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Reducing Routing Overhead For Multimedia Traffic in Manet Using Rebroadcast Probability

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Abstract: **Mobile ad hoc networks (MANET) have been proposed for a variety of applications where support for real-time multimedia services will be necessary. Due to high mobility of nodes in mobile ad hoc networks, there exist frequent link breakages which lead to frequent path failures and route discoveries. Traditional routing protocols in Mobile Ad hoc Network (MANET) send periodic messages to realize the changes in topology. Sending periodic messages cause 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. In this paper, we propose reducing routing overhead for multimedia traffic in MANET using rebroadcast probability. 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. The performance evaluation based on NS simulations shows that reduce the routing overhead for multimedia traffic due to the neighbor coverage knowledge and the probabilistic mechanism. It can also improve the performance of routing in mobile ad hoc networks.**

Index Terms—**mobile ad hoc networks, neighbor coverage, network connectivity, probabilistic rebroadcast, routing overhead.**

I. INTRODUCTION

The advancement in wireless technology, portable computers with wireless interfaces can communicate among themselves. It is that future wireless network will be converged to be more easily reconfigurable situations such as Mobile Ad hoc network (MANET). A mobile ad hoc network (MANET) is a self-organizing and self configuring wireless network, infrastructure less network of mobile devices connected by wireless links. The base stations are not supported in such an environment. MANET is a type of wireless mobile network in which mobile hosts can communicate without any infrastructure and can be deployed for many applications such as soldiers relaying information, business associates sharing information during meetings. MANETs are envisioned to offer multimedia services to mobile users in areas with no pre-existing communications infrastructure exists.

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.

The long standing feature of routing protocols in Mobile Ad hoc Network (MANET) send periodic messages to realize the changes in topology. Sending periodic messages cause overhead. Such routing protocols can be classified into two major classes: proactive protocols and reactive protocols. Proactive protocols disseminate routing information from each node to each other periodically, and find routes continuously, whereas reactive protocols find routes on demand, i.e. only when a source sends information for forwarding to a destination. Compared to proactive routing protocols, reactive routing protocols can cause less overhead. Broadcasting can cause broadcast storm problem. In this paper, we propose a formulation of the routing problem in MANETs in the context of multimedia services.

To overcome the drawbacks of flooding the solutions such as probability-based, counter-based, distance based, location based and neighbor knowledge based approaches have been proposed. This paper proposes neighbor coverage based probabilistic rebroadcast protocol. The number of rebroadcasts can effectively limit to optimize the broadcasting. In order to effectively exploit the neighbor coverage knowledge, we need a novel rebroadcast delay to

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determine the rebroadcast order.

Probability-based approach [5] is another simple one. It depends upon 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.

The rest of this paper is organized as follows: In Section II, we introduce the background and related work of broadcasting in MANET. In Section III, we describe our approach, dynamic probabilistic broadcasting based on coverage area and neighbor confirmation, highlighting the differences from other similar approaches. In Section IV, we simulate our approach by using network simulator tool and compare the performance with the AODV. In section V, we conclude the paper and present directions for future work.

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.

Several robust protocols have been proposed in recent years besides the above optimization issues for broadcasting. 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 reach ability 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. In our protocol, we also set a deterministic rebroadcast delay, but the goal is to make the dissemination of neighbor knowledge much quicker.

III. Proposed System

The 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.

A. *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.

B. 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.

C. Algorithm

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.

Rebroadcast Delay

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
}
```

Rebroadcast Probability

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
}
```

IV. Protocol Implementation and Performance Evaluation

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.

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.

V. PARAMETERS

First, the network model must define the parameters related to the network environment. Such parameters include the network size, as well as the channel characteristics. In the context of this research, the network consists of 50 nodes that move over an area of 1000 x 1000 m2.

The channel characteristics mostly depend on the node transmission power. Some nodes may have the ability to vary their transmission power. In this case, the MAC layer protocol considered is 802.11b with a nominal transmission range of 250 meters. It operates in the 2 Mbps. The propagation model two-ray ground is used at the physical layer.

Moreover, two important variable parameters must be considered in the network model: the node mobility, as well as the traffic type and intensity. The node mobility generally includes the nodes' maximum and minimum speeds, the speed pattern and the pause time. The speed pattern determines whether the node moves at uniform speed, or whether the speed is constantly varying. The pause time determines the length of time each node remains stationary between each period of movement. Combined with the maximum and the minimum speed, this parameter determines how often the network topology changes and how often the network state information must be updated.

In this proposed work, the nodes move according to the random Waypoint model at a speed that is uniformly distributed. Many levels of mobility are considered by varying both speeds and pause times. In particular, speeds are varying from 1 to 5 m/s, whereas pause times take the following values: 0 seconds.

Moreover, traffic sources may generate packets at constant bit rate (CBR), or at variable bit rate (VBR). The CBR class is commonly used for voice and data services. In this context, the data rate and the delay remain constant during the packet transmission. More particularly, CBR traffic sources provide a constant flow of data packets of 512 bytes with a transmission rate of 4 packets per second. All CBR traffic scenarios are generated using cbrgen.tcl in NS-2. However, the CBR traffic class is not adapted to real time multimedia traffic generated by on-demand and video conferencing services. The VBR traffic closely matches the statistical characteristics of a real trace of video frames generated by an MPEG-4 encoder [5]. Two parameters were used to control the traffic stream.

VI. SIMULATION RESULTS

To evaluate the impact of mobility on the performance of each component of the multimedia traffic in a MANET, simulations with NS-2 are carried out using three sets of experiments. The first set only considers CBR traffic sources, whereas in the others, a mix of CBR and VBR traffic sources are used.

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.

A. 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.

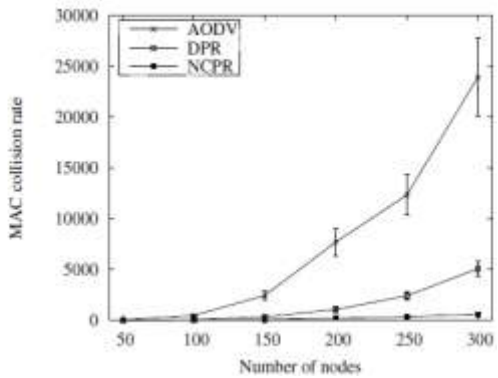

Fig 1. MAC Collision Rate With Varied Number Of Nodes

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 MAC collision rate by about 92.8% on the average. Under the same network conditions, the MAC 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. 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. Although the NCPR protocol increases the packet size of RREQ packets, it reduces the number of RREQ packets more significantly. Then, the RREQ traffic is still 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.

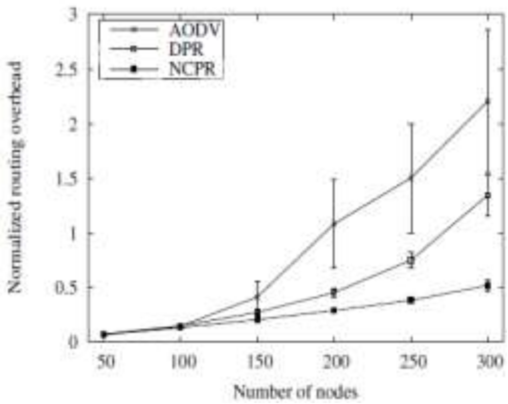

Fig. 2. Normalized Routing Overhead With Varied Number Of Nodes

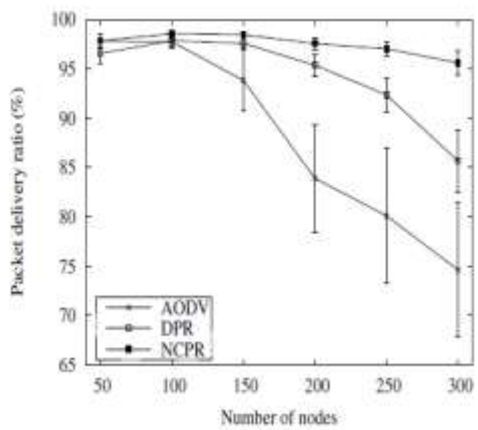

Fig. 3. Packet Delivery Ratio With Varied Number Of Nodes

Fig. 3 shows the packet delivery ratio with increasing network density. The NCPR protocol can increase the packet delivery ratio because it significantly reduces the number of collisions, which is shown in Fig. 1, so that it reduces the number of packet drops caused by collisions. On average, the packet delivery ratio is improved by about 11.9% in the NCPR protocol when compared with the conventional AODV protocol. And in the same situation, the NCPR protocol improves the packet delivery ratio by about 3.7% when compared with the DPR protocol. When network is dense, the NCPR protocol increases the packet delivery ratio about 21.8% and 6.3% when compared with the AODV and DPR protocols, respectively.

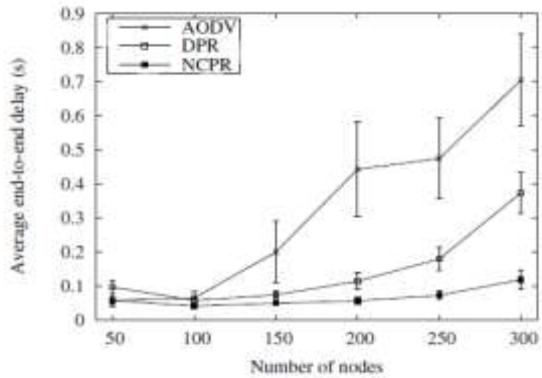

Fig. 4. Average end-to-end Delay With Varied Number Of Nodes

Fig. 4 measures the average end-to-end delay of CBR packets received at the destinations with increasing network density. The NCPR protocol decreases the average end-to end delay due to a decrease in the number of redundant rebroadcasting packets. The redundant rebroadcast increases delay because 1) it incurs too many collisions and interference, which not only leads to excessive packet drops, but also increases the number of retransmissions in MAC layer so as to increase the delay; 2) it incurs too many channel contentions, which increases the back off timer in MAC layer, so as to increase the delay. Thus, reducing the redundant rebroadcast can decrease the delay. On average, the end-to-end delay is reduced by about 60.8% in the NCPR protocol when compared with the conventional AODV protocol. Under the same network conditions, the delay is reduced by about 46.3% when the NCPR protocol is compared with the DPR protocol. When network is dense, the NCPR protocol reduces the average end-to-end delay by about 84.9% and 59.2% when compared with the AODV and DPR protocols, respectively. The NCPR protocol uses a rebroadcast delay based on coverage ratio to replace the random delay in the AODV protocol, and the *MaxDelay* in the NCPR protocol is equal to the upper limit random delay in the AODV protocol, so the NCPR protocol does not cause extra delay cost.

B . *Performance with Varied Number of CBR Connections*

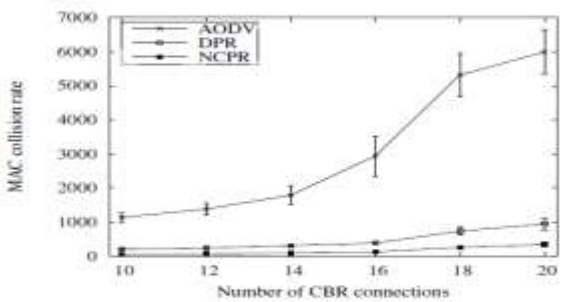

Fig. 5. MAC Collision Rate With Varied Number Of CBR connections

Fig. 5 shows the effects of the traffic load on the MAC collision rate. Since the data and control packets share the same physical channel in the IEEE 802.11 protocol, as the number of CBR connections increases, the physical channel will be busier and then the collision of the MAC layer will be more severe. Both the DPR and NCPR protocols do not consider load-balance, but they can reduce the redundant rebroadcast and alleviate the channel congestion, so as to reduce the packet drops caused by collisions. Compared with the conventional AODV protocol, the NCPR protocol reduces the MAC collision rate by about 95.2% on the average. As shown in Fig. 1, the NCPR protocol reduces more MAC collision rate than the DPR protocol as network density increases. But in the same node density and different traffic load, the NCPR reduce nearly the same scale of MAC collision rate than the DPR protocol, that is the MAC collision rate is reduced by about 69.2%. Therefore, at different traffic load, the NCPR protocol also can improve the routing performance.

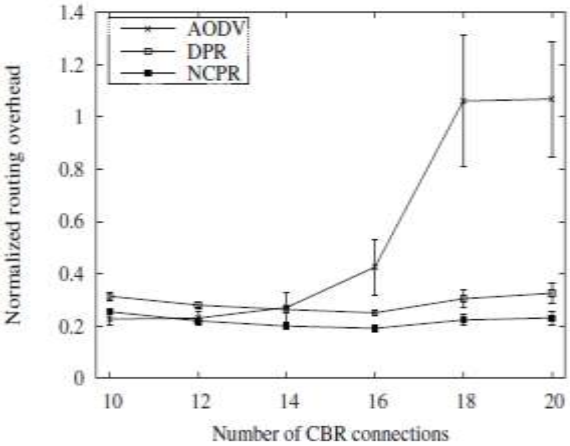

Fig. 6. Normalized Routing Overhead With Varied Number Of CBR Connection

Fig. 6 shows the normalized routing overhead with different traffic load. At very light traffic load (10 CBR connections), both the DPR and NCPR protocols have more routing overhead than the conventional AODV protocol. This is because that the *Hello* packets and neighbor list in the RREQ packet add extra overhead, and the effect of reducing redundant rebroadcast is not significant when traffic load is light. As the traffic load increases, the routing overhead of the conventional AODV protocol significantly increases, but the overhead of the DPR and NCPR protocols are relatively smooth. By contrast, both the DPR and NCPR protocols reduce the routing overhead. On average, the overhead is reduced by about 38.4% in the NCPR protocol compared with the conventional AODV protocol. Under the same network conditions, the overhead is reduced by about 23.9% when the NCPR protocol is compared with the DPR protocol.

Fig. 7 shows the packet delivery ratio with increasing traffic load. As the traffic load increases, the packet drops of the conventional AODV protocol without any optimization for redundant rebroadcast are more severe. Both the DPR and NCPR protocols increase the packet delivery ratio compared to the conventional AODV protocol, because both of them significantly reduce the number of collisions and then reduce the number of packet drops caused by collisions. On average, the packet delivery ratio is improved by about 11.5% in the NCPR protocol when compared with the conventional AODV protocol. And in the same situation, the NCPR protocol im-proves the packet delivery ratio by about 1.1% when compared with the DPR protocol.

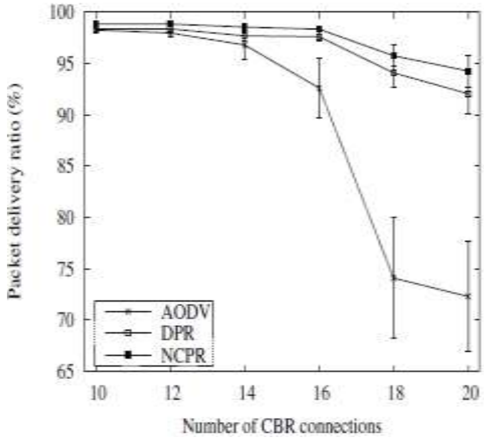

Fig. 7. Packet Delivery Ratio With Varied Number Of CBR Connections

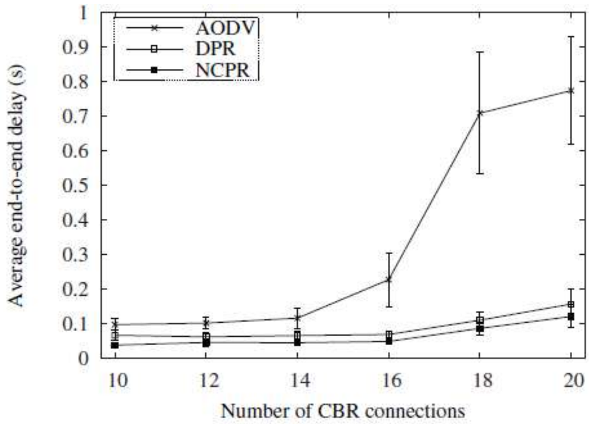

Fig. 8. Average end-to-end Delay With Varied Number Of CBR Connections

Fig. 8 measures the average end-to-end delay of CBR packets received at the destinations with increasing traffic load. The end-to-end delay of the conventional AODV protocol significantly increases with the an increase of traffic load, which is the same as the MAC collision rate and routing overhead. When the traffic load is heavy, by reducing the redundant rebroadcast, both the DPR and NCPR protocols alleviate the channel congestion and reduce the retransmissions at MAC layer, thus, both of them reduce the end-to-end delay. On average, the end-to-end delay is reduced by about 71.0% in the NCPR protocol when compared with the conventional AODV protocol. Under the same network conditions, the delay is reduced by about 28.7% when the NCPR protocol is compared with the DPR protocol.

VII. 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 optimize 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

REFERENCES

[1] C. Perkins, E. Belding-Royer, and S. Das, "Ad hoc On-Demand Distance Vector (AODV) Routing," *RFC 3561*, 2003.
[2] D. Johnson, Y. Hu, and D. Maltz, "The Dynamic Source Routing Protocol for Mobile Ad hoc Networks (DSR) for IPv4," *RFC 4728*, 2007.
[3] H. AlAamri, M. Abolhasan, and T. Wysocki, "On Optimising Route Discovery in Absence of Previous Route Information in MANETs," *Proc. of IEEE VTC 2009-Spring, pp. 1-5*, 2009.
[4] X. Wu, H. R. Sadjadpour, and J. J. Garcia-Luna-Aceves, "Routing Overhead as A Function of Node Mobility: Modeling Framework and Implications on Proactive Routing," *Proc. of IEEE MASS'07, pp. 1-9*, 2007.
[5] S. Y. Ni, Y. C. Tseng, Y. S. Chen, and J. P. Sheu. "The Broadcast Storm Problem in a Mobile Ad hoc Network," *Proc. of ACM/IEEE MobiCom'99, pp. 151-162*, 1999.
[6] A. Mohammed, M. Ould-Khaoua, L.M. Mackenzie, C. Perkins, and J. D. Abdulai, "Probabilistic Counter-Based Route Discovery for Mobile Ad Hoc Networks," *Proc. of IWCMC'09, pp. 1335-1339*, 2009.
[7] B. Williams and T. Camp, "Comparison of Broadcasting Techniques for Mobile Ad Hoc Networks," *Proc. ACM MobiHoc'02, pp. 194-205*, 2002.
[8] J. Kim, Q, Zhang, and D. P. Agrawal, "Probabilistic Broadcasting Based on Coverage Area and Neighbor Confirmation in Mobile Ad hoc Networks," *Proc. of IEEE GLOBECOM'04*, 2004.
[9] J. D. Abdulai, M. Ould-Khaoua, and L. M. Mackenzie, "Improving Probabilistic Route Discovery in Mobile Ad Hoc Networks," *Proc. Of IEEE Conference on Local Computer Networks, pp. 739-746*, 2007.
[10] Z. Haas, J. Y. Halpern, and L. Li, "Gossip-based Ad hoc Routing," *Proc. IEEE INFOCOM'02, vol. 21, pp. 1707-1716*, 2002.
[11] W. Peng and X. Lu, "On the Reduction of Broadcast Redundancy in Mobile Ad Hoc Networks," *Proc. of ACM MobiHoc'00, pp. 129-130*, 2000.
[12] J. D. Abdulai, M. Ould-Khaoua, L. M. Mackenzie, and A. Mohammed, "Neighbour Coverage: A Dynamic Probabilistic Route Discovery for Mobile Ad hoc Networks," *Proc. Of SPECTS'08, pp. 165-172*, 2008.
[13] J. Chen, Y. Z. Lee, H. Zhou, M. Gerla, and Y. Shu, "Robust Ad Hoc Routing for Lossy Wireless Environment," *Proc. of MILCOM'06, pp. 1-7*, 2006.
[14] A. Keshavarz-Haddady, V. Ribeirox, and R. Riedi, "DRB and DCCB: Efficient and Robust Dynamic Broadcast for Ad Hoc and Sensor Networks," *Proc. of SECON'07, pp. 253-262*, 2007.
[15] F. Stann, J. Heidemann, R. Shroff, and M. Z. Murtaza, "RBP: Robust Broadcast Propagation in Wireless Networks," *Proc. of SenSys'06, pp. 85-98*, 2006.
[16] F. Xue and P. R. Kumar, "The Number of Neighbors Needed for Connectivity of Wireless Networks," *Wireless Networks, vol. 10, issue 2, pp. 169-181*, 2004.
[17] X.M. Zhang, E.B. Wang, J.J. Xia, and D. K. Sung, "An Estimated Distance based Routing Protocol for Mobile Ad hoc Networks," IEEE Transactions on Vehicular Technology, vol.60,no.7, pp.3473-3484,Sept. 2011