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Editorial: MONET Special Issue on Recent Advances in Ad Hoc Networking

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Editorial:

This special issue includes six high quality papers on the recent advances in *ad hoc* networking. These papers are extended versions of papers recommended by the Technical Program Committee of the 9th EAI International Conference on *Ad Hoc* Networks (AdHocNets 2017) held in Niagara Falls, Ontario, Canada on September 28–29, 2017. *Ad hoc* networking covers a variety of network paradigms, such as mobile *ad hoc* networks (MANETs), wireless sensor networks (WSNs), vehicular networks, underwater networks, airborne networks, home networks, *etc.*, with wide applications in both commercial and military areas. This issue will cover some of the topics in the field.

The first paper, entitled "Doppler effect in the acoustic ultra low frequency band for wireless underwater networks," by Abdel Mehsen Ahmad, Jamil Kassem, Michel Barbeau, Evangelos Kranakis, Steven Porretta, and Joaquin Garcia-Alfaro, discusses the Doppler effect in communications between Autonomous Underwater Vehicles (AUVs), Underwater Sensors (USs) and remote operators. In this paper, the Doppler effect in relation to the half-power bandwidth and distance in the Ultra Low Frequency (ULF) band is studied. Two specific issues are investigated: the maximum shift that can be expected on underwater links in the ULF band, and the maximum frequency drift and associated patterns that can happen during the reception of data frames. Numeric simulations are conducted.

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The second paper, entitled "Exploiting multi-beam antennas for end-to-end delay reduction in *ad hoc* networks," by Jean-Daniel Medjo Me Biomo, Thomas Kunz, and Marc St-Hilaire, discusses the use of Multi-Beam Antennas (MBAs) for *ad hoc* networks. MBA nodes have the special capabilities of Multi-Packet Transmission (MPT) and Multi-Packet Reception (MPR). The authors provide an analysis of how MPT and MPR can be used to reduce the end-to-end delay for delivered packets in *ad hoc* networks, based on an optimization formulation. They show that, to maximally exploit the full potential of MBAs for delay reduction, the scheduling of links has to promote the formation of star nodes and keep the formation of bridges to a minimum, leading to the selection of routes that very often are not the shortest. The optimal link scheduling comes at the expense of a higher overhead in terms of the total number of packet transmissions. Furthermore, the beamwidth has a direct and significant impact on the end-to-end delay and the computation time.

The third paper, entitled "ARP cache poisoning and routing loops in *ad hoc* networks," by David Brown and Tricia Willink, presents a new application of the well-known ARP spoofing (or ARP cache poisoning) attack. In this paper, the authors introduce a variant of ARP spoofing unique to multi-hop *ad hoc* networks, in which routing loops are created among target wireless hosts. It is shown that the routing loops not only results in a denial-of-service against the targeted hosts, but also creates a resource consumption attack, where the targets waste power and occupy the channel, precluding its use by legitimate traffic. In addition, the paper identifies the network topology pre-conditions under which routing loops are possible, and discusses how ARP spoof messages can be used to create routing loops of arbitrary size. Finally, the authors show experimental results of an implementation and provide suggestions as to how to prevent, detect, or mitigate the attack.

The fourth paper, entitled "A routing and interface assignment algorithm for multi-channel multi-interface (MCMI) *ad hoc* networks," by Yifeng Zhou, presents a routing and

interface assignment algorithm for multichannel multi-interface (MCMI) wireless *ad hoc* networks. The proposed algorithm takes into account both the number of hops between the source to the destination nodes, and the effects of adjacent hop interference. The algorithm consists of two decoupled steps: route selection and interface assignment. The route selection step finds the path that has the minimum lower bound routing metric among all possible routes between the source and the destination while the interface assignment step assigns an interface to a channel on each hop on that path. The interface assignment is based on the use of the Viterbi algorithm. The decoupling makes the algorithm computationally efficient, while the use of the lower bound metrics in route selection and the Viterbi algorithm in interface assignment helps improving the global optimality of the routing. Computer simulation and examples are used to demonstrate the effectiveness and performance of the proposed technique.

In the fifth paper, entitled "Misbehavior detection in industrial wireless networks: Challenges and directions," by Sebastian Henningsen, Stefan Dietzel, and Björn Scheuermann, the authors discuss new directions and future challenges in detecting insider attacks for the exemplary application domain of industrial wireless networks (often *ad hoc*), an enabling technology for the current trend towards the smart factory. They first review existing work on intrusion detection in mobile ad-hoc networks with a focus on physical-layer-based detection mechanisms, and then conduct a proof-of-concept study of insider detection in industrial wireless networks using real-world measurements from an industrial facility. In the end, they point out new directions for future research based on the discussion.

The last paper, entitled "Applying message forwarding and replication to multi-UAV message ferry networks," is by Mehdi Harounabadi and Andreas Mitschele-Thiel. This paper presents the use of cooperative mobility-controlled message ferries for delivering messages for stationary and disconnected wireless nodes in a sparse *ad hoc* network. In this paper, Unmanned Aerial Vehicles (UAVs) are utilized as message ferries with an on-the-fly mobility decision making. The multi-hop delivery of messages is enabled by efficient message forwarding and replication among UAVs to accelerate the delivery of messages. Each UAV makes its decisions based on local observations through signaling due to lack of global knowledge. Trajectory-aware and priority-based message replication schemes are proposed to limit the number of message replications and to reduce the delay of message delivery. The results show that multi-hop message delivery in a message ferry network by message forwarding and replication among UAVs accelerates the delivery of messages comparing with a pure message ferrying scheme without any message forwarding.

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