International Journal of Emerging Technology and Advanced Engineering
Website: www.ijetae.com (ISSN 2250-2459 (Online), An ISO 9001:2008 Certified Journal, Volume 3, Special Issue 1, January 2013)

International Conference on Information Systems and Computing (ICISC-2013), INDIA.

A NEIGHBOR COVERAGE BASED PROBABILISTIC REBROADCAST FOR REDUCING ROUTING OVERHEAD IN MOBILE AD HOC NETWORKS

V.Deeban Chakravarthy, V.Divya Renga

Computer Science & Engineering, SRM University, Chennai, India;
Software Engineering, SRM University, Chennai, India

vdeeban@gmail.com;
rivyaa@gmail.com.

Abstract

Traditional routing protocols in Mobile Ad hoc Network (MANET) send periodic messages to realize the changes in topology. Sending periodic messages cause overhead. Compared to proactive routing protocols, reactive routing protocols can cause less overhead. Broadcasting can cause broadcast storm problem .To discover the route better than broadcasting methodology rebroadcast can done with the help of neighbor knowledge methods. We propose neighbor coverage based probabilistic rebroadcast protocol for reducing routing overhead in MANETs. In order to effectively exploit the neighbor coverage knowledge, we propose a novel rebroadcast delay to determine the rebroadcast order, and then we can obtain the more accurate additional coverage ratio by sensing neighbor coverage knowledge. We also define a connectivity factor to provide the node density adaptation. This approach can significantly decrease the number of retransmissions so as to reduce the routing overhead and also improve the routing performance. Thus finding the neighborhood node, we use channel awareness mechanism for data transmission and to improve the quality.

General Terms-- **Wireless Networks, Mobile Ad hoc Networks.**

Keywords-- **Neighbor Coverage, Network Connectivity, Probabilistic Rebroadcast, Routing Overhead.**

I. INTRODUCTION

A mobile ad-hoc network (MANET) [8] is a self-configuring infrastructure less network of mobile devices connected by wireless links. No base stations are supported in such an environment. Due to considerations such as radio power limitation, channel utilization, and power-saving concerns, a mobile host may not be able to communicate directly with other hosts in a single-hop fashion. In this case, a multi hop scenario occurs, where the packets sent by the source host are relayed by several intermediate hosts before reaching the destination host. However, due to node mobility in MANETs, frequent link breakages may lead to frequent path failures and route discoveries. It increases the overhead of routing protocols which reduces the packet delivery ratio and also increases the end-to-end delay. Thus, reducing the routing overhead in route discovery is an essential problem. The conventional on demand routing protocols use flooding to discover a route. They broadcast a Route Request (RREQ) packet to the networks, and the broad casting induces excessive redundant retransmissions of RREQ packet.

It causes the broadcast storm problem [3], which leads to a considerable number of packet collisions, especially in dense networks.

More sophisticated solutions such as probability-based, counter-based, distance based, location based and neighbor knowledge based approaches have been proposed to overcome the drawbacks of flooding. This paper proposes neighbor coverage based probabilistic rebroadcast protocol [1].Limiting the number of rebroadcasts can effectively optimize the broadcasting. In order to effectively exploit the neighbor coverage knowledge, we need a novel rebroadcast delay to determine the rebroadcast order. Probability-based approach [5] is another simple one. It depends upon pre-defined fixed probability to determine whether it rebroadcast the packets or not and then we can obtain a more accurate additional coverage ratio. We use the coverage area concept to adjust the rebroadcast probability of a node.

If a mobile node is located in the area close to sender, which means it has small additional coverage area and its neighbors may receive the same broadcasting message from others, so its rebroadcast probability will be set lower. On the contrary, if a mobile node is located in the area far from sender, which means its additional coverage area is large. Then its rebroadcast probability will be set higher. The coverage area can be estimated from the distance between sender and receiver node, and the distance can be estimated by signal strength or global positional system (GPS).

II. RELATED WORK

The routing overhead occurred because of the dissemination of routing control packets such as RREQ packets can be quite huge, especially when the network topology frequently changes. Traditional on-demand routing protocols produce a large amount of routing traffic by blindly flooding the entire network with RREQ packets during route discovery. Recently, the issue of reducing the routing overhead associated with route discovery and maintenance in on demand routing protocols has attracted increasing attention.

Huang [2] proposed a methodology of dynamically adjusting the Hello timer and the Timeout timer according to the conditions of the network. For example, in a high mobility network (with frequent topology changes) it is desirable to use small values for the timers to quickly detect the changes in the network. On the other hand, in a low mobility network where the topology remains stable and with few changes, a large value for the timers is more effective to reduce the overhead. In order to decide whether the mobility of the network is high or low, we use a simple way to approximate in real time of the link change rate. The reduction of the overhead is greatly achieved with the minimal cost of slightly increasing the drop rate in data traffic. While the packet loss increases around 1%, the overhead reduction reaches 40%.

Ould-Khaoua[4]proposed two new probabilistic route discovery method, called Adjusted Probabilistic route discovery(AP) and Enhance Adjusted Probabilistic route discovery (EAP) which addresses the broadcast storm problem in the existing on-demand routing protocols. The forwarding probability is determined by taking into account about the local density of the sending node.

In order to reduce the routing overhead without degrading the network throughput in dense networks, the forwarding probability of nodes located in sparse areas is set high while it is set low at nodes located in dense areas. EAP-AODV reduces overhead by 71% while AP-AODV reduces the overhead by 55%.

Aminu[6] proposed a rebroadcast probability function which takes in to account about the value of the packet counter together with some key simulation parameters(i.e. network topology size, transmission range and number of nodes) to determine the appropriate rebroadcast probability for a given node. The rebroadcast probability of a node is computed based on these parameters. Compared to the other schemes, simulation results have revealed that counter Function achieved superior saved rebroadcast (about 20% better than its closest competitor i.e., counter-based scheme, in dense network) and end-to-end delay (around 26% better than counter-based scheme in dense network) without sacrificing reach ability in medium and dense networks.

III. NEIGHBOR COVERAGE BASED PROBABILISTIC REBROADCAST (NCPR) PROTOCOL

This paper proposes neighbor coverage based probabilistic rebroadcast protocol [1] which combines both neighbor coverage and probabilistic methods. In order to effectively exploit the neighbor coverage knowledge, we need a novel rebroadcast delay to determine the rebroadcast order, and then we can obtain a more accurate additional coverage ratio. In order to keep the network connectivity and to reduce the redundant retransmissions, we need a metric named connectivity factor to determine how many neighbors should receive the RREQ packet. After that, by combining the additional coverage ratio and the connectivity factor, we introduce rebroadcast probability, which can be used to reduce the number of rebroadcasts of the RREQ packet and to improve the routing performance.

3.1 Rebroadcast Delay

We proposed a scheme to calculate the rebroadcast delay. 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, this rebroadcast delay enables the information about the nodes which have transmitted the packet to more neighbors, which is the key success for the proposed scheme.

When a node ni receives an RREQ packet from its previous node s, node s can use the neighbor list in the RREQ packet to estimate how many its neighbors have not been covered by the RREQ packet . 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 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 ...receive and process the RREQ packet. We assume that node nk has the largest number of common neighbors with node s, node nk has the lowest delay. Once node nk rebroadcasts the RREQ packet, there are more nodes to receive the RREQ, because node nk has the largest number of common neighbors. Node nk rebroadcasts the RREQ packet depends on its rebroadcast probability calculated in the next subsection. 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.

3.2 Rebroadcast Probability

We also proposed a novel scheme to calculate the rebroadcast probability. The scheme considers the information about the 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.

The node which has a larger rebroadcast delay may listen to RREQ packets from the nodes which have lowered one. We do not need to adjust the rebroadcast delay because the rebroadcast delay is used to determine the order of disseminating neighbor coverage knowledge.

When the timer of the rebroadcast delay of node ni expires, the node obtains the final uncovered neighbor set.

The nodes belonging to the final uncovered neighbor set are the nodes that need to receive and process the RREQ packet. Note that, if a node does not sense any duplicate RREQ packets from its neighborhood, its uncovered neighbor set is not changed, which is the initial uncovered neighbor set. Now we study how to use the final uncovered neighbor set to set the rebroadcast probability.

The metric Ra 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.

Xue [7] derived that 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. We assume the ratio of the number of nodes that need to receive the RREQ packet to the total number of neighbors of node ni is Fc(ni).If the local node density is low, the parameter Fc increases the rebroadcast probability, and then increases the reliability of the NCPR in the sparse area. If the local node density is high, the parameter Fc could further decrease the rebroadcast probability, and then further increases the efficiency of NCPR in the dense area. Thus, the parameter Fc adds density adaptation to the rebroadcast probability.

IV. Algorithm Description

The formal description of the Neighbor Coverage based Probabilistic Rebroadcast (NCPR) for reducing routing overhead in route discovery is shown in Algorithm 1 and Algorithm 2.

4.1 Algorithm 1

The algorithm describes the rebroadcast delay description for the node ni

Rebroadcast Delay ()

{

IF node ni receives RREQ from previous node s

Use neighbor list table to see the uncovered neighbors from s

THEN

IF RREQ comes for the first time

Find neighbor node knowledge

ELSE

Discard RREQ message

END IF

FOR every RREQ node s sends RREQ to neighbors of ni, i=1, 2…

DO

Assume nk has lowest delay

nk will rebroadcast based on Rebroadcast Probability which is find from Algorithm 2

END FOR

END IF

}

4.2 Algorithm 2

The algorithm describes to set the Rebroadcast Probability

Rebroadcast Probability ()

{

IF node ni receive duplicate RREQ from neighbor node nj

THEN

ni knows how many neighbors have been covered by RREQ from nj

ni adjusts its uncovered neighbor set according to neighbor list

SET a reschedule timer for node ni

IF timer expires

Node ni obtains final uncovered neighbor set

THEN

Uncovered neighbor set nodes need to receive and process RREQ

FOR each uncovered neighbor set

DO

Calculate

Number of nodes that are additional covered by rebroadcast

---= Fc (ni)

Total number of neighbors of node ni

=Node density

IF Fc (ni) is low

THEN SET Rebroadcast Probability as high

ELSE

SET Rebroadcast Probability as low

END IF

END FOR

END IF

}

V. Protocol Implementation And Performance Evaluation

5.1 Protocol Implementation

We modify the source code of AODV in NS-2 to implement our proposed protocol. The proposed NCPR protocol needs Hello packets to obtain the neighbor information, and also needs to carry the neighbor list in the RREQ packet. Therefore, in our implementation, some techniques are used to reduce the overhead of Hello packets and neighbor list in the RREQ packet, which are described as follows

In order to reduce the overhead of Hello packets, we do not use periodical Hello mechanism. Since 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.

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.

For sending or forwarding of RREQ packets, the neighbor table of any node ni has the following 3 cases:

1)If the neighbor table of node ni adds at least one new neighbor nj , then node ni sets the num neighbors to a positive integer, which is the number of listed neighbors, and then fills its complete neighbor list after the num neighbors field in the RREQ packet.

2) If the neighbor table of node ni deletes some neighbors, then node ni sets the num neighbors to a negative integer, which is the opposite number of the number of deleted neighbors, and then only needs to fill the deleted neighbors after the num neighbors field in the RREQ packet;

3) If the neighbor table of node ni does not vary, node ni does not need to list its neighbors, and set the num neighbors to 0.

International Journal of Emerging Technology and Advanced Engineering
Website: www.ijetae.com (ISSN 2250-2459 (Online), An ISO 9001:2008 Certified Journal, Volume 3, Special Issue 1, January 2013)
International Conference on Information Systems and Computing (ICISC-2013), INDIA.

The nodes which receive the RREQ packet from node ni can take their actions according to the value of num neighbors in the received RREQ packet:

1) If the num neighbors is a positive integer, the node substitutes its neighbor cache of node ni according to the neighbor list in the received RREQ packet;

2) If the num neighbors is a negative integer, the node updates its neighbor cache of node ni and deletes the deleted neighbors in the received RREQ packet;

3) If the num neighbor is 0, the node does nothing. Because of the two cases 2) and 3), this technique can reduce the overhead of neighbor list listed in the RREQ packet.

5.2 Simulation Environment

In order to evaluate the performance of the proposed NCPR protocol, we compare it 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 paper, we just study one of the applications, route request and route discovery. 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.

5.2.1 Performance with Varied Number of Nodes

In the conventional AODV protocol, the massive redundant rebroadcast incurs many collisions and interference, which leads to excessive packets drop. This phenomenon will be more severe with an increase in the number of nodes. It is very important to reduce the redundant rebroadcast and packet drops caused by collisions to improve the routing performance. Compared with the conventional AODV protocol, the NCPR protocol reduces the collision rate by about 92.8% on the average. Under the same network conditions, the collision rate is reduced by about 61.6% when the NCPR protocol is compared with the DPR protocol. This is the main reason that the NCPR protocol could improve the routing performance.

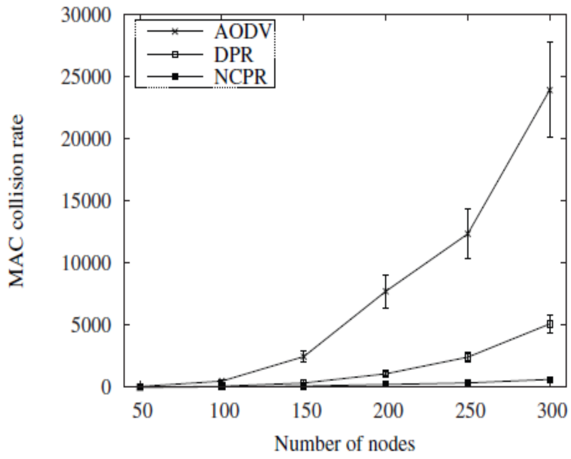

Fig 1. Collision rate with varied number of nodes

Fig. 2 shows the normalized routing overhead with different network density. The NCPR protocol can significantly reduce the routing overhead incurred during the route discovery, especially in dense network. Then, the RREQ traffic is reduced. In addition, for fairness, the statistics of normalized routing overhead includes Hello traffic. Even so, the NCPR protocol still yields the best performance, so that the improvement of normalized routing overhead is considerable. On average, the overhead is reduced by about 45.9% in the NCPR protocol compared with the conventional AODV protocol.

Under the same network conditions, the overhead is reduced by about 30.8% when the NCPR protocol is compared with the DPR protocol. When network is dense, the NCPR protocol reduces overhead by about 74.9% and 49.1% when compared with the AODV and DPR protocols, respectively. This result indicates that the NCPR protocol is the most efficient among the three protocols.

International Journal of Emerging Technology and Advanced Engineering
Website: www.ijetae.com (ISSN 2250-2459 (Online), An ISO 9001:2008 Certified Journal, Volume 3, Special Issue 1, January 2013)
International Conference on Information Systems and Computing (ICISC-2013), INDIA.

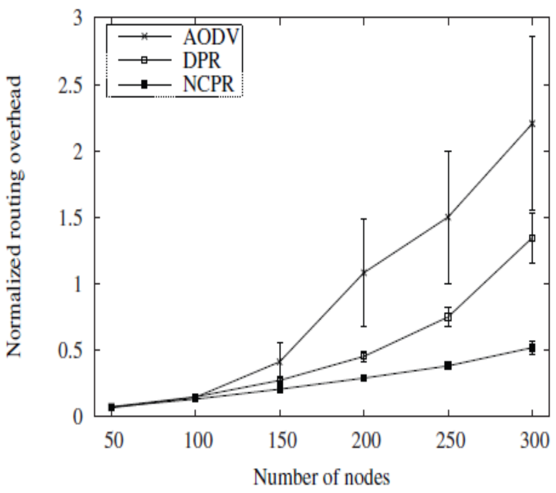

Fig 2. Normalized routing overhead with varied number of nodes

5.2.2 Performance with Varied Random Packet Loss Rate

Fig. 3 shows the effects of the packet loss rate on the Collision rate. Both the DPR and NCPR protocols do not consider robustness for packet loss, but they can reduce the redundant rebroadcast and alleviate the channel congestion, thus, both of them have the lower packet drops caused by collisions than the conventional AODV protocol. Compared with the conventional AODV protocol, the NCPR protocol reduces the collision rate by about 92.8% on the average. In the same network density and traffic load but in different packet loss rate, the collision rate is reduced by about 61.6% when the NCPR protocol is compared with the DPR protocol.

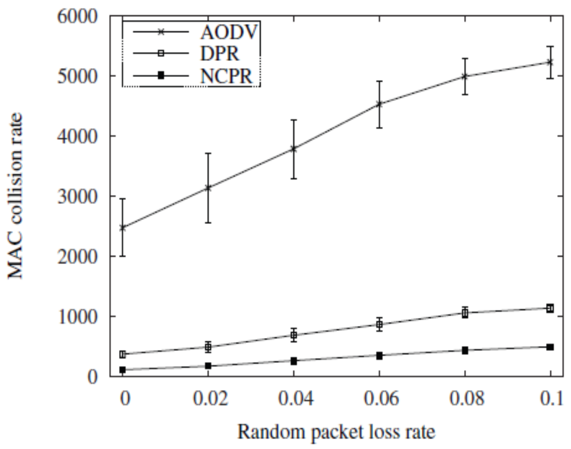

Fig 3. Collision rate with varied random packet loss rate

VI. Conclusion

In this paper we proposed a probabilistic rebroadcast protocol based on neighbor coverage to reduce the routing overhead in MANETs. This neighbor coverage knowledge includes additional coverage ratio and connectivity factor. We proposed a new scheme to dynamically calculate the rebroadcast delay, which is used to determine the forwarding order and more effectively exploit the neighbor coverage knowledge. Simulation results show that the proposed protocol generates less rebroadcast traffic than the flooding and some other optimized scheme in literatures. 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.

VII. Future Enhancements

By adding channel awareness mechanism the uncovered neighbor set with higher signal strength can be selected for easier and fast transmission of RREQ message and to improve the Quality of Service (QOS).

Acknowledgement

First and foremost, I would like to thank the God Almighty for showering his blessing throughout our life. I take this chance to express our deep sense of gratitude to our Management, and express our profound thanks to our beloved Professor and Head of the department Dr.C.Lakshmi B.E., M.E., Ph.D for her able administration and keen interest, which motivated me along the course.

References

[1] Xin Ming Zhang, En Bo Wang, Jing Xia, and Dan Keun Sung.*2012.*A Neighbor Coverage based Probabilistic Rebroadcast for Reducing Routing Overhead in Mobile Ad hoc Networks.

[2] Nelson, Shoji Yutaka, Takahashi.2010. Dynamic Hello/Timeout timer adjustment in routing protocols for reducing overhead in MANETs.

[3] Yao Ni, Yu-Chee Tseng, Yuh-Shyan Chen, and Jang-Ping Sheu.1999.The Broadcast Storm Problem in a Mobile Ad Hoc Network.

[4] Ould-Khaoua, L. M. Mackenzie.2007.Improving Probabilistic Route Discovery in Mobile Ad Hoc Networks.

[5] Tasneem Bano, Jyoti Singhai.2010. Probabilistic Broadcasting Protocol in AD HOC Network And Its Advancement: A Review.

[6] Aminu Mohammed, Mohamed Ould-Khaoua, and Lewis Mackenzie.2005.An Improved Rebroadcast Probability Function for an Efficient Counter-Based Broadcast Scheme in MANETs.

[7] Feng Xue, P.R. Kumar. 2004. The Number of Neighbors Needed for Connectivity of Wireless Networks.

[8] Charles E.Perkins.2001.Adhoc Networking, Pearson Edition.