E-Prnc: Enhanced Probabilistic Rebroadcast Based On Neighbor Coverage Area

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ABSTRACT- The mobility of nodes in mobile adhoc network leads to frequent link breakages and path failures which in turn lead to route discoveries. For route discovery, broadcasting is an efficient routing mechanism. Broadcasting induces excessive redundant retransmissions of RREQ packets and thus causes routing overhead. The overhead of route discovery cannot be neglected. Limiting the number of rebroadcasts can optimize the broadcasting. An enhanced probabilistic rebroadcast based on neighbor coverage area is used here to reduce the number of retransmissions and thus the routing overhead. Firstly, a novel rebroadcast delay is calculated using an uncovered neighbor set. The delay is used to calculate the rebroadcast order. And then an additional coverage ratio and connectivity factor is defined by sensing the neighbor coverage knowledge and using this, a rebroadcast probability is calculated. Therefore the performance of routing can be increased and thus the Quality Of Service.

Index Terms – Mobile adhoc network, route discovery, neighbor coverage, probabilistic rebroadcast, routing overhead.

I. INTRODUCTION

Mobile Adhoc Networks (MANETs) consist of a collection of mobile nodes that can communicate without the aid of any infrastructure and can be deployed for many applications such as battlefield, disaster relief and rescue etc. One of the fundamental challenges of MANETs is the design of dynamic routing protocols with good performance and less overhead. Adhoc On-Demand Vector routing(AODV) and Dynamic Source Routing(DSR) are some of the on-demand routing protocols that can improve the scalability of nodes by limiting the routing overhead when a new route is requested. Due to node mobility in MANETs, frequent link breakages may lead to frequent path failures and route discoveries, which could increase the overhead of routing protocols and reducing the packet delivery ratio and increasing the end to end delay. Thus reducing the routing overhead in route discovery is an essential problem. Many routing protocols have been suggested for MANETs over the past few years In general, the routing protocols for MANETs fall into two categories based on how route discovery process is initiated: proactive and reactive (or on demand). Proactive routing protocols, such as DSDV and OLSR, attempt to maintain consistent and up-to-date routing information from each node to every other node in the network. Each mobile node is required to periodically discover and maintain routes to every possible destination in the network. In the on-demand routing protocols, such as AODV and DSR, routes are discovered only when they are needed.

Each node maintains a route for a source-destination pair without the use of periodic routing table exchanges or full network topological view. Additionally, there are hybrid protocols that combine the features of both proactive and on demand protocols. In such protocols, each node maintains routing information about its zone using proactive routing, but uses on-demand routing outside the zone. In conventional on-demand routing protocols, a node that needs to discover a route to a particular destination, broadcasts a Route Request control packet (RREQ) to its immediate neighbours. Each mobile node blindly rebroadcast the received RREQ packet until a route is established. This method of route discovery is referred to as blind flooding. Since every mobile node is required to rebroadcast the received RREQ packet once. If the destination node is reached, the maximum number of rebroadcasts is about N – 2, where N is the total of number of nodes in the Network. This can potentially lead to excessive redundant retransmissions and hence causing considerable collisions of packets in a contention-based channel, especially in dense wireless networks. Such a phenomenon induces what is known as broadcast storm problem, which increases the routing overhead and end to end delay. Using E-PRNC the broadcast storm problem is avoided and thus the routing overhead.

II. RELATED WORK

Broadcasting is an effective mechanism for route discovery, but the routing overhead associated with the broadcasting can be quite large, especially in high dynamic networks [9].

Ni *et al.* [5] studied the broadcasting protocol analytically and experimentally, and showed that the rebroadcast is very costly and consumes too much network resource. The broadcasting incurs large routing overhead and causes many problems such as redundant retransmissions, contentions, and collisions [5]. Thus, optimizing the broadcasting in route discovery is an effective solution to improve the routing performance.

Haas *et al.* [10] proposed a gossip-based approach, where each node forwards a packet with a probability. They showed that gossip-based approach can save up to 35% overhead compared to the flooding. However, when the network density is high or the traffic load is heavy, the improvement of the gossip based approach is limited [9].

Kim *et al.* [8] proposed a probabilistic broadcasting scheme based on coverage area and neighbor confirmation. This scheme uses the coverage area to set the rebroadcast probability, and uses the neighbor confirmation to guarantee reachability.

Peng *et al.* [11] proposed a neighbor knowledge scheme named Scalable Broadcast Algorithm (SBA). This scheme determines the rebroadcast of a packet according to the fact whether this rebroadcast would reach additional nodes.

Abdulai *et al.* [12] proposed a Dynamic Probabilistic Route Discovery (DPR) scheme based on neighbor coverage. In this approach, each node determines the forwarding probability according to the number of its neighbors and the set of neighbors which are covered by the previous broadcast. This scheme only considers the coverage ratio by the previous node, and it does not consider the neighbors receiving the duplicate RREQ packet. Thus, there is a room of further optimization and extension for the DPR protocol.

Chen *et al.* [13] proposed an AODV protocol with Directional Forward Routing (AODV-DFR) which takes the directional forwarding used in geographic routing into AODV protocol. While a route breaks, this protocol can automatically find the next hop node for packet forwarding.

Keshavarz-Haddad *et al.* [14] proposed two deterministic timer-based broadcast schemes: Dynamic Reflector Broadcast (DRB) and Dynamic Connector-Connector Broadcast (DCCB). They pointed out that their schemes can achieve full reachability over an idealistic lossless MAC layer, and for the situation of node failure and mobility, their schemes are robustness.

Stann *et al.* [15] proposed a Robust Broadcast Propagation (RBP) protocol to provide near perfect reliability for flooding in wireless networks, and this protocol also has a good efficiency. They presented a new perspective for broadcasting: not to make a single broadcast more efficient but to make a single broadcast more reliable, which means by reducing the frequency of upper-layer invoking flooding to improve the overall performance of flooding.

III. OBJECTIVES & OVERVIEW OF THE PROPOSED MECHANISM

A. Objectives

The initial motivation of the system is to optimize broadcasting. For optimization of broadcasting in route discovery many methods have been introduced. These methods have their own advantages as well as disadvantages .But to optimize the rebroadcast in a more efficient manner a new system is used here by combining the advantages of Neighbor coverage based method and probabilistic methods. The main objectives of the Enhanced Probabilistic Rebroadcast based on Neighbor Coverage area is:

- To optimize the number of redundant retransmissions.
- To increase the routing performance
- To reduce the routing overhead

B. Overview of the proposed Mechanism

The initial motivation of Enhanced Probabilistic Rebroadcast based on Neighbor Coverage area is to limit the number of rebroadcast which can effectively optimize the broadcasting. An Uncovered Neighbor Set is defined first and using this novel rebroadcast delay is calculated. The rebroadcast delay is to determine the forwarding order. The node which has more common neighbors with the previous node has the lower delay. If this node rebroadcasts a packet, then more common neighbors will know this fact. Therefore the rebroadcast delay enables the information that the nodes have transmitted the packet spread to more neighbors. Also we are proposing a rebroadcast probability. It considers the information about uncovered neighbors, connectivity metric and local node density to calculate the rebroadcast probability. The rebroadcast probability is composed of two parts:a) Additional coverage ratio, which is the ratio of the number of nodes that should be covered by a single broadcast to the total number of neighbors; and b)Connectivity factor, which reflects the relationship of network connectivity and the number of neighbors of a given node.

IV. ENHANCED PROBABILISTIC REBROADCAST SYSTEM

A. UNCOVERED NEIGHBOR SET AND REBROADCAST DELAY

When node ni receives an RREQ packet from its previous node s, it can use the neighbor list in the RREQ packet to estimate how many its neighbors have not been covered by the RREQ packet from s. If node ni has more neighbors uncovered by the RREQ packet from s, which means that if node ni rebroadcasts the RREQ packet, the RREQ packet can reach more additional neighbor nodes. To quantify this, the UnCovered Neighbors (UCN) set U(ni) of node

Ni is defined as follows:

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

Where N(s) and N(ni) are the neighbors sets of node s and ni, respectively. s is the node which sends an RREQ packet to node ni. Due to broadcast characteristics of an RREQ packet, node ni can receive the duplicate RREQ packets from its neighbors. Node ni could further adjust the U(ni) with the neighbor knowledge. In order to sufficiently exploit the neighbor knowledge and avoid channel collisions, each node should set a rebroadcast delay. The delay is used to determine the forwarding order. When a neighbor receives an RREQ packet, it could calculate the rebroadcast delay according to the neighbor list in the RREQ packet and its own neighbor list. The rebroadcast delay, Td(ni) of node ni is defined as follows:

$$Tp(ni) = 1 - \underline{|N(s) \cap N(ni)|}$$

$|N(s)|$

$Td(ni) = MaxDelay \times Tp(ni)$,

where Tp(ni) is the delay ratio of node ni, and MaxDelay is a small constant delay. | · | is the number of elements in a set.

The rebroadcast delay is defined with the following reasons: Firstly, the delay time is used to determine the node transmission order. To sufficiently exploit the neighbor coverage knowledge, it should be disseminated as quickly as possible. When node s sends an RREQ packet, all its neighbors ni, i = 1, 2, · · · , |N(s)| receive and process the RREQ packet. Here it is assuming that node nk has the largest number of common neighbors with node s and node nk has the lowest delay. Once node nk rebroadcasts the RREQ packet, there are more nodes to receive it, because node nk has the largest number of common neighbors. Then there are more nodes which can exploit the neighbor knowledge to adjust their UCN sets. Of course, whether node nk rebroadcasts the RREQ packet depends on its rebroadcast probability. The objective of this rebroadcast delay is not to rebroadcast the RREQ packet to more nodes, but to disseminate the neighbor coverage knowledge more quickly. After determining the rebroadcast delay, the node can set its own timer.

B. NEIGHBOR KNOWLEDGE AND REBROADCAST PROBABILITY

The node which has a larger rebroadcast delay may listen to RREQ packets from the nodes which have lower one. For example, if node ni receives a duplicate RREQ packet from its neighbor nj , it knows that how many its neighbors have been covered by the RREQ packet from nj . Thus, node ni could further adjust its UCN set according to the neighbor list

in the RREQ packet from nj . Then the U(ni) can be adjusted as follows:

$U(ni) = U(ni) - [U(ni) \cap N(nj)]$.

After adjusting the U(ni), the RREQ packet received from nj is discarded. When the timer of the rebroadcast delay of node ni expires, the node obtains the final UCN set. The nodes belonging to the final UCN set are the nodes that need to receive and process the RREQ packet.

The additional coverage ratio (Ra(ni)) of node ni as:

$$Ra(ni) = \frac{|U(ni)|}{|N(ni)|}$$

This metric indicates the ratio of the number of nodes that are additionally covered by this rebroadcast to the total number of neighbors of node ni. The nodes that are additionally covered need to receive and process the RREQ packet. As Ra becomes bigger, more nodes will be covered by this rebroadcast, and more nodes need to receive and process the RREQ packet, and, thus, the rebroadcast probability should be set to be higher. If each node connects to more than 5.1774 log n of its nearest neighbors, then the probability of the network being connected is approaching 1 as n increases, where n is the number of nodes in the network. Then we can use 5.1774 log n as the connectivity metric of the network. The ratio of the number of nodes that need to receive the RREQ packet to the total number of neighbors of node ni is assumed to be Fc(ni). In order to keep the probability of network connectivity approaching 1, we have a heuristic formula: $|N(ni)| \cdot Fc(ni) \geq 5.1774 \log n$. Then, we define the minimum Fc(ni) as a Connectivity factor, which is:

$$Fc(ni) = \frac{Nc}{|N(ni)|}$$

where Nc = 5.1774 log n, and n is the number of nodes in the network.

V. PERFORMANCE EVALUATION

A. Simulation Model and Parameters

We use NS2 to simulate our proposed algorithm. In our simulation, 50 to 300 mobile nodes move in a 1000 meter x 1000 meter square region for 50 seconds simulation time. We assume each node moves independently with the same average speed. All nodes have the same transmission range of 250 meters. The simulated traffic is Constant Bit Rate (CBR).

Our simulation settings and parameters are summarized in table 1.

SIMULATION PARAMETER	VALUE
Simulator	NS-2
Topology Size	1000x1000
Transmission range	250 m
Bandwidth	2Mbps
Traffic type	CBR
Number of CBR connections	10,12...,15,...,18,20
Packet Size	512 bytes
Packet Rate	4 packets/sec
Pause Time	0s
Min Speed	1m/s
Max speed	5m/s

B. Performance Metrics

E-PRNC protocol needs Hello packets to obtain the neighbor information, and also needs to carry the neighbor list in the RREQ packet. Therefore, in the implementation of this protocol, some techniques are used to reduce the overhead of Hello packets and neighbor list in the RREQ packet. They are:

i) A node sending any broadcasting packets can inform its neighbors of its existence, the broadcasting packets such as RREQ and route error (RERR) can play a role of Hello packets. So the periodical hello mechanism is not used here instead the below mechanism is used here.

Only when the time elapsed from the last broadcasting packet (RREQ, RERR, or some other broadcasting packets) is greater than the value of HelloInterval, the node needs to send a Hello packet. The value of HelloInterval is equal to that of the original AODV.

ii) In order to reduce the overhead of neighbor list in the RREQ packet, each node needs to monitor the variation of its neighbor table and maintain a cache of the neighbor list in the received RREQ packet.

In order to evaluate the performance of the proposed E-PRNC protocol, it is compared with some other protocols using the NS-2 simulator. Broadcasting is a fundamental and effective data dissemination mechanism for many applications in MANETs. In this only route request is studied.. In order to compare the routing performance of the proposed NCPR protocol, we choose the Dynamic Probabilistic Route Discovery (DPR) protocol which is an optimization scheme for reducing the overhead of RREQ packet incurred in route discovery in recent literature, and the conventional AODV protocol.

The performance of routing protocols is evaluated using the following performance metrics:

• MAC collision rate: The average number of packets (including RREQ, route reply (RREP), RERR and CBR data packets) dropped resulting from the collisions at the MAC layer per second.

• Normalized routing overhead: The ratio of the total packet size of control packets (include RREQ, RREP, RERR and Hello) to the total packet size of data packets delivered to the destination. For the control packets sent over multiple hops, each single hop is counted as one transmission.

• Packet delivery ratio: The ratio of the number of data packets successfully received by the CBR destinations to the number of data packets generated by the CBR sources.

• Average end-to-end delay: the average delay of successfully delivered CBR packets from source to destination node. It includes all possible delays from the CBR sources to the destinations.

The performance of the protocol is calculated with both the varied number of nodes and varied random packet loss rate.

C. Results

In my first experiment i compare the MAC collision rate with number of nodes, in which E-PRNC yields 61.6% less collision rate than existing one.

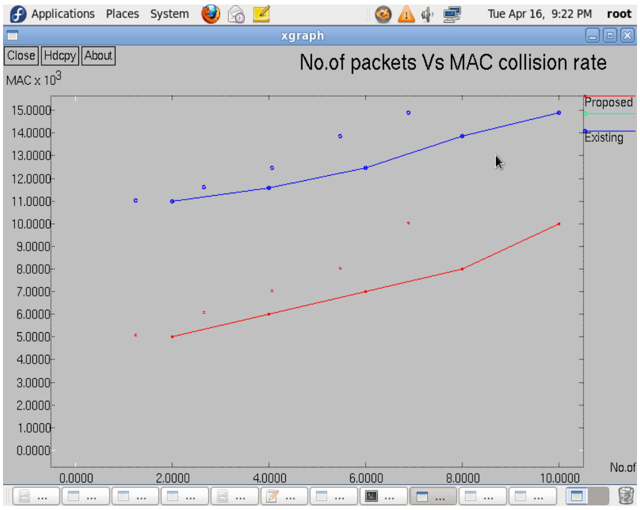

Figure 1: MAC Collision rate with number of packets

Secondly i compare the End-to-End Delay with number of nodes, in which E-PRNC yields 53.9% less delay than existing one.

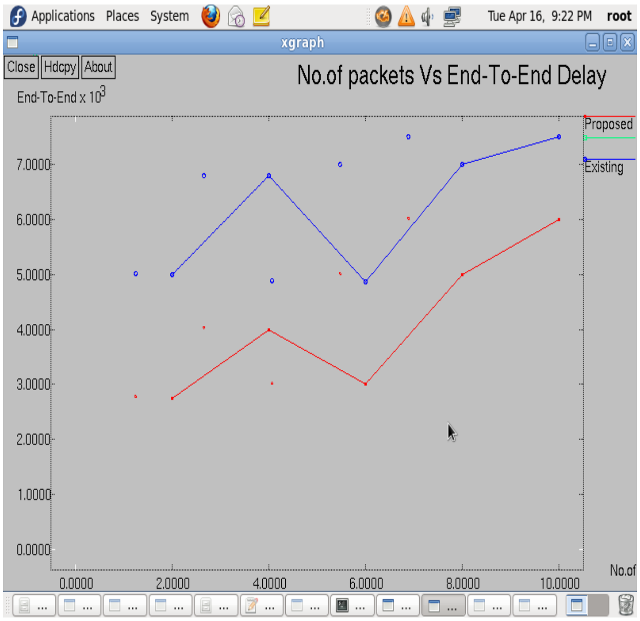

Figure 2: End-to-End Delay with number of packets

VI. CONCLUSION

In this paper an enhanced probabilistic rebroadcast protocol based on neighbor coverage is proposed to reduce the routing overhead due to the number of rebroadcasts in MANETs. This neighbor coverage knowledge includes additional coverage ratio and connectivity factor. A new scheme is proposed to dynamically calculate the rebroadcast delay, which is used to determine the forwarding order and more effectively exploit the neighbor coverage knowledge. The proposed protocol generates less rebroadcast traffic than the flooding and some other area based and counter based methods. Because of less redundant rebroadcast, the proposed protocol mitigates the network collision and contention, so as to increase the packet delivery ratio and decrease the average end-to-end delay. The simulation results also show that the proposed protocol has good performance when the network is in high-density or the traffic is in heavy load.

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Authors Profile

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