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AN EFFECTIVE LOCALIZATION BASED OPTIMIZED ENERGY ROUTING FOR MANET

[1]K.VINOTH KUMAR, [2] DR.S.BHAVANI
[1] Research Scholar, Karpagam University, Coimbatore, India
[2] Professor, Department of Electronics and Communication Engineering, Karpagam University, Coimbatore, India.
E-mail: vinodhkumaran87@gmail.com

ABSTRACT

Localization is one of key issues in MANET. It provides information about coverage, deployment, routing, location service, target tracking and rescue. If high mobility among the Mobile nodes occurs, path failure breaks. Hence the location information cannot be predicted. Here, we have proposed an Localization based Optimized Energy Routing (ELOER) based on cluster and energy consumption model to provide location information of nodes based on Trilateration method. Proposed approach consists of three phases. In first phase, Cluster head is chosen based on energy level. In second phase, location aided routing is chosen to alleviate computation cost and save Mobile nodes energy. In third phase, localization method is developed to improve accuracy and reduce node degree. To locate the target and Mobile Nodes Discrete Fourier Transform and distributed algorithm was used. By simulation results, the proposed approach ELOER achieves high location updated rate, improved network lifetime, less end to end delay and overhead in terms of mobility, pause time, throughput, and number of nodes than existing protocol ALARM.

Keywords: *MANET, Multipath Routing, Localization, Mobile Nodes Chosen Method, Network Lifetime, End To End Delay, Overhead, Throughput And Location Update Rate.*

1. INTRODUCTION

Localization is one of key supporting technologies to Mobile Ad hoc Networks. It could provide accurate position information for kinds of expanding application. Due to the availability of such low energy cost mobile nodes, microprocessor, and radio frequency circuitry for information transmission, there is a wide and rapid diffusion of MANET [1]. It consists of thousands of low-cost mobile nodes have been used in many promising applications such as health surveillance, battle field surveillance, and environmental monitoring. Localization is one of the most important subjects because the location information is typically useful for coverage, deployment, routing, location service, target tracking, and rescue. Hence, location estimation is a significant technical challenge for the researchers.

Location discovery is emerging as one of the more important tasks as accurate location information could greatly improve the performance of tasks such as routing, energy conservation, data aggregation and maintaining network security. Localization in wireless Mobile Nodes networks is performed following these steps:

1. Distance estimation- This phase involves measurement techniques to estimate the relative distance between nodes.
2. Position computation- It consists of algorithms to calculate the coordinates of the unknown node with respect to the location of known anchor nodes or other neighboring nodes.

Localization algorithms require techniques for location estimating depending on the beacon nodes' location. These are called multi-lateration (ML) techniques.

Iterative ML : Some nodes may not be in the direct range of three beacons. Once a node estimates its location, it sends out a beacon, which enables some other nodes to now receive atleast three beacons. Iteratively, all nodes in the network can estimate their location but location estimation may not be accurate as errors may propagate.

Collaborative ML : When two or more nodes cannot receive atleast three beacons each, they collaborate with each other. In the figure shown below nodes A and B have three neighbors each. Of the six participating nodes, four are beacons, whose positions are known.

Proximity technique is used when there is no range information available. It reveals whether or not a node is in range or near to a reference point.

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Localization algorithms using this technique determine if a node is in proximity to a reference point by enabling the reference to transmit periodic beacon signals and whether the node is able to receive at least certain value of the beacon signals set as threshold. In a period *t* if it receives *n* beacons greater than the set threshold then it is in proximity to that reference point.

2.Localization algorithms - It determines how the information concerning distances and positions, is manipulated in order to allow most or all nodes of WSN to estimate their position. Optimally the localization algorithms may involve algorithms to reduce the errors.

1.1. Design goals of MANET

Based on the application, different architecture, goals and constraints have been considered for MANETs. The design goals are given below.

a) *Unattended operation* – Mobile networks can be deployed in unattended environments, therefore there is a risk of physical attacks on the Mobile nodes. Also, the sink might not be present at all times. The Mobile network has to continue its operation in the presence of compromised and/or destroyed nodes and when the sink is not present.
b) *Resource limitation* – The nodes have limited memory which has to be considered both when collecting data and when developing software and security solutions, e.g., keying material might require a lot of storage for a long period of time.
c) *Computational power* – Mobile nodes usually have limited computational power which limits the choice of security mechanisms.
d) *Power consumption* – As Mobile nodes are battery driven, all applications running on nodes should try to limit their energy consumption as much as possible. One of the most energy consuming tasks is transmitting and receiving messages. The protocols/applications used should not only minimize the power consumption of individual nodes, it should also try to minimize the power consumption in the entire network. Many security protocols, especially the ones using public key cryptography, require long messages, and has therefore high power consumption.
e) *Wireless medium* – All communication in a Mobile Nodes network is wireless. The wireless medium is prone to interference, resulting in unreliable communication, and it is also easy to eavesdrop on. The eavesdropping is further made easy by the fact that a Mobile Nodes network is usually deployed in an unattended environment. It is also quite easy to insert messages on the wireless channel.
f) *Reliability* – Due to the nature of the cheap hardware, node failure is a concern. Redundancy is a good solution for dealing with cheap and unreliable hardware. A security protocol should therefore not count on all nodes being able to reply at all times and be able to use the redundancy in the system.
g) *Multi-hop communications* – The risk for messages to be modified or dropped increases with the number of hops the message must travel.

2. RELATED WORK

Karim El Defrawy et.al [2] proposed the anonymous reactive routing protocol in suspicious location-based MANETs. It relies on group signatures to authenticate nodes, ensure integrity of routing messages while preventing node tracking. It works with any group signature scheme and any location-based forwarding mechanism. The routing overhead was evaluated which shows the performance of anonymous link state based approaches under certain traffic patterns.

Jubin Sebastin et.al [3] introduced a Location Based Opportunistic Routing Protocol (LOR) to addresses the problem of delivering data packets for highly dynamic mobile ad hoc networks in a reliable and timely manner. It takes advantage of the stateless property of geographic routing and the broadcast nature of wireless medium. When a data packet is sent out, some of the neighbor nodes that have overheard the transmission will serve as forwarding candidates, and take turn to forward the packet if it is not relayed by the specific best forwarder within a certain period of time. By utilizing such in-the-air backup, communication is maintained without being interrupted.

Wen Hwa et.al [4] proposed a new routing protocol called GRID, which tries to exploit location information in route discovery, packet relay, and route maintenance. Existing protocols, as compared to this, are either not location-aware or partially location-aware in that location knowledge is not fully exploited in all these three aspects. The strong route maintenance capability is handled and the

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intermediate hosts of a route performed a "handoff" operation similar to that in cellular systems when it roams away to keep a route alive.

Durgesh Pyatil and Rekha [5] explored a method to offer high anonymity protection at a low cost, is Anonymous Location-based Efficient Routing protocol (ALERT). It dynamically partitioned the network field into zones and randomly chooses nodes in zones as intermediate relay nodes, which form a non-traceable anonymous route. ALERT provides high level security to sources, routes and destinations.

Sastry and Supraja [6] developed the algorithm is to derive bandwidth-efficient, long-lived routes using location information to improve the performance of routing protocols for mobile ad- hoc networks. The route to the destination is selected based on nodes having associativity states that imply periods of stability. Period of stability is an interval in which a node is constantly associated with certain neighbours over time without losing connectivity with it.

Helensupriya et.al [7] provided a secure communication by hiding the node identities and preventing the traffic analysis attacks from outside observers in order to provide a mysterious protection. It dynamically partition the network into subzones till the sender and receiver are in different zones and the nodes in the zones are connected as intermediate relay nodes. It uses random relay node selection is difficult for intruder detection and dynamically generating an unpredictable routing path for a message. It maintains a time limit for message transmission due to security and control the time delay.

Dipankar deb et.al [8] proposed an algorithm which is location aided and also energy efficient. This approach was applicable in GPS scarce network. The major contribution of the work was in proposing a new location aided routing methodology that is energy efficient too. The positioning framework that this new protocol uses was suitable for GPS scarce environment.

Komma Reddy et.al [9] proposed a novel MANET routing protocol which takes advantage of the stateless property of geographic routing and broadcast nature of wireless medium. Besides selecting the next hop, several forwarding candidates are also explicitly specified in case of link break. Leveraging on such natural backup in the air, broken route can be recovered in a timely manner .The efficacy of the involvement of forwarding candidates against node mobility, as well as the overhead due to opportunistic forwarding.

Sourabh Pandey et.al [10] proposed a new location based energy efficient scheme based on DREAM algorithm. Nodes in network are not intimated about their energy status, for that remove the suddenly link breakage. If the nodes in network are know about the energy status and also about the status of location of receiver that reduces the energy consumption. If the node was a part of communication then in that case no link is break but if not then break. The main aim of proposed scheme was to enhance the energy utilization in network.

Indu Kashyap [11] explored a node-disjoint location based multi-path routing protocol for mobile ad hoc networks to reduce the number of broadcast multi-path route discoveries and the average hop count per path from the source to the destination. During route discovery process, the intermediate nodes include their location information along with the distance in the Route-Request (MP-RREQ) packet. The destination node selects a set of node disjoint paths from the MP-RREQ packet received and sends a Route-Reply (MP-RREP) packet on each of the node-disjoint paths.

Swades De et.al [12] presented that a meshed multipath routing (M-MPR) scheme, which allows some intermediate nodes to have more than one forwarding direction to a given destination. In addition, it was proposed that selective forwarding of packets (SF) where the forwarding decision is taken dynamically, hop-by-hop, based on the conditions of downstream forwarding nodes. End to end FEC coding is also used to avoid acknowledgment based retransmission. A new mesh-based multipath searching scheme is proposed which requires a lower control overhead and a smaller nodal database than tree-based and sequential searching approaches.

Karim El Defrawy et.al [13] addressed some interesting issues arising in such MANETs by designing an anonymous routing framework (ALARM). It uses node's current locations to construct a secure MANET map. Based on the current map, each node can decide which other nodes it wants to communicate with. ALARM takes

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advantage of some advanced cryptographic primitives to achieve node authentication, data integrity, anonymity and untraceability. It also offers resistance to certain insider attacks.

Suri et.al [14] proposed the power aware routing which helps in decreasing the routing overhead by utilizing the concept of global location information of mobile nodes. This protocol Location Based Power Aware Routing (LBPAR) protocols use location information to minimize the Request Zone to reach the destination node. LBPAR will also help in reducing the overheads at each node by decreasing the number of calculations performed at each node, which in turn increased the battery life of node.

Namrata et.al [15] proposed the routing scheme based on Location Aided Routing schemes to improve routing facilities along with some enhanced signature schemes to provide privacy and security of data. All nodes acquire public and private keys base on the Group signature scheme from the group Manager. When a node decides to communicate, it first locates the destinations coordinates, using Location Aided Routing scheme it will calculate the approximate Radius and the flood angle of the destination node. The source then creates a Route request message (RREQ), and broad casts it in the calculated direction only.

Haiying Shen and Lianyu Zhao [16] proposed an Anonymous Location-based Efficient Routing proTocol (ALERT) to offer high anonymity protection at a low cost. It dynamically partitions the network field into zones and randomly chooses nodes in zones as intermediate relay nodes, which form a nontraceable anonymous route. In addition, it hides the data initiator/receiver among many initiators/receivers to strengthen source and destination anonymity protection. Thus, ALERT offered anonymity protection to sources, destinations, and routes. It also had strategies to effectively counter intersection and timing attacks.

The paper is organized as follows. The Section 1 describes introduction about MANETs, localization algorithms and design goals of MANET. Section 2 deals with the previous work which is related to the location protocols. Section 3 is devoted for the implementation of proposed scheme. Section 4 describes the performance analysis and the last section concludes the work.

3. IMPLEMENTATION OF PROPOSED SCHEME

In the proposed scheme, multipath route is deployed to improve the load balancing and network lifetime. The Mobile Nodes choosing approach is proposed to provide less performance loss and high energy saving against the more battery consumption. Localization scheme is proposed to locate target node and unknown Mobile nodes based discrete fourier transform and distributed algorithm.

3.1 Cluster Head Election Phase

In this approach, the whole Mobile Nodes field is divided into many smaller regions and a coarse target position is used to select regions in which mobile nodes need to report their decisions to the Cluster Head (CH). Therefore, this method can greatly save Mobile Nodes energy. The energy a Mobile Nodes uses can be divided into three main categories. The first category E_1 is the energy a Mobile Nodes uses to measure the signal from the target. The second category E_2 is the energy a Mobile Nodes uses to maintain essential functions, such as receiving information from the fusion center and keeping itself awake. The third category E_3 is the energy a Mobile Nodes uses to send the decisions to the CH.

A Mobile Nodes election phase can reduce energy consumption by choosing mobile nodes containing more useful information and allowing those nodes to send the decisions to the Cluster Head (CH) while nodes containing less useful information are not allowed to send decisions to the cluster head., nodes are selected based on target information from all nodes. The computation cost of this selection method may be prohibitive if the total number of nodes is large. The computation cost can also be alleviated based on Mobile Node selection phase.

The steps of proposed approach are as follows:

(1) Partition the whole Mobile Nodes network into different regions. Place M_0 number of anchor Mobile Nodes in grid points.

(2) Use anchor Mobile Nodes and the weighted average method to estimate a common target position.

(3) Use the coarse target position to choose all nodes in the region where the estimated target is located.

(4) If the target falls into region M_1, nodes in the remaining neighboring region will be chosen.

(5) Selected nodes will report decisions to the cluster head. nodes not in selected regions will not report decisions.

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3.2 Location based Energy Routing

The set of Mobile Nodes has been deployed to implement the localization of Mobile Node. In this network, anchor Mobile Nodes need to propagate the whole network for localizing the Mobile Nodes. Hence more number of anchor nodes is required for localization of Mobile Nodes. To minimize number of anchor nodes involved in the localization of network new technique Trilateration has been implemented which aims to localize more number of Mobile Nodes using with greedy technique. An acoustic signal from a target decays as distance from the target to the measurement location increases. The relation can be determined by,

$$a_k^2 = \frac{G_p P_l^{'}}{(d_k / d_l)^m} \qquad (1)$$

$P_l^{'}$ is the power emitted by the target measured at a reference distance d_l, a_k is the signal amplitude from the target measured at the k[th] nodes, G_p is the gain of the p[th] nodes, which is determined by the Mobile Nodes antenna, and m is the power decay exponent. The Euclidean distance between the target and the k[th] Mobile Nodes is

$$d_k = \sqrt{(x_k - x_t)^2 + (y_k - y_t)^2} \qquad (2)$$

where (x_k, y_k) and (x_t, y_t) are the positions of Mobile nodes and the target. Here, every mobile node has equal gain and $d_k = 1$.

It is assumed that M targets are placed in a field, each generating a decaying signal such as heat, sound, etc. Throughout this work, It is assumed that an exponential signature model for the targets, however, the proposed methods are not limited to exponential signature only and other signal models can be accommodated. At time *t*, the measurement observed by the Mobile Nodes *i* at location z_i is given by

$$u_l(t) = \sum_{m=1}^{M} A_M(t) e^{-\ _M |z_l - c_m(t)|} \qquad (3)$$

where $c_m(t)$ is the coordinate, $A_M(t)$ is the strength, and m is the decay rate of the m-th target, respectively. The process evolves over time as the targets move along unknown trajectories.

Assuming that targets are located exactly on grid points, we

can replace the IDFT basis Ψ that is used in ELOER, as given by Equation (3), with the following basis based on exponential signatures,

$$\cdot = \begin{bmatrix} 1 & e^{-p|z_1-z_2|}.... & e^{-p|z_1-z_N|} \\ e^{-p|z_2-z_1|} & 1...... & e^{-p|z_2-z_N|} \\ e^{-p|z_N-z_1|} & e^{-p|z_N-z_2|}..... & 1 \end{bmatrix} \qquad (4)$$

This can be generalized with this setup to the case in which the targets are not exactly located on grid points, i.e. the nodes are located on a *P x Q* grid, while the targets can be located on a $J_1 \times J_2$ grid, where $J_1 \times J_2 = J$ and $J \geq N$.

Every unknown Mobile node in the network will execute a distributed algorithm as follows:

Step 1: The unknown node initializes its position estimate to the entire space.

Step 2: The node then waits to receive beacon packet from its neighboring nodes, and upon receiving a beacon packet, updates its position estimate by computing the constraint and intersects it with the current estimate to obtain the new estimate.

Step 3: If the position estimate improves, it will wait for a specific period of time and will broadcast its new estimate to all of its neighbors.

Step 4 : Every node receives a beacon packet either directly from a beacon or from another unknown node. Each such packet contains a location estimate field of the node originating the packet

Step 5: The finer the grid, the greater the memory required to store the estimates. There is a clear trade off between the precision of the position estimate and the storage requirement. Wireless Mobile Nodes usually have limited memory resources, and the grid representation would consume most of those resources.

Step 6: When a beacon sends a beacon packet, all of its neighbors may update their position estimates; and, in return, each sends a beacon packet, which will reach the neighbor's and will keep multiplying. In reality, fewer numbers of beacon messages propagate in the network and, hence, maintain the locality of the algorithm.

3.3 Energy Consumption Model

The energy model of proposed algorithm is given below. In this model energy consumption for transmitting M bit is equal to:

E_{tr} (M, d) = E_{elec} x M + ₵ $_{amp}$ x M x d^2 - E_{wast} (P_{drop})

M = bit contain some information like current energy level of the node, data label, node's location and hop count.

E_{elec} = Energy to be Transmitted and Received electronic device module (75 nJ/bit).

₵ $_{amp}$ = Transmitter Amplifier (150 pJ/bit/m^2)

d = distance between the two nodes.

E_{wast} (P_{drop}) = Energy wasted on packet dropping.

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And the energy for receiving K bit is equal to:
$E_{rr} = E_{elec} \times M$

3.4 Proposed packet format

Source ID	Destination ID	Location update status	Location estimate	Energy Conservation Rate	CRC
2	2	4	4	4	2

Fig.1.Proposed Packet format

In fig.1, the proposed packet format is shown. Here the source and destination node ID carries 2 bytes. Third one is location update status of the node. The location update status induces the whether the Mobile Nodes are located with anchor nodes. It occupies 4 bytes. In fourth field, the location estimate is indicated to maintain memory requirement of unknown mobile nodes which occupies 4 bytes. In fifth, the energy conservation ratio is allotted to ensure minimum energy consumption that occupies 4 bytes. The last filed CRC i.e. Cyclic Redundancy Check which is for error correction and detection in packet while route maintenance process that occupies 2 bytes.

4 PERFORMANCE ANALYSIS

We use Network Simulator (NS2.34) to simulate our proposed algorithm. Network Simulator-3 (NS2.34) is used in this work for simulation.NS2 is one of the best simulation tools available for Wireless ad hoc Networks. We can easily implement the designed protocols either by using the otcl coding or by writing the C++ Program. In either way, the tool helps to prove our theory analytically. In our simulation, 100 mobile nodes move in a 1200 meter x 1200 meter square region for 60 seconds simulation time. All nodes have the same transmission range of 250 meters. Our simulation settings and parameters are summarized in table 1.

4.1 Performance Metrics

We evaluate mainly the performance according to the following metrics.

End-to-end delay: The end-to-end-delay is averaged over all surviving data packets from the sources to the destinations.

Location update rate: It is the ratio of number of nodes location updated to location not reported successfully.

Communication Overhead: It is defined as the total number of routing control packets normalized by the total number of received data packets.

Network Lifetime : It is defined as the nodes lifetime based on energy consumption.

Table 1. Simulation Settings And Parameters Of ELOER

No. of Nodes	100
Area Size	1200 X 1200
Mac	802.11
Radio Range	250m
Simulation Time	60 sec
Traffic Source	CBR
Packet Size	80 bytes
Mobility Model	Random Way Point
Transmitter Amplifier	150 $pJ/bit/m^2$
Package rate	5 pkt/s
Protocol	AODV

4.2 Performance Metrics

We evaluate mainly the performance according to the following metrics.

Communication overhead: Communication overhead can be defined as the average number of control and data bits transmitted per data bits delivered. Control bits include the cost of location updates in the preparation step and destination searches and retransmission during the routing process.

Packet Delivery Ratio: The delivery rate is defined as the ratio of numbers of messages received by the destination and sent by senders. The best routing methods employing this metric are those that guarantee delivery in which message delivery is guaranteed assuming “reasonably” accurate destination and neighbor location and no message collisions.

Node degree: It is the important metric to evaluate the performance of topology control algorithms. If the node degree is higher, it indicates that higher collision will be. So value of node degree should be kept small.

Network connectivity ratio: It determines the nodes are connected in the intermediate region. It should be kept small while varying the average speed.

End-to-End Delay: This is also referred to as latency, and is the time needed to deliver the message. Data delay can be divided into queuing delay and propagation delay. If queuing delay is ignored, propagation delay can be replaced by hop count, because of proportionality.

The simulation results are presented in the next part. We compare our proposed scheme ELOER with EMLARP [17] and ALARM [13] in presence of topology control environment.

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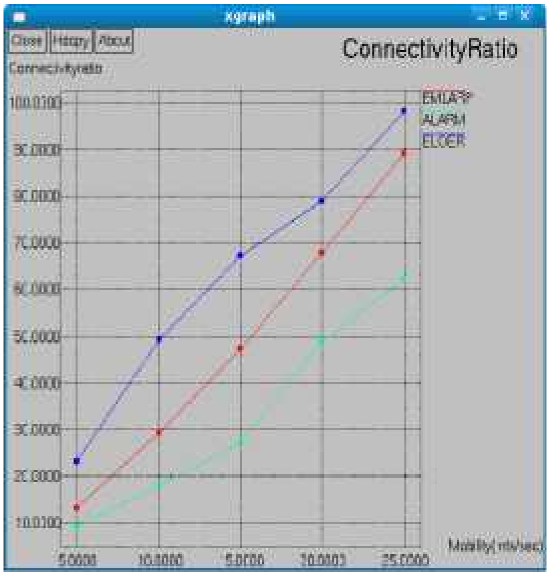

Fig.2. Mobility Vs Connectivity Ratio

Fig. 3. Speed Vs Node degree

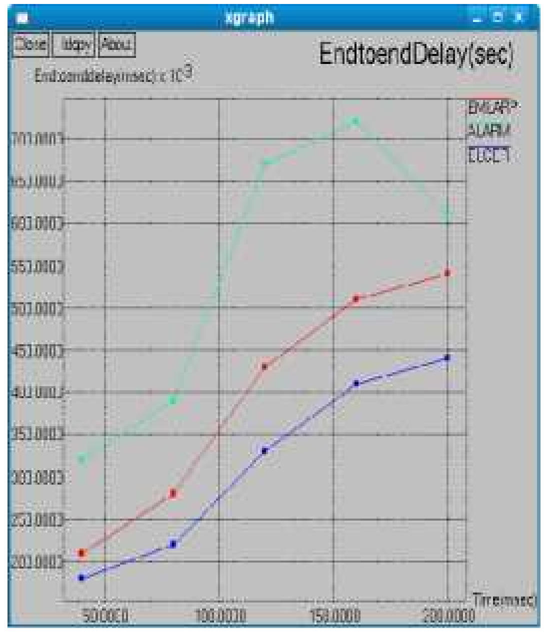

Fig.4. Time Vs End to end delay

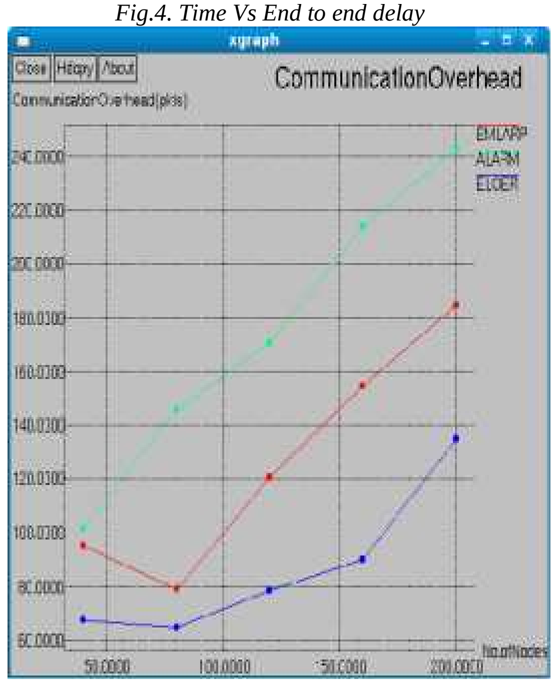

Fig.5.No. of Nodes Vs Overhead

Fig.2 shows the results of connectivity ratio for varying the mobility from 5 to 25. From the results, we can see that ELOER scheme has slightly lower connectivity ratio than the EMLARP and ALARM method because of location update of node calculations.

Fig.3, presents the comparison of node degree It is clearly shown that the node degree of ELOER has low overhead than EMLARP and ALARM.

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Fig.4 shows the results of Time Vs End to end delay. From the results, we can see that ELOER has slightly lower delay than the EMLARP and ALARM scheme because of stable routes.

Fig.5, presents the comparison of overhead while varying the nodes from 0 to 200. It is clearly shown that the of ELOER has low overhead than EMLARP and ALARM method.

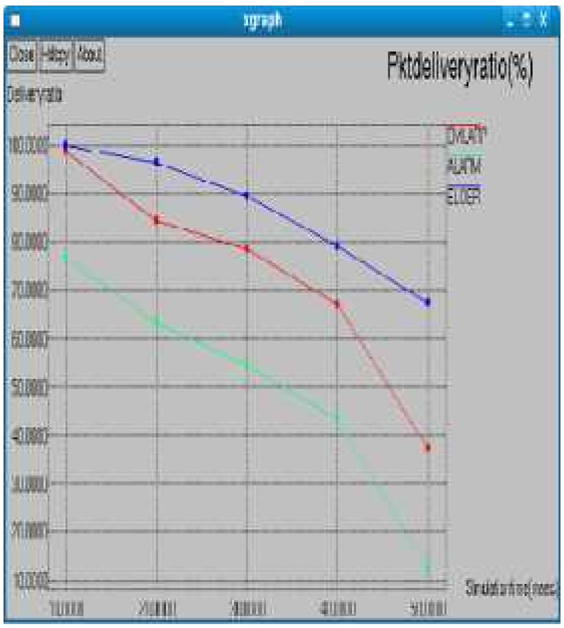

Fig.6. Throughput Vs Packet Delivery Ratio

Fig.6 show the results of average packet delivery ratio for the simulation time 10, 20…50 secs for the 200 nodes scenario. Clearly our ELOER scheme achieves more delivery ratio than EMLARP and ALARM scheme since it has both multipath routing and cluster enhancement features.

5. CONCLUSION

In this research work, we have developed an Localization Approach which attains to make a balance between network life time, location updated rate and delay among the Mobile nodes. In the first phase of the scheme, cluster head is elected to alleviate computational overhead. In second phase, Mobile selection scheme is deployed to save energy of Mobile Nodes. In third phase, localization algorithm is proposed based on energy and trilateration method. In four phase, packet format is proposed. It contains following factors location update rate, location estimated field to favour better route selection and reduce energy consumption of Mobile Nodes. By simulation results we have shown that the ELOER achieves high network lifetime, high location update rate, while attaining low end to end delay, low overhead than the existing scheme ALARM and our previous scheme EMLARP while varying the number of nodes, speed, mobility and pause time.

In future work, we have planned to implement secure localization approach based on identity based cryptography to achieve data integrity.

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