On the Life Time in Compass Routing on Delaunay Triangulation in Wireless Sensor Networks

Hassan Asadollahi, Hadi Asharioun, Abdul Samad Ismail, and Sureswaran Ramadass

***Abstract*—One of the most interested open issues in wireless sensor networks is life time issue. Because of energy limitation the sensors will die and the networks cannot sense as a result increasing life time is very important. Researchers try to increasing life time with new methods and algorithms and they need obtain the life time of previous method with new method to comparisons and calculating the life time is need for comparing. In this paper we calculate the life time of the network base on delanuay triangulation routing in localized routing.**

***Index Terms*—Compass routing, delanuay triangulation, life time, sensor networks.**

I. Introduction

There are many applications on wireless sensor networks as a monitoring and tracing [1]. While various energy efficient protocols have been proposed to prolong network lifetime, lifetime analysis is notoriously difficult since the network lifetime depends on many factors including network architecture and protocols, data collection initiation, lifetime definition, channel characteristics, and energy consumption model. Upper bounds on lifetime are thus derived for various WSNs [2].

Several localized routing protocols guarantee the delivery of the packets when the underlying network topology is a planar graph[3-10]. Typically, relative neighbourhood graph (RNG) or Gabriel graph (GG) is used as such planar structure. However, it is well-known that the spanning ratios of these two graphs are not bounded by any constant (even for uniform randomly distributed points). Bose et al [10]. Recently developed a localized routing protocol that guarantees that the distance travelled by the packets is within a constant factor of the minimum if Delaunay triangulation of all wireless nodes is used, in addition, to guarantee the delivery of the packets. However, it is expensive to construct the Delaunay triangulation in a distributed manner. Given a set of wireless nodes, we model the network as a unit-disk graph (UDG), in which a link uv exists only if the distance $\|uv\|$ is at most the maximum transmission range. In this paper, we present a novel localized networking protocol that constructs a planar 2.5-spanner of UDG, called the localized Delaunay triangulation (LDEL), as network topology. It contains all edges that are both in the unit-disk graph and the Delaunay triangulation of all nodes. The total communication cost of our networking protocol is $O(n\,log\,n)$ bits, which is within a constant factor of the optimum to construct any structure in a distributed manner. Our experiments show that the delivery rates of some of the existing localized routing protocols are increased when localized Delaunay triangulation is used instead of several [6] previously proposed topologies. Our simulations also show that the travelled distance of the packets is significantly less when the FACE routing algorithm is applied on LDEL, rather than applied on GG.

The paper is organized as follows: Section 2 discusses about different geometrical routing algorithm. In Section 3, we discuss about lifetime in compass routing and we present the result of our simulation. Finally, Section 4 gives concluding remarks.

II. Routing Algorithms

There are many kind of graph routing in geometrical routing as

Compass rout Compass Routing (Cmp): Let t be the destination node. Current node u finds the next relay node v such that the angle $< vut$ is the smallest among all neighbors of u in a given topology. See [3].

Random Compass Routing (RndCmp): Let u be the current node and t be the destination node. Let v_1 be the node on the above of line ut such that $\angle v_1ut$ is the smallest among all such neighbours of u. Similarly, we define v_2 to be nodes below line ut that minimizes the angle $\angle v_2ut$. Then, node u randomly chooses v_1 or v_2 to forward the packet. See [3].

Greedy Routing (Grdy): Let t be the destination node. Current node u finds the next relay node v such that the distance $\|vt\|$ is the smallest among all neighbours of u in a given topology. See [11].

Most Forwarding Routing (MFR): Current node u finds the next relay node v such that $\|v't\|$ is the smallest among all neighbors of u in a given topology, where v' is the projection of v on segment ut. See [7].

Nearest Neighbor Routing (NN): Given a parameter angle α node u finds the nearest node v as forwarding node among all neighbors of u in a given topology such that $\angle vut \leq \alpha$.

Farthest Neighbor Routing (FN): Given a parameter angle α, node u finds the farthest node v as forwarding node among all neighbors of u in a given topology such that $\angle vut \leq \alpha$.

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Hassan Asadollahi and Abdul Samad Ismail are with Department of Computer System and Communication, Faculty of Computer Science and Information, University Technology Malaysia (hasan_asadolahi@yahoo.com, abdsamad@utm.my).

Hadi Asharioun and Sureswaran Ramadass are with National Advanced IPv6 Centre (NAv6), University Sains Malaysia (hadi@nav6.usm.my, Sures@nav6.usm.my).

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III. Delaunay Triangulation

The Delaunay triangulation $D(P_n)$ of a set of n points P_n on the plane, is the partitioning of the convex hull of P_n into a set of triangles with disjoint interiors such that

- the vertices of these triangles are points in P_n
- for each triangle in our triangulation the circle passing through its vertices contains no other point of P_n in its interior.

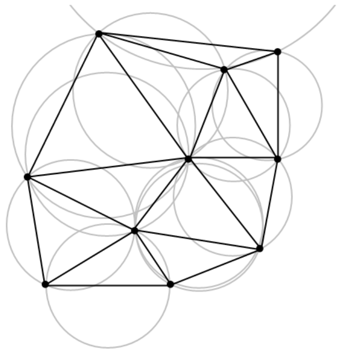

Fig. 1. A delaunay triangulation graph

IV. Compass Routing II

We now obtain a local information routing algorithm that guarantees that any message will eventually reach its destination. We describe our algorithm first for the case in which our geometric graphs are convexly embedded, i.e. all the faces of our geometric graph are convex, except for the unbounded one which is assumed to be the complement of a convex polygon, see Fig. 2. Our algorithm proceeds as follows:

Compass Routing II:

1) Starting at s determine the face $F = F_0$ incident to s intersected by the line segment st joining s to t. Pick any of the two edges of F_0 incident to s, and start traversing the edges of S_0 until we find the second edge, say $u - v$ on the boundary of F_0 intersected by st.
2) At this point, we update F to be the second face of our geometric graph containing $u - v$ on its boundary. We now traverse the edges of our new F until we find a second edge $x - y$ intersected by st. At this point we update F again as in the previous point. We iterate our current step until we reach t.

Let $F_0, F_1, \ldots F_r$ be the faces intersected by st. Observe $F = F_0$ that initially F_0, and that each time we update F, we change its value from F_i to F_{i+1}, so eventually we will reach F_k, the face containing t, and when we traverse its boundary we will arrive at t [3].

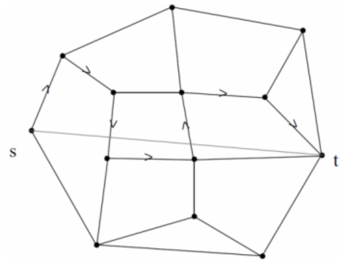

Fig. 2. Routing in convexly embedded geometric graphs.

Network lifetime has become the key characteristic for evaluating sensor networks in an application specific way. Especially the availability of nodes, the sensor coverage, and the connectivity have been included in discussions on network lifetime. Even quality of service measures can be reduced to lifetime considerations. A great number of algorithms and methods were proposed to increase the lifetime of a sensor network while their evaluations were always based on a particular definition of network lifetime. Motivated by the great differences in existing definitions of sensor network lifetime that are used in relevant publications, we reviewed the state of the art in lifetime definitions, their differences, advantages, and limitations.

This paper was the starting point for our work towards a generic definition of sensor network lifetime for use in analytic evaluations as well as in simulation models. Focusing on a formal and concise definition of accumulated network lifetime and total network lifetime. Our definition incorporates the components of existing lifetime definitions, and introduces some additional measures. One new concept is the ability to express the service disruption tolerance of a network. Another new concept is the notion of time-integration: in many cases, it is sufficient if a requirement is fulfilled over a certain period of time, instead of at every point in time. In addition, we combine coverage and connectivity to form a single requirement called connected coverage. We show that connected coverage is different from requiring non-combined coverage and connectivity. Finally, our definition also supports the concept of graceful degradation by providing means of estimating the degree of compliance with the application requirements. We demonstrate the applicability of our definition based on the surveyed lifetime definitions as well as using some example scenarios to explain the various aspects in uencing sensor network lifetime [11].

V. Lifetime in Compass Routing

Network lifetime is the time span from the deployment to the instant when the network is considered nonfunctional. When a network should be considered nonfunctional is, however, application-specific. It can be, for example, the instant when the first sensor dies, a percentage of sensors die, the network partitions, or the loss of coverage occurs [2].For a WSN with total non-rechargeable initial energy ε_0, the average network lifetime $\mathbb{E}[L]$, measured as the average amount of time until the network dies, is given by [2].

$$\mathbb{E}[L] = \frac{\varepsilon_0 - \mathbb{E}[E_\omega]}{P_c + \lambda \mathbb{E}[E_r]} \tag{1}$$

where Pc is the constant continuous power consumption over the whole network, $\mathbb{E}[E_\omega]$ is the expected wasted energy (i.e., the total unused energy in the network when it dies), λ is the average sensor reporting rate defined as the number of data collections per unit time, and $\mathbb{E}[E_r]$ is the expected reporting energy consumed by all sensors in a randomly chosen data collection. In [12] the authors denote E_{rx} for receive energy of signals (one bit) and E_{tx} for the transmit energy for a bit in the sensors. We suppose N

nodes are deployed in $M \times M$ area. And node S want to transfer data to node D. To transfer data node S desspate E_{rx} and each relays nodes received and then transferred the data (i.e. each relay node dissipate $E_{rx} + E_{tx}$) then node D just dissipate E_{rx}. As a result, if we have k relay nodes, the energy dissipation to communicate one bit from S to D is $(k+1)(E_{rx} + E_{tx})$ and For P consisting of N points, all triangulations contain 2N-2-K triangles, 3N-3-k edges [12]. N is number of points in P and k is number of pint in convex hull of p.

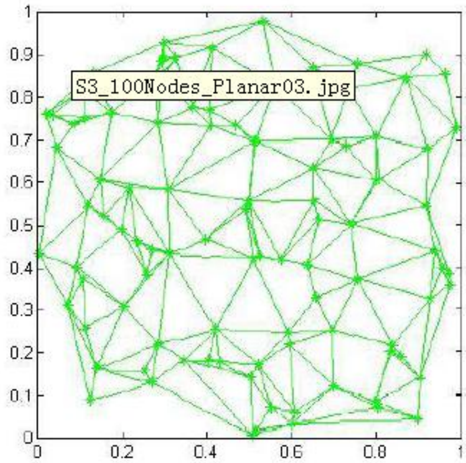

Fig. 3. A randomgraph with 100 nodes on the simulations.

TABLE. I: THE DELIVERY RATE OF DIFFERENT LOCALIZED ROUTING METHODS ON DELAUNAY TOPOLOGIES

Routing	Rate
Compass rout Compass Routing	100%
Random Compass Routing	100%
Greedy Routing	100%
Most Forwarding Routing	95.2%
Nearest Neighbor Routing	99.1%
Farthest Neighbor Routing	92.1%

We have run simulation for the greedy routing for 100 nodes in a 1×1 unit area with node transmission range 0.3. In each time two nodes is selected randomly and a packet is routed from source to destination and source node and destination node and relay nodes increase their counter to obtain energy consumption then to use for obtaining life time. The simulator transfers a frame 50000 times between two random selected nodes on a random graph. The result shows that greedy routing is better than compass routing in the delivery ratio and in both of compass and greedy nodes are on the face of the graph, consume energy less than others, and nodes are in the centre of the graph use more energy than other nodes. Each node is connected with more edge, relay more energy as result they are died sooner than others. Also the result shows delivery rate of Delaunay is 100%. Comparison between other routing algorithm shows in table1.

VI. CONCLUSION

One of the most interested open issues in wireless sensor networks is life time issue. Because of energy limitation the sensors will die and the networks cannot work well as a result increasing life time is very important. We simulate on the life time of the network base on Delanuay triangulation routing in localized routing. The result shows that nodes are on the face of the graph, consume energy less than others, and nodes are in the centre of the graph use more energy than other nodes. Each node is connected with more edge, relay more energy as result they are died sooner than others.

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