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Energy Conservation using Location Aided Routing Protocol in MANET

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***Abstract*— In a Mobile Ad hoc Network (MANET), mobile nodes move around arbitrarily, nodes may join and leave the network at any time, and the resulting topology is constantly changing. Routing in a MANET is challenging issue because of the dynamic topology and the lack of fixed infrastructure. Since each mobile node has a limited battery lifetime, energy conservation is essential to prolong network lifetime in MANET. Hence, it is required to invent a new routing algorithm which makes efficient use of battery. The main objective of our paper is to optimize energy consumption in Location Aided Routing (LAR1). LAR1 is selected for enhancement because of higher packet delivery ratio, moderate energy consumption and best suited for mobile and dense network. Proposed protocol named as Energy Aware Location Aided Routing (EALAR1) senses remaining lifetime of node during route discovery and selects the path with maximum lifetime. Node remaining lifetime is the function of residual energy and drain rate of node. EALAR1 also sets the transmission power according to the distance of the next hop. We have analyzed relative performance of EALAR1 and LAR1 for different performance parameter like packet delivery ratio, delay, energy consumption and control overhead under the different network condition using QualNet 5.0 simulator. The proposed EALAR1 enhances network lifetime by reducing energy consumption and improves Packet Delivery Ratio for dense network. EALAR1 also reduces the control overhead compared to LAR1.**

Keywords*— *MANET, Routing, LAR1, GPS.

I. INTRODUCTION

The use of wireless technology has become a ubiquitous method to access the Internet or connect to the local network whether in a corporate, educational, or private setting. It is much easier and inexpensive to deploy a wireless network compared to a traditional wired network, as the required effort and cost of running cables are negligible. When devices equipped with wireless adapters are part of a WLAN and are managed by a wireless access point, their coordination is controlled by a centralized entity. Device must be within the range of a wireless access point to connect to other devices because they communicate via the access point. These types of wireless system depend upon an existing infrastructure and imply limitation on mobility. To overcome these issues, the wireless equipped devices themselves must operate autonomously to provide connection such that a device not directly within transmission range of another device is able to communicate.

A Mobile Ad hoc Network (MANET) is an autonomous system of mobile routers (and associated hosts) connected by wireless links, the union of which form an arbitrary graph. The routers are free to move randomly and organize themselves arbitrarily. Thus, the network's wireless topology may change rapidly and unpredictably. Such a network may operate in a standalone fashion, or may be connected to the larger Internet [1]. In other words, A Mobile Ad hoc Network (MANET) is a collection of mobile terminals that are able to dynamically form a temporary network without any aid from fixed infrastructure or centralized administration. The set of applications for MANETs is diverse, ranging from large-scale, mobile, highly dynamic networks, to small, static networks that are constrained by power sources [2]. MANET applications include communication in battlefields, disaster recovery areas, emergency operations etc.

Deployment of MANET leads to many challenges such as dynamic topology, asymmetric links, limited bandwidth, interference, multi hop routing, and limited battery power [3]. MANET nodes are operated by batteries. Hence, energy conservation becomes a crucial problem. To improve the network lifetime, it is necessary to design energy efficient routing scheme that reduces energy consumption and makes efficient use of battery. There are different adhoc routing schemes like OLSR, DSR, AODV, ZRP and LAR which are not energy aware. Here, we are proposing Energy Aware Location Aided Routing (EALAR1) which senses the remaining lifetime of node and set the transmission power according to the distance of the next node.

The rest of this paper is organized as follows. Section 2 discusses Literature survey of different routing algorithms in MANET. Section 3 demonstrates brief overview of LAR1 protocol. The energy efficient routing schemes are surveyed in Section 4. Section 5 explains proposed work. Section 6 gives the detail description of simulation model and performance metrics used for simulation. Comparative analysis of proposed and original LAR1 protocols using QualNet 5.0 simulator is described in section 7. Finally, we conclude the work in section 8 with Future work in section 9.

II. CLASSIFICATION OF ROUTING PROTOCOL

Routing protocols in MANET can be classified depending on routing strategy and network structure. According to the routing strategy the routing protocols can be categorized as Table-driven and source initiated, while depending on the

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network structure these are classified as flat routing, hierarchical routing and geographic position assisted routing. Both the Table driven and source initiated protocols come under the Flat routing [4].

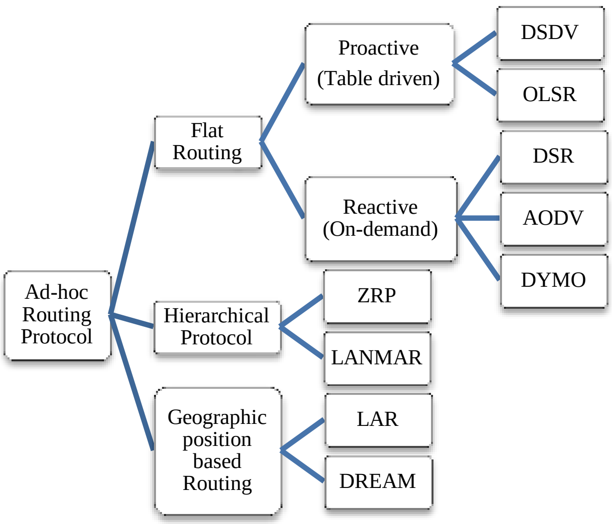

Figure 1. Classification of routing protocols

A. *Proactive Routing Protocols*

Proactive routing protocols attempt to maintain consistent, up-to-date routing information from each node to every other node in the network. Proactive routing protocols maintain information in a table on each node about the routing to the other node in the network. Although the topology of the network does not change, this information must be updated. The two kinds of table updating in proactive protocols are the periodic update and the triggered update. In periodic update, each node periodically broadcasts its table in the network. Each node just arriving in the network receives that table. In triggered update, as soon as a node detects a change in its neighborhood, it broadcasts entries in its routing table that have changed as result. Many proactive routing protocols have been proposed, for e.g. Destination Sequence Distance Vector (DSDV), Optimized Linked State Routing (OLSR) and so on.

B. *Reactive Routing Protocols*

When a node requires a route to a destination, it initiates a route discovery process within the network. This process is completed once a route is found or all possible route permutations have been examined. The route discovery usually occurs by flooding the route request packets throughout the network. Once a route has been established, it is maintained by a route maintenance procedure until either the destination becomes inaccessible along every path from the source or until the route is no longer desired. Several reactive protocols have been proposed such as Dynamic Source Routing protocol (DSR), Ad hoc On-demand Distance Vector (AODV), Temporary Ordered Routing Algorithm (TORA), Dynamic MANET On demand (DYMO) routing protocol etc.

C. *Hybrid Routing Protocols*

When wireless network becomes larger, it is complex to design routing protocols. All nodes in the network are separated into groups, called cluster. All clusters form a hierarchical infrastructure. In such network, hybrid routing protocols, i.e., combining proactive and reactive routing protocols, are used in order to take advantages on these two routing protocols where proactive maintains route in a cluster and reactive maintains route between clusters. Several hybrids routing protocols have been proposed such as Zone Routing Protocol (ZRP) and Cluster gateway source routing protocol (CGSR).

D. *Geographic Position Based Routing Protocols*

Position-based routing protocols make minimum use of the topology information. Hence, they exhibit better scalability compared to topology-based routing protocols. Such protocols use 'localized' algorithms like greedy forwarding in which a node forwards a packet to a next hop that is geographically closest to the destination among its one-hop neighbors. Several Position-based protocols have been proposed such as Location aided Routing (LAR) and Distance Routing effects Algorithm for Mobility (DREAM).

III. LOCATION AIDED ROUTING PROTOCOL

Position-based routing protocols exhibit better performance, scalability and robustness against the dynamic topology of MANET. Position based Location Aided Routing (LAR1) exploits positional information to direct flooding towards the destination in order to reduce overheads and power consumption and improve performance of network [5]. LAR1 is on-demand geographical positioned based routing protocol.

A. *Location Information*

LAR1 protocol makes use of geographical location information of nodes for the restricting flooding to a certain area. Location information is provided by Global Positioning System (GPS) [5]. It is possible to know the physical position of node by using GPS.

B. *Routing Zones*

LAR1 defines two zones such as Expected zone and Request zone. To find the destination, Source node estimates the expected zone of destination according to the velocity of the destination. Source node also sets Request zone where a route request should be forwarded from source.

Expected Zone: Consider a Source node S that needs to find a route to Destination node D. Node S knows that node D was at location P at time t_0 by using GPS, and the current time is t_1. Then, the expected zone of node D at time t_1, is the region that node S expects to contain node D at time t_1. Node S can determine the expected zone based on the knowledge that node D was at location P at time t_0. For instance, if node S knows that node D travels with average speed v, then S may assume that the expected zone is the circular region of radius $v(t_1 - t_0)$, centered at location P. If actual speed happens to be larger than the average, then the destination may actually be outside the expected zone at time t_1. Thus, expected zone is only an estimate made by node S to determine a region that may contain D at time t_1. In general, it is also possible to define v to be the maximum speed instead of the average.

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If source node does not know a previous location of destination node, then source cannot determine the expected zone of destination node. In this case, the entire region occupied by the ad hoc network is assumed to be the expected zone. Hence, our algorithm reduces to the basic flooding algorithm.

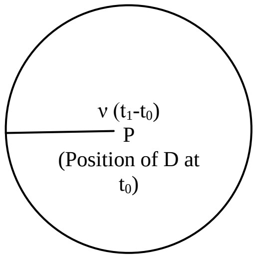

Figure 2. Expected Zone

Request Zone: Source node defines a request zone where a route request should be forwarded from source to destination. An Intermediate node forwards a route request only if it belongs to the request zone otherwise node discards route request. Request zone should comprise expected zone and source node to reach destination. To increase the probability that the route request will reach destination node, the request zone may also include other regions around the request zone. Size of the rectangular request zone is proportional to average speed of nodes and time elapsed since the last known location of the destination was recorded.

C. Working of LAR1

Assume that node S knows that node D was at location (X_d, Y_d) at time t_0. At time t_1, node S initiates a new route discovery for destination D. We assume that node S also knows the average speed v with which D can move. Using this, node S defines the expected zone at time t_1 to be the circle of radius $R = v\,(t_1 - t_0)$ centred at location (X_d, Y_d).

Route Request (RREQ): LAR sets request zone to be the smallest rectangle that includes current location of Source S and the expected zone, such that the sides of the rectangle are parallel to the *X* and *Y* axis. The source node S can determine the four corners of the request zone. When route discovery is initialized, S includes their coordinates with the route request message. An intermediate node discards the route request if the node is not within the rectangle specified by the four corners included in the route request. In fig. 3, if node I receive the route request from another node, node I forwards the request to its neighbors, as node I is within the rectangular request zone. However, when node J receives the route request, node J discards the request, because node J is not within the request zone.

Route Reply (RREP): When node D receives the route request message, it replies by sending a route reply message, which contains current time and current location of node D. When node S receives this route reply message, it records the location of node D. Node S can use this information to determine the request zone for a future route discovery. Note that when source node is within the expected zone than request zone is same as expected zone.

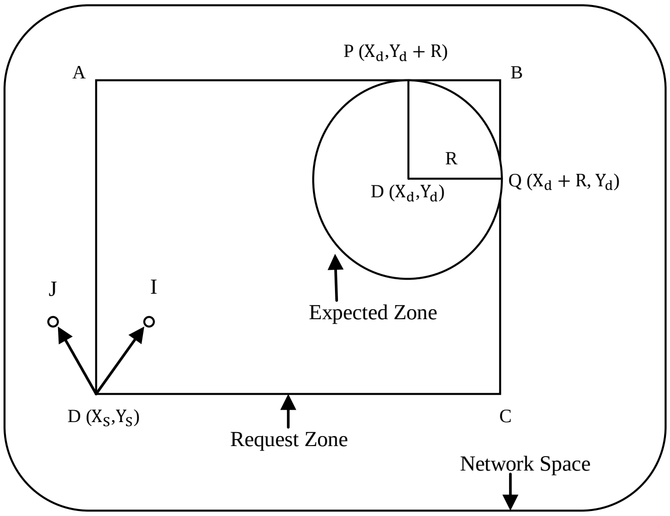

Figure 3. LAR1 scheme

IV. SURVEY OF ENERGY EFFICIENT ROUTING

Several energy-efficient techniques are proposed to reduce energy consumption in MANET. These techniques use energy aware metrics such as residual energy, transmission power, link distance, node remaining lifetime, drain-rate etc. to establish a path in a network.

Nivedita N. Joshi and Radhika D. Joshi have proposed variable range energy efficient location aided routing for MANET [7]. The proposed scheme controls the transmission power of a node according to the distance between the nodes. It also includes energy information on route request packet and selects the energy efficient path to route data packets. They have used energy factor which is the ratio of remaining energy to initial energy of node.

Dahai Du and Huagang Xiong have developed Location aided Energy-Efficient Routing (LEER) protocol for adhoc Networks which finds out the all possible paths from source to destination and selects minimum energy path to route the packets[8].

Morteza Maleki, Karthik Dantu, and Massoud Pedram in [9] have proposed a new power-aware source-initiated (on demand) routing protocol for mobile Ad-hoc networks that increase the network lifetime up to 30%. A greedy policy was applied to fetched paths from the cache for load balancing and also make sure that each selected path has minimum battery cost among all possible path between two nodes. Power-aware Source Routing (PSR) senses both the node mobility and the node energy.

Nen-Chung Wang and Si-Ming Wang have proposed a idea which sets the baseline line between the source node and the destination node, for route discovery [10]. The next hop is then selected based on baseline by broadcasting the request packets in request zone. The neighboring node with the shortest distance to the baseline is chosen as the next hop node. This method reduces control overheads by finding a better routing path than LAR scheme. They have proposed a partial reconstruction process for maintaining broken links of routing path.

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V. PROPOSED WORK

As we know, LAR1 use location information for routing. RREQ packet comprises of source location and destination location information which used to calculate the distance between the nodes and sets transmission power according to distance. We have also added node remaining lifetime in RREQ packet for selection of energy efficient path.

A. Calculation of Node Remaining Lifetime

Mehdi Lotfi, Sam Jabbehdari, and Majid Asadi Shahmirzadi have proposed a new energy efficient routing algorithm based on a new cost function called node remaining lifetime in wireless ad hoc networks [11]. Node remaining lifetime can be calculated by

$$\mathbf{RLT_i} = \frac{\mathbf{RE_i}}{\mathbf{DR_i}} \qquad (1)$$

Where RLT_i is the remaining lifetime, RE_i is the residual energy, and DR_i is the drain rate of node i and indicates how much the average energy is consumed by a node per second during the interval.

$$\mathbf{DR_i} = \frac{\mathbf{CE_i}}{\mathbf{t_i - t_0}} \qquad (2)$$

Energy consumed (CE_i) by node is the difference between initial energy (IE_i) and remaining energy of node. t_i and t_0 indicates current and initial time respectively.

$$\mathbf{CE_i} = \mathbf{IE_i} - \mathbf{RE_i} \qquad (3)$$

From (2) and (3), we can derive drain rate in terms of initial energy and remaining energy

$$\mathbf{DR_i} = \frac{\mathbf{IE_i - RE_i}}{\mathbf{t_i - t_0}} \qquad (4)$$

From (1), (3) and (4) we can define node remaining lifetime in terms of initial energy and remaining energy

$$\mathbf{RLT_i} = \frac{\mathbf{RE_i(t_i - t_0)}}{\mathbf{IE_i - RE_i}} \qquad (5)$$

If the node remaining lifetime is sufficient time to send data packets, which are supposed to send from source to destination, it broadcasts Route Request packet, otherwise it will drop it.

B. Algorithm for EALAR1

1. A source node S gets the location information, estimates the velocity of destination node and decides the expected and request zones accordingly.
2. Source node S floods RREQ packets containing the coordinates of request zone and location information of S in the request zone.
3. When the intermediate node receives RREQ packets, it checks whether it is in request zone or not.
4. If intermediate node belongs to request zone then,
   i. It calculates average node life-time of the each node in the request zone.
   ii. Intermediate node within the request zone is selected if the obtained average node life-time is above threshold value otherwise node will not be selected as next hop node to forward the RREQ packets.
   iii. After the selection of next hop node, node calculates its distance from previous node. If an intermediate node I receives a RREQ packet from a node located at J, then Euclidian distance between them is calculated
   iv. According to the distance transmission power is set at the physical layer of node J.
5. If intermediate node is not in request zone then it simply discards the RREQ packet.
6. When destination node receives the RREQ packet, it replies with RREP packet containing its location as well as velocity at current time instance and forwards it to source node S.

VI. SIMULATION MODEL AND PERFORMANCE METRICS

We have used QualNet 5.0 [12] simulator for comparative analysis of LAR1 and EALAR1. This simulator provides a comprehensive environment for designing protocols, creating and animating network scenarios, and analyzing their performance. It is extremely scalable and makes good use of computational resources and models large-scale networks with heavy traffic and mobility, in reasonable simulation times.

A. Simulation Models

There are different types of simulation models such as traffic model, mobility model, battery model and energy model described below.

Traffic Models: Constant Bit Rate (CBR) sources represent voice sources and ftp sources are the ones used for file transfer applications. We focus on Constant Bit Rate (CBR).The packet size is limited to 512 bytes.

Mobility Model: We have used random way point mobility model where nodes in network moves randomly in any direction with given speed. In this model, Node stays in one location for a certain period of time (i.e., a pause time). Once this time expires, the Node chooses a random destination as well as a speed that is uniformly distributed between [0, MAXSPEED]. It then travels towards the newly chosen destination at the selected speed. Upon arrival, the Node takes another break before starting the process again [13].

Battery Model: Nodes are battery operated in the mobile ad-hoc network. Hence, battery models are useful tools for such types of system design approach, because they enable analysis of charging and discharging behavior of the battery under different circumstances. Linear battery model is used for experimentation.

Energy Model: The User-defined energy model is a configurable model that allows the user to specify the energy consumption parameters of the radio in different power modes. The power required for transmission, reception, idle (node is listening the medium) and sleep modes is given in Table.

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TABLE I. POWER REQUIREMENT FOR DIFFERENT MODES

Parameter	Value
Transmission current load (mA)	280
Reception Load (mA)	204
Idle current load (mA)	178
Sleep current load (mA)	14
Supply voltage of interface (v)	3

B. Performance Metrics

End-to-end Delay: The average time interval between the generation of a packet in a source node and the successfully delivery of the packet at the destination node [14]. For the better performance of the network delay should be minimum.

Packet Delivery Ratio/ Packet Delivery Fraction: It is the ratio of total number of data packets received successfully at destination to number of data packets generated at the source [15]. PDR lies between 0 to 1.

Energy consumption: Energy consumed by all nodes in the network. Energy consumption should be as low as possible so as to prolong the network lifetime.

Control overheads (Routing overheads): The total number of routing packets transmitted for each delivered data packet. The routing load metric evaluates the efficiency of the routing protocol.

VII. SIMULATION RESULTS AND ANALYSIS

A. Impact of Node Density

In this simulation, we have varied number of mobile nodes to analyze the behavior of LAR1 and EALAR1 protocols. Simulation parameters are given in table 2.

TABLE II. SIMULATION PARAMETER FOR IMPACT OF NODE DENSITY

Parameters	Values
Number of nodes	50,75,100,125,150
Field size (m)	1000x1000
Simulation duration (s)	300
Mobility Model	Random Way Point
Pause time (s)	30
Speed (m/s)	10
Mac Layer	IEEE 802.11
Traffic	CBR
Packet Size (bytes)	512

PDR: Fig. 4 demonstrates impact of varying number of nodes on Packet Delivery Ratio. Here, variation of number of nodes does not have significant impact on PDR for LAR1 and EALAR1. Value of PDR for LAR1 and EALAR1 is 0.97 and 0.99 respectively.

Average end to end delay: Fig. 5 illustrates average end to end delay by varying number of nodes. It can be analyzed that characteristics of Jitter and Average end to end delay are almost same. Our simulation results show that LAR1 is the best scheme in terms of delay because EALAR1 may eliminate the nodes from the shortest path if nodes don't have enough remaining lifetime.

Energy consumed in transmit mode: Fig. 6 depicts energy consumed in transmit mode as a function of number of nodes. We can observe that energy consumption decreases monotonically as node density increases. EALAR1 overrides with lowest energy consumption in transmit mode compared to LAR1.

Control overhead: Fig. 7 shows control overhead as a function of number of nodes. EALAR1 definitely predominates with 20% lower control overhead as compared to LAR1.

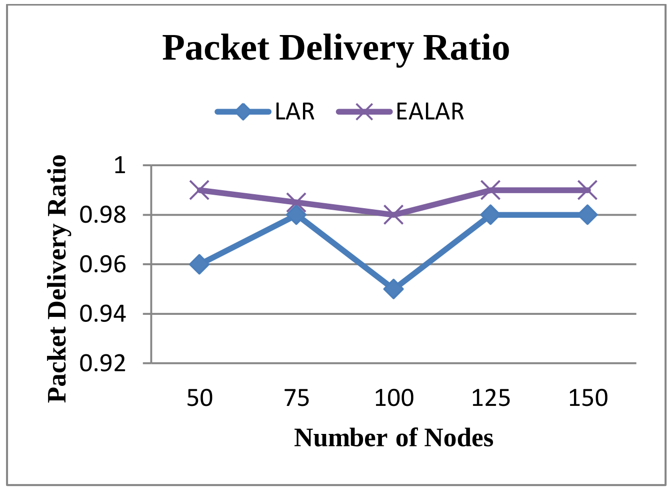

Figure 4. PDR vs. Number of Nodes

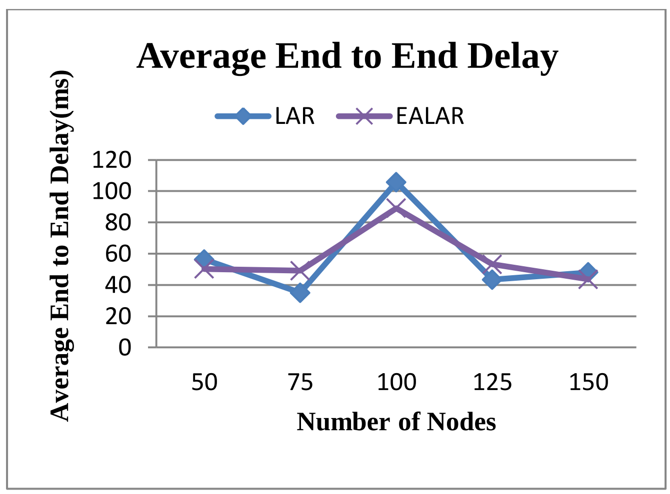

Figure 5. Average End to End Delay vs. Number of Nodes

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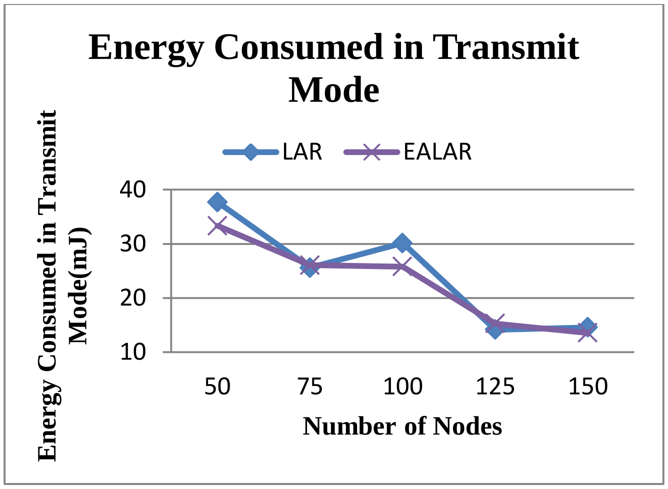

Figure 6. Energy Consumption vs. Number of Nodes

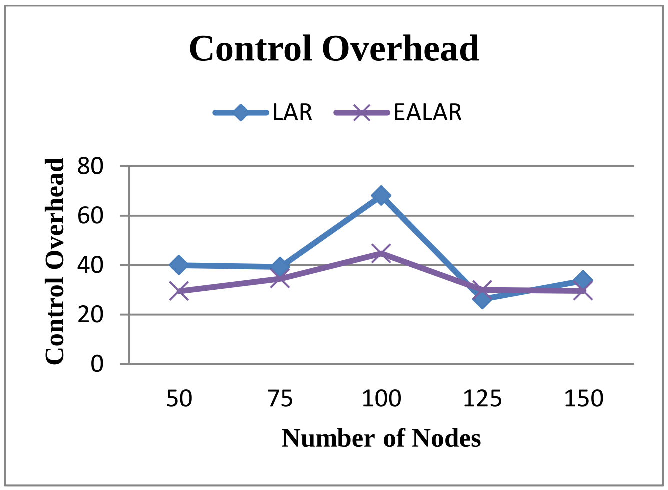

Figure 7. Control Overhead vs. Number of Nodes

B. Impact of Pause-time

In this section we are going to observe the effects of variation of pause time on performance parameters. Mobility model used is Random Waypoint mobility model. Hence, it is very important to study the effects of pause time on different parameters.

TABLE III. SIMULATION PARAMETER FOR IMPACT OF PAUSE-TIME

Parameters	Values
Number of nodes	50
Field size (m)	1000x1000
Simulation duration (s)	300
Mobility Model	Random Way Point
Pause time (s)	0,20,40,60,80,100
Speed (m/s)	10
Mac Layer	IEEE 802.11
Traffic	CBR
Packet Size (bytes)	512

PDR: Fig. 8 demonstrates impact of varying pause-time on Packet Delivery Ratio. We can observe that PDR has slight variation with increasing pause-time. LAR1 can deliver 98% packets successfully and EALAR1 having ability to deliver 99% packet.

Average end to end delay: Fig. 9 illustrates average end to end delay by varying pause-time. As we know that EALAR1 select the path with maximum lifetime, again LAR1 definitely dominates with lowest delay as compared to EALAR1.

Energy consumed in transmit mode: Fig. 10 depicts energy consumed in transmit mode as a function of pause-time. We can observe that energy consumption increases monotonically as pause-time increases. Again EALAR1 prevails over LAR1 protocols, by consuming lower energy.

Control overhead: Fig. 11 shows control overhead as a function of pause-time. EALAR1 definitely predominates with 25% lower control overhead as compared to LAR1. However, EALAR1 gets more control overhead than LAR1 when pause-time is greater than 80 seconds.

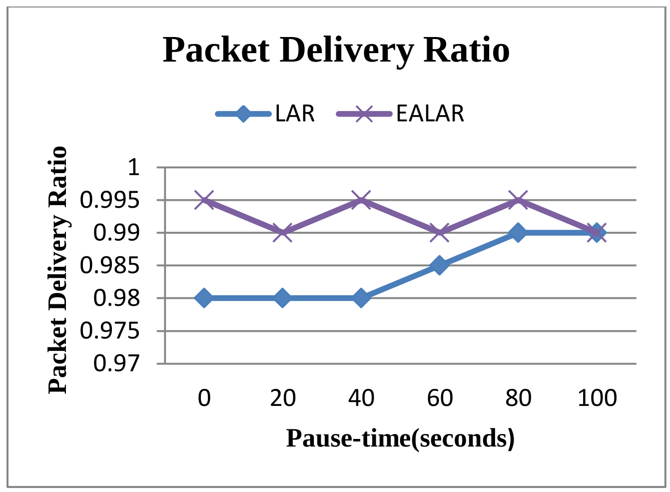

Figure 8. PDR vs. Pause-time

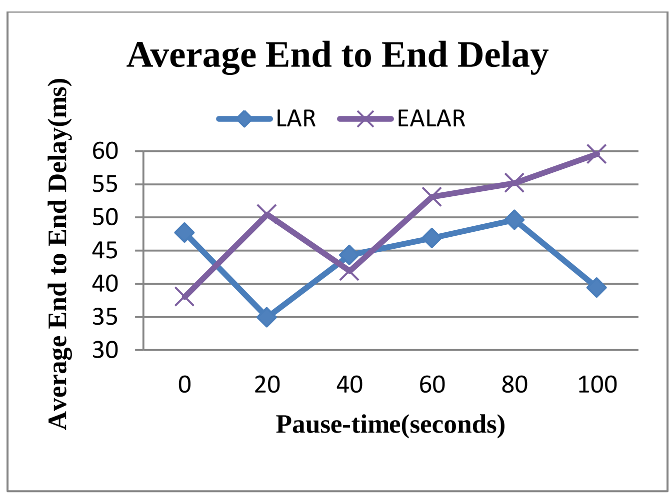

Figure 9. Average End to End Delay vs. Pause-time

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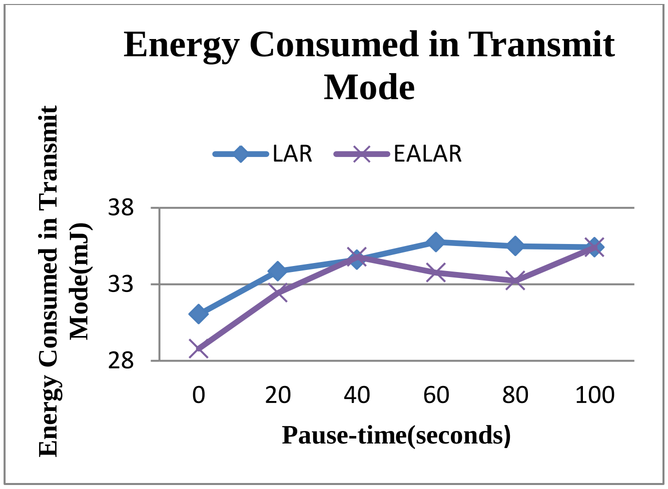

Figure 10. Energy Consumption vs. Pause-time

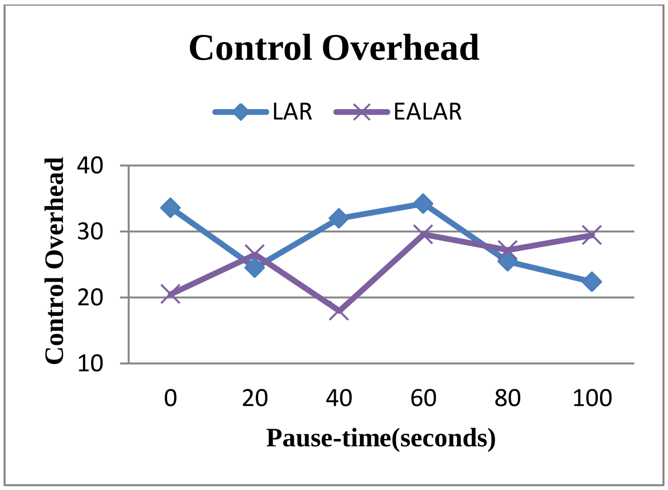

Figure 11. Control Overhead vs. Pause-time

C. Impact of Node Mobility

MANET's are having dynamic topology. Hence, the evaluation of performance parameters for various node speeds is necessary. Some parameters related to this model are given in table 4.

TABLE IV. SIMULATION PARAMETER FOR IMPACT OF NODE MOBILITY

Parameters	Values
Number of nodes	50
Field size (m)	1000x1000
Simulation duration (s)	300
Mobility Model	Random Way Point
Pause time (s)	30
Speed (m/s)	5,10,15,20,25
Mac Layer	IEEE 802.11
Traffic	CBR
Packet Size (bytes)	512

PDR: Fig. 12 demonstrates impact of varying speed on Packet Delivery Ratio. We can observe that PDR has slight variation with increasing speed. Here, EALAR1 comes up as best performer over LAR1 with 0.99 packet delivery fraction.

Average end to end delay: Fig. 13 illustrates average end to end delay by varying node mobility. We have analyzed that delay increases monotonically as node speed increases. EALAR1 prevails over LAR1 with lower delay.

Energy consumed in transmit mode: Fig. 14 shows Energy consumed in transmit mode as a function of node velocity. We can observe that energy consumption increases monotonically as node speed increases. EALAR1 overrides with lowest energy consumption in transmit mode compared to LAR1 protocols.

Control overhead: Fig. 15 demonstrates control overhead as a function of node velocity. EALAR1 definitely predominates with 25% lower control overhead as compared to LAR1.

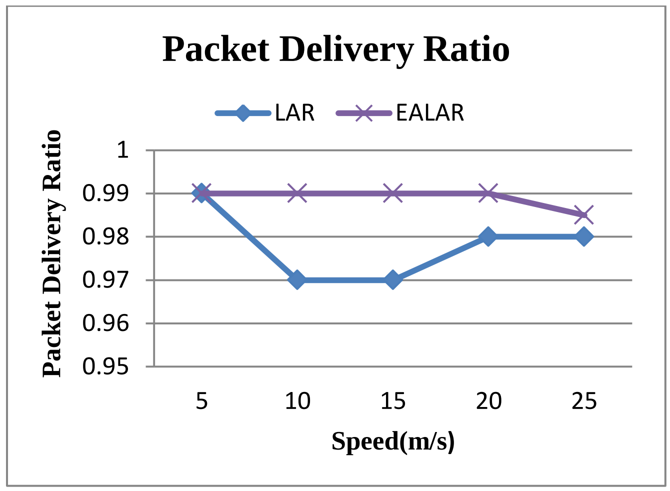

Figure 12. PDR vs. Speed

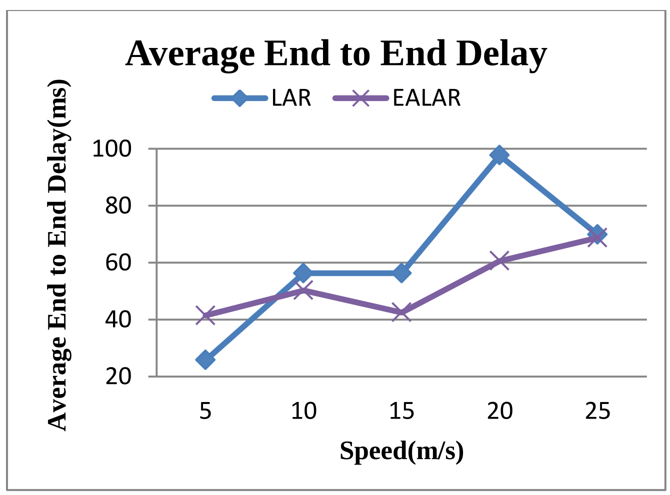

Figure 13. Average End to End Delay vs. Speed

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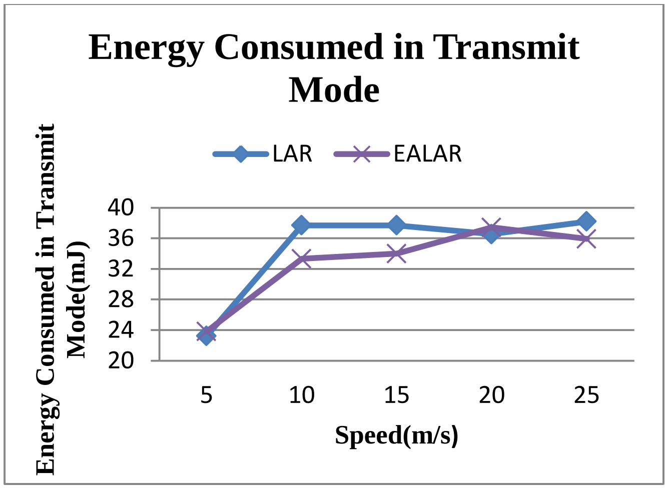

Figure 14. Energy Consumption vs. Speed

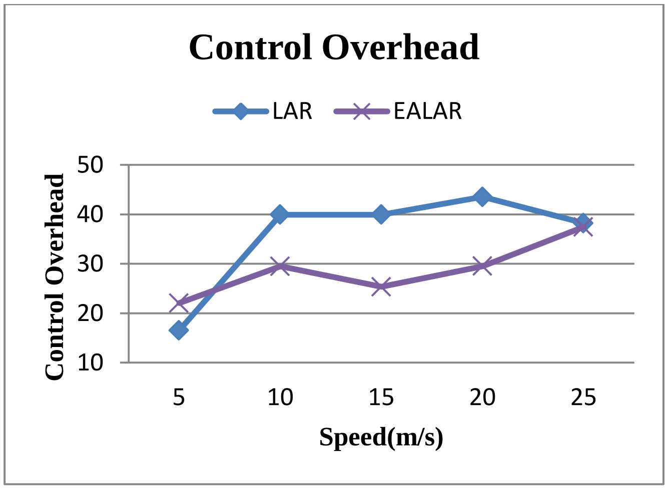

Figure 15. Control Overhead vs. Speed

VIII. CONCLUSION

The work demonstrates relative performance of LAR1 and EALAR1 for different network parameters like node density, pause-time and different node speeds using QualNet 5.0 simulator. We have examined different performance parameters such as PDR, average end to end delay, energy consumed in transmit mode and control overhead for EALAR1 and LAR1. Our simulation results show that EALAR1 having slightly higher delay in comparison of LAR1 under the distinct network condition because of selection of path with maximum lifetime. It is observed that EALAR1 predominates with lower energy consumption, lower control overhead and slightly higher PDR compare to LAR1 for highly mobile dense network. EALAR1 reduces energy consumption by 15 to 20% relative to LAR1 by varying node density, pause-time and node mobility. Hence, EALAR1 enhance the network lifetime.

IX. FUTURE WORK

The work can be extended to analyze the performance of EALAR1 by varying packet rate and simulation area for same performance metrics used in paper as well as throughput and jitter.

REFERENCES

[1] F. Baker, "An outsider's view of MANET", Internet-Draft, March 17, 2002.

[2] Jun-Zhao Sun, "Mobile Ad Hoc Networking: An Essential Technology for Pervasive Computing", International Conference on Info-tech and Info-net, vol. 3, pp. 316-321, 2001.

[3] Krishna Gorantala, "Routing Protocols in Mobile Ad-hoc Networks", Master Thesis in Computer Science, pp. 1-36, June 2006.

[4] Geetha Jayakumar, and G. Gopinath, "Ad Hoc Mobile Wireless Networks Routing Protocols – A Review", Journal of Computer Science 3 (8), pp. 574-582, 2007.

[5] Young-Bae Ko and Nitin H. Vaidya "Location-Aided Routing (LAR) in mobile ad hoc networks" Computer Engineering Department, North Tehran Branch, Islamic Azad University, Tehran, Iran

[6] G. Dommety & R. Jain, "Potential networking applications of global positioning systems (GPS)", Tech. Rep. TR-24, CS Dep., The Ohio State University, 1996.

[7] Nivedita N. Joshi and Radhika D. Joshi, " Variable Range Energy Efficient Location Aided Routing for MANET" CCSEA, pp. 321–333, 2011.

[8] Dahai Du & Huagang Xiong, "A Location aided Energy-Efficient Routing Protocol for Ad hoc Networks", 19th Annual Wireless and Optical Communications Conference (WOCC), pp1-5, 2010.

[9] Morteza Maleki, Karthik Dantu & Massoud Pedram, "Power-aware Source Routing Protocol for Mobile Ad Hoc Networks", Iternational Symposium on Low Power Electronics and Design (ISLPED), pp72-75, 2002.

[10] Nen-Chung Wang & Si-Ming Wang, "An Efficient Location-Aided Routing Protocol for Mobile Ad Hoc Networks", 11th International Conference on Parallel and Distributed Systems (ICPADS'05), Vol. 1, pp335-341, 2005.

[11] Mehdi Lotfi, Sam Jabbehdari, and Majid Asadi Shahmirzadi, "New Energy Efficient Routing Algorithm Based On A New Cost Function in wireless adhoc network"

[12] www.scalablenetworks.com

[13] Mohd Izuan Mohd Saad, Zuriati Ahmad Zukarnain "Performance Analysis of Random-Based Mobility Models in MANET Routing Protocol", Euro Journals Publishing 2009

[14] M.uma and Dr.G.Padmavathi, "A comparative study and performance Evaluation of reactive quality of service Routing protocols in mobile adhoc networks", JATIT 2005 – 2009

[15] Dr. S. Karthik, S. Kannan, Dr. M.L. Valarmathi, Dr. V.P. Arunachalam, and Dr. T. Ravichandran, "An performance Analysis and Comparison of multi-hop Wireless Ad-hoc Network Routing protocols in MANET", International Journal of Academic Research, vol. 2, no. 4, pp. 119-124, July 2010.

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