Localized Communication and Topology Protocols for Ad Hoc Networks—Part II: A Preface to the Special Section

Stephan Olariu, David Simplot-Ryl, and Ivan Stojmenovic

1 The Scope

We are very proud and honored to have been entrusted the task of guest-editing this special section. Papers were sought to cover, comprehensively, the algorithmic issues in the "hot" area of ad hoc and sensor networks. The concentration was on the network layer problems which can be divided into two groups: *data communication* and *topology control* problems. The main paradigm shift is to apply localized schemes as opposed to existing protocols requiring global information. Localized algorithms are distributed algorithms where simple local node behavior achieves a desired global objective. Localized protocols provide scalable solutions, that is, solutions for wireless networks with an arbitrary number of nodes, which is the main goal of this plan. Sensor and rooftop/mesh networks, for instance, have hundreds or thousands of nodes.

2 Submissions Statistics

In response to the Call for Papers, we received 114 submissions from all over the world, leading to a truly international competition. After an initial screening, 13 submissions were declared "out of scope" for this special section and the remaining 101 papers were sent to reviewers. The initial plan was to accept the seven best papers from all submissions, for one special section. However, the quality and quantity of submissions was overwhelming, and Pen-Chung Yew, the past *Editor-in-Chief* of *IEEE Transactions on Parallel and Distributed Systems* (*TPDS*), kindly agreed to allow us to select an additional batch of seven articles for a second special section, and a few more articles to be published in regular issues of the journal.

All manuscripts underwent a very rigorous peer review process, which included also a selection of additional reviewers after revisions of articles were received. After the first round of reviews, only seven articles did not have any major revisions requested, and they were selected for the first special section published in the April 2006 issue. That issue also contains a longer introduction discussing the localized protocols in more detail. The review of all submitted articles was finalized in December 2005. Seven articles were selected for this second special section, and five more articles were accepted for publication in regular issues of *TPDS*.

Many individuals contributed to the success of this special section. We take this opportunity to thank all the authors for their submissions. We are also indebted to a small army of referees who have put in the hard work and the long hours to review each paper in a timely and professional way! The Administrator of Society Publications, Jennifer Carruth, did an amazing job in chasing all of us for doing a proper job, and provided enormous and valuable assistance. Last, but not least, we are indebted to Pen-Chung Yew for offering us this opportunity and patiently waiting for its completion.

3 A Sneak Preview

At this point, we feel it is appropriate to briefly introduce the seven papers appearing in this special section.

In "Geographical Cluster-Based Routing in Sensing-Covered Networks," Hannes Frey and Daniel Görgen study the impact of a sensing covered network's range ratio on the success of a specific variant of geographic routing, which is based on clustering over a virtual grid structure (e.g., regular hexagonal mesh). They identify geometrical properties of the network's deployment area which provide delivery guarantees of geographical cluster-based routing for a given minimum range ratio.

In "A Fault-Local Self-Stabilizing Clustering Service for Wireless Ad Hoc Networks," Murat Demirbas, Anish Arora, Vineet Mittal, and Vinodkrishnan Kulathumani present a fast local clustering service that partitions a multihop wireless network into nonoverlapping and approximately equal-sized clusters. They show that the service achieves locality of clustering and fault-local self-stabilization. Through simulations and experiments with actual deployments, they analyze the trade offs between clustering time and the quality of clustering.

In "Adaptive Localized QoS-Constrained Data Aggregation and Processing in Distributed Sensor Networks," Jin Zhu, Symeon Papavassiliou, and Jie Yang propose an efficient Quality of Service (QoS)-constrained data aggregation and processing approach for distributed wireless sensor networks. QoS requirements are taken into account to determine

- *S. Olariu is with the Department of Computer Science, Old Dominion University, Norfolk, VA 23529. E-mail: olariu@cs.odu.edu.*
- *D. Simplot-Ryl is with LIFL, University of Lille, INRIA Futurs, France. E-mail: simplot@lifl.fr.*
- *I. Stojmenovic is with SITE, University of Ottawa, Ontario K1N 6N5, Canada. E-mail: ivan@site.uottawa.ca.*

For information on obtaining reprints of this article, please send e-mail to: tpds@computer.org.

when and where to perform the aggregation in a distributed fashion, based on the availability of local only information. Data aggregation is performed on the fly at intermediate sensor nodes.

In "Congestion Avoidance Based on Lightweight Buffer Management in Sensor Networks," Shigang Chen and Na Yang propose a congestion-avoidance scheme for sensor networks based on lightweight buffer management. Their approaches automatically adapt the sensors' forwarding rates to nearly optimal without causing congestion, maintain near-optimal throughput with a small buffer at each sensor, and achieve congestion-free load balancing when there are multiple routing paths toward multiple sinks.

In "Energy Optimization under Informed Mobility," Chiping Tang and Philip K. McKinley show that ad hoc networks can exploit controlled node mobility to reduce communication-related energy consumption. They study the energy optimization problem that accounts for both communication and physical node movement, refer to this model as *informed mobility*, and describe localized algorithms and protocols for informed mobility.

In "Distributed Construction and Maintenance of Bandwidth and Energy Efficient Bluetooth Scatternets," Metin Tekkalmaz, Hasan Sözer, and Ibrahim Korpeoglu propose a distributed algorithm for a Bluetooth scatternet formation problem that dynamically constructs and maintains a scatternet based on estimated traffic flow rates between nodes. The algorithm is adaptive to changes and maintains a constructed scatternet for bandwidth-efficiency when nodes come and go or when traffic flow rates change.

In "Toward Quasiregular Sensor Networks: Topology Control Algorithms for Improved Energy Efficiency," Xiaowen Liu and Martin Haenggi describe and analyze localized algorithms for topology control that provide a trade off between performance and deployment cost. The objective is to regularize the topology for improved energy efficiency. The basic algorithm produces quasiregular networks, which have a significant energy and lifetime advantage compared with purely random networks.

Stephan Olariu
David Simplot-Ryl
Ivan Stojmenovic
Guest Editors

Stephan Olariu received the PhD degree in computer science from McGill University, Montreal, Canada. He was the recipient of a US National Science Foundation Research Initiation Award. Professor Olariu's research interests range from parallel algorithms, to graph theory, to wireless networks and mobile computing, to biology-inspired algorithms, and sensor network applications. He has published more than 200 articles in top-flight archival journals. He is the director of the Sensor Networks Research Group at Old Dominion University.

David Simplot-Ryl received the PhD degree in computer science in 1997 from the University of Lille, France. He is the scientific director of the COM research project at IRCICA, and head of the POPS research team at the INRIA Futurs research unit. His research interests are in the areas of sensor and mobile ad hoc networks, mobile and distributed computing, and RFID technologies. He is editor and guest editor of several journals, cochair of workshops on ad hoc networks at the IEEE International Conference on Distributed Computing Systems, and general cochair of the InterSense Conference in 2006.

Ivan Stojmenovic received the PhD degree in mathematics. He established three journals (on multiple-valued logic, ad hoc and sensor networks, and on parallel, emergent, and distributed systems). He edited three recent handbooks with Wiley on wireless networks (2002), ad hoc networks (2004), and sensor networks (2005). He published more than 200 distinct articles and his work was cited more than 2,200 times. He earned the Fast Breaking Paper in Computer Science for October 2003 from ISI, and the Award for Excellence in Research for 2005 from the University of Ottawa.