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Routing and quality of service support for mobile ad hoc networks

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Abstract

OLSR is an optimization over classical link state protocols tailored for mobile ad hoc networks. In this paper, we propose the QOLSR protocol which includes quality parameters to the standard OLSR. Three variants of QOLSR are introduced, taking into account the delay measurement together with the hop count metric. Then, we analyze new heuristics for the multipoint relay selection, and evaluate our proposed approaches comparing them with the standard OLSR protocol. Simulation results show that an increased load-balancing and a reduced dropped packets rate are achieved due to the inclusion of the delay information.

Keywords: Ad hoc networks; Routing protocols; QoS support; Delay metric

1. Introduction

The highly dynamic nature of a mobile ad hoc network results in frequent and unpredictable changes in the network topology, increasing the complexity of routing among nodes. Such challenges make routing probably the most active research topic within the MANET area. Besides the challenges associated with mobility, more difficulties are introduced by the specific characteristics of the wireless channel.

Broadcast is the basic mode of operation over a wireless channel where, in general, each transmitted message can be received by all neighbors located within one-hop from the sender. In terms of traffic classification, in unicast the MAC layer is supposed to filter the messages and deliver them to higher layers those whose address matches with the node. When, broadcast is used all neighbors that receive

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the message will forward them to higher layers regardless of its address, while the routing will forward the messages to other nodes. Such broadcast traffic is often used by routing protocols for path discovery. In this case, the simplest implementation of the broadcast operation is by naive flooding, which may cause the broadcast storm problem due to redundant re-broadcast [1].

Numerous routing protocols and algorithms have been proposed. Their performance under various network environments and traffic conditions have been extensively studied and compared [2]. MANET routing protocols are typically subdivided into two main categories: *reactive on-demand routing protocols* and *proactive routing protocols*. Reactive on demand routing protocols establish the route to a destination only when there is a demand for it. In proactive routing protocols routes are calculated before needed. Such protocols can be derived from either legacy Internet distance-vector or link-state protocols. For mobile ad hoc networks, the proactive routing protocols are table-driven, where each node tries to maintain routing information about every other node in the network at all times.

An example of a proactive protocol is OLSR [3], which is an optimization over the classical link state protocol [4] (*e.g.* OSPF [5]). OLSR is now officially defined by the RFC 3626 of the IETF [6] in the Mobile Ad hoc NETworks (MANET) working group. It performs hop-by-hop routing, *i.e.*, each node uses its most recent information to route a packet. Therefore, each node selects a set of its neighbor nodes as MultiPoint Relays (MPRs) [7]. In the OLSR protocol, only the nodes selected as MPRs are responsible for forwarding control traffic, intended for diffusion to the entire network. MPRs provide an efficient mechanism for flooding control traffic that reduces the number of required transmissions. The MPRs are also responsible for declaring the link state information over the network. However, no QoS information is taken into account, leading to a non optimal path selection in terms of QoS requirements.

In this paper we propose a QoS-enhancement for the OLSR protocol, which we define as the QOLSR protocol. The QOLSR protocol extends the standardized OLSR protocol [3], introducing QoS metrics to wireless and mobile ad hoc networks. While the hop distance may be a valid metric for wired and stationary networks, it does not consider the specifics of wireless links nor node movement. We introduce three QOLSR variants of OLSR with different tradeoffs: QOLSR1, QOLSR2 and QOLSR3. The three variants – QOLSR1, QOLSR2 and QOLSR3 are heuristics designed for the selection of MPRs based on QoS parameters. The heuristic used in QOLSR1 selects as MPR the neighbor node that can reach the largest number of nodes (such a node will have what we define as the maximum reachability or degree). If there are two or more neighbor nodes with the same reachability, then QOLSR1 prioritizes the neighbor with the smallest delay. The next heuristic is the one used in QOLSR2, which prioritizes the node with the smallest delay when selecting the MPR node. If there are two or more neighbors with the smallest delay, then the node to be chosen as MPR will be the one with the largest reachability. The last proposed heuristic, used in QOLSR3, selects as MPR the neighbor node with the smallest delay among the neighbors that are, at most, within two hops from the initial node. We demonstrate that QOLSR3 finds the optimal shortest path, in terms of delay, using only partial knowledge of the network topology.

The remainder of this paper is organized as follows. A detailed specification of the QOLSR protocol is presented in Section 2, while in Section 3 we present its performance evaluation. In Section 4 we conclude the paper.

2. QOLSR

2.1. OLSR

OLSR [3] is a proactive routing protocol that shares the stability of link state algorithms [4] and the advantage of having the routes immediately available when needed. In pure link state protocols, all links within neighbor nodes are declared and control messages are flooded over the entire network. The OLSR protocol is an optimization of pure link state protocols (*e.g.* OSPF [5]) for mobile ad hoc networks. First, it reduces the size of the control packets: instead of all links, it declares only a subset of links within those neighbors that are in the MPR set [8]. Second, it minimizes the flooding of control traffic by using only those nodes within the MPR set to broadcast its messages. Therefore, only MPRs of a node rebroadcast packets. This technique significantly reduces the number of retransmissions in a flooding or broadcast procedure [7]. A detailed description of the OLSR protocol can be found in the RFC3626 [3].