MONET Special Issue on Towards Future Ad Hoc Networks: Technologies and Applications (II)

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Guest Editorial

An ad hoc network is a wireless system in which network nodes are connected via wireless links and cooperate to self-organize into a network with no need for any infrastructure such as access points or base stations. Ad hoc networks cover a variety of paradigms such as mobile ad hoc networks (MANETs), wireless sensor networks (WSNs), vehicular ad hoc networks (VANETs), underwater networks, airborne networks, underground networks, personal area networks, and home networks. These types of networks promise a wide range of applications in civilian, commercial, and military areas. However, the distributed and multi-hop nature of ad hoc networking as well as the highly dynamic topology of ad hoc networks due to node mobility have presented many formidable technical challenges, such as scalability, quality of service, reliability and security, and energy efficiency, which have stimulated a considerable amount of research activities in this broad area in recent years.

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This special issue includes six papers that report recent research advances in the area of ad hoc networks, among which four papers are selected from AdHocNets 2019 and two are selected from open call. In the first paper, “Communication by Credence: Trust Communication in Vehicular Ad Hoc Networks”, Sun et al. proposed the concept of Trust Communication (TC) to address the low-cost and real-time security issue caused by high mobility in vehicular ad-hoc networks (VANETs). Following this concept, each vehicle gains a trust value depending on its performance of communication, and then other vehicles choose to communicate with the vehicle owning a high enough trust value. However, how to allocate the trust value and how to make a trust communication method to adapt the complex scenario of a VANET are crucial and unsolved problems. The authors presented an in-depth investigation on the Trust Communication issue in VANETs. The background of the Trust Problems is first introduced in VANETs. Then, the most basic trust models for VANETs and a classification of these models are surveyed and discussed. Given the limitations of these basic models, the authors further presented various improvement measures for each model and finally discussed the performances of the trust models under various application scenarios.

In the second paper, “The Time-Free Comparison Model for Fault Diagnosis in Wireless Ad hoc Networks,” Jarrah et al. described a new comparison-based model for fault diagnosis in wireless ad hoc networks. Specifically, they introduced a time-free self-diagnosis model which is adaptable to the topology's changes, imposes no known bounds on time delays, and requires limited network information. Further, they developed a fault diagnosis protocol that can correctly diagnose faulty nodes undergoing static and dynamic faults in mobile ad-hoc networks (MANETs). It is shown through both an analytical model and a simulation study that the proposed fault diagnosis protocol is efficient in terms of communication and time complexity in various scenarios.

In the third paper, “LEER: Layer-Based Energy-Efficient Routing Protocol for Underwater Sensor Networks

(UWSNs),” Zhu et al. proposed a routing protocol called Layer-based Energy-Efficient Routing (LEER) protocol to address the routing failure problem with greedy routing as well as the long end-to-end delay and high energy consumption problems in UWSNs. In the LEER protocol, each node extracts the layer field information from its received hello packets and updates its own layer to avoid the routing failure problem. All nodes forward packets to the sink node without the need for any location information. Simulation results show that the LEER protocol outperforms the depth-based routing (DBR) protocol in terms of delivery rate and end-to-end delay.

The fourth paper, “Graph-Based Resource Allocation for Air-Ground Integrated Networks,” by Chen et al., proposes a novel architecture of air-ground integrated networks (AGIN), which leverages civil aircrafts and ground base stations to support the network service to terrestrial users. Aiming at maximizing the overall capacity of downlink transmission in an AGIN, the authors formulated the resource allocation problem as an optimization problem subject to both quality of service (QoS) and fairness requirements. To address the formulated problem, they proposed a graph-based joint optimization algorithm for resource block (RB) and power allocation. Specifically, an improved Kuhn-Munkras (KM) algorithm based on graph theory is proposed for RB allocation. Meanwhile, a multi-level water-filling method is proposed for power allocation. By leveraging an alternating descent approach, a joint optimal solution can be obtained after a finite number of iterations. It is demonstrated through simulation results that the proposed joint optimization algorithm converges fast and shows significant improvement in terms of the sum-rate, fairness, access latency, and system capacity.

In the fifth paper, “A Delay Balanced Adaptive Channel Allocation Mechanism for LTE-U and WiFi Coexistence Systems,” Xiao and Zheng proposed a delay-balanced adaptive channel allocation (DB-ACA) mechanism for improving the channel access performance of an LTE-U and WiFi coexistence system. To support the DB-ACA mechanism, an integrated network architecture is introduced for coordinating the channel access in the coexistence system. Based on the integrated network architecture, the coexistence system is able to adaptively adjust the number of unlicensed channels allocated to the LTE-U system and WiFi system, respectively, according to the current traffic load status of the coexistence system. To ensure the access fairness of the LTE-U and WiFi systems, the DB-ACA mechanism introduces a fairness criterion, which requires that the channel access delay be balanced on the unlicensed band between the LTE-U system and the WiFi system. Theoretical models are developed to determine the

number of unlicensed channels that need to be adjusted, and performance models are derived to analyze the blocking probability and access delay of the LTE-U system and the WiFi system, respectively. It is demonstrated through numerical results that the proposed DB-ACA mechanism can effectively ensure access fairness of the coexistence system, and significantly improve the system performance in terms of the blocking probability and access delay.

In the last paper, “Energy-Efficient Power Allocation for D2D Communication underlaying Cellular Networks,” Shi et al. considered the power allocation problem in device-to-device (D2D) communication underlaying a cellular network and formulated the problem as a nonlinear fractional programming problem with an objective to maximize the energy efficiency of a D2D communication link subject to four different combinations of transmitting and interference power constraints. To solve the original formulated nonlinear fractional programming problem, they first converted it into a dual nonlinear parametric programming problem, and then decoupled the dual problem into several solvable concave problems. Further, a closed-form solution is derived to each dual problem and an efficient power allocation algorithm is proposed to find a numerical solution to the formulated problem. Simulation results show that the proposed power allocation algorithm outperforms an ergodic capacity maximization algorithm and a uniform power distribution algorithm in terms of the energy efficiency of a D2D link, and can efficiently improve the overall ergodic capacity of a cellular network.

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It is our hope that the papers included in this special issue present recent research advances in ad hoc networks, and will become an important reference for researchers and practitioners in the area. Finally, we hope that the readers will find this special issue timely and informative.

Guest Editors

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