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AN ENERGY SAVING CLUSTERING ROUTING PROTOCOL BASED ON LEACH WITH ITS VARIANTS IN WIRELESS SENSOR NETWORKING

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ABSTRACT

The growth of Wireless device Network is efficiently increasing because it could be a network of device nodes while not having associatey central controller and there's an vast field for analysis during this space. Sensors entirely rely upon the battery for power, that can't be revived. therefore the style of energy aware protocol is important in relation to enhance the network period. LEACH is associate energy-efficient hierarchical primarily based protocol that balances the energy expense, saves the node energy and therefore prolongs the period of the network. during this survey paper we are going to be that specialize in wireless device network that has some challenges and a few limitations. The paper also will discuss concerning LEACH protocol that is predicated on hierarchic routing protocol utilized in wireless device network. Comparison of varied network parameters is worn out the shape of tables and graphs and within the last conclusions is drawn.

Keywords: LEACH, Cluster Head , WSN, Hierarchal, Energy efficiency.

I. INTRODUCTION

A WSN typically consists of a large number of sensor nodes deployed in an area of interest [1]. Sensor nodes are used to monitor physical or environmental conditions, such as temperature, sound, pressure, etc. These nodes are low-power, low-cost devices small in size basically equipped with a sensing device to collect data from the environment, a processing unit to do some operations on data, a transceiver to send and receive collected, and an energy source to provide the required energy to operate (usually a battery). These sensor nodes sense the information and transmit it to the base station where the analysis of received data and computation is performed. The energy supply for a sensor node is important as the batteries have small capacity and recharging by energy scavenging is complicated and volatile. Hence, the energy consumption of a sensor node must be carefully done. In most applications sensor nodes are randomly deployed in the field. Therefore, battery replacement or charging is not practical. The resource constrained nature of sensor nodes poses the unique challenges to the design of WSNs for their applications. The limited power of sensor nodes mandates the design of energy-efficient communication protocol in WSNs [2]. As a result, routing protocols must be energy-efficient

to prolong the network lifetime .For this purpose clustering routing protocol is the most common technique used for energy aware routing in WSNs.The routing protocols on this scheme impose a structure on the network to achieve energy efficiency, stability, and scalability. In this class of protocols, network nodes are organized in clusters in which a node with certain properties takes the role of a cluster head. Clustering has the potential to reduce energy consumption and extend the lifetime of the network. It has high delivery ratio and scalability and can balance the energy consumption. Low Energy Adaptive Clustering Hierarchy (LEACH) is known to be a mac protocol to reduce the energy utilization required to generate and preserve clusters which further improve the life of a wireless sensor network [1, 2]. LEACH is taken to find the improvement scope due to its hierarchical structure and well developed algorithm for wireless sensor network. In this, cluster head gets the data from its member nodes of the cluster and aggregate the data before sending to the base station.

This paper reviews the following subjects. In Section 2, we mentioned about classification of routing protocols in WSNs. In Section 3, we discuss a brief about hierarchical routing protocol along with cluster based hierarchical model along with some difficulties arise in hierarchical cluster based routing. In Section 4, we discuss about LEACH protocol along with its advantages and disadvantages. In Section 5, we discuss some improvement of LEACH protocols in an energy efficient way. In section 6, we discuss the comparative study of different improved version LEACH with LEACH routing protocol based on different criteria. In Section 7, we finally conclude the paper.

II. WSN DESIGN CHALLENGES & ISSUES: ROUTING ISSUES

The ways how to effectively route the collected data among nodes is very challenging in WSNs because of several discriminated characteristics of WSN that distinguish them from wireless ad hoc networks. In WSNs, there are applications that need the real- time requirements of the message delivery and maximization of network lifetime. Different architectures and constraint have been considered for sensor networks, depending on the application. The process to forward the data packets between each pair of source- sink nodes is an important issue in WSNs. So the challenges of routing in these networks because of low power wireless sensor networks are:

A. Limited Energy Capacity

Energy poses a big challenge for the network designers in hostile environments. Since sensor nodes are battery powered, they have limited energy capacity. So when the energy of a sensor reaches a certain threshold, they become faulty and are not able to function properly which affects the overall network performance to great extent. Consequently, the routing protocols designed for sensors should be as energy efficient as possible to extend their lifetime and hence prolong the network lifetime.

B. Network Characteristics and Unreliable Environment

Routing protocol must be capable of sustain the network topology dynamics, increase network size, energy consumption level, sensor nodes mobility and their related issues like coverage and connectivity to retain specific application requirements. The WSN is consistently prone to frequent topology changes because of extremely vulnerable to node failure, sensors addition, deletion, node damage, link failure, sensor energy exhaustion etc. also susceptible to noise, time consistency and errors due to wireless nature of the network. In a

multihop sensor network, communicating nodes are linked by a wireless medium. To enable global operation of these networks, the chosen transmission medium must be available worldwide.

C. Node capabilities

In a sensor network, different functionalities can be associate with the sensor nodes. Depending on the application a node can be dedicated to particular special function such as relaying, sensing and aggregation since engaging the three functionalities at the same time on a node might quickly drain the energy of that node.

D. Scalability

Scalability is very important in WSN as the number of sensor nodes may vary in the order of hundreds, thousands or more. So the routing protocols should be designed to work consistently, keeping in consideration that sensors may not necessarily have the same capabilities in terms of energy, processing, sensing, and particularly communication

E. Fault Tolerant Communication

Some sensor nodes may fail or be blocked due to lack of power, have physical damage or environmental interference. Due to faulty and unreliable nodes some nodes cannot communicate other nodes. Thus failure of sensor nodes should not affect the overall task of the sensor network.

F. Power Consumption

Power may be either stored (e.g., in batteries) or scavenged from the environment by solar cells. Transmission power is directly proportional to distance squared or even higher order in presence of obstacles. Nodes lifetime is strongly dependent on its battery lifetime.

G. Data Aggregation

Similar packets from multiple nodes can be aggregated to reduce the extra overhead due to number of the transmissions. Data aggregation is done to remove redundancy and to minimize the number of transmissions.

H. Node Deployment

Topological deployment of the sensors in WSNs is application dependent and finally affects the performance of the routing protocol. The deployment is either deterministic or self-organizing. In that infrastructure, the position of the sink or the cluster-head is also crucial in terms of energy efficiency and performance.

I. Sensor Location

Managing the locations of the sensors is another challenge that features the design of the routing protocols. Most of the proposed protocols assume that the sensors either are equipped with GPS receivers or use some localization technique to learn about their locations.

III. ROUTING PROTOCOLS CLASSIFICATION

Routing protocols in WSNs might differ depending on the application (Protocol-Operation-based) and network architecture (Network-Structure-based) [2],[3]. Figure2 shows the classification of routing protocols in WSNs [4].

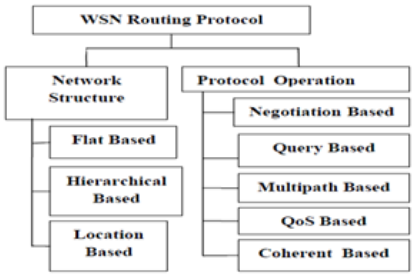

Fig.1. Routing protocols classification for WSNs

Among the various routing protocols as can be seen in figure 1, One of the most proficient routing protocols in WSN is hierarchical cluster-based routing protocols as it has greater energy efficiency, scalability of network and retransmission of data scalability, lifetime, reduces the size of the routing table by localizing the route setup within the clusters [3],[,5]. In this type of routing, sensor nodes are organized into clusters, where the nodes with higher energy as served as cluster head(CH) used to collect data from cluster members(CM) having lower energy. The sensed data is sent to cluster heads by cluster members where data aggregation and data fusion is done to decrease the number of transmitted messages to the sink. This process of creating the clusters and cluster head rotation increases the network lifetime cycle, network scalability, and network reliability. The main goal of cluster-based routing protocol is to efficiently maintain the energy consumption of sensor nodes by involving them in multi-hop communication within a cluster.

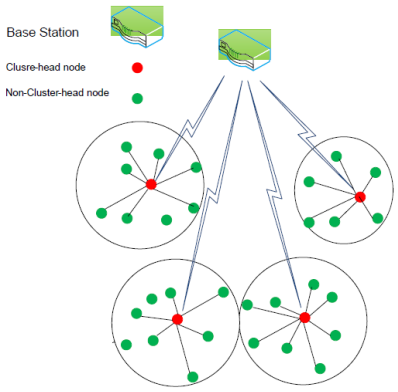

Fig.2. Clustering Model Hierarchical routing

IV. ENERGY EFFICIENT NETWORK: LEACH

Low-Energy Adaptive Clustering Hierarchy (LEACH) is the first and most popular energy efficient hierarchical clustering algorithm for WSNs proposed for reducing power consumption and also to increase the lifetime of the network [6]. LEACH includes distributed cluster formation. LEACH randomly selects a few sensor nodes as cluster-heads and rotates this role to evenly distribute the energy load among the sensors in the network. In LEACH, the cluster-heads compress data arriving from nodes that belong to the respective cluster and send an aggregated packet to the BS in order to reduce the amount of information that must be transmitted to the BS. Being a cluster-head node consumes more energy than a non-cluster head node which leads the cluster head nodes to die earlier than other nodes. LEACH forms clusters by using a distributed algorithm where nodes make autonomous decisions without any centralized control

This protocol is divided into rounds (i) Set-up Phase (ii) Steady Phase

Set-up Phase:

In the set-up phase, the cluster head nodes are randomly selected from all the sensor nodes and several clusters are constructed dynamically. Each node decides independent of other nodes if it will become a CH or not. This decision is made by looking into account when the node served as a CH for the last time (means the node that hasn't been a CH for long time is more likely to elect itself than nodes that have been a CH recently). This is done according to a threshold value, T (n).

$T(n)= p/1-p \times (r \bmod p-1)$, Where p is the cluster head probability

Based on all messages received within the cluster, the CH creates a TDMA schedule, pick a CSMA code randomly, and broadcast the TDMA table to cluster members every node wanting to be the cluster-head chooses a value, between 0 and 1. If this random number is less than the threshold value, T(n), then the node becomes the cluster- head for the current round. Then each elected CH broadcasts an advertisement message to the rest of the nodes in the network to invite them to join their clusters. Based upon the strength of the advertisement signal, the non-cluster head nodes decide to join the clusters.

Steady Phase:

The steady-state operation is broken into frames where nodes send their data to the cluster-head at most once per frame during their allocated transmission slot. This stage is for data transmission where normal nodes sense data and send this sensed data to their respective cluster-head nodes. The processing of received data (data aggregation and data fusion) is done by cluster head nodes and processed data will be sent to the base station. The set-up phase does not guarantee that nodes are evenly distributed among the cluster head nodes. Therefore, the number of nodes per cluster is highly variable in LEACH, and the amount of data each node can send to the cluster-head varies depending on the number of nodes in the cluster. To reduce energy dissipation, each non-cluster-head node uses power control to set the amount of transmits power based on the received strength of the cluster-head advertisement. The radio of each non-cluster-head node is turned off until its allocated transmission time. Since all the nodes have data to send to the cluster-head and the total bandwidth is fixed, using a TDMA schedule is efficient use of bandwidth and represents a low latency approach, in addition to being energy-efficient [9],[19]. Once the cluster-head receives all the data, the CH aggregate these data and send it to the BS.

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Disadvantages of LEACH protocol

The different disadvantages that the LEACH protocols having are as follows [19],[12]

A. In classical LEACH protocol, the cluster head node consumed more energy as compared to normal nodes in sending aggregated data to the base station (located far away). Therefore, the cluster head node dies early and the whole cluster will become useless, results data loss.

B. Leach does not work well with the applications require large area coverage along with multi-hop inter-cluster communication .It relies on cluster heads rather than cluster members which incurs issues like failure of the cluster heads. In LEACH CHs are not uniformly distributed within the cluster. It incurs overhead due to calculations which leads to the energy inefficiency for dynamic clustering in large scale networks. There is no inter-cluster communication in the network because CHs directly communicate with sink. This process requires high range of transmission power in the network. For this only,LEACH is not best suited for large- scale networks that interns require single hop communication with sink.

V. COMPARISION OF EXPLORED ADVANCED LEACH PROTOCOL WITH BASIC LEACH

Many researchers worked to describe the improved version on LEACH to perform better and remove the drawbacks in Leach. Some of them summarized in this paper [14] are:

A. LEACH-B (Balanced Low Energy Adaptive Clustering Hierarchy)

LEACH-B uses de-centralized approach of cluster formation in which each sensor node knows about its own position and position of final destination irrespective of position of rest of the nodes in the network. It works in three stages: Cluster head selection, Cluster formation and data transmission with multiple accesses. The energy dissipated in the path between destination node and originating node is calculated and based on this only each of the sensor nodes would choose its own cluster heads. LEACH-B has better energy efficiency than basic LEACH protocol [4],[16],[17].

B. LEACH-C (Centralized Low Energy Adaptive Clustering Hierarchy)

Centralized LEACH has same steady-state as basic LEACH but the set-up phase varies. The cluster head nodes are chosen by base station. In steady state phase, each node sends information about its current position and energy level to BS. In the set-up phase, each node would send its current location and energy level information to the sink node. Based on this information the BS will determine the different clusters along with CH node and non-CH nodes of each and every cluster. The BS would able to produce better clusters by utilizing its global information of the whole network and by this process less energy is being consumed for data transmission. The assumption usually is that each node has a GPS receiver. The BS have to insure the evenly distribution of energy among nodes. So it determines a threshold for energy level. Advantage of this protocol over basic LEACH is the deterministic approach of choosing number of cluster head nodes in each round which is predetermined at the time of deployment. But LEACH-C requires current location information of all nodes using GPS which is not robust [17],[18], [19].

C. LEACH-S (Solar aware Centralized and Distributed Low Energy Adaptive Clustering Hierarchy)

In Centralized LEACH-S, the base station selects the CHs with the help of improved central control algorithm and selects solar powered nodes having maximum residual energy the solar status along with the energy of the sensor nodes is transmitted to the base station and the nodes with having the higher energy are selected as the CHs. When the number of solar-aware nodes is getting increased, the performance of sensor network is also get increased and by this the lifetime of the network also get increased.

In Distributed LEACH-S, the solar driven nodes are given more preference than the battery driven nodes for choosing CHs. The cluster head handover takes place if the sun duration is smaller [20].

D. V-LEACH (Vice Cluster Level Low Energy Adaptive Clustering Hierarchy)

V-Leach was proposed to overcome the problem in basic Leach that when a CH dies the cluster would become useless, because the information collected by the cluster members will not able to transmit to the sink. In V-LEACH protocol, along with CH, there is a vice-CH that comes to act as a CH when the CH dies and thus the protocol reduces overhead of selecting new cluster head each time when a cluster head dies and the data will always reach to the base station. The other working is same as the LEACH protocol [20],[21].

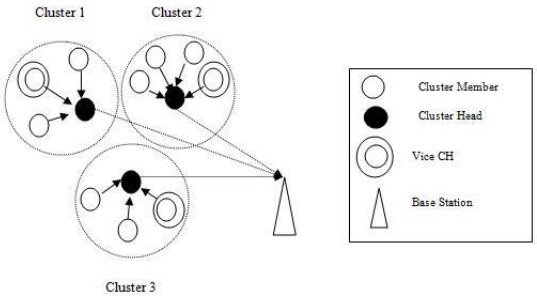

Fig3.Vice Cluster Level Leach

E. TL-LEACH (Two level Low Energy Adaptive Clustering Hierarchy)

In LEACH protocol cluster heads send data to sink directly in a single hop, and because of this CH dies early due to loss of energy for transmission to sink. TL-LEACH protocol was proposed to overcome this as works in two-level hierarchy. The aggregated data from each cluster head is collected by a cluster head lies between cluster heads and the base station, instead of sending directly to the base station and it improves energy efficiency by using a cluster head node as relay node in between cluster head nodes. [18]

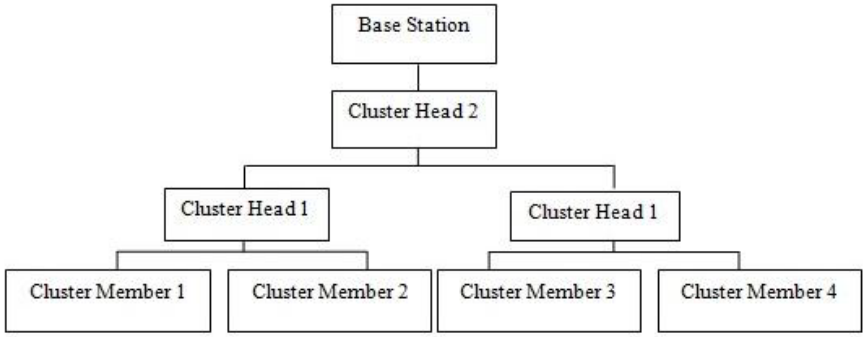

Fig4.Two Level Leach

F. I-LEACH (Improved Low Energy Adaptive Clustering Hierarchy)

I-Leach was designed to serve the Detection of Twin nodes and assignment of Sub-Cluster Head (SCH) nodes. In I-Leach two nodes located very close to each other called Twin nodes would sense the same information. Thus it is necessary to keep one node sleep until the energy of another node depletes. I-LEACH has uniform distribution of cluster head so that it doesn't run out of energy for longer distance. It uses threshold approach to manage the number of cluster members for each cluster head in the network at a time [20].

G. LEACH-A (Advanced Low Energy Adaptive Clustering Hierarchy)

Leach-A is a heterogeneous energy protocol to decrease the node's failure probability and increase the time interval before the first node dies called as stability period. Each sensor knows the starting of each round using synchronized clock. The maximum energy nodes are selected as cluster head for each cluster and these nodes are called as CAG node and they will continue to send data even after failure of all normal nodes. It uses TDMA/CDMA techniques that save maximum energy by allowing clusters' hierarchy on different levels [21].

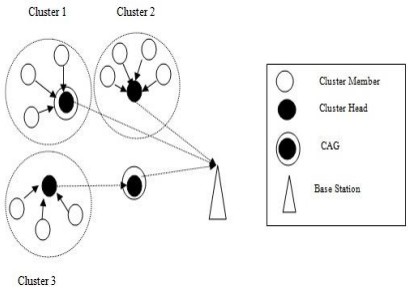

Fig5.Advanced Leach

H. LEACH-M (Mobile Low Energy Adaptive Clustering Hierarchy)

Mobility is an important issue in any protocol and LEACH-M was proposed to meet this. This protocol provides mobility to the both non-cluster head nodes and cluster head nodes in the set-up and the steady-state. Nodes are homogeneous and location of each node is calculated by GPS. The nodes with minimum mobility and the lowest attenuation are chosen as cluster head and broadcast their status to all nodes within its transmission range [20].

Table I Performance Comparision Between Leach Protocol Variants

Clustering Routing Protocol	Classification	Mobility	Scalibility	Self Organisation	Randomized Rotation	Distributed	Hop Count	Energy Efficiency	Homogenous	Use of Location Information	Data Aggregation
LEACH	Hierachical	Fixed BS	Limited	Yes	Yes	Yes	Single Hop	High	Yes	No	Yes
A-LEACH	Hierachical	Fixed BS	Good	Yes	Yes	Yes	Single Hop	Very High	Yes	Yes	Yes
LEACH-A	Hierachical	Fixed BS	Good	Yes	Yes	Yes	Single Hop	Very High	No	No	Yes
LEACH-B	Hierachical	Fixed BS	Good	Yes	Yes	Yes	Single Hop	Very High	Yes	Yes	Yes
LEACH-C	Hierachical	Fixed BS	Very Good	Yes	Yes	No	Single Hop	Very High	Yes	Yes	Yes
C-LEACH	Hierachical	Fixed BS	Very Good	Yes	Yes	Yes	Single Hop	Very High	Yes	Yes	Yes
I-LEACH	Hierachical	Fixed BS	Good	Yes	Yes	Yes	Multi Hop	Very High	Yes	Yes	Yes
LEACH-M	Hierachical	Fixed BS	Mobile BS and Nodes	Yes	Yes	Yes	Single Hop	Very High	Yes	Yes	Yes
M-LEACH	Hierachical	Fixed BS	Very Good	Yes	Yes	Yes	Multi Hop	Very High	Yes	Yes	Yes

LEACH-S	Hierachical	Fixed BS	Very Good	Yes	Yes	Yes	Single Hop	Very High	Yes	No	Yes
TL-LEACH	Hierachical	Fixed BS	Very Good	Yes	Yes	Yes	Single Hop	Very High	Yes	Yes	Yes
V-LEACH	Hierachical	Fixed BS	Very Good	Yes	Yes	Yes	Single Hop	Very High	Yes	Yes	Yes

VI. CONCLUSION & FUTURE WORK

The resource constrained nature of sensor nodes poses the unique challenges to the design of WSNs for their applications. Routing protocols must be energy-efficient to prolong the network lifetime. For this purpose, clustering routing protocol is the most common technique used for energy aware routing in WSN. LEACH has found one of the most energy efficient protocols used in WSN. In this survey, LEACH protocol has been discussed with its drawbacks and how these drawbacks are overcome by its descendants. A brief study of various improved versions of LEACH protocol has been done in order to compare performance of these descendants with the classical LEACH. Each of the routing protocol has its own advantages compared to the fundamental leach routing protocol. This paper also compares the features and performance of each hierarchical clustering routing protocol It is concluded from given survey that there is need to explore more robust, reliable and efficient protocols in future. The process of data aggregation and fusion among clusters is also one of an interesting problem to explore. It is needed to satisfy the constraints introduced by factors such as fault tolerance, topology change, cost, environment, scalability, and power consumption for realization of sensor networks. Since these constraints are highly specific and stringent for sensor networks, new wireless ad-hoc networking techniques will have to be explored further.

REFERENCES

[1] Akylidiz LF, Su W, Sankarasubraniam Y, Cayirci E, "A survey on sensor networks", IEEE Communication Magazine, 40(8): 102~114. Vol.25, No.4, 2002, 114-124.

[2] Shio Kumar Singh, M P Singh and D K Singh, "A Survey of Energy-Efficient Hierarchical Cluster-Based Routing in Wireless Sensor Networks", in Int. J. of Advanced Networking and Applications, Vol. 02, Issue 02, 2010, pp. 570-580.

[3] Neetika & Simarpreet Kaur, "Review on Hierarchical Routing in Wireless Sensor Networks", in International Journal of Smart Sensors and Ad- Hoc Networks (IJSSAN), Vol. 2, Issue 3, 4, 2012, pp. 85-90.

[4] Sandeep Verma, Richa Mehta, Divya Sharma and Kanika Sharma,"Wireless Sensor Network and Hierarchical Routing Protocols: A Review", International Journal of Computer Trends and Technology (IJCTT), Vol. 4, Issue 8, August, 2013, pp. 2411-2416.

[5] A.Braman and Umapathi G.R, "A Comparative Study on Advances in LEACH Routing Protocol for Wireless Sensor Networks: A survey," International Journal of Advanced Research in Computer and Communication Engineering (IJARCCE), vol. 3, issue 2, pp. 5683-5690, February 2014.

[6] Sabarish B A, Guru Moorthy S M, Dhivya M A, Sakthi Naveen K, Vaishnavi S "A survey on clustering protocols in Wireless Sensor Networks" International Journal of Advances in Computing and Information Technology, published on April 2012.

[7] W. B. Heinzelman, A. Chandrakasan and H. Balakrishnan, "Energy-Efficient Communication Protocol for Wireless Micro Sensor Networks," Proc. 33rd Hawaii Int'l. Conf. Sys. Sci., Jan. 2000.

[8] M. Bani Yassein, A. Al-zou'bi, Y. Khamayseh, W. Mardini "Improvement on LEACH Protocol of Wireless Sensor Network (VLEACH)", International Journal of Digital Content Technology and its Applications Volume 3, Number 2, June 2009.

[9] M. J. Handy, M. Haase, D. Timmermann,"Low Energy Adaptive Clustering Hierarchy with Deterministic Cluster-Head Selection", IEEE MWCN, 2002.

[10] Parminder Kaur1, Mrs. Mamta Katiyar, "The Energy-Efficient Hierarchical Routing Protocols for WSN: A Review" International Journal of Advanced Research in Computer Science and Software Engineering, Vol. 2, Issue 11, November 2012, pp. 194-199.

[11] J.Gnanambigai, Dr.N.Rengarajan, K.Anbukkarasi, "Leach and Its Descendant Protocols: A Survey", International Journal of Communication and Computer Technologies, Vol. 01, No.3, Issue 02, September 2012, pp. 15-21.

[12] Jia Xu,Ning Jin, Xizhong Lou,Ting Peng,Qian Zhou,Yanmin Chen"Improvement of LEACH protocol for WSN", 2012, IEEE.

[13] Amit Bhattacharjee, Balagopal Bhallamudi and Zahid Maqbool, "Energy-Efficient Hierarchical Cluster Based Routing Algorithm in Wsn: A Survey", International Journal of Engineering Research & Technology (IJERT), Vol. 2 Issue 5, May, 2013, pp. 302-311.

[14] Ali Norouzi1, Abdul Halim Zaim, "An Integrative Comparison of Energy Efficient Routing Protocols in Wireless Sensor Network", in Scientific Research of Wireless Sensor Network, Vol. 4, 2012, pp. 65-67.

[15] Wendi B. Heinzelman, Member, IEEE, Anantha P. Chandrakasan, Senior Member, IEEE, and Hari Balakrishnan, Member, IEEE, "An Application-Specific Protocol Architecture for Wireless Microsensor Networks" IEEE TRANSACTIONS ON WIRELESS COMMUNICATIONS, VOL. 1, NO. 4, OCTOBER 2002

[16] ThiemoVoigt,Hartmutt Ritter,Jochen Schiller, Adam Dunkels, and Juan Alonso,"Solar-aware Clustering in Wireless Sensor Networks",In Proceedings of the Ninth IEEE Symposium on Computers and Communications,June 2004.

[17] M.Ahmad Jan and M.Khan, "A Survey of Cluster-based Hierarchical Routing Protocols," International Journal of Computer Networks and Wireless Communications (IJCNWC),vol.3, no.2, pp. 138-143, April 2013.

[18] P.Manimala and R.Senthamil selvi, "A Survey on Leach-Energy Based Routing Protocol," International Journal of Emerging Technology and Advanced Engineering (IJETAE), vol.3, issue 12, pp. 657-660, December 2013

[19] A. Depedri, A. Zanella and R. Verdone, "An Energy Efficient Protocol for Wireless Sensor Networks" in Proc. AINS, 2003, pp. 1-6.

[20] M.Usha and Dr.N.Sankarram, "A Survey on Energy Efficient Hierarchical (Leach) Clustering Algorithms in Wireless Sensor Network," International Journal of Innovative Research in Computer and

Communication Engineering (IJIRCCE), Proceedings of International Conference On Global Innovations In Computing Technology (ICGICT'14), vol.2, special issue 1, pp. 601-609, March 2014.

[21] RENGUGADEVI G & SUMITHRA M.G, "Hierarchical Routing Protocols for Wireless Sensor Network–A survey" International Journal of Smart Sensors and Ad Hoc Networks (IJSSAN), Vol. 2, Issue 1, 2012, pp. 71-75.