Available online at www.sciencedirect.com
ScienceDirect
ELSEVIER
April 2017, 24(2): 66–71
www.sciencedirect.com/science/journal/10058885
The Journal of China Universities of Posts and Telecommunications
http://jcupt.bupt.edu.cn

Location aided probabilistic broadcast algorithm for mobile Ad-hoc network routing

Bai Yuan[1,2] (✉), An jie[1], Zhang Huibing[2]

1. School of Electrical and Electronic Engineering, Tianjin University of Technology, Tianjin 300384, China
2. Guangxi Key Laboratory of Trusted Software, Guilin University of Electronic Technology, Guilin 541004, China

Abstract

On-demand routing protocols are widely used in mobile Ad-hoc network (MANET). Flooding is an important dissemination scheme in routing discovering of on-demand routing protocol. However, in high-density MANET redundancy flooding packets lead to dramatic deterioration of the performance which calls broadcast storm problem (BSP). A location-aided probabilistic broadcast (LAPB) algorithm for routing in MANET is proposed to reduce the number of routing packets produced by flooding in this paper. In order to reduce the redundancy packets, only nodes in a specific area have the probability, computed by location information and neighbor knowledge, to propagate the routing packets. Simulation results demonstrate that the LAPB algorithm can reduce the packets and discovery delay (DD) in the routing discovery phase.

Keywords mobile Ad-hoc network, route protocol, broadcast storm problem, probabilistic broadcast

1 Introduction

In MANET, on-demand protocols and flooding are used to propagate the route packets. In low-density network flooding is the most efficient scheme which uses all neighbor nodes to discover route. However, the drawback of flooding is that overwhelming redundancy packets can cause the BSP due to collisions and contention as the number of nodes increases [1–2]. In order to alleviate the BSP probabilistic broadcast algorithms are proposed in the last decade [3–6]. In the probabilistic broadcast algorithms [7–9], a source node broadcasts the route request (RREQ) to its all neighbors. When first time receiving a RREQ, neighbor node with a probability P broadcasts RREQ to its neighbors and with an other probability to discard the RREQ.

Dynamic probabilistic broadcasting scheme (DPBSC) is proposed in Ref. [7], and it adopts the cross-layer design which lets routing layer share the received signal power information at medium access control (MAC) layer and adjusts the value of the rebroadcast probability dynamically according to its additional transmission range benefited from rebroadcast. After a node receives a broadcasting packet, DPBSC refers to its additional coverage of rebroadcast to determine the rebroadcast probability. However this algorithm based on the received signal power information will cause redundancy packets in high-density areas.

Probabilistic broadcast based on Jaccard distance is proposed in Ref. [8]. Instead of Euclidean distance the Jaccard distance is used to select dissimilar nodes during the discovery phase in order to reduce redundancy. The Jaccard distance is strongly dependent on the intersection area of two nodes' radio transmission ranges. But this algorithm cannot adjust the probability of broadcast when the density of network has changed.

Gossip is proposed in Ref. [9]. Gossip sets the optimum probability within the interval $[0.65, 0.75]$ in networks with fewer than 1 000 nodes. It also proposes $P = 0.5$ as an optimum value for network scenarios with certain node

---

Received date: 07-01-2017
Corresponding author: Bai Yuan, E-mail: snowbaiyuan@163.com
DOI: 10.1016/S1005-8885(17)60200-0

densities (150 nodes in a rectangular grid of $1\ 650\ \text{m}\times 1\ 200\ \text{m}$). Furthermore, when the node density becomes lower, the value of *P* should be set higher so that routing packets could be transmitted to the destination node.

In the probabilistic broadcast algorithms the key question is to find the optimum probability *P*. The optimum value for *P* should vary from scenario to scenario, which requires topologies and node mobile models being considered. The above algorithms cannot adjust the probability *P* as the changing of network environment. Furthermore, they may choose some farther nodes to transmit packets.

In this paper, LAPB algorithm is proposed. It uses an adaptive probability based on location information and neighbor knowledge to help routing. According to the location information, LAPB selects more effective nodes to broadcast RREQ packets in order to save overhead. By neighbor knowledge the changing of densities in local area can be recognized by forwarding nodes, and then the probability of broadcast is varied. Simulation results demonstrate that LAPB reduces the overhead and alleviates BSP in MANET.

2 Proposed approach

In this paper, it is assumed that the mobile nodes are moving in a two-dimensional (2D) plane. Location information used in the LAPB algorithm may be provided by the global positioning system (GPS). With the availability of GPS, it is possible for a node to know its physical location. Each node gets its neighbor nodes' location information by periodic HELLO messages.

Assume that source node *S* knows the destination node *D* was at location *L* at time t_0, and the current time is t_1. Consider node *S* needs to find a route to node *D*. Node *S* defines (implicitly or explicitly) a forward zone for the RREQ. A node forwards a RREQ only if it belongs to the forward zone. If in high-density areas there are still too many neighbour nodes rebroadcasting RREQ in the forward zone which leads to a high overhead, see Fig. 1. LAPB uses location information to reduce the number of the nodes that will forward routing packets. The location information of neighbor node is shown in Fig. 2. In Fig. 2 $X_{I,J}$ represents the projection of neighbor node J, and it is on the line of current node *I* to the destination node *D* [10–11].

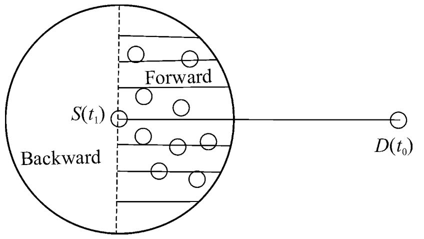

Fig. 1 Definitions of forward and backward zone

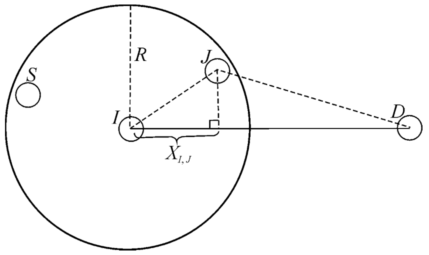

Fig. 2 Projection of neighbour node

$$X_{I,J} = d_{I,J}\frac{d_{I,J}^{\ 2}+d_{I,D}^{\ 2}-d_{J,D}^{\ 2}}{2d_{I,J}d_{I,D}} = \frac{d_{I,J}^{\ 2}+d_{I,D}^{\ 2}-d_{J,D}^{\ 2}}{2d_{I,D}} \tag{1}$$

where, $d_{I,J}$ is the Euclidean distance of node *I*, *J*. *S* and *D* represent source and destination node respectively.

I and *J* know the location information each other and the destination node's location information by RREQ, so that they can compute $X_{I,J}$ individually.

2.1 Algorithm of LAPB

In LAPB, the broadcast probability $P_{I,J}$ is determined by the projection of nodes *J* in forward zone of node *I*. At first, LAPB sets the probability function as

$$P_{I,J} = \left(\frac{X_{I,J}}{R}\right)^g;\quad 0 < X_{I,J} \leqslant R \tag{2}$$

where $P_{I,J}$ is in the interval $[0,1]$. *R* is the transmission range of the nodes. *g* is an adjust value. A big *g* is suitable for high-density networks. In case of low-density network, a small *g* is the best to ensure high reachability [2].

In large scale networks the densities in difference areas may be variable. LAPB wants to adjust the value of *g* through neighbour knowledge to reduce the overhead in some high-density areas of network.

LABP updates broadcast probability $P_{I,J}$ with following:

$$P_{I,J} = \begin{cases} \left(\dfrac{X_{I,J}}{R}\right)^{N_I}; & X_{I,J} > 0, N_I > k \\ 0; \ X_{I,J} < 0 \end{cases} \tag{3}$$

where N_I is the quantity of neighbor nodes in the