

Wireless Sensor Networks (WSN): Geographic Routing nearby Connectivity Holes

Nafiza Syed
Asso. Prof.
Department of ECE
Siddhartha Institute of Technology and Sciences
Narapally, Hyderabad, Telangana, India

Radhika Goli
Asst. Prof.
Department of ECE
Siddhartha Institute of Technology and Sciences
Narapally, Hyderabad, Telangana, India

Abstract— Wireless sensor network has various challenges among which the two major issues are coverage and connectivity. Closed-end routing is solved by the current technology Adaptive Load Balancing Algorithm and Rainbow (ALBA-R). However, in ALBA-R, the network's lifetime can only be prolonged up to a specific point. A self-healing method is employed to recover the hole in the network in the suggested system, Advanced Adaptive Load Balancing Algorithm with Rainbow Mechanism (AALBA-R). The rainbow technique is used to determine which nodes are affected by dead ends and should transfer the packet to the destination. When a relay selection towards the sink cannot be discovered, this method permits the nodes to send packets away from the sink. We can improve the network lifetime and cover the most area by using this approach. We demonstrated that the packet delivery ratio and network lifetime are enhanced, and the end-to-end delay is lowered, using simulation.

Keywords - ALBA-R, Life Time, Network, Delivery Ratio, Simulation

I. INTRODUCTION

Wireless Sensor Networks (WSN) are made up of spatially distributed autonomous sensor nodes that monitor real-world properties and send data to the appropriate area. By conveying the message, the sensor nodes communicate with one other. The majority of WSN protocol research focuses on geographic location routing techniques, in which a relay is greedily picked depending on the distance to the sink. One key design difficulty that many geographic routing methods addressed was routing around connectivity holes [1]. A hole in the network is defined as a set of sensor nodes that stop working and do not participate in data sensing and communication. Communication is hampered by the gaps. The flaws have a significant impact on the network's performance. Damaged, attacked, or inaccessible nodes in the network are identified using hole detection. If there is a hole in the network, data will be routed along the hole boundary nodes repeatedly, causing the energy present at these nodes

to be depleted prematurely. The size of the network hole will grow as a result of this. The detection of holes prevents additional energy usage due to congestion around the holes. It guarantees a long network life and appropriate service quality [2].

To mitigate the impact of connectivity holes, several solutions have been proposed. Face routing ensures packet delivery using a planar graph, and on face Planar graphs, on the other hand, do not operate in the presence of localization defects [3].

1. To present a converging casting protocol called Advanced adaptive load balancing Algorithm-Rainbow (AALBA-R) that cope with high density networks and uses the Rainbow mechanism for packet routing.

2. The AALBA-R, a self-healing algorithm, must be utilized to repair the network hole utilizing sensor node relocation. The sensor node is moved to increase energy efficiency and eliminate traffic and connectivity gaps in the network. The AALBA-R compares topological based converge casting, such as IRIS [4], with learning how to route packets around connectivity holes, such as learning how to route packets around connectivity holes [5]. In terms of energy efficiency, packet delivery ratio (PDR), and latency, AALBA-R outperforms the competition.

2 RELATED WORK

GeRaF is one of the pioneer cross-layer converge casting solutions in WSN. It saves energy by having nodes shift between awake and sleepy states according to a defined duty cycle schedule. IRIS is a framework for converge casting in wireless sensor networks (WSNs) that uses hop count routing. The system is combined with a probabilistic forwarding-based interest dissemination algorithm. The load balanced routing objective for hole diffusion and path enlargement was primarily created to deal with large holes in the network. The goal is to provide the area's size and shape [6]. Sensor network lifetime is extended by improving energy efficiency and

coverage. The LEACH clustering algorithm boosts performance and extends the life of the system [7].

The distributed MAC technique allows for high-performance and efficient data transport relaying [8]. At remote nodes, distributed sensor networks run programs. The DSN employs a simplified analytical model for a sensor network in order to maximize received signal intensity while minimizing path loss and energy usage [9]. There are a variety of solutions available for dealing with connectivity gaps. Topologically based warping is performed using virtual coordinates. Furthermore, hop count is used to connect the coordinates of one node to another node. Greedy routing forwards packets caught in dead ends even if they lack location information, but it does not remove them. [10] [11][12][13][14]. Greedy routing does not allow for geographic routing. Planarization only necessitates a few connectivity holes and as few next hop relays as practical. A solution-based planar graph has a number of drawbacks. By imposing larger latencies on a spanner network that comprises a set of techniques [15], a planar graph switch with a large number of nodes can be created. [16][17]. Furthermore, due of the construction of protocols, localization problems result in disconnected planar graphs that are non-planar. Assume that the network topology is characterized by Unit Disk graph (UDG), but this cannot be ensured in most genuine scenarios. Periodic signals must be used to ensure that no links are crossed, as determined by the Cross-Link Detection Protocol (CLDP)[18]. However, in WSNs, this transmission influences network performance.

3. THE ADVANCED ADAPTIVE LOAD BALANCED ALGORITHM

The issue of connection holes is discussed in this section. Connectivity holes are created by voids in sensor deployment or by sensor node failure for a variety of causes such as malfunctioning, battery depletion, or an external event such as a wildfire or a structural collapse physically destroying the nodes. Local minimum phenomena, which is common in geographic greedy forwarding, can also cause routing holes. The distance between node size, position, and colour in the network was set to zero. Route discovery enables nodes to find routes in the network and choose which one to use. The nodes are placed in areas where there is a lot of traffic. Then transmit the Request to Send (RTS) packet after updating the sink location.

3.1 Fast Relay Selection

A RTS packet is broadcast by the sender to communicate pertinent routing information. The available nearby nodes react with a clear-to-send (CTS) packet including data that allows the sender to select the optimal relay. The queue priority index (QPI) and the geographic priority index (GPI) are two characteristics that define relay (GPI). The requested number of packets to be sent in a burst (back-to-back transmissions) is NB, while the number of packets in an eligible relay's queue is Q. The possible relay continues to move an average of M packets it was able to send back-to-back without mistakes. The QPI is then calculated as $\{\min(Q + NB)/M, Nq\}$, where Nq is the highest possible QPI.

By balancing network traffic across good forwarders, QPI seeks to reduce latency at each hop. GPI calculates the number of geographic regions in the sender's forwarding area where a prospective relay can be found. It sends out RTS to qualified forwarders, asking them to compute their QPI and GPI and inviting responses from nodes QPI. The RTS provides all of the data that the relays need to calculate their QPI and GPI. The RTS is answered by eligible forwarders, the best GPI search begins, and the set of qualified forwarders is determined. This decision was taken to facilitate a quick relay selection after locating a region with active neighbors.

3.2 Coloring

The Rainbow process defines the color of each node, ensuring that there is always a feasible route to the sink. AALBA's Rainbow technique for dealing with dead ends. When a relay giving advancement toward the sink cannot be found, the basic principle for preventing connection holes is to allow nodes to move packets away from the sink. Each node is tagged by a color picked from an ordered list of colors to remember whether to seek for relays in the direction of the sink or in the opposite direction, and searches for relays among nodes with its own color or the color immediately before it in the list.

3.3 Cross Layer Integration

Wake/sleep schedules, MAC, routing, traffic load balancing, and back-to-back packet transmissions are all integrated into a cross-layer solution for converge casting in WSNs to achieve an energy-efficient data gathering method. AALBA-R uses a cross-layer relay selection method that favors nodes that can forward traffic more effectively and reliably, depending on

traffic and link quality, to reduce end-to-end latency and scale up to large traffic.

4. THE RESOLVINGCONNECTIVITY HOLE AND AALBA-R

The self-healing algorithm searches for different routes to automatically rearrange their network link. The edges are added with respect to the location information in the network if the central control node in the region identifies connectivity holes. The central controller locates the nearest node to be relocated (select potential energy node) and calculates the position and distance required to shift the node to its new location. Sensors form a circle around a specific geographical location. Only a specific area is covered by the sensor. The central controller requests that the sensor node be moved to the appropriate zone. A node can be adjacent to another node at an angle higher than 120 degrees. It is necessary to reposition a sensor node. Sensor node relocation improves energy efficiency and lowers the occurrence of traffic and connectivity gaps.

5.PERFORMANCE EVALUATION

The network simulator has all protocols integrated within it (NS-2). Successful packet delivery has been achieved using a fixed transmission range. We give out 50-node networks. In each zone, the sensors are covered in an ordered circle form. The typical number of nodes transmitting varies between 200 and 300. A large amount of data traffic has been created over the whole network. Per node, the average packet queue length should be 20 packets. New packets are accepted when the buffer is not full. The traffic rate should range between 2 and 4 packets per second.

Our simulations must update all of the outcomes. We considered the packet delivery ratio, end-to-end delay, and packet overhead before and after the sensor node was relocated.

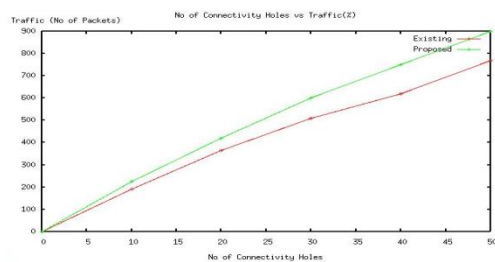


Fig. Traffic in the network before relocating the Sensor Nodes

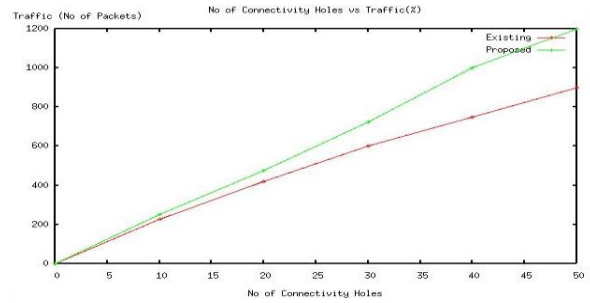


Fig. After Relocation of Sensor Node

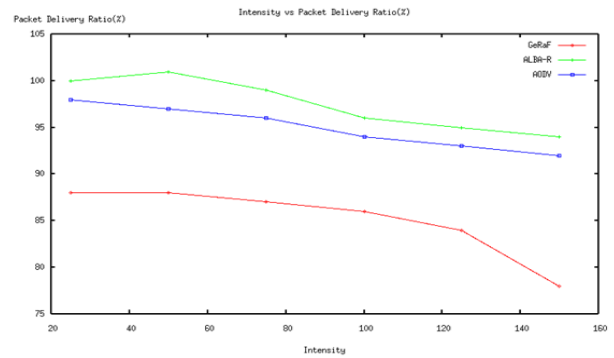


Fig. Packet Delivery Ratios

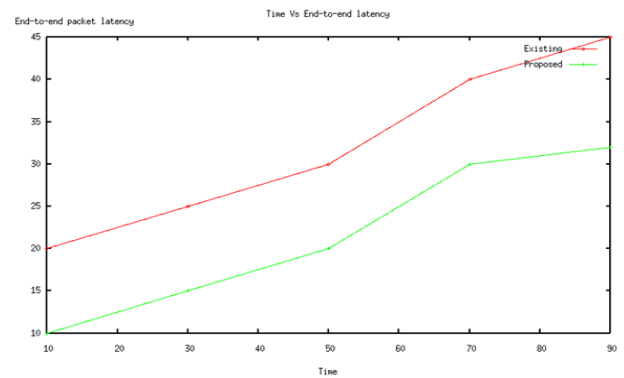


Fig. End-to-End Latency

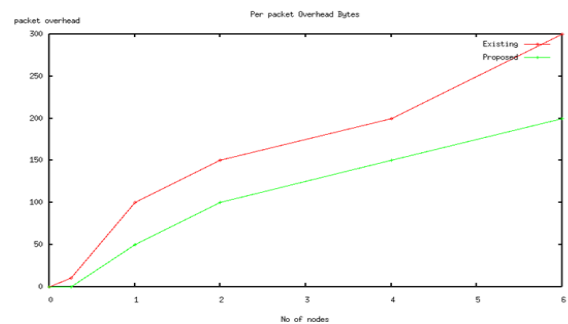


Fig. Packet Overhead

Each packet requires extra bytes of format information due to packet overhead. The raw data's overall transmission speed is slowed as a result of this overhead.

6. CONCLUSION

We introduced the Advanced adaptive load balancing Algorithm-Rainbow (AALBA-R) for converge casting in this project, which deals with high density networks and uses the Rainbow mechanism for packet routing. The AALBA-R achieves energy efficiency by combining geographic routing, dead end handling, and back-to-back transmission. The energy-efficient routing protocol uses loop freedom to perform routing. The amount of color changes in the pathways from a node to the sink determines the loop freedom. Holes are recognized and prevented for the specified spot utilizing a self-healing algorithm. The link is unavailable if one or more connectivity gaps have arisen. By shifting the sensor nodes and modifying the colors using the rainbow technique, AALBA-R allows packets to be transmitted through the sink. We can lower the end-to-end delay, extend the network lifetime, and cut energy usage by doing so.

REFERENCES

1. H. Huang, H. Yin, G. Min, J. Zhang, Y. Wu and X. Zhang, "Energy-Aware Dual-Path Geographic Routing to Bypass Routing Holes in Wireless Sensor Networks," in *IEEE Transactions on Mobile Computing*, vol. 17, no. 6, pp. 1339-1352, 1 June 2018, doi: 10.1109/TMC.2017.2771424.
2. L. Cheng, J. Niu, J. Cao, S. Das and Y. Gu, "QoS aware geographic opportunistic routing in wireless sensor networks", *IEEE Trans. Parallel Distrib. Syst.*, vol. 25, no. 7, pp. 1864-1875, Jul. 2014.
3. C. Fraser, C. Kevin, S. Jose and M. Sandra, "A survey of geographical routing in wireless Ad-Hoc networks", *IEEE Commun. Surv. Tutor.*, vol. 15, no. 2, pp. 621-653, Apr.-Jun. 2013.
4. Q. Chen, S. S. Kanhere and M. Hassan, "Adaptive position update for geographic routing in mobile Ad Hoc networks", *IEEE Trans. Mob. Comput.*, vol. 12, no. 3, pp. 489-501, Mar. 2013
5. H. Frey and I. Stojmenovic, "On delivery guarantees of face and combined greedy face routing in Ad Hoc and sensor networks", *Proc. 12th Annu. Int. Conf. Mobile Comput. Netw.*, pp. 390-401, 2006
6. X. Li, J. Yang, A. Nayak and I. Stojmenovic, "Localized geographic routing to a mobile sink with guaranteed delivery in sensor networks", *IEEE J. Selected Areas Comm.*, vol. 30, no. 9, pp. 1719-1729, Oct. 2012.
7. G. Tan and A. M. Kermarrec, "Greedy geographic routing in large-scale sensor networks: A minimum network decomposition approach", *IEEE/ACM Trans. Netw.*, vol. 20, no. 3, pp. 864-877, Jun. 2012.
8. J. Kuruvila, A. Nayak and I. Stojmenovic, "Progress and location based localized power aware routing for Ad Hoc and sensor wireless networks", *Hindawi Int. J. Distrib. Sen. Netw.*, vol. 2, no. 2, pp. 147-159, 2006.
9. Y. Yan, G. Ramesh and E. Deborah, "Geographic and energy aware routing: A recursive data dissemination algorithm for wireless sensor networks", 2001.
10. G. Zhao, X. Liu and M. T. Sun, "Energy-efficient geographic routing with virtual anchors based on projection distance", *Elsevier Comp. Commu.*, vol. 31, no. 10, pp. 2195-2204, Jun. 2008.