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Guest Editorial

Advances in Ad Hoc Networks (I)

Ad hoc networks, which include a variety of autonomous networks for specific purposes, promise to enable a broad range of civilian, commercial, and military applications. These networks were originally envisioned as collections of autonomous mobile or stationary nodes that dynamically auto-configure themselves into a wireless network without relying on any existing network infrastructure or centralized administration. With the significant advances achieved in the last decade, the concept of ad hoc networks now assumes an even broader scope, referring to the many types of autonomous wireless networks designed and deployed for a specific task or function, such as wireless sensor networks, vehicular networks, home networks, and so on. In contrast to the traditional wireless networking paradigm, such networks are all characterized by sporadic connections, highly error-prone communications, distributed autonomous operation, and fragile multi-hop relay paths.

The various forms of ad hoc networks have led to significant new and interesting research challenges and problems, attracting substantial attention from academia, industry, and government. The new wireless networking paradigm necessitates reexamination of many established concepts and protocols, and calls for developing new understanding of fundamental problems such as interference, mobility, connectivity, capacity, and security, among others. While it is essential to advance theoretical research on fundamental and practical research on efficient policies, algorithms and protocols, it is also critical to develop useful applications, experimental prototypes, and real-world deployments to achieve immediate impact on society for the success of this wireless networking paradigm.

The annual International Conference on Ad Hoc Networks (AdHocNets) aims to provide a forum that brings together international researchers and practitioners to showcase recent research advances in ad hoc networks. AdHocNets 2009, the first edition of this event, was held in Niagara Falls, Canada, in September 2009. This special issue includes a collection of nine outstanding research papers selected from the technical program of AdHocNets 2009, which is a result of a two-stage rigorous selection process. First, out of the 109 submissions from 16 countries/regions in 5 continents, 43 papers were accepted for presentation, including a few invited papers. Among the 43 papers, 9 papers were invited to extend and enhance their work for further consideration for publication, and were finally accepted for inclusion in the special issue after revision based on the reviewers' comments provided in a rigorous review process.

The papers included in this special issue cover a range of topics that report recent research advances in ad hoc networks. In the first paper, "Scalable Max–Min Fairness in Wireless Ad Hoc Networks", Zhou and Maxemchuk demonstrate how to apply a macro model that they previously proposed to perform flow and access control in wireless ad hoc networks to achieve max–min fair rate allocation, which can guarantee the quality of service for many real-time applications.

In the second paper, "Upper Bounding Service Capacity in Multihop Wireless SSMA-Based Ad Hoc Networks," Du, et al. study the upper bounds on the service carrying capacity of a multihop wireless SSMA-based ad hoc network, and present an efficient tabu search-based heuristic algorithm to solve the problem and rigorously assess the quality of the results.

The third paper, "Connectivity-Aware Minimum-Delay Geographic Routing with Vehicle Tracking in VANETs," by Shafiee and Leung, et al. proposes a connectivity-aware minimum-delay geographic routing (CMGR) protocol for vehicular ad hoc networks (VANETs), which adapts well to the continuously changing network status in such networks, and studies the performance limitations of CMGR in special vehicular networking situations.

The fourth paper, "Joint Random Access and Power Control Game in Ad Hoc Networks with Non-cooperative Users," by Long, et al. considers the joint random access and power control problem in wireless ad hoc networks and formulates the problem as a non-cooperative game, in which each user minimizes its average transmission cost to support a given rate requirement. An asynchronous distributed algorithm is proposed to compute the solution of

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the game based on myopic best response updates, which converges to the Nash equilibrium globally.

The fifth paper, "Contact Time in Random Walk and Random Waypoint: Dichotomy in Tail Distribution," by Zhao and Sichitiu performs a mathematical analysis of the contact time distribution in random walk models in the hope of bridging the gap between two existing models: the direct traversal model and the consecutive random walk model, and concludes that for general random walks with uniform speed distribution, the probability distribution function of the contact time has a tail that is actually between the two extremes, a power-law-sub-exponential dichotomy.

In the sixth paper, "Performance Analysis of Slotted ALOHA and Network Coding for Single-Relay Multi-User Wireless Networks," Umehara, et al. develop mathematical models that can be used to analyze the throughput and delay of slotted ALOHA (S-ALOHA) and S-ALOHA with network coding (S-ALOHA/NC) in single-relay multi-user wireless networks with bidirectional data flows.

In the seventh paper, "Graph Marginalization for Rapid Assignment in Wide-Area Surveillance," Ebden and Roberts consider the problem of decentralized optimization in a wide-area surveillance sensor network setting. Graph marginalization in the form of belief propagation is employed to achieve the goal of maximizing an arbitrary utility function related to object tracking or identification.

The eighth paper, "SPECS: Secure and Privacy Enhancing Communications Schemes for VANETs," by Chim, et al. provides a software-based solution which makes use of only two shared secrets to satisfy the privacy requirement and gives lower message overhead and at least a 45 percent higher success rate than previous solutions in the message verification phase using Bloom filter and the binary search techniques.

In the last paper, "Computationally Efficient Mutual Entity Authentication in Wireless Sensor Networks," Li and Gong propose a computationally efficient authentication framework based on learning parity with noise (LPN), which introduces a new noise mode to prevent a general man-in-the-middle attack against previous LPN-based protocols, presents a gentle approach to securely combine several HB-like one-way authentication protocols, and extends to mutual authentication which effectively thwarts the reflection attack.

The papers included in this special issue represent recent significant research advances in ad hoc networks. We hope that the readers will find this collection timely and informative, and that the special issue will become an important reference for researchers and practitioners in the area.

We thank all the authors for their contributions to this special issue. We are grateful to all reviewers for their time and efforts in carefully reviewing all the papers and providing valuable review comments. We would also like to thank Prof. Ian F. Akyildiz, the Editor-in-Chief of the *Ad Hoc Networks* journal, for providing the opportunity to accommodate this special issue. We would also like to thank Devaprakash Kothandapani, the Journal Manager, Jie Chen, the Content Development Coordinator, and all other production staff for their support during the publication process.

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He serves as an Associate Technical Editor of ***IEEE Communications Magazine***, an Editor of ***IEEE Communications Surveys & Tutorials***, and an editorial board member of several other refereed journals, including ***Elsevier Ad Hoc Networks Journal*** and ***Wiley Wireless Communications and Mobile Computing***. He has co-edited ten special issues for different refereed journals and magazines, including ***IEEE Journal on Selected Areas in Communications*** and ***IEEE Network***, all as Lead Guest Editor. He has served as the founding General Chair of AdHocNets'09, General Chair of AccessNets'07, and TPC or Symposium Co-Chair for several international conferences and symposia, including IEEE GLOBECOM'08, ICC'09, GLOBECOM'10, and ICC'11. He has also served as a TPC member for a number of international conferences and symposiums. He is a senior member of the IEEE.

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