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Reliable and Efficient Neighbor Coverage Probabilistic Routing With Swarm Optimization in MANET

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Abstract: ***In routing broadcast storm problem is a common issue where in which a mobile node blindly rebroadcasts received route request packets until a route to a particular destination is established. This leads to high redundant retransmission causing excessive packet collisions in the network. This work introduces a scheme to optimize the routing process as well as reduce routing overhead and latency. In the proposed scheme to obtain the optimal path only reliable nodes are selected and it is further filtered according to rebroadcast delay. Reliable nodes are decided on the basis of trust values. The rebroadcast delay determines the forwarding order, hence the nodes with lower rebroadcast delay is selected for transmission. This protocol combines the advantages of neighbor coverage knowledge, probabilistic rebroadcast, particle swarm optimization, trusted values and firefly algorithm. Reliability is evaluated according to the trusted values. The concept of Firefly algorithm includes the self-improving process with the current space, and also includes the improvement among its own space from the previous stages.***

Keywords: NCPR, Particle swarm optimization, Trust values, Firefly algorithm, Reliability.

I. INTRODUCTION

A mobile ad hoc network is a system of wireless mobile nodes that can freely and dynamically self-organize in arbitrary and temporary network topologies without the need of wired backbone or a centralized administrator. Mobile ad hoc networks provides unique benefits and versatility for certain environment and application. They have no fixed infrastructures including the base stations as perquisites, they can be created and used anywhere and at any time. Manet is extremely useful in disaster prone areas, medical areas and military areas. Mobile ad hoc network nodes are furnished with wireless transmitters and receivers using antennas, which may be highly directional: point-to-point or Omni directional. This ad hoc topology may be modified with time as the nodes move or adjust their transmission and reception parameters.

a) Routing In Manet:

Manet researchers pay special attention to routing and forwarding, as these are the basic networking services in constructing a multihop ad hoc network. Routing is the function of finding the most efficient and loop free path between the sender and receiver, and forwarding is the function of delivering the packets along this path. Manet routing is point to point and independent of applications. The routers in the Manet simply forwards the data packet without checking its contents. One of the biggest challenges in Manet routing is to design a routing protocol that handles node mobility, rapid changes in topology and reduce the routing overhead incurred. There are three types of routing protocols: Proactive, Reactive and Hybrid routing protocols [1]. Proactive routing protocols are table driven as it computes routes between all nodes in the network in advance. Reactive routing protocols has an on demand nature as it computes routes only when it is needed for communication. Hence reactive possess minimal routing overhead. Hybrid is a combination of proactive and reactive. Some examples of Hybrid routing protocols are ZRP (Zone routing protocol) and TORA (Temporarily Ordered Routing Algorithm).

Main Contribution of this paper is to find an optimal path from source to destination such that the number of rebroadcast can be significantly reduced. With the concepts of rebroadcast delay, trust values, connectivity factor and additional coverage the proposed protocol can tackle control overhead along variation in network density.

The remainder of this paper is organized as follows. In Section II, we explain background of broadcasting in routing protocols. In Section III, we describe the analysis of related work and compare the performance with Neighbor coverage probabilistic routing- particle swarm optimized protocol (NCPR-PSO). In section IV, described the identified problem in NCPR-PSO. In Sections V, described the proposed work i.e. to further optimize the path selection in route discovery and section VI, describe the simulation environment and the performance analyses, respectively. Finally, we conclude this paper in Section VII.

II. BACKGROUND

Broadcasting is the basic mode of operation over a wireless channel where in which each message transmitted over the wireless channel are received by all the one hop neighbor of the sender. The simplest implementation of the broadcast operation to all network nodes is by flooding. In flooding the mobile node blindly rebroadcasts received route request (RREQ) packets until a route to a particular destination is established.

Due to frequent changes in the position of the nodes causes link failures. This potentially leads to high redundant retransmission and thus excessive packet collisions in the network. This situation in known as Broadcast storm problem. The increase in overhead and end to end delay degrades the network performance. Hence the improvement of the broadcast service used for the on demand route discovery is very crucial towards a good network performance and scalability. There are various broadcasting mechanism used to discover the route in Manet : Blind broadcast, probabilistic based methods which includes the counter based approach, Distance and location based approach, Cluster based schemes and neighbor knowledge based schemes [2].

III. RELATED WORK

Ni et al, [3] analyzed different broadcasting protocols such as probabilistic-based, counter-based, distance-based, location-based and cluster-based. The main aim of these schemes was to reduce redundancy, contention and collision. After vigorous study and analysis of the broadcast protocols they concluded that rebroadcast is very costly as it consumes a lot network resources. Comparatively, the location-based scheme is the better choice as it can eradicate most of the redundant rebroadcasts under various host distributions without compromising reachability. Hence there was a need to optimize broadcast in route discovery for enhancing the network routing performance.

ZJ Haas, JY Halpern, L Li [4] proposed a gossiping protocol which uses probability to forward packets between nodes. It was concluded that, when compared to flooding, gossiping can reduce overhead up to 35 %. This protocol is very useful in large networks, it is robust and able to withstand faults.

Kim et al.[5] proposed an approach that combines the advantages of probabilistic approach with coverage area and neighbors confirmation. Here a mobile node can dynamically adjust the value of rebroadcast probability according to its additional coverage in its neighborhood. The additional coverage is estimated from the distance between sender and consequently depending upon this distance the rebroadcast probability is set. This scheme uses neighbor confirmation so as to prevent an early die out of rebroadcast. Unfortunately there is no provision in this scheme to handle duplicate packets.

Zhang et al. [6] proposed neighborhood coverage based probabilistic rebroadcast protocol. Basically this approach focuses on the reduction of routing overhead incurred in routing. This protocols is divided into two section first the rebroadcast delay is calculated and next the rebroadcast probability. For sufficient exploitation of the neighbor knowledge and to avoid channel collisions, each node sets a rebroadcast delay. The knowledge for neighbor coverage is used to determine the additionally cover nodes. Rebroadcast probability is set according to connectivity factor and additional coverage ratio. The rebroadcast probability considers the uncovered neighbors, connectivity metric and the local node density. Furthermore as per this probability the RREQ is broadcasted or discarded.

G Kaur, R Garg,[7] proposed Neighbor coverage probabilistic rebroadcast with particle swarm optimization (NCPR-PSO). The main aim of this scheme is to improve the rebroadcast by finding the best optimal fitting value for finding the route and hence reduce the routing overhead. All the parameters are converted into weights hence the time required for computation also reduces thereby reducing delay and increasing the network efficiency. The calculation of rebroadcast delay and probability is similar to NCPR. The duplicate requests are checked against PSO fitness function and timer is adjusted accordingly. Finally if the packet value of the node is less than the rebroadcast probability node then the request is broadcast or else it is discarded. It was concluded that this protocol generates lesser rebroadcast traffic than NCPR, flooding, and some other broadcasting protocols. It also toned down the network collision and contention.

Nancharaiah, B., & Mohan, B. C [8] proposed a hybrid model of PSO with ACO approach to enhance Manet link performance. It was concluded that the PSO_ACO algorithm had the ability to cope with networks having high density. This algorithm proved to have less total link delay and least communication cost when compared with conventional system.

a) Observation Analysis

TABLE I shows several protocols share some common characteristics. However, they also differ in their broadcasting techniques. By using parameters such as control overhead and communication latency they can be used to analyze the performance of these various protocols.

» Routing Overhead: the total number of RREQ packets transmitted during the simulation time. For packets sent over multiple hops, each transmission over one hop is counted as one transmission.

» End-to-end delay (or average delay): is the average time difference between the time a data packet is sent by the source node and the time it is prosperously received by the destination node.

Many collisions occur due to redundant rebroadcasts these results in packet drops and hence affect the packet distribution ratio of packets. NCPR-PSO utilizes a number of iterations to find the optimal path. It is a multipath protocol therefore it avails to reduce the rebroadcast overhead. NCPR-PSO reduces the routing overhead despite the large size of the packets as the request serves the purpose of hello packets. NCPR-PSO reduces the number of collisions to a great extent as compared to others. Therefore it reduces packet drops and latency. Some of the pros and cons of the literature survey are summarized in the table 1

TABLE 1

Comparison of routing protocols

Protocol	Overhead	Latency	Advantage	Disadvantage
Gossip	Reduced by 35%	Average	Robust, Scalable, Fault tolerant	High Packet loss
Probabilistic (coverage & neighbor confirmation)	Less	Occurs due to poor reachability	Simple & Reduces degrading effects	No duplicate RREQ resolution
NCPR	Very less	Less	Efficient, high PDR High Performance	Lengthy calculation, vulnerable to attacks, latency due to reactive nature

NCPR-PSO	Lesser than NCPR	Lesser	Efficient, optimized calculations, High performance in heavy traffic	PSO suffers from the partial optimism, difficult to work out problems in scattering, no coordinating system

IV. PROBLEM STATEMENT

The neighbor coverage based probabilistic approaches does indeed enhance the network performance. But yet there is still room for further optimization. Efficient routing can be attained by limiting routing overhead and latency. By optimizing the route, it will be possible to find an optimal path to the destination. The main criteria for an optimal path is that it should be reliable and stable, thus reducing the need for control messages on the path. Hence we can further limit the rebroadcasting of RREQ.

V. PROPOSED WORK

The proposed protocol RNCPR-PSO works in following steps:

1. Compute Trust values for the nodes to identify the Reliable nodes.
2. Calculate rebroadcast delay to determine the forwarding order.
3. At each one hop node along the path, calculate rebroadcast delay among their own neighbors.
4. Higher rebroadcast delay values are replaced with lower rebroadcast values.
5. Next Duplicate RREQ are handled by checking against the PSO fitness value.
6. The rebroadcast probability is calculated using connectivity factor and additional coverage ratio.
7. Finally the packet value is computed from the PSO fitness function and checked against the rebroadcast probability.

The proposed protocol consists of the following modules:

A. Trust Values:

In the proposed work a trust value is assigned for each node. Nodes are allowed to participate in routing on basis of their trust values. A threshold value is assigned and if the nodes trust value is greater than this value its marked as trustworthy node and allowed to participate in routing else the node is not considered. To calculate the trust value, first compute between two neighbor nodes the ratio of the number of packets received to the number of packet sent. Then the final trust value of node will be the average trust value given to it by its neighbor nodes.

B. Rebroadcast Delay:

The neighbor coverage knowledge is used to calculate the rebroadcast delay. The concept introduced here is that if the number of common neighbors of a node 'ni' and the RREQ packet is more, then lesser will be the delay and the greater is the probability of rebroadcast of node 'ni'.

To calculate Rebroadcast Delay:

1. Obtain the Neighbor list for each node.
2. Obtain the Uncovered node list for each node.
3. Find the Intersection between ni and nj along the path.
4. Assume Max delay as small constant.
5. Use the equation 1 to compute the RD value.

Rebroadcast delay (RD)=maxdelay*(1-intersect(Neigh_covrd(s), Neigh_covrd(ni))/ Neigh_covrd(s))

When a node receives a RREQ it compares its own neighbor list with the list in the RREQ packet and hence obtain the uncovered nodes i.e. the nodes that are not covered by this RREQ packet. The variable 'Neigh_covrd(s)' is obtained from the request packet which the destination node has received. This variable represents the neighbors of source node. The variable 'Neigh_uncovrd(ni)' is the set of uncovered neighbors of the destination node. The destination node determines the rebroadcast delay on the basis of its own neighbor list and the neighbor list of the sender.

C. Firefly Algorithm:

Concept of Firefly Algorithm:

- » Inspired by the flashing behavior of fireflies.
- » The primary purpose for a firefly's flash is to act as a signal system to attract other fireflies
- » Intensity/Attractiveness is proportional to Distance.
- » The less bright one will be attracted by (and thus move to) the brighter one

In the proposed work at each hop node along the path from source to destination, the Rebroadcast delay is computed among the node's own neighbours. In case we get a node with RD value lower than the current node in the path, then the path will be redirected along the node with lower RD value. Thus obtaining an efficient and optimal path to destination.

D. Handle Duplicate Requests:

In case if a node ni receives a duplicate request from another node nj before the timer expires, then node ni will calculate its PSO fitness_val on the basis of the covered list of neighbors of the duplicate request source and the uncovered list count.

Conditions used:

If the value of Request id is less than the Computed PSO fitness_val

Then the Packet is accepted i.e. it's not duplicate.

Else

The packet is discarded and the timer is readjusted according to the PSO fitness_val.

E. Rebroadcast Probability:

When the timer expires the rebroadcast probability 'Pre' is calculated. The rebroadcast probability considers the uncovered neighbors, connectivity metric and the local node density. To calculate probability, first we need to compute two factors: Connectivity Factor and Addition coverage Ratio.

Additional coverage ratio (ACR): represents the ratio between the numbers of nodes that need to receive the RREQ packet (uncovered nodes) to the total number of neighbors of node.

VI. SIMULATION RESULT

Here implement the simulation experiment using tool network simulator-2 (version 2.34). The evaluations are mainly focused on control overhead, average end to end delay, packet delivery ratio and throughput between existing protocol and proposed work.

A. Simulation Setup

The network maximum 90 nodes are simulated and the simulation area is 1000m × 1000m. The two- ray ground model used for the simulation ratio-propagation model and the media access control using IEEE 802.11 model. The transmission range

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of the node was set between 250m to 625m and a bandwidth of 10 Mbits/sec. Traffic source have been chosen to be CBR (Constant Bit Rate) and the packet size is 512 bytes. The underlying routing protocol used for routing the packets was NCPR (Neighbor Coverage Probabilistic Routing Protocol).

B. Result Analysis

In this simulation the existing neighbor coverage protocols generates a greater number of control messages. Consequently, reduces the available bandwidth and increase the latency and overhead. Fig 1 shows the behavioral pattern of routing overhead with increasing number of nodes. On an average the overhead is reduced in RNCPR-PSO when compared with NCPR-PSO. The figure shows the variation of overhead with increase in network density. The RNCPR-PSO protocol reduces the routing overhead which occurs during the route discovery process. RNCPR-PSO protocol has accomplished in reducing the number of RREQ packets. As a result there is a significant decrease in routing overhead.

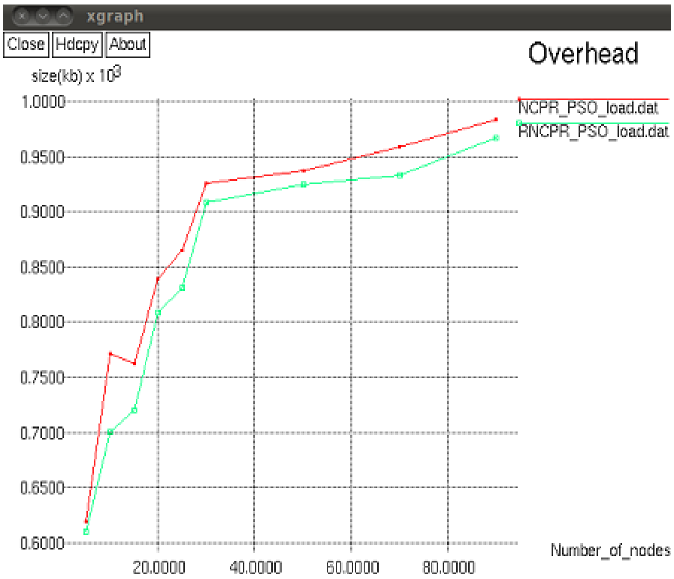

Fig.1. Control Overhead vs number of nodes

Fig 2 shows the results of average end to end delay with increasing number of nodes. Average end to end delay is decreased in RNCPR-PSO when compared to NCPR-PSO. The RNCPR-PSO protocol decreases the average end-to-end delay due to a decrease in the number of redundant rebroadcast packets. With the help of the particle optimization technique and trust evaluation an optimal and reliable solution is found to forward the packet due to which the probability of rebroadcast is reduced.

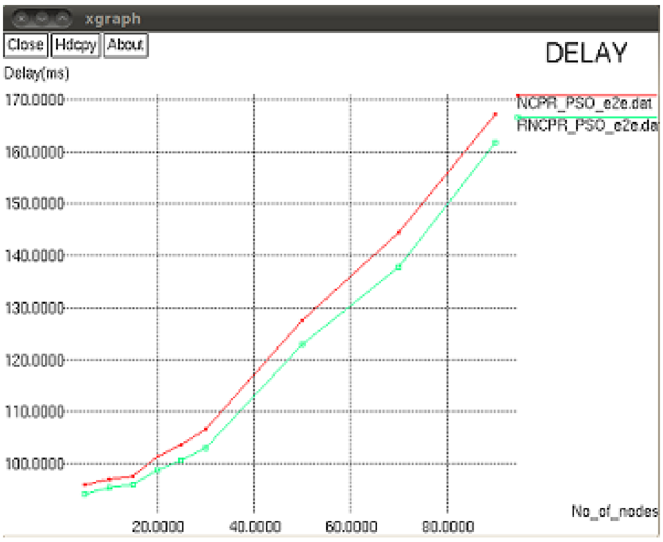

Fig.2. Average end to end vs number of nodes

Fig 3 shows the variation of PDR with increase in network density. RNCPR-PSO protocol managed to further reduce the number of collision as a result reduction in packet loss. Therefore there is a significant increase in packet delivery ratio.

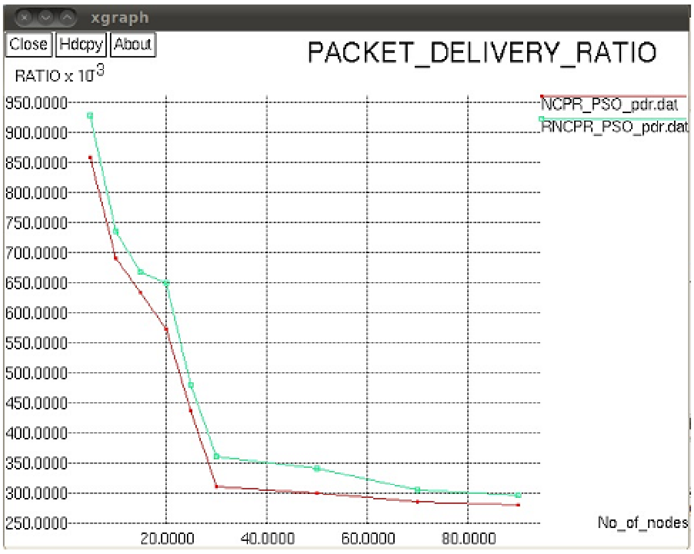

Fig.3. Packet delivery ratio vs number of nodes

Fig 4 shows the results of throughput. Here also RNCPR-PSO protocol has a better performance with increase in network density when compared to NCPR-PSO.

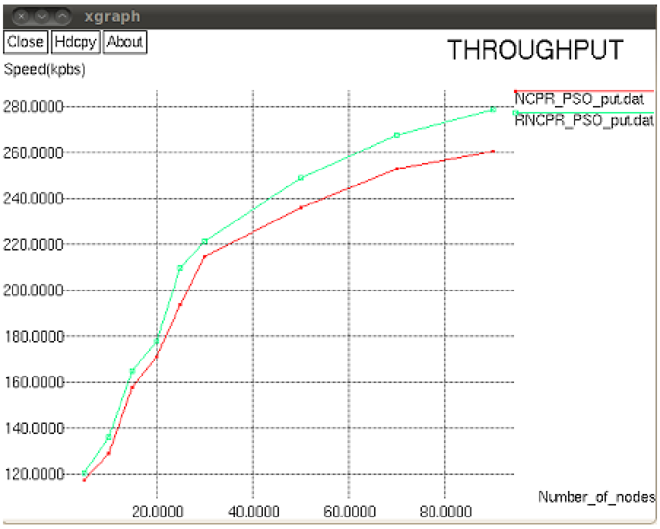

Fig.4. Throughput

VII. CONCLUSION

In the presented work, the implementation of NCPR-PSO protocol has been done in NS2.34. Furthermore it is enhanced using the concept of firefly algorithm and trusted nodes. Trusted nodes with lowest rebroadcast delay are selected for transmission. Hence a more reliable path is chosen during route discovery. The simulation have been done on different metrics such overhead, latency, packet delivery ratio and throughput. The simulation results shows that proposed protocol RNCPR-PSO generates lesser number of rebroadcast. Hence there is significant increase in packet delivery ratio and throughput. At the same time latency and overhead was further reduced. The proposed protocol has good performance in high network density or heavy traffic.

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