LACBER: A NEW LOCATION AIDED ROUTING PROTOCOL FOR GPS SCARCE MANET

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ABSTRACT

Completely GPS-free positioning systems for wireless, mobile, ad-hoc networks typically stress on building a network-wide coordinate system. Such systems suffer from lack of mobility and high computational overhead. On the other hand, specialized hardware in GPS-enabled nodes tends to increase the solution cost. A number of GPS free position based routing algorithms have been studied by the authors before proposing a new positioning framework in this paper. The proposed positioning framework is characterized by using only a handful of GPS enabled nodes. Lower dependence on specialized GPS hardware reduces the total cost of implementing the framework. A new location aided routing protocol called Location Aided Cluster Based Energy-efficient Routing (LACBER) has been proposed in the paper. Simulation results show that using the proposed positioning framework, LACBER turns out to be efficient in lowering mean hop and hence in utilizing the limited energy of mobile nodes.

KEYWORDS

Routing Protocols, GPS-free positioning, mobility, Location Aided Routing

1. INTRODUCTION

Routing is an important aspect in mobile, ad-hoc network Routing protocols that find a path to be followed by data packets from a source node to a destination node. A major challenge that a routing protocol designed for ad hoc wireless networks faces is resource constraints. Devices used in the ad hoc wireless networks in most cases require portability and hence they also have size and weight constraints along with the restrictions on the power source. Increasing the battery power may make the nodes bulky and less portable. The energy efficiency remains an important design consideration for these networks. Therefore ad hoc network routing protocol must optimally balance these conflicting aspects.

In cluster-based routing, the network is dynamically organized into partitions called clusters with the objective of maintaining a relatively stable effective topology. The membership in each cluster changes over time in response to node mobility, node failure or new node arrival. Location-aided routing protocol (LAR) [12] utilizes the location information for routing. However, LAR assumes the availability of the global positioning system (GPS) for obtaining the geographical position information necessary for routing. Each of the nodes is involved with calculating its position, which consumes bulk energy. Moreover during the routing process, the hop count is relatively higher than that of cluster based routing. Higher the hop counts, more is the energy consumption for routing a packet from source to destination. These problems motivated us to propose a protocol to improve performance of LAR in terms of energy efficiency.

In this paper, a new location aided cluster based energy efficient routing protocol (LACBER) has been proposed in section 4. Before this we present a brief review in section 2 on some of the existing solutions that we came across. Although the proposed protocol is location-based, we proposed to use only a few GPS enabled nodes in the entire network to keep costs lower. The proposed planning and assumptions for network formation including a proposed algorithm for selection of cluster heads is given in section 3. Section 5 presents a performance analysis of LAR with the adoption LACBER using simulation results.

2. RELATED WORK

Position based routing means forwarding packets to the destination's position or nearer to the position. Position-based routing algorithms eliminate some of the limitations of topology-based routing by using additional information. They require that information about the physical position of the participating nodes be available. Each node determines its own position through the use of GPS or some other type of positioning service. A location service is used by the sender of a packet to determine the position of the destination.

GPS uses the satellites as reference points to effectively calculate the positions of ground nodes. Some of the real world applications of GPS include location estimation, tracking, navigation, mapping and providing timing services. To use GPS, a node must be equipped with a GPS receiver which is responsible for estimating the absolute position of the node in the global coordinate system. Though GPS makes it possible to provide a wide range of positioning services, it is not a completely viable solution for ad hoc networks due to its additional hardware support, cost, and power consumption.

A wide variety routing protocols aimed to localize the ad hoc network without the support of GPS [1, 3, 5, 6, 7] have been proposed over the years. Some techniques use GPS but for very few nodes. These nodes are often referred as anchor nodes or reference nodes. Both of these type of localization i.e. 'Completely GPS Free Localization [1], [3], [5], [6], [7] etc or 'Using Very Few Anchor Node' [2], [8], [14], provide techniques to localize the network in a GPS-Less or GPS-Scarce area. The GPS-less localization approaches establish a virtual coordinate system and try to localize the network in that coordinate System. These coordinate system are established on the basis distance measurement [1, 6] (using ToA or AoA) or on the basis of hop count [5, 7]. But the problem with this coordinate system is that the exact physical position of the nodes can not be determined in the absence of GPS.

In paper [1], nodes can measure relative distances from neighbours using the method called Time of Arrival (ToA) mobile nodes estimate their positions. AOA (Angle of Arrival) and other approaches are also used for calculating position of the node [2]. Only a fraction of the nodes have positioning capabilities through GPS. However, each node will be able to calculate the position and orientation. Nodes are required to have compass to compute the AoA. A localization procedure is proposed in [3] which is mainly designed for completely GPS-free and mobile environment. The network nodes do not need to calculate their position with respect to any anchor node. A local network coordinate system is formed in absence of GPS. This localization is based on directional neighbours localization. This algorithm runs on a fairly large or small and mobile environment.

The algorithms [5] determine locations of nodes based on the connectivity between nodes. The basic idea behind that algorithm is to estimate distances between nearby nodes by counting their common neighbours. This is a hop count and connectivity based approach. The process starts while an anchor node initiates the algorithm by broadcasting a message to its neighbour. On receiving this message a node estimates its hop count from anchor. While any intermediate node broadcast this message then the sender ID hop count and distance of the predecessor are included inside the message. From this received message a node get the distance of previous two nodes and distance between them. In order to calculate the distance with respect to the current node a method called ‘Progress Estimation’ is proposed. In this method the displacement to the current node is calculated, from this the distance to the current can be calculated. The positioning approach described in [6] is a distributed and scalable GPS free positioning algorithm for wireless sensor networks. A clustering based approach for the coordinate formation is used, wherein a small subset of the nodes can successfully establish the coordinate system for the whole network. The basic idea behind this procedure is that, with a small set of nodes local coordinate system is formed and at last it converges to a global coordinate system. It is assumed that nodes measure relative distance with other neighbour with TOA method. This positioning algorithm is claimed to be scalable into large network. Construction of a virtual coordinate system in a sensor network where no position information is available is the main objective of the algorithm proposed in [7]. The virtual coordinate system is referred as VCap. It is claimed that virtual coordinate assignment support geographic routing. The protocol (called VCap) supports geographic routing which defines coordinates exclusively based on hop distances. The VCap protocol exploits four rounds (based on broadcasts) to identify three anchor nodes (namely *X*, *Y* and *Z*), and it assigns each node with a triplet of coordinates given by the hop distances from the anchors. The storage overhead for each sensor node is limited to the storage of the triplet of coordinates it is assigned. The approach suggested in [8] will require deployment of some reference point (RPs). These RPs periodically broadcast beacon frame containing positioning information. It is a distributed GPS-less self-positioning system. In this RP based system, the location can be determined by the sensor node itself without GPS or centralized server. Sensor nodes only use simple connectivity metric and localization data in the beacon frame to calculate their locations. That is, the sensor nodes require little computation to localize by themselves. So this localization system is a connectivity based approach. A Comparison of ad hoc localization Algorithms is shown in Table 1.

Table 1. Comparison of ad hoc localization Algorithms.

Name of Localization	**Reference Node**	**Positioning Approach**	**Assumptions**	**Limitations**	**Approach**
GPS free Positioning in MANET [1]	NO	**1.** TOA **2**. Triangulation	**1.** Maximum speed of the node limited. **2.** Nodes have high degree of connectivity.	**1.** Sufficient number of nodes is assumed to be static. **2.** Position is measured in 2D space.	A location reference group is formed with the reference node in centre.
APS [2]	YES	AOA	To measure AOA each node is required have Actuator.	APS aims to keep low signaling complexity.	Each node calculate DV-bearing and DV-radial from the anchors nodes
GPS Free Node Localization [3]	NO	TOA	Each node has Motion actuators that allow nodes to move a specific distance in a specific direction (with respect to North)	While two nodes move equal distance in parallel, this algorithm will be unable to calculate relative distance.	Calculate the relative distance and exchange the direction of movement and distance covered

Name of Localization	**Reference Node**	**Positioning Approach**	**Assumptions**	**Limitations**	**Approach**
GPSFR with intelligent vehicle [4]	NO	Directional antenna and local periodical beaconing	It designed for vehicular n/w.	Each node has to maintain a cache to store info about its f-node and b-node	Each node has two antennas f-antenna for front direction and b-antenna for rear direction
Scalable & Distributed GPS free positioning for sensor Network[6]	NO	TOA	Nodes estimate distance using ToA.	**1.** The ID based approach is not applicable in WSN. **2.** As it is a distributed system so the concept of master node is not suitable. **3**.Each time the master node with lowest ID move away the coordinate system have to be formed	Cluster based distributed approach
GPS free Coordinate Assignment [7]	NO	A virtual Coordinate is established, main on basis of Hop Distance	**1.** Each node has an unique ID **2.** Nodes are static or have low mobility	If the elected coordinate fails or moves away then the anchor selection process has to be reinitiated. Each node is assumed to have unique ID. This is not applicable for WSN by definition of the sensor networks.	The VCap protocol exploits four rounds to identify three anchor nodes and it assigns each node with a triplet of coordinates given by the hop distances from the anchors
A GPS less outdoor, self positioning method [8]	YES	RP periodically broadcast location information. From this information node calculates their position.	Some RP node are there in the network which periodically broadcast localization data	The PRs are assumed to be static. It may not be possible to accurately calculate the centroid.	Reference point based approach for sensor N/W

3. PROPOSED POSITIONING FRAMEWORK FOR BUILDING THE NETWORK

We propose that there would be three types of nodes as G-nodes, CG-nodes, and N-node. It is assumed that G-nodes are GPS-enabled and can find their own location using GPS. In the network only a few nodes need to be G-nodes. The rest of the network can find there positions in a process described later in this section. The assumed network structure and routing proposed in the paper are primarily aimed for a GPS scarce area. The CG-nodes are equipped with antennas. These antennas are capable of receiving signals from other nodes and can measure the received signals strength indicator (RSSI), the angle of arrival (AOA) of received signals from other nodes. A CG-node X can compute its position by exchanging signals with some other node Y, whose location has been recently estimated. At last the N-nodes, which are not aware of their position. These nodes form a part of a cluster and need not find their precise positions. Usage of these three types of nodes is aimed towards making the protocol energy-efficient.

The exact distribution of the G-nodes and CG-nodes across the network may vary. However, the proposed LACBER protocol requires that each cluster must have at least one G-node or CG-node in it. The GPS components are expensive and tend to reduce portability of nodes. Besides, the nodes need to spend their battery-power for estimating positions. The energy requirement is particularly more for GPS activities. However, we stress on the factor that the proposed routing protocol does not demand a high precision in estimating the position of nodes. Therefore, a relatively sparse population of G-nodes and CG-nodes would serve the purpose. This makes the entire protocol more energy-efficient.

There will be a process to select a reference node or the cluster head of a cluster, consisting of the G-node, CG-node and N-node. This reference node or cluster head election process will take place first, in the G-node level on the basis of a couple of criteria that is remaining energy, and speed of node. A reference node has to find its position till it serves in that role. Hence, it must be left with sufficient energy when it is elected. On the other hand, if a candidate node has a very high mobility, then it is likely to leave the cluster soon. This would involve re-electing another node as the new reference node. Thus, an ideal candidate for reference node must have relatively low mobility and high remaining energy level.

A node matching both of these criteria may be elected as the reference node. If a node is G-node but it is having very low energy level, then it can not be the reference node. If no G-node is found in a zone that meets the criteria to be a reference node, then any CG-node which can communicate with nearer zone's reference node to estimate its own position, may be the reference of that zone. However, the CG-node too like candidate G-nodes must meet the composite criteria of high remaining energy and low speed. These reference nodes form different cluster along with the CG-nodes, N-nodes, and may be also with other G-node that are not selected as reference node. Figure 1 shows the cluster, formed with nodes labelled from 1 to 8.

3.1. Election of Reference Node

Our objective is just not to propose a cluster based routing protocol, but to make it efficient by making it location aware. We require a reference node in each cluster that would be able to find its position, and thus would give a rough location of the cluster in the network. All the member nodes in the cluster shall be using the position of the reference node for finding routes to other nodes in the MANET.

At the beginning each G-node calculates its priority as function of its average speed and remaining energy. Nodes priority measurement is based on the idea proposed in [9]. In case there is no G-node in a cluster, or all the G-nodes in the cluster have low priority values falling below the threshold value, the CG-nodes in the cluster become candidates for the reference node. Each candidate cluster node, say C, then broadcast respective priority values within the cluster and initiates a local timer, say T_C. The node waits for replies from other candidate nodes in the cluster. If it does not get any response within T_C, then we assume that there is no other candidate node in the cluster. Node C is elected as the reference node of the cluster. The detailed process of the election of a reference node for the cluster in presence of a candidate G-node and in its absence has been discussed in sub-section 3.1.1 and in 3.1.2.

3.1.1. Reference Node Election in Presence of G-node

Let us explain the formation of cluster when there are G-nodes in an area. Each G-node, say G_i, would compute its priority value, say P_i using EQN 1.

$$P_i = \xi\,(S_i, E_i) \qquad \text{…. EQN 1}$$

where, Si represents the speed of node G_i, $Si \in (0, \infty)$; E_i represents the energy level of node G_i, $Ei \in [0,1]$. There would be a threshold value P_T for this priority. A node cannot be a candidate for reference node if its priority P_i is less than P_T. Next, Now, each G-node in the cluster whose priority is greater than or equal P_T, broadcasts its priority within the cluster and at the same time it initiates a local timer. The value of this timer is decided such that before the timer expires, the concerned G-node receives priority reply from other G-nodes in the cluster. This way, all the candidate G-nodes in the cluster get the priority values of each others. The G-node with the highest priority value will be the reference node of that cluster.

In Figure 1, C_1 is referred to as the Cluster 1. In this area nodes G_1, G_2 and G_7 are three G-nodes. Now, each of these nodes, say G_2 calculates its priority, say P_2 using EQN 1. If Pi is greater than or equal to P_T then it broadcasts its priority within the cluster and at the same time it initiates a timer, say T_2. G_2 waits for any reply from G_1, G_7. Value of T_2 is decided such that before the timer expires, G_2 receives priority reply from both G_1, G_7. This way, all three competitors get the priority of each others. The G-node with the highest priority, say G_1 in this case, will be elected as the reference node of the cluster.

3.1.2. Reference Node Election in Absence of G-node

Suppose in some area there are no G-nodes, then the cluster formation will be the responsibility of the present CG-nodes. A CG-node is not GPS enabled. However, it is equipped with antennas capable of receiving signals from other nodes and can measure the received signals strength indicator (RSSI), the angel of arrival (AOA) of received signals from other nodes. A CG-node X can compute its position by exchanging signals with some other node Y, whose location has been already computed.

In order to elect a CG-node X as the reference node of a cluster, two basic criteria are to be met. Firstly, priority of X must not be less than P_T as explained in section 3.1.1 and there must be some node Y (a G-node or another CG-node) within the radio frequency range of X whose position is already known. Node X now can exchange signals with Y and from the RSSI and AOA, it would be able to compute its position [1]. In this way, a reference node may be elected for a cluster where there is no G-node.

It can be seen from figure 1 that in the lower-left portion there are no G-Node to take the responsibility of a reference node. In this situation node CR_2 (or CR_6) finds that there is no broadcast message from any reference node announcing itself as a reference node. So CR_2 (or CR_6) try to estimate their position from any nearer G-Node. CR_2 will estimate its position from G_1, G_3, and G_5. In this way CR_6 will estimate its position from G_8 and G_5. When they estimate their position then it will be the master node. If in an area two node perform the same function then which one broadcast it self as a reference node will be considered as a reference node of that area. And under its reference cluster will be formed.

There is another case in which the CG-nodes are not even getting position information from nearer cluster's G-Node. In this case CG-Node will estimate its position from another CG-Node which has already estimated its position from any G-Node near by. In cluster 7, node CR_7 estimates its position from CR_2 and takes the responsibility of a reference node for the cluster.

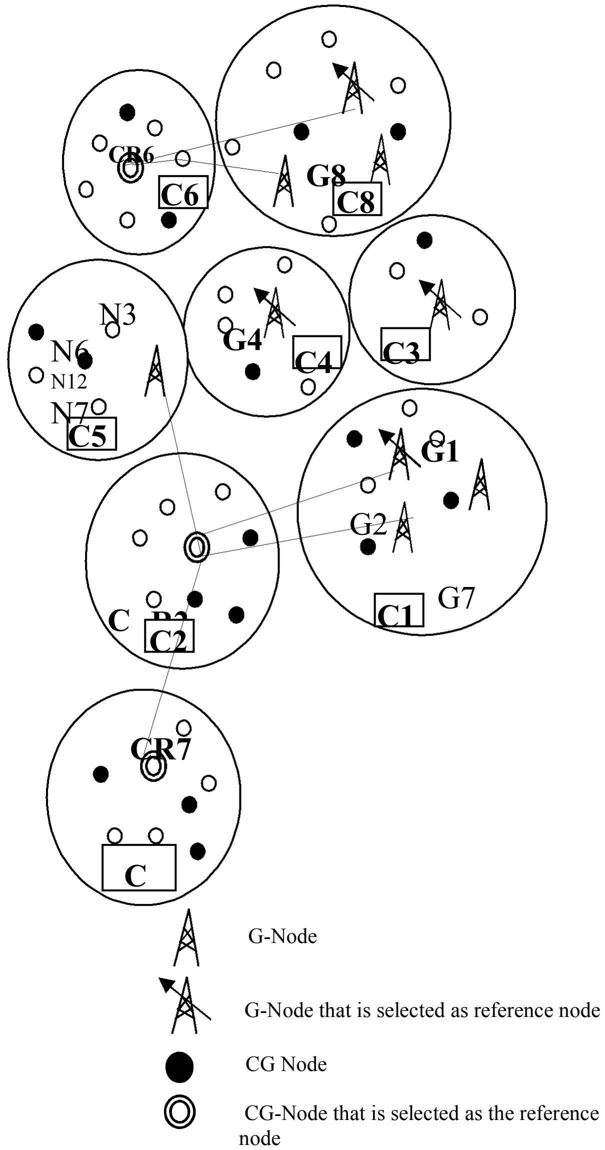

Figure 1: Cluster Formation

3.2. Algorithm for Reference Node Election

After reference node is elected by any of the above method, reference node informs all the nodes within its range. When a node becomes reference node then it broadcasts a message announcing itself as a master. All nodes in the range of node G_1 who receive this message become member nodes. When the member nodes receive this message they inform the reference node about their position by some acknowledgement massage. Thus a number of clusters established within the network. In [6] the 'local coordinate system' formation is done by measuring TOA between slaves. The local coordinate system converges to global coordinate system. The zones are assumed to be non-overlapping.

In this proposed system when the clusters are established under reference nodes. The reference nodes exchange their cluster information. After the deployment of the ad-hoc network the priority of each GPS enable node is calculated.

Procedure Election

```
Begin
Pi = calculatepriority();
if (Pi ≥ PT)
    start timer T1;
    boardcast priority Pi;
    poll for reply priority from other candidate nodes;
    timer lapses (T1=0)
    if no RM is received then
        /* RM is the reply message */
        Node = ClusterHead;
    else
        find node X with highest priority from the RMs;
        elect X as reference node;
    endif
else
    discard Node as candidate reference node;
endif
End
```

```
Function Calculatepriority()
Begin
    P = f (E, S);
        /* P, E and S are priority, remaining energy and mobility of the node respectively */
    return(P);
End.
```

3.3. Energy Efficiency

One of the objectives of proposing LACBER is to minimize consumption of energy in route discovery. The aim is to quantify the energy consumed and to study the total energy required by varying the number of nodes in the network.

Lemma I: If P_{ij} and E_p be the energy required to route data packet from node i to node j and the energy required to calculate position by the node respectively then the total energy consumed by the node in the network E_c is

$$E_c = \sum_{i=1,\, j=2}^{n} P_{ij} + E_{p},$$

Proof: Let E_e be the total initial energy of a node and E_c is the energy consumed by the node in the network. Therefore the remaining energy of each node E_i may be calculated as $E_i = E_e - E_c$

Total energy consumed by the node in the network is equal to the energy required to route packet from one node to another node plus the energy required to calculate the position by the node. The energy required P_{ij} to route packet from node i to node j, would be $P_{ij}= K*D_{ij} + \partial$, where K is the average size of the packet, D_{ij} is the distance between the node i and node j and ∂ is the environmental constant.

Therefore the total energy consumed by the node in the network E_c is

$$E_c = \sum_{i=1,\, j=2}^{n} P_{ij} + E_p,$$

Corollary I: The average energy level of nodes and hence of the network is given by:

$$E_a = (\sum_{i=1}^{n} E_i) /n, \text{ where n is the total number of nodes.}$$

As most of the nodes are not involved in calculating their position E_p becomes NULL. Moreover our algorithm ensures less number of hoop counts which in turn reduces $\sum P_{ij}$ These factors in turn increases the average energy level of each node and hence of the network. The lower computational complexity towards calculation of location information in making routing decision minimizes energy consumption per routing tasks.

4. Location Aided Cluster Based Energy Efficient Routing

We now introduce the proposed location aided cluster based energy efficient routing (LACBER) algorithm. In this approach the main importance is not the position accuracy but the zone based forwarding of the packets. A reference tries to forward the packet in the zone of the intended receiver. Before we describe the logic of routing that utilizes the reference nodes as described above, let us note the additional data structure that are to be maintained in the reference nodes.

4.1. Additional Storage Requirement in Nodes

The routing protocol does not require ordinary cluster members to store any additional information other than the ID and position of the corresponding reference nodes. However, each reference node in the clusters maintains a local reference table in which the clustering information including the positions of the reference nodes in the clusters are stored.

Each reference node exchanges information with other reference nodes stating its position and the list of members in the cluster. As for example, if position of the reference node, say G_5, in Cluster C_5 is (X_1, Y_1, Z_1) and the other members in C_5 are N_3, N_6, N_7, N_9, and N_{12}, then the reference node would broadcast a cluster message $<G_5, (X_1, Y_1, Z_1), N_3, N_6, N_7, N_9, N_{12}>$ for other reference nodes in the network. Each of the reference nodes stores these cluster messages in a local reference table. The structure of a typical reference table is shown in Table 2.

The member nodes know their reference node's position. When a node X in the network needs to communicate to another node Y, node X first sends the RREQ to the reference node R_X of its own cluster. The reference node maintains a table from which it can identify the cluster for the target node Y. The position of the reference node for the target cluster is noted. RREQ packets are forwarded to the nodes that fall only in the direction of the target.

Suppose any member node under reference G_1 want to send message to node under reference node CR_2. G_1 node knows that the intended receiver is in the cluster of node CR_2, which is either a G-node or CG node. So the position information in reference level is available. So reference G_1 sends that message towards the cluster 2. If the target node is still in cluster2, then the RREQ through the cluster head reaches the target and a RREP is to be sent back. The position of the target cluster thus would reduce the overhead of control messages as the RREQ packets can be sent towards a specific direction, and need not be broadcasted to all possible directions.

In this environment no node is considered as completely static. If a member node leaves its cluster (suppose node 'N_{11}' move from CR_2 cluster to G_1). So reference node G_1 can identify its position. While the routing takes place from G_8 to CR_7 and between the routes if reference node G_1 can sense that intended node is in its cluster, then G_1 stops further forwarding the message.

The major steps in the adaptation scheme are: (1) form cluster using LACBER; (2) execute LAR on each reference node; (3) forward packets to receivers through their respective reference none. The clusters are communicated via reference nodes. In our approach the reference nodes which form a *super reference node cluster* follows routing algorithm as per LAR. The rest of the procedure is done according to the following algorithm. The corresponding sequence diagram of the routing is shown in Figure 2.

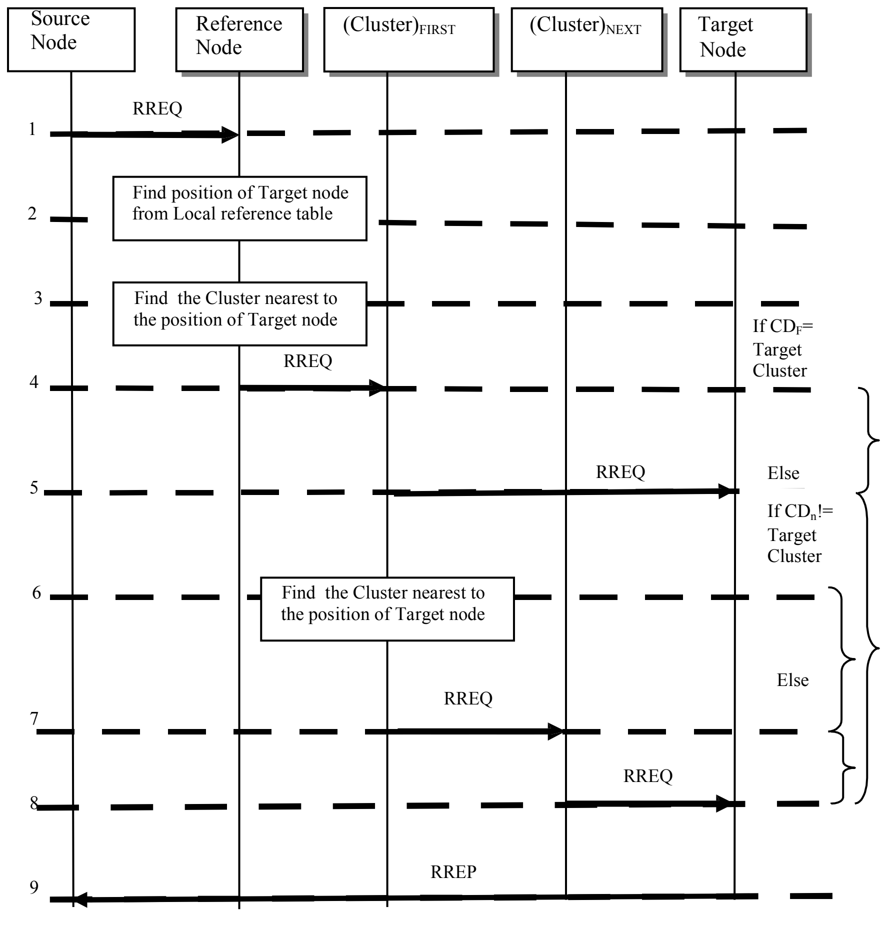

Figure 2: Sequence Diagram of the Routing

5. Performance Analysis

We have evaluated our approach by simulation. The simulated environment consists of 1024 wireless mobile nodes which are randomly distributed in a square area of 10000m×10000m. The MAC protocol is IEEE 802.11 and its data rate is 11 Mbps. The radio transmission range is 200 meters. The energy required for calculating the position of a node is considered as unit.

Size of the data packet is also considered as unit. Total electronic energy of a node is considered to be 10 unit.

In successive stages total of 64, 128, 256 and 512 set of nodes are created respectively. The performance metrics used for the evaluation of LACBER are stated as follows

- Total energy required for position calculation by successive set of nodes
- Total number of hop counts for routing data packets by successive set of nodes
- Average energy per packet for routing from source to destination for successive number of nodes
- Total remaining energy of successive number of nodes
- Average energy level of each node for successive set of nodes

The results are plotted against the above set of nodes consecutively to get the graph shown in figures 3 thru 7.

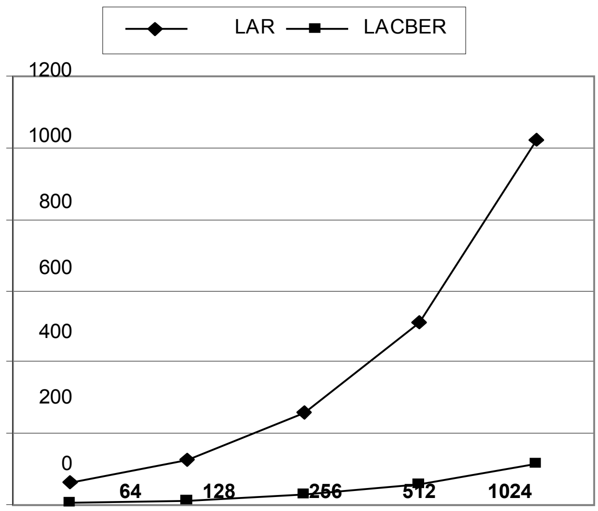

Figure 3. Total Energy Required Vs Number of Nodes

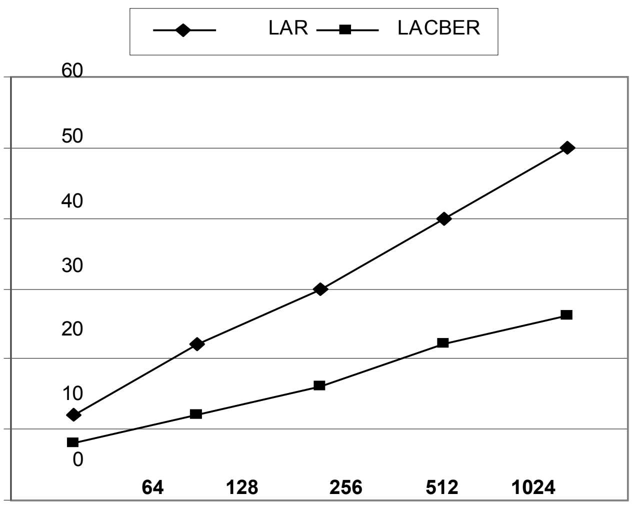

Figure 4. Hop Counts Vs Number of Nodes

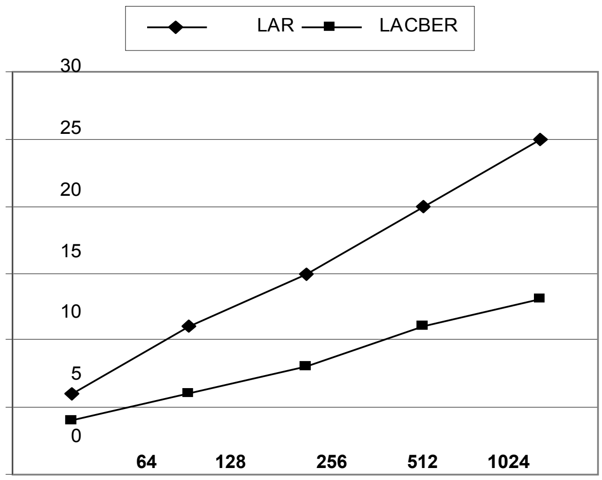

Figure 5. Average Energy Required Vs Number of Nodes

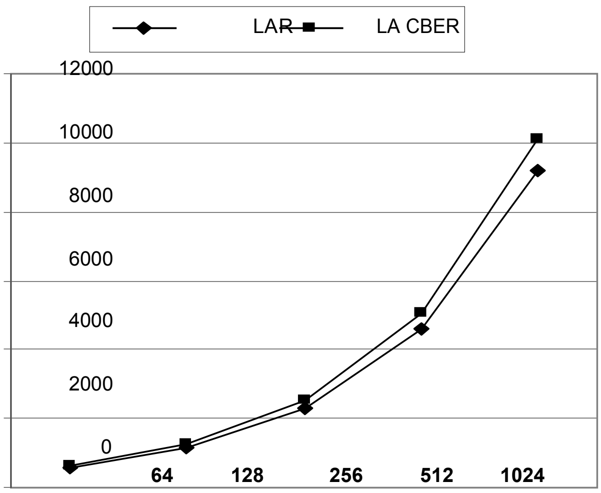

Figure 6. Total Remaining Energy Vs Number of Nodes

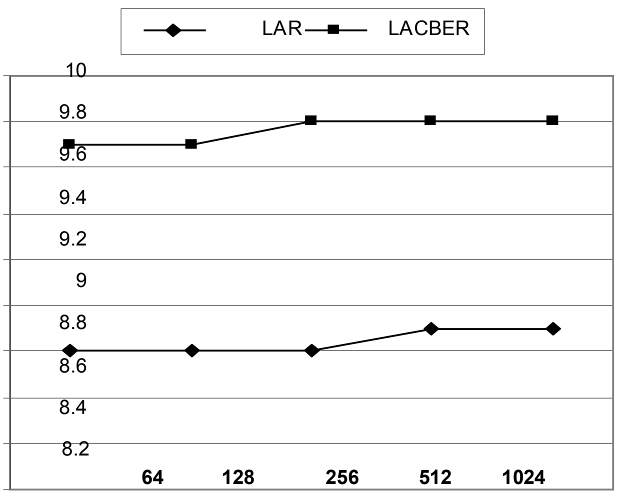

Figure 7. Average Remaining Energy Vs Number of Nodes

Figure 3 shows the variance in the total energy required for calculating position with respect to the number of nodes. It is observed that the energy required for position calculation is less in LACBER as compared to LAR [12]. This may be explained by the fact that in LACBER, a majority of the nodes need not required to calculate its position. Figure 4 shows the variance in the total number of hop counts for routing data packets with respect to the number of nodes. It is observed that the total number of hop counts for routing data packets is less in LACBER as compared to LAR.

Figure 5 shows the variance in the average energy per packet for routing from source to destination with respect to the number of nodes. In LACBER total number of hop counts for routing data packets is less. Due to this the average energy per packet for routing from source to destination is less in LACBER as compared to LAR[12]. Figure 6 shows the variance in the total remaining energy with respect to the number of nodes. In LACBER total energy consumed by the node (which is the sum total of the energy by nodes required to route packet from source to destination and energy required by the nodes to calculate position) in the network is less. Due to this the total remaining energy of nodes is more in LACBER as compared to LAR[12]. Figure 7 shows the variance in the average energy level of each node with respect to the number of nodes. In LACBER the remaining energy of the nodes is more and hence the average energy level of each node is more in LACBER as compared to LAR [12].

The results show that using the proposed positioning framework, the routing performance has improved over Location aided routing (LAR) in terms of total energy consumption, mean hop count and the average energy of the network.

Lower communication overhead: All the reference nodes have a local reference table to maintain information about the clusters from where it finds the position of the cluster for target node. It guarantees all routes are loop-free, and typically provides multiple routes for any source/destination pair that requires a route. Following topological changes that do require reaction, the protocol quickly reestablishes valid routes. This ability to initiate and react infrequently serves to minimize communication overhead.

Low cost: In the proposed framework, most of the nodes are GPS free. So the hardware infrastructure requirement for the network is limited as compared to LAR with all GPS enable nodes. These in turn makes it cost effective.

Energy efficient: The proposed LACBER consumes less energy than LAR. The two possible reasons are: first, most of the nodes are not involved in calculating their location information; second, proposed algorithm ensures less number of hoop counts. These in turn reduces the energy consumption per routing tasks.

6. CONCLUSION

In this paper, we have presented an algorithm which is location aided and also energy efficient. This approach is applicable in GPS scarce network. The major contribution of the work is in proposing a new location aided routing methodology that is energy efficient too. The positioning framework that this new protocol uses is suitable for GPS scarce environment. The proposed LACBER is a better location aided routing protocol comparing LAR in terms of lower hop-count and improved energy utilization. The solution is low cost and energy efficient. The GPS enable nodes wakes up periodically to listen for changes and goes back to the sleep mode to conserve energy. The location information helps keeping the number of control message exchanges low during the route discovery process. This is useful for better utilization of bandwidth.

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