Neighborhood-Based Route Discovery Protocols for Mobile Ad Hoc Networks

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ABSTRACT

Network-wide broadcasting is used extensively in mobile ad hoc networks for route discovery and for disseminating data throughout the network. Flooding is a common approach to performing network-wide broadcasting. Although it is a simple mechanism that can achieve high delivery ratio, flooding consumes much of the communication bandwidth and causes serious packet redundancy, contention and collision. In this paper, the authors propose new broadcast schemes that reduce the overhead associated with flooding. In these schemes, a node selects a subset of its neighbors for forwarding the packet being broadcast to additional nodes. The selection process has for goal reducing the number of neighbors and maximizing the number of nodes that they can reach (i.e., forward the packet to). By applying this novel neighborhood-based broadcasting strategy, the authors have come up with routing protocols that have very low overhead. These protocols were implemented and simulated within the GloMoSim 2.03 network simulator. The simulation experiments show that our routing protocols can reduce the overhead for both low and high mobility substantially, as compared with the well-known and promising AODV routing protocol. In addition, they outperform AODV by increasing the delivery ratio and decreasing the end-to-end delays of data packets.

Keywords: AODV, Broadcasting, Flooding, Mobile Ad Hoc Network (MANET), Route Discovery

1. INTRODUCTION

A Mobile Ad hoc Network (MANET) is an autonomous ad hoc network consisting of a collection of mobile nodes that utilize wireless transmission for communication and cooperation. MANETs are self-configured, self-organized and self-controlled, without reliance on any pre-existing infrastructure or centralized access points. Therefore, they can be deployed anytime and anywhere. The numerous applications of MANETs include search and rescue operations, academic and industrial applications, and Personal Area Networks (PANs).

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A node in a MANET is required to operate as a host as well as a router that can forward packets so that they can reach nodes that do not reside within the transmission range of the source node. The topology of MANETs is dynamic. Nodes are free to change their physical location by moving freely in all directions (Yao Yu et al., 2009).

A Network Wide Broadcast (NWB) is a common operation that is used extensively in MANETs to discover routes and to disseminate data throughout the network. Flooding is a common operation that is used to perform NWB. Flooding refers to the process whereby a node rebroadcasts a packet when it receives it for the first time (Rogers et al., 2005). Although flooding is simple and can achieve delivery to a large percentage of nodes in the network, it has been shown to be expensive and wasteful; it consumes much of the communication bandwidth, wastes network resources and causes serious redundancy, contention and collision, which are collectively referred to as the broadcast storm problem (Ni et al., 2002).

Many researchers have identified the disadvantages of flooding, and they suggested various solutions in the literature (Ni et al., 2002; Tseng et al., 2003). Several of these solutions use a fixed threshold value (Bani Yassein et al., 2009; Sasson et al., 2003). A node that receives a broadcast packet participates in the NWB only if some local measure meets the threshold value. Some other schemes build a virtual backbone whose task is to disseminate the broadcast packet throughout the network (Alzoubi et al., 2002; Clausen & Jacquet, 2003). Only backbone members are responsible for broadcasting packets. This approach is vulnerable to transmission losses and poor robustness, measured in terms of achieved coverage in the presence of losses. The virtual backbone becomes disconnected when a node moves away from its neighbor or neighbors. Also, location-based schemes were proposed. An issue with these schemes is that they depend on node location information that is typically provided by additional equipment, such as GPS devices (Williams & Camp, 2002).

The main goal of the protocols proposed in this paper is also to reduce the overhead resulting from flooding. However, the strategy we propose is based on selecting a subset of neighbors that can forward a broadcast packet to a large number of nodes. Our protocols do not require distance measurement or exact location determination devices. A forwarding node that receives the broadcast packet selects a subset of its neighbors based on their ability to reach additional nodes, and only the selected neighbors will continue the broadcasting process. To begin with, the source node selects its forwarding neighbors that will participate in the process. By applying this strategy, we have, in particular, come up with route discovery protocols that have very low overhead. Yet, they are able to adapt quickly to changes in the network topology, providing also high packet delivery ratio and low end-to-end delay. The proposed protocols have been implemented and simulated using the GloMoSim 2.03 network simulator.

The rest of this paper is organized as follows. Section 2 contains a review of previous research work related to network-wide broadcasting. In Section 3, we present the proposed neighborhood-based schemes. In Section 4, we discuss the simulation environment, the simulation parameters and the various performance metrics that are measured in the simulations. In addition, the simulation results are presented and analyzed. Simulation results for larger area are presented in Section 5. Finally, in Section 6, we conclude this paper and provide directions for future work.

## 2. RELATED WORK

In Mobile Ad hoc Networks, NWB is used extensively for many purposes, including route discovery, address resolution and carrying out other network layer tasks (Rogers & Abu-Ghazaleh, 2005). For instance, reactive routing protocols such as AODV (Perkin et al., 1999) and DSR (Johnson, 1994) benefit from the information gathered while broadcasting.
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