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Optimum Route Selection by Modified Neighbour Coverage Algorithm in MANET

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Abstract— Broadcasting is a fundamental and effective data dissemination mechanism for route discovery, address resolution and many other network services in ad hoc networks. While data broadcasting has many advantages, it also causes some problems such as the broadcast storm problem, which is characterized by redundant retransmission, collision, and contention. Although many approaches have been proposed to solve them, none of them guarantees the lowest bound. We propose a novel scheme to calculate the rebroadcast probability. The scheme considers the information about the uncovered neighbours towards destination (UCN) $_{td}$, connectivity metric and local node density to calculate the rebroadcast probability. By combining the additional coverage ratio and connectivity factor, we set a reasonable rebroadcast probability. This protocol is implemented over the MANET network and simulated using Network Simulator (NS2). This paper contributes a nodes having highest energy will broadcast the RREQ packets to its neighbours. Performance of the proposed system evaluated based on the parameters such as normalized routing overhead, Packet delivery ratio and Average end-to-end delay.

Keywords— MANET, IETF, RSS, RWP, RREQ

I. INTRODUCTION

(MANETs) are wireless networks which are characterized by dynamic topologies and no fixed infrastructure. Each node in a MANET is a computer that may be required to act as both a host and a router and, as much, may be required to forward packets between nodes which cannot directly communicate with one another. Each MANET node has much smaller frequency spectrum requirements that that for a node in a fixed infrastructure network. A MANET is an autonomous collection of mobile users that communicate over relatively bandwidth constrained wireless links. Since the nodes are mobile, the network topology may change rapidly and unpredictably over time. The network is decentralized, where all network activity including discovering the topology and delivering messages must be executed by the nodes they, i.e., routing functionality will be incorporated into mobile nodes.

A mobile ad hoc network is a collection of wireless nodes that can dynamically be set up anywhere and anytime without using any pre-existing fixed network infrastructure. Movements of nodes in a mobile ad hoc network cause the nodes to move in and out of range from one another. As the result, there is a continuous making and breaking of links in the network, making the network connectivity (topology) to vary dynamically with time. Since the network relies on multi-hop transmissions for communication, this imposes major challenges for the network layer to determine the multi-hop route over which data packets can be transmitted between a given pair of source and destination nodes. Because of this time-varying nature of the topology of mobile ad hoc networks, traditional routing techniques, such as the shortest-path and link-state protocols that are used in fixed networks, cannot be directly applied to ad hoc networks. A fundamental quality of routing protocols for ad hoc networks is that they must dynamically adapt to variations of the network topology. This is implemented by devising techniques for efficiently tracking changes in the network topology and rediscovering new routes when older ones are broken. Since an ad hoc network is infrastructure less, these operations are to be performed in a distributed fashion with the collective cooperation of all nodes in the network. Because of its many challenges, routing has been a primary focus of researchers in mobile ad hoc networks.

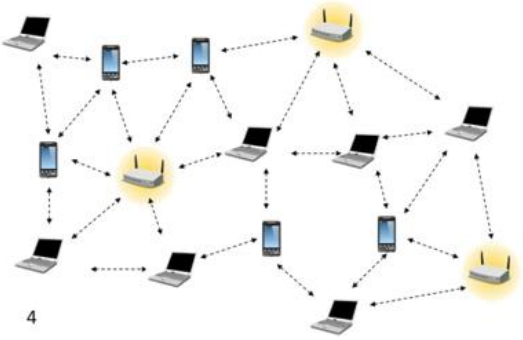


Fig.1 Mobile Adhoc Network

The MANET working group in the IETF has been working on the issue of standardizing an IP based routing standard for mobile ad hoc networks. Consequently, a large number of dynamic routing protocols applicable to mobile ad hoc networks have been developed.

Wireless mobile networks have traditionally been based on the cellular concept and relied on good infrastructure support, in which mobile devices communicate with access points like base stations connected to the fixed network infrastructure. Typical examples of this kind of wireless networks are GSM, UMTS, WLL, WLAN, etc. As to infrastructure less approach, the mobile wireless network is commonly known as a mobile ad hoc network (MANET). A MANET is a collection of wireless nodes that can dynamically form a network to exchange information without using any pre-existing fixed network infrastructure. This is a very important part of communication technology that supports truly pervasive computing, because in many contexts information exchange between mobile units cannot rely on any fixed network infrastructure, but on rapid configuration of a wireless connections on-the-fly. Wireless ad hoc networks themselves are an independent, wide area of research and applications, instead of being only just a complement of the cellular system. It describes the fundamental problems of ad hoc networking by giving its related research background including the concept, features, status, and applications of MANET. Some of the technical challenges MANET poses are also presented based on which the paper points out the related kernel barrier. Some of the key research issues for ad hoc networking technology are discussed in detail that are expected to promote the development and accelerate the commercial applications of the MANET technology.

BROADCAST ALGORITHMS

Flooding in mobile ad hoc networks has poor scalability as it leads to serious redundancy, contention and collision. In this paper, we propose an efficient approach to reduce the broadcast redundancy. In our approach, local topology information and the statistical information about the duplicate broadcasts are utilized to avoid unnecessary rebroadcasts. It can greatly reduce the redundant messages, thus saving much network bandwidth and energy. It can also enhance the reliability of broadcasting. It can be used in static or mobile wireless networks to implement scalable broadcast or multicast communications. Many approaches are proposed for broadcasting in MANET. But none of them have been considered as an optimal method for the broadcasting. The simplest one to achieve broadcasting is through flooding. Even though flooding is very simple and reliable approach, it produces a high overhead in the network. Therefore, it leads to excessive contention, collision and redundant rebroadcasts. More sophisticated solutions such as probability-based, counter-based, distance-based, location-based, and neighbour knowledge- based approaches have been proposed to overcome the drawbacks of flooding. Probability-based approach is another simple one. It depends upon pre-defined fixed probability to determine whether it rebroadcast the packets or not. One problem of the probabilistic approach is how to set the rebroadcast probability. It is demonstrated in that the optimal rebroadcast probability is around 0.65. Intuitively, this value does not seem globally optimal for different node density and relative location from the sender. For example, the mobile hosts close to sender will have more neighbours whose coverage areas significantly overlap. So, the rebroadcast probability of a node in MANET should be set dynamically according to its circumstances.

It classifies the broadcasting schemes into five classes to reduce redundancy, contention, and collision: probabilistic, counter-based, distance-based, location-based and cluster-based. In probabilistic scheme, a mobile host rebroadcasts packets according to a certain probability. In counter-based scheme, a node determines whether it rebroadcast a packet or not by counting how many identical packets it receives during a random delay. It is assumed in counter-based scheme that the expected additional coverage is so small that rebroadcast would be in vain when the number of recipient broadcasting packets exceeds a threshold value. In distance-based scheme, they used the relative distance between a mobile node and previous sender to make the decision whether it rebroadcast a packet or not. In location-based scheme, additional coverage concept is used to decide whether to rebroadcast a packet or not. Additional coverage is acquired by the locations of broadcasting hosts using the geographical information of a MANET. In cluster-based scheme, MANET is divided into clusters, which is a set of mobile hosts. There are one cluster head and several gateways in a cluster. Cluster head is representative of a cluster and its rebroadcast can cover all hosts in that cluster. Only gateways can communicate with other clusters and have responsibilities to propagate the broadcast message.

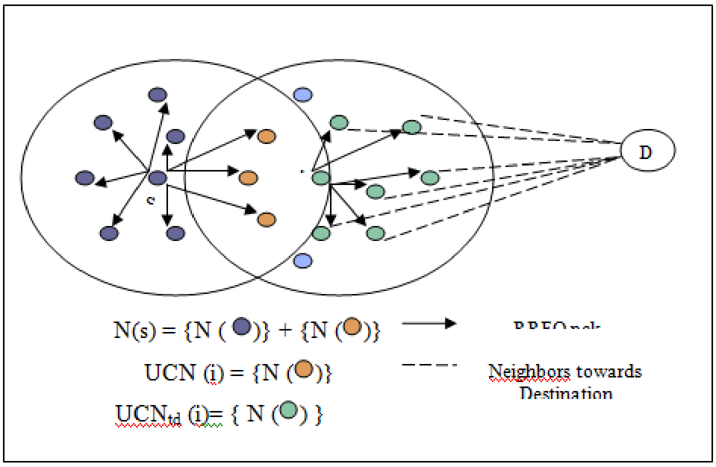


Fig.2 Architecture

II. LITERATURE REVIEW

Jae-soo Kim proposed [1] it proposes a probabilistic broadcasting based on coverage area and neighbour confirmation in mobile ad hoc networks. In addition, it uses the coverage area of a node to adjust the rebroadcast probability. If a mobile node is located in the area closer to sender, which means it has small additional coverage and rebroadcast from this node can reach less additional nodes, so its rebroadcast probability will be set lower. *Hussein proposed*[2] Optimization mechanism to alleviate the effect of broadcast storm problem during route discovery and other services in mobile ad hoc networks (MANETs).In current dynamic probabilistic algorithms, the retransmission probability of the intermediate nodes is expressed as a function of the first-hop neighbours. Usually, two neighbourhood densities are identified (low and high), and for each of them a certain constant probability is assigned regardless of the actual value of neighbours**.**Xin Ming Zhang[3] proposes an estimated distance (EstD)-based routing protocol (EDRP) to steer a route discovery in the general direction of a destination, which can restrict the propagation range of route request (RREQ) and reduce the routing overhead. In the EDRP, the change regularity of the received signal strength (RSS) is exploited to estimate the geometrical distance between a pair of nodes, which is called the estimated geometrical distance (EGD). Simulation experiments based on a random waypoint (RWP) model show that the EGD can effectively reflect the actual distance when it is less than the expected value of the distance [which is called the estimation radius (E-Radius)] between any node pairs

III. PROPOSED ALGORITHM

In NCPR protocol the RREQ flooding is based on the rebroadcast delay and rebroadcast probability. The rebroadcast probability is less than the threshold value, the node will not broadcast the RREQ packets, because the node is identified the dense area. Suppose due to the mobility of nodes are moving into another location, in that situation the packets are not reached in the destination. Therefore to solve this issue, this project contributes a nodes having highest energy will broadcast the RREQ packets to its neighbours. This condition is only applied in the dense area. Therefore the rebroadcast probability of node is less than the threshold value; the nodes having highest energy will broadcast the RREQ packets to its neighbours.

MODULE 1

1. Determination of Common neighbours

Initially, each node in the network sends the beacon packets to each node in the communication range. A node which receives the beacon packet replies to the sender including its information. Thus, each node maintains the neighbour list frequently. A source node sends the RREQ packet to its neighbours, when it initiates the route discovery process. A node which receives the RREQ packet, it compares the neighbour list with its sender neighbour list. And, it determines the common neighbours.

MODULE 2

2. Rebroadcast Delay and Timer

If node ni has more neighbours uncovered by the RREQ packet from s, which means that if node ni rebroadcasts the RREQ packet, the RREQ packet can reach more additional neighbour nodes. In the proposed work, define the UnCovered Neighbors set U(ni) of node ni as follows:

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

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

$$T_d(n_i) = MaxDelay \times T_p(n_i),$$

The delay time is used to determine the node transmission order. To sufficiently exploit the neighbour coverage knowledge, it should be disseminated as quickly as possible. When node s sends an RREQ packet, all its neighbours ni; i = 1; 2; . . . ; |N(s)| receive and process the RREQ packet. We assume that node ni has the largest number of common neighbours with node s, node nk has the lowest delay. Once node nk rebroadcasts the RREQ packet, there are more nodes to receive it, because a node ni has the largest delay. Based on the rebroadcast delay, a node set the timer. When a node receives the duplicate RREQ packet before expires the timer, it adjusts the UCN list.

Algorithm 1. ENCPR

Definitions:

RREQv: RREQ packet received from node v.
Rv.id: the unique identifier (id) of RREQv.
N(U): Neighbor set of node u.
U(u; x): Uncovered neighbors set of node u for RREQ whose id is x.
Timer(u; x): Timer of node u for RREQ packet whose id is x.
{Note that, in the actual implementation of NCPR protocol, every different RREQ needs a UCN set and a Timer.}

```
if ni receives a new RREQs from s then
{Compute initial uncovered neighbors set U (ni; Rs: id) for RREQs :}
U(ni;Rs:id) = N(ni) _  [N(ni) ∩ N(s)]- {s}
{Compute the rebroadcast delay Td(ni).}
```

```
Tp(ni) (1 - |N(s) ∩ N(ni)j / |N(s)|
Td(ni)  [MaxDelay * Tp(ni)
Set a Timer(ni;Rs:id) according to Td(ni)
end if
while ni receives a duplicate RREQj from nj before
        Timer(ni;Rs:id) expires do
{Adjust U(ni;Rs:id):}
U(ni;Rs:id)  [U(ni;Rs:id) - {U(ni;Rs:id) ∩ N(nj)_
discard(RREQj)
end while
```

MODULE 3

3. Rebroadcast Probability

Additional coverage ratio

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

This metric indicates the ratio of the number of nodes that are additionally covered by this rebroadcast to the total number of neighbours of node ni. The nodes that are additionally covered need to receive and process the RREQ packet. As Ra becomes bigger, more nodes will be covered by this rebroadcast, and more nodes need to receive and process the RREQ packet, and, thus, the rebroadcast probability should be set to be higher.

Connectivity factor:

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

Where Nc = 5:1774 log n, and n is the number of nodes in the network, It observes that when |N(ni)| is greater than Nc, Fc(ni) is less than 1. That means node ni is in the dense area of the network, then only part of neighbors of node ni forwarded the RREQ packet could keep the network connectivity. And when |N(ni)| is less than Nc, Fc(ni) is greater than 1. That means node ni is in the sparse area of the network, then node ni should forward the RREQ packet in order to approach network connectivity. Combining the additional coverage ratio and connectivity factor, we obtain the rebroadcast probability Pre(ni) of node ni:

$$P_{re}(n_i) = F_c(n_i) \cdot R_a(n_i),$$

The parameter Fc is inversely proportional to the local node density. That means if the local node density is low, the parameter Fc increases the rebroadcast probability, and then increases the reliability of the NCPR in the sparse area. If the local node density is high, the parameter Fc could further decrease the rebroadcast probability, and then further increases the efficiency of NCPR in the dense area. Thus, the parameter Fc adds density adaptation to the rebroadcast probability.

MODULE 4

In NCPR protocol the RREQ flooding is based on the rebroadcast delay and rebroadcast probability. The rebroadcast probability is less than the threshold value, the node will not broadcast the RREQ packets, because the node is identified the dense area. Suppose due to the mobility of nodes are moving into another location, in that situation the packets are not reached in the destination. Therefore to solve this issue, this project contributes a nodes having highest energy will broadcast the RREQ packets to its neighbours. This condition is only applied in the dense area. Therefore the rebroadcast probability of node is less than the threshold value; the nodes having highest energy will broadcast the RREQ packets to its neighbours.

IV. SIMULATION AND RESULTS

Performance Metrics

MAC collision rate:

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:

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:

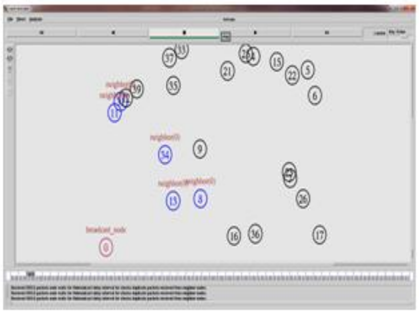
It defined as the ratio of the number of data packets successfully received by the CBR destinations to the number of data packets generated by the CBR sources.

Average end-to-end delay:

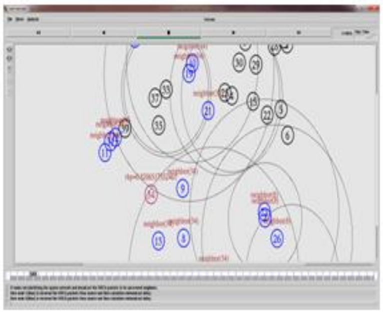
The average delay is defined as the successfully delivered CBR packets from source to destination node. It includes all possible delays from the CBR sources to destinations.

Network Architecture

Source broadcast RREQ packets to its neighbours

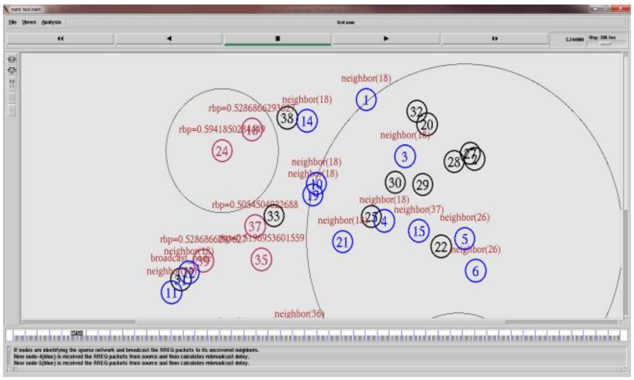


Rebroadcast delay



Rebroadcast Probability

Rebroadcast Probability is calculated for identifying the dense network or sparse network. If the nodes are deployed in dense area, the rebroadcast probability of nodes will be decreased. Because in the dense area, more number of neighbour node should be covered (local density is high) and therefore these neighbours get the chance to RREQ packet received from any neighbour node. If the nodes are deployed in sparse area, the rebroadcast probability of nodes will be increased. Because in the sparse area, less number of neighbour nodes only discovered (local density is low) and therefore it doesn't get chance to receive the RREQ packets._So source is automatically broadcast the RREQ to its neighbours in the sparse area.



If nodes are identifying the sparse network and broadcast the RREQ packets to its uncovered neighbors.
Now node-4(blue) is received the RREQ packets from source and then calculates rebroadcast delay.
Now node-5(blue) is received the RREQ packets from source and then calculates rebroadcast delay.

If the rebroadcast probability of node is less than the threshold vale (0.5), the node will not rebroadcast the RREQ packets, where as the rebroadcast probability of node is greater than the threshold value (0.5), the node should rebroadcast the RREQ packets to its uncovered neighbours.

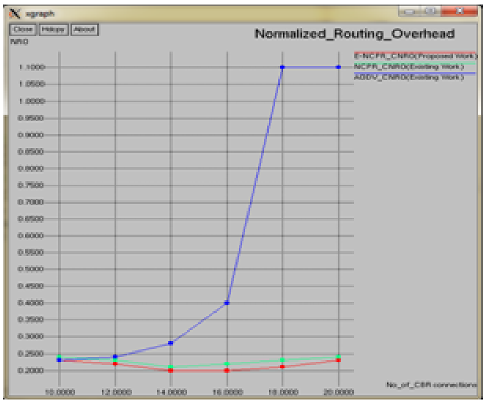


Fig 3 NRO Vs No_CBR_Connections

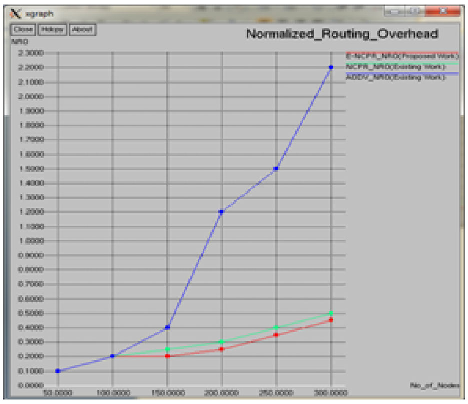


Fig 4 NRO Vs Number of Nodes

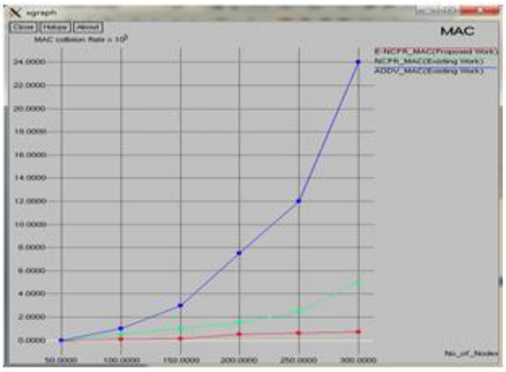


Fig 5 MAC Vs Number of Nodes

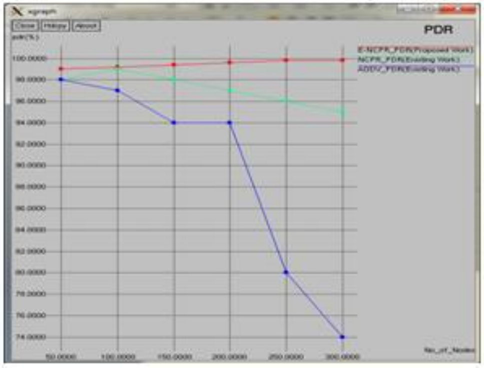


Fig 6 PDR Vs Number of Nodes

Fig 7 End to End Delay Vs Number of Nodes

V. CONCLUSION

In this paper, we proposed a probabilistic rebroadcast protocol based on destination towards neighbour coverage to reduce the routing overhead in MANETs. This neighbour coverage knowledge includes additional coverage ratio and connectivity factor. The rebroadcast delay determines the forwarding order and the node which has more common neighbours with the previous node has the lower delay. By combining the additional coverage ratio and connectivity factor, we set a reasonable rebroadcast probability. Simulation results show that our approach can improve the average performance of broadcasting in various network scenarios respect to PDR, delay, Mac Collision and Normalized routing overhead.

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