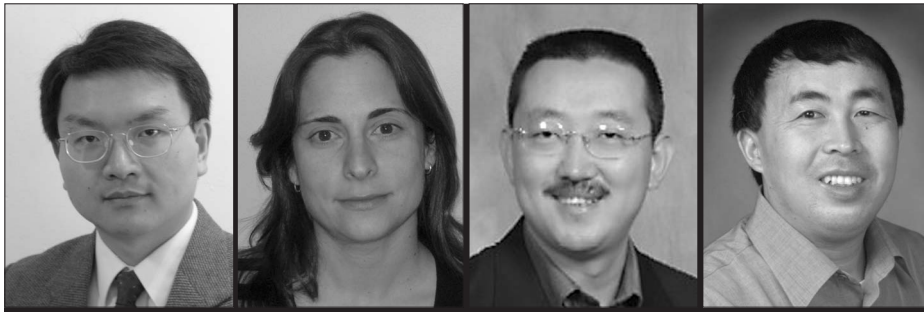


Wireless Mesh Networks: Applications, Architectures, and Protocols



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Wireless mesh networks (WMNs) have been actively researched and developed as one of the most promising and enabling network technologies to support various multimedia services and applications in wireless personal area networks (WPANs), wireless local area networks (WLANs), wireless metropolitan area networks (WMANs), and cellular multihop networks. Compared to traditional mobile ad hoc networks (MANETs), wireless sensor networks (WSNs), and infrastructure-based mobile cellular networks, WMNs are quasi-static in network topology and architecture, have fewer resource constraints at the mesh routers, and are easy and flexible to deploy with lower costs. Potential applications of WMNs include broadband home networking, community and neighborhood networking, enterprise networking, building automation, health and medical systems, public safety and security systems, intelligent transportation systems, emergency/disaster networking, metropolitan area broadband Internet access, and so on. This wide range of applications and services has different technical requirements and challenges in the design and deployment of mesh networking architectures, algorithms, and protocols. This special issue consists of 10 articles addressing a variety of technical challenges and advanced solutions in the design, implementation, and deployment of mesh networks from different aspects such as architectures, protocols, algorithms, services, and applications.

The first two articles survey routing issues in WMNs. In the first article, “Routing Metrics and Protocols for Wireless Mesh Networks,” Campista *et al.* analyze the state-of-the-art WMN routing metrics and propose a taxonomy for the main routing protocols. Performance measurements collected from a practical mesh network testbed are presented. In the second article, “On Routing in Multichannel Wireless Mesh Networks: Challenges and Solutions,” Liu and Liao focus on the challenges in designing multichannel routing algorithms for WMNs, examine existing routing metrics designed for multichannel WMNs, and address some open research issues related to routing in multichannel WMNs.

The next three articles develop novel routing protocols for multimedia services and large-scale networks. In the third article, “Multimedia-Centric Routing for Multiple Description Video in Wireless Mesh Networks,” Mao *et al.* propose new cross-layer multipath routing for multiple description video

communications in WMNs. The authors show that such a problem could be formulated through a multimedia-centric cross-layer optimization approach. A genetic-algorithm-based approach provides a near-optimal solution, which is amenable to distributed implementation and could be extended to the more general case of group communication. The fourth article, “Routing in Large-Scale Wireless Mesh Networks Using Temperature Fields,” by Baumann, Heimlicher, and Plattner, proposes an anycast routing protocol called HEAT, which is based on temperature fields similar to thermal physics. HEAT only requires communication between neighboring nodes and has good scalability properties due to its fully distributed implementation. In the fifth article, “A General Framework of Interference Models for Joint Routing and Link Scheduling in Wireless Mesh Networks,” Badia *et al.* introduce the notion of link activation constraints and propose a versatile framework for the joint design of routing and link scheduling in WMNs. A taxonomy of wireless interference models is presented to harmonize the existing approaches in the literature. When the optimal joint routing and link scheduling solution is employed, the impact of various interference models on network capacity is discussed.

The sixth article, “Using Incompletely Cooperative Game Theory in Wireless Mesh Networks,” by Zhao, Zhang, and Zhang, proposes a medium access control (MAC) algorithm design approach based on the new concept of incompletely cooperative game theory. Each node estimates the current state of the game and then adjusts its equilibrium strategy by tuning its local contention parameters to the estimated game state. A hybrid CSMA/CA protocol is developed and studied for WMNs.

The seventh article, “Joint Power-Frequency-Time Resource Allocation in Clustered Wireless Mesh Networks,” by Cheng and Zhuang, presents a low-complexity intracluster resource allocation algorithm, taking power allocation, subcarrier allocation, and packet scheduling into consideration. Numerical results show that the proposed optimality-driven resource allocation approach outperforms a greedy algorithm, working out a better performance compromise among throughput, packet dropping rate, and packet delay.

In the eighth article, “Wireless Mesh Network for In-Home IPTV Distribution,” Shihab *et al.* discuss the IPTV distribution in broadband home mesh networks. Three different WMN

architectures for home IPTV services are compared in terms of cost, reliability, scalability, and admission regions. Both analytical and simulation results suggest that a heterogeneous wireless and wired mesh network architecture offers the best performance for IP services.

The last two articles address some practical issues in developing WiMAX (802.16) based WMNs. In the ninth article, "IEEE 802.16 Mesh Schedulers: Issues and Design Challenges," Ali *et al.* overview the IEEE 802.16 mesh network standard and identify major design issues impeding the realization of IEEE 802.16-based WMNs. A survey of representative proposals for improving system performance and the standards are provided. In the final article, "An Effective QoS Differentiation Scheme for Wireless Mesh Networks," Hu, Zhang, and Chen study an effective QoS differentiation scheme for the IEEE 802.16 mesh networks. Both a collocated scenario and general topology are exploited. As illustrated by numerical examples, the proposed scheme can effectively differentiate various services and improve network scalability.

In closing, the guest editors would like to thank all the authors who submitted their research work to this special issue. We want to thank all anonymous reviewers who have done a wonderful job in the review process, which has helped to improve the quality and readability of this special issue. Specifically, we are very grateful to Drs. Chatschik Bisdikian and Ioanis Nikolaidis, the past and current Editor-in-Chiefs of *IEEE Network*, for their valuable advice and constant support during the process of planning and editing this special issue. We would also like to thank Dr. Georgios Papadimitriou, the Liaison Editor, for his timely guidance and helpful suggestions. Most important, we hope that all readers will enjoy reading these accepted articles and find them informative and useful.

Biographies

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XUEMIN (SHERMAN) SHEN (M'97-SM'02) received a B.Sc. (1982) degree from Dalian Maritime University, China, and M.Sc. (1987) and Ph.D. (1990) degrees from Rutgers University, New Jersey, all in electrical engineering. He is a professor and University Research Chair, and Associate Chair for Graduate Studies, Department of Electrical and Computer Engineering, University of Waterloo, Canada. His research focuses on mobility and resource management in interconnected wireless/wired networks, UWB wireless communications systems, wireless security, and ad hoc and sensor networks. He is a co-author of three books, and has published more than 300 articles and book chapters in wireless communications and networks, control, and filtering. He served as Technical Program Committee Chair for IEEE GLOBECOM '07, and General Co-Chair for Chinacom '07 and QShine '06, and is the Founding Chair of IEEE Communications Society Technical Committee on P2P Communications and Networking. He also serves as a Founding Area Editor for *IEEE Transactions on Wireless Communications*; Editor-in-Chief for *Peer-to-Peer Networking and Application*; and as an Associate Editor for *IEEE Transactions on Vehicular Technology*; *KICS/IEEE Journal of Communications and Networks*, *Computer Networks*; *ACM/Wireless Networks*; and *Wireless Communications and Mobile Computing* (Wiley). He has also served as Guest Editor for *IEEE JSAC*, *IEEE Wireless Communications*, and *IEEE Communications Magazine*. He received the Excellent Graduate Supervision Award in 2006 and the Outstanding Performance Award in 2004 from the University of Waterloo, the Premier's Research Excellence Award (PREA) in 2003 from the Province of Ontario, Canada, and the Distinguished Performance Award in 2002 from the Faculty of Engineering, University of Waterloo. He is a registered Professional Engineer of Ontario, Canada.