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An Efficient Broadcasting Scheme in Mobile Ad-Hoc Networks

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Abstract

Information broadcasting in MANETs is an essential building block for cooperative operations, group discussions, and common announcements (e.g., filling routing tables). The flooding is the simplest broadcasting scheme used in MANETs. In this scheme, source nodes broadcast at once packets to all neighbors. Broadcasting through flooding causes increased messages redundancy, collision, and wastage of bandwidth and energy. Several approaches have been proposed to solve these issues and could be classified into two main categories: static schemes and adaptive schemes. In this paper, we introduce an adaptive scheme for information broadcasting in MANETs. This scheme allows nodes to select an appropriate action, either to rebroadcast or to discard receiving messages. The decision is based on the amount and timestamps of received messages. Simulations have been conducted and results show that the proposed scheme reduces the number of packet transmissions, has better latency and SRB, good reachability, and low energy consumption.

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Keywords: Ad hoc networks; MANETs; Broadcasting schemes; Flooding; Broadcast Storm Problem; Performance evaluation.

1. Introduction

MANETs are well suited for communication in environments where conventional communication infrastructures are absent, destroyed or in situations in which their deployment is very expensive. In MANETs, each network node participates in the procedure as a router where packets are sent from source nodes, relayed by several intermediate nodes before reaching destination nodes. The flooding or pure diffusion is one straight-

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forward and a simplest mechanism used for broadcasting in MANETs. The process begins with a source node broadcasting a packet to all its neighbors. Each of these neighbors in turn rebroadcasts the packet exactly once and this process continues until all accessible nodes in the network received the packet. Thus, step by step, the packets flood the network. This operation leads to the problem of broadcast storm[1]. Mainly, broadcasting through flooding causes increased redundancy of messages, contention, collision, and wastage of channel bandwidth and energy.

Several enhanced versions of the flooding scheme have been proposed to solve these issues and are categorized into two main categories: static broadcasting schemes and adaptive broadcasting schemes. Static broadcasting schemes are mainly related to some threshold values or the network topology (e.g., clusters, spanning tree). In dynamic networks, it is however, difficult or even impossible to determine a priori these threshold values or to maintain information about the network topology. For instance, dynamically changing the threshold values, in order to minimize the number of redundantly received messages while maintaining good latency and reachability, is considered as a complex issue without the use of centralized controllers or constant threshold parameters. Adaptive broadcasting schemes have been proposed to handle these issues with respect to SRB, energy consumption, and reachability. More precisely, the core problem in these broadcasting schemes is how to minimize the number of redundantly received messages, named save broadcast, while maintaining good latency and reachability since rebroadcasting causes tradeoff between reachability and efficiency under different network densities and speeds.

All proposed schemes use mechanisms that inhibit certain nodes from rebroadcasting to alleviate these issues, but they mainly differ in how each node estimates redundancy and how it accumulates knowledge to assist decision for either rebroadcast or discard received messages. In this paper, we introduce an adaptive broadcasting scheme that allows nodes, when receiving messages, to either rebroadcast or discard. The decision is based on the amount and the timestamps of received messages. Simulations have been conducted and results show that the proposed scheme has significant SRB, higher reachability, and good latency compared to the flooding and to an adaptive protocol named AID[11].

The remainder of this paper is structured as follows: Section 2 reviews broadcasting schemes proposed in literature for wireless ad hoc networks. Section 3 describes the proposed broadcasting scheme. Section 4 presents the simulation parameters, performance metrics, and obtained results. Conclusions and future work are presented in Section 5.

2. Background and related works

In the past years, several schemes have been proposed to deal with the rebroadcasting storm issue. Authors in [12] classified existing schemes from literature into two main categories: static schemes and adaptive schemes (or protocols, algorithms). Static schemes are mainly related to some fixed threshold values or network topology structures. However, in dynamic networks, fixing these values or maintaining the structure (e.g. spanning three, clusters) of the network topology is difficult and generates an extra overhead in terms of energy and bandwidth consumption. In this section, we focus mainly on adaptive schemes and we refer reader to [12] for more details about static schemes.

Several adaptive broadcasting algorithms have been proposed. These algorithms are classified into three categories: Pure Machine Learning (PML), Intra-Protocol Learning (IAPL), and Inter-Protocol Learning (IEPL)[7]. In PML, nodes learn to adapt to their environment and improve through experience. For example, in [7] authors proposed a broadcasting scheme in which a node builds a classifier using data collected from the exchanged massages. In this scheme, the classifier is trained to select the best suitable action, i.e., either to rebroadcast or to discard the received packet. The concept of a successful retransmission was introduced as a feedback loop[13] using an objective function to assess whether a given node is contributing to the delivery of broadcast packets. Each node tunes its behavior accordingly based on an estimated objective function.

Unlike PML schemes, IAPL use online parameterized techniques in which nodes learn to change one of the parameters. For example, as stated in [8,9], RAD (Random Assessment Delay) is a parameter, randomly chosen between 0 and τ seconds, that was shown to be sensitive to the density of neighboring nodes and congestion. It is worth noting that most broadcasting schemes use the RAD as a delay time required for waiting before making any decision[1]. For example, Authors in [7] propose to use a simple model that allows each node to estimate the most