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NCPR and Node- NCPR Protocol in Mobile Ad- Hoc Networks

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Abstract— The increase in availability and popularity of mobile wireless devices has lead researchers to develop a wide variety of Mobile Ad-hoc NETworking (MANET) protocols to exploit the unique communication opportunities presented by these devices. Each node operates not only as an end system, but also as a router to forward packets. The nodes are free to move about and organize themselves into a network. These nodes change position frequently. The main classes of routing protocols are Proactive, Reactive and Hybrid. A Reactive (on-demand) routing strategy is a popular routing category for wireless ad hoc routing. This paper proposes a neighbor coverage-based probabilistic rebroadcast (NCPR) protocol for reducing routing overhead in MANETs. And also compare the performance of two prominent on demand reactive routing protocols for MANETs: Ad hoc On Demand Distance Vector (AODV), Dynamic Probabilistic Routing (DPR) protocols with NCPR protocol. DPR and AODV are reactive gateway discovery algorithms where a mobile device of MANET connects by gateway only when it is needed. The new protocol combines the advantages of the neighbour coverage knowledge and the probabilistic mechanism, which can significantly decrease the number of retransmissions so as to reduce the routing overhead, and can also improve the routing performance.

Keywords— Mobile Ad-hoc Network: AODV; DPR; NCPR; Probabilistic Rebroadcast; Routing Overhead

I. INTRODUCTION

A MANET (Mobile Ad Hoc Network) is defined as a collection of wireless mobile nodes forming a low- power temporary network without the aid of any established centralized administration or infrastructure. A data packet in a MANET is forwarded to other nodes within the network through an efficient and reliable route established by routing protocols[1]. Ad-hoc network routing protocols have been developed to provide the route discovery and maintenance route mechanisms for each node in the network to communicate with all other nodes of the network. There are mainly two types of routing protocols: Proactive and Reactive. In proactive routing, table driven protocol, each node should indicate all other nodes in the network if there is any change in the network topology. The maintenance of the up-to-date information will increase the cost of routing overhead. In Reactive routing protocol, each node in a network discovers or maintains a route based on-demand. It floods a control packet by broadcast during discovering a route and when route is discovered then bandwidth is used for data transmission. This protocol needs less routing information of all nodes in the network but the disadvantages are that it produces large number of control packets due to route discovery during topology changes which occurs frequently in MANETs. And also it incurs higher latency and the cost of routing overhead

Dynamic routing protocols in the ad- hoc networks consist of two major phases, route discovery and route maintenance. Route discovery is the phase in which source and destination nodes is established a route between them for the first time. In this phase, the source broadcasts a route request (RREQ) packet to its neighboring nodes, which then forward it to their neighbors, and so on, until either the destination itself or a node that have a fresh route to the destination is located, which subsequently responds with a route reply (RREP) packet back to the source through the route from which it first received the RREQ. In the route maintenance phase, the route is maintained between source and destination; and if it is broken for any reason, then the source either finds other known route on its routing table or initiates new route discovery procedure, therefore, the cost of information exchange during route discovery is high.

The conventional broadcasting protocols are of four types: “simple flooding methods, probability-based methods, area based methods, and neighbor knowledge methods.”[1] For the above four types of broadcasting protocols, they understand that an increase in the number of nodes in a network will decrease the performance of the probability-based and area-based methods. This indicated that the performance of neighbor knowledge methods is better than that of area-based ones, and the performance of area-based methods is better than that of probability-based ones. Then it combines the advantages of both neighbor coverage method and probabilistic method to form neighbor coverage-based probabilistic rebroadcast (NCPR) protocol. Therefore, first in order to effectively exploit the neighbor coverage knowledge, it need a novel rebroadcast delay to determine the rebroadcast order, and then this can obtain a more accurate additional coverage ratio; second in order to keep the network connectivity and reduce the redundant retransmissions, it 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, introduce a rebroadcast probability, which can be used to reduce the number of rebroadcasts of the RREQ packet, to improve the routing performance [1].

II. ROUTING PROTOCOLS IN MANET

Routing Protocols in mobile ad hoc network is classified into the three important types:

- Proactive Routing: It has the global network view that is the node disseminates the routing information continuously and route is always available when needed. Proactive routing incurs the more overhead in Mobile Ad hoc network. In proactive routing process of approaching of node is slow. Example of Proactive Routing is DSDV (Destination-Sequenced Distance-Vector Routing) and OLSR (optimized link state routing) [3].
- Reactive Routing: It has a partial network view that is only active or cached routes are known and routes are discovered when needed. Reactive routing reacts quickly when topology of network changes. Reactive Routing incurs less overhead in Mobile Ad hoc network. Example of reactive routing is AODV (Ad hoc on demand distance vector routing) and DPR (Dynamic Probabilistic Route Discovery) [3].
- Hybrid Routing: Hybrid routing achieves scaling. Hybrid routing is combination of AODV routing and link state routing. In hybrid routing process of approaching node is more and requires less processing power [3].

2.1. Ad Hoc On Demand Distance Vector Routing

Ad hoc On Demand Distance Vector Routing (AODV), a novel algorithm for the operation of such ad hoc networks. Each Mobile Host operates as a specialized router and routes are obtained as needed i.e on demand with little or no reliance on periodic advertisements. AODV routing algorithm is quite suitable for a dynamic self-starting network as required by users wishing to utilize ad hoc networks. AODV provides loop free routes even while repairing broken links. Because the protocol does not require global periodic routing advertisements the demand on the overall bandwidth available to the mobile nodes is substantially less than in those protocols that do necessitate such advertisements [4].

Although AODV does not depend specifically on particular aspects of the physical medium across which packets are disseminated, its development has been largely motivated by limited range broadcast media such as those utilized by infrared or radio frequency wireless communications adapters. Using such media, a mobile node can have neighbors which hear its broadcasts and yet do not detect each other the hidden terminal problem. AODV do not make any attempt to use specific characteristics of the physical medium in our algorithm nor to handle specific problems posed by channelization needs of radio frequency transmitters. Nodes that need to operate over multiple channels are presumed to be able to do so. The algorithm works on wired media as well as wireless media, as long as links along which packets may be transmitted are available. The only requirement placed on the broadcast medium is that neighboring nodes can detect each other's broadcasts. AODV uses symmetric links between neighboring nodes. It does not attempt to follow paths between nodes when one of the nodes cannot hear the other one however we may include the use of such links in future enhancements.

AODV stands Ad hoc on demand distance vector routing. It is reactive protocol. Protocol flooding is to discover the route when needed. Only active routes in the routing table are present to discovers the route (route request and route reply). For route discovery send the HELLO message from source though the monitor links its discovers the destination by giving the sequence numbers in control messages for avoiding the routing loop then finally we get the destination but if any error in route discovery then gives explicit route error notification(RERR).

When the local connectivity of the mobile node is of interest, each mobile node can become aware of the other nodes in its neighborhood by the use of several techniques, including local (not system-wide) broadcasts known as hello messages. The routing tables of the nodes within the neighborhood are organized to optimize response time to local movements and provide quick response time for requests for establishment of new routes. The algorithm's primary objectives are:

- To broadcast discovery packets only when necessary
- To distinguish between local connectivity management (neighbourhood detection) and general topology maintenance
- To disseminate information about changes in local connectivity to those neighboring mobile nodes that is likely to need the information

2.2. Dynamic Probabilistic Route Discovery

The 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 [8].

In fixed Probabilistic based scheme is used in which source node broadcast the packet by using flooding mechanism and every mobile node rebroadcast the packet based on predetermined fixed probability P. The main reason for appropriate adjustment of forwarding probability is varying degree of MANET node density. Every node in MANET has assigned fixed probability of route discovery which lead to unfair distribution in fixed probabilistic approach. Dynamic probability route discovery approach determines the forward probability of RREQ considering set of covered neighbour and local node density of forwarding node which overcome the problem. By using Hello protocol the neighbour information is collected. The local neighbour information is used to estimate number of node in a particular region. Mobile node send the hello packet to neighbour node it check the entry in neighbour table if it does not have entry it create the entry in table or if neighbour node have the entry in table it update that entry. At certain amount of time if neighbour node is not receive hello packet delete the entry in table because all node in table are active node and thus link between them.

When node sending RREQ packet attach with recent neighbour list to intermediate node it search through the list to determine its set of node that have been covered by the broadcast. When large number of neighbour are covered then in that case forwarding probability at a node is set low otherwise set high.

2.3. Neighbor Coverage Based Probabilistic Rebroadcast Protocol

In neighbor coverage-based probabilistic rebroadcast (NCPR) protocol it calculates 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 [10]. If this node rebroadcasts a packet, then more common neighbors will know this fact. Therefore, this rebroadcast delay enables the information that the nodes have transmitted the packet spread to more neighbors, which is the key to success for the proposed scheme. In NCPR it also calculates the rebroadcast probability. The scheme considers the information about the uncovered neighbors (UCN), connectivity metric and local node density to calculate the rebroadcast probability. The rebroadcast probability is composed of two parts:

- 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
- connectivity factor, which reflects the relationship of network connectivity and the number of neighbors of a given node

2.4. Proposed Protocol-Node NCPR Protocol

In NCPR Protocol mainly considering about link failures or link breakages. Node NCPR protocol, it not only considering link breakages but also failure of node. In Node- NCPR protocol if any node is failure in network architecture a substitute node act as an intermediate node and transmission of data packets completed. For this a node is reserved only for act as a substitute node. Consider in a row all nodes are failure, and then this substitute node moves from its position to near to this row [3]. Then this node completes the action. In another case, if all nodes are failure in column wise then this substitute node moves to this column and complete the action.

III. NEIGHBOR COVERAGE BASED PROBABILISTIC REBROADCAST (NCPR) PROTOCOL

3.1. Rebroadcast Delay

This scheme is 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

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.

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.

3.3. Algorithm

1. The node which has a larger rebroadcast delay may listen to RREQ packets from the nodes which have lower one.
2. If node n_i receives a new $RREQ_s$ from s
3. Compute the initial uncovered neighbors of node and set U
4. Compute the rebroadcast delay T_d from U
5. Set a Timer according to rebroadcast delay T_d
6. While n_i receives a duplicate $RREQ_j$ from n_j before Timer expires
7. Adjust the uncovered neighbors
8. When the n_i did not receives the duplicate $RREQ_j$ from n_j
9. Discard ($RREQ_j$)
10. If the Timer Expires
11. Compute the rebroadcast probability
12. If the Rebroadcast Probability ≥ Random(0,1)

13. Then Broadcast ($RREQ_s$)
14. If the Rebroadcast Probability ≤ Random(0,1)
15. Discard ($RREQ_s$)

IV. SIMULATION AND EXPERIMENTAL RESULTS

The proposed method is tested on NS (v 2.30), to justify the effectiveness of the proposed scheme. The various network parameters used for the simulations are shown in Table 1.

Table 1: Network Parameters

Simulation Parameter	Value
Simulator	NS2(V 2.30)
Topology Size	1000m × 1000m
No. of Nodes	300
Transmission Range	250
Bandwidth	2Mbps
Traffic Type	CBR
No. of CBR Connections	15
Packet Size	512 bytes
Packet Rate	4 packets/sec

Evaluate the performance of routing protocols 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 destinations. 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 destinations.

The experiments are divided to three parts, and in each part we evaluate the impact of one of the following parameters on the performance of routing protocols:

- Number of nodes
- Number of CBR connections
- Random packet loss rate

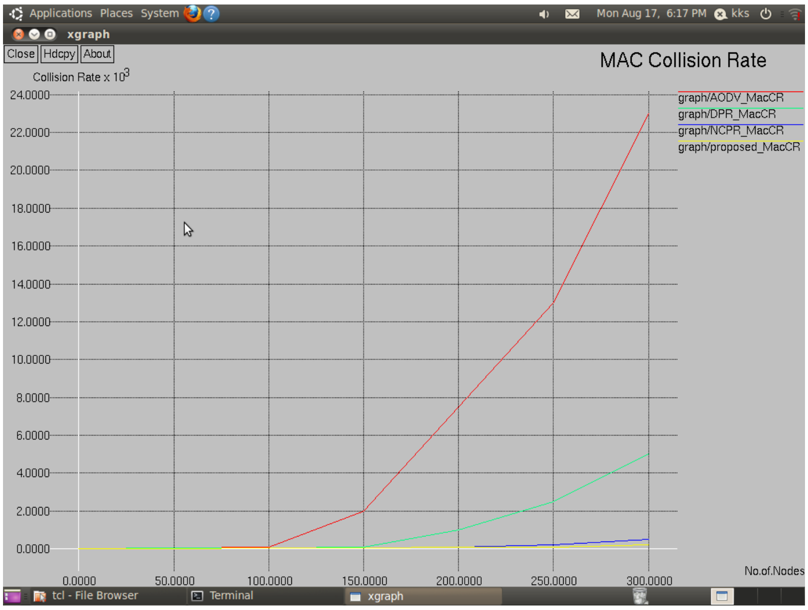

Figure. 1: MAC collision vs No. of nodes

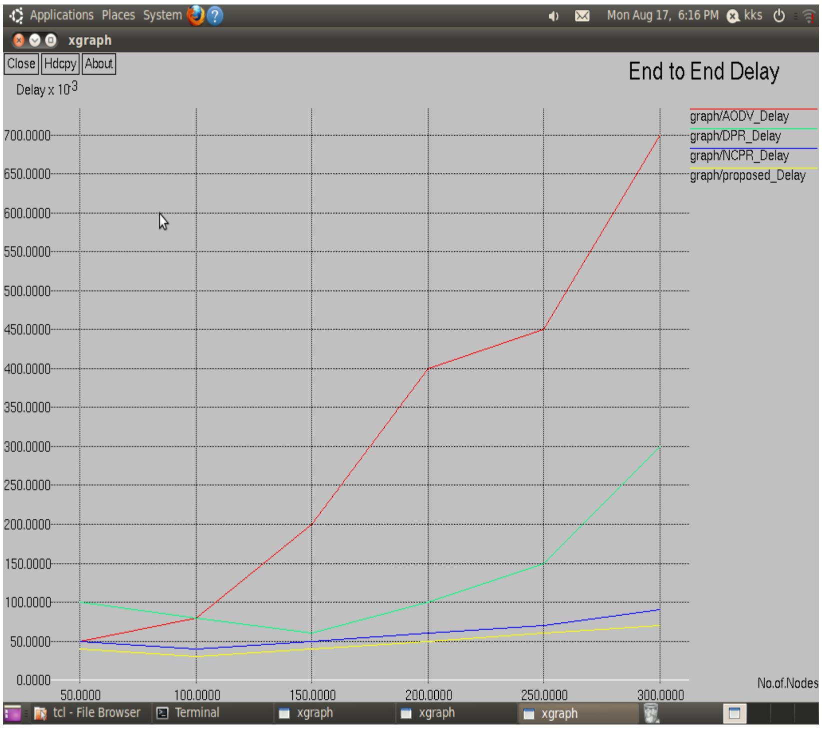

Figure.2: End to end delay vs No. of nodes

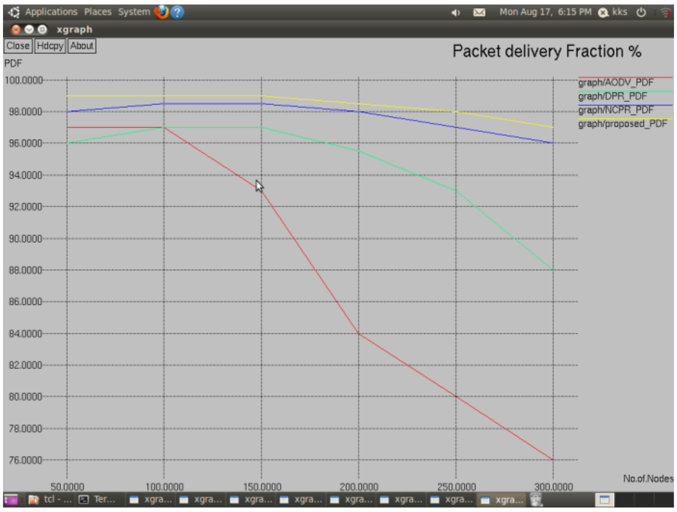

Figure. 3: Packet delivery ratio vs No.of nodes

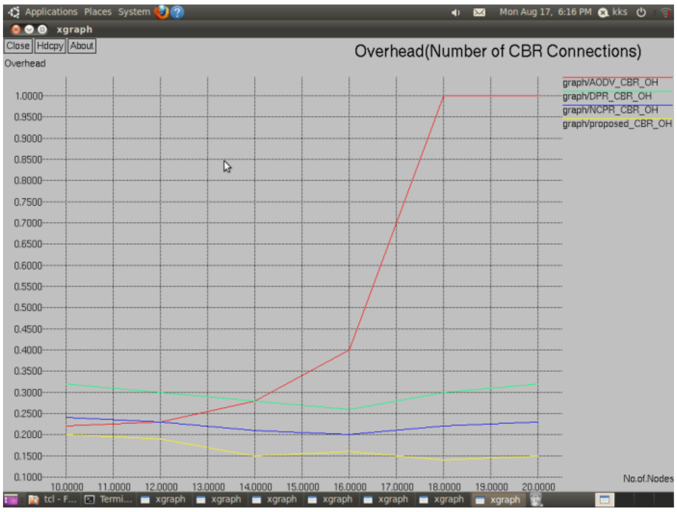

Figure. 4: Routing overhead vs No.of nodes(CBR Connection)

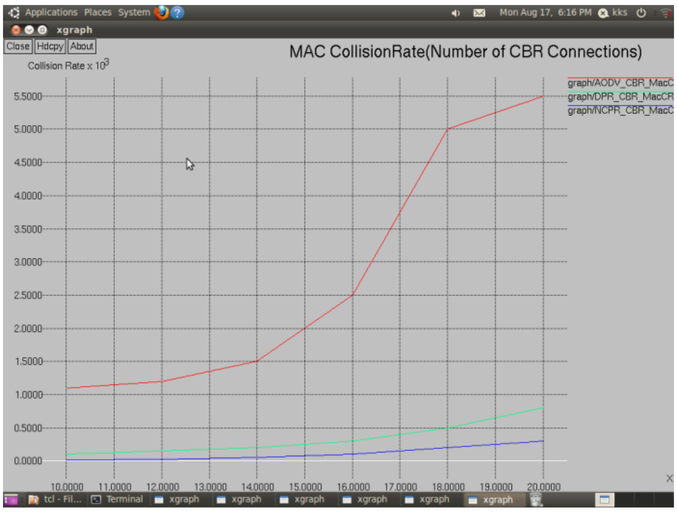

Figure. 5: MAC collision Rate vs No.of nodes(CBR Connections)

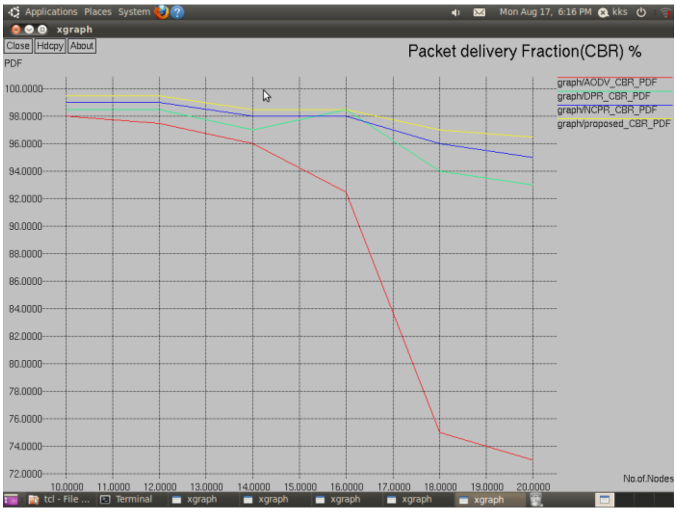

Figure. 6: Packet delivery ratio vs No.of nodes(CBR Connections)

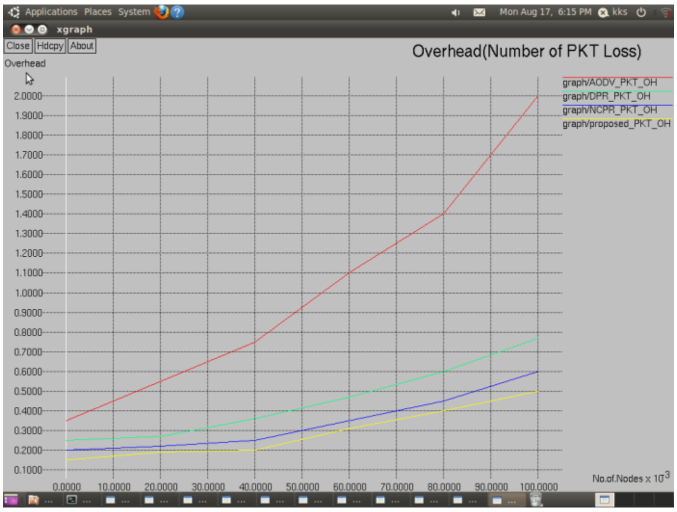

Figure. 7: Routing overhead vs No.of nodes(Packet loss)

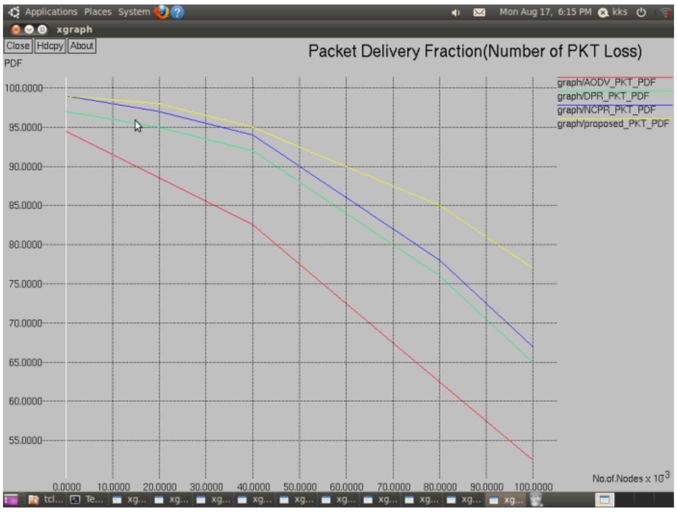

Figure. 8: Packet delivery ratio vs No.of nodes(Packet loss)

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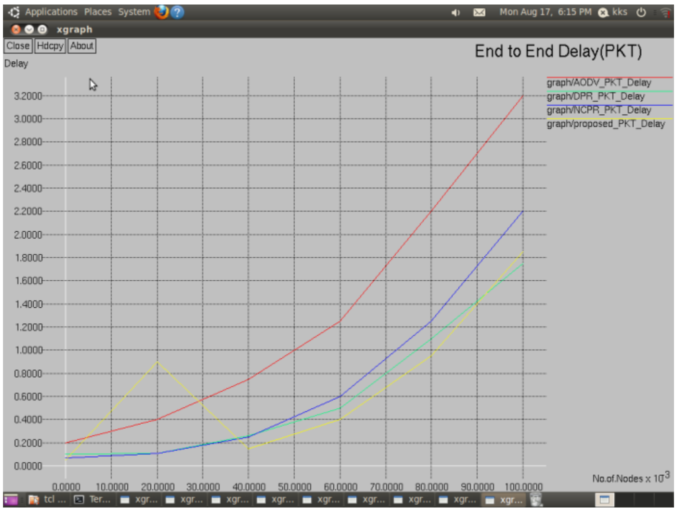

Figure. 9: End to end delay vs No.of nodes(Packet loss)

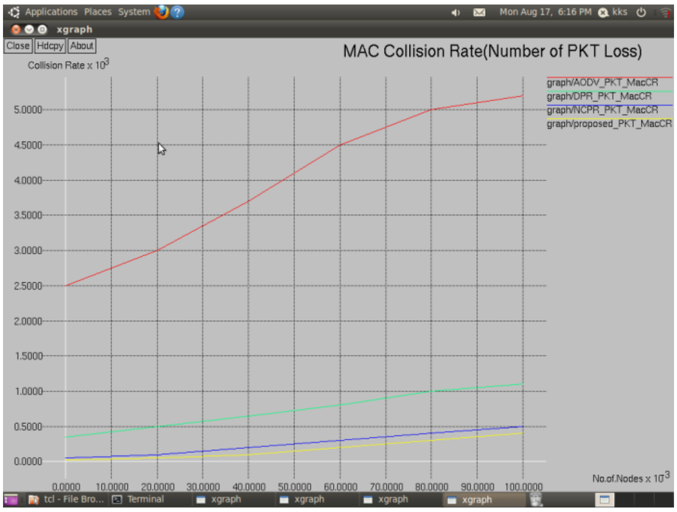

Figure. 10: MAC collision rate vs No.of nodes(Packet loss)

Simulation results show that the Node- NCPR protocol generates less rebroadcast traffic than the flooding and some other optimized scheme in literatures. Because of less redundant rebroadcast, the Node- NCPR 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.

V. CONCLUSION

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. 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. Advantages of the system are:

- Increase in packet delivery ratio.
- Decrease in the average end -to -end delay Transmissions.
- Reduce in Frequent link breakages and path failures leads to good routing performance when the network is in high density.
- Routing and mobility management should be maintained.

The proposed approach has efficient routing as well as security is also a challenging factor in ad hoc networks. Resisting flooding attacks in ad hoc networks incur two flooding attacks: Route Request (RREQ) and Data flooding attack. In RREQ flooding attack the attacker selects many IP addresses which are not in the network or select random IP addresses depending on knowledge about scope of the IP address in the network. In future we propose a new trust approach based on the extent of friendship between the nodes is proposed which makes the nodes to co-operate and prevent flooding attacks in an ad hoc environment.

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