International Journal of Innovative Research in Electronics and Communications (IJIREC)
Volume 1, Issue 7, October 2014, PP 1-8
ISSN 2349-4042 (Print) & ISSN 2349-4050 (Online)
www.arcjournals.org

A Neighbor Coverage-Based Rebroadcast in MANETs Based on Energy Efficient Rebroadcast Probability

Safna Sulaiman
PG Scholar in CSE
AJCE, Kanjirappally, Kerala
Safna.sulai@gmail.com

Tintu Alphonsa Thomas
Asst. Professor in CSE
AJCE, Kanjirppally, Kerala
tintualphonsathomas@amaljyothi.ac.in

Abstract: *Mobile ad hoc networks (MANETs) consist of a set of mobile nodes lacking a predetermined infrastructure. Due to this dynamic nature, there exist rapid link breakages which leads to frequent path failures and simultaneous route discoveries. For improving the routing performance we propose a novel routing protocol called Enhanced Neighbor Coverage-Based Probabilistic Rebroadcast Protocol (ENCPR) for reducing routing overhead in MANETs, it propose the strong coverage condition for reducing the number of redundant transmissions. It also checks the link and path stability among nodes to allow the reduction of control overhead and it can offer some benefits also in terms of energy saving in mobile ad hoc networks. It can get hold of more precise additional coverage ratio by sensing neighbor coverage knowledge, it also identify a connectivity factor to offer the node density adaptation. By combining the additional coverage ratio and connectivity factor, it put a sensible rebroadcast probability. This approach combines the advantages of the neighbor coverage knowledge and the probabilistic mechanism, which can drastically diminish the number of retransmissions so as to reduce the routing overhead, and can also improve the routing performance*

1. INTRODUCTION

Mobile ad hoc networks (MANETs) consist of a set of mobile nodes lacking a predetermined infrastructure. The network topology may change quickly and erratically in time. New nodes can connect the network, and other nodes may depart the network. Due to this dynamic nature, there exist rapid link breakages which leads to frequent path failures and simultaneous route discoveries. These nodes can be vigorously self organized into arbitrary topology networks without a predetermined infrastructure. When a node need to send data to destination, it first starts route discovery process. The node broadcasts a RREQ message to the network. A route can be determined when the RREQ reaches either the destination itself, or an intermediate node with a 'fresh enough' route to the destination. The route is made available by send a RREP back to the source node of the RREQ. Each node receiving request caches a route back to the originator of the request, so that the RREP can be send from the destination along a path to that originator, or likewise from any intermediate node that is able to satisfy the request. Due to the random movement of nodes in MANET causes frequent link breakage and recurrent execution of route discovery process. It leads heavy traffic in the network and causes contention and collision .One of the fundamental challenges of MANETs is the design of dynamic routing protocols with good performance and less overhead. 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. Thus, optimizing the broadcasting in route discovery is an effective solution to improve the routing performance, Limiting the number of rebroadcasts can optimize the broadcasting**.**

2. RELATED WORKS

The essential and successful data dissemination mechanism selected in Mobile Ad hoc Networks for discovering route is Broadcasting. In order to avoid blind flooding as in AODV Chen et al [6] proposed dynamic rebroadcast probability update at every node stating how much overhead is created by rebroadcast and paves path to the Broadcast storm Problem. In case of high dynamic networks the routing overhead imposed is much more higher as per Abdulai et al[1] and the considerable impact on networks performance is mentioned. Haas et al. [5] showed that gossip-based approach can save up to 35 percent overhead compared to the flooding in which each node forwards a message with certain probability. However, when the network density is high or the traffic load is heavy, the improvement of the gossip-based approach is limited [1]. Kim et al. [8] proposed a probabilistic broadcasting scheme based on coverage area and neighbor confirmation. Peng and Lu [7] 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. [2] 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. Keshavarz-Haddad et al. [9] 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. [5] 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. Xin et al.[3] proposed a protocol NCPR that is Neighbor Coverage Based Probabilistic Routing protocol which covers both the methods of coverage based and probabilistic based. They have compared NCPR with AODV and DSR in end to end delay, MAC collision rate, number of CBR connections, Random packet loss rate and NCPR deals with the connectivity factor and additional coverage ratio which extends in calculating rebroadcast delay and rebroadcast probability. The proposed protocol and DSR are out performed by AODV at very light traffic load because of NCPRs delay neighbor list calculation.

3. PROPOSED METHOD

The primary motivation of the system is to optimize broadcasting for obtain the better perfomance. For this many methods have been proposed. These methods have their own advantages as well as disadvantages. The main intention of the our proposed Enhanced Neighbor coverage based probabilistic rebroadcast protocol is:

- To reduce the number of redundantretransmissions.
- To increase the Packet delivery ratio.
- To decrease the routing overhead

The main concepts of our proposed method are:

3.1 Strong Coverage Condition

In the first step, each node broadcasts its id to its 1-hop neighbors (simply called neighbors). Thus, at the last part of the first step, each node has a list of its neighbors. The proposed broadcast algorithm is a cross algorithm, and so every node that broadcasts the message could select several neighbors to forward the message. In our proposed broadcast algorithm, every broadcasting node chooses at most one of its neighbors. A node have to broadcast the message only if it is selected to forward and selection is based on coverage condition. This decision is made based on a self-pruning condition called the coverage condition. Every node u uphold two lists $List_{cov}U$ and $List_{str}U$ used for every single message m. $List_{str}U$ (m)is generated and fill up with the ids of u's neighbors upon the former reception of message m. $List_{cov}U$ also contains all the neighbors of node u. Also, every time u take delivery of m, it updates $List_{str}U$ (m) as follows: Let v be the broadcasting node and v selects a node w ($w \neq u$). Node u check it $List_{str}U$ (m) and remove all the neighbors of v from $List_{str}U$ (m) . Then it checks the priority of w in terms of connectivity. If the priority of w is greater than u, it removes all the neighbors of w from $List_{str}U$ (m). Then we check strong coverage condition for node u. If u satisfies the strong coverage condition we can abort the broadcasting of message from u. This will reduces the redundant rebroadcasting of messages.

The strong coverage condition is satisfied for node u at time t,

$$\text{If } List_{str}U\ (m)= 0 \text{ at time t.}$$

The strong coverage condition is only apply for the selected nodes to ensure that whether they need to broadcast or not. If the strong coverage condition is true for a selected node, then it will abort the broadcasting. It will reduce the redundant rebroadcast and ensures full delivery.

Calculation of Energy

In the mobile ad hoc networks, every node takes different amount of energy for transmitting and receiving the data packets. If the energy consumption decreases, then the lifetime of the nodes is increased. So, by using this energy metric the node has to be selected for data transmission and reception.

The energy needed to transmit a packet from node i:

$$E_{tx}(p,i) = I.v.t_b \text{ Joules}$$

Where `I` is the current and `v` is the voltage

The total energy E(p, i) is taken to transmit a packet is:

$$E(p, i) = E_{tx}(p, i) + E_{rx}(p,j)$$

Where E_{tx} is the amount of energy spent to transmit the packet from node i to node j and E_{rx} is the Amount of energy spent to receive the packet at node j.

Residual Energy=Available Energy–

(Transmission Energy+ Reception Energy)

$$E_{res}(i) = E_{ave}(i) - (E_{tx}(p, i) + E_{rx}(p, j))$$

Where $E_{res}(i)$ is the residual energy of node i and $E_{ave}(i)$ is the available energy. We need to select the nodes with maximum residual energy for broadcasting messages. Before forwarding we have to check that our selected node have sufficient energy for forwarding the messages.

3.2 Link Quality Estimation

Link quality estimation (LQE) mechanism is used to select the most stable paths for data delivery. For this we pick links with the maximum quality and remove those of bad quality. If we use stable routes for data delivery it will increase the throughput and life time of the network. Advantage of ink quality estimation are:

- Increasing the Packet delivery ratio and decreases the end to end delay.
- It avoids the unnecessary retransmission due to the low quality of links.
- It also reduces the energy consumption rate by avoiding the transmission in bad quality links.
- Reduce route re-selection process by preventing link failures.

The correctness of the link quality estimate will impact the integrity of decision prepared by routing protocols in selecting established routes. The more precise the estimate is, the more unwavering routes will be, and this improves delivery rates. consequently, precise link quality estimate is a requirement for efficient routing mechanisms. The initial estimator be the PRR(Packet Reception Rate) metric, which determines the average of successfully received packets. From the sequence number of packets we can obtain the number of lost packets. The second estimator be RNP(Required Number of Packet Transmissions) calculates the average number of packet transmissions/re-transmissions, essential before its successful reception.

To estimate Link quality Estimator (LQE):

$$LQE= PRR+RNP$$

PRR is Packet reception rate, it is calculated by:

$$PRR = \text{No of Received Packets} \div \text{No of sent Packets}$$

RNP is Required number of packet transmissions:

RNP = No of transmitted and Retransmitted packets ÷ number of successfully received packets.

We choose nodes which have efficient link quality for broadcasting packets.

3.3 Power Field and Selection of Nodes

Power field is the power emitted to transmit at a given instant of time.

To compute power field $p_{i,}$

P_i = No of packet transmitted ÷ Time period

The particular node is to be selected as

- Maximum remaining energy
- High link quality
- Less number of neighbors than the average number of neighbors
- Less power field than the average power field

After choosing the node we find out its rebroadcast probability. Next section deals with the calculation of rebroadcast probability.

3.4 Uncovered Neighbor Set

Before broadcasting RREQ packet, source node append its neighbor list to it. Node n_i receives the RREQ packet and it compare its own neighbor list with source node's neighbor list. From this n_i determines which neighbors are common to both nodes and how many of them are unique to each nodes. The UnCovered Neighbors set, $U(n_i)$ of node n_i as follows:

$$U(ni) = N(ni)-[N(ni)^\wedge N(s)]-s$$

Where N(s) and $N(n_i)$ are the neighbors sets of node s and n_i respectively. s is the source node which sent RREQ packet to node n_i..

3.5 Additional Coverage Ratio

It is the ratio of the uncovered neighbor set of node n_i to the total number of neighbors of node $n_{i.}$. The additional coverage ratio ($Ra(n_i)$) of node n_i as

$$Ra(n_i) = |U(n_i)| \div |N(n_i)|$$

The uncovered neighbor set need to receive and process the RREQ packet. Because the common neighbors receives the packet during the first broadcast. while Ra becomes larger, more nodes will be covered by this rebroadcast, and more nodes have to to receive and process the RREQ packet.

3.6 Connectivity Factor

Xue and Kumar [7] proposed that if each node attached to more than 5.1774 log n of its adjacent neighbors, then the chance of the network being linked is approaching 1. Connectivity Factor is the ratio of the number of nodes that require to accept the RREQ packet to the total number of neighbors of node n_i is $Fc(n_i)$.

The connectivity factor ($Fc(n_i)$) is

$$Fc(n_i) = Nc \div N(n_i)$$

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

If $N(n_i)$ is larger than Nc, then $Fc(n_i)$ will be less than 1. That is we can conclude that node n_i is in dense area. So only uncovered neighbors need to forward the RREQ packet, it reduces the redundant retransmission. Otherwise node n_i is in sparse area and every neighbors need to forward the RREQ packet to achieve network connectivity.

Rebroadcast Probability

It can be used to reduce the number of retransmission and improving routing perfomance.

By join the additional coverage ratio and connectivity factor, we acquire the rebroadcast probability Pre of node n_i:

$$Pre(n_i)=Fc(n_i)*Ra(n_i)$$

If the parameter Fc is low means rebroadcast probability will be high, then node n_i forward the RREQ packet to all of its neighbors. If the parameter Fc is high means rebroadcast probability will be low, then node checks the strong coverage condition for rebroadcast the RREQ message.

4. PERFOMANCE EVALUATION

Simulation Model and Parameters

We use NS2 to simulate our proposed algorithm. Our simulation settings and parameters are summarized in table 1.

Table 1. *Simulation Parameters*

Simulation Parameter	Value
Simulator	NS2
Topology Size	1000x1000
Bandwidth	2mbps
Transmission range	250m
Traffic type	CBR
Packet Size	512 bytes
Packet rate	4packet/sec
Pause time	0s
Min speed	1m/s
Max speed	5m/s

Performance Metrics

ENCPR protocol obtain neighbor information by using Hello packets and it also carries neighbor list in the RREQ packet. For reducing the overhead of HELLO packet and neighbor list, ENCPR protocol implements following mechanisms:

i) ENCPR protocol doesn't implement periodical hello mechanism. Only when the time intervened from the very last broadcasting packet is larger than the value of Hello Interval, Only then the node wants to send a Hello packet.

ii) For reducing the overhead of neighbor list in the RREQ packet, node required to observe the disparity of its neighbor table and keep a cache of the neighbor list in the received RREQ packet.

In order to evaluate the performance of the proposed ENCPR protocol, it is compared with conventional AODV protocol using the NS-2 simulator. We evaluate the performance of ENCPR and AODV protocols using the following performance metrics:

- MAC collision rate: The average number of 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 to the total packet size of data packets delivered to the destinations.
- Packet delivery ratio: The ratio of the number of data packets successfully received by the destinations to the number of data packets generated by the sources.
- Average end-to-end delay: The average delay of successfully delivered CBR packets from source to destination node.

5. EXPERIMENTAL RESULTS

We plot graphs for packet delivery ratio, MAC collision rate, Average end-to-end delay, Normalized routing overhead, and energy consumption rate. Red line shows the performance of AODV protocol and green line shows the performance of proposed ENCPR protocol. From the experimental results we can conclude that the performance of our ENCPR protocol is better than conventional AODV protocol.

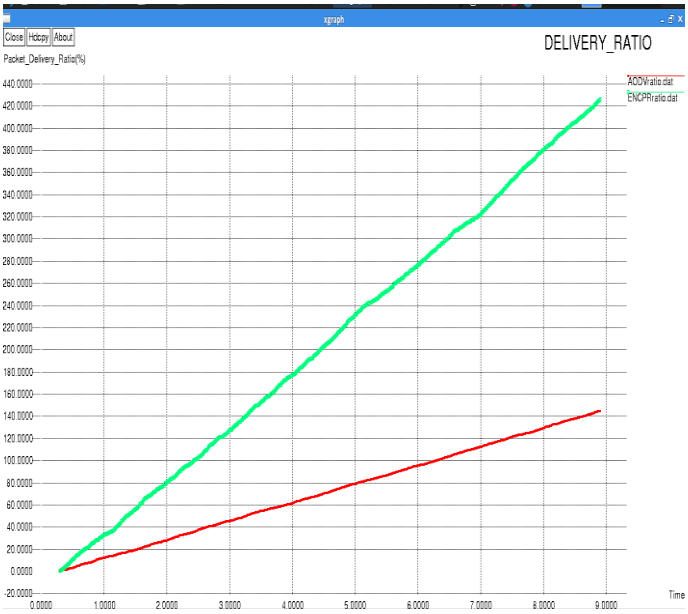

Figure 5.1. *Packet Delivery Ratio*

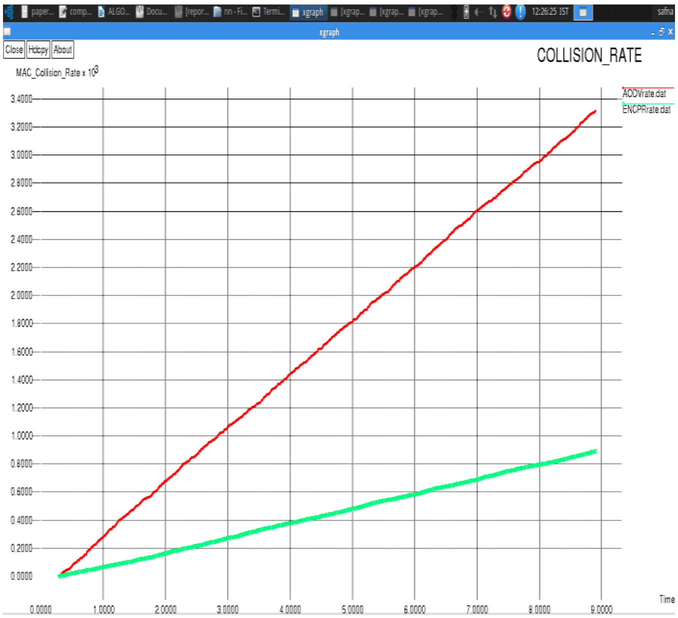

Figure 5.2. *MAC Collision Rate*

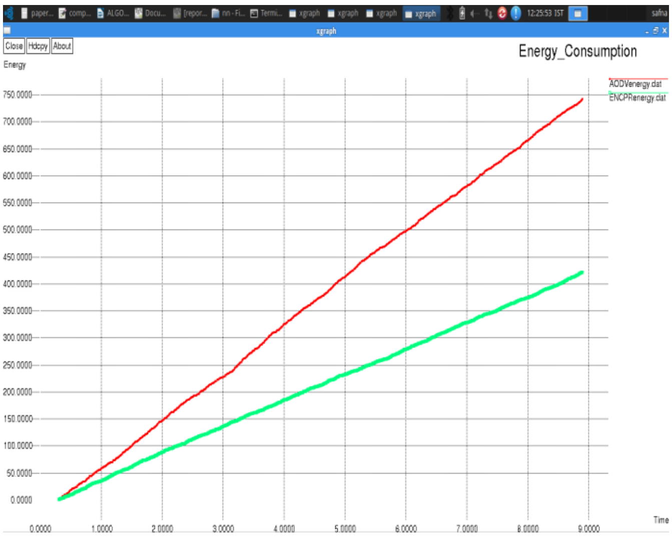

Figure 5.3. *Energy Consumption Rate*

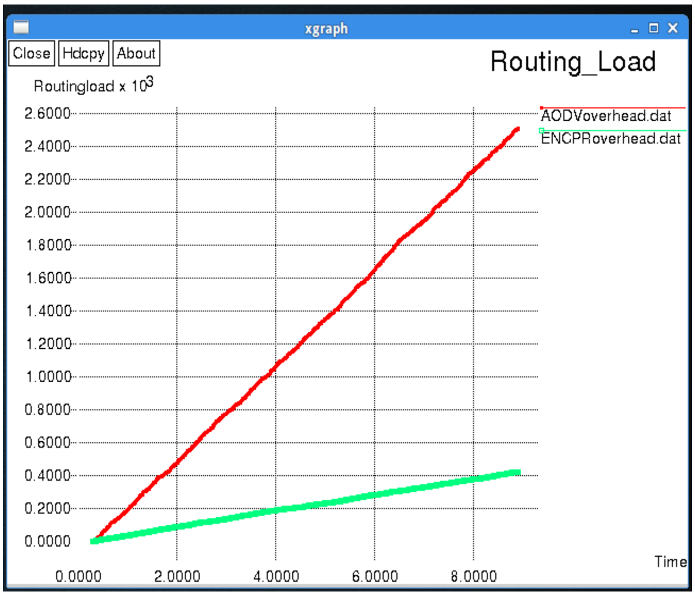

Figure 5.4. *Routing Overhead*

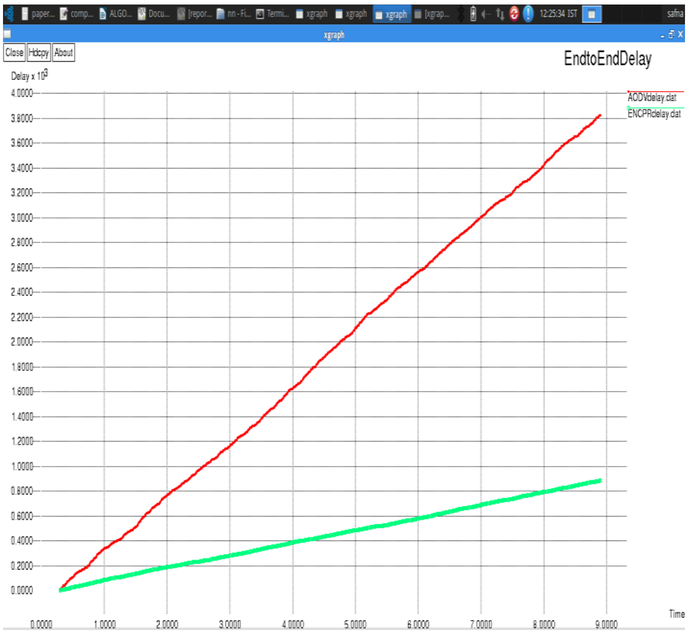

Figure 5.5. *End to end delay*

6. Conclusion

In this paper an enhanced neighbor coverage based probabilistic rebroadcast protocol is proposed to reduce the routing overhead in MANETs. This paper first checks the strong coverage condition for selecting nodes for broadcasting message. Then it find out residual energy, link quality of selected node .finally it selects some nodes for forwarding RREQ packet, then it find out the rebroadcast probability for the selected nodes and according to the probability rebroadcasting will be done. 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, routing overhead, MAC collision rate, and it have less energy consumption. 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.

Reference

[1] Xin Ming Zhang, Member, IEEE, En Bo Wang, Jing Jing Xia, and Dan Keun Sung, A Neighbor Coverage-Based Probabilistic Rebroadcast for Reducing Routing Overhead in Mobile Ad Hoc Networks

[2] Majid Khabbazian, Ian F. Blake, and Vijay K. Bhargava, Local Broadcast Algorithms in Wireless Ad Hoc Networks: Reducing the Number of Transmissions

[3] Nouha Baccour, Anis Koubaa, Maissa Ben Jamaa , Habib Youssef, Marco Zuniga, and M ario Alvest, A Comparative Simulation Study of Link Quality Estimators in Wireless Sensor Networks

[4] Chrif Diallo, Michel Marot, Monique Becker, Using LQI to Improve Cluster Head Locations in Dense ZigBee based Wireless Sensor Networks

[5] P.Vijayakumara, T. Poongkuzhali, E_cient power aware broadcasting technique for mobile ad hoc network, The International Conference on Communication Technology and System Design 2011

[6] C. Perkins, E. Belding-Royer, and S. Das, Ad Hoc On-Demand Distance Vector (AODV) Routing, IETF RFC 3561, 2003.

AUTHORS' BIOGRAPHY

Safna Sulaiman received the **B.Tech.** degree in Computer Science and Engineering from the Amal Jyothi College of Engineering, M.G University, Kerala, India, in 2012.Currently doing **M.Tech.** in Computer Science and Engineering in Amal Jyothi College of Engineering, M.G University, Kerala, India. Her research interest includes Mobile Ad hoc networks, Sensor Networks, Neural Networks and Wireless Communication.

Tintu Alphonsa Thomas received the **B.Tech.** degree in Computer Science and Engineering in M.G University, Kerala, India in 2008. She did **M.Tech** in Software Engineering in Karunya University, Coimbatore in 2011. Now working as Asst. Professor at Amal Jyothi College of Engineering since Oct 2011. Her research interest includes Mobile Ad hocnetworks, Image Processing and Wireless Communication.