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A Rebroadcast Technique for Reducing Routing Overhead in Mobile Ad Hoc Network

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ABSTRACT

In Mobile Ad hoc Networks (MANETs), the freedom in mobility of nodes lead to rapid link breakages causing simultaneous route discoveries and variable topology shifts. Flooding is the common solution opted for finding routes. Despite its simplicity, flooding results in redundant rebroadcasts, collision and contention problems collectively referred as the Broadcast Strom Problem, increasing the routing overhead. Apart from the vital role played by the control messages (RREQ, RERR, RREP, HELLO MESSAGES) and neighbor list table, the routing overhead caused has a considerable higher impact in networks performance.In order to enhance Neighbor Coverage-Based Rebroadcast (NCPR) protocol, a rebroadcast technique is proposed for minimizing routing overhead by using a time elapsed for sending HELLO MESSAGES instead of periodic ones and adding a new field num_neigh in RREQ message format for indicating the neighbor coverage. This proposal has a significant improvement in the performance and NCPR after enhancement likely supports even at very light traffic load.

Keywords— MANETS, Broadcast storm Problem, Routing Overhead, Neighbor Coverage, Traffic Load.

1. INTRODUCTION

The Mobile Ad hoc Networks (MANETS) is a special type of wireless mobile network in which mobile hosts can communicate without any aid of established infrastructure and can be deployed for many applications such as battlefield, disaster relief and rescue, etc. The nodes are free to move randomly and act as end points as well as routers to forward packets in a multi-hop environment where all nodes may not be within the transmission range of the source.

The network topology may change rapidly and unpredictably in time. New nodes can join the network, and other nodes may leave the network. The expected size of a MANET is larger than the transmission range of the nodes, because of this fact it is necessary to route the traffic through a multi-hop path for giving the nodes the ability to communicate with each other. There exist neither fixed routers nor fixed locations for the routers nor centralized administration. The lack of any fixed infrastructure is compensated by the routing ability of every mobile node. They all act as mobile routers and for this they need the capability to discover and maintain routes to every node in the network and to route the packets accordingly.

To optimize the broadcasting, limiting the number of rebroadcasting in the routing will help. Rebroadcasting delay helps to define the neighbor coverage knowledge in network, in order to strengthen the network connectivity, broadcasting neighbors should receive the RREQ packet these reduce the redundant and number of rebroadcasts of the RREQ packet in the data transmission. Always neighbor selection has to done randomly, due to random mobility model in network. Number of collisions in re-broadcasting will occur in the physical layer. Since data packets and routing packets share the same physical channel, the collision possibility is high when there is a large number of routing packets (request / response).

2. RELATED WORK

The fundamental and effective data dissemination mechanism opted in Mobile Ad hoc Networks for finding route is Broadcasting.In order to avoid blind flooding as in AODV Chen et al [10] proposed dynamic rebroadcast probability update at every node stating how much overhead is created by rebroadcast and paves path to the Broadcast storm Problem. In case of high dynamic networks the routing overhead imposed is much more higher as per Abdulai et al[1] and the considerable impact on networks performance is mentioned.

Haas et al. [5] showed that gossip-based approach can save up to 35 percent overhead compared to the flooding in which each node forwards a message with certain probability. However, when the network density is high or the traffic load is heavy, the improvement of the gossip-based approach is limited [1]. Kim et al. [8] proposed a probabilistic broadcasting scheme based on coverage area and neighbor confirmation. Peng and Lu [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. [2] 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.

Keshavarz-Haddad et al. [7] 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 reachability over an idealistic lossless MAC layer, and for the situation of node failure and mobility, their schemes are robustness. Stann et al. [13] 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. Xin et al.[16] proposed a protocol NCPR that is Neighbor Coverage Based Probabilistic Routing protocol which covers both the methods of coverage based and probabilistic based. They have compared NCPR with AODV and DSR in end to end delay, MAC collision rate, number of CBR connections, Random packet loss rate and NCPR deals with the connectivity factor and additional coverage ratio which extends in calculating rebroadcast delay and rebroadcast probability.The proposed protocol and DSR are out performed by AODV at very light traffic load because of NCPRs delay neighbor list calculation.

The Neighbor coverage based probabilistic rebroadcast protocol defines the following: Using the upstream coverage ratio of the control messages received two parameters namely rebroadcast delay and rebroadcast probability are found out using the additional coverage ratio and calculated connectivity factor. The one hop neighbor node information is needed.

1. Rebroadcast delay: This parameter considers the fact of common neighbors to the current node. Incase if two nodes (current and previous node) share more common neighbors then the delay is low and this avoids channel collisions. So in case of rebroadcasting if a node rebroadcasts a packet more common neighbors will know this, thus this parameter guarantees that the packet spread is done for a wide range of neighbors and decides the forwarding order. The uncovered neighbor list (UCN), which is the calculation of common neighbors covered by the current and previous nodes. Multiplication of max delay with delay ratio found using UCN gives rebroadcast delay.
2. Rebroadcast probability: The combination of Additional Coverage Ratio and Connectivity factor results in Rebroadcast Probability. The local node density is also a concern here.
    - The Additional Coverage Ratio, which is the ratio of UCN and total number of neighbors.If this ratio is larger, this rebroadcast will cover more nodes.
    - The Connectivity Factor is the value 5.1774logn[17] divided by the modulo of number of total neighbors covered by current node is taken into account. This parameter defines the extent to which each node is connected to its neighbor node.

3. PROPOSED RREQ MESSAGE

The proposed RREQ message format consists of the same fields as that of the usual one but two extra field namely num_neigh field which has three values along with a node id field are added in addition to that of the original ones in AODV RREQ default format.

3.1 num_neigh Field

On ADDITION the num_neigh field turns positive indicating that the new neighbors should be added along with the common ones and the node id field holds the id's of the neighbor nodes which are to be added right now. On DELETION the num_neigh field turns negative indicating that the new neighbors should be added along with the common ones and the node id field holds the id's of the neighbor nodes which are to be deleted alone. On SAME CONDITIONS the num_neigh field turns zero indicating that the new neighbors should be added along with the common ones and the node id field holds the id's of any node.

3.2 Neighbor List

Table 1 Values of num_neigh field

CONDITION	**Num_neigh FIELD VALUE**	**NODES ID FIELD INCLUDES**
ADDITION OF NODES	POSITIVE (+)	Includes all the neighbors identity (which is uncommon to the current node)
DELETION OF NODES	NEGATIVE (-)	Includes only the deleted nodes identity
NO CHANGE	ZERO (0)	Includes no nodes identity

The table says the list of the new fields added to the existing formats in order to enhance routing process in terms of exploiting neighbor knowledge.

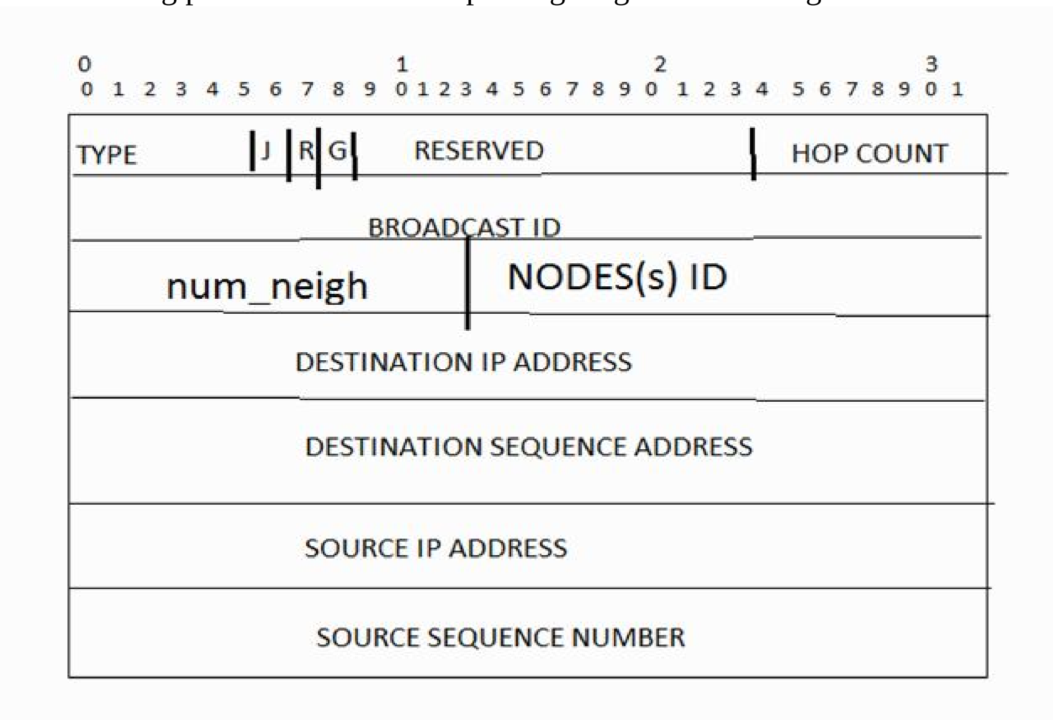

Figure 1 Proposed RREQ message format

These are the fields indicated as per the default format of RREQ:: **J**: Join flag (reserved for multicast) ; R: Repair flag (for multicast) ; **G:** Gratuitous RREP flag; indicates whether a gratuitous RREP should be unicast to the node specified in the Destination IP Address field.; **Hop Count:** The number of hops from the Source IP Address to the node handling the request. **Broadcast ID:** A sequence number uniquely identifying the particular RREQ when taken in conjunction with the source node's IP address. **Num_neigh :** It contains three values which were briefed above.It indicates the neighbor addition and deletion. By default holds the value of 0, meaning no change. **Nodes id (s) :** The neighbor nodes which are either added or deleted are noted here in the form of id values corresponding to values in predecessor field. **Destination IP Address:** The IP address of destination for which a route is desired. **Destination Sequence Number:** The last sequence number received in the past by the source for any route towards the destination. **Source IP Address:** The IP address of the node which originated the Route Request. **Source Sequence Number:** The current sequence number to be used for route entries pointing to (and generated by) the source of the route request.

4. PROPOSED ALGORITHM

According to the Algorithm, **U (n, Rs.id) :** Uncovered set of node n. **N (n) :** Neighbor nodes of node n. **RREQj:** RREQ message sent by node j.

1. if n receives a new RREQs from s then 2. {Compute initial uncovered neighbors set U (n, Rs.id) for RREQs:} 3. U (n, Rs.id) = N (n) − [N (n) ∩ N (s)] − {s} 4. {Compute the rebroadcast delay Td (n) :} 5. Tp (n) = 1 − |N (s) ∩N (n) | / |N (s) | 6. Td (n) = MaxDelay × Tp (ni) 7. Set a Timer (n, Rs.id) according to Td (n) 8. end if 9.else wait for elapsed time (hello interval), forward hello packets in case if no control messages are received. while ni receives a duplicate RREQj from nj before Timer (ni, Rs.id) expires do	10. Refer to the num_neigh field in the RREQ message and {Adjust UCN:} 11. if (num_neigh==0), no change 12. Else if (num_neigh==positive or negative), change neighbor list accordingly. 13. U (ni, Rs.id) =U (ni, Rs.id) −[U (ni, Rs.id) ∩N (nj)], discard (RREQj) ; 14. end while 15. if Timer (ni, Rs.id) expires then 16. {Compute the rebroadcast probability Pre (ni) :} 17. if Random (0, 1) ≤ Pre (ni) then 18. broadcast (RREQs), else 19. discard (RREQs), end if 20. end if

Initially RREQ message is sent to all nodes, it carries the details of the neighbor node it covers With an ID from which node it was sent. In case of addition or Deletion of nodes updating of UCN of node takes place. Every node waits for a time elapsed else sends a hello message to indicate its presence. Updating of neighbor node takes place after visualizing the changes in previous node finally rebroadcast probability and rebroadcast delay are noted and broadcasting takes place.

5. CONCLUSION

In this work, the routing overhead caused by the neighbor list and the control messages in Neighbor Coverage Based Probabilistic Routing Protocol is considerably minimized. The role of individual HELLO messages in a NCPR protocol is modified by using a time limit.RREQ message collectively plays the role of HELLO message too. When there is no replay for a RREQ control message and when the time limit is over, an HELLO message is forwarded to show the nodes presence. The neighbor table complexity is reduced by using two new fields namely num_neigh and node id in the default RREQ format. Thus the NCPR now supports the flow of data even at very light traffic load efficiently.

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