Engineering Universe for Scientific Research and Management
(International Journal)
A Universe of Research
ISSN(ONLINE) : 2319-3069
Vol. 9 Issue 3
March 2017

# Energy Efficient Routing Protocol for Load Balanced Wireless Sensor Network: A Survey

**Bahskar Pandey[1], Anurag Jain[2]**
**Department of Computer Science & Engineering**
**Radharaman Institute of Technology and Science, Bhopal[1, 2]**

**Abstract**

Now a days there are number of communication technologies but wireless technologies are mostly used and in wireless technology. Maxing network lifetime is a vital consideration when designing routing protocol in Wireless Sensor Networks(*WSNs*). Traditional routing protocols mostly concentrate on minimizing the total network energy dissipation. However, balancing energy consumption is also important in many applications of *WSNs*. This paper focus recent research on the multi-transmission power of sensor node to raise the linkage of topology to decentralize the load of the sensor nodes around the sink node and build a routing mechanism with load balance to enhance the network lifetime. Finally this paper gives a bird eye over sensor network and their load spectrum towards lifetime of network.

**Keywords: Wireless Network, Sensor Network, Load Balancing, Proactive, Reactive, Hybrid Routing Protocol**.

## 1. Introduction

In recent years, Wireless Sensor Networks (WSNs) areapplied in many areas, such as environment monitoring, medical treatment, traffic control and target tracking, etc. However, the limited and irreplaceable battery power of each sensor node have hindered the development of WSNs. Making use of sensor node's energy to prolong the networks lifetime is a primary goal when designing WSNs routing protocol.

The main task of WSN is to perceiving and collecting the information from the application environment it is in [1]. So, more and more wireless sensor nodes are used in the fields of environmental monitoring, medical care target tracking and military. Routing protocol plays an important role in the WSN. It decides the extendibility and reliability of WSN.Most of the nodes in the WSN are powered by battery, and it has a large amount of nodes that the general node has limited capabilities in calculation and storage. The design of traditional routing protocol of WSN mainly aims at simple networking and energy conservation but has no relatively systematic consideration on network multi hop,reliability and extendibility and the capabilities of node storage, calculate and transmission. So, it is necessary to design a low power consumption routing protocol which has no high demands on the capabilities of node storage and calculation and can also be networked in large scale.

Due to the energy conserving and well expansibility [1], Cluster-based routing protocol has been caused a wide attention. Among many hierarchical clustering routing protocols, the Low-energy Adaptive Clustering Hierarchy (*LEACH*) [2] was firstly proposed. On the one hand, compared with the non-clustering routing protocols ,both the energy consumption and the first node dead time have greatly improved, however , the protocol also has many disadvantages, such as the uneven distribution of cluster heads, the election of cluster heads has disregarded the node's residual energy, etc. aiming at the deficiency of *LEACH* protocol, there are many improved protocols have been proposed, such as *LEACH*-Centralized(*LEACH-C*) [3], Power-Efficient Gathering in Sensor Information Systems (*PEGASIS*)[4], Hybrid Energy-Efficient Distributed Clustering (*HEED*)[5], Threshold sensitive Energy Efficient sensor Network (*TEEN*)[6] et al. Among these protocols, mostly belonging to dynamic clustering, As everyone knows, frequently clustering will consume extra energy of sensor nodes, The fuzzy C-means(*FCM*) clustering routing protocol are considered good solutions to optimize the cluster structure[7], which can improve the network lifetime through minimizing the energy consumption of intra clustering communication. In the literature, protocols such as [8-9],many*FCM* routing protocols have been proposed. However, the problem *FCM* creates is that the noise points ,far but equidistant for the central structure of two clusters, which can nonetheless be given equal membership in both, when it seems far more natural that such points be

given very low membership in either cluster. PossibilisticCMeans (*PCM*)[10] can overcome this problem, which through relaxing the constrains of membership in *FCM*, to reduce the effect caused by noise points. However, *PCM* is very sensitive to initializations, and it sometimes generates coincident cluster.

## 2. Sensor Networks

Wireless Sensor Networks (WSNs) have a few to many of tiny sensor nodes which are used to sense the data, compute the sensed data, and then transmit that data by transreceiver. Many protocols for routing of data, power management which is main issue in WSNs, and data transmission are framed for them, in all this energy consumption or the life span of WSN is a major design issues. There are three types for routing of data which are:- data should be centric, data should be sending hierarchically and third one is location-based data transmission. The main objective of all routing techniques is to get better throughput and to increase lifetime of the detector network. Traditionally routing WSNs is based on topologies. Drawback of using topologies is the regular use of particular path and its sensor node, due to regular use of tracing nodes they become dead and are unable to forward the packets generated by other sensor nodes, these packets then will never reach their destination and are discarded. Many routing techniques fail to address the design issues of WSNs. The aim is to provide balancing of load among the nodes and to overcome the packet loss due to dead sensor nodes. So, there is a mechanism for balancing of load among nodes known as ALBA mechanism which split the data into packets, generate a key for each packet, so that when particular packet is discarded can be recognized and resend, and signature on data for authentication.

In configuration of WSNs many sensor nodes are dispersed throughout a specific physical area. Actually there is no particular architecture or hierarchy of sensor nodes in WSNs and therefore, the WSNs are considered ad hoc network. As wireless sensor networks are used for particular application so they may be used as separate networks, these networks can be connected to other wireless network to form larger Internet through a base stations which are places where the information send by senor nodes is collected they are having complex and usually have an unlimited power supply. With the recent advancement in wireless detector technologies and ease of their use these networks are deployed for multiple functions like monitoring of area, monitoring of health, monitoring of air/water pollution, forest fire detection, landslide detection etc. the main motive of sensor nodes in WSNs is to sense the area , collect information and send it to the destination for further operations.

There are number of routing protocols which are designed for many applications. Most of the routing protocols follow single path strategy in which trough out the life of WSNs single route is followed. In tree based topology data transmitted from root node to its next neighbor sensor node forming a parent child relation. In normal topologies cluster level strategy are used in cluster heads are formed which are responsible for sending to the base stations but all these topologies have some drawbacks and the main issue is the life span of wireless less networks.

## 3. Path Planning in Sensor Networks

On a plane, many wireless nodes are kept, which are collecting data. The data needs to be transmitted to a base station, where the whole data processing will take place. So, there are various approaches for the same. First is, multihop forwarding, where the nodes are in the range of each other such that, the data from one node can be transmitted to the basestation by multiple transmission and reception. Though this process is quite fast, but has various disadvantages. Firstly, the lifetime of a node nearer to the basestation will decrease drastically, as they will always be involved in the communication. So, as the number of nodes will increase, the lifetime of the nodes nearer to the base station will decrease. Moreover, the nodes should always be kept in such a way, so that, they would lie in the range of some nodes, so that data can be transmitted till the base station. And as a result, larger number of nodes will be needed for covering an area, as connectivity among the nodes should also be met. Also, proper protocols needed to be setup, so that, collision while transmitting is minimum, as many nodes can try to transmit the data at the same time. As a result, problems like node synchronization problems can also occur. Considering these issues, an alternative approach has been put into effect, where rather than nodes

transmitting data, [3]a mobile device is installed which travels to every node, and collect data from them. This device is called data mule. This process improves the lifetime of the whole system manifold. But, as a single mule needs to cover all the nodes, to collect data, latency issues will arise. As a result, path optimization becomes an important task. [2]The paper, Path planning of Data mules in sensor networks, by Ryo Sugihara and Rakesh Gupta, has worked on this problem of optimizing the path of the Data mule. They have divided the problem into three parts: 1) Path Selection: Finding such a path, such that, mule will be able to cover all the nodes. 2) Speed Manipulation: Changing the speed of the mule in such a way, so that, minimum time is taken in collecting all the data from the nodes. 3) Scheduling: The whole schedule, as to when, data from which node should be collected, needs to be worked out beforehand, in order to avoid collision problems later. They have tried to increase the independence between the three parts, and then tried to optimize each one of them. As finding an optimal path, to travel to all nodes and collect data from them, resembles Travelling Salesman Problem(TSP), which is an NP- hard problem. So by heuristics, they have come up with a path, where firstly, they made a clique between all the nodes, then found a minimum spanning tree (MSP) on the same, and then came up with a TSP-like formation on the same. For decreasing the path further, they have exploited the concepts of the wireless networking. There is no need to go till the node, for collecting the data. A mule is capable of collecting the data from a node by mere being in its range, rather than going till the node. So, when a mule is moving on a predefined path, and the mule is in the range of some unvisited node, than rather than going till the unvisited node and wasting time, the mule will collect data on its path only. So, by using this approach, where we are bypassing some nodes, as they lie on the path to some other nodes, decreases the distance as well as the total time to a great extent. As this iteration and pruning based method, reduces the path and time, we have come up with more strategies to reduce the path further. they have used the concepts of Steiner points, for the same. Suppose there are 5 nodes, whose ranges are overlapping in a region. So, we will put a Steiner point in this overlapped region. So, if the mule will visit this Steiner point, there will not be any need to travel to the 5 nodes separately, as the mule will be able to collect data from all these 5 nodes by just visiting a single point.

## 4. Sensor Network Routing Protocols: A Brief Overview

Sensor Network routing protocols are IP based and may use unicast, multicast or hybrid approaches and should allow for interaction with standard wired IP services rather than being regarded as a completely separate entity. Figure 1 shows the categorization of different routing protocols of Sensor Network.

**Reactive Routing Protocols**

In reactive (also known as Demand based) routing protocols, a route is discovered only when it needed. Nodes only maintain routes to active destinations. The communication overhead is reduced at the expense of delay due to route search. These protocols are significant for the Ad hoc environment since battery power is conserved both by not sending the advertisements and by not receiving [17]. All nodes maintain the discovered routes in their routing tables. However, only valid routes are kept and old routes are deleted after an active route timeout. A serious issue for sensor network arises when link failures occur due to high node mobility; at the same time new links may also be established between previously distant nodes. This significantly increases the network broadcast traffic with rapid link make/break effect of intermediate nodes. Figure 2 shows the path discovery process for a reactive routing protocol [18].

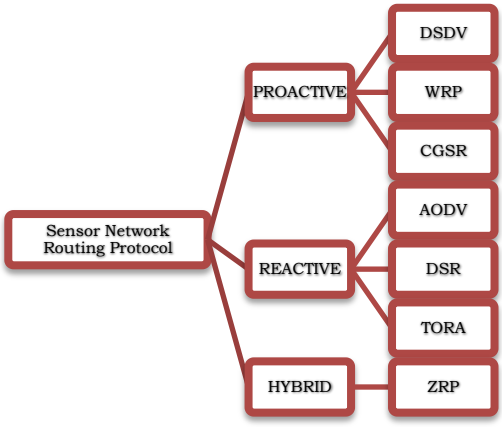


Figure 1: Routing protocols of Sensor Network

**Proactive Routing Protocols**

In proactive schemes, also known as table driven approaches, every node continuously maintains the complete routing information of the network. When a node needs to forward a packet, the root is readily available; thus there is no delay in searching for a root. However for a highly dynamic topology, the proactive schemes spend a significant amount of scarce wireless resources in keeping the complete routing information correct [19]. However, when frequency of link breakage is high, the proactive routing protocols need a higher rate routing table updates, which lower the network performance.

**Hybrid Routing Protocols**

Hybrid routing is the third category of routing scheme, in which proactive and reactive, both approaches are combined. An example of such a protocol is Zone Routing Protocol (ZRP).

## 5. Related Work

The work of 2014 Delaney, D., Russell Higgs, and G. O'Hare [11] on a tree structural routing in WSNs introduced the central concept of neighborhood heuristics (NHs), it is a method in which routing of data and finding location of destination is considered in wholistic manner. The best sensor location is finding out by combining the metrics of presently used sensor nodes and the metrics of its neighbor nodes. The destination node is considered as the central node where all data is collected, the sensor nodes when transmit the data select the best node having good quality alternative routes so that at the time of failure of any sensor node neighbor sensor node route can be followed to transmit the data. 2014 Ghadimi, Euhannaet. al. [12] have proposed Opportunistic Routing in Low Duty-Cycled WSNs. Traditionally data is transmitted in two steps: in first step routing protocol select next sensor node and in second step protocol MAC wait for terminus sensor node to get up to receive the data as WSNs are considered as standalone networks in which nodes get slept when they are not used to increase the life span of the network. So in the paper the authors have introduced ORW, for WSNs. In a Duty cycled setting data packets are forwarded to each neighbor sensor node and sensor node which wakes up first receives the data. This method increases the strength of the WSNs. 2014 Sahin, Dilan et. al. [13] has worked upon a technique applied for the communication system of smart grid. WSNs place an important role to cope up with the problem which is faced by power grid with its low cost deployment characteristics. During bad environmental condition when power grid stops working due to occurrence of fault WSNs are used as they are deployed prior to check the weather condition. In it clusters form as WSNs are deployed to large areas. Each cluster has cluster head sensor nodes under particular cluster has sent data to it, data collected at cluster head is further send to the BS. WSNs are also deployed in power grid to check the fault occur during bad environmental condition. In this regard, this helps in developing of routing protocols for environments of smart grid. 2012 Kwon, Kiwoonget. al. [15] IP WSN is an essential thing for IoT (Internet of Things). There are various routing protocols which are proposed for IP WSNs but they have some issues like point to point traffic in which many processing resources are required to address the problem in P2P traffic stateless P2P routing protocol (SPR) is used in it data packet is delivered to the node having smallest remaining hop count instead of delivering data from parent to child tree route. SPR also provide stateless routing in which it determines the route through hierarchical address and one neighbor information without storing the global route. 2014 Tunca, Can, SinanIsik, M. Donmez, and CemErsoy [16] as we know in tree based routing the knob nearer to the terminus knob lose their batteries faster as compare to other knob and cause the destruction of the network to solve this problem they have proposed a survey upon distributed mobile sink routing method for WSN. In mobile sink routing method Mobile sinks provide load balancing and uniform consumption of the energy in sensor knobs. Mobile sink means that terminus knob is not fixed the location of terminus node in WSN changes as per the energy of its neighboring nodes, but it introduces overheads in measures of packet delivery delay or energy consumption. 2012 Bechkit, Walidet. al. [17] as in tree based routing aim is to send the traffic toward destination node the author of present research use shortest path routing tree (SPT) mechanism. In this mechanism the cost of each path is calculated by summation of the weights alloted to the paths and path with minimum cost is used for transmission of data. In many to one WSN there is a problem so weighted path

cost function is used and on the basis of these weights tree is constructed for transmitting the data.

## 6. Conclusion

This paper gives a review over load balancing towards minimized power consumption. Parking garage in wireless sensor network restricts power consumption and data transmission time in terms of hardware equipment and service management. That leads to overuse power consumption of sensor node and degrade the life time of network. However, balancing energy consumption is also important in many applications of *WSNs*. This paper focus recent research on the multi-transmission power of sensor node to raise the linkage of topology to decentralize the load of the sensor nodes around the sink node and build a routing mechanism with load balance to enhance the network lifetime.

## Reference

[1] K Akkaya and M Younis, "A survey of routing protocols in wireless sensor networks," Ad Hoc Networks, 2005, pp. 325-349.
[2] W R Heinzelman, A Chandrakasan, and H Balakrishnan, "Energyefficient communication protocol for wireless microsensor networks,"Proc.HICSS-33, Maui, Hawaii, USA, pp. 10–19,Jan 2000.
[3] W R Heinzelman, A Chandrakasan and H Balakrishnan, "An application-specific protocol architecture for wireless microsensor networks," IEEE Transactions on Wireless Communications, 2002, pp. 660-670.
[4] S Lindsey , C S Raghavendra, and K Sivalingam , " Data gathering algorithms in sensor networks using energy metrics," IEEE Transactions on Parallel and Distributed Systems, 2002, pp. 924–935.
[5] O Younis and S Fahmy , " HEED: A hybrid, energy-efficient, distributed clustering approach for ad hoc sensor networks ," IEEE Trans, Mobile Computing, vol.3, pp. 366–379,2004.
[6] A Manjeshwar and D P Agrawal, "TEEN: a routing protocol for enhanced efficiency in wireless sensor networks," Proceedings of the 15th Parallel and Distributed Processing Symposium (IPDPS '11), San Francisco, Calif, USA, pp. 2009–2015, 2001.
[7] D C Hoang, R Kumar, and S K Panda , " Realisation of a cluster-based protocol using fuzzy C-means algorithm for wireless sensor networks ," IET Wireless Sensor Systems, 2013, pp. 163–171.
[8] D C Hoang, R Kumar, and S K Panda , " Fuzzy C-means clustering protocol for wireless sensor networks ," in Proceedings of the IEEE International Symposium on Industrial Electronics (ISIE '10), pp.3477– 3482, July 2010.
[9] OsamaMoh'd Alia. "A Decentralized Fuzzy C-Means-Based Energy - efficient Routing Protocol for Wireless Sensor Networks," The Scientific World Journal, vol. 2014, Article ID 647281, 9pages, 2014. doi:10.1155/2014/647218.
[10] R Krishnapuram and J Keller, "A possibilistic approach to clustering," IEEE Trans Fuzzy Systems,1993, pp. 98-110.
[11] Delaney, D., Russell Higgs, and G. O'Hare. "A stable routing framework for tree-based routing structures in wsns." (2014): 1-1.
[12] Ghadimi, Euhanna, Olaf Landsiedel, Pablo Soldati, Simon Duquennoy, and Mikael Johansson. "Opportunistic Routing in Low Duty- Cycled Wireless Sensor Networks." ACM Transactions on Sensor Networks 10, no. 4 (2014).
[13] Sahin, Dilan, VehbiCagriGungor, TaskinKocak, and Gurkan Tuna. "Quality-of-service differentiation in single-path and multi-path routing for wireless sensor network-based smart grid applications." Ad Hoc Networks (2014).
[14] Singh, Dharmendra, Shubhanjali Sharma, Vinesh Jain, and JyotiGajrani. "Energy efficient source based tree routing with time stamp in WSN." In Signal Propagation and Computer Technology (ICSPCT), 2014 International Conference on, pp. 120-124. IEEE, 2014.
[15] Kwon, Kiwoong, Minkeun Ha, Taehong Kim, SeongHoon Kim, and Daeyoung Kim. "The stateless point to point routing protocol based on shortcut tree routing algorithm for IP-WSN." In Internet of Things (IOT), 2012 3rd International Conference on the, pp. 167-174. IEEE, 2012.
[16] Tunca, Can, SinanIsik, M. Donmez, and CemErsoy. "Distributed Mobile Sink Routing for Wireless Sensor Networks: A Survey." (2014): 1-21.
[17] Bechkit, Walid, MouloudKoudil, YacineChallal, AbdelmadjidBouabdallah, BrahimSouici, and KarimaBenatchba. "A new weighted shortest path tree for convergecast traffic routing in WSN." In Computers and Communications (ISCC), 2012 IEEE Symposium on, pp. 000187- 000192. IEEE, 2012.
[18] Adam N., Ismail M. Y., Abdullah J., Effect of node density on performances of three MANET routing protocols, ICEDSA, Pages: 321- 325, 2010.
[19] Sakar N. I. Lol W.G., A study of MANET routing protocols: Joint node density, packet length and mobility, ISCC, Pages: 515-520, 2010.

[20] Kumar D., Srivastava A. And Gupta S.C., Performance comparison of pro-active and reactive routing protocols for MANET, ICCCA, Pages: 1-4, 2012