GREEN COMMUNICATIONS AND COMPUTING NETWORKS




Jinsong Wu *John Thompson* *Honggang Zhang* *Daniel C. Kilper*

Environmental issues are increasingly becoming one of central concerns in global societies. The production, application, and disposal of information and communication technology (ICT) platforms and relevant systems may introduce significant environmental problems. These include increasing environmental pollution, the exhaustion of natural resources and energy sources, which motivate us to reduce the negative environmental impact of ICT. On the other hand, ICT may also provide strong tools to solve, mitigate, or reduce environmental problems introduced by a wide range of factors. These topics may be considered as the core contents of "green ICT." Green ICT may profoundly impact the research, development, manufacturing, usage, and disposal processes of ICT systems and applications. The main motivation of green ICT is to support environmental sustainability.

The May 2015, second, issue of the IEEE Series on Green Communications and Computing Networks is a continual effort to support green ICT, and includes six relevant articles addressing both non-energy and energy related green topics.

The article "Cyber-Physical Systems for Water Sustainability: Challenges and Opportunities," written by Z. Wang and *et al.*, provides an overview on an extremely important non-energy green topic: the challenges for ICT to support water resources. This article provides an overview of water cyber-physical systems for sustainability from four critical aspects: sensing and instrumentation, communications and networking, computing and control, and opportunities and design challenges of relevant techniques.

The article "Macro-Assisted Data-Only Carrier for 5G Green Cellular Systems," written by X. Zhang and *et al.*, advocates a macro-assisted data-only carrier system for small cell enhancement. This article proposes a macro-assisted data-only carrier (DoC) for future 5G networks from a green perspective, and the relevant approach is verified using a complete system and link-level simulation platform, achieving significant throughput improvement and energy efficiency gain.

The article "Is Green Networking Beneficial in Terms of Device Lifetime?," written by L. Chiaraviglio *et al.*, discusses one often overlooked aspect of green networking, which is that the additional impact of green methodologies on cost, reliability, and even the overall life cycle analysis may go into the carbon footprint. This article considers the case of sleep mode power cycles and their impact on the lifetime of network devices, including both optical and cellular network elements. The impact is shown to depend on both the hardware details as well as the algorithms and parameters that are used in the green network design.

The article "Energy-Efficient Infrastructure Sharing in Multi-Operator Mobile Networks," written by A. Antonopoulos *et al.*, describes energy saving approaches in wireless networks by switching off base stations. In particular, the authors focus on the enhanced energy savings that are possible through dynamic infrastructure sharing among multiple mobile operators that collaborate. Initial performance results are presented, and practical implementation issues are discussed.

The article "A Low-Cost Methodology for Profiling the Power Consumption of Network Equipment," written by A. Francini *et al.*, describes a novel approach for modeling the power consumption of network switches and routers. The approach requires minimal equipment and uses linear models to approximate the true behavior of devices under test. The initial model results in the article highlight the importance of future hardware platforms including packet-timescale rate adaptation.

The article "Cost-Aware Green Cellular Networks with Energy and Communication Cooperation," written by J. Xu *et al.*, discusses two cooperative approaches, energy cooperation and communication cooperation, to reduce energy costs and reliably supply time- and space-varying wireless traffic over cellular networks, and proposes joint energy and communication cooperation among the base stations for cellular networks.

ACKNOWLEDGMENTS

We would like to acknowledge the great support and help from Osman S. Gebizlioglu and Sean Moore, the new and

former Editors-in-Chief of *IEEE Communications Magazine*, S. Charis Scoggins, Managing Editor of IEEE Communications Society Magazines, Jennifer Porcello, Production Specialist, and the other IEEE Communications Society publication staff. We also highlight the great support of this Green Series from the members of the IEEE Technical Committee on Green Communications and Computing (TCGCC) of the IEEE Communications Society.

BIOGRAPHIES

JINSONG WU [SM] (wujs@ieee.org) is an associate professor in the Department of Electrical Engineering, Universidad de Chile, Santiago. He is the Founding Chair of the IEEE Technical Committee on Green Communications and Computing. He is an Editor of the *IEEE Journal on Selected Areas in Communications* Series on Green Communications and Networking. He was the leading Editor and co-author of the comprehensive book *Green Communications: Theoretical Fundamentals, Algorithms, and Applications* (CRC Press, 2012).

JOHN THOMPSON [SM] (john.thompson@ed.ac.uk) currently holds a personal chair in Signal Processing and Communications at the School of Engineering, University of Edinburgh, United Kingdom. He was deputy academic coordinator of the recent Mobile Virtual Centre of Excellence Green Radio project. He currently leads the European Marie Curie Training Network ADVANTAGE, which trains 13 Ph.D. students in the area of smart grid technology. He is also a Distinguished Lecturer on green topics for ComSoc in 2014–2015.

HONGGANG ZHANG [SM] (honggangzhang@zju.edu.cn) is co-director of the York-Zhejiang Lab for Cognitive Radio and Green Communications at Zhejiang University, China. He served as Chair of the Technical Committee on Cognitive Networks of ComSoc during 2011–2012. He was the lead Guest Editor of *IEEE Communications Magazine* Feature Topic issues on Green Communications. He was General Co-Chair of IEEE GreenCom 2010 and TPC Co-Chair of IEEE Online GreenComm 2014. He is the book co-editor/co-author of *Green Communications: Theoretical Fundamentals, Algorithms and Applications* (CRC Press, 2012).

DANIEL C. KILPER [SM] (dkilper@optics.arizona.edu) is with the University of Arizona. He served as the founding Technical Committee Chair of the GreenTouch Consortium, and was the Bell Labs Liaison Executive for the Center for Energy Efficient Telecommunications at the University of Melbourne, Australia. While at Bell Labs, he received the President's Gold Medal Award in 2004 and was a member of the President's Advisory Council on Research. He has served as the General Co-Chair of the IEEE Online Green Communications Conference 2014 and 2015.