Rebroadcasting Neighbour Coverage Routing Protocol in MANET using MAC layer Design

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ABSTRACT

In MANET broadcasting is a virtual role which covers the neighbour to reach destination, its resolves many issues in Mobile Ad hoc Network. Dynamic change of radio frequency leads to un-covered neighbour search in network. In this re-broadcasting cause's congestion among radio signals, it overlap the neighbour coverage and initiates the flooding and results in redundancy, Routing Overhead, and collision in MAC layer , In particular, due to mobility environment in network link failure and neighbour coverage problem e.g., (radio frequency or) bandwidth congestion occur. Collision avoidance is a storm difficult in network, thus MAC follow a Carrier Sense Multiple Access / Collision Avoidance (CSMA/CA) mechanism in MAC layer design to improve the channel allocation of data transmission. We proposed a protocol (RBNC) Rebroadcasting Neighbour Coverage protocol which reduces the high channel contention causing redundant and reduce routing overhead by Retransmissions. Routing path can be reduced using the delay tolerant (DTN) of intermediate nodes (i.e. the number of RREQ packets transmitted during route discovery is reduced).Our protocol is simulated in NS2 and the performance is evaluated and the rebroadcasting is analytically discussed.

Index Terms

Rebroadcasting Neighbour Coverage protocol, Mac layer, broadcast, DTN, mobile ad hoc network (MANET).

1. INTRODUCTION

In Mobile Ad hoc Network **(MANET)** the nodes can get the service using random mobility model to communicate each other in the network. There is no centralized service to network i.e. [1] No base station service to mobile node, due to high mobility in network link failure and the routing path cannot be define constantly for data transmission , so data loss and path failure is the major issues in MANET. Dynamic routing leads to improper neighbour selection to reach destination.

Ad hoc On Demand Distance Vector (AODV) Routing Protocol broadcasting is not necessary; it minimizes the number of active routes between source and destination. Here hop is reduced and routing occur due to flooding and the node will maintain the routing table store as,

In Uni-cast data delivery; dynamic source routing will give better performance than on-demand routing. But in multicasting the source will get more request and response from the intermediate node to select the best neighbour and delay will occur to reach destination. Flooding is the major problem in MANET, (it is a packet which blindly broadcasting the generated request) we will handled the flooding by routing discovery counter [2].Broadcasting is defined as the radio signal frequency (RF) produced to cover the neighbour (activate the neighbour by fixed frequency i.e. 150-350 MHz) and which routing path can be easily found to reach destination.

destination addr, next-hop addr, destination sequence number, lifetime

Table 1: Routing table

Why Re-Broadcasting Needed?

In MANET , A node forward the rebroadcasting packet based on the current node which dint receive the broadcast message, there Rebroadcasting packet exists, which provide the service to activate the sleeping node in the routing [1]. It mainly helps to cover the neighbour activeness for routing, which gives the results to reduce the redundancy over re- broadcasting.

To optimize the broadcasting, we can limit the number of rebroadcasting in the routing [8]. Rebroadcasting delay helps to define the neighbour coverage knowledge in network [11], in order to strengthen the network connectivity, broadcasting neighbours should receive the RREQ packet [8] these reduce the redundant and number of rebroadcasts of the RREQ packet in the data transmission [11]. Always neighbour selection has to done randomly, due to random mobility model in network. Number of collisions in re-broadcasting will occur in the physical layer [9]. 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).

A channel allocation has to be done in MAC layer to reduce the congestion and delay in network. It is very hard to update the neighbour routing table in dynamic topology [7]. MAC layers can avoid broadcast collisions via random channel or slot selection, but hidden terminal problem cannot be resolved [12]. Gossip routing optimized the flooding problems in transmission with local repairs of missed data, [5] gossiping routing shows the bimodal behavior in the network. In gossiping the initial routing neighbour has less chance to a misbehaving node.

In the survey of network data transmission, we come over the issues which affect the performance in network, thus we propose a new protocol called (RBNC) Rebroadcasting Neighbour Coverage protocol, it increases the overall performance of congestion control mechanism using MAC layer, reducing the redundant and routing overhead of broadcasting in MANET.

2. RBNC Protocol

In this section, we calculate the neighbour routing table by the node broadcasting knowledge and reducing redundant in MAC layer by our proposed Rebroadcasting Neighbour Coverage protocol (RBNC), according to the radio frequency signal range neighbours are listed.

2.1 Neighbour coverage

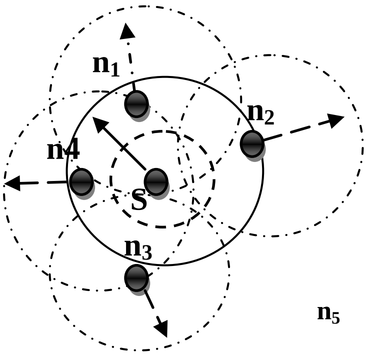


Fig 1: Neighbour Coverage

When a node n_i receives an RREQ packet from the source node *s* , it can find out the neighbour using the radio frequency range from the simulation parameter table 2.From the fig1 we can tell that source covers the neighbour n_1 , n_2 , n_3 , n_4 nodes. But the n_5 node has no coverage to find neighbour and not acting as neighbour to any other node in the network. According to the distance and the coverage signal the neighbours can change, the un- covered neighbour will produce the RREQ packets until it search the neighbour for communication. Here it have the interesting concept where the neighbour list will be represented by both covered and un-covered node, but the covered node participated in data communication and the un-covered node wait for the radio signal to activate the node for data communication.

From the fig 2. We can define the un-covered neighbour set UC (n_i) as

$$UC\ (ni) = Ni - [\ N_l \sim N_s\ ] \qquad (1)$$

Where , Ni is the neighbour node , N_l is the list of neighbour or the collection of neighbour and Ns is the source node , the difference between the list and source node gives the unversed node list . For other set of neighbour group. According to equation (1) we found the un-covered neighbour list. A node can be place in the simulation area by their three-dimensional location as x, y, z from this we can find the distance of each and every node in the network and the neighbour list by the coverage area (150-350 MHz).

Let x, y, z be the 3 location of a single node,

```
for i=0
   { i < total no of nodes (nn) }
set k 0
for j=0
   { j < total no of nodes (nn) }
√((xj − xi)² + (yj − yi)b²
if {$ g <= 300 && $i != $j} {
puts "Distance from node($i) --to--node($j)---->$g"
```

Table 3: Neighbour Calculation

The above calculation gives neighbour values of every node in the network, thus output as follows

OUTPUT:

| Node | One hop neighbour | Distance (m/sec)

| Node (0) | node (1) |

Distance from node (0) to node (1) -->125.89772719155812

| Node (0) | node (2) |

Distance from node (0) to node (2) -->298.57786910300314

Here, output explains the current node with their neighbour and the distance of it. Distance will be always less than 300 m because the value of radio range is *g <= 300*, from the table 3. In this section neighbour list coverage and un-covered neighbour are discussed analytically with real time scenario also. From this we can reduce the delay in searching the neighbour for data communication, routing hop is reduced in communication.

2.2 Redundant Rebroadcasting

From the diagram, we can tell that only 2 transmissions are possible in broadcasting if flooding occurs also. If it is 4- node communication then, only one transmission broadcasting is possible, to reduce the redundancy when more re-broadcasting occur when each broadcast, then it cause congestion and the data loss will occur.

$$\int \sqrt{r^2 - x^2}\, dx = \frac{x}{2}\sqrt{r^2 - x^2} + \frac{r^2}{2}\sin^{-1}\left(\frac{x}{r}\right) + c$$

----------- (2)

By the area of the circle Formula (circle represents the radio frequency signal coverage): refer equation (2)

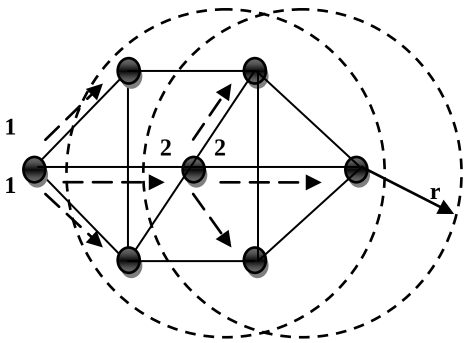


Fig: 2 Redundant

The radio frequency range of circle depends on the re-broadcasting of request packets which is broadcasted. Here, 6 transmission is possible in the above fig: 2 . The transmission covered the neighbour by their coverage area which cause less redundant.

$$distance\ between\ 2\ nodes(d) = 4\int_{d/2}^{x} \sqrt{r^2+x^2}\,dx$$

----------- (3)

Only there-fourth of the area is covered among the network, where the radio range is 300 m/sec which cover the landscape equally to its broadcasting range. Thus the distance covered or the range between 2 nodes is discussed by the equation (3).

$$\sqrt{a^2-x^2}\ dx = \frac{x}{2}\sqrt{a^2-x^2} + \frac{a^2}{2}\sin^{-1}\left(\frac{x}{a}\right)$$

----------- (4)

$$\int_{d/2}^{x}\sqrt{r^2-x^2}\ dx = \frac{x}{2}\sqrt{r^2-x^2} + \frac{r^2}{2}\sin^{-1}\left(\frac{x}{r}\right) \quad (i.e.\, a = r)$$

----------- (5)

Applying limits to equation (5), we get equ (6) and (7):

$$= -\left[\frac{d/2}{2}\sqrt{r^2-\frac{d^2}{4}} + \frac{r^2}{2}\sin^{-1}\left(\frac{d}{2r}\right)\right] + \left[\frac{r}{2}\sqrt{r^2-r^2} + \frac{r^2}{2}\sin^{-1}\left(\frac{r}{r}\right)\right]$$

----------- (6)

$$= -\left[\frac{d}{4}\sqrt{r^2-\frac{d^2}{4}} + \frac{r^2}{2}\sin^{-1}\left(\frac{d}{2r}\right)\right] + \left[0 + \frac{r^2}{2}\times\frac{\pi}{2}\right] \quad i.e. \sin^{-1}(1) = \frac{\pi}{2}$$

----------- (7)

When d = r

$$= -\left(\frac{x}{4}\sqrt{r^2-\frac{r^2}{4}} + \frac{r^2}{2}\sin^{-1}\left(\frac{1}{2}\right)\right) + \frac{\pi r^2}{4}$$

----------- (8)

$$= -\frac{\pi}{4}\sqrt{\frac{3r^2}{4} - \frac{\pi^2}{2}} \times \frac{\pi}{6} + \frac{\pi r^2}{4}$$

$$= -\frac{\pi^2}{8}\times\sqrt{3} - \frac{\pi x^2}{12} + \frac{\pi r^2}{4}$$

$$= \frac{\pi r^2}{4}\left[-\frac{\sqrt{3}}{2\pi} - \frac{1}{3} + 1\right]$$

$$= \frac{\pi r^2}{4}(-0.27566 - 0.333 + 1)$$

$$= \frac{\pi r^2}{4}(+0.3911)$$

$$4\int_{d/2}^{r}\sqrt{r^2-x^2}\ dx = 4\left(\frac{\pi r^2}{4}\right) \times (0.3911)$$

----------- (9)

$$= \pi r^2\ (0.3911)$$

$$\pi r^2 - INTC\ (r) = \pi r^2 - \pi r^2\ (0.3911)$$

$$= 0.6089\,\pi r^2 \cong 0.61\,\pi r^2$$

Thus the value obtained here, shows the broadcasting can occur only 0 ~ 0.61πr2. According to the distance of the intermediate nodes the coverage area will be differ

2.3 Algorithm: RBNC Protocol

```
#define rbnc_LOCAL_REPAIR
#define rbnc_LINK_LAYER_DETECTION

class rbncBroadcastTimer : public Handler {
public:
      rbncBroadcastTimer(rbnc* a) : agent(a) {}
      void handle(Event*);
private:
      rbnc    *agent;
            Event      intr;
};

class rbncHelloTimer : public Handler {
public:
      rbncHelloTimer(rbnc* a);
      void handle(Event*);
      FILE *fp;
private:
      rbnc    *agent;
            Event      intr;
};

class rbncNeighbourTimer : public Handler {
public:
      rbncNeighbourTimer(rbnc* a) : agent(a) {}
      void handle(Event*);
private:
      rbnc    *agent;
            Event      intr;
};

class rbncRouteCacheTimer : public Handler {
```

```
public:
       rbncRouteCacheTimer(rbnc* a) : agent(a) {}
       void handle(Event*);
private:
        rbnc    *agent;
               Event     intr;
};

class rbncLocalRepairTimer : public Handler {
public:
       rbncLocalRepairTimer(rbnc* a) : agent(a) {}
       void handle(Event*);
private:
       rbnc    *agent;
              Event      intr;
};
```

The above RBNC protocol steps give the routing link failure detection and the repair with neighboring table update

2.4 Collision in MAC Layer

The average number of packets transmitted or dropped at the MAC layer in per second called collision, which includes the packets like RREQ, route reply –RREP, RERR and the data packets, by using the different data traffic rate, we can improve the connections of transmission in network. We measure the collision rate in physical layer, here AODV and RBNC have less collision in MAC layer

2.5 MAC Layer channel assignment:

```
class rbncChannelAssignTimer : public TimerHandler {
public:
       rbncChannelAssignTimer(rbnc* a) :TimerHandler()
        {
          a_ = a;
        }
       void expire(Event *e);
protected:
       rbnc *a_;

};

class rbncHelloCounterTimer : public TimerHandler {
public:
       rbncHelloCounterTimer(rbnc* a) :TimerHandler()
        {
          a_ = a;
        }
       void expire(Event *e);
protected:
       rbnc *a_;

};
```

In order to reduce the flooding among transmission gives the overhead reduction of network, each node has to monitor the neighboring update and the dynamic routing list.

RBNC broadcasting timer handles the delay tolerant of re-broadcasting , when hello packets occurs in the neighbor searching table, then route cache timer repair the routing path or the link failure, and reduce the hello packet occurrence, (redundant is reduced) .

3. Simulation Setup

To evaluate the performance of proposed protocol which improve the data communication in network? We have compared the results with AODV and our proposed protocol RBNC in NS2 simulator. Broadcasting is the main role to transmits the data communication in the network, where due to random mobility model the node response cannot be accept in time , so re-broadcasting help to improve the data delivery , in that collision has to be reduced , we have implemented a new protocol which solve the issued in existing.

Simulation parameter:

To improve the data delivery rate, MAC protocol has to be perfect among others; we use IEEE 802.11 which helps to transmit the data, where the 512 bytes per sec the CBR rating will be transmitted in MAC Layer. Transmission range will be 100Kbyts. The radio frequency range from 150to 350 MHz for broadcasting the max delay of rebroadcasting is set as 0.01sec for our proposed RBNC protocol, where AODV have it as default; these things are used to perform the scenario.

Table 2: Simulation Parameters

Parameter	**Value**
Simulator	Ns2 - 2.31
Number of nodes	25, 50
Simulation Time	15 min
Packet Interval	0.01 sec
Simulation Landscape	1000 x 1000
Background Data Traffic	CBR
Packet Size	1000 bytes
Queue Length	50
Transmission Range	100 Kbytes
Node Transmission range	250 m
Antenna Type	Omni directional
Mobility Models	Random-waypoint (0-30 m/s)
Radio Frequency	150-350 MHz
Routing Protocol	AODV , RBNC
MAC Protocol	IEEE 802.11

4. Performance Evaluations

1. Redundant:

In dynamic topology network redundancy will occur to increase the reliability of data transmission, in that to control the hello packets by rebroadcasting. As the no of transmission increases along with the coverage of the neighbor node, it maintain the area same, because the covered area is divided by the area of circle, which reduce one-part of its coverage area. So the transmission of that reduces the redundancy in the network as shown in the fig 3.

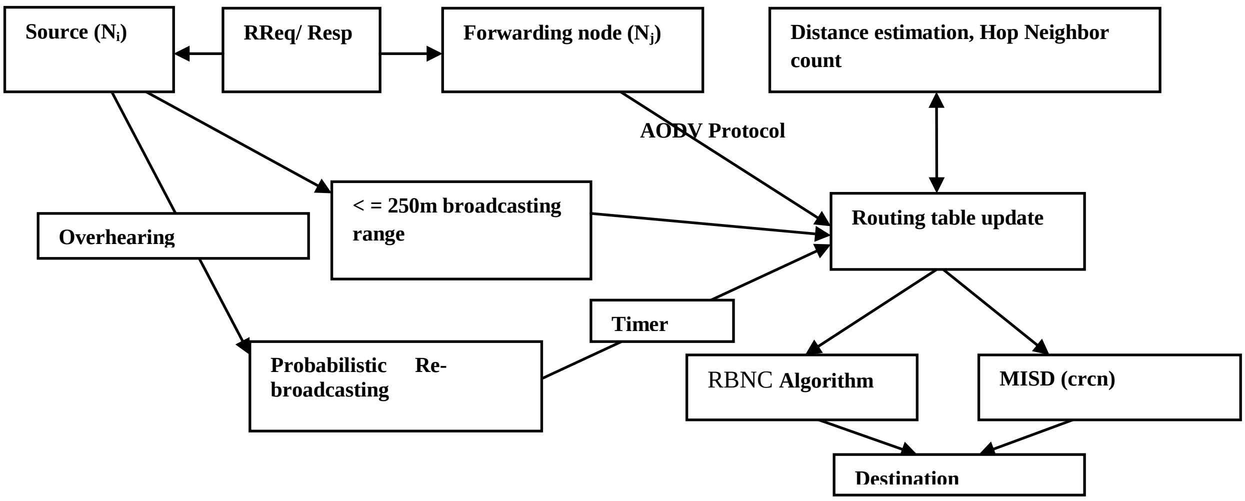
2. End to end delay in network:

The average delay in the network is the success of data delivery packets from source to destination node by their time different like end time difference to start time of the data transmission.DTN (Delay tolerant network) is shown in fig 4.From the fig of delay graph we can tell that AODV protocol will search the best neighbour to reach destination unless it Find the shortest routing path in the network but our proposed protocol RBNC will separate the covered and uncovered neighbour among search or in selection of neighbour routing node to reach destination , so end to end delay of the network will be less when comparing with AODV.

3. Average no of forwarding hops:

If the network showing the packet delivery rate is high then the routing path should be shortest or the forwarding hops to Be reduced. From the fig 5 we can tell that our RBNC.

Fig: 3 Overall Block Diagram



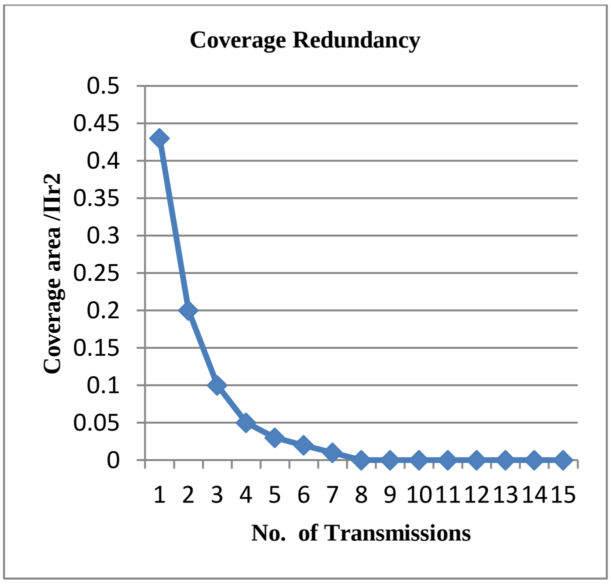


Fig 3: Redundancy in Network

Protocol reduces the number of forwarding nodes in the network which reduce the delay. Packet delivery ratio can be increased only if number of forwarding hops is reduced in the transmission, here broadcasting radio signal will decide the coverage of neighbour around initiating nodes in the network.

5. Packet delivery ratio:

Packet delivery ratio is defined as the ratio of number of data packets received and the data packets generated by the source

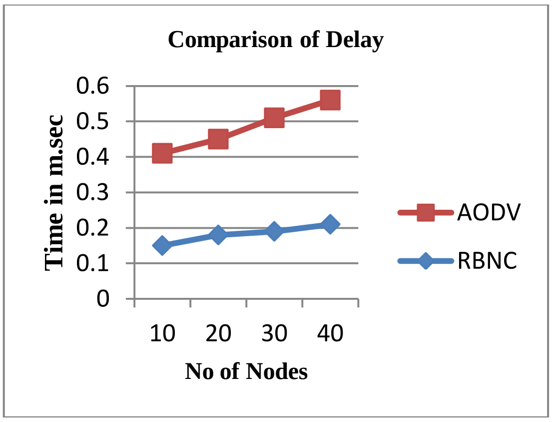


Fig 4: Delay in Network

In the network. Our fig 6 shows the delivery rate is high in RBNC protocol due to the less delay in route selection. Where AODV routing protocol select the alternate route by the source node but our RBNC selects the routing from where the routing is break in network, which improves in data transmission.

6. Routing Overhead:

Routing overhead is defined as the ratio of total packet size of broadcasting packets which include (RREQ, RREP, RERR and Hello packets), to the data packets delivered to the destination. Here the data packets received in the destination will be high when comparing with AODV.

7. MAC Collision Rate:

It measure the no of collision packets which generated from the source, the packets dropped due to collision in data transmission will be rebroadcasted using MAC channel assignment to reduce the collision rate in MAC Layer. AODV search the neighbour until it cover the neighbor list, so collision rate is high in AODV when comparing with the RBNC protocol from fig 8.

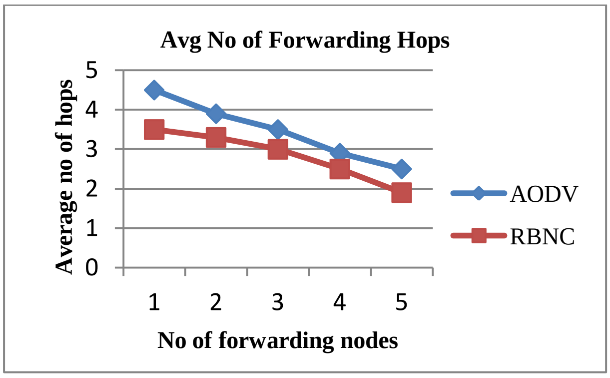


Fig 5: Average no of forwarding hops

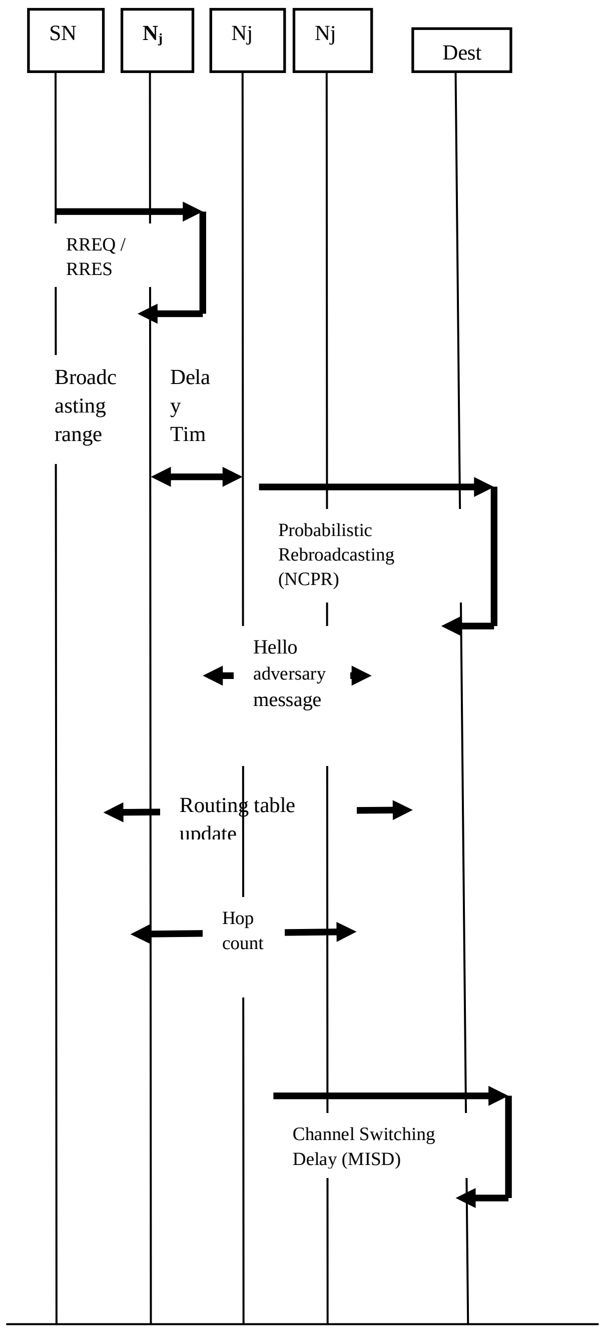
8. Conclusion

Thus we have implemented a new protocol named **RBNC** which solves the issues in MANET like, redundant, routing overhead and fast neighbor search coverage and which improves the overall data communication in highly prone network. Neighboring calculation has been analytically discussed and the re-broadcasting mechanism helps to find the coverage is 61 % by the radio frequency signal range. Simulation results showed our RBNC protocol results better performance when comparing with ON-demand routing protocol AODV.

9. Future Enhancement

Our RBNC protocol can be verified with the scalability, and location based devices like, GPS, GPSR, WIMAX, and LTE. Future enhancement of RBNC protocol mainly concentrate on the radio signal frequency coverage methodology like ellipse, parabola, and by probability distribution with geographic information of the nodes in the network with dynamic topology.

LTE: Long-Term Evolution



N- Node, N $_i$ - First neighbor node

N $_j$ - 2 hop node

Fig 4. Use case diagram

RBNC: Rebroadcasting Neighbour Coverage protocol

GPS: Global Positioning System

GPSR: Greedy Perimeter Stateless Routing

WiMAX: Worldwide Interoperability for Microwave Access

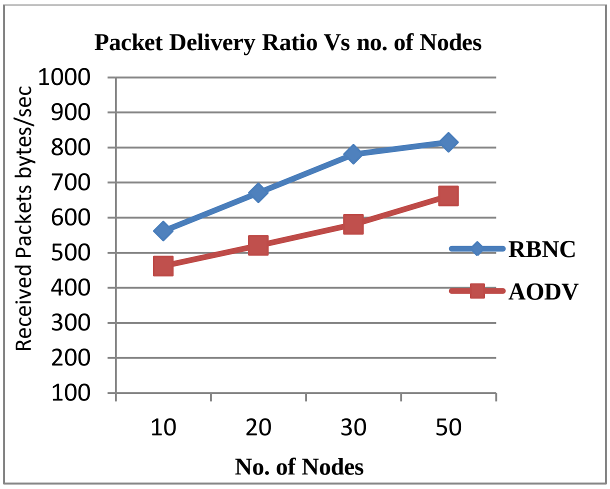


Fig 6 Packet delivery ratio

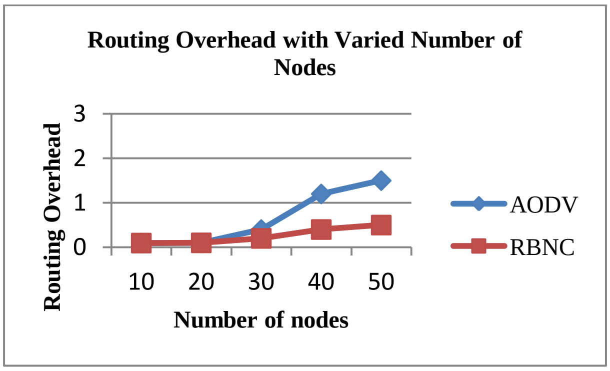


Fig 7: Routing Overhead

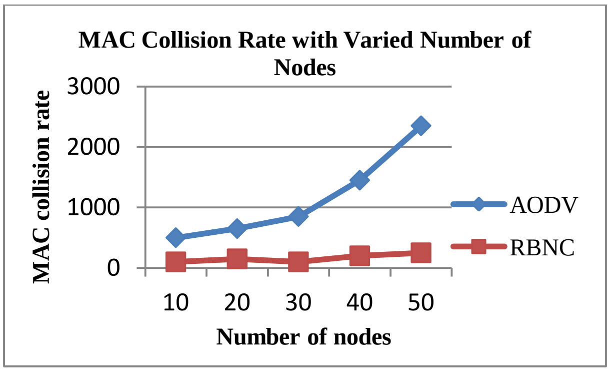


Fig 8: Mac Collision Rate

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