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Enhancement of accuracy metrics for energy levels in MANETs ☆

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ABSTRACT

Mobile ad hoc networks (MANETs) are wireless, self-organizing and infrastructure-less networks with nodes that rely on power. Hence, there is a need for an energy-aware and energy-efficient routing protocol. To enhance the lifetime of nodes and network performance, intervals such as the Hello-Interval and TC-Interval of the optimized link state routing (OLSR) protocol are tuned. Additionally, the residue forecast algorithm is incorporated with the protocol, yielding the Hello-Interval 1, TC-Interval 3 residue forecasted optimized link state routing (HTR-OLSR) protocol. In addition, the modified multipoint relay (MPR) selection plays a vital role in energy consideration. In the case of dynamic networks, a gain in throughput of approximately 10% to 15% is obtained.

1. Introduction

Mobile ad hoc networks (MANETs) consist of wireless nodes that form a communications network among themselves without a fixed infrastructure [1]. MANETs are frequently used in special situations such as emergency operations, including natural or man-made disasters, rescue activities, battlefields or tutorial halls, particularly in areas where there is no fixed infrastructure or the infrastructure has been destroyed [2]. Topology changes in MANETs usually occur due to the mobility of a participating node or the breakdown of a node due to the loss of energy in that node [3]. These dynamic conditions disrupt smooth communication between nodes in networks [4].

Conceptually, in MANETs, a node may function either as an end node or as a router forwarding data packets between end nodes [5]. An effective routing mechanism is required to maintain acceptable service quality during communication between nodes [6]. Hence, the strength of a node in terms of the available energy in the node becomes an important issue during the selection of an intermediate node to maintain stable transfer of data between nodes [7].

Maintaining an optimized lifetime of a routing path in a network is a very challenging task because the power or energy of nodes depends on node size, the propagation model, the properties of the model, and the capacity of the battery [8]. The energy stored in batteries is continuously depleted due to node activities such as transmission, reception and overhearing. The depletion of energy in nodes, especially intermediate nodes, disrupts communication and results in changes in the network topology. However, disruption can be minimized through an efficient selection of intermediate nodes. The selection of

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criteria in this respect must be the first step in any route selection, followed by maintaining the stable routing of data between the end nodes [9].

The node selection process has been incorporated into many routing algorithms and techniques [10]. Hence, these algorithms and techniques take service quality into account as an important factor. However, these algorithms and techniques suffer from certain shortcomings, especially during the route discovery process [11]. These techniques do not consider the available energy of a node as a parameter, so they may select a node with a low energy level as an intermediate node [12]. The selection of a node with a low energy level reduces the stability of the communication path because that node may deplete its energy, causing the breakdown of the communication channel. In this paper, the proposed system uses a probability-based node selection method in which the available energy level of a node is an important parameter [13].

The remainder of this paper is organized as follows: Section 2 addresses the existing strategy of the OLSR protocol; in Section 3, an instance detailing how the HTR-OLSR protocol functions is discussed; Section 4 provides an evaluation of the performance-related factors followed by a discussion of the results obtained; and conclusions is presented in Section 5.

2. Related works

OLSR is a table-driven, proactive routing protocol for MANETs. In a classic link-state algorithm, the link-state information is flooded all over the network [14]. OLSR uses this approach as well; however, because the protocol operates in wireless multi-hop setups, the message flooding in OLSR is enhanced to preserve bandwidth. The optimization is actually based on a technique called multipoint relaying. In this technique, all nodes contain pre-computed route information concerning all other nodes in the network. This information is reciprocated by protocol messages after a certain time interval [15].

OLSR performs hop-by-hop routing, wherein each node uses its most recent topology information for routing. Each node chooses a set of its neighbor nodes as multipoint relays (MPRs). Only nodes that are selected as MPRs are responsible for forwarding the control traffic. The MPRs are selected such that the 2-hop intermediate nodes must be accessible through at least one MPR node, and OLSR provides the shortest path routes to all destinations by providing link-state information for its MPR selectors [16]. The nodes that have been selected as MPRs by some neighbor nodes broadcast this information periodically through their control messages. The MPRs are used to form the routes from the starting node to the destination node in the MANET [17]. All of this information is broadcast to neighboring MPRs through control messages. The purpose of selecting MPR is to reduce flooding overhead and provide optimal flooding distance. Fig. 1 illustrates flooding with MPR.

The key messages in OLSR are Hello messages and Topology Control (TC) messages. Hello messages are actually periodically exchanged to notify nodes about their neighbors and their neighbors' neighbors. They are 1-hop broadcast messages. The 2-hop neighborhood information is locally used by every node to estimate MPRs. In contrast, TC messages are flooded throughout the network to inform all other nodes about the (partial) network topology. At a minimum, TC messages are composed of information regarding MPRs and their MPR selectors [18].

There are a few parameters in OLSR that can control the efficiency of OLSR. The Hello-Interval parameter represents the frequency of Hello message generation [19]. When increasing the frequency of Hello message generation, updates about the neighborhood are more frequent and thus a considerably more accurate view of the network is obtained, which results in overhead. The TC-Interval parameter represents the frequency of generating a TC message and is used for topology discovery. If the frequency of TC messages increases, then nodes have more recent information regarding topology because nodes leave and enter the network very frequently. The MPR coverage parameter allows one node to select redundant MPRs. The number of MPRs should be minimal because it introduces overhead into the network. However, as the number of MPRs increases, the reachability improves. The TC-redundancy parameter specifies the amount of information in the local node that may be

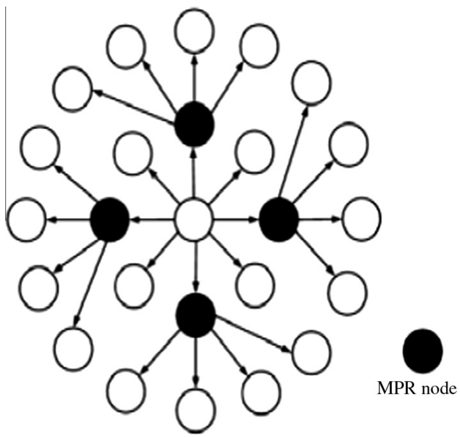

Fig. 1. Flooding with MPR.