ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 2, Issue 12, June 2013

Geographic Routing Protocols for Wireless Sensor Networks: A Review

Rama Sundari Battula, O. S. Khanna

Abstract*— Wireless Sensor Networks (WSNs), which is a system of nodes connected by wireless links, is a very popular area for exploration. The nodes are free to move around and organize themselves into a network. The network topology is often changing, and for relatively smaller networks, the flat routing schemes are sufficient. However in larger networks, either geographical or hierarchical routing protocols are required. Geographical routing uses location information to formulate an efficient route search toward the destination. In this paper, some of the major geographic routing protocols for WSNs are presented.

***Index Terms*—Geographic Routing, Wireless Sensor Networks.**

I. INTRODUCTION

Sensor network is an infrastructure comprised of sensing (measuring), computing and communication elements that gives an administrator the power to observe and respond to events in a given environment. The four basic components of sensor network are explained in Figure 1.

- Distributed and localized sensors
- An interconnecting network
- A Central point of information clustering
- A set of computing resources at that central point to manage the data correlation, status queuing as well as data mining.

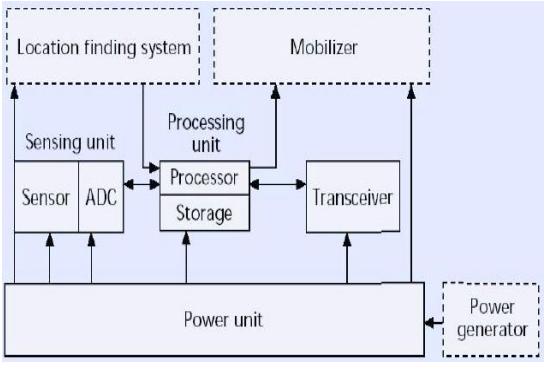

Fig 1 Components of Sensor Nodes [1]

A. CHALLENGES AND HURDLES IN WIRELESS SENSOR NETWORKS

- Limited functional capabilities, including problems of size
- Power factors
- Node costs
- Environmental factors
- Transmission channel factors
- Topology management complexity and node distribution
- Standards versus proprietary solutions
- Scalability concerns

B. APPLICATIONS OF SENSOR NETWORKS [1] [13]

There are many applications of the WSNs. The military applications include monitoring of enemy forces, monitoring of friendly forces and equipment, military –theatre and battlefield surveillance, battle damage assessment, targeting, nuclear and chemical attack detection and many more. The environmental applications include microclimates, forest fire detection, flood detection and precision agriculture. Among the health applications are monitoring doctors and patients within a hospital, remote monitoring of psychological data, drug administration, elderly assistance and many more. The home applications inculcate home automation and instrument environment. The commercial applications include environmental control in industrial and office buildings, inventory control, vehicle tracking and detection, and traffic flow surveillance.

II. ROUTING IN WIRELESS SENSOR NETWORK

The network layer of sensor networks contributes for routing in it. It is designed according to the following principles:

- Power efficiency is always important.
- Sensor networks are mostly data centric.
- Data aggregation is practicable only when it does not hamper the cooperative efforts of the sensor nodes.
- An ideal sensor network has attributed based addressing and location awareness.

Energy efficient routes can be found based on the available power (PA) in the nodes or the energy required (α) for transmission in the links along the routes. [2] An energy efficient route is selected by one of the following approaches.

- Maximum PA route
- Minimum energy route
- Minimum hope route
- Maximum minimum PA route.

A. GEOGRAPHIC ROUTING

Geographical routing [2] [3] uses location information to formulate an efficient route search toward the destination. Geographical routing is very suitable to sensor networks, where data aggregation is a useful technique to minimize the number of transmissions toward the base station by eliminating redundancy among packets from the different sources. [1]It is much attractive for large multi-hop wireless

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 2, Issue 12, June 2013

networks in which the nodes are not reliable and their network topology is frequently changing. Geographical routing only requires the propagation of single hop topology information, like the best neighbor, to make correct forwarding decisions. Its localized approach reduces the need of maintaining routing tables, and hence reduces the control overhead. It does not require flooding. Only nodes that lie within the designated forwarding zone are allowed to forward the data packet. The forwarding region can be defined by the source node or by the intermediate nodes to exclude nodes that may cause a detour while forwarding the data packet. The second property of geographical routing is its position based routing. Here a node requires knowing only the location information of its direct neighbor. The mechanism used is greedy mechanism where each node forwards a packet to the neighboring node that is closest to the destination. The Euclidean distance to the destination is generally used as metric. Position based routing protocols have the potential to reduce control overhead and reduce energy, as flooding for node discovery and state propagation are localized to within a single hop [1]. The network density, the accurate localization of nodes and the forwarding rule decides the efficiency of the scheme.

B. ADVANTAGES OF GEOGRAPHIC ROUTING

- The mobility support can be facilitated. Since each node sends its coordinates periodically, all its neighbors update their routing tables accordingly. Thus all nodes aware of its alive neighbor nodes.
- It is scalable. The size of routing table depends on network density not on network population. Hence wider networks consisting of thousands of nodes can be realized without cluster formation.
- Minimum overheads are introduced. The only information needed is the location of neighbors. Only localized interactions take place. Hence bandwidth is economized. The processing and transmission energy is saved and the dimensions of routing table are decreased.

III. REVIEW OF GEOGRAPHIC ROUTING PROTOCOLS

P. Karkazis et al [2] discuss about the security attacks in wireless sensor networks. The security issues can be tackled by checking the location information in the networks. They analyzed the second security attack as the malicious node does not forward any or part of the received packets. The paper discusses solution to both of these attacks. They reviewed different geographical routing protocols and their advantages and disadvantages. The authors anticipated that geographical routing is going to be a crucial protocol in future since it offers a clear, low cost solution for WSN killer applications. They suggest that the location information required to perform geographical routing can be achieved through a variety of techniques at different implementation costs. The paper assures that geographical routing can be exploited to build scalable, dense, secure and energy aware ad-hoc wireless sensor supporting high mobility levels. Pramod Kumar et al [3] attempt to analyze geographical location based hierarchical routing algorithms. The entire network life time depends on energy of individual nodes. The routing algorithm is modified in such a way that it highly depends on location information. This is to utilize the scare resource of energy. A Binary Location Index is formulated based on the binary encoded spatial frames for all participating nodes. This is to impart location aspects in an algorithm in much simpler way and avoids the situation of 'hot spot'. In the proposed method the entire service area is divided in to four zones and indexed as (I, II, III and IV). These zones are subdivided into subzones and into regions, sub regions and lastly into grids. The grids are further decomposed into infinitesimal area called cells. After a long duration these Location Areas and simple nodes reach their specified lowest energy. And it leads to a phenomenon called hot spot. This hot spot effect should be prolonged till the occurrence of maximum expected time (Horizon time). The selection of LAs and sensor nodes should be done likewise, for lifetime maximization of entire network. Young-Gwan and Kang [4] propose the routing protocols that define the direction of data which is routed based on the position information of individual and sink nodes. The objective of this paper is to extend the service life of networks by reducing the energy consumed in networks through reducing the frequency of communication in each node using the routing protocol that employs position coordinates in each node. The paper defines a direction defining algorithm and evaluates its operation, to perform this goal. The proposed algorithm by authors, the position coordinate is not applied to actual longitudes and latitudes but simple abstractized x and y coordinates because it evaluates the performance of the protocol in a simulation level. In their work they conclude that the nodes that received messages identify whether their own position corresponds to the direction for the target area. If the results of the identification are true, the message will be forwarded, otherwise destroyed. Tarek R. Sheltami et al [5] use energy aware neighbor selection to route a packet towards the target region and geographic forwarding or flooding approaches to disseminate the packet inside the destination region.

The Protocol's object is to fairly balance the energy among neighbor nodes. The paper evaluates the performance of GEAR protocol and investigates the possibility to optimize its operation to achieve greatest performance. The simulator used is java. Static centralized strategy, dynamic and adaptive decentralized strategies are included for distance and energy balancing. The authors describe the importance of energy efficient communication and routing techniques to increase the network life time. They analyzed many protocols proposed by different researches. GEAR minimizes delay due to distance traveled on geographic routing and improving energy balancing and improves energy balancing. The main contribution of this GEAR protocol is experimental analysis and investigates the optimization problem and tradeoffs between distance and energy balancing. The paper also

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 2, Issue 12, June 2013

narrates the impact of the preference metric in the system performance. The preference parameter α is defined and it is used to manipulate static, dynamic and adaptive assignment approaches. The paper concludes that the preference choice in the static approach or in the dynamic or adaptive approaches does not have a major impact on the optimality of GEAR operation. Ana Maria Popescu et al [6] surveys almost 50 protocols and considers the position based routing with many advantages worth considering. Position based protocols have application potential in networks with demanding requirements. Of all the position based protocol the geographic approach is the one which captures the attention in the context of location aided routing. The authors say that geographic routing is an elegant way to forward packets from source to destination in very demanding environment without wasting network resources or creating any impediment in the network design. The paper gave application suggestions for position based routing protocols, like industrial, home, health, environmental, military, automotive and commercial.

The authors suggested future work in geographical routing. Position based algorithms have to consider the intrinsic error of inaccurate localization techniques. They say more practical solutions are needed which maintain energy consumption low and preserve the packet delivery ratio even when nodes are mobile. The paper also discusses about 3D applicability and secure routing. B.Shanmuga Raja et al [7] discuss about modified GPSR (Greedy perimeter Stateless Protocol). In traditional GPSR nodes advertise their availability to update the routing table. Here the authors introduce modified GPSR, which identifies optimal route based on energy utilization. The energy and delay are minimized and substantially increases the network lifetime of sensor node. But it still uses GPSR with bulk of overheads. In the proposed scheme is the energy consumed to send a message to a distant node is greater than the energy needed for a short transmission. Here GPSR is extended using aggregation node or head set node. It is proved in this algorithm that Modified algorithm produces good performance in routing path lengths compared to previous protocols. Marc et al [8] discussed about GRMax (Greedy Routing for Maximum Lifetime). The authors proposed this protocol whose goal is to manage the restricted energy so that the wireless sensor network stay connected for the maximum time possible (By adding VIP nodes). This algorithm combines the energy consumption optimization with the use of multiple routes. In this algorithm an active route (also called the primary route) is monitored to control its residual energy. Meanwhile other routes can be discovered. If the residual energy of the active route does not exceed the energy of an alternative route, the corresponding secondary route is then used. Bin Guo et al [9] discussed the shortcoming of the various algorithms used for clustering. The shortcoming they observed is, in all these protocols the clusters are performed in advance. The actual data distributed and the similarity of the data is not considered. The authors propose a Dynamic clustering algorithm called DCRR (Dynamic Clustering Reactive Routing Algorithm). The nodes are modeled with some basic behaviors like Excite, Transmit and receive. DCRR changes the classical methods in which all the cluster heads are selected in advance. The function of temporary cluster head can be diverted among the nodes in the area where the event takes place moves [7].

The algorithm uses the similarity of the data, decreased the messages forwarded and hence it enhances the efficiency of the data merging. The authors compare the performance of DCRR algorithm with another clustering algorithm TEEN and found that DCRR gives better balance in battery power and extends the network lifetime. Chunguo Jing et al [10] discuss about an application in geographical routing. The authors propose a mechanism consisting of sensor node, a remote terminal unit [RTU]. In this paper, a geographical routing strategy was proposed based on network features. The proposed work is simple and not need to maintain net topology and complex path discovery algorithms. The node manual deployment, obstructions among nodes, clustering and energy unlimited are thoroughly summarized. The authors improved the node forwarding approaches used in flooding to fit the street lighting system. Here each node is self and ensures reliable of data transmission. It adopts broadcast to transmit data and has high consumption. The authors in [11] clearly highlight two types of mechanisms in routing- Geographical routing and Reactive approach. Geographic routing is used to find the optimal path. In reactive routing, routing occurs only on demand.

The RGRP (Reactive Geographical Routing protocol) proposed by the authors reduce the packets for routing discovery and end to end delay and hence possible to get low routing protocol overhead and more reliability for long link. They suggest two steps to find the shortest path-first, calculating the shortest path between source and destination, and second, to create the reverse route.

The performance characteristics like packet loss, average end to end delay, and route discovery overheads are compared with the GPSR and proved them to be better. Lijuan Wang et al [12] propose improved algorithm GPSRI (GPSR- Improved) which reduces the delay and hops. It resolves the void issue of GPSR very effectively. The reliability can also be improved by node- disjoint multipath realization. It improves greedy Forwarding and adds the path optimization strategy by finding the node disjoint multi paths. Comparison is evaluated between GPSR and GPSRI and proved that GPSRI gives better results regarding transfer delay, multipath realization and number of hops.

IV. CONCLUSION

WSNs have seen tremendous developments in design and applications over the recent years. This speedy progress has resulted in the stress towards solving the hurdles that this area has to face. Routing is an important issue in WSNs. The literature review in this paper elaborately discussed the various geographical routing protocols.

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 2, Issue 12, June 2013

REFERENCES

[1] Kazem Sohraby, Diniel Minoli and Taieb Znati "Wireless sensor networks- Technology,protocols and applications" A John Wiley & Sons, Inc.,Publications.

[2] Kakaziz,p; Liliguo, H.C; Zahariadis, T; Orphanoudakis, T" Geographical routing in Wireless sensor networks" International conference on Telecommunications and Multimedia (TEMU), Pages 19-24, 2012.

[3] Kurmar,p; Chaturvedi, A; Kulkarni, M; "Geographical location based Hierarchical routing Strategy for wireless Sensor networks". IEEE Conference on Devices, Circuits and Systems (ICDCS), pp. 9 – 14, 2012.

[4] Young Gwan, K; Yim Jae-Hong "Position Coordinate- based energy efficient routing protocol for wireless sensor networks", Fuzzy systems and knowledge Discovery (FSKD), 9th IEEE international conference, Page(s): 2193-2197, 2012.

[5] Sheltani, T.R, Shashuki E.M, Maarouf I.K," Performance evolution for geographical and energy aware protocol" GCC conference & Exhibition 5th IEEE page(s) 1-5, 2009.

[6] Ana Maria Popescu, Gabriel Ion Tudorache, Bo Peng, Andrew H. Kemp, "Surveying position based routing protocols for Wireless Sensor Networks" International Journal of Communication Networks and Information Security (IJCNIS) vol4, No1 page(s):41-65.

[7] Bin Guo; Zheli; Yan Meng "A Dynamic Clustering Reactive Routing Algorithms for Wireless Sensor Networks" Communication and Networking in Chaina, IEEE Conference Publications. Page(s): 1-6, 2006.

[8] Marc, A.K.J.; Okada, K.; Kanai, K.; Onozato, Y. "Greedy Routing for Maximum Lifetime in Wireless Sensor Networks", IEEE 20th International Symposium on Personal, Indoor and Mobile Radio Communications, Page(s): 1888 – 1892, 2009.

[9] Raja, B.S.; Prabakaran, N.; Dhulipala, V.R.S. "Modified GPSR Based Optimal Routing Algorithm for Reliable Communication in WSNs". International Conference on devices and Communications (ICDeCom), Page(s): 1-5, 2011.

[10] Chunguo Jing; Liangchao Ren; Deying Gu, "Geographical routing for WSN of street lighting monitoring and control system", International Conference on Computer Design and Applications (ICCDA), 2010 Vol: 3 Pp.V3-235 - V3-238, 2010.

[11] Rong Ding; Lei Yang, "A Reactive Geographic Routing Protocol for Wireless Sensor Networks". IEEE Sixth International Conference on Intelligent Sensors, Sensor Networks and Information Processing (ISSNIP), 2010.

[12] Lijuan Wang; Haitao Liang, "Research and Improvement of the Wireless Sensor Network Routing Algorithm GPSR". International Conference on Computing, Measurement, Control and Sensor Network (CMCSN), Page(s): 83 – 86, 2012.

[13] Al.Karaki, J.N, Kamal, A.E, "Routing Techniques in Wireless Sensor Networks", Wireless Communication IEEE, vol 11, page(s) 6-28, 2004.

[14] Arampatzis, Th, Lygeroes, J, Manises, S, "A Survey of Applications of Wireless Sensors and Wireless Sensor Networks", Intelligent Control, IEEE International Symposium on, Mediterrean Conference on Control and Automation, Page(s): 719 – 724, 2005.

AUTHRO'S PROFILE

B. Rama Sundari, M.E. scholar, NITTTR, Chandigarh.

O.S Khanna, Associate professor in ECE department, National Institute of Technical Teachers Training and Reasearch