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DOMINATING SET BASED GEOCAST WITH TEMPORAL STABILITY FOR WIRELESS MOBILE ADHOC AND SENSOR NETWORKS

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ABSTRACT

Geocast is a variant of a location based multicast where a packet is delivered from a source to all nodes specific to a geographic area interested by the source. The objective here is to 1.Efficiently utilize the energy; this can reduce the void formation. 2. Reduce the transmission cost and the delay for delivering the packet. The existing geocast protocols are either multicast or flooding based whose transmission cost and overhead of maintenance are quite high. The proposed concept of Dominating Set based Geocast for Mobile adhoc and sensor network (DSGM) protocol, chooses a dominating set (DS), based on the stability factor by predicting its location and connectivity of link existing between two neighboring node. The DS formed in distributed way guarantees the delivery of the message and even keeps the transmission cost to the minimal. We use a simple location prediction concept, which improves the packet delivery ratio and makes geocasting efficient for mobile nodes. The existing geocast protocol assumes the node to be static while performing geocast, thus restricting the mobility of a node. This paper describes a technique of how a simple prediction can bring significant improvement in the reliability of geocast protocol. Simulation results show that the DSGM improves the message delivery in a mobile environment than the existing protocol with minimal transmission cost.

Keywords: *Geocast, Sensor networks, Dominating set, Location prediction.*

1. INTRODUCTION

Geographic addressing in sensor node gives way to a stateless routing, which needs very miniscule memory for routing process. Georouting protocol includes many real time applications in areas, which lack network infrastructure like emergency communication for disaster relief and commercial geographical short message service application. The most scalable, responsive and reliable implementation of geographical routing is via a geocast, where location aware nodes broadcast and selectively rebroadcast packets based on local decision rules [1]. Geocasting is a variant of location based multicasting. Geocast in wireless sensor networks is a task to deliver a message to all nodes within the geographical region. The challenging problem in geocasting is to distribute this message with high probability of delivery and with low overhead. Geocasting is becoming a crucial communication primitive for many applications like disaster management, traffic, battle field and infotainment etc in wireless sensor networks as it can spread an geo message to all the nodes in a particular area. Geocasting could also be used to assign tasks to nodes or to query nodes in a certain area. For example, a user may request all sensors in an area where a fire is spreading to report their sensed data, or a query where we want to know all the active sensor nodes in a given location. Geocasting could also facilitate location-based services by announcing a service in a certain region or sending an emergency warning to a region [2]. In an opportunistic network or in a pervasive environment the nodes are generally mobile where the geocast is called as mobile geocast [3]. In such a situation it's necessary for the correct operations of many applications, geocast need to guaranty the packet delivery in the region of interest. The challenge is that in order to reach all nodes in the region, the message may have to traverse those nodes outside the region causing extra overhead. There is a tradeoff

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between the ratio of region nodes reached and the overall overhead incurred due to a geocast transmission. For example, in order to guarantee that all nodes in the region receive a geocast packet, global flooding, by sending the packet to all nodes in the network, may be used which causes very high bandwidth and energy consumption, and can significantly reduce the network lifetime.

The earlier proposed protocols have concentrated on the guaranteed message delivery and low transmission cost [4], [5]. The two objectives ensure that every node in the region gets a copy of the packet with minimal amount of transmission. Since sensors are battery powered with limited resources it's a prerequisite for sensor node that geocasting consumes as little energy as possible. Hence it becomes quite a necessity to develop a technique that utilizes the energy resources of the node intelligently without depleting the node and ultimately maximizing the network lifetime. An exhaustive taxonomy on energy saving is discussed in [6]. Sensor networks are expected to be deployed in a wide range of environments, including very callous environments, therefore robust protocols should be able to cope with different conditions, such as irregular node distributions, gaps and obstacles. So, the major requirement of sensor node is to utilize their battery power intelligently. Repeated geocast in the particular area should not lead to node death prematurely, whereby the network may end with void initially and at latter stage could partition the network totally. In this paper we are motivated to investigate dominating sets (DS) based geocast can accrue in restricted flooding for extending the network lifetime with minimal cost. We focus on locally selected DS in a distributed way by considering the energy reserve and the temporal stability of the node.

When we have connected network topology, which is converted into a planar graph where no two edges cross each another. The network is portioned into faces, a face is a continuous area enclosed by sequence of edges. These faces are categorized into: interior faces and exterior faces. The perimeter traversal uses this faces to traverse towards the destination by right or left hand rule. We propose a DS based geocast protocol for mobile environment DSGM, which comprises of a mobility prediction module [7] to increase the stability factor of the DS. The stability factor is defined based on the temporal prediction of a link. We prove that DSGM not only reduces the transmission cost but also improves the network lifetime. In DSGM, the boundary face, which covers the geographical region R is formed by merging the faces in the planar graph. DSGM works in three phases: DSGM forwarding, DSGM traversal, and intelligent flooding. Initially in the first phase, message from the source node is delivered to one of the boundary node of the merged face covering the region of interest R using a position based routing protocol [5]. In second phase of DSGM traversal, the boundary node which had received the message initiates the traversal in both directions of right and left. When a node on the boundary receives both the message implicitly understands that all the boundary nodes are traversed and stops further transmission of the message copy. Finally, in the intelligent flooding, nodes within R that have overheard the DSGM traversal message, performs the DS based intelligent flooding.

The rest of this paper is organized as follows. In Section II, we review related work. We define some terms and elaborate the concept of DSGM in Section III. The DSGM algorithm is discussed in Section IV. The performance is analyzed and evaluated in Section V. We conclude the work in Section VI.

2. RELATED WORK

Existing literatures implements geocasting protocol two phases. Initially the message is unicasted to a node in the geographical region R from the source. Latter perform restricted flooding or broadcast the message within R. Our discussion on related work is pertaining to these two phases of the protocol.

2.1 Location based routing

The basic assumption behind location based routing is every node in the network knows its geographic location and the location of its neighbors [8]. Hence, the routing decision is primarily based on the nodes location, which invariably reduces the routing overhead. The initial location-based routing algorithm based on a greedy principle was proposed by Finn, in which each node chooses the neighbor closest to the destination as its next forwarding node [9]. The algorithm fails if a dead end (local minima) exists in the forwarding direction, that is, the message reaches an intermediate node that is closer to the destination than any of its neighbor nodes. To get rid of this problem, face routing was introduced in which, a planar graph derived from the network topology and the network area is partitioned into a set of faces. Here the packet

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traverses along the face intersected by the line between the source and destination. This protocol gets rid of void at the cost of longer traveling path. To optimize the path length a combination of both was introduced in Greedy Face Greedy [5]. The planarization based schemes ensures guaranteed delivery as discussed in [10]. It is generally a preprocessing activity, but an on the fly planarization is analyzed in [11].

2.2 Geocasting Algorithms

In Location-Based Multicast (LBM), the minimum rectangle containing both the source and the geocasting region is chosen as the forwarding zone. Next, restricted flooding is performed by nodes within the forwarding zone [12], [13]. The Depth-First Face Tree Traversal algorithm (DFFTT) used a face traversal for restricted flooding and thus guarantying the delivery. In the first phase DFFTT uses GFG to deliver a geocasting message to a node in a geocasting region. Then, a face tree covering all the faces that intersect with is region is constructed. By traversing every node on the face tree, the message is delivered to all nodes in location [14], [5]. The Next algorithm is RFIFT, It is identical to DFFTT. In the second phase, RFIFT performs restricted flooding within and traverses all the faces intersecting. Each face traversal is determined by a pair of nodes: internal border node and external border node [14]. In RFIFT, each internal border node performs traversal by using left-hand rule with respect to all of its planar neighbors that are external border nodes.

The next algorithm used previous protocol is Entrance Zone Multicasting- based Geocasting (EZMG), sub-divides the surrounding area of a region into a set of entrance zones. Each source node sends a multicast message to all entrance zones. Each node in entrance zones receiving the message broadcasts the message, and all nodes in that hear the message perform restricted flooding in the location. The above algorithms guarantee message delivery, but they incur high transmission costs [14]. Hall proposed a novel geocast heuristic, the Centre Distance with Priority (CD-P) in [15]. Both heuristics significantly improves on reliability of existing scalable geocasts and yet also remains scalable as scenario complexity increases. Like Hall, the urban environment was also explored for geocast in VANET by others [16]. The geocast is based on the traffic light behavior and improves the normal flooding approach used in geographical routing. A proactive geocast with trajectory information of the node rather than the timing updates is implemented in [17]. Carrying on the legacy geocast can also be performed by different variation of broadcasting which has high contention, cost and message collision [14].

3. TERMINOLOGY AND DSGM

In this section we consider a network model and propose the concept of DSGM.

3.1 Preliminary

Unit Disk Graph (UDG): UDG is a simplified model of wireless networks in which all nodes have an identical transmission range. Let N(v) is the set of all the neighboring nodes of node v. Let UDG (V) denote a UDG, where V is a set of nodes whose transmission radii are normalized to 1.For a node u, let ⊙(u) denote the unit disk centered at u. An edge e_{uv} between nodes u and v, exist if and only if Euclidean distance d(u,v) between them is not larger than one.

Planar Graph and Gabriel Graph (GG): A Gabriel graph GG(V) is: for any two nodes u and v, if $d(u,v) \leq 1$ and ⊙(u,v) and does not contain any nodes other than u and v, then $e_{uv} \in GG(V)$. For every $e_{uv} \in GG(V)$, u and v are called Gabriel neighbors.

Faces in Planar Graph: The network can be portioned into faces, a face is a continuous area enclosed by sequence of edges. There are two types of faces: interior faces and exterior faces where interior face is a continuous bounded area enclosed within the sequence of edges. The exterior face is the unbounded area outside the boundary of a network. The face traversing can prevent the node from being stuck at void or any local minima.

Face traversal rule: Deploying Right Hand Rule or Left Hand Rule to traverse the face. In the former case a person explores the faces by keeping her right hand on the wall (edges) and traverse anticlockwise whereby eventually visits all the nodes in the face. In the latter case the person explores a face by traversing clockwise

Geocasting boundary nodes: The edges in a planar graph partition the network area into a set of faces compass routing [3]. The Figure 1 shows the planarized graph with three faces. When all the faces are merged to cover the geographic region, the outermost nodes form the boundary nodes consisting of $b_1 \rightarrow b_2 \rightarrow b_3 \rightarrow b_4 \rightarrow b_5 \rightarrow b_6$

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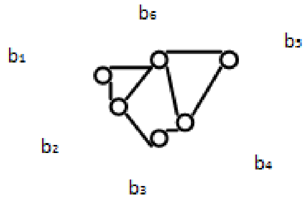

Figure 1. Planarized Graph

3.2 Basic idea of DSGM

The first step to geocasting starts with a preprocessing activity of planarization where the UDG is converted into a Gabriel graph (GG). Now, for any two faces that share an edge between them and the face exist within or part of its area overlap with the region of interest R, then the two faces are merged. The merging of faces is done by eliminating common edges. The process begins from identifying shared edge and ignoring them, and then the two faces are merged into one single face with a larger area. In the geocasting region, if we repeatedly merge all faces intersecting with R by ignoring their shared edges, we will eventually find a single large face suffice to contain R. This face is called a boundary face (BF) of R In face traversal; some nodes may be visited more than once, which occurs when a face contains a dead-end. A dead-end of a face is a sub-path such that entering and exiting the sub-path can only be done through the same node. Once the BF is formed the geocasting source node S sends the message to one of the boundary node on BF. The BF node is the node on the boundary which is at the shortest distance to the source. The delegated BF node with the geo message takes the onus of further intelligently flooded within R by DS.

4. DISTRIBUTED DSGM ALGORITHM

The three major activities, which have to be carried out, are stated as follows. 1. Construction of a Gabriel Graph. 2. Separating the region into faces. 3. DS based Intelligent flooding Algorithm

4.1 DSGM Forwarding

A location based protocol [5] can be used to forward the Geo message from the source node to the boundary face node. A node on the boundary of a geocasting region R is called a Boundary Face (BF) node, and an edge on the boundary is called a BF edge.

4.2 DSGM Traversal

The DSGM forwarding hands over the geo message to one of the BF node say 'b_1', then the DSGM traversal is initiated with the message {geo_msg,S,b_1,R,trav_rule}. The message propagates along the BF edges. The forwarded message consist information about the source ID S, region of interest R, ID of intermediate BF node b_1 and face traversal rule. This traversal will be terminated once the message comes back to b_1, if only one traversal rule is incorporated. Otherwise if both right and left rule of traversal are applied simultaneously any of the BF node which receives the same message with two different traversal rules can terminate the traversal further. The objective of defining a BF is as follows. To deliver a message to all the nodes in R, the message can be sent to one of the BF node and traverses all the BF edge on the boundary of the region R. As the message traverses the boundary, any internal border node overhearing the traversal message performs intelligent flooding within R. Then all the nodes in R will eventually receive the geo message once DS based intelligent flooding is carried out locally.

4.3 Intelligent flooding

Geocasting can be easily achieved by flooding the network, thereby achieving guaranteed message delivery. However, flooding is not energy efficient since it requires at least N transmissions, where N is the total number of nodes in the network. Geocasting Algorithm uses the DSGM forwarding, DSGM Traversal and Intelligent flooding algorithms to execute the geocasting process.

4.4 DS based Intelligent Flooding.

The DSGM chooses the Dominating set (DS) based upon the link stability, highest degree 'd' (no. of neighboring node) and the highest residual battery power 'p' of the node. This pair of metrics will increase the efficiency of geocasting while extending the lifetime of the network. The battery power consumption for each node is calculated based on the number of packets sent and the number of packets received. Every node consumes 0.06J, 0.042J for transmitting (e_t) and receiving(e_r) the packets respectively. The total energy consumed by the node for transmitting and receiving a single packet is calculated as $e=e_t+e_r$. Local DS construction is performed by each internal node u which overhears a geocasting MSG. Assume that each

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Temporal aware DS based Intelligent Flooding
Input for each node u in R overhearing MSG( either during traversal or during flooding) for the first time;
1:  BEGIN
2:   While (u overhears MSG from x within R)
3:  {
4:  If((u is in R)= = false) {u ignores MSG and go to line 2;}
5:  N_tx (u) ← N_tx (u) ∪{x}; u computes N_rx (u), N_ext (u) and N_int (u)
6: If( N_ext (u) ∪ N_int (u) = =∅) {u discards the MSG;exit;}
7:  for(every node v in N_ext (u) ∪ N_int (u) )   {
8:      need_Broadcast ←true; set flag=0;
9:        for(every node w in N_rx (u)) {
10:       If(key(w)> key(u) && v is a UDG neighbor of w){
11:         need_Broadcast ←false; break; }
12:         if( need_Broadcast = =true ){ set flag = 1;break ;}
13:       }
14:            if( need_Broadcast = = false) {u discard the MSG;exit}
15:  u chooses a random back-off time Δ t1 or Δ t2
16:  If (flag== 1){set timer Δ t1;}
17:  else set timer Δ t2
18:  while (the timer is not timeout ){
19:  if (u receives a new MSG from a node not in N_tx(u))
20:  { u cancels the timer ; goto line 4}
21:  } // timeout occurs
22:  u broadcast the MSG; exit;
23:  }
25:  END
```

Figure 2. DSGM Protocol

node has a unique ID. Once u overhears an MSG with a geocasting region R and u has not broadcasted the MSG yet, u computes and maintains four neighbor sets based upon the highest degree of the node and the highest battery power of the node. The main objective of this four set is to identify nodes who haven't heard the geocast message.

$N_{tx}(u)$: The set of UDG neighbors of which have already transmitted the MSG (the MSG can be either a VSF traversal message or a broadcasting message within R).

$N_{rx}(u)$: The set of UDG neighbors of u such that $\forall v \in N_{rx}(u)$, v is the internal node of R and v has not transmitted the MSG yet.

$N_{ext}(u)$: The set of GG neighbors of u such that $\forall v \in N_{ext(u)}$, v has no UDG neighbor in $N_{tx}(u)$, e_{uv} forms a crossing edge, and v has not transmitted the MSG yet.

$N_{int}(u)$: The set of UDG neighbors of u such that for each node v in $N_{int}(u)$,v is an internal node of R, v is not in $N_{tx(u)}$ U' $N_{rx}(u)$, v and has not transmitted the MSG yet.

The four computed sets help to broadly categorize the nodes which haven't heard the geo message and the ones which have heard. Now the nodes in the $N_{rx}(u)$ can compete with each other to identify, who takes the onus of transmitting the geo message by comparing their respective key. The key consist of four parameters in the order of priority to decide their dominance. The parameters are residual energy, degree and ID of the respective node. The node with highest energy takes over the job of transmission, if energy happens to equal the next deciding factor is the degree of the node, if both the parameters are similar, then the tie is broken by the ID of the node. In this way the energy motivated DS spreads the geo message in the region of interest. The Figure 2 shows the temporal aware DSGM protocol for wireless adhoc sensor network. The geocasting region R is given as input. Topology location table construct the location table for all the nodes in the geocasting region.

Table 1: Location Table of node

Current Position of a node	Velocity	Moving direction	Time
--	--	--	--

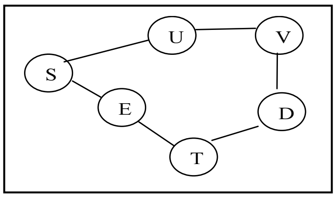

Figure 3. Finding Position From Source S To Destination D

In Table 1 shows the location table which maintains the temporal information of the neighbouring nodes. The table has attributes of the current position, velocity and moving direction of each node in this geocasting region. Example, consider the Figure 3, which shows a node S that needs to send a message to the given geographic location. Source node S finds the nearest node from the geocasting region by DSGM forwarding. Assume that node S knows that node D was the nearest node to the source node and it at location L at time t_0, and that the current time is t_1. Then, the "predicted zone" of node D, from the viewpoint of node S at time t_1, is the region that node S believes to contain node D at time t_1. Node S can determine the predicted zone based on the knowledge that node D was at location L at time t_0. For instance, if node S knows that node D travels with average velocity v, then S may assume that the expected

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zone is the circular region of radius $v(t_1 - t_0)$, centered at location L . If actual velocity 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 potentially contains D at time t_1.

In general, it is also possible to define v to be the maximum velocity of the node. If node S does not know a previous location of node D, then node S cannot reasonably determine the expected zone in this case, the entire region that may potentially be occupied by the ad hoc network is assumed to be the expected zone. The position and the amount of time two nodes (i and j) are connected 'D_t' can be calculated by the following mathematical equation 1. This will be updated in location table, which expresses the temporal stability of two neighboring nodes.

Suppose 2 nodes i and j are within the transmission range r of each other.

(x_i, y_i) : co-ordinates of mobile host i

(x_j, y_j) : co-ordinates of mobile host j

v_i and v_j : velocity of i and j respectively

o_i and o_j : moving directions of i and j respectively

Amount of time i and j will stay connected is predicted by:

$$D_t = \sqrt{\frac{-(ab + cd) + (a^2 + c^2) r^2 - (ad - bc)^2}{a^2 + c^2}} \quad (1)$$

where

$a = v_i \cos o_i - v_j \cos o_j v_j$

$b = x_i - x_j$

$c = v_i \sin o_i - v_i \sin o_j$ and

$d = y_i - y_i$

The location table is the input for the Gabriel graph construction module. This algorithm constructs the Gabriel graph from the location table. The generation of the graph is based on the velocity of the nodes in the network region. The position of the node at time t is calculated based on the past history of the node and the velocity of the node in the region. The graph is then separated into the various faces interior faces and Exterior Faces to reduce the number of node traversal during the Geocasting. This face traversal can be improvised by predicting its location to make sure that the packet is delivered for to the source node as a destination node i.e. the source node must be a destination node. Geocasting and Restricted flooding algorithms are applied to reduce the transmission cost. Then to design the DS based restricted flooding algorithm based on the high battery power, low mobility and high degree of node in the geocasting region.

4.5 To find the position of the node.

This model defines a method of determining a probabilistic guarantee of finding a destination node in a given direction. When a source node S wants to send information packets to a destination node D as shown in Figure 4, it retrieves the location information of D stored within it location tables. Using this location information as a reference, S determines those nodes amongst its neighbors who are "in the direction" of D, and forwards the message packet to them. On receipt of this information packet, the intermediate neighboring nodes in turn perform a lookup into their location tables to retrieve the location entry for the destination D. The intermediate nodes in turn forward the message packet to those nodes, amongst it neighbors who are in the direction of D, similar to S. This process continues until the destination D is eventually reached.

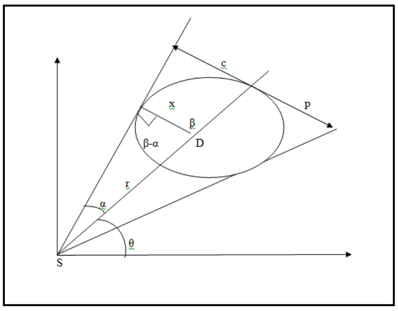

Figure 4. Predicting Node Position

The method of selecting neighbors within a given direction range, results in a certain probabilistic guarantee for the node as p, where $0 < p < 1$, that destination B will be reached. Each location update packet, and therefore the associated location entry for a given node represented by a location packet, contains the location, the time of sending the update message and the velocity of an individual node. Given the information of D within the location table of S as entry $LT(D) = t_0$, as detailed in figure 3, it is now easily possible to calculate the distance 'r' (from node S to D) and the angle D_θ. When node S needs to send information packets to the destination node D at some later time t_1, where $t_1 > t_0$, S needs to choose its neighbors to which it can forward the packet. Neighbors A are chosen by S such that, A_θ i.e. the direction vector of A, lies within the range $[\theta+\alpha, \theta-\alpha]$. The value of θ must be chosen in such

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a manner that the probability of finding the destination D is the sector C is maximized. The sector C is centered about the line segment connecting S and D and defined by [θ+α, θ-α]. Within the time interval $t_1 - t_0$, the maximum distance node D can travel at velocity v can be calculated as $x = v(t_1 - t_0)$.

The circle P is drawn with the radius as x, centered on the position of node D at time t_0. This circle borders and confines of the new position of node D at time t_1. Thus implying that node D cannot be anywhere outside of circle P after the time interval $t_1 - t_0$. Even if the direction of travel of node D is not specifically known, D can move in any direction β uniformly Therefore the optimum or minimum value of α needs to be chosen such that, the maximum distance x that D can travel within $t_1 - t_0$ at velocity v is within the sector C. The value of α is clearly dependant on the velocity *v* of D. Therefore, if either the average or maximum velocity of the node D is known, then it is straightforward to calculate the value of α which guarantees that D will lie within the direction [θ+α, θ-α].

$$\alpha = \arcsin v(t_1\text{-}t_0)/r) \qquad (2)$$

It is evident, that if the distance x traveled by D is greater than the distance r i.e. the distance between S and D, then D could be anywhere around S. In this case, α would = π.

5. DISCUSSION AND PERFORMANCE EVALUATION

5.1 Disscussion

The Figure 5 illustrates an example network graph covering the geocasting region. The graph has seven interior faces and the outermost nodes form the boundary nodes consisting of $b_1 \rightarrow b_2 \rightarrow b_3 \rightarrow ...b_{11} \rightarrow b_{12}$ With respect to node u $N_{tx}(u)$ ={ b_{12}, b_{11}, b_{10} } are the UDG neighbors of node u which have already transmitted the message, $N_{rx}(u)$ = { w} are UDG neighbors of node u which have received the message but yet to transmit, $N_{int}(u)$ = {z ,y} are the UDG neighbor inside the region R and $N_{ext}(u)$ = { } is null. Similar kind of vibrant set will be computed with respect to each internal node in the figure 5. Hence for ever node in the set $N_{rx}(u)$ one of the node broadcast the geocasting message. A random timer is set in the node of $N_{rx}(u)$, so the best capable among it get the chance to transmit

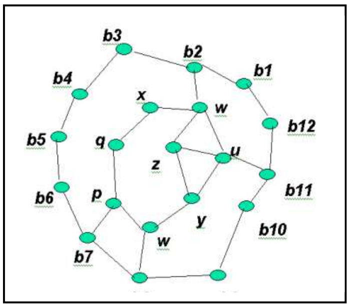

Figure 5. Face Partition and Boundary nodes

and the other nodes in the set cancel their transmission when they overhear the neighboring node transmit. This computation of set is carried out by the entire internal node until every node overhears the geocasting message. The temporal aware algorithm in Figure 1 runs on every node in the network graph to decide the set of dominating nodes.

5.2 Simulation and Results

The algorithm has been simulated using ns2 simulator and the performance has been evaluated by comparing the algorithm with VSFG. The simulation area of 300m x 500m is considered with the number of nodes varying from 50 to 250 with each node having a fixed transmission range of 50m. The evaluation is done for the metrics of transmission cost, network lifetime and end to end delay. The transmission cost is defined by the total number of transmission required for distributing the geo message in R which includes the location forwarding, boundary traversal and intelligent flooding. The network lifetime is determined by the amount of average residual energy retained by the node to stay connected in the network. The time it takes for a data packet to traverse from the source node to the destination node.

The geocasting region is 20x20m region was randomly chosen within the simulation area and the performance was evaluated for the metrics described above. An average of 10 runs are taken to plot the performance graph. The DSGM forwarding involves a GFG protocol we have restricted our computation with traversal cost and the intelligent flooding cost. From the above Figure 6 the average transmission cost of VSFG2 is less than that of VSFG1 and VSFG, and the transmission cost of VSFG1 is less than that of VSFG. This is the average transmission cost is evaluated for the geocasting region on a average of 10 simulation results.

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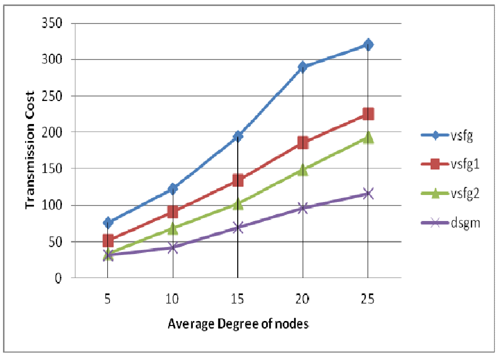

Figure 6. Cost Performance

The simulation environment contains 250 nodes, and the total simulation area is 300x500m and the geocasting region is 20x20m region. The transmission cost of VSFG, VSFG1 and VSFG2 increases whenever the average degree of nodes increases in the geocasting region. The average transmission cost of DSG is less than that of VSFG2. The cost of DSGM is 3.5% less than of vsfg2, because the effective selection of the dominating set during geocasting. Faster energy depletion will impair the lifetime of the node which in turn brings down the network lifetime. The Figure 7 shows that DSGM has comparatively higher residual energy than that of the VSFG2, thanks to the DS, which retain considerable amount of residual energy in the nodes. As expected both the graphs show an exponential decay of energy with the simulation time

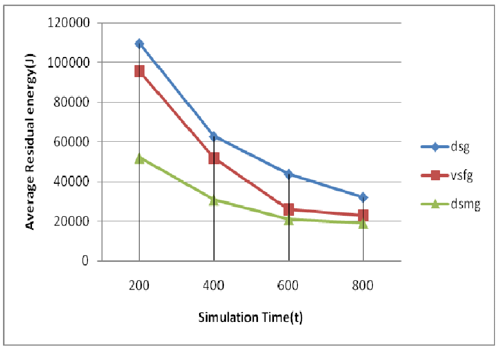

Figure 7. Network Lifetime

End-to-end delay evaluates the ability of the protocol to use the network resources efficiently. The Figure 8 shows average end-to-end delay simulated for EFG and DSMG with the various average hop count. The end to end delay of DSMG is 5 % less than that of EFG. Because the high percentage of end-to-end delay in DSGM is

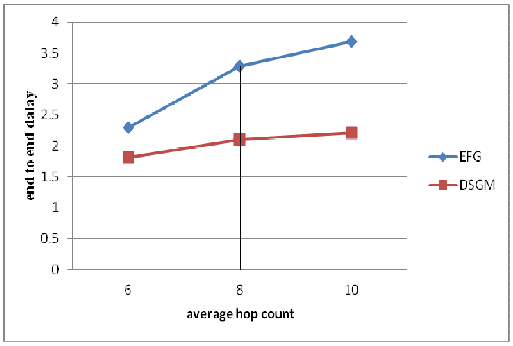

Figure 8. End to End Delay

due to the mobile network environment. As the DSGM contains effective set of nodes in the dominating set which has the high battery power compared to its Gabriel graph neighbors. The nodes with unstable links delegate DS nodes with higher temporal stability to perform transmission, thus resulting in lesser failure and in turn reduced delay of nodes in the geocasting region.

6. CONCLUSION

This paper proposes a temporal aware geocasting algorithm with guaranteed message delivery, reduced transmission cost of the geocasting region. The DSGM geocasting algorithm utilizes planarization and face traversal to guarantee delivery of packets. The merged face of a planarized graph covering the geocasting region, initiates the boundary traversal and latter performs the intelligent flooding using a dominating set covering the merged face, which is computed locally in a distributed manner. The intelligent DS makes sure that, the average residual energy is efficiently used to perform geocasting. The stability factor of a node depending on its mobility is taken into account in deciding the DS for performing geocast.

The DSGM geocasting algorithm provides guaranteed message delivery and a low transmission cost. It also increases the life time of the network. The DSGM geocasting algorithm provides guaranteed message delivery and a low transmission cost. The lifetime of the network is increased by the DSGM. The packet delivery factor of DSGM is 11% greater than DSMG,because the DSMG algorithm is for mobile network environment. The dominating set used in the DSGM reduces the transmission cost 3.5% less than of VSFG. By applying Dominating set based Resstricted flooding in DSMG significantly improves the performance on average cases for dense networks. This algorithm performs the geocasting in the single region

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which can be extended for multiple geocasting at the same time initiated by a single source or different sources targeting vivid area. The multiple geocasting at the same time i.e multiple transmissions should be initiated separately by the message source when more than one target regions need to receive the same geocast messages.

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