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A link stability-based multicast routing protocol for wireless mobile ad hoc networks

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ABSTRACT

Recently, several studies have been conducted to design mobility-based multicast routing protocols for wireless mobile ad hoc networks (MANET). These protocols assume that the mobility parameters of the network are fixed, and so they cannot perform well under real MANET scenarios in which the mobility parameters of the hosts vary over time at random. Finding the optimal solution to the multicast routing problem is incredibly hard, if the mobility parameters are assumed to be random variables. This becomes more difficult when the probability distribution function of these random variables is assumed to be unknown. In this paper, we propose a weighted multicast routing algorithm for MANET in which the mobility parameters are supposed to be random variables with unknown distribution. In this method, the multicast routing problem is first transformed into an equivalent stochastic Steiner tree problem in which the random weight associated with a communication link is its expected duration time. Then, a learning automata-based algorithm is proposed for solving the proxy Steiner tree problem. The aim of the proposed algorithm is to find the most stable multicast route (with the maximum duration) against the host mobility. Experimental results confirm the superiority of the proposed method over the best existing mobility-based multicast routing protocols in terms of the packet delivery ratio, multicast route lifetime, control message overhead, and end-to-end delay.

1. Introduction

Multicasting is a technique for data routing in networks that allows the same message is forwarded to a group of destinations simultaneously. Multicast routing problem (MRP) is one of the most challenging problems in communication networks in which the source node is connected to a set of destinations, while some cost function is simultaneously minimized. The most efficient method is forwarding the multicast packets along the tree edges, and so the multicast routing problem can be defined as a Steiner tree problem where the multicast group members are terminals (leaf nodes) in the Steiner tree (Wu et al., 2004). Finding the Steiner tree is known to be NP-hard in graph theory (Karp, 1972) even if links have unit cost (Aggarwal et al., 2006). However, the minimal spanning tree problem that is a well known approach for broadcasting has also been used in Chiang et al. (2007) and Rodolakis et al. (2008) to model the multicast routing problem. In MANET due to the host heterogeneity, host mobility, strict resource limitations, and host failure, the characteristics of the network (e.g., residual energy, mobility parameters, transmission power, etc.) are stochastic and vary over time. In these networks, the deterministic approaches in which the network parameters are assumed to be fixed cannot reflect the real behavior of the random environment, and so do not perform well. This paper proposes a multicast routing protocol for MANET in which the stability of the communication links changes with time due to host mobility.

Lee et al. (1999) proposed an on-demand routing technique called ODMRP for multicasting in ad hoc networks in order to reduce the channel overhead and improve scalability. ODMRP is implemented based on the forwarding group concept (Chiang et al., 1998) in which a set of nodes are responsible for forwarding multicast packets along the shortest paths connecting the multicast sender to receivers. ODMRP is a reactive protocol that delivers packets to destinations on a mesh topology using limited flooding of data. Simplicity and scalability are the major strengths of ODMRP. An enhanced version of ODMRP with motion adaptive refresh called E-ODMRP was proposed by Oh et al. (2008) in which the adaptation is driven by receivers' reports on link breakages rather than mobility prediction. The rate at which E-ODMRP periodically refreshes the network information is dynamically adapted to the host mobility. E-ODMRP unifies the local recovery mechanism and receiver joining process. Local

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