An Efficient Location Aided Routing Protocol in Mobile Ad-Hoc Network

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***Abstract*: In the last few years, Mobile Ad-hoc Networks (MANET) have gained increasing attention from both the researchers and the actual users. As MANET nodes are generally battery-powered devices, the challenging task is how to reduce the energy consumption of nodes and hence conserve energy of the whole system, which extend the lifetime of the network to a reasonable time. One way to achieve this goal is efficient routing protocol algorithm in MANET. Therefore we have taken location in account during route discovery and route maintenance. But in location-aided routing (LAR) of MANET, due to nodes mobility inaccuracy of location information may result in constant flooding, which will reduce the network performance. We propose a modified-LAR algorithm to improve the efficiency of LAR. Modification is based on the idea of enlarging the request zone, in case of failure of the route discovery phase, instead of going to flooding. This concept is based on memory hierarchy of computer. This result in a significant reduction in the number of routing messages compares to flooding in case of failure.**

***Index term:* MANET, routing, LAR, request zone, expected zone**

I.INTRODUCTION

MANET is a combination of mobile nodes. Nodes may be static or free to move in geographical area. It is an infrastructure less network. Network establish on ad-hoc based whenever nodes wants to communicate. Not like to conventional wireless networks, MANETs are wireless networks with no fixed routers, servers, hosts, or wireless base stations. In an ad hoc network, there is no dedicated base station to manage the channel resources such as bandwidth for each network node. Nodes are mobile so routing is very critical issue in MANET since mobility induced route change and route error. For latest applications for wireless and potential business uses of MANETs routing should be such that it decrease the protocol overhead in term of number of control packets since they consumes network bandwidth. .

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Till now many routing protocols have been proposed in manet but they can broadly categorized in proactive or table-driven, reactive or on-demand and third one are hybrid approach. In proactive routing each node attempts to maintain consistent, up-to-date routing information to every other node in the network. A proactive routing protocol maintains extensive routing tables for the entire network which are periodically shared among nodes. As a result, a route is found as soon as it is requested. It is *proactive* in the sense that when a packet needs to be forwarded the route is already known and can be immediately used. It is similar to wired network where the routing table is constructed using either *link-state* or *distance vector* algorithms containing a list of all the destinations, the next hop, and the number of hops to each destination. The main advantage of a proactive protocol is its low latency in discovering new routes. However, proactive protocols generate a high volume of control messages required for updating local routing tables. DSDV[1], OLSR[2] are some protocols which works in proactive pattern. But in case of reactive approach routes are discovered only when a source node desires them. *Route discovery* and *route maintenance* are two main procedures: The route discovery process involves sending route-request packets from a source to its neighbor nodes, which then forward the request to their neighbors, and so on. Once the route-request reaches the destination node, it responds by unicasting a route-reply packet back to the source node via the neighbor from which it first received the route-request. When the route-request reaches an intermediate node that has a sufficiently up-to-date route, it stops forwarding and sends a route-reply message back to the source. Once the route is established, some form of route maintenance process maintains it in each node's internal data structure called a route-cache until the destination becomes inaccessible along the route. The main advantage of a reactive protocol is the low overhead of control messages. However, reactive protocols have higher latency in discovering routes. *Dynamic Source Routing* (DSR) [3] and *Ad-Hoc On-Demand Distance Vector* (AODV) [4] are examples of on-demand driven protocols. Hybrid approach combines good features of both proactive and reactive approach. It divides routing in two parts the proactive part of the protocol is restricted to a small neighborhood of a node and the reactive part is used for routing across the network. This reduces latency in route discovery and reduces the number of control messages as well. Zone routing protocol (ZRP) [5] and HSR [6]. Ad hoc routing protocols can also be classified into three categories according to underlying network structure. They are: 1). Flat routing approaches. Each node participating in routing plays an equal role, such as AODV [4] and DSR [3]. 2). Hierarchical routing usually assigns different roles to network nodes. Some protocols require a hierarchical addressing system or some divides routing area in specific zones. Such as ZRP [5] and HSR [6]. 3). Location aided routing. Routing with the node location information can improve the performance, such as LAR [7], GPSR [8], and EECR [9].

The rest of paper is organized in fallowing manner: a brief description of previous work in this field is given in section II. The modified routing algorithm is present in section III. Section IV present simulation result. In section V we have given conclusion of paper.

II. PREVIOUS WORK

In the early of 90's proactive approaches are used in routing in MANET. But as the number of nodes increases in MANET overhead of this approaches routing is increases exponentially. So it becomes obsolete as the requirement of the time is increased. After that time came of reactive approaches. DSR is based on reactive approach. In DSR source node flooded route request (RREQ) message to its entire neighbor which are in coverage of source node. In similar pattern all the nodes broadcast RREQ till it reaches to destination. After receiving RREQ destination reply unicast route reply (RREP) to source node and route is establish [3]. But in this scheme overhead of all those nodes increases to whom there is no concern to source and destination. Energy of those nodes are wasted in this pattern and to many extra control packet are generated which increases overhead in network. Whole geographical area is taken in consideration during route discovery and route maintenance. A number of protocol optimizations, adaptation and variation are also proposed to reduce the route discovery overhead.

Perkins and Royer [4] present the AODV (Ad hoc On demand Distance Vector routing) protocol that also uses a on demand-driven route establishment procedure. Hass and Pearlman [5] attempt to combine proactive and reactive approaches in the Zone Routing Protocol (ZRP), by initiating route discovery phase on demand, but limiting the scope of the proactive procedure only to the initiator's local neighborhood.

These all previous MANET routing algorithms had not taken into account the physical location of a destination node as well as source node. Node location information can reduce significant amount of overhead and control packets. It can be achieved easily through Global Positioning System (GPS). Young-Bee Ko and Nitin. H. Vaidya proposed a location-aided routing (LAR) in mobile ad hoc Networks [7]. LAR uses destination location information in the route discovery process. In the route discovery phase source node S uses location information of destination node D provided by GPS to estimate the region that the destination node expects to appear, since node D may moving they called it the expected zone. It is given that at time $t1$, node S knows that node D was at location $L_0(x_0, y_0)$ at time $t0$, and D's average moving speed is v. Then, S can determine the expected zone to be a circular region centered at location $L_0(x_0, y_0)$ and with a radius $v(t_1 - t_0)$, node D must be in this circle see Fig. 1. If S has not the location information of destination D then whole geographical area is expected zone as in previous protocols –DSR, AODV etc.

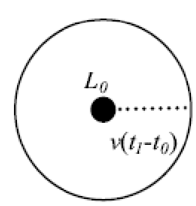

Fig. 1 The expected zone [7]

Through the location of S and expected zone source S can define a request zone that is shown in Fig 2(a) and 2(b). In Fig 2(a) source node S is outside to the expected zone and in Fig 2(b) source S is within expected zone.

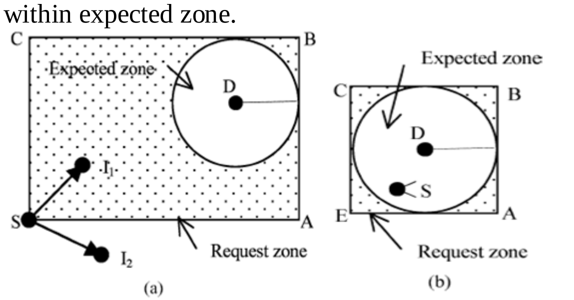

Fig. 2 (a) S is outside the expected zone. (b) S is within the expected zone [7]

The source node *S* determines the coordinates of the four corners of the rectangular request zone and includes them within the route request (RREQ) message transmitted when initiating the route discovery phase. When node D receives the route request message, it replies by sending a route reply (RREP) message in which it includes its current location and current time [7]. Request zone should always include the expected zone to increase the probability of the route request will reach D. LAR is totally based on flooding with just one modification as follows: In LAR, the route request packet is only forwarded by those nodes which are within the request zone. For example in Fig 2(a) node I_2 will receive route request RREQ packet from S but it will not forward to it but if node I_1 will receive RREQ then it will forward to its neighbor since it is in request zone. So it is better than blind search in whole geographic area as traditional flooding algorithms do and it also saves routing cost.

Another request region confined algorithm, A Distance Routing Effect Algorithm for Mobility (DREAM), is proposed by S. Basagni et al. [10]. In DREAM each node maintains its database by periodically sending probe packets in network. The accuracy of entry in database is depending on its age. As concern the maintenance of the location database, DREAM may be classified as proactive routing protocol. The route construction is based on an on demand pattern, like a reactive routing algorithm. When the source node wants to transmit any message, it uses the location information of the destination node so that it can estimate the direction of the destination node, and then forwards the packet to all its coverage neighbors within this confined direction. Each neighbor node in the same direction repeats the similar procedure until the message reaches to the destination node if it is reachable.

Xiaojiang Du[9] proposed another location

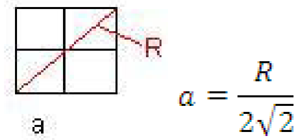

Fig 3. The relationship between *a* and R [9]

based algorithm Energy Efficient Cell Relay (EECR) in which geographical area is divided in number of square cell. Size of cell decided by radio range of node as shown fig 3. Number of cells C_0,C_1,C_3…are counted between source S and destination D. The node with highest residual energy in cell forward message to consequent cell.

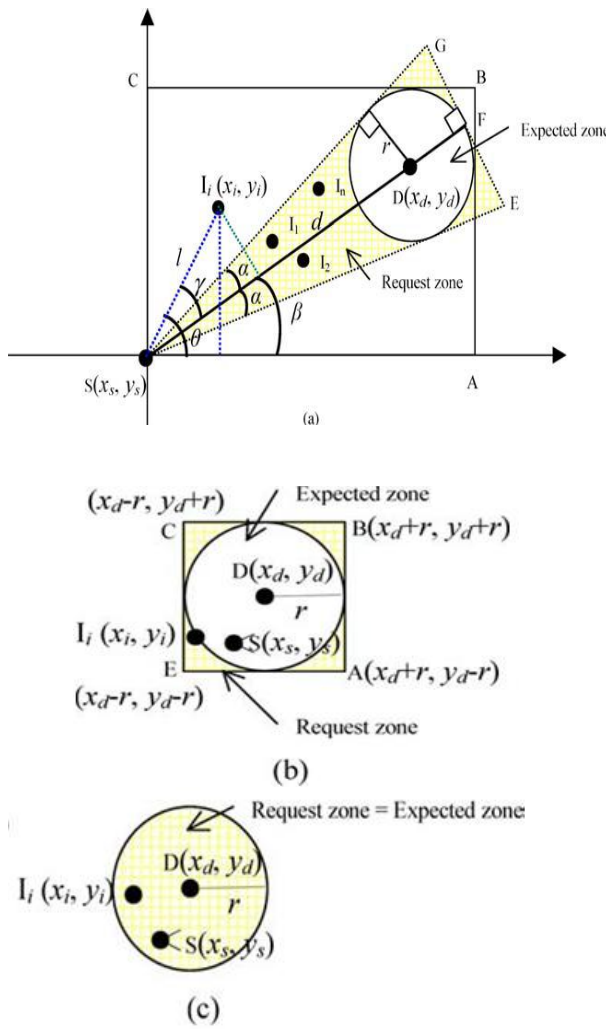

Fig. 4 (a) TRIANGLEZONE, source node S outside the expected zone. (b) RECTZONE, S within the expected zone. (c) CIRCLEZONE, S within the expected zone [11]

Tzay-Farn Shih , Hsu-Chun Yen[11] proposed Location-aware routing protocol with dynamic adaptation of request zone (LARDAR) in which they has taken triangular request zone instead of rectangular zone. As shown in Fig 4 three different situation has been shown accordingly request zone.Size of the triangle zone is adapted as message forwarded to intermediate nodes.

III. EFFICIENT LOCATION AIDED ROUTING PROTOCOL

In location based routing from the position of source and destination node request zone is decided. Performance of routing protocol depends upon shape and size of request zone. In more selective request zone probability of finding path is less as well as it reduces overhead. If we take less selective zone then probability of finding path is more but it increases the overhead. So optimal size of request zone gives more probability of finding path and minimum overhead.

In this paper modification in LAR algorithm is proposed while computation of request zone during route discovery phase we call it efficient-LAR. Our concept is to normally use rectangle request zone defined for LAR but this rectangle is not made parallel to the x and y axis but its one side is parallel to the line joining S and D. in case of failure in first route discovery attempt i.e if destination D is not found then we compute a new “increased” request zone instead of broadcasting or flooding route request in whole network.

In summary, the step involved for route discovery by the efficient- LAR protocol is fallowing:

- In the first route discovery attempt, RREQ packets are forwarded by source node S inside the rectangular request zone as shown in fig 5.
- In case of destination not found, a second attempt of route discovery is performed and RREQ packets are forwarded by source node S inside new increased rectangular request zone.
- In case of again failure, a third attempt of route discovery is performed and RREQ packets are forwarded by source node S inside new increased rectangular request zone.
- In case of further failure RREQ packets are flooded into the entire network.

All other methodology is similar to LAR scheme 1 such as deciding nodes in rectangle, route maintenance in case of route error.

According to the efficient–LAR, increased request zone computed by source at second and third step is a rectangle as well, its size is incremented as fallow:

$$X_{2\text{-step}} = X_{1\text{-step}} + \Delta X \quad (2)$$

$$Y_{2\text{-step}} = Y_{1\text{-step}} + \Delta Y \quad (3)$$

$$X_{3\text{-step}} = X_{2\text{-step}} + \Delta X \quad (4)$$

$$Y_{3\text{-step}} = Y_{2\text{-step}} + \Delta Y \quad (5)$$

Where $X_{2\text{-step}}$ and $Y_{2\text{-step}}$ are respectively horizontal (parallel to SD line) and vertical size of the increased request zone computed by the source in second attempt, X3-step and $Y_{3\text{-step}}$ are respectively horizontal and vertical size of increased request zone in third attempt. X1-step and Y1-step are size of original request zone. ΔX and ΔY are increment in request zone that can be computed as percentage P_X and P_Y of x and y respectively, from the fallowing equation:

$$\Delta X = P_X * X_{1\text{-step}} \quad (6)$$

$$\Delta Y = P_Y * Y_{1\text{-step}} \quad (7)$$

In this paper we chosen $P_X = P_Y = P_S$, where s stand for source. The increment ΔX and ΔY have to satisfy fallowing condition:

$$\Delta X > \Delta X_{min} = 2 * V_{max} * T_{timeout} + \delta_X \quad (8)$$

$$\Delta Y > \Delta Y_{min} = 2 * V_{max} * T_{timeout} + \delta Y \quad (9)$$

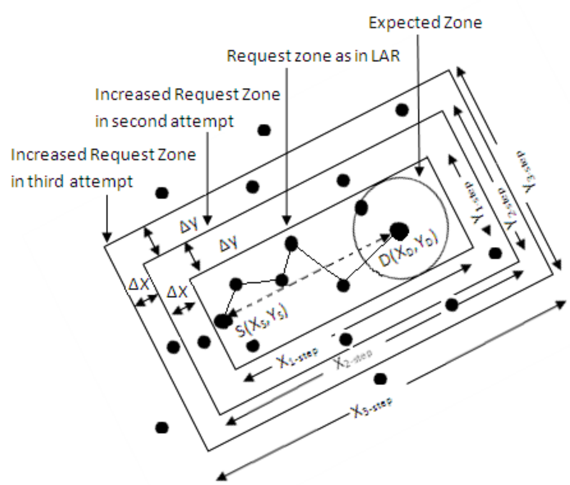

Fig 5: original and increased request zones in efficient-LAR protocol

Where δ_X and δ_Y are error factor for the evaluation of node D position (X_D, Y_D), V_{max} is the maximum velocity of source node S and destination node D and $T_{timeout}$ is the timeout for successive RREQ. It means that RREP packet not received before timeout period expiration, then a second RREQ packet is sends in increased request zone. Since source S and destination D both can move in timeout period so twice of max distance coverage has been taken. In this way increased request zone guarantees to cover the area in which destination can be found.

IV. SIMULATIONS AND TEST RESULS

ELAR routing protocol is implemented in QualNet4.5 a scalable packet-level simulator with an accurate radio model. IEEE 802.11b was used as the MAC protocol. We distribute 50 nodes uniformly at random in an area of 400*m* × 400*m* to simulate a dense network.Smulation run time was 300 simulated second. Transmission range of node is 50m. The mobility in the environment was simulated using a random-waypoint mobility model, where in each node randomly chooses a point in the field and moves with the average speed v has a pausing time 10 sec. The node speed is randomly distributed in the range $[0, V_{max}]$. For computation increased zone in efficient-LAR we have choose δx=δy=0 in equation (8) and (9).

TABLE 1:
SIMULATION PARAMETER

Input Parameter	
Simulation area	400×400 m
Traffic sources	CBR
Number of sources	10
Transmission range	50 m
Size of data packet	64 byte
Simulation time	300 s
Timeout	30 s
Mobility Model	
Mobility model	Random way point
Pause time	10 s
Traffic pattern	Peer-to-peer
Mobilty average speed	0-50 m/s
Simulator	
Simulator	Qualnet 4.5
Medium Access Protocol	IEEE802.11
Link Bandwidth	1 mbps
Confidence interval	95%
LAR constant	
Timeout for 1 hop route request	30 ms
Route request timeout	500ms
Forwarding error factor	0.0
Buffer size	100 packet
Packet lifetime in buffer	30 s
$\delta_X = \delta_Y$	0

We first measured the routing overhead of ELAR

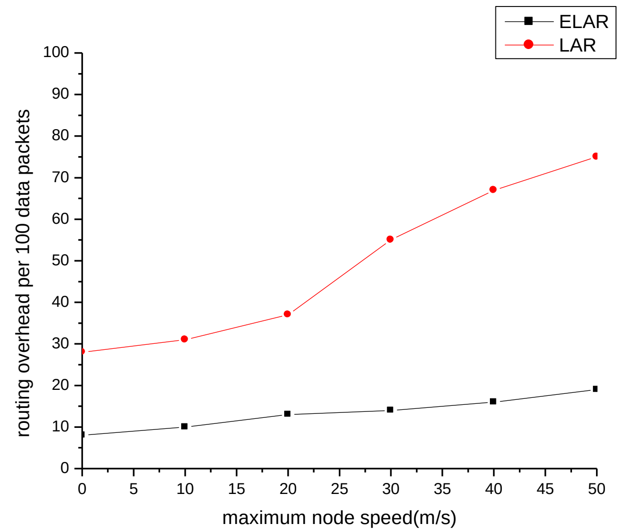

Fig 6: Routing overhead for different mobility

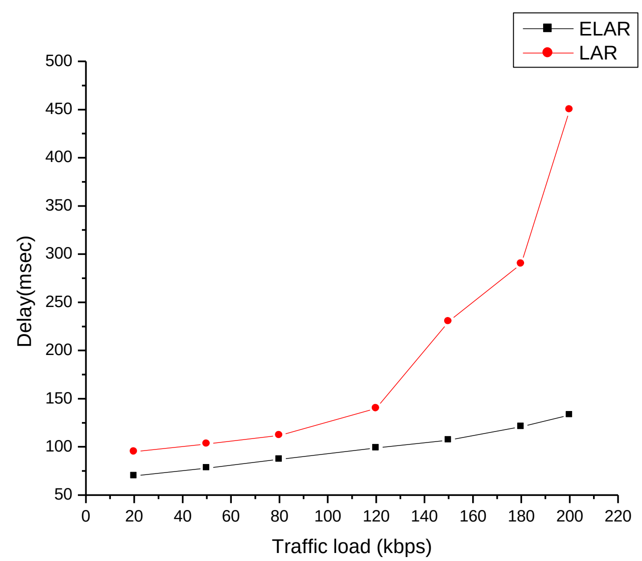

Fig 7: Delay comparison

protocol under different mobility, and we compared the overhead with LAR. As shown in Fig 6

The delay between source to destination in data packet transmission under different traffic load is reported in fig7. Delay in LAR increases exponentially as traffic load increases but in ElAR it increases linearly.

We also compared the throughputs LAR and ELAR for different traffic load. The results are shown in Fig8. In the simulation, the maximum node speed is 35 m/s. The traffic load varies from 20 kbits/sec to 200 kbits/sec.

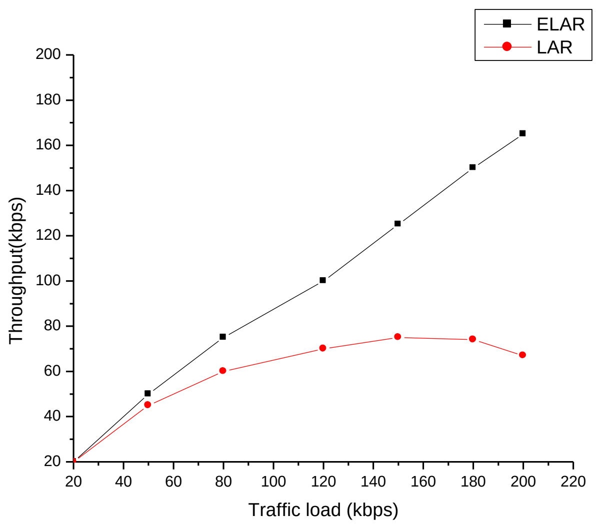

Fig 8: Comparison of throughput

V. CONCLUSION

In this paper we have proposed a modification of the position based LAR protocol. In our proposed algorithm on failure of first phase of route discovery, source node increases request based on mobility of nodes and time out for the second attempt of route discovery. If again failures happen then it repeat same process iteratively for the third attempt of route discovery instead of going to flooding. We have shown that this modification is successful to achieving better performance especially in terms of control overhead, while maintaining the advantages of original LAR in terms of packet delay and loss. After simulating and changing property of intermediate node we found that it has less routing overhead, less delay and better throughput than LAR. it brings to a decrease in control overhead equal to 35% compared to traditional LAR.

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