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Guest Editorial

Special Issue: Advances in Resource-Constrained Device Networking

By Stephen F. Bush and Amit B. Kulkarni, Guest Editors

Mobile communication devices of the next generation are expected to have an increasingly diminishing form-factor and at the same time are expected to be capable of universal network access. Nanoscale networks [1] and molecular networking are on the horizon. This leads to numerous challenges due to limited resources, such as battery power, radio size, and limited transmission range. To obtain universal connectivity, such devices must be able to recognize and connect to networks in their vicinity by forming ad hoc networks until data reaches a backbone network. This should be accomplished instantaneously and seamlessly with or without the support of a pre-existing infrastructure. These devices should have the capability for self-organization, support for multiple levels of quality of service, and high security. This special issue contains contributions in the area of wireless and ad hoc networking with special emphasis on resource-constrained communication devices.

The networking community is slowly applying concepts from other disciplines in terms of self-organization and low-overhead, low-power networking, for example, techniques from biology such as using pheromones for route discovery in AntNet [2], stigmergic data fusion in sensor networks [3]. Similarly, concepts from physics such as $1/f$ noise and power-law indicators of organization have been leveraged, e.g. cooperative energy savings [4], Boolean Networks and attractors [5], and self-organized clustering [6]. However, there is still a long way to go.

This issue begins with one of the best overview papers to have come out recently on this topic, by Kevin Mills, *A Survey of Self-Organization in Wireless Networks*. This paper surveys deeper theoretical aspects explaining how self-organization might be applied in tomorrow's wireless networks. It squarely faces the challenge posed by this special issue, namely: how can self-organization be applied as a design principle to solve networking problems more efficiently and with less predefined infrastructure. It surveys the techniques and applications in which numerous components interacting on a microscopic level lead to a range of macroscopic behaviors that emerge, or self-organize, at a global level.

The remainder of the papers in this issue has made incremental technical advances in terms of exploiting self-organization for improvements in resource-constrained networks. They are divided into techniques that utilize *caching*; those that yield *energy savings*, and those that provide increased *security.* The paper by Narottam Chand, *Exploiting Caching in Heterogeneous Mobile Environment*, explores cooperative caching to reduce overhead and latency in an ad hoc network. Song-Yi Yi, in *Increasing a Mobile Client's Cache Reusability in Wireless Client-Server Environment*, examines a cache invalidation mechanism that includes the cost of purging an older cache.

With regard to energy minimization, Bhaskar Krishnamachari, in *An Adaptive Energy-Efficient and Low-Latency MAC for Tree-based Data Gathering in Sensor Networks*, proposes an energy efficient and low latency MAC that is designed and optimized for data gathering trees in wireless sensor networks. It solves the sleep-scheduling problem by giving the active/sleep schedule of a node an offset that depends upon its depth in the tree. It further proposes a data prediction mechanism to alleviate problems pertaining to channel contention and collisions. Lin Xiao Hui, in *On Channel Adaptive Energy Management with Available Bandwidth Estimation in Wireless Sensor Networks*, proposes an adaptive channel coding and modulation scheme, which allows a sensor

terminal to dynamically adjust the data throughput via changing the amount of error protection incorporated. Eylem Ekici, in *Cluster-Based Information Proceeding in Wireless Sensor Networks: An Energy-Aware Approach*, proposes collaboration among sensors through parallel processing methods as a promising solution. A localized task mapping and scheduling solution for energy-constrained applications in a wireless sensor network is presented.

With regard to security, Heeyoul Kim, in *A Practical Approach of ID-Based Cryptosystem in Ad Hoc Network*, proposes a security model that minimizes the need for infrastructure support and distributes the role of key generation. Finally, Yiliang Han, in *Generalization of Signcryption for Resources-Constrained Environments*, looks at signcryption, which is a new cryptographic primitive that simultaneously fulfills both the functions of signature and encryption and promises significant computational cost savings.

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Guest Editors' Biographies

Stephen F. Bush is a researcher in Active Networking and Algorithmic Communications Network Theory at the GE Global Research Center. Stephen explores novel concepts in complexity and algorithmic information theory for applications ranging from network management and wireless ad hoc networking to RNA sequence analyses and novel concepts in nanotechnology-based networking. Dr Bush has been the Principal Investigator for many DARPA and Lockheed Martin sponsored research projects. Stephen coauthored a book on active network management, titled *Active Networks and Active Network Management: A Proactive Management Framework*, published by Kluwer Academic Publishers. Before joining GE Global Research, Stephen was a researcher at the Information and Telecommunications Technologies Center (ITTC) at the University of Kansas. He received his B.S. in Electrical and Computer Engineering from Carnegie Mellon University and M.S. in Computer Science from Cleveland State University.

Amit B. Kulkarni is a Computer Scientist at General Electric Global Research Center in Niskayuna, NY. Amit's primary research is in the area of mobile ad hoc and sensor networking. He has pioneered innovative concepts such as self-organized criticality for routing, network management, and service discovery. Amit also has many publications and patents in the areas of active networks, transport protocols, and quality of service. He is the co-author of a book on active network management titled *Active Networks and Active Network Management: A Proactive Management Framework*, published by Kluwer Academic Publishers. Before joining GE, Amit was a researcher at the Information and Telecommunications Technology Center (ITTC) at the University of Kansas where he worked on the DARPA Multi-dimensional Applications and Gigabit Inter-network Consortium (MAGIC-II) project. He received his Bachelors degree in Electronics and Telecommunications Engineering from the University of Pune, India and his M.S. and Ph.D. from the University of Kansas.

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