Efficient Routing Protocol in MANET

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Abstract— Ad hoc wireless mobile network does not have any fixed infrastructure. Therefore all nodes are able to move freely in the network and they are connected dynamically to each other in arbitrary manner. The routing protocol is used to discover a route, if mobile nodes are not within the wireless range of each other. Efficient Routing Protocol (ERP) scheme is proposed for communication in the mobile ad hoc network. ERP defines a new metric average active path count for routing. In ERP, possible routes are discovered and then select a route for communication that has less traffic. ERP decreases congestion and increase packet delivery ration which ultimately enhances the network performance.

Keywords- *Mobile Ad-hoc Network(MANET); Routing Protocols; Rebroadcast Probability; Neighbor Coverage Knowledge; Load balancing; AODV; RREQ; RREP; RERR.*

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I. Introduction

MANET is a network consisting of a group of portable devices which communicates with each other without any dedicated infrastructure. There is no any fixed topology so mobile nodes can move in the network freely. Nodes have limited transmission range. If destination node is located within the source node's transmission range then they can directly communicate with each other. On the other hand, if destination node is located outside the source node's transmission range then they can communicate through intermediate nodes.

Many routing protocols are proposed for MANET. They are broadly classified into two types: Proactive routing protocol and Reactive routing protocol. In reactive routing protocols, broadcasting mechanism is used for route discovery, where each node sends a received route request packet to other nodes in the network until it finds a path to the destination. Broadcasting causes broadcast storm problem [7] such as redundant retransmissions, collisions and contentions. Williams and Camp [3] classified broadcasting techniques into four families: Simple Flooding, Probability Based Methods, Area Based Methods and Neighbor Knowledge Methods. In simple flooding method, source node broadcasts a packet to its neighbors and neighbor nodes rebroadcast the packet to their neighbors exactly one time and this process repeats until find a destination. Retransmission of packet causes congestion in the network. In probability based methods, when node receives route request packet first time some probability is assigned and rebroadcast the packet to neighbors with this probability. In network, if nodes share very less transmission coverage then probability is set to high otherwise set to low. When probability is one, this approach is similar to flooding. In area based methods, node calculates the additional coverage area and by using this scheme they can decide whether to rebroadcast the packet or not. In neighbor knowledge method, each node obtains its 1-hop neighbors by using Hello packet and based on they can decide whether to rebroadcast the packet or not.

In mobile ad hoc network, existing protocols choose shortest routing path on the basis of hop-count. So most of paths goes through the center of the network. So there are situations where huge load is given to the nodes at the center of network and the nodes located far from the center may be idle. The imbalance of load at the center causes congestion, large delays, lower packet delivery and higher routing overhead. An ERP protocol is proposed for reducing routing overhead in MANETs. A scheme average active path count is used distribute the load over the network. Rebroadcast delay is calculated to discover the forwarding order and the additional coverage ratio can be obtained by observing the neighbor coverage knowledge. Also a connectivity factor is defined to retain the network connectivity and reduce the redundant retransmissions. The rebroadcast probability is calculated by integrating additional coverage ratio and connectivity factor.

II. LITERATURE SURVEY

MANET is a network consisting of a group of portable devices which communicates with each other without any dedicated infrastructure. Mobile nodes move in the network freely therefore there is no any fixed topology. Nodes have limited transmission range. If destination node is located within the source nodes transmission range then they can directly communicate with each other. On the other hand, if destination node is located outside the source nodes transmission range then they can communicate through intermediate nodes.

Many routing protocols are proposed for MANET. They are broadly classified into two types: Proactive routing protocol and Reactive routing protocol. In proactive routing protocols, each mobile node maintain routing table which contain list of all available destinations. These tables are updated by transmitting routing information periodically throughout the network. In Reactive routing protocols, route is established only when it is needed. Reactive routing protocol contains two processes: route discovery and route maintenance. When a source node wants to communicate with destination node, it starts a route discovery process by broadcasting route request packet to its neighbors. This process repeats until it finds destination path and send route reply packet to source node. The route maintenance process is used when source node detects any change in topology or destination becomes inaccessible or the route is no longer available. Unnecessary periodic updates are avoided therefore these protocols require less bandwidth as compared to proactive protocols. A route discovery process is required for every unknown destination. Well known reactive routing protocols are Ad hoc On-demand Distance Vector (AODV)[2] and Dynamic Source routing (DSR) [6][9].

C. Perkins, E. Belding-Royer, and S. Das, AODV is very simple and advantageous routing protocol for MANET which does not have any fixed topology. In this protocol route is established when it is needed. Source node broadcast a RREQ packet to neighbor nodes. Neighbor node has receives a packet and searches a route to destination in routing table. If a route is available then generate a RREP packet, and send back to source. Each node set forward path to the node from where it is received. If a destination route is not available then it set a reverse entry path and rebroadcast a received RREQ packet to its neighbor nodes. This process continuous until it finds destination path. AODV uses Simple flooding technique in route discovery process which causes broadcast storm problem [2].

H. AlAamri, M. Abolhasan, and T. Wysocki proposed On-demand Tree-based Routing Protocol (OTRP) for ad hoc networks. This protocol combines AODV with an efficient route discovery algorithm called Tree-based Optimized Flooding (TOF) to improve scalability of MANETs when new route is needed to destination. TOF selects branching nodes during route discovery process. Branching nodes are selected based on location. The neighbors area of parent node is divided into four regions and transmission range of parent node is partitioned into three subareas. For finding branching nodes, the rebroadcast nodes are selected in each region. After finding branching nodes, node location and addresses of four branching nodes are updated in RREQ packet. These nodes rebroadcast RREQ packet in four regions. Each selected node chooses three branching nodes to rebroadcast packet, excluding the region from where the packet came [4].

J. Kim, Q. Zhang, and D.P. Agrawal, the probability based and area based method is incorporated in this approach. In probability based method all mobile nodes set fixed predefined probability. But in MANET nodes can change their topology dynamically so there is no use of fixed probability. In this approach author should set the rebroadcast probability dynamically. Probabilistic broadcasting is depending on coverage area and neighbor confirmation. Coverage area scheme is used to set a rebroadcast probability and neighbor confirmation scheme make sure that all nodes should receive the broadcasting packet. If a node is situated near to source node then its coverage area is small and if a node situated far from source node then its coverage area is large. Coverage area is obtained by considering distance between source node and destination node and distance is calculated using signal strength or global positioning system (GPS). If destination node is situated far from source node then rebroadcast probability is set to high and if it is situated near then rebroadcast probability is set to low. The neighbor confirmation scheme confirms that all neighbors should receive a RREQ packet. Consider node N1 rebroadcast a packet to its neighbor and wait for certain time interval. After time expired, N1 make sure that all neighbors rebroadcast packet or not. If any neighbor didn't receive packet, N1 retransmit packet. Author compares this approach with flooding method. This approach requires less rebroadcasting than flooding and also decrease collision [11].

A simple flooding broadcasting method is used in most of routing protocols which leads to serious problems like redundant retransmissions, collision and contention in network. Wei Peng and Xi-Cheng Lu propose a new approach to reduce redundant retransmissions. In SBA, if all neighbors have been covered by previous transmission then there is no need to broadcast packet. A source node broadcast a packet to its neighbors. When neighbor node or intermediate node receives a packet, it knows about its covered neighbors by checking neighbor list source node. These covered nodes are added into broadcast covered set. If all nodes are in covered set then rebroadcast is not required otherwise rebroadcast a packet. Duplicate packets received by intermediate nodes are discarded [12].

In general probabilistic broadcast method, source node broadcast a packet with predefined broadcasting probability. In MANET, mobile nodes change their topology dynamically so we need to adjust probability dynamically. In this approach, each node after receiving packet, forward the packet with probability P which is obtained by considering covered neighbor set and local density of the node. It overcomes a broadcast storm problem. J.D. Abdulai, M. Ould-Khaoua, L.M. Mackenzie, and A. Mohammed approach, neighborhood information is collected using Hello packet. In hello protocol node sends hello packet periodically. If node receives hello packet from its neighbor and if there is no entry for that node in Neighbor list then it makes entry for neighbor node in its own neighbor list. If node does not receive hello packet from its neighbor within certain time interval, remove the entry of that node from neighbor list. In DPR approach, probability is dynamically calculated by considering its local density and neighbors covered by broadcast. If more neighbors are covered by broadcast, probability is set to low and if less nodes are covered, set probability high. DPR generates less routing overhead as compared to conventional AODV protocol [5].

F. Stann , J. Heidemann, R. Shroff and M. Z. Murtaza proposed Robust Broadcast Propagation(RBP) protocol to provide more reliability for broadcasting. The new approach is presented for broadcasting i.e. make a single broadcast more reliable which means it reduces the frequency of upper layer invoking flooding. It improves performance of broadcasting [8].

Xin Ming Zhang, Member, IEEE, En Bo Wang, Jing Jing Xia, and Dan Keun Sung , NCPR protocol combines the approach of probabilistic method and neighbor knowledge method. This protocol solve broadcast storm problem as well as decrease routing overhead and increase performance. In NCPR, each node maintains their neighbor list. If source node wants to communicate with destination node, it broadcasts a RREQ (route request) packet with its own neighbor list to all the 1-hop neighbors. Consider neighbor node N1 receives a RREQ packet from source node, it uses neighbor list of source node to calculate uncovered neighbor set (UCN). The initial UCN is calculated by comparing its own neighbor set with neighbor set of its previous node. After calculating initial

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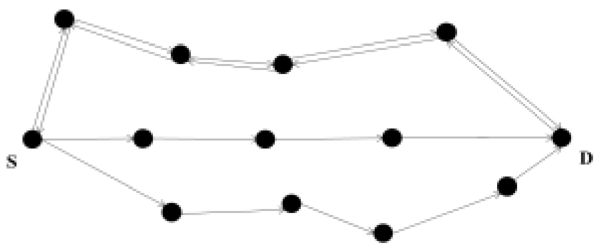
UCN, N1 set timer. Before timer expired, if N1 receives same RREQ packet from its other neighbor then it recalculate UCN. It calculates rebroadcast delay to discover forwarding order. Rebroadcast delay is used to set a timer. After timer expired, Rebroadcast Probability is estimated by combining additional coverage ratio and connectivity factor. Additional coverage ratio is the ratio of number of nodes covered by broadcast to total number of neighbor nodes. By considering rebroadcast probability, node can decide whether to broadcast a packet or not. NCPR protocol reduces redundant retransmission of packet. Due to this collision and contention is reduced. Also it reduces end to end delay and increase packet delivery ratio [1].

In MANET, routing protocols use a shortest path for communication and most of shortest paths use centrally located nodes as intermediate nodes of path. Therefore these centrally located nodes carry too much load which increases congestion, large delay and decreased performance. Oussama Souihli, Mounir Frikha, Mahmoud Ben Hamouda proposed load balancing approach which distribute the central load to other nodes located far from the central nodes. In this approach, intermediate nodes compare routes using eccentricity metric. Eccentricity is nothing but the size of its routing table. When source node wants to communicate with destination, it sends RREQ packet with size of its routing table as eccentricity. After receiving RREQ packet, intermediate node calculates average eccentricity by using previous nodes eccentricity and its own eccentricity and sends this average eccentricity with RREQ packet to its 1-hop neighbours. This process is repeated until it find destination. Destination node receives different RREQ packets from different routes. It compares all received eccentricities and selects a path with less eccentricity by sending RREP packet. This mechanism distribute central load which decreases congestion and improve performance. Pham and Perreau assume that nodes in network are uniformly distributed. This hypothesis not studied for non-uniform node distribution [10].

III. PROPOSED SYSTEM

A. *Working flow*



Architecture Diagram

1) *Route Discovery*

When the source node wants to communicate with destination node, it checks its route table to confirm whether it has the valid route to destination. If so, it sends the packet to the appropriate next hop towards the destination. However, if the node does not have a valid route to the destination, it must initiate a route discovery process.

2) *Broadcast RREQ*

The source creates a RREQ (Route Request) packet. This packet contains message type, source address, current sequence number of source, destination address, the broadcast ID and route path. The broadcast ID is incremented every time when the source node initiates a RREQ. If node does not have valid route in routing table source node attaches average active path count and neighbor list to RREQ packet and broadcast it to neighbor nodes. Intermediate nodes receives RREQ packet from source node check route in routing table. If route found, an intermediate node generate RREP packet and with the help of reserve entry path forward RREP packet to the source node.

3) *Compute Uncovered Neighbor Set, Average Active Path Count and Rebroadcast Delay*

Source node send RREQ packet attach with neighbor list of itself and average active path count field to neighbor node. When intermediate node receive RREQ packet, node check RREQ id, if route request packet is new calculate initial Uncovered Neighbor Set else if RREQ packet is duplicate then Adjust Uncovered Neighbor Set and discard duplicate RREQ. Also it calculates the average active path count by using routing table size of previous node and current node. Rebroadcast Delay can be calculated by comparing the neighbor list of itself and neighbor list pervious node and set timer according to the rebroadcast delay.

4) *Rebroadcast Probability Computation*

Before timer expire node adjust the Uncovered Neighbor Set by receiving duplicate RREQ packet. As time expired, node form the final uncovered neighbor set and that neighbor set is used to calculate additional coverage ratio and connectivity factor. By combining additional coverage ratio and connectivity factor rebroadcast probability is calculated. Rebroadcast probability is used to decide whether node forward a packet or discard it.

5) *Select path*

When the destination node receive RREQ packets, destination node check average active path count values came from each path and select path with less average active path count value, and forward the RREP packet through that path and create forward entry path.

6) *Transmission of data packet*

Once the source node receive RREP packet, it adds the route in routing table. By using the forward entry path source node transmit data packet to destination node. If link break, reinitiate route discovery.

B. *Algorithm*

Algorithm for ERP protocol.
s: source node.
$RREQ_p$: RREQ packet received from node p.
R_p:id: the unique identifier (id) of $RREQ_p$.
N(p): Neighbor set of node p.
U(p, x): Uncovered neighbors set of node p for RREQ whose id is x.
Timer(p, x): Timer of node p for RREQ packet whose id is x.
1: *Source node s sends a RREQ message including the size of its routing table as its average active path count and attaches the neighbour list of it. if v_i receives a new $RREQ_s$ from s then*
2: Acquires the average active path count of previous node from the received RREQ message and modify average active

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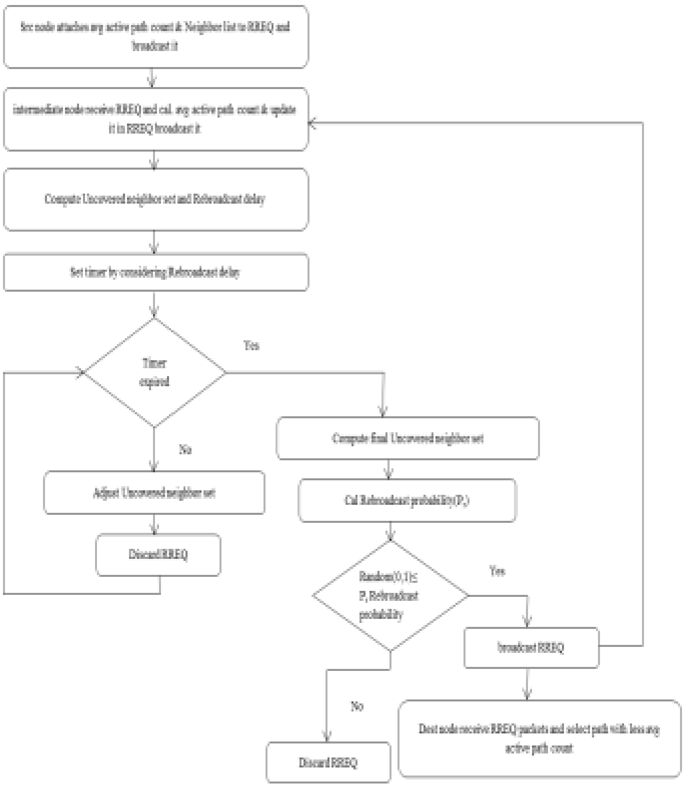
path count in RREQ and Obtain initial uncovered neighbors set $U(v_i, R_s{:}id)$ for $RREQ_s$.
3: Calculate delay ratio $T_p(v_i)$.
4: Compute the rebroadcast delay $T_d(v_i)$ using delay ratio.
5: Set a Timer(v_i, R_s:id) according to $T_d(v_i)$
6: end if
7: while v_i receives a duplicate $RREQ_j$ from node v_j before timer expires do
8: Adjust uncovered neighbor set $U(v_i, R_s{:}id)$
9: discard ($RREQ_j$)
10: end while
11: If Timer(v_i, R_s:id) expired
12: calculate additional coverage ratio $R_c(v_i)$
13: compute connectivity factor $F_c(v_i)$
14: compute Rebroadcast probability $P_r(v_i)$ by multiplying additional coverage ratio and connectivity factor.
15: if random probability <= $P_r(v_i)$
16: broadcast $RREQ_s$ packet
17: else
18: discard $RREQ_s$ packet
19: end if
20: end if
21: this process repeats until packet reaches to destination. Destination node chooses the route having the smallest average active path count value.

C. Flow Diagram



IV. RESULT ANALYSIS

The main purpose of project is to reduce the normalized routing overhead, end to end delay and increase packet delivery ratio. For this study three parameters are considered.

Normalized Routing overhead: the ratio of all control packets to all data packets send by source node.
Packet Delivery Ratio: the ratio of total number of data packets received to total number of data packets sent.
End-to-End Delay: the time taken by source node to send the data packet to destination node successfully.

The performance of the system is investigated by varying number of nodes with density. The below results are analyzed for connection 5 and mobility 10.

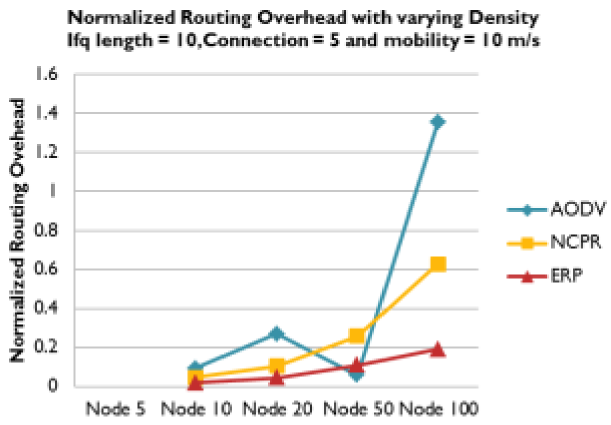


Fig. 1 Normalized Routing Overhead vs Node Density

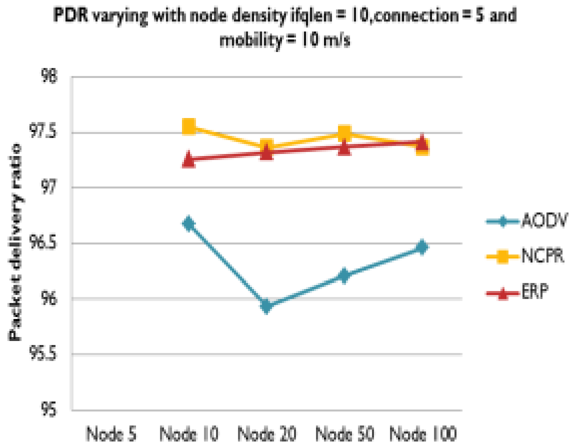


Fig. 2 Packet Delivery Ratio vs Node Density

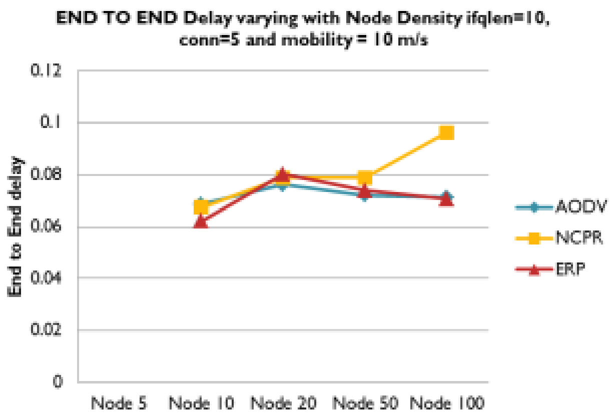


Fig. 3 End to End Delay vs Node Density

Figure 1, 2 and 3 shows the comparison between AODV, NCPR and ERP protocol. An ERP protocol reduces normalized routing overhead as compared to AODV and NCPR.

V. CONCLUSION

The ERP protocol is used to reduce the routing overhead in MANET. This proposed protocol use neighbor knowledge method, rebroadcast probability and average active path count to overcome the problem of redundant retransmissions and congestion. Thus, due to reduction in redundant control packets, proposed protocol mitigates end to end delay and routing overhead and increases packet delivery ratio which will ultimately minimize the delay in the network.

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