Perspectives of a Selfish Behavior in Self-Policing Wireless Mobile Ad Hoc Network

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A wireless mobile ad hoc network (MANET) consists of a number of devices equipped with wireless communication capabilities. It operates without a support from any fixed infrastructure, thus the devices are expected to cooperate on packet forwarding. Due to the fact that MANET is formed with battery constrained devices like laptops, PDAs, or smartphones, the network users are tempted to act selfishly by not participating to the packet forwarding duty. A general approach for solving the problem is referred to as a distributed cooperation enforcement mechanism. It assumes that nodes forward packets only on behalf of those who behaved correctly in the past (i.e. cooperated on packet forwarding). However, as in MANET nodes belong to different authorities, the use of a given forwarding strategy cannot be enforced. Thus it has to be beneficial to its potential users. But what is good from a single user's point of view might not always be beneficial to other users, thus sometimes rational behavior of network participants might lead to a noncooperative network. Since the forwarding relationships between nodes are game-theoretic in nature (an optimal packet forwarding strategy of a node depends on the strategies used by others) such a network cannot be represented and analyzed as a parametric situation.

In the paper we investigate the conditions, where the development of the enforcement mechanism among MANET users is very unlikely, i.e. the reciprocity-based cooperative behavior is not beneficial to the network users. We demonstrate that in the presence of a large number of unconditionally cooperative nodes a selfish permanent defection strategy is more successful than a reciprocal tit-for-tat strategy. Firstly, a direct reciprocity-based model of packet relaying is introduced. Next, an evolutionary game-theoretical approach combining genetic algorithms and replicator equations for the search and analysis of strategies for given networking conditions is introduced. The genetic algorithm is used to discover the condition-specyfic forwarding strategies, while the replicator dynamics-based approach allows to further verify the performance of the strategies.