Using an evolutionary algorithm to optimize the broadcasting methods in mobile ad hoc networks

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A B S T R A C T

A mobile ad hoc network (MANET) is a collection of mobile nodes communicating through wireless connections without any prior network infrastructure. In such a network the broadcasting methods are widely used for sending safety messages and routing information. To transmit a broadcast message effectively in a wide and high mobility MANET (for instance in vehicular ad hoc network) is a hard task to achieve. An efficient communication algorithm must take into account several aspects like the neighborhood density, the size and shape of the network, the use of the channel. Probabilistic strategies are often used because they do not involve additional latency. Some solutions have been proposed to make their parameters vary dynamically. For instance, the retransmission probability increases when the number of neighbors decreases. But, the authors do not optimize parameters for various environments. This article aims at determining the best communication strategies for each node according to its neighborhood density. It describes a tool combining a network simulator (ns-2) and an evolutionary algorithm (EA). Five types of context are considered. For each of them, we tackle the best behavior for each node to determine the right input parameters. The proposed EA is first compared to three EAs found in the literature: two well-known EAs (NSGA-II and SPEA2) and a more recent one (DECMOSA-SQP). Then, it is applied to the MANET broadcasting problem.

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1. Introduction

A mobile ad hoc network (MANET) is a set of mobile nodes communicating through wireless connections without any pre-existent network infrastructure. The mobile nodes can be laptops, mobile phones or any other equipment with a wireless network device. MANETs were initially used to make the establishment of communication systems easier during the relief following a disaster. Nowadays, these networks are used for various purposes: sharing data, playing games, sending road traffic information, etc. Due to the constraints related to the signal propagation (distance and/or obstacles), each node has a limited coverage area (area delimiting the neighbors it can communicate with). In such an environment, if a node wants to send a message beyond its coverage area, at least one of the neighbors it can communicate with should agree to relay its message. There are different types of communication between nodes: unicast (one source to one destination), multicast (one source to multiple destinations) or broadcast (from a source to all the nodes in its coverage area). This last type (broadcast) is widely used in MANETs, especially for sending safety messages and routing information. Since the radio resources (for instance bandwidth) are limited, the communication must be managed effectively, which means it must avoid unnecessary retransmissions.

The bandwidth consumption is related to the number of nodes that are in the same coverage area. In a dense environment, if each node relays each message as soon as it is received, the number of collisions will quickly grow, preventing potential highly relevant and time-critical messages from getting access to the shared wireless channel. In a sparse environment (low density), if nodes rarely relay the communications, the broadcasting chain might be broken (while using a realistic propagation model). Regarding message retransmissions, the behavior of the nodes must depend on the context. The problem is how to communicate effectively without unnecessarily saturating the channel.

Many researches focus on message dissemination strategies in MANETs. Karthikeyan et al. (2010) and Zhang and Agrawal (2005) present several mechanisms to reduce redundancy, contention...