Guest Editorial

Special Issue: Research in Ad Hoc Networking, Smart Sensing, and Pervasive Computing

By Y.-C. Tseng, J.-P. Sheu, S. Das and R.-S. Chang

Wireless communications have added a new dimension to the networking field. One recent development is the wireless ad hoc network, which is characterized by many mobile computers interconnected by wireless transceivers without the support of fixed infrastructure, making it attractive for use in emergency relief and battlefield communication. The network can be formed quickly and dynamically. However, efficiency of ad hoc networks needs to be addressed carefully. For example, power saving is a critical issue to extend the lifetime of an ad hoc network. The medium access control (MAC) is also a very challenging issue since interference would be intensive in an ad hoc network. Mobility management and QoS are important to support high-level applications.

Sensor networks, which are created by tiny smart sensors combined with computation and communication capabilities, are being proposed recently for applications such as military combat, environment surveillance, and pollution detection. Common features of sensor networks and ad hoc networks include multi-hop communication and dynamically changing network topology. These two new network architectures, together with the development of lightweight, small computing devices, have made pervasive computing possible. Many issues, such as routing, medium access, energy management, fault tolerance, and scalability, need to be addressed.

This special issue is targeted at addressing the development of these issues. Nine papers are selected for publication in this special issue from over thirty submissions. The first paper 'Spatial Agents: integrating of user mobility and program mobility in ubiquitous computing environments' by I. Satoh presents a framework for the building of context-aware applications in ubiquitous and mobile computing settings. The framework provides people, places, and things with computational functionalities to support and annotate them. Using location-tracking systems, the framework provides a way for mobile agents to follow their users as they move around. A prototype implementation of the framework has been built on a Java-based mobile agent system and tested with several practical applications, including follow-me applications and a user navigational assistance system.

The second paper 'Power-aware broadcasting and activity scheduling in ad hoc wireless networks using connected dominating sets' by J. Wu and B. Wu and I. Stojmenovic addresses the broadcasting issue in an ad hoc network. A straightforward broadcasting by flooding is usually very costly and will result in substantial redundancy and more energy consumption. A new broadcasting based on connected dominating sets is proposed. The authors propose to apply the notion of power-aware connected dominating set to broadcasting and activity scheduling. The effectiveness of the proposed method in prolonging the life span of the network is confirmed.

The third paper 'Reliable MAC layer multicast in IEEE 802.11 wireless networks' by M. Sun, L. Huang, S. Wang, A. Arora and T.-H. Lai addresses the multicast/broadcast support in an IEEE 802.11 wireless network. The IEEE 802.11 multicast/broadcast protocol is designed based on CSMA/CA and does not provide any MAC layer recovery on multicast/broadcast frames, thus suffering from the reliability problem. To redress the problems of reliability and efficiency, the authors propose a reliable **Batch Mode Multicast MAC** protocol, which considerably reduces the time required for a multicast/broadcast. Then the authors further propose a **Location Aware Multicast MAC** protocol that uses station location information to further improve the performance.

One of the most important applications for mobile commerce is location-based application and location determination technology. In the fourth paper entitled

A cell-based location-sensing method for wireless networks' by H.-C. Chu and R.-H. Jan, a location-sensing method, called *cell-based location-sensing*, is presented. The accuracy of the method is reported and optimized, by tuning the transmission powers of base stations. The results are useful to deploy wireless networks for location-based applications.

The fifth paper 'A resource-efficient QoS routing protocol for mobile ad hoc networks' by S. De, C. Qiao and S. K. Das is based on the observation that by proper coupling of nodal mobility and location information in an ad hoc network, better QoS support can be achieved with reduced control traffic and database requirements. The authors investigate the performance of a location aware QoS routing protocol, called *trigger-based distributed routing (TDR)*. The protocol is featured by distributed rerouting control, directed alternate route discovery, and rerouting based on signal degradation history.

The sixth paper 'Design and performance analysis of leader election and initialization protocols on ad hoc networks' by C.-S. Hsu and J.-P. Sheu discusses the leader election and initialization problems in a mobile ad hoc network. The authors propose two contention-based leader election and initialization protocols for IEEE 802.11-based single-hop ad hoc networks. The paper also presents an efficient approach to evaluate the performance of the proposed protocols. The evaluation results can be used as a guideline to set the size of contention window for any contention-based protocols.

One of crucial design objectives in an ad hoc network is to achieve routing responsiveness and updating efficiency. C.-Y. Chiu, G.-H. Chen and E. H.-K. Wu, present the seventh paper, entitled 'A stability aware cluster routing protocol for mobile ad hoc networks', where an efficiently repairable routing protocol, called *gravitational cluster routing (GCR)* protocol, is proposed. It contains a stable cluster structure to cover dense areas and avoid articulation nodes. The reaction to mobility can be reduced significantly by unicast. Active routing paths can be maintained locally in each cluster. The proposed GCR can find routing paths that satisfy different parameters of QoS.

The eighth paper, 'A new BlueRing scatternet topology for Bluetooth with its formation, routing, and maintenance protocols' presented by T.-Y. Lin, Y.-C. Tseng and K.-M. Chang discusses the scatternet formation problem in a Bluetooth network to support personal-area networks and pervasive computing. The authors propose a scatternet topology called *BlueRing*, which connects piconets as a ring interleaved by bridges between piconets, and address its formation, routing, and topology maintenance protocols. The BlueRing architecture enjoys a stateless routing. The architecture is scalable to median-size scatternets easily. Maintaining a BlueRing is an easy job even as some Bluetooth units join or leave the network. The protocol can also tolerate single- and multi-point failures.

The ninth paper 'Average case analysis-based protocols to initialize packet radio networks' by J.-F. Myoupo, L. Thimonier and V. Ravelomanana proposes two randomized protocols by which n initially identical stations of a Packet Radio Network can be assigned IDs from 1 to n to distinguish them. They run regardless of the number of stations per channel. The first one is derived from recursive probabilistic divide-and-conquer techniques. The second solution needs the prefix sums algorithm. These results are obtained by means of the average case analysis of algorithms, using probabilistic generating functions and formal methods.

In closing, we would like to thank the support from the Editor-in-Chief, Dr. Mohsen Guizani, and the contributions from authors and reviewers, to make this special issue possible.

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Guest Editors' Biographies

Yu-Chee Tseng received his B.S. and M.S. degrees in Computer Science from the National Taiwan University and the National Tsing-Hua University in 1985 and 1987, respectively. He worked for the D-LINK Inc. as an engineer in 1990. He obtained his Ph.D. in Computer and Information Science from the Ohio State University in January of 1994. From 1994 to 1996, he was an Associate Professor at the Department of Computer Science, Chung-Hua University. He joined the Department of Computer

Science and Information Engineering, National Central University in 1996, and has become a Full Professor since 1999. Since Aug. 2000, he has become a Full Professor at the Department of Computer Science and Information Engineering, National Chiao-Tung University, Taiwan. Dr. Tseng has served as a Program Chair in the *Wireless Networks and Mobile Computing Workshop*, 2000 and 2001, as an Associate Editor for *The Computer Journal*, as a Guest Editor for *ACM Wireless Networks* special issue on "Advances in Mobile and Wireless Systems", as a Guest Editor for *IEEE Transactions on Computers* special on "Wireless Internet", as a Guest Editor for *Journal of Internet Technology* special issue on "Wireless Internet: Applications and Systems", as an Editor for *Journal of Information Science and Engineering*, and as a Guest Editor for *Telecommunication Systems* special issue on "Wireless Sensor Networks". His research interests include wireless communication, network security, parallel and distributed computing, and computer architecture. Dr. Tseng is a member of the IEEE Computer Society.

Jang-Ping Sheu received the B.S. degree in computer science from Tamkang University, Taiwan, Republic of China, in 1981, and the M.S. and Ph.D. degrees in computer science from the National Tsing Hua University, Taiwan, Republic of China, in 1983 and 1987, respectively.

He joined the faculty of the Department of Electrical Engineering, National Central University, Taiwan, Republic of China, as an Associate Professor in 1987. He is currently a Professor of the Department of Computer Science and Information Engineering, National Central University. He was a Chair of Department of Computer Science and Information Engineering, National Central University from August 1997 to July 1999. He was a visiting professor at the Department of Electrical and Computer Engineering, University of California, Irvine from July 1999 to April 2000. His current research interests include wireless communications, mobile computing, parallel processing, and distributed computing Systems.

He was an associate editor of Journal of the Chinese Institute of Electrical Engineering, from August 1996 to July 2000. He was an associate editor of Journal of Information Science and Engineering from August 1996 to July 2002. He is an associate editor of Journal of the Chinese Institute of Engineers. He was a Guest Editor of Special Issue for Wireless Communications and Mobil Computing Journal. He was a Program Chair of IEEE ICPADS'2002. He received the Distinguished Research Awards of the National Science Council of the Republic of China in 1993–1994, 1995–1996, and 1997–1998. Dr. Sheu is a senior member of the IEEE, a member of the ACM and Phi Tau Phi Society.

Sajal K. Das received B. Tech. degree in 1983 from Calcutta University, M.S. degree in 1984 from Indian Institute of Science, Bangalore, and Ph.D. degree in 1988 from the University of Central Florida, Orlando, all in Computer Science. Currently he is a Professor of Computer Science and Engineering and also the Founding Director of the Center for Research in Wireless Mobility and Networking (CReWMaN) at the University of Texas at Arlington (UTA). Prior to 1999, he was a professor of Computer Science at the University of North Texas (UNT), Denton where he founded the Center for Research in Wireless Computing (CReW) in 1997, and also served as the Director of the Center for Research in Parallel and Distributed Computing (CRPDC) during 1995-97. Dr. Das is a recipient of the UNT Student Association's Honor Professor Award in 1991 and 1997 for best teaching and scholarly research; UNT's Developing Scholars Award in 1996 for outstanding research; UTA's Outstanding Senior Faculty Research Award in Computer Science in 2001 and 2003; and the UTA College of Engineering Research Excellence Award in 2003. An internationally-known researcher, he has visited numerous universities, research organizations, government and industry labs worldwide for collaborative research and invited seminar talks. He is also frequently invited as a keynote speaker at international conferences and symposia.

His current research interests include resource and mobility management in wireless networks, mobile and pervasive computing, wireless multimedia and QoS provisioning, sensor networks, mobile internet architectures and protocols, distributed processing, grid computing, performance modeling and simulation. He has published over 200 research papers in these areas, directed numerous projects funded by industry and government, and holds four US patents in wireless mobile networks. He received the Best Paper Awards in the 5th Annual ACM International Conference on Mobile Computing and Networking (MobiCom'99), 16th International Conference on Information Networking (ICOIN-16), 3rd ACM International Workshop on Modeling, Analysis and Simulation of Wireless and Mobile Systems (MSWiM 2000), and 11th ACM/IEEE International Workshop on Parallel and Distributed Simulation (PADS'97). Dr. Das serves on the Editorial Boards of IEEE Transactions on Mobile Computing, ACM/Kluwer Wireless Networks, Computer Networks, Journal of Parallel and Distributed Computing, Parallel Processing Letters, Journal of Parallel Algorithms and Applications. He served as General Chair of IEEE PerCom 2004, IEEE MASCOTS-2002; General Vice Chair of IEEE PerCom-2003, ACM MobiCom-2000 and IEEE HiPC 2000-01; General Chair of ACM WoWMoM 2000-02; Program Chair of IWDC-2002, WoWMoM 1998-99; TPC Vice Chair of ICPADS-2002; and as TPC member of numerous IEEE and ACM conferences. He is a member of the IEEE TCPP and TCCC Executive Committees and on the Advisory Boards of several cutting-edge companies.

Ruay-Shiung Chang received his B.S.E.E. degree from National Taiwan University in 1980 and his Ph.D. degree in Computer Science from National Tsing Hua University in 1988. From 1988 to 1992, he was a senior researcher at the Chung Shan Institute of Science and Technology. From 1992 to 1998, he was with the Department of Information Management, National Taiwan University of Science and Technology. In August 1998 he joined the Department of Computer Science and Information Engineering National Dong Hwa University, where he currently the Dean of Academic Affairs of NDHU. Dr.

Chang is a regular reviewer of *ACM Computing Review* and served as a program committee member for many national and international conferences. He was the Editor-in-Chief of *Communications of ROC Institute of Information & Computing Machinery* from 1996 to 1997, the program co-chair for ICPADS-2002, and the Program Chair for ICS2002. His research interests include Internet, high-speed networks and wireless networks. Dr. Chang is a member of ACM, IEEE, and ROC Institute of Information and Computing Machinery.