International Journal of Engineering Research and General Science Volume 3, Issue 3, May-June, 2015
ISSN 2091-2730

Load Balancing Geo-routing and routing around Holes in Wireless Sensor Networks

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
Contact: 8884640346, 8792240346

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, Greedy Forwarding, Connectivity holes, Dead ends, Planarization, face routing, localization errors**.**

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 protocol 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.

LITERATURE SURVEY

Robust position-based routing in wireless ad hoc networks with unstable transmission ranges[16]:
Several papers showed how to perform routing in ad hoc wireless networks based on the positions of the mobile hosts. However, all these protocols are likely to fall if the transmission ranges of the mobile hosts vary due to natural or man-made obstacles or weather conditions. These protocols may fall because in routing either some connections are not considered which effectively results in disconnecting the network, or the use of some connections causes lovelocks. These algorithms include Greedy mode and Recovery mode. The path strategies are shortest path, flooding-based, hop count. It provides low delivery rates for sparse graphs and high communication overhead for sparse graphs. It can perform up to 200 nodes geographic routing combined with GLS. Robust has the ability to deliver a message when the communication model deviates from the unit graph, due to obstacles or noise. It also involves greedy schemes for the performance of optimal shortest path algorithm for dense graphs.

A location-based routing method for mobile ad hoc networks[17]:
Using location information to help routing is often proposed as a means to achieve scalability in large mobile ad hoc networks. However, location-based routing is difficult when there are holes in the network topology and nodes are mobile or frequently disconnected to save battery. Terminode routing, presented here, addresses these issues. It uses a combination of location-based routing (Terminode Remote Routing, TRR), used when the destination is far, and link state routing (Terminode Local Routing, TLR), used when the destination is close. TRR uses anchored paths, a list of geographic points (not nodes) used as loose source routing information. Anchored paths are discovered and managed by sources, using one of two low overhead protocols: Friend Assisted Path Discovery and Geographical Map-based Path Discovery. DREAM proactively maintains location information at each node in routing tables and data packets are partially flooded to nodes in the direction of the destination. It able to handle node failures and provides guaranteed delivery. It does not require additional storage.

Locating and bypassing holes in sensor networks[18]:
In routing, holes cause difficulties in organizing the networks. Holes define the “hot spots” regions created by traffic congestion and sensor power shortage. A commonly used assumption in studying sensor networks is that sensors are uniformly densely distributed in the plane. However, in a real system deployment, this assumption does not generally hold. Even if sensors are distributed uniformly at random, there are still regions with sensor density much lower than others. In practice, sensor networks usually have holes, i.e. regions without enough working sensors.. The applications are avoiding network hot spots, supporting path migration. The applications are avoiding network hot spots, supporting path migration, information storage mechanisms. It can able to handle node failures, information storage and memory requirement. It uses TENT rule and BOUNDHOLE techniques to identify and build around holes. TENT rule requires each node to know its 1-hop neighbors locations. To help packets get out of stuck nodes, BOUNDHOLE to find the boundary of the hole.

A scalable logical co-ordinates framework for routing in wireless sensor networks[19]:
Large scale sensor networks can be deployed to carry out various tasks without the need for human intervention. Efficient data dissemination among different parts of the network is crucial for overall application performance. Such dissemination hinges on the

design and implementation of efficient routing protocols. The latter implicitly defines a set of destinations by their attributes and delivers the data to all matching destinations. It is likely that future sensor networks need both types of routing protocols. Content-based routing may be used as an efficient multicast mechanism that discovers a set of destinations matching given criteria (and returns their addresses to the sender if needed). Address-based routing can then be used to unicast data individually to particular destinations in the content-based groups as dictated by application logic. In this paper, focus on the latter type and assume that when the address-based routing is needed, the addresses of the destinations have been obtained in advance, presumably through some content based mechanism.

Survey of localization techniques in wireless sensor networks[20]:

The localization methods algorithms are centralized, Distributed, Range-free, absolute and Relative. In Centralized localization method requires base station to gather network wide environment information & with plenty of computational power. Examples are SDP-semi definite programming. It performs longer-delay, lower energy. In Distributed localization method each node is independent. It performs up to limited communication and poor localization. Example is diffusion and approximate point of triangular test. In Range-free localization method is based on distance between nodes to obtain unknown node's location. Therefore, it requires additional energy consumption. Examples are centroid localization, APIT. In absolute localization method is based on GPS. It requires sensor equipped with GPS receiver. It is easily understood and used by users. In relative localization method is used to obtain the relationship of distance (or) angle between nodes. It is performed by manual configuration or reference nodes.

On the effect of localization errors on geographic face routing in sensor networks[21]:

The reason for geographic routing protocols does not need to maintain per destination information and only neighbor location information is needed to route packets. Geographic routing protocols are very attractive choices for routing in sensor networks. Most geographic routing protocols use greedy forwarding for basic operations. Greedy forwarding is based on next forwarding hop is chosen to minimize the distance of the destination. It fails in dead-ends. Most geographic routing protocols use greedy forwarding for basic operations.In order to provide correct routing in the presence of dead ends, face routing has been introduced. GPSR is a geographic routing protocol for wireless networks that combines greedy forwarding and face routing. GPSR uses GHT is a geographic hash table system that hashes keys into geographic location and stores the key-value pair at the sensor node closest to the hash of its key.GHT uses mainly for geographic routing to the hash location. The applications are data centric storage and distributed indexing.

ROUTING AROUND HOLES

A.THE ADAPTIVE LOAD BALANCING ALGORITHM (ALBA):

ALBA [2] is a greedy forwarding protocol for WSNs. It is designed to take congestion and traffic load balancing into consideration. ALBA is a cross layer solution for convergecasting in WSN's that integrates awake/asleep schedules, MAC, routing, traffic load balancing, and back to back packet transmissions. Nodes alternate between awake/asleep modes according to independent wake-up schedules with fixed duty cycle d. Packet forwarding is implemented by having the sender polling for availability its awake neighbors by broadcasting an RTS packet for jointly performing channel access and communicating relevant routing information (cross-layer approach). Available neighboring nodes respond with clear-to-send (CTS) packet carrying information through which the sender can choose the best relay. Relay selection is performed by preferring neighbors offering "good performance" in forwarding packets.

Every relay is characterized by two parameters: the queue priority index(QPI), and the geographic priority index(GPI).

The QPI is Calculated as: The requested number of packets to be transmitted in a burst is N_B, and the number of packets in the queue of an eligible relay is Q. The potential relay keeps a moving average M of the number of packets it was able to transmit back-toback, without errors, in the last *k* forwarding attempts.

The QPI is then defined as min $\{[(Q + N_B)/M], N_B\}$, where $N_q$is the maximum allowed QPI. The QPI has been designed so that congested nodes (with a high queue occupancy Q) and "bad" forwarders (experiencing high packet transmission error, i.e., with a lower M) are less frequently chosen as relays. The selection of relays with low QPI,therefore, aims at decreasing latency at each hop by balancing the network load among good forwarders.

Based on positioning information (as provided to a node by GPS, or computed through some localization protocol), and on the knowledge of the location of the sink, each node also computes its GPI, which is the number of the geographic region of the forwarding area of the sender where a potential relay is located.
An example of QPI and GPI assignment is provided in figure 2.

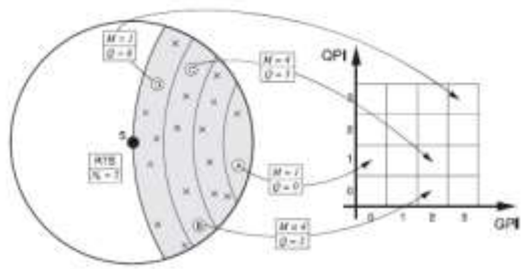


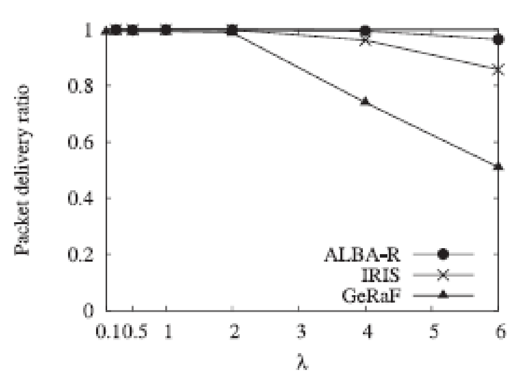
Fig 2: Computing QPI and GPI Values.

B.THE ADAPTIVE LOAD BALANCING ALGORITHM- RAINBOW (ALBA-R):

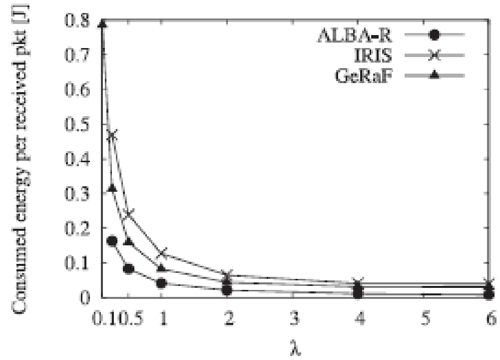
ALBA-R[1] features the cross-layer integration of geographic routing with contention-based MAC for relay selection and load balancing (ALBA), as well as a mechanism to detect and route around connectivity holes (Rainbow). ALBA and Rainbow (ALBA-R) together solve the problem of routing around a dead end without overhead-intensive techniques such as graph planarization and face routing.
The Rainbow mechanism allows ALBA-R to efficiently route packets out of and around dead ends. Rainbow is resilient to localization errors and to channel propagation impairments. It does not need the network topology to be planar, unlike previous routing protocols. It is, therefore, more general than face routing-based solutions and is able to guarantee packet delivery in realistic deployments.

RESULTS AND DISCUSSION:

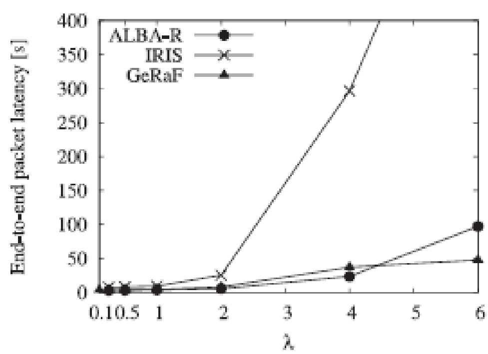
We compare ALBA with two protocol that are of cross layer routing in dense WSN's, i,e., We compare ALBA with two protocols that are exemplary of cross layer routing in dense WSNs, i.e., in networks where dead ends are not likely to occur. The first protocol is GeRaF, one of the first cross layer protocols based on geographic greedy forwarding [3]. The other protocol is IRIS [5], which performs convergecasting based on a hop count metric and on a local cost function.
Results are shown in Fig. 3 for networks with 600 nodes. ALBA achieves the best performance in terms of packet delivery ratio, per packet energy consumption, and end-to-end latency. It scales to increasing traffic much better than the other two protocols because of the effectiveness of the QPI-based selection scheme in balancing the traffic among relays, of its low overhead, and its being able to aggregate packets into burst.



(a) Packet delivery ratio.



(b) Per packet energy consumption.



(c) End-to-end packet latency.

ACKNOWLEDMENT:

I would like to thank Dr. Nataraj K R, HOD, Department of Electronics and Communication, SJBIT Bangalore, for his support, guidance and encouragement throughout the course of this work.
I am indebted to my family for supporting me with my work and my interest.

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. Results from an extensive performance evaluation comparing ALBA-R, GeRaF, and IRIS show that ALBA-R achieves remarkable delivery ratio and latency and can greatly limit energy consumption.

REFERENCES:

[1]Stojmenovic, "Position Based Routing in Ad Hoc Networks," IEEE Comm. Magazine, vol. 40, no. 7, pp. 128-134, July 2002.

[2]K. Seada, A. Helmy, and R. Govindan, "On the Effect of Localization Errors on Geographic Face Routing in Sensor Networks," Proc. IEEE/ACM Third Int'l Symp. Information Processing in Sensor Networks (IPSN '04), pp. 71-80, Apr. 2004.

[3]M. Zorzi, "A New Contention-Based MAC Protocol for Geographic Forwarding in Ad Hoc and Sensor Networks," Proc. IEEE Int'l Conf. Comm. (ICC '04), vol. 6, pp. 3481-3485, June 2004.

[4] Q. Fang, J. Gao, and L. Guibas. "Locating and bypassing routing holes in sensor networks", in proc. Mobile networks and applications, vol.11, page(s).187-200, 2006.

[5] S. Funke. "Topological hole detection in wireless sensor networks and its applications", in proc. of 3rd ACM/SIGMOBILE International Workshop on Foundations of Mobile Computing (DIALM-POMC), Cologne, 2005, page(s). 44-53.

[6] Y. Wang, J. Gao, and Joseph S.B. Mitchell. "Boundary recognition in sensor networks by topological methods", in 12th Annual International Conference on Mobile Computing and Networking (MobiCom'06), Los angeles, USA, September 2006.

[7] J. Li, J. Jannotti, D. DeCouto, D. Karger, and R. Morris. "A scalable location service for geographic ad-hoc routing", in proceedings of 6th Annual ACM/IEEE International Conference on Mobile Computing and Networking, 2000

[8] S. Ratnasamy et al. "GHT: A geographic hash table for data-centric storage in sensornets", in 1st ACM International Workshop on Wireless Sensor Networks and Applications (WSNA), 2002, page(s).78–87.

[9] S. Lee, B. Bhattacharjee and S. Banerjee. "Efficient Geographic Routing in Multihop Wireless Networks", in proc. of the 6th ACM International Symposium on Mobile Ad hoc Networking and computing, page(s).230 – 241, Urbana-Champaign, IL, USA,2005.

[10] N. Ahmed, S.S. Kanhere, S. Jha. "The holes problem in wireless sensor networks: a survey", in ACM SIGMOBILE Mobile Computing and Communications Review, New York, USA, 2005, page(s).4-18, vol.9, issue.2.

[11] M. Battelli and S. Basagni, "Localization for Wireless Sensor Networks: Protocols and Perspectives," Proc. IEEE Canadian Conf. Electrical and Computer Eng., (CCECE '07), pp. 1074-1077, Apr. 2007.

[12] Z. Li, R. Li, Y. Wei, and T. Pei, "Survey of Localization Techniques in Wireless Sensor Networks," Information Technology J., vol. 9, pp. 1754-1757, Sept. 2010.

[13]. Q. Fang, J. Gao, and L. Guibas. ―Locating and bypassing routing holes in sensor networks‖, in proc. Mobile networks and applications, vol.11, page(s).187-200, 2006

[14]. Y. Wang, J. Gao, and Joseph S.B. Mitchell. ―Boundary recognition in sensor networks by topological methods‖, in 12th Annual International Conference on Mobile Computing and Networking (MobiCom'06), Los angeles,USA,September 2006.

[15]. C. Zhang, Y. Zhang and Y. Fang. ―Defending against physical destruction attacks on wireless sensor networks‖, in Military Communications Conference, 2006, MILCOM 2006, page(s) 1-7, October 2006, Washington, DC.

[16] L. Barrie`re, P. Fraigniaud, L. Narayanan, and J. Opatrny, "RobustPosition-Based Routing in Wireless Ad Hoc Networks withUnstable Transmission Ranges," J. Wireless Comm. and Mobile Computing, vol. 2, no. 3, pp. 141-153, 2001.

[17] L. Blazevic, J.-Y. Le Boudec, and S. Giordano, "A Location-BasedRouting Method for Mobile Ad Hoc Networks," IEEE Trans.Mobile Computing, vol. 4, no. 2, pp. 97-110, Mar. 2005.

[18] Q. Fang, J. Gao, and L.J. Guibas, "Locating and Bypassing Holes inSensor Networks," ACM Mobile Networks and Applications, vol. 11, no. 2, pp. 187-200, Apr. 2006.

[19] Q. Cao and T. Abdelzaher, "A Scalable Logical Coordinates

Framework for Routing in Wireless Sensor Networks," Proc. IEEE Real-Time Systems Symp., pp. 349-358, Dec. 2004.
[20] Z. Li, R. Li, Y. Wei, and T. Pei, "Survey of Localization Techniquesin Wireless Sensor Networks," Information Technology J., vol. 9, pp. 1754-1757, Sept. 2010.

[21] K. Seada, A. Helmy, and R. Govindan, "On the Effect ofLocalization Errors on Geographic Face Routing in Sensor Networks," Proc. IEEE/ACM Third Int'l Symp. Information Processingin Sensor Networks (IPSN '04), pp. 71-80, Apr. 2004