Ad Hoc Networks 13 (2014) 107–109

Contents lists available at ScienceDirect

Ad Hoc Networks

journal homepage: www.elsevier.com/locate/adhoc

Editorial

Special issue on models and algorithms for wireless mesh networks

The increasing demand of wire-free connectivity has been driving the development of new and easy-to-deploy wireless networking solutions. Within this field, Wireless Mesh Networks (WMNs) provide an effective solution for several services and applications domains, such as community networks and municipal networks. On the other hand, WMN deployments pose several challenges to the network designers and operators. First, WMNs often feature large scales in terms of the number of network devices, users, and services to be supported, and in terms of their geographical dimensions. Further, communication support in WMNs is carried out through the cooperation of wireless devices in a multi-hop manner, and it requires different algorithms and protocols (medium access control, routing, transport) that interact in a nontrivial manner. The network designers and operators often do not have complete control over the environment, and hence WMNs must be able to self-configure and adapt to unpredictable changes automatically.

Such distinctive features and intrinsic complexity of WMNs call for a deeper understanding on the fundamental principles governing these networks. To this extent, the design, analysis and deployment of WMNs require quantitative methods to plan/optimize the network structure, to assess the network performances (e.g., in terms of throughput, delay and energy consumption), as well as to steer the design of low-complexity centralized/distributed algorithms and communication protocols. This special issue is aimed to present novel research contributions on the theoretical foundations of wireless mesh networking with special emphasis on performance evaluation and algorithm design. This special issue is comprised of ten papers covering various aspects within these fields. Each submitted paper has been reviewed by at least two independent reviewers and the accepted papers went through two or more review rounds.

The first paper, "Combining Stochastic Geometry and Statistical Mechanics for the Analysis and Design of Mesh Networks," employs tools form stochastic geometry and statistical mechanics to derive the throughput and end-to-end delay performances of multi-hop wireless networks under two different channel access mechanisms: Carrier Sense Multiple Access (CSMA) and ALOHA.

The second paper, "Robust Resource Allocation for Multi-hop Wireless Mesh Networks with End-to-end Traffic Specifications," targets the design of multi-hop, multi-radio, multi-channel wireless networks with guaranteed end-to-end achievable transmission rate. The problem is formalized as a mixed-integer nonlinear programming (MINLP) formulation and heuristic algorithms are finally proposed to get suboptimal solution in reasonable time.

Mathematical programming is used also in the following paper, "On max–min fair flow optimization in wireless mesh networks," which is devoted to modeling WMNs through mixed-integer programming (MIP) formulations. The exact joint optimization modeling of the WMN capacity and the max–min fairness traffic objectives is the main contribution of the paper.

Multi-channel wireless networks are also addressed in "On Channel-Discontinuity-Constraint Routing in Wireless Networks," which introduces novel distributed algorithms to design WMNs under the "Channel-Discontinuity-Constraint" (CDC).

Multicast routing is addressed in the fifth paper, "Multicast with Cooperative Gateways in Multi-Channel Wireless Mesh Networks," which targets the design of high-throughput multicast routes to overcome interference and bandwidth limitation. A cross-layer approach is introduced to properly set the channels and the power levels used to support multicast flows.

The paper, "An analytical framework for Distributed Coordinated Scheduling in IEEE 802.16 Wireless Mesh Networks," proposes a queuing-based model to assess the link-layer performance of IEEE 802.16 networks. The proposed model, originally developed for a single network node, is then leveraged to calculate the end-to-end delay and the throughput.

The following paper, "Analytical Modeling of Context-Based Multi-Virtual Wireless Mesh Networks," studies the case where a single physical wireless mesh network can be logically partitioned into several virtual networks. An analytical model is introduced to evaluate the impact of network virtualization and the complexity of the discovery and extension mechanisms defined for reconfiguring the virtual networks.

1570-8705/$ - see front matter
http://dx.doi.org/10.1016/j.adhoc.2013.11.003

The paper, "The Robust Joint Solution for Channel Assignment and Routing for Wireless Mesh Networks With Time Partitioning," introduces a novel algorithm to jointly solve the routing and channel assignment problem.

The problem of routing information in WMNs is also addressed in paper "Probing-based Anypath Forwarding Routing Algorithms in Wireless Mesh Networks." However, the authors consider here a network topologies with link quality uncertainties. In this scenario, an optimal anypath routing scheme is introduced, which is shown to reduce, in reference network scenarios, the end-to-end delay and improve the packet delivery ratio with respect to deterministic routing schemes.

The paper, "A Theoretical Analysis of Multi-hop Consensus Algorithms for Wireless Networks: trade off among Reliability, Responsiveness and Delay Tolerance," addresses the problem of reaching a consensus in network of mesh nodes under m-hop protocols where each node-agent can access to the state of its m-steps neighboring agents. The stability of the consensus protocol is studied in presence of heterogeneous transmission delays between neighboring nodes.

Guest Editors
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Matteo Cesana received his M.S. degree in Telecommunications Engineering and his Ph.D. degree in Information Engineering from the Politecnico di Milano in July 2000 and in September 2004, respectively. From September 2002 to March 2003 he has been working as a visiting researcher at the Computer Science Department of the University of California in Los Angeles (UCLA). He is now an Assistant Professor of the Electronics and Information Department of the Politecnico di Milano. His research activities are in the field of design, performance evaluation and optimization of wireless networks with a specific focus on Cognitive Radio Networks and Wireless Sensor Networks. He is an Associate Editor of Ad Hoc Networks Journal (Elsevier).

Xiaojun Lin received his B.S. from Zhongshan University, Guangzhou, China, in 1994, and his M.S. and Ph.D. degrees from Purdue University, West Lafayette, Indiana, in 2000 and 2005, respectively. He is currently an Associate Professor of Electrical and Computer Engineering at Purdue University.

Dr. Lin's research interests are in the analysis, control and optimization of wireless and wireline communication networks. He received the IEEE INFOCOM 2008 best paper award and 2005 best paper of the year award from Journal of Communications and Networks. His paper was also one of two runner-up papers for the best-paper award at IEEE INFOCOM 2005. He received the NSF CAREER award in 2007. He was the Workshop co-chair for IEEE GLOBECOM 2007, the Panel co-chair for WICON 2008, the TPC co-chair for ACM MobiHoc 2009, and the Mini-Conference co-chair for IEEE INFOCOM 2012. He is currently serving as an Associate Editor for IEEE/ACM Transactions on Networking and an Area Editor for (Elsevier) Computer Networks journal.

Ness B. Shroff received his Ph.D. degree from Columbia University, NY in 1994 and joined Purdue university immediately thereafter as an Assistant Professor. At Purdue, he became Professor of the school of Electrical and Computer Engineering in 2003 and director of CWSA in 2004, a university-wide center on wireless systems and applications. In July 2007, he joined the ECE and CSE departments at The Ohio State University, where he holds the Ohio Eminent Scholar Chaired Professorship of Networking and Communications. From 2009–2012, he also served as a Guest Chaired professor of Wireless Communications at Tsinghua University, Beijing, China, and currently holds an honorary Guest professor at Shanghai Jiaotong University in China.

Dr. Shroff's research interests span the areas of communication, social, and cyberphysical networks. He currently serves on the editorial boards of IEEE/ACM Trans. on Networking (as senior editor), Computer Networks Journal, IEEE Network Magazine, IEEE Trans. on Networking and IEEE Transactions on Control of Network Systems, and the Networking Science journal. He has served on the technical and executive committees of several major conferences and workshops.

Dr. Shroff is a Fellow of the IEEE, and a National Science Foundation CAREER awardee. His papers have received numerous awards at top-tier venues. For example, he received the best paper award at IEEE INFOCOM 2006 and IEEE INFOCOM 2008 and runner-up awards at IEEE INFOCOM 2005 and IEEE INFOCOM 2013, and the best paper of the year in the journal of Communication and Networking (2005) and in Computer Networks (2003). His papers have also received the best student paper award (from all papers whose first author is a student) at IEEE WIOPT 2013, IEEE WiOPT 2012, and IEEE IWQoS 2006.

Dr. Zhang joined Hong Kong University of Science and Technology in Sept. 2005 where she is a full Professor in the Department of Computer Science and Engineering. She is also serving as the co-director of Huawei-HKUST innovation lab and the director of digital life research center of HKUST. Before that, she was in Microsoft Research Asia, Beijing, from July 1999, where she was the research manager of the Wireless and Networking Group. Dr. Zhang has published more than 300 refereed papers in international leading journals and key conferences in the areas of wireless/Internet multimedia networking, wireless communications and networking, wireless sensor networks, and overlay networking. She is the inventor of about 30 pending International patents. Her current research is on cognitive and cooperative networks, dynamic spectrum access and management, as well as wireless sensor networks. She also participated many activities in the IETF ROHC (Robust Header Compression) WG group for TCP/IP header compression.

She is a Fellow of IEEE for "contribution to the mobility and spectrum management of wireless networks and mobile communications". Dr. Zhang has received MIT TR100 (MIT Technology Review) world's top young innovator award. She also received the Best Asia Pacific (AP) Young Researcher Award elected by IEEE Communication Society in year 2004. She received the Best Paper Award in Multimedia Technical Committee (MMTC) of IEEE Communication Society in 2005 and Best Paper Award for QShine 2006, IEEE Globecom 2007, IEEE ICDCS 2008, IEEE ICC 2010, and IEEE Globecom 2012. She received the Oversea Young Investigator Award from the National Natural Science Foundation of China (NSFC) in 2006. She holds the Cheung Kong Chair Professor in Huazhong University of Science and Technology (2012–2015). She has been elected as IEEE Communication Society Distinguished Lecture from January 2010 to December 2011.

Dr. Zhang was CHAIR of the Multimedia Communication Technical Committee of the IEEE Communications Society from 2008 to 2010. She is Chair of Chapter Coordination Committee of IEEE Asia Pacific Board (APB) of IEEE Communication Society. Dr. Zhang is also a member of the Visual Signal Processing and Communication Technical Committee and the Multimedia System and Application Technical Committee of the IEEE Circuits and Systems Society. Dr. Zhang received the B.S., M.S., and Ph.D. degrees from Wuhan University, China, in 1994, 1996, and 1999, respectively, all in computer science.