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Reducing Routing Overhead in Mobile Ad-Hoc Networks Using NCPR Protocol

[1]Pratibha Madargi, [2]Prof. Dhananjay M

[1]M.Tech Student, [2]Professor, CSE Dept. GNDEC, Bidar, India

Abstract: **MANET's consists of number of mobile nodes which form special types of mobile networks on fly. During route discovery employing mobile ad-hoc networks collision and contention occurs which increases overhead of mobile nodes resulting in broadcast storm problem. This may increase end to end delay and reduce packet delivery ratio. To solve this problem we are using neighbour coverage based rebroadcast which reduces collision and contention of mobile ad-hoc networks in route discovery. A rebroadcast delay is introduced to determine the neighbor coverage knowledge which will help in finding accurate additional coverage ratio and rebroadcast order. In this paper an attempt has been made to compare AODV protocol with proposed NCPR protocol. Simulation results shows our proposed NCPR protocol produces good performance as compared to AODV protocol.**

Keyword: **Mobile ad-hoc network, AODV, rebroadcast delay, rebroadcast probability, neighbourhood coverage.**

I. INTRODUCTION

MANET's consists of many mobile nodes and packets transformation takes place through these mobile nodes. Mobile ad-hoc networks have dynamic infrastructure, they form self-organized arbitrary topology. In MANET's topology changes frequently which lead to collision between the mobile nodes and increase overhead of the routing protocols. MANET is having multiple hop wireless network data must be routed via intermediate nodes. MANET consists of three types of routing protocols: proactive routing protocol, reactive routing protocol and hybrid routing protocol. Proactive routing protocols maintain routes between every pair at all-time ex: DSDV, reactive routing protocols determine routes if and when needed ex: DSR, hybrid routing protocols are combination proactive and reactive. The Broadcast Storm Problem [2] in a Mobile Ad Hoc Network has identified an important issue in a MANET, the broadcast storm problem. They have demonstrated, through analyses and simulations, how serious this problem could be. They proposed several scheme to reduce the redundant retransmission and differentiate timing of rebroadcasts to alleviate to the broadcast storm problem. Gossip-Based Ad Hoc Routing [3], proposed a gossiping-based approach, where each node forwards a message with some probability, to reduce the collision and contention of the routing protocols. Gossiping exhibits bimodal behavior in sufficiently large networks. A Dynamic Probabilistic Route Discovery [6] for Mobile Ad Hoc Networks, a Dynamic Probabilistic Route Discovery (DPR) scheme based on neighbor coverage is considered. 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. Kim et al. 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. The neighbor knowledge methods perform better than the area-based ones and the probability-based ones. We propose a neighbor coverage-based probabilistic rebroadcast (NCPR) protocol.

II. A NEIGHBOR COVERAGE BASED PROBABILISTIC REBROADCAST

In this section, we propose neighbour coverage based probabilistic rebroadcast protocol. The proposed protocol is divided into as follows.

- Rebroadcast delay.
- Rebroadcast probability.

A. Rebroadcasting Delay calculation:-

Rebroadcast Delay calculation is used to establish the transmission order from the source to the destination. For that it first find out uncovered neighbour nodes of source nodes and start the timer, it will see if a neighbour node receiving duplicate packet before timer expires then it will discard that packet. During rebroadcast delay calculation, when a node receives the RREQ packet from the previous nodes, it checks the neighbour list of the previous node for the redundant RREQ packet. If the current node has more common neighbours than the previous node, then the rebroadcast order value will be lower and so the packet will reaches the large number of neighbour nodes .If the current node has less common neighbours than the previous node which has highest rebroadcast order value, then it forwards the RREQ packet to next neighbour node. Rebroadcast order the node can set its own timer for further transmissions. Rebroadcast delay is calculated as follows,

$$Tp(ni) = 1 - \frac{|N(s) \cap N(ni)|}{|N(s)|} \quad \text{... (2.1)}$$

$$Td(ni) = MaxDelay \times Tp(ni) \quad \text{... (2.1)}$$

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

B. Rebroadcast Probability:-

To keep the network connectivity and reduce redundant retransmission we use rebroadcast probability. If a node receives duplicate packet then it will discard that packet and recalculate the uncovered neighbour nodes stop timer. The rebroadcast probability contains two parts:

1)Coverage range, which is the ratio of the number of neighbour nodes that should be covered in the single broadcast which is based on the total number of neighbours. This is calculated as follows,

$$Ra(ni) = \frac{|U(ni)|}{|N(ni)|} \quad \text{... (2.3)}$$

Where Ra(ni) gives coverage ratio, U(ni) gives uncovered neighbour set and N(ni) gives neighbour nodes of node ni.

2) Connectivity value, which reflects the relationship of network connectivity factors and the number of neighbors of a given node. This is calculated as follows,

$$Fc(ni) = \frac{Nc}{|N(ni)|} \quad \text{... (2.4)}$$

Fc (ni) gives connectivity value, Nc=5.1774logn where n is number of nodes in the network.

After calculation of coverage range and connectivity value we get the rebroadcast probability. Rebroadcast probability is the combination of both coverage range and connectivity value. This is given below,

$$\Pr e(ni) = Fc(ni) \cdot Ra(ni) \quad \text{... (2.5)}$$

Where Pre (ni) is Rebroadcast probability.

After calculation of rebroadcast probability, if this value is greater than or equal to random numbers zero or one then it will broadcast RREQ packets otherwise discard RREQ packet. The node which has higher rebroadcast order must receive the RREQ packet from the node which has lower rebroadcast order. The node with higher order checks for the duplication of the packet. If it finds the duplication in the packet which is received, this discard the packet and make changes in the neighbors list. When the timer of the rebroadcast order of the node expires, the node obtains the final Uncovered Neighbors set. The nodes belonging to the final UCN set are the nodes that need to receive and process the RREQ packet. If a node does not sense any duplicate RREQ packets from its neighborhood, its UCN set is not changed, which is the initial UCN set. Finally calculated Coverage range is combined with the connectivity value and the probability value is set to 1.

III. A PROTOCOL IMPLEMENTATION AND PERFORMANCE EVALUATION

A. Protocol Implementation:

We modify the source code of AODV in NS-2 to implement our proposed protocol. AODV protocol uses periodic hello packets and broadcast packets using routing table information. The proposed NCPR protocol needs Hello packets to obtain the neighbour information, and also needs to carry the neighbour list in the RREQ packet.

- 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 neighbours 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 neighbour list in the RREQ packet, each node needs to monitor the variation of its neighbour table and maintain a cache of the neighbour list in the received RREQ packet.

B. Simulation Environment:

In order to evaluate the performance of the proposed NCPR protocol, we compare it with AODV protocols using the NS-2 simulator. Broadcasting is a fundamental and effective data propagation mechanism for many applications in MANETs. In this paper, we just study one of the applications: route request in route discovery. In order to compare the routing performance of the proposed NCPR protocol, we choose the AODV protocol which is an optimization scheme for reducing the overhead of RREQ packet incurred in route discovery in the recent literature.

Simulation parameters are as follows: The Distributed Coordination Function (DCF) of the IEEE 802.11 protocol is used as the MAC layer protocol. The radio channel model follows a Lucent's WaveLAN with a bit rate of 2 Mbps, and the transmission range is 250 meters. We consider constant bit rate (CBR) data traffic and randomly choose different source destination connections. Every source sends four CBR packets whose size is 512 bytes per second. The mobility model is based on the random waypoint model in a field of 1;000 m _ 1;000 m. In this mobility model, each node moves to a random selected destination with a random speed from a uniform distribution [1, max-speed]. After the node reaches its destination, it stops for a pause time interval and chooses a new destination and speed. In order to reflect the network mobility, we set the max-speed to 5 m/s and set the pause time to 0. The MaxDelay used to determine the rebroadcast delay is set to 0.01 s, which is equal to the upper limit of the random jitter time of sending broadcast packets in the default implementation of AODV in NS-2. Thus, it could not induce extra delay in the route discovery. The simulation time for each simulation scenario is set to 300 seconds. The detailed simulation parameters are shown in Table 1.

TABLE 3.1 Simulation Parameters

Simulation Parameter	Value
Simulator	NS-2
Topology size	1000m*1000m
Number of Nodes	50,100,150,….300
Transmission Range	250m
Bandwidth	2Mbps
Interface queue length	50
Traffic Type	CBR
Packet Size	512 bytes
Packet Rate	4 Packet/sec
Pause Time	0s
Min Speed	1 m/s
Max Speed	5 m/d

C. 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 end to end delay and increases packet delivery ratio. This indicates that the NCPR protocol is the most efficient among the three protocols.

D. Results:

To show the performance AODV and NCPR protocol, we plotted graph by using varied number of nodes with packet delivery ratio and end to end delay.

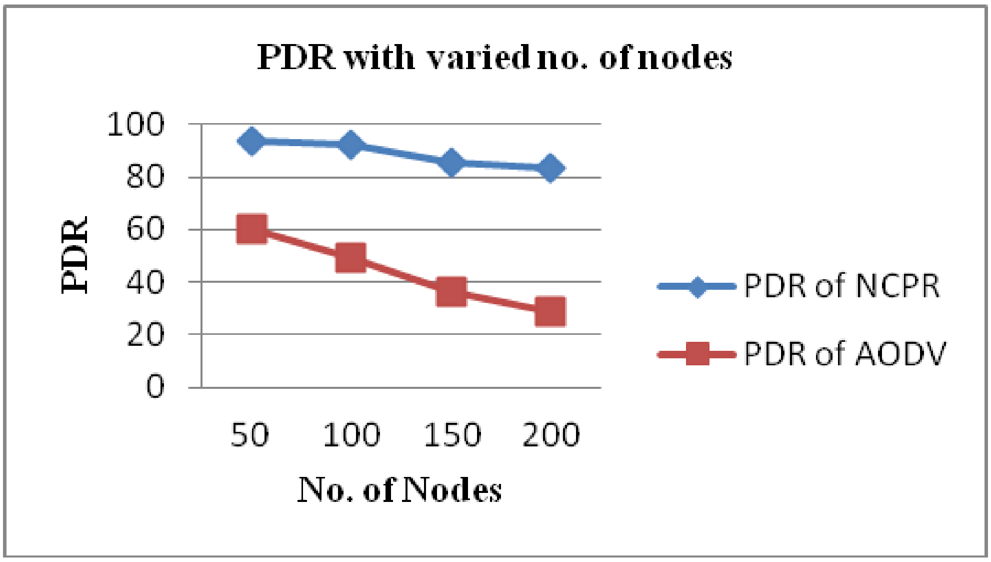

Figure 3.1:PDR with varied no. Of nodes

In the packet delivery ratio with varied number of nodes, x-axis shows number of nodes from 50,100,200 and y-axis shows packet delivery ratio. The graph shows packet delivery ratio of NCPR protocol more than AODV protocol.

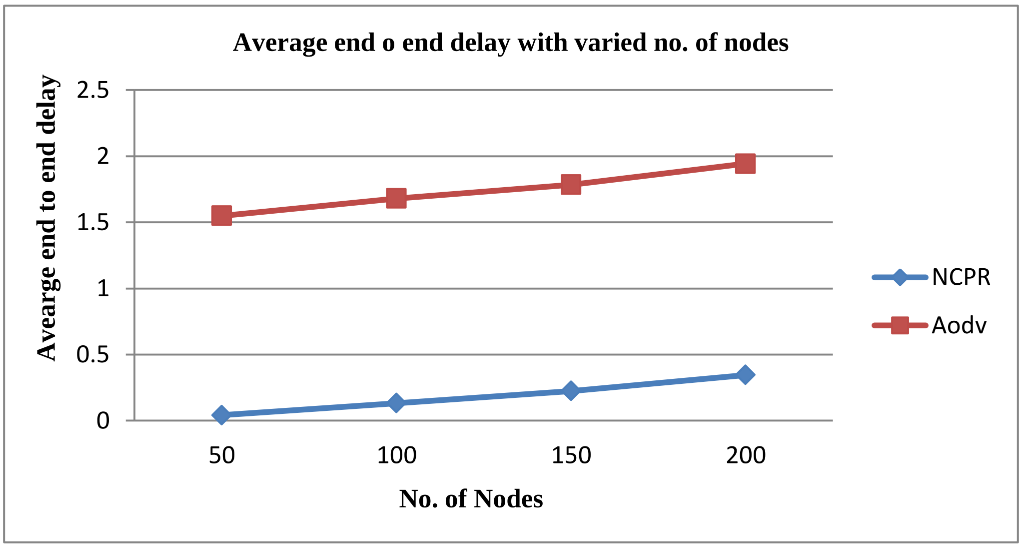

Figure 3.2: Average end to end delay with varied no. Of nodes

Above graph is plotted using varied number of nodes with end to end delay. X-axis shows number of nodes and Y-axis shows average end to end delay. From the graph we can see that average end to end delay is less by using NCPR protocol than AODV protocol.

IV. CONCLUSION

In this paper we proposed rebroadcast delay to determine forwarding order which gives the transmission order from source to destination. If it is having more number of uncovered neighbour nodes rebroadcast delay is less, if it is having less number of uncovered neighbour nodes then rebroadcast delay is more. We also proposed rebroadcast probability in which we have calculated additional coverage range and connectivity value combination of these two gives rebroadcast probability. We compared our proposed NCPR protocol with AODV protocol. Simulation results shows proposed protocol is having less delay than flooding and some other methods in literature Simulation results also shows NCPR protocol is having high packet delivery ratio and less end to end delay than the AODV protocol. The proposed protocol mitigate network collision and contention in mobile ad-hoc networks, this is shown by the simulation results. This method significantly decreases the number of retransmissions so as to reduce the routing overhead.

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