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A New Scheme of Routing in Mobile Ad hoc Networks for Reducing Delay and Finding Shortest Path

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Abstract : *Wireless networks offer more flexibility and adapt easily to changes in the configuration of the network. Wireless ad hoc network is a decentralized type of wireless network. Mobile ad hoc network is a type of ad hoc network, in which each and every node can change its location. Frequent link breakages exist due to its high mobility of nodes which leads to frequent path failures and route discoveries. An efficient and fundamental data dissemination mechanism is broadcasting, the mobile node blindly rebroadcasts the first received route request, even if there is no route to destination leads to broadcast storm problem.. In this paper a hybrid protocol is proposed, which combines the advantages of neighbor coverage based probabilistic rebroadcast protocol and adhoc on demand distance vector routing protocol and is simulated by Network Simulator. The neighbor coverage and probabilistic mechanism significantly decreases the number of retransmissions so as to reduce the routing overhead. Adhoc on demand distance vector routing protocol finds the shortest path to destination by evaluating the hop count. The shortest path reduces the average end to end delay more effectively. Thus hybrid protocol improves the routing performance.*
Keywords: *Rebroadcast delay, rebroadcast probability, connectivity factor, additional coverage ratio, shortest path*

I. Introduction

A Mobile Ad-hoc Network (MANET) is a dynamic wireless network that can be formed without the need for any pre-existing infrastructure in which each node can act as a router. Mobile ad hoc network (MANET) is an autonomous system of mobile nodes connected by wireless links. Each node operates not only as an end system, but also as a router to forward packets [5]. The nodes are free to move about and organize themselves into a network. These nodes change position frequently**.** 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 [1]. 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. In traditional protocol the route from the source to destination is selected on the basis of hop counts and sequence number. The route which has minimum number of hop counts and highest sequence number will be selected as the best route. The sequence numbers tells us the freshness of the route [2].

The long standing feature of routing protocols in Mobile Ad hoc Network (MANET) send periodic messages to realize the changes in topology. The traditional routing protocols in MANETs send periodic messages to realize the changes in topology of mobile ad hoc network. When compared to reactive routing protocols, the Proactive routing protocols causes high routing overhead and the broadcasting of messages causes broadcast storm problem [4]. 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. Without a fixed infrastructure the mobile nodes in MANETs can be dynamically self-organized into arbitrary topology networks. Thus MANETs are suitable for emergency situations like natural or human-induced disasters, military conflicts, emergency medical situations, etc because of its random topology. Using random mobility model, the nodes in Mobile Ad hoc Network can get the service to communicate each node in network [1]. The proposed hybrid protocol is combines the advantages of neighbor coverage based probabilistic rebroadcast protocol (NCPR) and ad hoc on demand distance vector routing protocol l(AODV). The neighbor coverage based probabilistic rebroadcast protocol, exploits the neighbor coverage knowledge by rebroadcast delay and thus obtains additional coverage ratio. Connectivity factor is defined and it is combined with additional coverage ratio to set rebroadcast probability. Ad hoc on demand distance vector routing protocol finds the shortest path to destination by evaluating the hop count. Thus hybrid protocol improves the routing performance.

II. Related Works

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 [8]. The broadcasting protocol analytically and experimentally, and showed that the rebroadcast is very costly and consumes too much network resource [4]. In traditional protocol the route from the source to destination is selected on the basis of hop counts and sequence number [2]. A gossip-based approach has been proposed, where each node forwards a packet with a probability. However, when the network density is high or the traffic load is heavy, the improvement of the gossip based approach is limited [9]. A probabilistic broadcasting scheme based on coverage area and neighbor confirmation has been proposed [7]

III. Hybrid Protocol

The proposed hybrid protocol combines the advantages of both Neighbor coverage based probabilistic rebroadcast protocol and Ad hoc on demand distance vector routing protocol. A novel rebroadcast delay is used to determine the rebroadcast order, and it obtains the more accurate additional coverage ratio. Connectivity factor is defined and it is combined with additional coverage ratio to set rebroadcast probability. Ad hoc on demand distance vector routing protocol finds the shortest path to destination by evaluating the hop count.

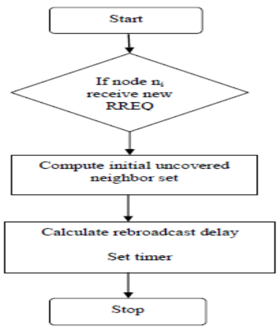

Fig 1 Flowchart for the calculation of rebroadcast delay and uncovered neighbor set

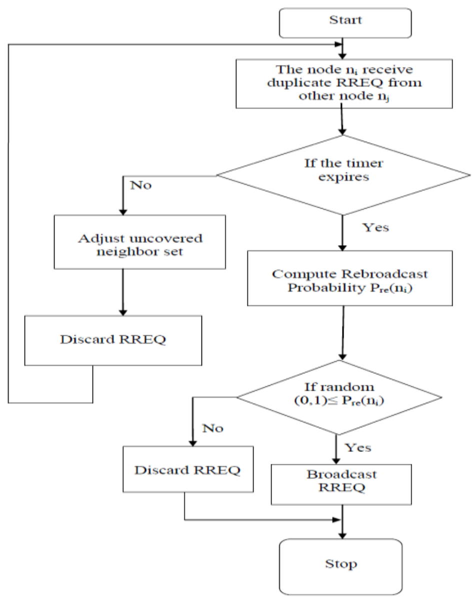

Fig 2 Broadcasting and discarding of RREQ

3.1 Rebroadcast Delay Calculation

To estimate how many its neighbors have not been covered by the RREQ packet from s, when node n_i receives an RREQ packet from its previous node s, it can use the neighbor list in the RREQ packet. To calculate this, the Uncovered Neighbors set $U(n_i)$ of node is defined. It is given below:

$$U(n_i) = N(n_i) - [N(n_i) \cap N(s)] - \{s\} \tag{1}$$

Where N(s) and N (n_i) are the neighbors sets of node s and n_i, respectively. s is the node which sends an RREQ packet to node n_i. The key to success for the neighbor coverage based probabilistic rebroadcast protocol is the choice of a proper delay [1] . The rebroadcast delay $T_d(n_i)$ of node n_i is defined as follows:

$$T_p(n_i) = \frac{1 - |N(s) \cap N(n_i)|}{|N(s)|} \quad (2)$$

$$T_d(n_i) = MaxDelay \times T_p(n_i) \quad (3)$$

Where $T_p(n_i)$ is the delay ratio of node n_i, and MaxDelay is a small constant delay. Its value is 0.01. Consider that node n_k has the largest number of common neighbors with node s, according to (3). Then the node n_k has the lowest delay. The node can set its own timer after determining the rebroadcast delay.

3.2 Rebroadcast Probability Calculation

The RREQ packets from the nodes which have lowered rebroadcast delay may listen to the node which has a larger rebroadcast delay. According to the neighbor list in the RREQ packet from $n_{j,}$ the node n_i could further adjust its UCN set [1]. Then, the $U(n_i)$ can be adjusted as follows:

$$U(n_i)=U(n_i)-[U(n_i)\cap N(n_j)] \quad (4)$$

The RREQ packet received from node n_j is discarded after adjusting the $U(n_i)$. To determine the order of disseminating neighbor coverage knowledge to the nodes which receive the same RREQ packet from the upstream node, the rebroadcast delay is used. The additional coverage ratio of node n_i is (R_a (n_i)), which is defined as follows:

$$R_a(n_i) = \frac{|U(n_i)|}{|N(n_i)|} \quad (5)$$

This equation indicates the ratio of the number of nodes that are additionally covered by this rebroadcast to the total number of neighbors of node n_i. To keep the probability of network connectivity approaching 1, [3] a heuristic formula is used: $|N(n_i)| \cdot F_c(n_i) \geq 5.1774 \log n$. Then define the minimum F_c (n_i) as a connectivity factor, which is given by:

$$F_c(n_i) = \frac{N_c}{|N(n_i)|} \quad (6)$$

Where N_c = 5:1774 log n, and n is the number of nodes in the network. From (6), it is observed that $F_c(n_i)$ is less than 1, when $|N(n_i)|$ is greater than N_c. The rebroadcast probability P_{re} (n_i) of node n_i:

$$P_{re}(n_i) = F_c(n_i).R_a(n_i) \quad (7)$$

Where, set the $P_{re}(n_i)$ to 1,if the P_{re} (n_i) is greater than 1, The rebroadcast probability is defined with the following reason. From the additional coverage ratio $R_{a,}$ it can be determine that how many neighbors should receive and process the RREQ packet.

1.3 Shortest Path Calculation

The Ad hoc On Demand Distance Vector (AODV) routing algorithm is a routing protocol designed for ad hoc mobile networks. As the route reply packet traverses back to the source, the nodes along the path enter the forward route into their tables [2]. In AODV protocol, the route from the source to destination is selected on the basis of hop counts and sequence number. The route which has minimum number of hop counts and highest sequence number will be selected as the best route. Here AODV considers minimum five paths to find the shortest path to destination. From these the destination node send back the RREP packet. The route which has minimum hop count is selected as shortest path.

1.4 Simulation Parameters

Table 1 Simulation Parameters

Simulation Parameter	Value
Simulator	NS-2(v2.34)
Topology Size	1200 × 1200 m
Number of Nodes	350
Transmission Range	250 m
Interface Queue Length	50
Traffic Type	CBR
Packet Size	512 bytes
Packet Rate	4 packets/sec
Min Speed	1 m/sec
Max Speed	5 m/sec

3.5 Performance Analysis

To evaluate the performance of Hybrid protocol, it is compared with some other protocols such as AODV and NCPR. It is simulated by using NS-2 simulator version 2.34. A fundamental and effective data dissemination mechanism for many applications in Mobile Ad Hoc Networks is broadcasting. The Neighbor Coverage based probabilistic rebroadcast protocol [1], which is an optimization scheme for reducing the overhead of RREQ packet in route discovery and the conventional AODV protocol, is chosen to compare the routing performance of the Hybrid protocol. Various performance parameters are evaluated.

MAC Collision Rate: It is defined as 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: It is 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.

Packet Delivery Ratio: It is the ratio of the number of data packets successfully received by the Constant Bit Rate (CBR) destinations to the number of data packets generated by the CBR sources.

Average End-To-End Delay: It is the average delay of successfully delivered Constant Bit Rate (CBR) packets from source to destination node. It includes all possible delays from the CBR sources to destinations. The constant bit rate data traffic and randomly chosen different source to destination connections.

IV. Results

The sending of route request packet (RREQ) or route to send packet (RTS) and acknowledgement (ACK) is shown in NAM window in figure 3. The green circles show the RREQ, ACK packets. The blue color nodes indicate the source and destination. The RREQ packet is send for the route discovery from the source to destination.

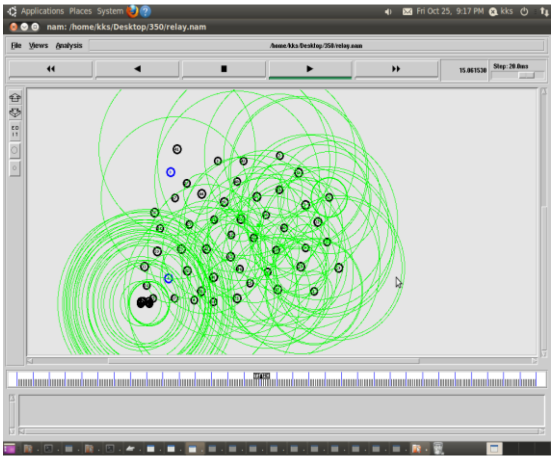

Fig 3 Transmission of RREQ and ACK

4.1 Varied Nodes With Various Performance Metrics

The MAC collision rate with varied number of nodes is shown in figure 4. The MAC collision rate of conventional AODV is more severe. Thus the retransmission increases. It incurs severe end to end delay. NCPR protocol induces less collision than AODV. The hybrid protocol is more efficient than AODV and NCPR.

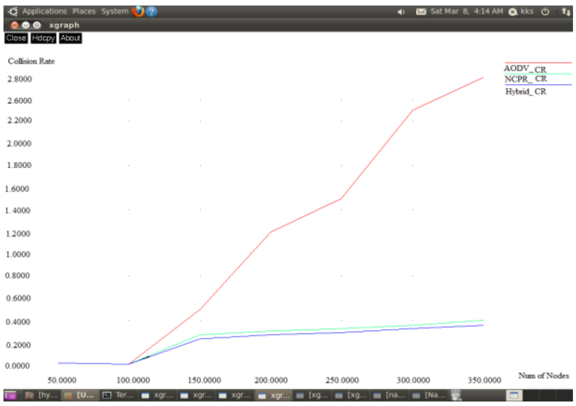

Fig 4 MAC collision rate with varied number of nodes

The routing overhead with varied number of nodes is shown in figure 5. Compared with the conventional AODV protocol, the overhead is reduced by above 45.9 percent in the NCPR protocol. The overhead of Hybrid protocol is reduced more efficiently than the NCPR protocol. When network is dense, the Hybrid protocol reduces the routing overhead more effectively when it is compared with AODV and NCPR.

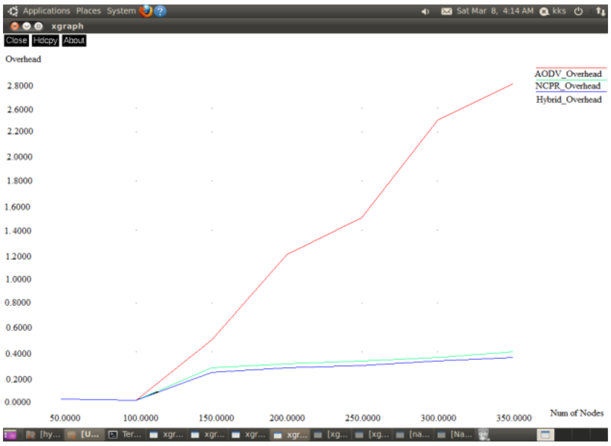

Fig 5 Routing Overhead with Varied Nodes

Delay with varied number of nodes is shown in figure 6.The MAC collision rate of conventional AODV is more severe. Thus the retransmission increases. It incurs severe end to end delay. NCPR reduces end to end delay by above 60.8 percent when compared with AODV. The Hybrid protocol has less delay when it is compared with NCPR protocol.

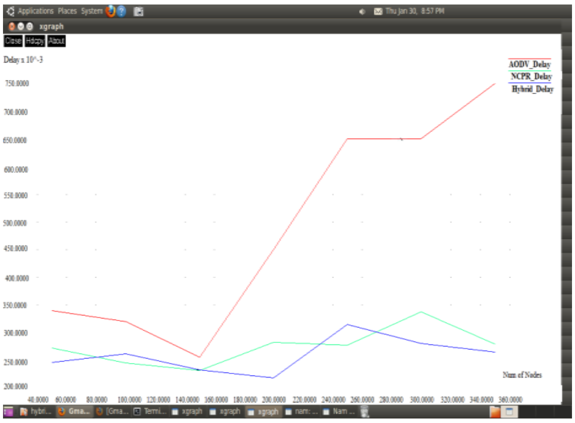

Fig 6 Delay with Varied Nodes

The packet delivery ratio with varied number of nodes is shown in figure 7. The MAC collision rate of AODV is excess. So, it leads to packet drops. It reduces packet delivery ratio. When AODV and NCPR are compared with Hybrid protocol, the packet delivery ratio of Hybrid protocol is more increased.

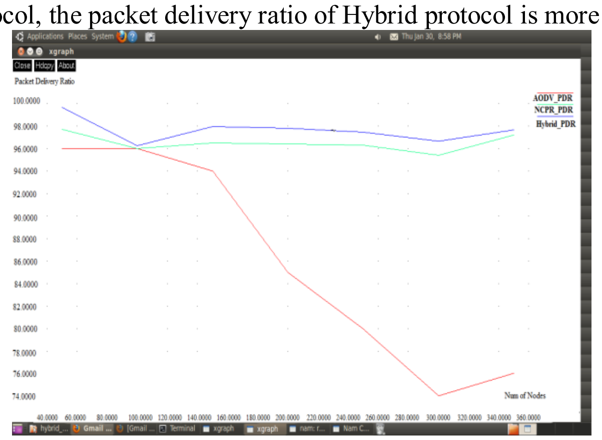

Fig 7 Packet Delivery Rate with Varied Nodes

V. Conclusion

The proposed hybrid protocol improves the routing performance of mobile ad hoc networks. The hybrid protocol combines the advantages of both NCPR and AODV protocol. In the hybrid protocol, the neighbor coverage knowledge includes additional coverage ratio and connectivity factor. This approach significantly decreases the number of retransmissions so as to reduce the routing overhead. Adhoc on demand distance vector routing protocol finds the shortest path to destination. Simulation results show that the Hybrid Protocol generates less rebroadcast traffic than the flooding and some other optimized scheme in literatures and it finds the shortest path to destination.

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