A Protocol for Reducing Routing Overhead in Mobile Ad Hoc Networks

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Abstract— In a mobile ad hoc network (MANET), frequent link breakage occures due to mobility of nodes which leads to frequent route discoveries. This overhead of route discovery cannot be tolerated. Broadcasting is a fundamental data dissemination mechanism in a route discovery where mobile nodes blindly rebroadcast the RREQ packet unless it got route up to the destination. Thus it raises the broadcast storm issue. In this paper we are going to propose a protocol for reducing routing overhead in mobile ad hoc network.We propose rebroadcast delay to determine the rebroadcast order.We set a rebroadcast probability by aggregating additional coverage ratio and connectivity factor.This approach would combines the advantages of probabilistic mechanism and neighbor coverage knowledge which can reduce the number of retransmissions so as to decrease the routing overhead which will improve the packet delivery ratio.

Keywords- Mobile ad hoc networks, neighbor coverage, network connectivity, probabilistic rebroadcast, routing overhead.

I. INTRODUCTION

Mobile ad hoc networks (MANETs) consist of a collection of mobile nodes which can move openly. These nodes are without infrastructure and can be dynamically self organized into arbitrary topology networks. One of the vital challenges in MANETs is the design and implementation of dynamic routing protocols with less overhead and better performance. Ad hoc On-demand Distance Vector Routing (AODV) and Dynamic Source Routing (DSR) protocols have been proposed for mobile ad hoc network. AODV and DSR protocol are on demand routing protocols, and they can improve the scalability of mobile ad hoc networks by limiting the routing overhead when a new route is demanded. Node mobility in MANETs leads to frequent link breakages and route discovery. Frequent path failure increases the overhead of routing protocols for route discovery which reduces the packet delivery ratio and increases end-to-end delay. So an essential issue is that to reduce the routing overhead in route discovery.

II. RELATED WORK

Broadcasting is an effective tool for route discovery, but the routing overhead related to the broadcasting can be quite large, especially in highly dynamic and mobile networks [2]. Ni et al. [3] Studied the broadcasting protocol experimentally and has shown that the rebroadcast is very expensive and consumes too much network resource. In highly dynamic and mobile networks, broadcasting is an effective tool for route discovery, but the routing overhead related with each broadcasting can be large. Ni et al. [3] has studied the broadcasting protocol analytically and experimentally and has concluded that the rebroadcast is very expensive and it consumes network resource heavily. The problems such as redundant retransmissions, contentions and collisions are caused by large routing overhead. Thus, optimizing the broadcasting in a route discovery is essential to improve the routing performance in MANET. Haas et al. [4] has proposed a gossip based approach, where each mobile node forwards a packet with a probability. They concluded that gossip-based approach can save up to 35 percent overhead compared to the flooding. However, the improvement of gossip-based approach is limited [2] when the network density is high or the traffic load is heavy. Abdulai et al. [5] has proposed a Dynamic Probabilistic Route Discovery (DPR) scheme and it is based on neighbor coverage. In this approach the forwarding probability is determined by each node according to the number of its neighbors and the set of neighbors which have been covered by the previous broadcast. This approach only considers the coverage ratio by the previous node and it has not considered the neighbors receiving the duplicate RREQ packet. Thus, there is a chance of further optimization of the DPR protocol.

III. PROBABILISTIC REBROADCAST PROTOCOL

In this section we are discussing how to calculate rebroadcast delay and rebroadcast probability of the Probabilistic Rebroadcast (PR) protocol, which is based on neighbor coverage [1]. PR protocol has been proposed for reducing the routing overhead in highly dynamic network. Other protocols like AODV and DPR have been proposed for MANET and they improve the scalability of MANET but due to high mobility of node in MANET they are limited. We have proposed PR protocol to improve the performance of node in high dynamic and heavy loaded traffic network.

A. Calculation of Uncovered Neighbors Set and Rebroadcast Delay.

When node n_i receives RREQ packet from its neighbor node s, it can use the neighbor list available in the RREQ packet to calculate how many its neighbors have not been covered by the RREQ packet which has been delivered from node s. If node n_i has more neighbors uncovered by the RREQ packet from node s, which means that if node n_i rebroadcasts the RREQ packet, this RREQ packet could reach more extra neighbor nodes.We calculate the Uncovered Neighbors set $U(n_i)$ of node n_i as follows:

$$U(n_i)=N(n_i)- [N(n_i) \cap N(s)]- \{s\}.$$

We obtain the initial UCN set. Due to broadcast characteristics of RREQ packet, node n_i can receive the redundant RREQ packets from its neighbors. Node n_i could further adjust the $U(n_i)$ with the neighbor knowledge. where $N(s)$ and $N(n_i)$ are the neighbors sets of node s and n_i respectively. s is the node which sends the RREQ packet to node n_i.The Rebroadcast delay T_d (n_i) of node n_i is calculated as follows:

$$T_p(n_i) = 1 - \frac{|[N(n_i) \cap N(s)]|}{|N(s)|}$$

$$T_d\ (n_i) = \text{MaxDelay} \times T_p(n_i)$$

where $T_p(n_i)$ is the delay ratio of node n_i and MaxDelay is a Small constant delay.| | is the number of elements in a set.

B. Calculation of Neighbor Knowledge and Rebroadcast Probability.

If node n_i receives a redundant RREQ packet from its neighbor n_j then node n_i can further adjust its UCN set according to the neighbor list in the RREQ packet from n_j. Then $U(n_i)$ can be adjusted as follows:

$$U(n_i)= U(n_i) - [U(n_i) \cap N(n_j)]$$

After adjusting the $U(n_i)$, the RREQ packet received from n_j is discarded.The rebroadcast probability is composed of additional coverage ratio and connectivity factor. Additional coverage ratio $R_a(n_i)$ of node n_i is defined as follows:

$$R_a(n_i) = \frac{|U(n_i)|}{|N(n_i)|}$$

This formula indicates the ratio between the number of nodes that are additionally covered by this rebroadcast to the total number of neighbors of node n_i. $F_c(n_i)$ is defined as a connectivity factor as follows:

$$F_c(n_i)= \frac{N_c}{|N(n_i)|}$$

Where N_c=5.1774 log n, and n is the number of nodes in the network.The rebroadcast probability $P_{re}(n_i)$ of node n_i as follows:

$$P_{re}(n_i) = F_c(n_i) \times R_a(n_i)$$

Where, if the $P_{re}(n_i)$ is greater than 1, we set the $P_{re}(n_i)$ to 1.

IV. PROTOCOL IMPLEMENTATION AND PERFORMANCE EVALUATION

To implement our proposed protocol we modify the given source code of AODV in NS-2 (v2.34). PR protocol needs Hello packets to obtain the information about neighbors, and also needs to carry the neighbor list in the RREQ packet. Therefore, some techniques have been used to reduce the overhead of Hello packets and neighbor list in the RREQ packet[1].To evaluate the performance of the proposed PR protocol, we have compared it with some other protocols using the NS-2 simulator.

TABLE I. SIMULATION PARAMETERS

Simulation Parameter	Value
Simulator	NS-2 (v.2.34)
Topology Size	1000m × 1000m
Number of Nodes	50,100,150....200
Traffic Type	CBR
Transmission Range	250m
Bandwidth	2Mbps
Interface Queue Length	50
Number of CBR Connections	8,10,12....20
Packet Size	512 bytes
Packet Rate	4 Packets /sec
Pause Time	0 s
Min speed	1m/sec
Max speed	5m/sec

V. CONCLUSION

In this paper, we have proposed a Probabilistic Rebroadcast protocol, which is based on Neighbor coverage for reducing the routing overhead in mobile ad hoc networks. We have also proposed a new scheme for dynamically calculating the rebroadcast delay and it is used to determine the forwarding order and exploit the neighbor coverage knowledge. When the network is dense, the PR protocol increases the packet delivery ratio when compared with the AODV. The Proposed protocol reduces the network collision, the average end-to-end delay and contention by reducing the number of redundant rebroadcast, so as to increase the packet delivery ratio. The simulation results have shown that the proposed protocol has good performance compared to AODV protocol when the network traffic is heavy loaded.

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