On The Reduction of Flooding Overhead With Adaptive Location Aided Routing In MANETs

Gorre Narsimhulu[1], Dr. D. Srinivasa Rao[2]

[1] Assistant professor in ECE Department, St Peters Engineering college, Hyderabad
[2] Professor in ECE department, JNTU, college of engineering Hyderabad

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Abstract: In Mobile Adhoc Networks (MANETs), the route discovery phase involves with a huge flooding overhead due to the propagation of route request packets without any constraints. The redundant flooding packets lead to dramatic deterioration of the network performance. Location constraint-based flooding is one possible solution to reduce the flooding overhead. In this paper, we propose an Adaptive Location Aided Routing which is adaptive for varying topology and varying node density. This method aims at the determination of an optimal network portion (called as Request zone) which lessens the flooding overhead by allowing only few nodes to rebroadcast the request packets. The request zone is determined based on location coordinates and communication rage of source and destination nodes. Once the request zone is derived, the source node appends the coordinates of request zone and broadcasts the request packets. For any node which lies in the request zone, it rebroadcasts the request packet otherwise it simple drops the packet. An extensive simulation experiments are conducted, and the performance is assessed with Routing Overhead and Route Discovery delay with varying network parameters.

Keywords: MANETs, Flooding overhead, Request zone, location aided routing, Routing overhead, Route Discovery delay.

I. Introduction

In recent years, Mobile Adhoc Networks (MANETs) have gained a huge interest due to its widespread applicability in different kind of applications like emergency rescue operations, military operations, collaborative distributed computing, disaster management and some personal network applications [1] etc. Since the node sin MANETs are not restricted to a fixed administration and hence they can be deployed in such kind applications where the physical assistance is not possible. Rescuing the people in disaster management is a better example for such kind of situations. In general, a MANET is comprised of different set of self-organizing mobile nodes those were able to communicate directly without any additional requirement fixed infrastructure and centralized administrator. In MANETs, mobile nodes are able to perform both tasks such as hosts and routers. In the host mode, the mobile nodes forward their self-packets to destination while in the router mode; they help to other nodes in forwarding the packets to eth corresponding destinations. However, the major issues in MANETs are their varying mobility nature which consequences to a serious link failures, network security and Quality of Services challenges for researchers [2-4].

In general, the major issue in MANETs is routing. Particularly, due to the mobility nature of nodes in network, the topology of network changes rapidly, making the routing more challenging. Notably, there are umber of routing algorithms are proposed for MANETs in earlier (see, e.g., [5-6]) and often assumed that the mobile nodes move at a deterministic speed after choosing a direction, or an upper bound on the speed is preset. However, this assumption with deterministic speed is a very restrictive because in real time the mobile nodes won't have any deterministic speed and no upper bounds. Moreover, during this assumption, the resulting models are tractable and they also compromise the accuracy of the routing algorithms especially in geographic routing and it restricts the applicability significantly.

Several standard routing protocols are developed for MANETs which provides a better understanding about the mobility and characteristics if mobile nodes. All the routing protocols are classified into two classes they are reactive and proactive. Adhoc On demand distance vector (AODV) [7] routing and dynamic source routing (DSR) [8] are the two best examples for reactive routing. According to these protocols, the source node discovers a route towards the destination whenever it required. For this purpose, the source node broadcasts the route request packet into the network. This kind of un-administered flooding results in a huge control overhead in the network. To mitigate this problem, some researches tied to develop routing protocols in which the flooding is restricted to only a particular network portion. Location Aided Routing (LAR) [9], and Greedy Perimeter Stateless Routing (GPSR) [10, 11] are the two best examples for such kind of protocols those utilize geographical position formation to route the messages. Among these two protocols, LAR is very simple location oriented routing protocol but is restricts the attributes of network portion to the horizontal and vertical axes of the network. This is not a feasible solution because the source and destination nodes won't always lies constant. Hence there is a need to develop a new location aided routing approach which derives an adaptive portion of network which have a direct link with the updated position of source and destination nodes.

Towards such objective, in this paper, we propose a modified version of LAR called as Adaptive LAR (ALAR) for the determination of request zone in the network. The main aim of ALAR is to determine an adaptive request zone by which the RREQ flooding overhead will get reduced. In the proposed ALAR, the request zone is derived based on the location of destination and source nodes and their communication ranges. Once the request zone is derived, the source node appends the coordinates of request zone and broadcasts the request packets. For any node which lies in the request zone, it rebroadcasts the request packet otherwise it simple drops the packet.

The remaining paper is stipulated as follows; section II explores the literature survey details. Section III explores the proposed method details. Section IV explores the details of simulation experiments and section V concludes the paper.

II. Literature Survey

In earlier so many authors focused on the reduction of control overhead n MANETs and for that purpose they have proposed different methods. LAR and GPSR are the preliminary routing protocols those are developed based on the location information and aimed at the reduction of flooding overhead by reducing the network search area.

Location Aided Routing [9] is the simple and effective routing protocol which uses location information to lessen the search area for a desired route. LAR is an on-demand routing protocol which have similar attributes with the DSR protocol. In LAR, the Location information is obtained with the help of GPS attached to every node. The location information is piggybacked on all messages to lessen the overhead of a next phase route discovery. However, in LAR, the obtained search area (called as request zone) is a rectangle which has sides parallel to the x- and y- axis of network.

Mohannad Ayash et al. [12] proposed a modified version of LAR in which they assumed that the destination node moves even in the route discovery phase and they added a new factor called tolerance factor to the communication range of destination node. Due to this addition factor, the communication range of destination node is modified which is not a valid solution because at any instant of time or at any instant of position, the mobile nodes has constant communication range and it won't get change. Moreover, the length and width calculation of rectangular request zone is linked with time factor which won't determine a perfect request zone.

Bai Yuan et al. [13] focused on the redundancy of flooding in MANETs and proposed an algorithm called as Location Aided Probabilistic Broadcast (LAPB). The LPAB routing algorithm reduced the number of packets produced by flooding. For that purpose, they allowed the nodes only in a specific area and it was calculated based on the location information and neighbor knowledge. The nodes are chosen based on their broadcasting probabilities which were indirectly linked to the location coordinates of mobile nodes.

Yuntao Zhu et al. [14] utilized a stochastic semi-definite programming (SSDP) [15, 16] to deal with the location uncertainty linked with the node mobility. This approach modeled both the speed and direction of node movement by random variables and constructs a random ellipses model according to the better capture the location uncertainty and heterogeneity across nodes. Based on SSDP, a stochastic location aided routing (SLAR) is proposed to optimize the tradeoff between control overhead and the latency.

Maen Saleh [17] proposed an optimized Location Aided Routing protocol by integrating the diffie-hellman key management protocol and determined a tilted rectangular shaped (TRS) request zone [18]. This approach also focused on the security provision and hence it is called as Secure Tilted-Rectangular-Shaped Request Zone Location-Aided Routing Protocol (STRS-RZLAR) and it provides security from Man in the middle attack for Vehicular AdHoc networks. According to the STRS-RZLAR protocol, the source node calculates the relative coordinates of the request zone and then does coordinates translation to the real X and Y coordinates.

Sumet Prabhavat et al. [19] proposed a Low Overhead Localized Flooding (LOLF) algorithm, an efficient overhead reduction method for MANETs. LOLF is an extension to the conventional Query Localization (QL) [20] routing protocol and the main purpose of LOLF is control the propagation of routing packets in the route discovery and route replay phase. However, they have introduced a small overhead at in the packet by inserting extra control information.

Shih and Yen [21] proposed a location aware routing with dynamic adaption of request zone for MANETs. This approach works similar to the LAR in the determination of request and expected zones. Though, it employed a triangular shaped zone rather than rectangular shaped request zones like LAR. Moreover, this approach also utilizes an accurate method than LAR to calculate the expected zone. All nodes within the derived request zone rebroadcast the request packets generated b source nodes to form the triangle shaped zone. The triangle shape rises until it covers the entire network if it fails to reach the destination node.

A. S. Vijendran and J. V. Gripsy [22] proposed a secure multipath routing to facilitate the nodes of MANET to perform on-demand route discovery. This approach proposed a Rectangular Zone based Location Specific Routing (RZLSR) to provide energy efficiency, adaptivity and security and utilizes the labels to carry the disjointness threshold between nodes during route discovery. This approach followed rectangular shaped titled request zone [18] and uses it to find the path between source and destination nodes.

Some more algorithms are developed based on location information, they are namely Adaptive cell relay routing (ACR) [23] protocol and distance routing effect algorithm for mobility (DREAM) [24]. In the case of ACR, the entire network area is divided into squares of the same size called cells. Route Request packets is flooded to only a sequence of cells instead of sending the entire rectangular regions in LAR. Hence the routing overhead of ACR is less compared to the LAR. Next the DREAM protocol uses geographical information to limit the region into which the flooding packets are routed. Unlike LAR and ACR, the DREAM is a proactive protocol and hence there is a no need of route discovery and no need of routing request packets. DREAM exploits mobility and location information of nodes for routing of data packets. However, in DREAM routing protocol the mobile nodes needs an additional storage requirement to store the information related to location of other mobile nodes.

III. Proposed Approach

3.1 Overview

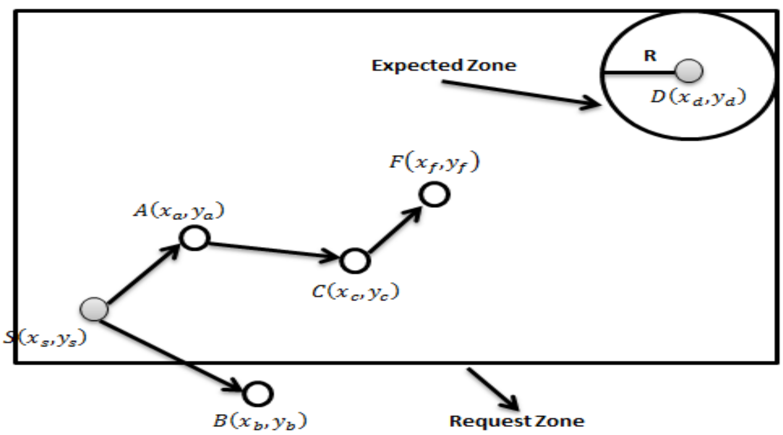
In this paper, we propose a new location aided routing mechanism for MANETs. The main aim of this method is to lessen the RREQ flooding overhead in the MANETs. According to this method the RREQ flooding is restricted only to a limited portion of network which is different from the traditional routing protocols those floods the RREQ in entire network. Here our method aims at the determination of that particular limited portion (called as request zone) of network based on the coordinates of source and destination nodes those want to communicate with each other. The proposed method is an extension to the traditional most popular Location Aided Routing (LAR) protocol. Unlike the LAR which searches for the request zone that has parallel attributes with X- and Y- axis of the network, the proposed method searches for the request zone that has an adaptive attributes and they are parallel to the line connecting source and destination nodes. Here the request zone derived based on the mobility of source and destination nodes, i.e., for any kind of mobility in source or destination nodes, the obtained request zone is always lies parallel to the line connecting to source and destination nodes. The request zone adapts to the mobility of nodes such that it can provide a better performance even in the case of route breakages. After the determination of request zone the source node broadcasts the RREQ packets with destination ID. Upon receiving the RREQ the intermediate nodes decides whether to rebroadcast or to simply drop the packet. The decision is based on their presence or absence in the obtained request zone. If the intermediate node found that it was present in the request zone, then it rebroadcasts the RREQ otherwise it simple drops the RREQ packet. Due to this process, the unnecessary rebroadcasting of RREQ packets is reduced thereby the control overhead is reduced in the network.

3.2 LAR based search area

LAR [9] is an on-demand routing protocol which uses the location information to limit the area for the determination of new route to a smaller request zone. In LAR, the RREQ packets flooding are not allowed to the entire network and they are limited to the nodes only those lay in the request zone. In the traditional on-demand routing protocols like AODV and DSR, the source node and intermediate nodes floods the RREQ packets throughout the network and it creates a huge control overheard in the network. The main aim if LAR is to lessen this control overhead and make the network to live long.

In LAR, the determination of request zone is done through different schemes. In the first scheme, the source node predict the expected zone (circular area) in which the destination node is expected to be found in the current time instant. The size of circle and the position of destination node are calculated with the help of previous location of destination node, the time instant linked with previous location, and the average speed of destination node. Next, the request zone is very smaller in size when compared with size of entire network. Moreover, the request zone has to cover the source node as well as expected zone. When the source node wants to initiate route discovery, it append the location coordinates four corners of request zone in RREQ packet and broadcasts it. Since the RREQ packet has the location coordinates of four corner points of request zone, their broadcasting is limited to that particular request zone only. Hence, if any node in the request zone has received the RREQ packet, it forwards the packets normally. On the other hand, if a node which was not in the request zone has received the RREQ packet, then it simply drops the packet. Consider an example shown in Figure.1, if the node A receives the RREQ packet, it forwards to its neighbors normally, because node A is within the request zone. But if the node B receives the RREQ packet, then it simply drops the packet because it is not present in the request zone.

Figure.1 Standard LAR scheme



Once the destination node receives the RREQ packets, it sends back the route reply (RREP) packets similar to the tradition al flooding protocols. The RREP of destination node differs by containing its average speed, actual time, and its present position. Then the source node utilizes this information for route discovery in future. If source node S knows the previous location of destination node at time t_1, if it also knows the average speed of destination node and the current time t_2, then the expected zone at time t_2 is a circle and its radius is calculated as follows;

$$R = (t_2 - t_1) * v \quad (1)$$

Where v is the average speed of destination node and R is the radius of expected zone and it can simply called as communication range of destination node.

In the second scheme, initially the source node calculates the distance between itself and destination node based on the location information of destination node. At the route discovery phase, the source node appends the distance information in RREQ packet and sends it to the neighbor nodes. When an intermediate node receives the RREQ packet, it calculates the distance to the destination node. The intermediate node relays the request only if it found that its distance to the destination is less than the distance present in Request packet. At this phase, the intermediate node checks whether it is closer the destination or not. If it found that it is closer to the destination, then only it rebroadcasts the received request message to its neighbor otherwise it simply drops the Request packet. This verification done by intermediate nodes signify that they are closer to the destination as well as they are also in the same direction towards the destination.

However, the conventional LAR protocol makes a restriction on the directions of request zone that is the sides of request zone (rectangle) are always parallel to x-axis and y-axis. Due to this reason the source node floods RREQ packets may receive by more number of intermediate nodes due to their presence in the request zone. Because LAR has no restriction on the communication range of source node since its main focus is on the communication range of destination node only.

3.3 Adaptive LAR

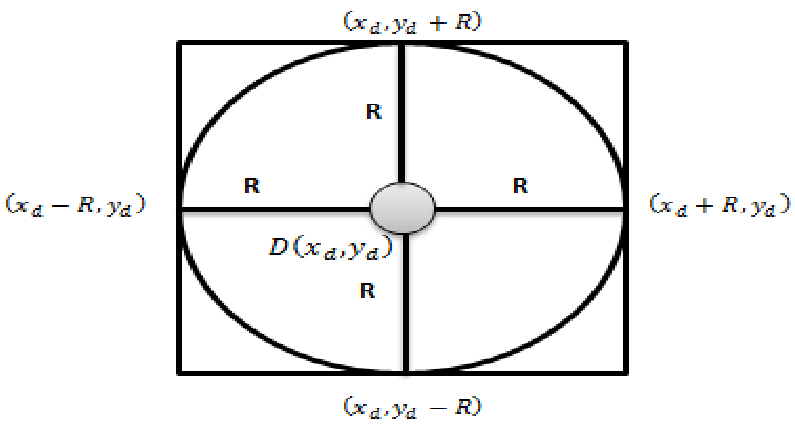
To solve the restriction problem with LAR, here we propose a new version of LAR which determines the request zone based on source and destination node's communication rages as well as their mobility constraints. The proposed approach aims at the determination of an optimal request zone which can reduce the RREQ control overhead further. Unlike the request zone derived by the traditional LAR protocol which has a restriction of parallel sides, the proposed approach derives an adaptive request zone which was tilted in nature and rectangular in shape. The sides of request zone derived through the proposed approach are not parallel to the x- and y- axis of the network; they are parallel to the line connecting source and destination nodes. Here we assume that the communication range of all nodes in the network is uniform in nature. Based on the communication rages of source as well as destination nodes, the source node finds an adaptive rectangular shaped request zone which has only limited number of intermediate nodes. Due to the presence of limited number of intermediate nodes, the RREQ flooding overhead is reduced.

Consider (x_s, y_s) be the location coordinates of source node and (x_d, y_d) be the location coordinates of destination node at time instant t_1. At this instance, the distance between source and destination node are calculated through Euclidean distance, as follows;

$$d_{SD} = \sqrt{(x_d - x_s)^2 + (y_d - y_s)^2} \quad (2)$$

Consider R be the communication range of destination node, now we measure the four possible corner points of expected zone with the help of R. Figure.2 show the simple calculation of location coordinates of four corner points of expected zone.

Figure.2 Coordinates of expected zone of destination node



Let's consider the names of four corner points of expected zone are C_1, C_2, C_3 and C_4. Mathematically the coordinates of these four corner pints are calculated as

$$C_1(x, y) = (x_d + R,\ y_d) \quad (3)$$

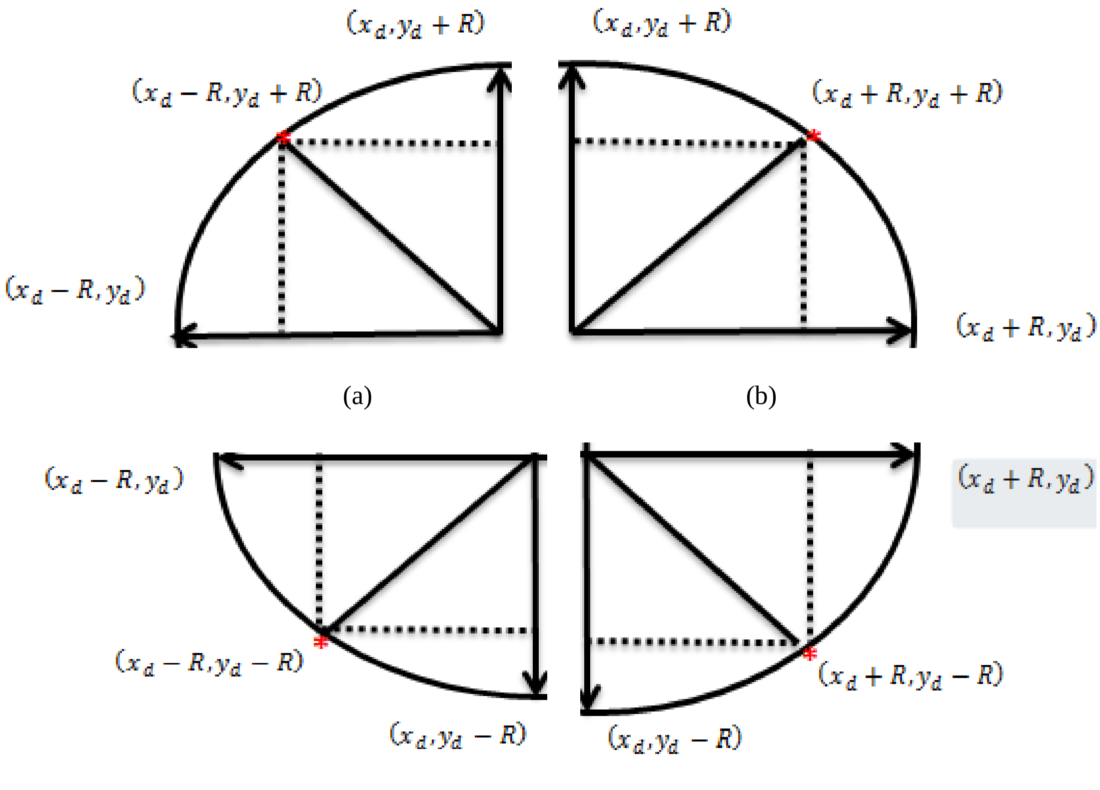
$$C_2(x,y) = (x_d,\ y_d + R) \quad (4)$$

$$C_3(x,y) = (x_d - R,\ y_d) \quad (5)$$

$$C_4(x,y) = (x_d,\ y_d - R) \quad (6)$$

These four coordinates are major coordinates which has major significance in the estimation of request zone. Along with these four coordinates, we also measure four more coordinates for four regions of expected zone. The regions are divided based on the directions such as left, right, top and bottom. By considering the current position of destination (i.e., (x_d, y_d)) as a reference coordinate, we divide the entire expected zone into four regions, they are top left region, top right region, bottom left region and bottom right region. The region partition based on reference coordinate is shown in Figure.3.

Figure.3 (a) Top left zone (b) Top right zone (c) Bottom left zone (d) Bottom right zone



We calculate a common coordinate for each region based on the reference coordinate and the communication range of destination node. For each region, the common coordinate is named according to the combination of major coordinates. For instance, consider the top left region (Figure.3(a)), which lies between second and third major coordinates, it is denoted as C_{23} and its coordinates are calculated as

$$C_{23}(x,y) = (x_d - R,\ y_d + R) \quad (7)$$

Next consider the top right region (Figure.3(b)), which lies between second and first major coordinates, it is denoted as C_{12} and its coordinates are calculated as

$$C_{12}(x,y) = (x_d + R,\ y_d + R) \quad (8)$$

Next consider the Bottom right region (Figure.3(d)), which lies between first and fourth major coordinates, it is denoted as C_{41} and its coordinates are calculated as

$$C_{41}(x,y) = (x_d + R,\ y_d - R) \quad (9)$$

Finally, for the bottom left region (shown in Figure.3(c)), which lies between third and fourth major coordinates, it is denoted as C_{34} and its coordinates are calculated as

$$C_{34}(x,y) = (x_d - R,\ y_d - R) \quad (10)$$

Based on these eight coordinates, we measure the length and width of rectangle (request zone). For this purpose, initially we find the maximum x-value which helps in the determination of length of request zone. Let M_d^x is the maximum x-coordinate, it is measured as

$$M_d^x = maximum\left(C_1(x), C_2(x), C_3(x), C_4(x), C_{23}(x), C_{12}(x), C_{41}(x), C_{34}(x)\right) \quad (11)$$

Next, we measure the width of request zone based on the obtained eight coordinate points. Among the available eight coordinate points, we find the maximum y-value which helps in the determination of width of request zone. Let M_d^y is the maximum y-coordinate, it is measured as

$$M_d^y = maximum\left(C_1(y), C_2(y), C_3(y), C_4(y), C_{23}(y), C_{12}(y), C_{41}(y), C_{34}(y)\right) \quad (12)$$

The above mentioned M_d^x and M_d^y are the maximum x- and y- values of expected zone, i.e., the maximum length and width up to which the destination node can communicate. This calculation is belongs to only destination side. To find the entire request zone, we need to consider the source node expected zone also. For this purpose, we apply the entire process of eight coordinates calculation (Eq,(3) to Eq.(12)) over the expected zone of source node. Let $C_1(x), C_2(x), C_3(x), C_4(x), C_{23}(x), C_{12}(x), C_{41}(x)$, and $C_{34}(x)$ be the eight x-coordinate values of source node S, then we find the minimum x-coordinate. Let M_s^x is the minimum x-coordinate, it is measured as

$$M_s^x = minimum\left(C_1(x), C_2(x), C_3(x), C_4(x), C_{23}(x), C_{12}(x), C_{41}(x), C_{34}(x)\right) \quad (13)$$

Similarly, let's consider $C_1(y), C_2(y), C_3(y), C_4(y), C_{23}(y), C_{12}(y), C_{41}(y)$ and $C_{34}(y)$ be the eight y-coordinate values of source node S, then we find the minimum y-coordinate. Let M_s^y is the minimum y-coordinate, it is measured as

$$M_s^y = minimum\left(C_1(y), C_2(y), C_3(y), C_4(y), C_{23}(y), C_{12}(y), C_{41}(y), C_{34}(y)\right) \quad (14)$$

Finally based on these four values such as M_d^x, M_d^y, M_s^x and M_s^y, the length and width of rectangle are calculated as follows;

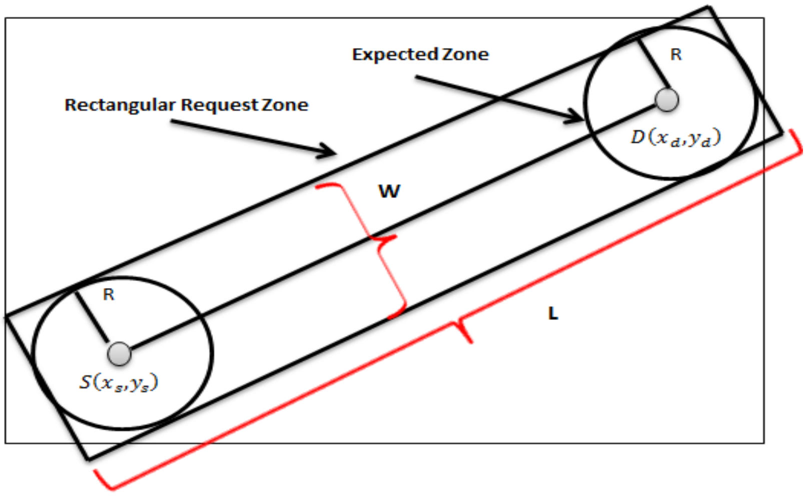
$$L = M_d^x - M_s^x \quad (15)$$

And

$$W = M_d^y - M_s^y \quad (16)$$

The derived rectangular shaped request zone which is parallel to line connecting source and destination is shown in the figure.4. These two values (L and W) will get updated automatically with the positions of source and destination nodes and the obtained request zone continuously reduce the RREQ control overhead. Moreover, from the above length and width calculations we can observe that they are completely time and velocity independent. They are only dependent on the node locations and based on updated locations, the coordinates of request zone are updates. For every update, the source node appends the coordinates of request zone and sends it to its neighbors.

Figure.4 Rectangular shaped titled request zone



IV. Simulation Results

In this section we explore the details of simulation experiments conducted over the proposed approach. Initially we discuss about the details of simulation setup, i.e., the network parameters employed to create the network. Next we discuss the details of performance metrics those were calculated to explore the effectiveness of proposed approach. Under the simulation study, we studied several case studies by varying different network parameters such as average speed, transmission range, and number of nodes.

4.1 Simulation set up

In the simulation set up initially we create a network and the number of nodes chosen is varied from 20 to 60 with the deviation of 10. Next, the area of network is considered as 1000*1000 m^2. The deployment of nodes is done in a random manner. For every simulation, the mobile nodes are deployed randomly and their positions are not related with the positions of earlier simulation study. Here we varied three network parameters namely speed (m/s), transmission range and number of nodes. The number of nodes is varied from 20 to 60 and the transmission range is varied from 10% to 25% of network area, i.e., 100, 150, 200, and 250. Finally the average speed of mobile node is varied from 5 m/s to 25 m/s and we employed random way point mobility model for mobility realization. In the simulation, the source and destination node pairs are chosen randomly. Any data packet that was not delivered to the destination is simply considered as dropped due to broken route. On an average, the source node generates 10 packets per second and the size of each packet is assumed to 512 kilo bytes. Due to the limited availability of request zone, we considered the lower data rate. The details of simulation setup are shown in Table.1.

Table.1 Simulation set up

Network parameter	**Value**
Number of nodes	20-60
Transmission Range	10% to 25% of network area
Average speed	5 m/s to 25 m/s
Mobility model	Random way point (RWP)
Data packets	10
Size of data packets	512 kilobytes
Nodes deployment	Random
Source and destination pair selection	Random

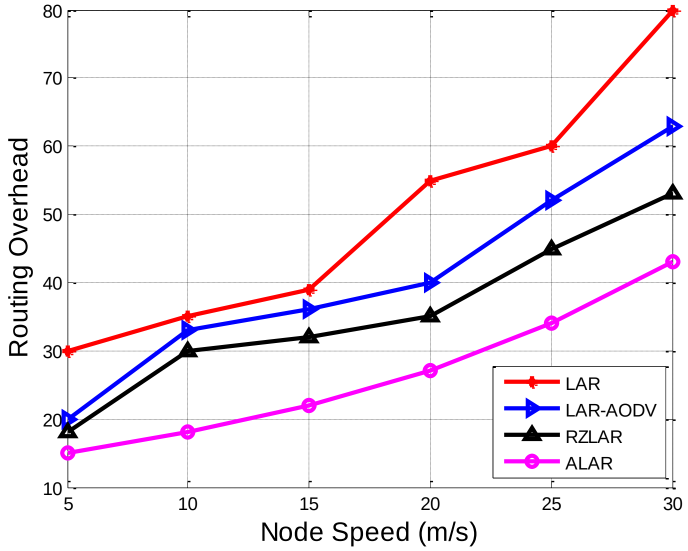
4.2 Results

In the starting, we assume that the mobile node knows its current locations accurately without any error and it fetches the location of destination node through HELLO packets from destination nodes. Based on these two locations, the source node establishes an adaptive request zone and then forwards data packets. After the completion of data transmission, we measure the performance of proposed approach through the several performance metrics like Routing Overhead, Throughput, Packet Delivery Ratio and Route Discovery Delay. All the performance metrics are averaged for 25 runs each with different mobility, transmission range and number of nodes. At every simulation, we compare the proposed approach with existing methods such as LAR [9], LAR-AODV [12] and RZLAR [17].

4.2.1 Routing Overhead

In this simulation study, we compute the Routing Overhead (RO) of proposed approach under three different environments such as mobility, transmission range and number of nodes. Here we kept the 100 data packets as a base reference to measure the RO. At each phase of simulation, the observed routing overhead is compared with the routing overhead of existing methods. In this work, the routing overhead is defined with respect to the additional overhead incurred at the route discovery phase. The routing overhead considers both route request and route reply packets. To study and analyze the effect of different network parameters on routing overhead we conduct different simulations with varying network parameters. In this first phase, we varied the node speed form 5 m/s to 30 m/s. Figure.5 shows the routing overhead observation with varying node speed. As the node speed increases, the position or location of node change rapidly. Due to these fast variations in the positions of nodes, they may move in and out of the rectangular region which was defined by the proposed method. For example consider a node which was cooperating for data transmission was moved out of rectangular area, then the source ode needs to perform route discovery again and due to this reason the routing overhead increases substantially. Hence the routing overhead always follows increasing characteristics with increasing node speed. However, the proposed approach has less RO compared to the existing methods. In the case of LAR, due to the possibility of more number of nodes (rectangular region with more area) the RO is very high. Unlike the LAR, the LAR-AODV and RZLAR has tilted rectangular regions but they didn’t consider the location of source at the determination of rectangular region. Hence they also observed to have considerable RO.

Figure.5 Routing Overhead for varying node speed



In the second phase of simulation, we varied the transmission range of mobile nodes and observed the RO. Figure.6 shows the variations of RO with varying transmission range. As the node's transmission range increases, the ability of a node to communicate for far distances increases. Due to this reason, the intermediate nodes won't rebroadcast the packets unnecessarily into the network. The source node can find the destination node within few hops and hence the routing overhead is less for increasing transmission range. Moreover, along with this benefit, if the location assisted routing is able to derive a fixed and compact region for rout discovery, and then it further reduces the RO. From Figure.6, we can observe that the proposed approach has less RO when compared with existing methods. Since the proposed approach is completely oriented to the transmission ranges of nodes, it has a great reduction in RO when compared with LAR, and its subsequent methods such as LAR-AODV and RZLAR.

Figure.6 Routing Overhead for varying Transmission Range

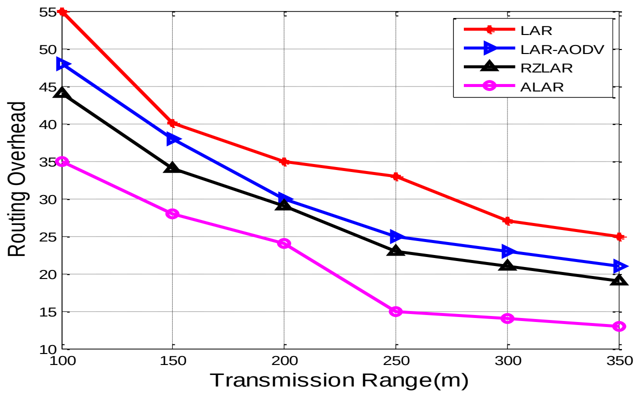
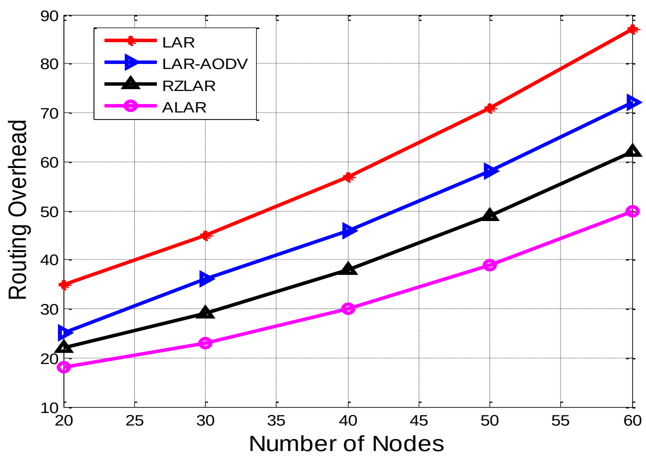


Figure.7 Routing Overhead for varying Number of nodes deployed in the network



In the third phase of simulation, we varied the number of mobile nodes deployed in the network and observed the RO. Figure.7 shows the RO variations with varying node count in the network. With the availability of more number of nodes in the network the nodes will become neighbor nodes for multiple nodes. In such condition, the nodes rebroadcast the request packets again and again and make the RO to increases linearly. In the case of LAR, the area is larger and the node's availability is also more hence the RO of LAR is higher compare to the other methods. In the case of LAR-AODV and RZLAR, the rectangular area is smaller is size and also tilted in nature. Hence the node availability reduces and results in less RO. Finally in our method, the nodes availability is much less than the conventional methods and hence the RO is less compared to all the other methods.

4.2.2 Route Discovery Delay

Route Discovery Delay is one more performance metric which computes the time incurred to perform the task. In our task, the main aim is to find the optimal route by rebroadcasting the request packets through only few nodes. As the number of nodes participating in the route discovery process is less, then the route discovery delay is also less. In this case study, we tried to study and analyze the effect of different network parameters (Node speed, Transmission range and Number of nodes in network) on the route discovery delay. Figure.8 shows the delay observations for varying nod speed. As the node speed increases, the nodes shift their locations very fast thereby the links established between them broke. For every instant of new location, the node breaks the link with some nodes and establishes links with some other nodes. Due to this reason, the request packets may get delayed and consequences to an increased route discovery delay. In the LAR, the delay is observed as very high when compared to the other methods because the nodes are more in number and their speed is also high. Among the titled rectangular region methods, the proposed method is observed to have less delay because the region of interest is very less and it is related to the source and destination node locations.

Figure.8 Delay (msec) for varying node speed

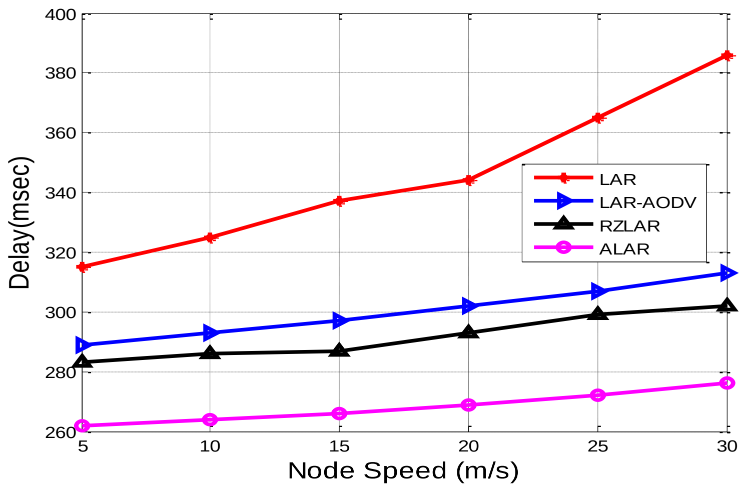


Figure.9 Delay (msec) for varying Transmission range

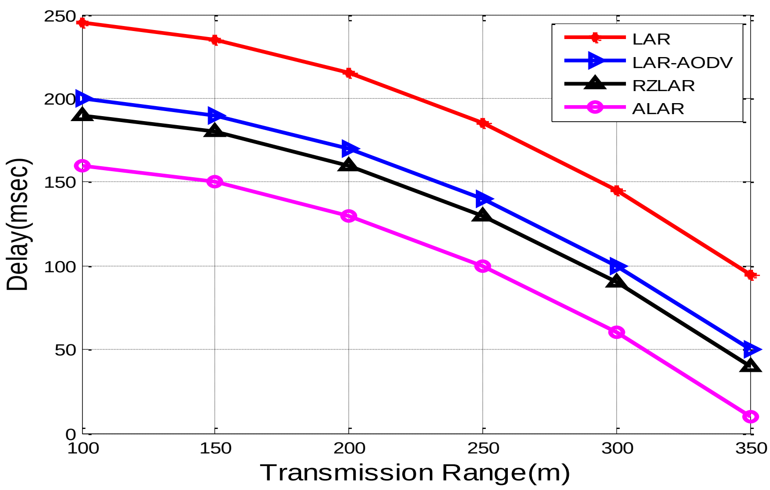
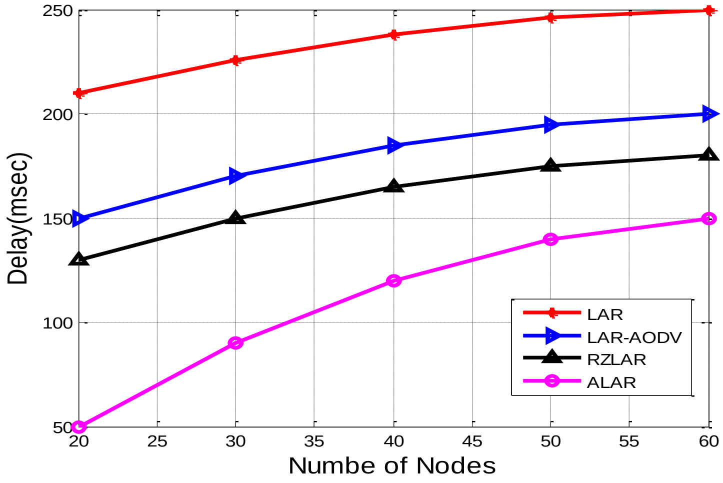


Figure.9 derived from the observations done for delay calculation at different values of transmission range. As the node's transmission range increases, the communication capability of node increases and results in less delay. The source node can establish route even with few nodes since their communication capability is high. In LAR even though the transmission range of nodes is high, the larger sized region of interest makes the request packet to rebroadcast multiple times. This kind of nature induces an excessive delay even at larger communication capabilities. Next, in LAR-AODV, they assumed that the communication range increases with node mobility and that is not a vital solution. Because the communication range of node is fixed at its completely dependent on its energy resource. In RZLAR, even though they found a tilted rectangular region with the source and destination node locations, the region is not linked with communication range of nodes. However, the proposed method derived the region which is linked with transmission ranges of nodes; it is observed to have less delay.

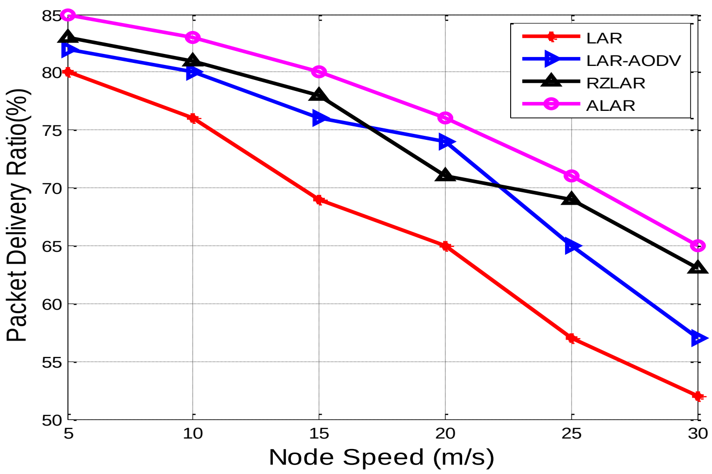
Figure.10 Delay (msec) for varying Number of nodes



As the number of nodes increases in the network, the routing discovery delay increases because the availability of number of node sis more and they will rebroadcast the request packet again and again. Due to this reason, the route discovery delay follows an increasing characteristic with an increase in the node count in network, as depicted in Figure.10. Since the proposed method has derived smaller sized rectangular and tilted region compared to other regions, the available nodes in that region has less possibility to rebroadcast to more number. They have only few nodes in available who are directed towards the destination node and hence the proposed approach is observed to have less delay. In LAR, this delay is observed as very high because the nodes have more available neighbor nodes and the request packet may get rotated within the nodes.

4.2.3 Packet Delivery Ratio

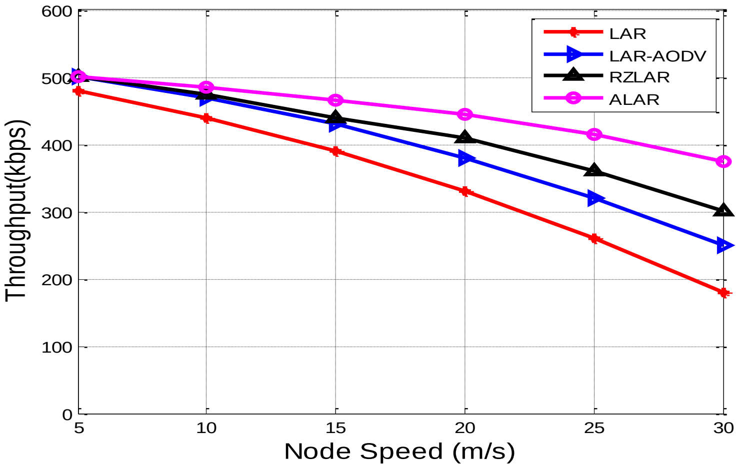
Figure.11 Packet delivery ratio for varying node speed



Packet Delivery Ratio (PDR) measures the quality of service (QoS) attained by the developed mechanism. Here we employed PDR to measure the QoS attained by the proposed and existing methods. Next, the PDR has an inverse relation with node speed, means as the node speed increases, the PDR decreases and vice versa. Since a node moving with high speed has more link breakages, the packets may get dropped at the same instant whenever it moves out of the result zone. Once the link was broken, the source node needs to stat the route discovery again. Due to this reason, the PDR follows decreasing characteristics with increasing node speed, as shown in Figure.11. From this figure, we can notice that even though the LAR has larger sized request zone, it is observed to have less PDR because it takes more time for route discovery and the simulation time fixed. Compared to LAR, it subsequent methods such as LAR-AODV and RZLAR has gained more PDR due to the availability of limited region for route discovery. The region obtained through the proposed approach is further improved PDR due to its adaptive request zone. Even though the nodes are moving with greater speed, the request zone derived follows the exact locations of source and destination nodes and hence it can establish a route quickly at link breakages.

4.2.4 Throughput

Figure.12 Throughput (kbps) for varying node speed



The throughput is defined as the ratio of total amount of data received at the destination node within the stipulated time period. Due to the high mobility, the link breakage rate is high and the source node consumes more time for re-route discovery. In that particular time period, there is no possibility of data packets transmission and hence the through has inverse relation with node speed. According to the results shown in FIgure.12, the higher throughout is observed for proposed approach because in the proposed approach, the route reestablishment is very fast due to the availability of destination oriented nodes. That too these nodes are constrained to limited region and helps in the quick transmission of route request. Even through the LAR-AODV has limited region, the link provided by them between location and communication range is not a vital solution. Next, the RZLAR does not follow the communication range statistics at the determination of request zone.

V. Conclusion

In this paper, we proposed an Adaptive Location Aided Routing which aims at the determination of an adaptive request zone which lessens the flooding overhead in the MNAETs. According to the proposed method, the source node finds an optimal request zone which has only limited number of intermediate nodes and they rebroadcast the request packets directly towards the destination. The proposed method is adaptive with respect to location coordinates of source and destination because the attributes of request zone is derived based on communication ranges which has a direct link with location coordinates. The nodes present in the obtained request zone only rebroadcasts the request packet while the remaining nodes simply drop even though they receive. For experimental validation, we adopt a randomly deployed network and numerous simulations are performed by varying different network parameters. At the comparative analysis, the proposed model had shown its effectiveness in lessening the routing overhead as well as route discovery delay.

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