261010>

Submitted on 27 Jan 2016

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial - NoDerivatives 4.0
International License

Date of current version January 20, 2016.

Digital Object Identifier 10.1109/ACCESS.2016.2516158

EDITORIAL

IEEE ACCESS SPECIAL SECTION EDITORIAL SMART GRIDS: A HUB OF INTERDISCIPLINARY RESEARCH

The smart grid is an important hub of interdisciplinary research where researchers from different areas of science and technology combine their efforts to enhance the traditional electrical power grid. Due to these efforts, the traditional electrical grid is now evolving. The envisioned smart grid will bring social, environmental, ethical, legal and economic benefits. Smart grid systems increasingly involve machine-to-machine communication as well as human-to-human, or simple information retrieval. Thus, the dimensionality of the system is massive. The smart grid is the combination of different technologies, including control system theory, communication networks, pervasive computing, embedded sensing devices, electric vehicles, smart cities, renewable energy sources, Internet of Things, wireless sensor networks, cyber physical systems, and green communication. Due to these diverse activities and significant attention from researchers, education activities in the smart grid area are also growing.

The smart grid is designed to replace the traditional electrical power grid. The envisioned smart grid typically consists of three networks: Home Area Networks (HANs), Neighborhood Area Networks (NANs), and Wide Area Networks (WANs). HANs connect the devices within the premises of the consumer and connect smart meters, Plug-in Electric Vehicles (PEVs), and distributed renewable energy sources. NANs connect multiple HANs and communicate the collected information to a network gateway. WANs serve as the communication backbone. Communication technologies play a vital role in the successful operation of smart grid. These communication technologies can be adopted based upon the specific features required by HANs, NANs, and WANs. Both wired and the wireless communication technologies can be used in the smart grid [1]. However, wireless communication technologies are suitable for many smart grid applications due to the continuous development in the wireless research domain. One drawback of wireless communication technologies is the limited availability of radio spectrum. The use of cognitive radio in smart grid communication will be helpful to break the spectrum gridlock through advanced radio design and operating in multiple settings, such as underlay, overlay, and interweave [2].

The smart grid is the combination of diverse sets of facilities and technologies. Thus, the monitoring and control of transmission lines, distribution facilities, energy generation plants, and as well as video monitoring of consumer premises

can be conducted through the use of wireless sensor networks [3]–[6]. In remote sites and places where human intervention is not possible, wireless sensor and actuator networks can be useful for the successful smart grid operation [7], [8]. Since wireless sensor networks operate on the Industrial, Scientific, and Medical (ISM) band, the spectrum might get congested due to overlaid deployment of wireless sensor networks in the same premises. Thus, to deal with this spectrum congestion challenge, cognitive radio sensor networks can be used in smart grid environments [9], [10].

The objective of this Special Section in IEEE ACCESS is to showcase the most recent advances in the interdisciplinary research areas encompassing the smart grid. This Special Section brings together researchers from diverse fields and specializations, such as communications engineering, computer science, electrical and electronics engineering, educators, mathematicians and specialists in areas related to smart grids. In this Special Section, we invited researchers from academia, industry, and government to discuss challenging ideas, novel research contributions, demonstration results, and standardization efforts on the smart grid and related areas. This Special Section is a collection of eleven articles. These articles are grouped into the following four areas: (a) Reliability, security, and privacy for smart grid, (b), Demand response management, understanding customer behavior, and social networking applications for smart grid, (c) Smart cities, renewable energy, and green smart grid, and (d) Communication technologies, control and management for the smart grid.

I. RELIABILITY, SECURITY, AND PRIVACY FOR SMART GRID

The electrical power grid is a critically important infrastructure in today's world. Cyber Physical Systems and many other facilities and networks depend on the proper functioning of the electrical power grid. For instance, an anomaly in the electrical power grid may disrupt banking transactions and thus a country's economy may freeze for a while. This problem will be more severe in terms of security and privacy, when the traditional power grid will totally evolve into the smart grid. Considering this important aspect, the first three articles in this Special Section address reliability, security and privacy.

The article entitled "On reliability of smart grid neighborhood area network" by Shengjie Xu, Yi Qian, and Rose Qingyang Hu, discuss in detail a comprehensive survey on reliability in Smart Grid. More precisely, the article

emphasize on reliability requirements, challenges, and case studies related to Smart Grid Neighborhood Area Network.

The Advanced Metering Infrastructure (AMI) is a component of Smart Grid that ensures communication for all smart meter related applications. One such application is automated meter reading, where the customer's electricity usage is communicated to the authorized persons for billing purpose and can also be used to forecast customers' demand for electricity. Thus, keeping privacy of this data is important. In the article entitled "DEP2SA: A decentralized efficient privacy-preserving and selective aggregation scheme in advanced metering infrastructure" by Mustafa A. Mustafa, Ning Zhang, Georgios Kalogridis, and Zhong Fan, authors proposed a privacy-preserving data collection scheme for advanced metering infrastructure.

Smart meters and automatic meter readings also result in generation of big data, which have to be moved to communication network supporting smart grid. In the article entitled "Smart meters big data: Game theoretic model for fair data sharing in deregulated smart grids" by Abdulsalam Yassine, Ali Asghar Nazari Shirehjini, and Shervin Shirmohammadi, authors proposed a solution to the problem of access control and proposed a game theory mechanism that compare between the beneficial use of data and individual's privacy in the context of decentralized smart grid.

II. DEMAND RESPONSE MANAGEMENT, UNDERSTANDING CUSTOMER BEHAVIOR, AND SOCIAL NETWORKING APPLICATIONS FOR SMART GRID

Demand Response Management (DRM) is considered as an important tool for the smart grid, as it is used to regulate and predict the electricity demand and supply profiles. DRM requires active participation from customer and one can understand customer behavior through DRM or vice versa. In DRM, customers can change their electricity consumption pattern through electricity tariff variations. Moreover, understanding customer behavior is important as it helps the engineers and researchers to design social networking based applications to facilitate the customers to use the smart grid efficiently. The next two articles deal with DRM and understanding customer behavior.

In the article entitled "Demand response management for residential smart grid: From theory to practice" by Wen-Tai Li, Chau Yuen, Naveed Ul Hassan, Wayes Tushar, Chao-Kai Wen, Kristin L. Wood, Kun Hu, and Xiang Liu, authors proposed a DRM scheme and constructed a residential smart grid testbed to implement the proposed scheme. This article includes a valuable experimental effort where the proposed scheme is verified through a testbed.

In the article entitled "Understanding customer behavior in multi-tier demand response management program" by Aqsa Naeem, Ali Shabbir, Naveed Ul Hassan, Chau Yuen, Ayaz Ahmad, and Wayes Tushar, authors aimed to provide deeper understanding of the customer behavior. In fact, authors investigated the factors that affect the customer's decision in subscribing to a particular DRM program.

III. SMART CITIES, RENEWABLE ENERGY, AND GREEN SMART GRID

The use of renewable energy sources is recommended for smart cities. Urban planning for new villages and cities is underway for the incorporation of smart grid. Information and Communication Technologies (ICT) are moving towards powering their communication infrastructure through renewable energy sources to reduce energy consumption and carbon emissions. Considering the importance, we have included three articles for this topic.

In the article entitled "Impact of interdisciplinary research on planning, running, and managing electromobility as a smart grid extension" by Alfredo D'Elia, Fabio Viola, Federico Montori, Marco Di Felice, Luca Bedogni, Luciano Bononi, Alberto Borghetti, Paolo Azzoni, Paolo Bellavista, Daniele Tarchi, Randolph Mock, and Tullio Salmon Cinotti, authors discuss smart grid by integrating Electromobility and the urban power distribution network. Authors discussed the results of different European projects for the development of a co-simulator tool which will be used for Electromobility planning, and recharging services in the smart grid.

In the article entitled "Integrating cellular networks, smart grid, and renewable energy: Analysis, architectures, and challenges" by Hussein Al Haj Hassan, Alexander Pelov, and Loutfi Nuaymi, authors proposed an architecture to power cellular networks with renewable energy sources.

In the article entitled "Revenue optimization frameworks for multi-class PEV charging stations" by Cuiyu Kong, Islam Safak Bayram, and Michael Devetsikiotis, authors proposed two queuing theory based optimization frameworks for Plug-in Electric Vehicles (PEVs).

IV. COMMUNICATION TECHNOLOGIES, CONTROL AND MANAGEMENT FOR THE SMART GRID

For the successful operation of the smart grid, data should be communicated efficiently and reliably between different entities. Moreover, the assets in the smart grid should also be controlled and monitored. Thus, considering the importance of this topic, we have included three articles in this section.

The article entitled "Delay critical smart grid applications and adaptive QoS provisioning" by Irfan Al-Anbagi, Melike Erol-Kantarci, and Hussein T. Mouftah, discuss a smart grid monitoring application utilizing wireless sensor networks. Authors proposed an adaptive Quality of Service (QoS) scheme to prioritize alarm data for high intensity traffic in IEEE 802.15.4 Wireless Sensor Networks that comply with smart grid latency requirements.

In the article entitled "Distributed state estimation using RSC coded smart grid communication" by Md Masud Rana, Li Li, and Steven Su, authors proposed a distributed approach to microgrid state estimation based on the concatenated coding structure.

The article entitled "Cascading failures in smart grid: Joint effect of load propagation and interdependence" by Zhen Huang, Cheng Wang, Tieying Zhu, and Amiya Nayak, contains the study of cascading failures in the smart grid.

As mentioned earlier, in the smart grid, both the communication/control network and the power network are dependent upon each other. A failure to any segment of the power or communication network may lead to cascading sequential failure in the entire smart grid, thus leading to cascading failures. Considering this important problem, authors classified the cascading failures and discussed them in detail.

ACKNOWLEDGEMENT

We would like to sincerely thank all the authors and reviewers for the tremendous efforts towards the success of this Special Section. We would also like to thank to the Editor-in-Chief Prof. Michael Pecht, and the Editorial Office including the Managing Editor, B. M. Onat, K. Shumard, and M. Meyer, for their help.

MUBASHIR HUSAIN REHMANI

*COMSATS Institute of Information Technology
Pakistan*

MELIKE EROL KANTARCI

*Clarkson University
New York, USA*

ABDERREZAK RACHEDI

*University Paris Est (UPEM)
France*

MILENA RADENKOVIC

*University of Nottingham
UK*

MARTIN REISSLEIN

*Arizona State University
Tempe, USA*

REFERENCES

- [1] M. Erol-Kantarci and H. T. Mouftah, "Energy-efficient information and communication infrastructures in the smart grid: A survey on interactions and open issues," *IEEE Commun. Surveys Tuts.*, vol. 17, no. 1, pp. 179–197, Mar. 2015.
- [2] A. A. Khan, M. H. Rehmani, and M. Reisslein, "Cognitive radio for smart grids: Survey of architectures, spectrum sensing mechanisms, and networking protocols," *IEEE Commun. Surveys Tuts.*, 2016.
- [3] A. Seema and M. Reisslein, "Towards efficient wireless video sensor networks: A survey of existing node architectures and proposal for a flexi-WVSNP design," *IEEE Commun. Surveys Tuts.*, vol. 13, no. 3, pp. 462–486, Sep. 2011.
- [4] S. Rein and M. Reisslein, "Low-memory wavelet transforms for wireless sensor networks: A tutorial," *IEEE Commun. Surveys Tuts.*, vol. 13, no. 2, pp. 291–307, May 2011.
- [5] M. Bouaziz and A. Rachedi, "A survey on mobility management protocols in wireless sensor networks based on 6LoWPAN technology," *Comput. Commun.*, Oct. 2014. [Online]. Available: <http://dx.doi.org/10.1016/j.comcom.2014.10.004>
- [6] M. H. Rehmani, A. Rachedi, S. Lohier, T. Alves, and B. Poussot, "Intelligent antenna selection decision in IEEE 802.15.4 wireless sensor networks: An experimental analysis," *Comput. Electr. Eng.*, vol. 40, no. 2, pp. 443–455, Feb. 2014.
- [7] M. Erol-Kantarci and H. T. Mouftah, "Wireless multimedia sensor and actor networks for the next generation power grid," *Ad Hoc Netw.*, vol. 9, no. 4, pp. 542–551, Jun. 2011.
- [8] B. Rashid and M. H. Rehmani, "Applications of wireless sensor networks for urban areas: A survey," *J. Netw. Comput. Appl.*, Dec. 2015. [Online]. Available: <http://dx.doi.org/10.1016/j.jnca.2015.09.008>
- [9] S. H. R. Bukhari, M. H. Rehmani, and S. Siraj, "A survey of channel bonding for wireless networks and guidelines of channel bonding for futuristic cognitive radio sensor networks," *IEEE Commun. Surveys Tuts.*, 2016.
- [10] A. Ahmad, S. Ahmad, M. H. Rehmani, and N. U. Hassan, "A survey on radio resource allocation in cognitive radio sensor networks," *IEEE Commun. Surveys Tuts.*, vol. 17, no. 2, pp. 888–917, May 2015.



MUBASHIR HUSAIN REHMANI received the B.Eng. degree in computer systems engineering from the Mehran University of Engineering and Technology, Jamshoro, Pakistan, in 2004, the M.S. degree from the University of Paris XI, Paris, France, in 2008, and the Ph.D. degree from the University Pierre and Marie Curie, Paris, France, in 2011. He was a Post-Doctoral Fellow with the University of Paris Est, France, in 2012. He is currently an Assistant Professor with the COMSATS Institute of Information Technology, Wah Cantonment, Pakistan. His research interests include cognitive radio ad hoc networks, smart grid, wireless sensor networks, and mobile ad hoc networks. He is the Founding Member of the IEEE Special Interest Group on Green and Sustainable Networking and Computing with Cognition and Cooperation. He served on the TPC of the IEEE ICC 2015, the IEEE WoWMoM 2014, the IEEE ICC 2014, the ACM CoNEXT Student Workshop 2013, the IEEE ICC 2013, and the IEEE IWCNC 2013 conferences. He is an Editor of the IEEE COMMUNICATIONS SURVEYS AND TUTORIALS and an Associate Editor of the *IEEE Communications Magazine*, the *IEEE ACCESS*, *Computers and Electrical Engineering* (Elsevier), the *Journal of Network and Computer Applications* (Elsevier), *Ad Hoc Sensor Wireless Networks*, the *Wireless Networks* (Springer) journal, and the *Journal of Communications and Networks*. He serves as a Guest Editor of *Ad Hoc Networks* (Elsevier), *Future Generation Computer Systems* (Elsevier), the *IEEE ACCESS*, *Pervasive and Mobile Computing* (Elsevier), and *Computers and Electrical Engineering* (Elsevier).

Engineering (Elsevier), the *Journal of Network and Computer Applications* (Elsevier), *Ad Hoc Sensor Wireless Networks*, the *Wireless Networks* (Springer) journal, and the *Journal of Communications and Networks*. He serves as a Guest Editor of *Ad Hoc Networks* (Elsevier), *Future Generation Computer Systems* (Elsevier), the *IEEE ACCESS*, *Pervasive and Mobile Computing* (Elsevier), and *Computers and Electrical Engineering* (Elsevier).



MELIKE EROL KANTARCI (SM'14) received the B.Sc. degree from the Department of Control and Computer Engineering, Istanbul Technical University, in 2001, and the M.Sc. and Ph.D. degrees in computer engineering from Istanbul Technical University, in 2004 and 2009, respectively. During her Ph.D. studies, she was a Fulbright Visiting Researcher with the Computer Science Department, University of California at Los Angeles. She was the Coordinator of the Smart Grid Communications Laboratory and a Post-Doctoral Fellow with the School of Electrical Engineering and Computer Science, University of Ottawa, Canada. She is currently an Assistant Professor with the Department of Electrical and Computer Engineering, Clarkson University, Potsdam, NY. Her main research interests are wireless sensor networks, smart grid, cyber-physical systems, and electrification of transportation, underwater sensor networks, mobility modeling, localization, and internet traffic analysis. She received a Fulbright Ph.D. Research Scholarship (2006) and the Siemens Excellence Award (2004). She has won two Outstanding/Best Paper Awards. She is the co-author of the paper entitled *Wireless Sensor*

Networks for Cost-Efficient Residential Energy Management in the Smart Grid, which has been selected for the IEEE ComSoc Best Readings on Smart Grid Communications. She is an Editor of the *International Journal of Distributed Sensor Networks* (Hindawi). She was the Vice Chair of Women in Engineering of the IEEE Ottawa Section. She is the Vice Chair of the Green Smart Grid Communications Special Interest Group of the IEEE Technical Committee on Green Communications and Computing.



ABDERREZAK RACHEDI (S'05–M'08–SM'15) received the Engineering degree in computer science from the University of Technology and Science Houari Boumedienne, Algiers, Algeria, in 2002, the M.S. degree in computer science from the University of Lyon, in 2003, the M.S. degree in computer science from the University of Savoie, France, in 2005, the Ph.D. degree in computer science from the University of Avignon, France in 2008, and the H.D.R. degree from Paris-Est University, in 2015. He has been a member of the Gaspard Monge Computer Science Laboratory since 2008. He is currently an Associate Professor (maître de conférences) with the University Paris-Est Marne-la-Vallée. His research interests lie in the field of wireless networking, wireless multihop networks, wireless sensor networks, vehicular ad hoc networks, machine-type communication, Internet of Things, distributed algorithms, quality of services with security, trust models design, network performance analysis, and evaluation. He advised multiple Ph.D. and master's students with Paris-Est University. His research efforts have culminated in more than 65 refereed journal, conference, and book publications in a wide

variety of prestigious international conferences and journals, including the IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY, *Elsevier Ad Hoc Networks*, the IEEE ICC, and the IEEE GLOBECOM. He participated in several national and international research projects, among them, ANR CLADIS (2006-2009), Digiteo ViSuNet (2010-2013), RECASURG-UTIC (2011-2013), PPS-WSNTM (2011-2014), MMASP-COFECUB (2012-2015), and SAN-ITEA3 (2012-2015). He serves on the Editorial Board of the IEEE ACCESS journal, *Wireless Communications and Mobile Computing* (John Wiley) journal, and the *International Journal of Communication Systems* (John Wiley). He has served as a Technical Program Committee Member and Reviewer of many international conferences and journals.



MILENA RADENKOVIC received the Ph.D. degree from the University of Nottingham, U.K., and the Dipl.-Ing. Degree from the University of Nis, Serbia. Her research spans the areas of mobile and delay tolerant networking, P2P systems, and their application to pervasive gaming, social networking, and environmental monitoring. She has been an Investigator of five EPSRC and EU grants. She has organized and chaired multiple ACM and IEEE conferences, served on many program committees, has been an Editor of premium journals and published in premium venues, including *Ad Hoc Networks* (Elsevier), the IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY, the IEEE TRANSACTIONS ON PARALLEL AND DISTRIBUTED COMPUTING, ACM MC2R, ACM CHANTS@Mobicom, the IEEE WONS, the IEEE Multimedia, MIT Press PRESENCE, ACM Multimedia, ACM VRST, and ACM CCGRID.



MARTIN REISSLEIN (A'96–S'97–M'98–SM'03–F'14) received the Ph.D. degree in systems engineering from the University of Pennsylvania, Philadelphia, PA, USA, in 1998. He is currently a Professor with the School of Electrical, Computer, and Energy Engineering, Arizona State University, Tempe, AZ, USA. He served as the Editor-in-Chief of the IEEE COMMUNICATIONS SURVEYS AND TUTORIALS from 2003 to 2007, and an Associate Editor of the IEEE TRANSACTIONS ON NETWORKING/ACM Transactions on Networking from 2009 to 2013. He serves as an Associate Editor of the IEEE TRANSACTIONS ON EDUCATION, *Computer Networks* (Elsevier), and *Optical Switching and Networking* (Elsevier).

...