

## Editorial

# Quality of Service in Mobile Ad Hoc Networks

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Mobile ad hoc networking is a challenging task due to the lack of resources residing in the network as well as the frequent changes in network topology. Although much research has been directed to supporting quality of service (QoS) in the Internet and traditional wireless networks, present results are not suitable for mobile ad hoc network (MANET). QoS support for mobile ad hoc networks remains an open problem, drawing interest from both academia and industry under military and commercial sponsorship. MANETs have certain unique characteristics that pose several difficulties in provisioning QoS, such as dynamically varying network topology, lack of precise state information, lack of central control, error-prone shared radio channels, limited resource availability, hidden terminal problems, and insecure media, and little consensus yet exists on which approaches may be optimal. Future MANETs are likely to be “multimode” or heterogeneous in nature. Thus, the routers comprising a MANET will employ multiple, physical-layer wireless technologies, with each new technology requiring a multiple access (MAC) protocol for supporting QoS. Above the MAC layer, forwarding, routing, signaling, and admission control policies are required, and the best combination of these policies will change as the underlying hardware technology evolves.

In response to the above demand for mobile ad hoc networks, this special issue aims at providing a timely and concise reference of the current activities and findings in the relevant technical fields, and focuses as well on the state-of-the-art and up-to-date efforts in design, performance analysis, implementation and experimental results for various QoS issues in MANETs.

We believe that all of these papers not only provide novel ideas, new analytical models, simulation and experimental results, and handful experience in this field, but also simulate the future research activities in the area of the quality of

service for mobile ad hoc networks. A brief summary of each paper is listed as follows.

The first paper by Qi He et al. first identifies two critical issues leading to the TCP performance degradation: (1) unreliable broadcast, since broadcast frames are transmitted without the request-to-send and clear-to-send (RTS/CTS) dialog and Data/ACK handshake, so they are vulnerable to the hidden terminal problem; and (2) false link failure which occurs when a node cannot successfully transmit data temporarily due to medium contention. Secondly, the authors propose a scheme to use a narrow-bandwidth, out-of-band busy-tone channel to make reservation for broadcast and link error detection frames only. The proposed scheme is simple and power efficient, because only the sender needs to transmit two short messages in the busy tone channel before sending broadcast or link error detection frames in the data channel. Analytical results show that the proposed scheme can dramatically reduce the collision probability of broadcast and link error detection frames. Extensive simulations with different network topologies further demonstrate that the proposed scheme can improve TCP throughput by 23% to 150%, depending on user mobility, and effectively enhance both short-term and long-term fairness among coexisting TCP flows in multi-hop wireless ad hoc networks.

The second paper by Deying Li et al. discusses the energy efficient QoS topology control problem for nonhomogeneous ad hoc wireless networks. Given a set of nodes with different energy and bandwidth capacities in a plane, and given the end-to-end traffic demands and delay bounds between node pairs, the problem is to find a network topology that can meet the QoS requirements, and the maximum energy utilization of nodes is minimized. Achieving this objective is vital to the increase of network lifetime. We consider two cases of the problem: (1) the traffic demands are not splittable, and (2) the traffic demands are splittable. For

the former case, the problem is formulated as an integer linear programming problem. For the latter case, the problem is formulated as a mixed integer programming problem, and an optimal algorithm has been proposed to solve the problem.

The third paper by Hsiao-Hwa Chen et al. proposes autonomous power control MAC protocol (APCMP), which allows mobile nodes dynamically adjusting power level for transmitting DATA/ACK according to the distances between the transmitter and its neighbors. In addition, the power level for transmitting RTS/CTS is also adjustable according to the power level for DATA/ACK packets. In this paper, the performance of APCMP protocol is evaluated by simulation and is compared with that of other protocols.

The fourth paper by Yang Yang et al. considers the hybrid problem of the infrastructure and the ad hoc modes in WLAN. They propose in this paper a new coverage improvement scheme that can identify suitable idle MSs in good service zones as traffic agents (TAs) to relay traffic from those out-of-coverage MSs to the AP. The service coverage area of WLAN is then expanded. The QoS requirements (e.g., bandwidth) of those MSs are considered in the selection process of corresponding TAs. Mathematical analysis, verified by computer simulations, shows that the proposed TA scheme can effectively reduce blocking probability when traffic load is light.

The fifth paper by S. Ahmed et al. analyzes the performance differentials to compare the commonly used ad hoc network routing protocols. They also analyze the performance over varying loads for each of those protocols using OPNET modeler 10.5. Their findings show that for specific differentials, TORA shows better performance over the two on-demand protocols, that is, dynamic source routing and ad hoc on-demand distance vector routing. Their findings are expected to lead to further performance improvements of various ad hoc networks in the future.

The sixth paper by Nagaraja Thanthy et al. analyzes various parameters that affect the performance of TCP in an ad hoc network environment. Congestion and path nonavailability are two major factors that affect TCP performance. It was also observed that, in the presence of multiple paths, TCP performance degrades when one of the paths used for forwarding data drops a packet. In the current paper, the authors have proposed establishing multiple connections for every data transfer between the source and the destination. The proposed mechanism would be transparent to the application and session layers; however, it involves the transport layer in multipath routing scheme.

The seventh paper by X. Wang et al. develops a modified version that we term CSMA/CCA (CSMA with copying collision avoidance) in order to mitigate fairness issues arising with CSMA/CA. A station in CSMA/CCA contends for the shared wireless medium by employing a binary exponential backoff similar to CSMA/CA. Different from CSMA/CA, CSMA/CCA copies the contention window (CW) size piggybacked in the MAC header of an overheard data frame within its basic service set (BSS), and updates its backoff counter according to the new CW size. Simulations carried out in

several WLAN configurations illustrate that CSMA/CCA improves fairness relative to CSMA/CA and offers considerable advantages for deployment in the 802.11 standard based WLANs.<sup>1</sup>

The eighth paper by S. Guizani et al. proposes a new technique to compensate the chromatic dispersion optically by applying Talbot effect. Results obtained are inline with what's proposed. This method is easy to implement and versatile since any type of fiber can be used. Moreover, our technique has the strength to revive a totally deformed signal regardless of the bits transmitted.

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

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