International Journal of Innovative Research in Engineering & Management (IJIREM)
ISSN: 2350-0557, Volume-2, Issue-3, May-2015

# Effective Survey on Hierarchical Routing Protocols in WSN

**Miss Reshma Jayesh Rasal**.
Final Year Master of Engineering
Department of Computer Engg.,
SPCOE,Dumbarwadi, Otur
Savitribai Phule Pune University,
Pune, India.
Email: reshmarasal2@gmail.com

**Dr. Shyamrao V. Gumaste**.
Professor and Head,
Department of Computer Engg,
SPCOE, Dumbarwadi, Otur
Savitribai Phule Pune University,
Pune India
Email: svgumaste@gmail.com

**Prof. Gajanan S. Deokate**.
Assistant Professor
Department of Computer Engg,
SPCOE,Dumbarwadi, Otur
Savitribai Phule Pune University,
Pune India
Email: deokate.gd@gmail.com

## ABSTRACT

Wireless Sensor Networks (WSNs) gives low cost solutions to various real world problems. WSN consists of autonomous sensors located at distance to monitor physical or environmental conditions, such as sound, vibration, pressure, temperature, motion or pollutants and to cooperatively transfer their data through the network to a main location. The energy balancing for nodes is an important factor in wireless sensor networks. Energy consumption is an essential design issue in WSNs. Thus, many routing, power management and data dissemination protocols have been specifically designed for WSNs. Designing energy-efficient routing mechanism to extend the overall network lifetime has become most important. So this paper studies the different hierarchical routing protocols.

**Keywords—**Cluster based routing protocol, Wireless Sensor Network, Sensor nodes, Cluster head

## 1. INTRODUCTION

Now day's wireless networks and multifunctional sensors develop rapidly with digital processing, power supply and communication capabilities. Wireless sensor networks are being widely deployed in physical environments for monitoring fine-grains in different classes of applications [1], [3]. Typically there are two deployment modes in wireless sensor networks. In one mode, if the price of the sensors is high and deployment with a huge number of sensors is not feasible then a small number of sensors are deployed in some preselected locations in the area. Here the most important issue is sensor placement means the place sensors in order to fulfill certain performance criteria. In second mode, if low cost sensors with a limited battery life are available then they are usually deployed with high density (up to 20 nodes) [2]. Here, the most important issue is *density control* means how to control the density and relative locations of active sensors at any time so that they properly cover the monitoring area. Other relevant issue is how to rotate the role of active sensors among all the sensors so as to extend the network lifetime. [4].

Current research on wireless sensor networks has typically assumed that nodes are homogeneous. But reality is different, that is homogeneous sensor networks rarely exist and homogeneous sensors also have different capabilities like different levels of depletion rate, initial energy etc. Hence the research on heterogeneous networks comes into existence where nodes considered are of two to three types. Mostly researchers commonly assume that nodes are divided on their functionalities base that are of two types such as advanced nodes and normal nodes. Initial energy of powerful nodes is more and fewer amounts as compare to the normal nodes and they act as clustering heads as well as relay nodes in heterogeneous networks. All researchers assume that the normal nodes have identical length data to transmit to the base station. Existing research in a heterogeneous sensor networks have two different types of nodes where they have same initial energy but different length data to transmit. The main restriction in designing a routing protocol in WSNs is the limited power of sensor nodes that authorized the design of energy-efficient communication protocol. Many protocols proposed for different wireless networks like mobile or ad-hoc. But, these protocols cannot be used directly because resource constraints of sensor nodes like limited battery power, computational speed and density of nodes and human interface of node devices in network. Aim of clustering techniques in wireless sensor networks is to gather data among groups of nodes, which select leaders (i.e. Clusterhead) among themselves. The cluster-heads or leader has the role of aggregating the data and reporting the refined data to the base station (BS). This paper studies the different hierarchical routing protocol for extending the network lifetime in heterogeneous WSN.

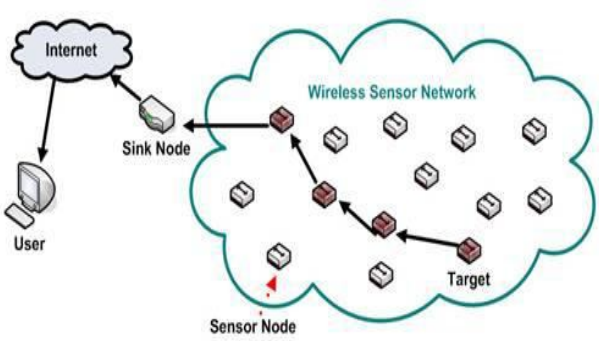


Fig. 1 Architecture of Wireless Sensor Network

## 2. ROUTING PROTOCOLS IN WSN

There is lot of difference between the routing in wireless sensor networks and conventional routing in fixed networks. Wireless links are unreliable, there is no infrastructure, sensor nodes may fail and energy saving requirements is must for routing protocols [5]. Many routing algorithms come into existence for wireless networks in general. All existing major routing protocols for WSNs may be divided into seven categories [6]. But this paper only discusses the different hierarchical protocols.

## 2.1 HIERARCHICAL PROTOCOLS

From last few years hierarchical clustering in WSN have explored with different perspectives [3]. Clustering is an energy efficient communication protocol. Sensors used this protocol to report their sensed data to the sink. Here a sample of layered protocols are discussed in which a network is made up of number of *clumps* or *clusters* of sensors. *Cluster head* manages each cluster, which is responsible for coordinating the data transmission activities of all sensors in its cluster.

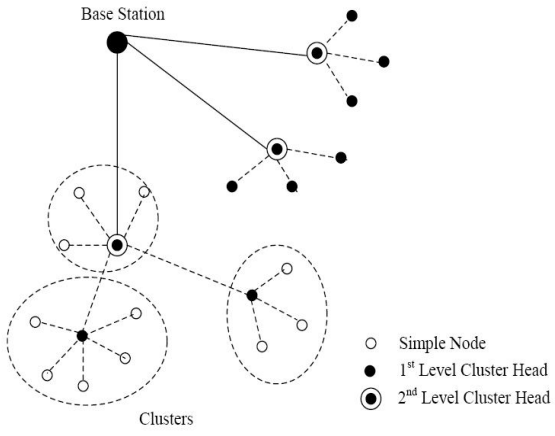


Fig. 2 Cluster-based Hierarchical Model

Figure 2 show a hierarchical approach which breaks the network into clustered layers [19]. All nodes are grouped into clumps with a cluster head. The responsibility of cluster head is to route data from the cluster to the other cluster heads or base stations. Travelling of data is done from a lower clustered layer to a higher one. Even though data moves from one node to another but each moves (hops) from one layer to another it covers larger distances. This quickly moves the data to the base station. Clustering provides essential optimization capabilities at the cluster heads. This section gives a sample review of hierarchical-based routing protocols for WSNs.

### *2.1.1 Low-energy adaptive clustering hierarchy (LEACH):-*

The first and most popular energy-efficient hierarchical clustering algorithm for WSNs is LEACH [14, 17] that was proposed for reducing power consumption. The clustering task is rotated among the nodes, based on duration in LEACH. Each cluster head (CH) used direct communication to forward the data to the base station (BS). Here, clusters are used to extend the life of the wireless sensor network. On an *aggregation* (or *fusion) based LEACH* technique combines or aggregates the original data into a smaller size of data packages that carry only meaningful information to all individual sensors. It divides the a network into number of cluster of sensors, where each cluster constructed by using localized coordination and control to reduce the size of data that are transmitted to the sink. It also make routing and data dissemination more scalable and robust. A randomize rotation of high-energy CH position used by LEACH, rather than selecting in static manner for giving a chance to all sensors to do a roll of CHs and avoid the battery depletion of an individual sensor and dyeing quickly. The operation of LEACH is divided into rounds each with two phases as below.

(i) a setup phase for organizing the network into clusters, CH advertisement, and transmission schedule creation

(ii) a steady-state phase to data aggregation, compression, and transmission to the sink.

LEACH is does not require global knowledge of network. LEACH reduces energy consumption by two ways such as-

(a) by minimizing the communication cost between sensors and their cluster heads and

(b) by turning off non-head nodes as much as possible [18].

Using single-hop routing in LEACH, each node can transmit data directly to the cluster-head and to the sink. Therefore, it is not applicable to networks deployed in large regions. The idea of extra overhead bring by dynamic clustering e.g. head changes, advertisements etc., which may decreases the gain in energy consumption. While LEACH helps the sensors within their cluster use their energy slowly, sensors are located farther away from the sink then CHs consume a larger amount of energy. LEACH clustering terminates in a finite number of iterations, but it assumes uniform energy consumption for CHs.

### *2.1.2 Power-Efficient Gathering in Sensor Information Systems (PEGASIS):-*

The extension of the LEACH protocol is PEGASIS [39]. It forms chains from sensor nodes so that each node can transmits and receives from a neighbor and from that chain only one node is selected to transmit to the base station

(sink). The data is collected and moves from one node to another node, aggregated and eventually sent towards base station. Greedy way used for the construction of chain. Instead of using multiple nodes PEGASIS avoids cluster formation and uses only one node in a chain to transmit to the BS (sink). In the data fusion phase, instead of sending data directly to its CH as in the case of LEACH, a sensor transmits to its local neighbors. The construction phase in PEGASIS routing protocol assumes that all the sensors have global knowledge about the network, the positions of the sensors and use a greedy approach. Due to low battery power a sensor fails or dies. The chain construction is done using the same greedy approach by bypassing the failed sensor. Compared to LEACH in each round, a randomly sensor node chosen from the chain will transmit the aggregated data to the BS, thus reducing the per round energy expenditure. PEGASIS topology adjustment can introduce important overhead especially for highly utilized networks.

### *2.1.3 Hybrid, Energy-Efficient Distributed Clustering (HEED):-*

The basic scheme of LEACH extends HEED [10, 13] by using residual energy and node density as a metric to achieve power balancing for cluster selection. Using an adaptive transmission power in the inter-clustering communication it operates in multi-hop networks. HEED was proposed with the following four primary goals.

(i) by distributing energy consumption extending network lifetime

(ii) terminating the clustering process within a fixed number of iterations,

(iii) minimizing control overhead

(iv) producing well-distributed CHs and compact clusters.

In HEED, the proposed algorithm appearing at intervals selects CHs corresponding to a combination of two clustering parameters. Their residual energy of each sensor node is the primary parameter and the secondary parameter is the intra-cluster communication cost as a function of cluster density or degree of node. To probabilistically select an initial set of CHs the primary parameter is used while for breaking ties the secondary parameter is used. The HEED clustering improves network lifetime over LEACH clustering because LEACH randomly selects CHs, they may result in faster death of some nodes. Finally the CHs selected in HEED are well distributed across the network and the communication price is minimized. The cluster selection deals with only a subset of parameters, where it can possibly impose constraints on the system. These methods are suitable for extending the network lifetime rather than for the entire needs of WSN.

### *2.1.4 Threshold Sensitive Energy Efficient Sensor Network Protocol (TEEN):-*

TEEN [9, 15] groups sensors into clusters with each led by a CH . It is a hierarchical clustering protocol. The sensors from a cluster report their sensed data to their CH. Until the data reaches the sink the CH sends aggregated data to higher level CH. A hierarchical grouping is used in the sensor network architecture of TEEN. Where it is based on the closer nodes form clusters and this process goes on the second level until the BS (sink) is reached. TEEN is useful for applications such as the users can control a trade-off between energy efficiency, response time dynamically and data accuracy. TEEN uses a data-centric method with hierarchical approach. TEEN is suitable for time critical sensing applications. The message transmission requires more energy than data sensing hence the energy consumption in this protocol is less than the proactive networks. But, TEEN is not suitable for sensing applications where periodic reports are needed thus the user may not get any data at all if the thresholds are not reached.

### *2.1.5 Adaptive Periodic Threshold Sensitive Energy Efficient Sensor Network Protocol (APTEEN):-*

APTEEN [44] is provides an improvement to TEEN for overcoming its limitations and trying to achieve at both capturing periodic data collections (LEACH) and also reacting to time-critical events (TEEN). APTEEN allows the sensor to send their sensed data periodically and give response to any sudden change in the value of the sensed attribute by reporting the corresponding values to their CHs. The architecture of APTEEN uses the concept of hierarchical clustering for energy efficient communication among the source sensors and the sink. This protocol supports to three following different query types.

(i)historical query for analyzing the past data values

(ii) one-time query which takes a snapshot view of the network

(iii) persistent queries which monitors an event for a period of time.

APTEEN guarantees the lower energy dissipation and a huge number of sensors alive [16].

### *2.1.6 Energy Efficient Homogenous Clustering Algorithm for Wireless Sensor Networks:-*

Homogeneous clustering algorithm for wireless sensor network is proposed **by** Singh et al. [2]. That saves power and extends network life. By ensuring a homogeneous distribution of nodes in the clusters the life span of the network is increased. A new cluster head is selected on the fundamental of the residual energy of existing cluster heads, nearest hop distance of the node and holdback value. The homogeneous algorithm considers that every node is either a cluster head or a member of one of the clusters in the wireless sensor network. In the existing clustering algorithm the cluster members are uniformly distributed and hence the life of the network is more extended. Only cluster heads broadcast cluster formation message and not to the every node. Hence, it extends the life of the sensor networks. The use of this approach is to extend the life span of the network by ensuring a homogeneous distribution of nodes in the clusters. Hence

there is less receiving and transmitting overhead on a Cluster Head.

## 3. CONCLUSION

Energy efficiency is the main challenge in the design of routing protocols for WSNs due to the scarce energy resources of sensors. The best objective of routing protocol design is to keep the sensors operating for as long as possible and extend the network lifetime. The energy consumption of the sensors is dominated by data transmission and reception. Designing energy-efficient routing mechanism to extend the overall network lifetime has become most important. This paper studies the different hierarchical routing protocols to achieve a best heuristic algorithm to extend the network lifetime in wireless sensor network design.

## 4. ACKNOWLEGEMENT

I am thankful to Dr. Shyamrao V. Gumaste Sir, Prof. Gajanan S. Deokate and Prof. Sandip A. Kahate Sir for their guidance. I also thank the college authorities for providing the required infrastructure and support. Finally, I would like to extend a heartfelt gratitude to my friends and family members.

## REFERENCES

[1] S. Vasudevan, M. Adler, D. Goeckel, and D. Towsley, "Efficient algorithms for neighbour discovery in wireless networks,"IEEE/ACMTrans.Netw., vol. 21, no. 1, pp. 69–83, Feb. 2013.

[2] S.K. Singh, M.P. Singh, and D.K. Singh, "Energy-efficient Homogeneous Clustering Algorithm for Wireless Sensor Network", International Journal of Wireless & Mobile Networks (IJWMN), Aug. 2010, vol. 2, no. 3, pp. 49-61.

[3] S.K. Singh, M.P. Singh, and D.K. Singh, "A survey of Energy-Efficient Hierarchical Cluster-based Routing in Wireless Sensor Networks", International Journal of Advanced Networking and Application (IJANA), Sept.–Oct. 2010, vol. 02, issue 02, pp. 570–580.

[4]Jun Zheng and Abbas Jamalipour, "Wireless Sensor Networks: A Networking Perspective", a book published by A John & Sons, Inc, and IEEEE, 2009.

[5]S. Misra et al. (eds.), Guide to Wireless Sensor Networks, Computer Communications and Networks, DOI: 10.1007/978-1-841882-218-4 4, Springer-Verlag London Limited 2009.

[6] Ming Liu, Jiannong Cao, Guihai Chen, and Xiaomin Wang, "An Energy-Aware Routing Protocol in Wireless Sensor Networks", Sensors 2009, vol. 9, pp. 445-462.

[7] Luis Javier García Villalba, Ana Lucila Sandoval Orozco, Alicia Triviño Cabrera, and Cláudia Jacy Barenco Abbas, "Routing Protocol in Wireless Sensor Networks", Sensors 2009, vol. 9, pp. 8399- 8421.

[8] Kemal Akkaya and Mohamed Younis, "A Survey on Routing Protocols for Wireless Sensor Networks", Ad hoc Networks, vol. 3, no. 3, May 2005, pp. 325-349.

[9] W. Lou, "An Efficient N-to-1 Multipath Routing Protocol in Wireless Sensor Networks", Proceedings of IEEE MASS'05, Washington DC, Nov. 2005, pp. 1-8.

[10] Ossama Younis and Sonia Fahmy" Heed: A hybrid, Energy-efficient, Distributed Clustering Approach for Ad-hoc Networks", IEEE Transactions on Mobile Computing, vol. 3, no. 4, Oct.-Dec. 2004, pp.366-369.

[11] Jamal Al-Karaki, and Ahmed E. Kamal, "Routing Techniques in Wireless Sensor Networks: A Survey", IEEE Communications Magazine, vol 11, no. 6, Dec. 2004, pp. 6-28.

[12] S. Lindsey and C.S. Raghavendra, "PEGASIS: Power-efficient Gathering in Sensor Information System", Proceedings IEEE Aerospace Conference, vol. 3, Big Sky, MT, Mar. 2002, pp. 1125-1130.

[13]Ossama Younis and Sonia Fahmy, "Distributed Clustering in Ad-hoc Sensor Networks: A Hybrid, Energy-efficient Approach", September 2002.

[14] W.R. Heinzelman, A. Chandrakasan, and H. Balakrishnan, "An Application-Specific Protocol Architecture for Wireless Microsensor Networks" in IEEE Tmnsactions on Wireless Communications (October 2002), vol. 1(4), pp. 660-670.

[15] A. Manjeshwar and D. P. Agrawal, "TEEN: A Protocol for Enhanced Efficiency in Wireless Sensor Networks", in the Proceedings of the 1st International Workshop on Parallel and Distributed Computing Issues in Wireless Networks and Mobile Computing, San Francisco, CA, April 2001.

[16] A. Manjeshwar and D. P. Agrawal, "APTEEN: A Hybrid Protocol for Efficient Routing and Comprehensive Information Retrieval in Wireless Sensor Networks", in the Proceedings of the 2nd International Workshop on Parallel and Distributed Computing Issues in Wireless Networks and Mobile computing, San Francisco CA, April 2001, pp. 2009-1015.

[17] W.R. Heinzelman, A. Chandrakasan, and H. Balakrishnan, "Energy-efficient Communication Protocol for Wireless Microsensor Networks", in IEEE Computer Society Proceedings of the Thirty Third Hawaii International Conference on System Sciences (HICSS '00), Washington, DC, USA, Jan. 2000, vol. 8, pp. 8020.

[18] Lan Wang and Yang Xiao, "A Survey of Energy-Efficient Scheduling Mechanisms in Sensor Network".

[19] D. B Johnson et al., "Dynamic Source Routing in Ad Hoc Wireless Networks", in Mobile Computing, edited by Tomas Imielinski and Hank Korth, Kluwer Academic Publishers, ISBN: 0792396979, 1996, Chapter 5, pp. 153-181.