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EFFICIENT GEO-ROUTING WITH LOAD BALANCING AND ROUTING AROUND CONNECTIVITY HOLES IN WSN's

Ashwini S R[1], Dr. Nataraj K R[2]

[1]PG Student, DCN, SJBIT, Bangalore
[2]Professor and HOD, SJBIT, Bangalore
Email: ashwinigowda@gmail.com, nataraj.sjbit@gmail.com

Abstract: - Sensing and data collection are monitoring applications that are implemented using Wireless Sensor networks. Geographic routing is well suited for WSN applications. In Geo routing, routing protocol obtains information of each node location. That information is very important for sensor networks. In greedy forwarding, connectivity hole are major issue.

This paper presents ALBA, a protocol for geographic forwarding in Wireless Sensor network that balances the load among nodes using a hybrid metric and Rainbow mechanism, it is a node coloring algorithm for routing around dead-ends and connectivity holes without Planarization and face routing. In this paper the performance of ALBA-R in terms of packet delivery ratio, per packet energy consumption and end to end latency is evaluated using ns-2 based simulations. Our results show that ALBA-R is energy efficient protocol compared to the other routing protocol in dense WSN's i.e., GeRaf/ IRIS, thus it is best suitable for real network deployments.

Keywords: Wireless Sensor networks, Geographic routing, Connectivity holes, localization errors.

I.INTRODUCTION

In WSN, transmission range, Processing and storage capabilities as well as energy resources of sensor node are limited. Routing protocol for wireless Sensor networks routes the packet in the network and ensures reliable multi hop communication. Routers is a networking device that forwards the data packets, using information in its routing table or based on routing policy. Geographic routing or Geo-Routing is a routing scheme based on geographic position information. Geographic routing requires that each node determines its own location and the source is aware of the destination location. Then the message is routed to the destination with this information without using route discovery.

The important design challenges in many geographic routing schemes are

1) Routing around connectivity holes
2) Efficiency in relay selection
3) Localization errors recovery

Connectivity holes are related to the greedy forwarding. Greedy forwarding is a single path a strategy tries to bring the message nearer to destination in each step using local information only. Thus each node forwards the packet to its neighbor. If there is no neighbor closers to the destination lead to a dead-end.

In this paper, routing around connectivity holes are achieved by using converge casting protocol called ALBA(Adaptive Load Balancing algorithm) for geographic routing, load balancing, contention based relay selection along with the mechanism to route packets out of and around dead ends, the Rainbow protocol. The combination of these two protocols is known as ALBA-R (Adaptive Load Balancing Algorithm-Rainbow).

The main contribution of this paper to WSN includes:

1) Enhancement of greedy geographic forwarding with the consideration of congestion and packet advancement while making routing decisions.
2) ALBA-R, rainbow mechanism route packets out of and around dead end efficiently and resilient to localization errors.
3) Ns-2 based simulation experiments that we performed shows that the performance of ALBA-R is superior than other protocol such as Ge-Raf and IRIS.

Advantage of Proposed work:

- Performance is superior than the existing protocol in terms of energy consumption, packet delivery ratio and end to end latency.
- Guarantee packet delivery is achieved by Rainbow mechanism
- A simulation result shows better performance of proposed protocol for routing around dead ends.

II.LITERATURE SURVEY

Robust position-based routing in wireless ad hoc networks with unstable transmission ranges:

Routing in Ad-hoc wireless network are based on the positions of the mobile hosts. Protocol fails if the transmission range of the mobile host varies due to obstacle, noise or weather conditions. During routing some connection are not considered results in disconnection of the network, or lovelocks occur, causes protocol fall. Robust, delivers a message when an obstacle or noise occurs results in the deviation of communication model from unit disk graphs. It also achieves optimal shortest path algorithm for dense graph with greedy schemes.

A location-based routing method for mobile ad hoc networks:

Routing using location information achieves scalability in large mobile ad-hoc networks. When holes occur in the network topology and nodes are mobile or disconnected frequently to save battery, location based routing become more difficult. Terminode routing presented in this paper addresses these issues. It consists of two routing schemes; location based routing called Terminode Remote Routing (TRR), when the destination is far and link-state routing known as Terminode Local routing (TLR), when the destination is close.

Location information at each node is maintained by DREAM (distance Routing Effect Algorithm for Mobility) in routing tables and data packets are forwarded to the node in the direction of the destination. It also handles node failure, achieves guaranteed delivery and does not require additional storage.

Locating and bypassing holes in sensor networks:

In real sensor network, distribution of sensors is not uniform. The regions without enough sensor node results in holes in the network. For routing in WSN's, many algorithms uses greedy forwarding to forward packet to the destination. "Local Minimum Phenomenon ", cause packet stuck is studied from this paper. TENT rule, tests each node in the network whether packet is stuck at that node. BOUND hole helps to get out of packets from stuck node by building routes around the holes. Application of BOUND Hole are geographic routing, information storage mechanism, path migration and to identify the region of interest.

A scalable logical co-ordinates framework for routing in wireless sensor networks:

Geo-graphic routing is the most scalable routing scheme, where the location information is necessary for this scheme. However, computing the location using current localization algorithm is not easy. This paper presents novel logical co-ordinate framework that encodes connectivity information for routing purpose without the geographic knowledge.

The advantages of this scheme are:

1) Improved robustness
2) Allows inferring bounds on route hop count from the logical co-ordinates of the source and destination node, thus easy to use in soft real-time systems.

Survey of localization for wireless Sensor Network:

This paper proposes different localization algorithm such as Centralized, Distributed, Range-free, Absolute and Relative. In centralized localization, in order to obtain network wide environment information requires base station. It performs longer delay, lower energy .e.g., SDP (Semi Definite Programming). Each node is independent in Distributed localization method and it performs up to limited communication and poor localization. e.g., Diffusion and approximate point of triangular test. Range free localization is based on distance between the nodes to obtain unknown nodes location. Hence, it requires additional energy consumption. e.g., Centroid localization. Absolute localization method is based on GPS. Thus sensor is equipped with GPS receiver. The relationship of distance or angle between the nodes is obtained by relative localization method. It is performed by manual configured or reference node.

On the effect of localization errors on geographic face routing in sensor network:

In the absence of location errors, geographic routing uses a combination of greedy forwarding and face routing. This paper provides a detailed analysis of the effect on the location errors on the correctness and performance of geographic routing in static sensor networks.

Results shows incorrect geographic routing with noticeable degradation in performance even for small location errors. Simple modification for face routing eliminates probable errors and leads to near perfect performance.

III. ROUTING AROUND HOLES

Adaptive Load balancing algorithm:

It is a cross layer protocol for geographic forwarding in WSN that balances the load among nodes using a hybrid metric. In ALBA, forwarders are selected based on the geographic proximity to the destination and the ability to receive and correctly forwards the packets. Operation involved here is that requested number of packets is forwarded in bursts is N_B and Q is the number of packets in the queue. And M is the average number of packets transmitted back to back without errors. Then QPI is computed by $\min\{[(Q + N_B)/M], N_B\}$. By selecting the relay with low QPI

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balances the network load among the good forwarders. GPI is calculated based on positioning information; lower GPI is selected for better progress. Binary tree collision resolution mechanism is used for multiple nodes having same QPI and GPI values.

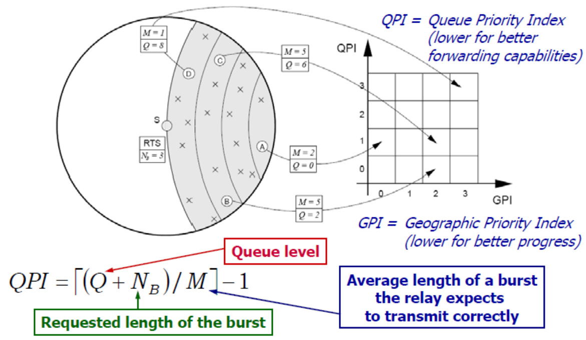


Figure: Hybrid metric in ALBA

Adaptive Load balancing algorithm-Rainbow (ALBA-R):

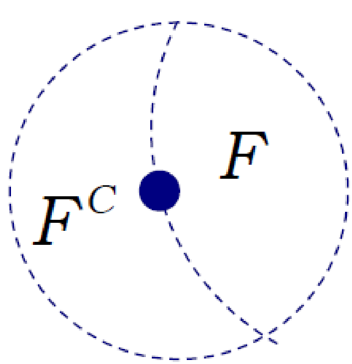
Dead end problem: The major difficulties that occur while performing geographic routing is dead end phenomenon. While forwarding the packet to the destination, if packet encounters a dead end it has to route the packet via an alternative route.

Current solution to dead end solution is planazing the network graph. It guarantees delivery and these algorithm can be distributed. But need to re-run if mobile destination an suffer from channel errors. Another approach to move the packets away from the dead-end is to compute the virtual destination. Algorithm includes TENT and BOUND Hole. TENT rule helps to know each node its 1-hop neighbor's location. BOUND Hole finds the boundary of the hole.

ALBA-R is a node coloring algorithm for routing around dead ends and connectivity holes. When the nodes recognize themselves as dead ends stop volunteering as relay. Therefore to route the traffic out of the dead end, nodes transmit backwards, in the negative advancement zone. Recursive coloring procedure can be achieved as follows.

In figure 2) F and F^c are the positive and negative advancement areas respectively. Initially all the nodes that uses greedy forwarding scheme to route the packet to sink remain yellow as in figure 3).

Figure 2. The F and F^c regions



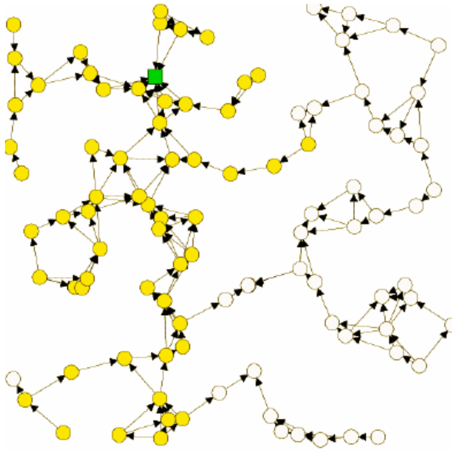


Figure 3: All the nodes are yellow

During routing, if yellow node cannot forward packet further, it switches to red as in figure 4. After occurrence of dead end node looks for either red or yellow relay in F^c region. If red node cannot forward further turn to blue as in figure 5, then they look only for red or blue relay in F region. Like this coloring continues until packet reach the sink.

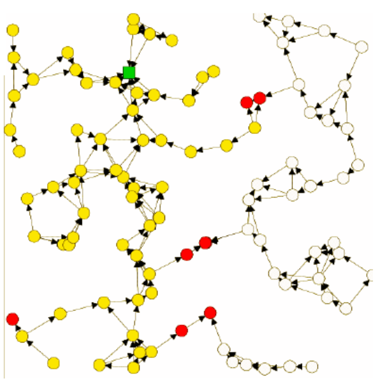


Figure 4: Switches to red

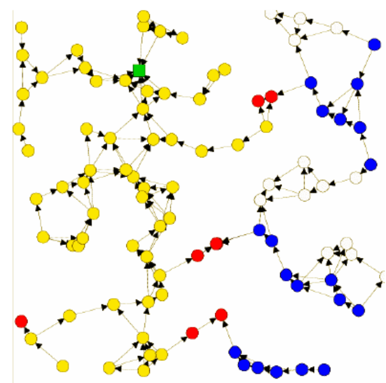


Figure 5: Switch from red to blue

In general, the number of color h is designer choice. More the number of colors, more nodes can be connected to converge-casting tree. C_0, C_1, ..., C_{h-1} are the selected set of colors.

When node encounters dead end, switching of nodes takes place as follows:

- Node labeled C_0 are the ones with greedy path to the sink
- Nodes with even color set i.e.,C_0, C_2, ... always search for relay in positive advancement region F.
- Nodes with odd color set i.e., C_1,C_3, ... always search for relay in F^c.
- Except C_0, other nodes C_k always look for C_k or C_{k-1} nodes. C_0 looks for other C_0 node.

IV. RESULTS AND DISCUSSION

Results is implemented by using ns-2 simulator. Performance parameters are packet delivery ratio, per packet energy consumption, end to end latency and throughput. The performance of ALBA-R (proposed) is compared with the GeRaF (existing) as shown in figures.

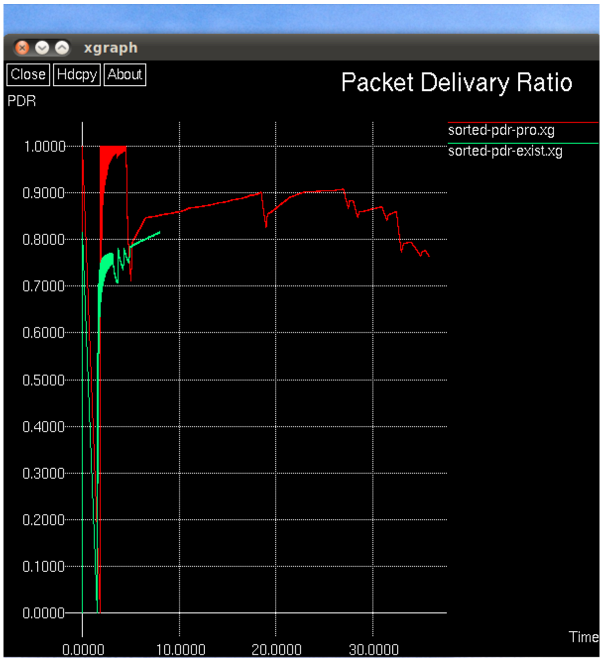


Figure 6.a): Packet Delivery ratio Comparison.

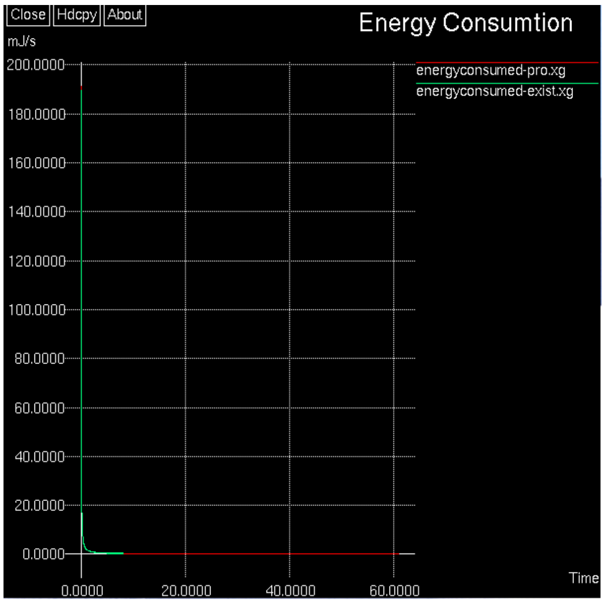


Figure 6.b): Energy Consumption Comparison

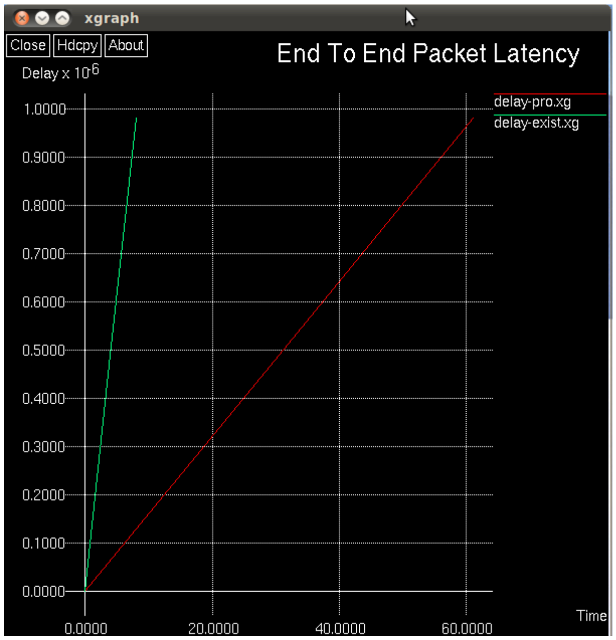


Figure 6.c): End to End latency Comparison

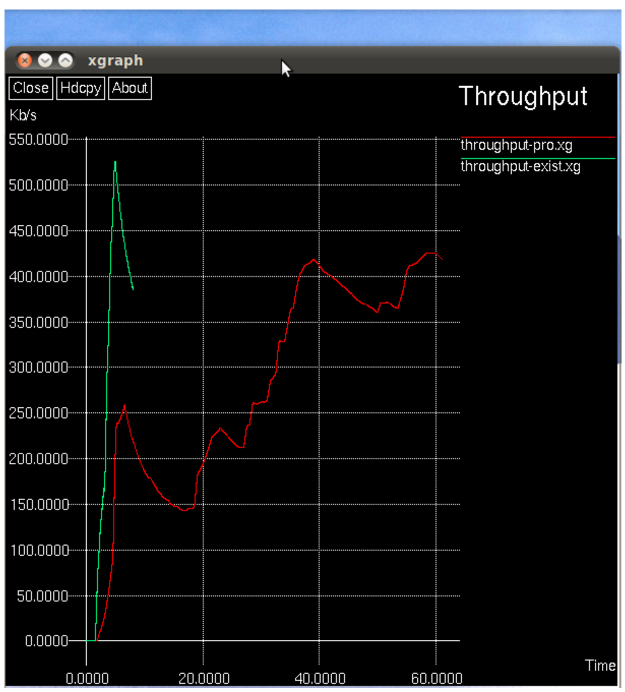


Figure 6.d): Throughput Comparison.

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V.CONCLUSION

Wireless sensor networks applications can be found in every field of life. One of the exigent problems occurring in such environment is the formation of network holes. It occurs when a group of nodes stop operating due to some reasons. Hole worsen the general performance of the networks. It destroys a major part of the network and leads to problems in data reliability and data routing. This paper gave an idea about connectivity holes in wireless sensor networks and some routing techniques that route packets around these holes. The cross-layer routing named ALBA-R gives the best performance in case of routing around connectivity holes. Comparing the performance of ALBA with GeraF shows that ALBA-R achieves remarkable delivery ratio and latency and can greatly limit energy consumption.

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