ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 22, April 2016

S
SURVEY ON DIFFERENT TYPES OF LEACH PROTOCOL IN WIRELESS SENSOR NETWORK

P. Sumathi,AP/CSE
Idhaya Engineering College for Women
Chinnasalem,India
sumathi.p20@gmail.com

Sr.J. Arockia Jaya, AP/CSE
Idhaya Engineering College for Women
Chinnasalem,India
sr.jaya88@gmail.com

S. Jeeva,AP/CSE
Idhaya Engineering College for Women
Chinnasalem,India
jevavelu.16@gmail.com

Abstract— Wireless sensor network concept is not a new one; it is deployed in 1990's. In recent we have seen a rapid research in the field of mobile computing. Due to inexpensive and widely availability of wireless devices, WSNs are widely used in many applications. Wireless sensor network equipped with large number of wireless sensors programmed to operate in unattended mode; they sense the physical parameters depending on application and transmit to remote location. As the sensor node composed of battery which has limited power constraint. This led many routing protocols designed for WSN to use energy efficiently. One of the most popularly used energy efficient clustering protocol is LEACH. This review article will address the architecture of WSN, energy efficient routing protocol LEACH, advances in LEACH and their mode of operation.

Keywords: Wireless sensor networks, sensor node, Routing protocols, Network structure base routing protocols, LEACH, advances

I. INTRODUCTION

Latest advances in the Micro-Electro-Mechanical System (MEMS) has been highly subjective the development of miniaturized sensor nodes [1]. These tiny nodes collaborate with each other via RF communication in ISM (Industrial, Scientific and Medical) band to form Wireless Sensor Network (WSN). Now a day's Wireless Sensor Networks are being widely used in many real time applications. Like Intrusion detection, tracking for military purpose, habitat monitoring, motion detection for understanding earthquake patterns, health application by monitoring the drug administered to the patients and for traffic analysis [2].

II.

Each sensor node in the network consists of three subsystems: *The sensor subsystem:* This consists of one or more sensors which are used to sense the environmental parameters such as temperature, humidity, pressure, sound etc. *The processing subsystem:* It has microcontroller which performs the local computations on the sensed data and controlling actions and internal memory to store data. *The communication subsystem:* This is responsible for transferring the sensed data to the sink node. The internal structure of sensor node is as shown in figure 1.

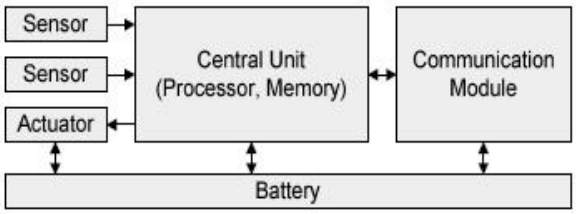


Fig. 1 Structure of Sensor node

All the wireless sensor nodes are operated on internal battery source. As the battery source has limited power and most of the time difficult to replace. Recharging of battery is also difficult task. Use of solar energy can be possible not trustworthy all the time. Therefore in most of the applications, sensor nodes undergo from limited energy. Depletion of these finite energy batteries can result in a change in network topology or end of network life itself. Therefore, prolonging the life of wireless sensor networks is important challenging issue in designing WSN [4].

Energy/power Consumption of the sensing device should be minimized so as to sensor nodes should be more energy efficient. To conserve power the node should shut off the radio power supply automatically when they are not in use. Another innovative technique is developed to use efficiently limited energy and maximize the lifetime of the network is to implementing routing protocols such that they perform efficiently and utilize the less amount of energy as possible for the communication among nodes within the network and along with between the networks [1] [3].

II. ROUTING PROTOCOLS IN WSN

In WSNs routing is challenging issue due to the inherent characteristics that differentiate these networks from other wireless networks such as mobile ad hoc networks, cellular networks. First, due to the quite large number of sensor nodes, it is not possible to build a global addressing scheme for the use of large number of sensor nodes as the overhead of ID maintenance is high. Therefore traditional IP-based protocols may not be used in WSNs. Second, sensor nodes are to be self organizing and should work in unattended mode and topology is not fixed etc

As a result many protocols have been projected in order to minimize the energy of these sensor nodes. Many routing protocols in WSN have been planned to take into account of the inherent features of WSNs

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 22, April 2016

into following group's protocol operation base, network structure base and routing algorithms base as shown in Fig.2.

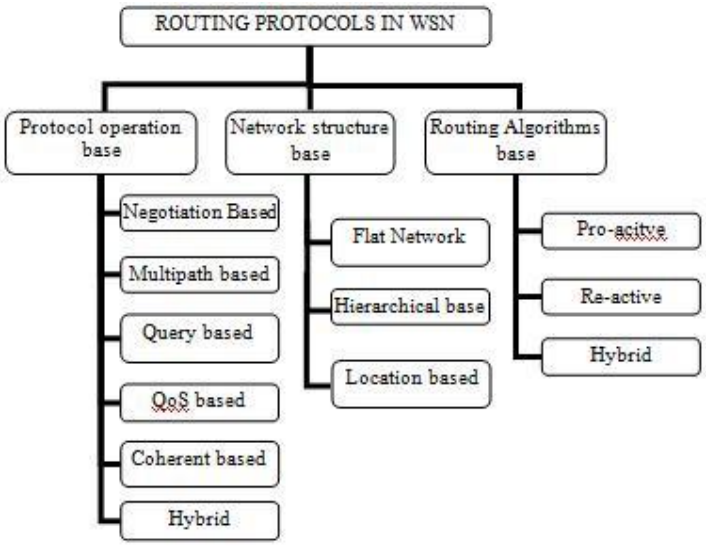


Fig. 2 Classification of Routing protocols in WSN

In general, depending on the operation of protocol routing protocols are classified into as follows negotiation based, multi path based, query based, QoS based, coherent based, hybrid. Christo Ananth et al. [6] discussed about a system, In this proposal, a neural network approach is proposed for energy conservation routing in a wireless sensor network. Our designed neural network system has been successfully applied to our scheme of energy conservation. Neural network is applied to predict Most Significant Node and selecting the Group Head amongst the association of sensor nodes in the network. After having a precise prediction about Most Significant Node, we would like to expand our approach in future to different WSN power management techniques and observe the results. In this proposal, we used arbitrary data for our experiment purpose; it is also expected to generate a real time data for the experiment in future and also by using adhoc networks the energy level of the node can be maximized. The selection of Group Head is proposed using neural network with feed forward learning method. And the neural network found able to select a node amongst competing nodes as Group Head. In location-based routing, sensor nodes positions are broken to route data in the network.

III. Network Structure Base Protocols

As network structure based routing protocols has three subcategories.

A. Flat Network based:

In flat-based routing, all nodes are typically plays equal roles or functionality and sensor nodes collaborate together to perform the sensing task. Due to the large number of such nodes, it is not possible to assign a global identifier to each node. This from the sensors located in the selected regions [7]. Since data is being requested through queries, attribute-based naming is necessary to specify the properties of data. SPIN, direct diffusion, Rumor routing, ACQUIRE, RUGGED and SAFE are the examples of flat routing protocols.

B. Hierarchical base

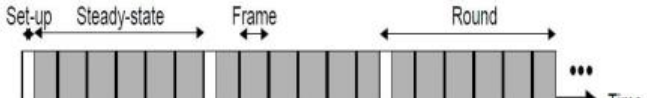
In hierarchical or clustered network, various nodes are combined together to form clusters. In a hierarchical architecture, nodes having higher energy can be used to processing and sending the information while nodes having low energy can be used to perform the sensing in the proximity of the target. This means that creation of clusters and assigning special tasks to cluster heads can greatly put in to overall system scalability, lifetime, and energy efficiency. Hierarchical routing is an efficient way to lower energy consumption within a cluster and by performing data aggregation and fusion in order to decrease the number of transmitted messages to the base station. Hierarchical routing is mainly two-layer routing where one layer is used to select cluster heads and the other layer is used for routing. LEACH, PEGASIS, TEEN, APTEEN, EAP, REAP, BCDCP are the examples of hierarchical routing protocols.

C. Location base

In location based routing the sensor nodes are addressed by means of their geographical information i.e. location. The distance between neighbouring nodes can be estimated on the basis of incoming signal strengths. Relative coordinates of neighbouring nodes can be obtained by exchanging such information between neighbours or by communicating with a satellite using GPS [7]. To save energy, some location-based schemes demand that nodes should go to sleep if there is no action. GAF, MECN, GPSR, GEAR are the examples of location aware routing protocols.

IV. Leach Protocol

Wendi B. Heinzelman, Anantha P. Chandrakasan and Hari Balakrishnan introduced the first and most popular energy-efficient hierarchical clustering algorithm for WSNs that was proposed for reducing power consumption known as Low-Energy Adaptive Clustering Hierarchy (LEACH). LEACH protocol is based following assumptions that all nodes can transmit with enough power to reach the base station, that the nodes can use power control to vary the amount of transmit power, and that each node has the computational power to support different MAC protocols and perform signal processing functions. The working of LEACH is divided into rounds. Each round starts with a set-up phase when the clusters are organized, followed by a steady-state phase when data are transferred from the nodes to the cluster head and on to the BS [8] as



ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 22, April 2016

Set-up Phase: During the setup phase, the CHs are selected based on an elective percentage of deployed nodes also by considering a factor that so far how many times an individual node performed the role of cluster-head. The selection depends on decision made by the node by choosing a random number lies between 0 - 1. If chosen the number is less than a set threshold T(n) then the sensor node becomes a cluster-head for the existing round. However threshold value T(n) is calculated as

$$T(n)=\begin{cases}\dfrac{p}{1-p(r \bmod (1/p))} & n \in G \\ 0 & others\end{cases}$$

Where p is the probability of the node being selected as a cluster-head node, r is the number of rounds passed, and G is the set of nodes that have not been cluster-heads in the last 1/p rounds, mod denotes modulo operator. Nodes that are cluster heads in round r shall not be selected in the next 1/p rounds. Once the cluster-head is selected, all nodes join the corresponding cluster according to the broadcast signal intensity of the cluster-head node. Then, the cluster set-up phase of this round is completed. When the cluster-head assigns time slots for members using TDMA mode, the network will enter the steady phase.

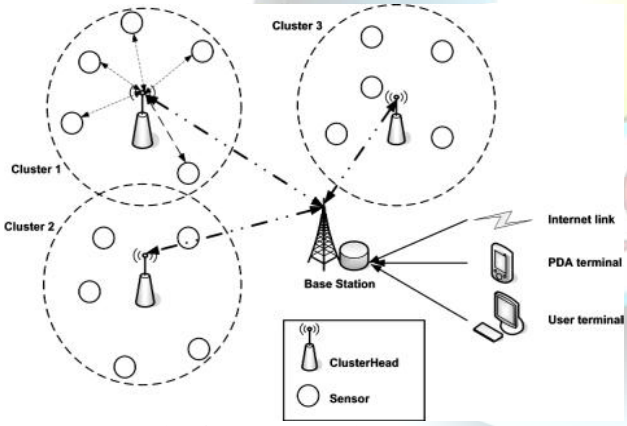


Fig. 5 LEACH Architecture

Steady State Phase: Steady Sate operation is broken into frames, where nodes send their data to the Cluster-head at most once per frame during their allocated slot. Cluster-Head sends the aggregated data to Base-Station (BS) in one hop manner.

There are some drawbacks of LEACH protocol: It uses single-hop routing where each node can transmit directly to the cluster-head and the sink [9]. CHs are elected randomly; hence there is Possibility that all CHs will be concentrated in same area. The idea of dynamic clustering is used which leads to extra overhead due to cluster head changes, advertisements etc. The protocol assumes that all nodes are having same amount of energy. It also assumes that CH consume around the same amount of energy for each node.

As LEACH protocol is one of the most important energy saving protocol but have some drawbacks. Many researchers worked on LEACH to improve the performance and remove the drawbacks. Following are some of them summarized in this paper.

1. *LEACH-C(Centralized Low Energy Adaptive Cluster Head):*

A modification over the LEACH protocol that uses a centralized clustering algorithm and the same steady state phase protocol [8] same as LEACH is called as centralized low energy adaptive cluster head (LEACH-C) protocol. During setup phase of LEACH-C, each node sends the current location and remaining energy of itself to the base station. The location can be determined by GPS system or any other tracking method. In addition to determine good cluster head the base station will elect only those nodes which have energy above average level and ensure that the energy load is evenly distributed among all the nodes. Once the cluster heads and linked clusters are found, the BS broadcasts a message that contains the cluster head ID for each node. If a node's cluster head ID matches its own ID, the node is a cluster head; otherwise, the node determines its TDMA slot for data transmission and goes to sleep until it is time to transmit data. The steady-state phase of LEACH-C is same as that of LEACH.

2. *LEACH-F (Fixed number of cluster Low Energy Adaptive Clustering Hierarchy):*

In 2000, Heinzelman proposed LEACH-F a modified version of LEACH with fixed clusters and rotating cluster heads [10]. This protocol uses centralized approach for cluster formation as that of LEACH-C. Once the cluster formation process is done, then there is no re-clustering phase in next round. The clusters are fixed and only rotation of cluster head nodes within its clusters. The steady-state is same as classical LEACH. The overhead of re-clustering in basic LEACH is removed by LEAC-F protocol as once the fixed number of clusters is formed; they are maintained throughout the network. But this protocol provides no flexibility of adding or removing the nodes once clusters are formed and nodes cannot adjust their behaviour on node dying.

3. *LEACH-B (Balanced Low Energy Adaptive Clustering Hierarchy):*

Mu Tong and Minghao Tang proposed LEACH-B algorithm to balance the number of cluster heads based on the residual energy of the sensor nodes. LEACH-B uses decentralized 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. LEACH-B works in three stages: Cluster head selection, Cluster formation and data transmission with multiple accesses. According to energy dissipated in the path between a node and final receiver, each node chooses its cluster head. LEACH-B has better energy efficiency than basic LEACH protocol [11].

4. *TL-LEACH (Two level Low Energy Adaptive*

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 22, April 2016

TL-LEACH protocol proposed by V. Loscrì, G. Morabito, S. Marano, unlike LEACH protocol where cluster heads send data to the base station directly in a single hop, TL-LEACH protocol 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. Advancement of this protocol reduces data transmission energy. Cluster head nodes die early compared to other nodes, far away from base station and TL-LEACH improves energy efficiency by using a cluster head node as relay node in between cluster head nodes [12].

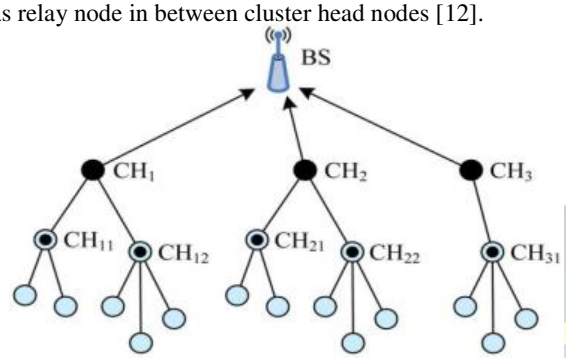


Fig. 6 Topology of TL-LEACH Protocol

5. *LEACH-E (Energy Low Energy Adaptive Clustering Hierarchy):*

In LEACH-E protocol, initially all nodes have same energy and same probability of becoming the cluster head. After the first round, energy level of each node changes. Then the amount of residual energy of each node is used to select cluster head nodes. The nodes with highest residual energy are preferred on rest of the nodes. LEACH-E enhance lifetime of network by balancing energy load among all nodes in the network [11].

6. *MH-LEACH (Multi-Hop Low Energy Adaptive Clustering Hierarchy):*

In LEACH protocol, the cluster head nodes send data to the base station directly irrespective of distance between them. This will cause high energy dissipation of cluster head node if base station is located far away from it. As the network diameter increases, the distance between base station and cluster head nodes increases and this is disadvantages of LEACH protocol. To increase energy efficiency of the protocol, multi-hoping communication is introduced. Firstly cluster member nodes send data to their respective cluster head nodes which further transfer data to cluster head rather than base station directly. This protocol adopts an optimal path between cluster head and the base station [13].

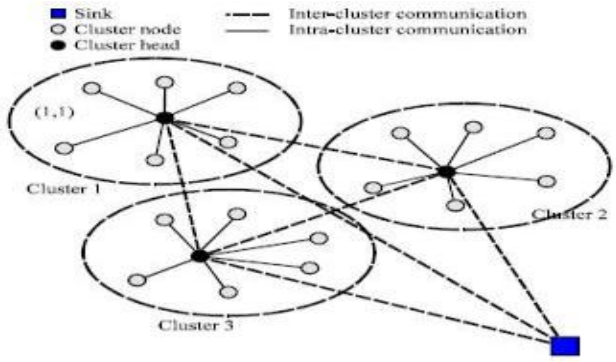


Fig.7 MH-LEACH Protocol

7. *LEACH-M (Mobile Low Energy Adaptive Clustering Hierarchy):*

Mobility issue in LEACH protocol was resolved by introducing LEACH-M protocol. This protocol provides mobility to the both non-cluster head nodes and cluster head nodes while 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 being selected as cluster head nodes and the role of cluster head nodes is broadcasted to all nodes within its transmission range [11] [14].

8. *I-LEACH (Improved Low Energy Adaptive Clustering Hierarchy):*

Authors Zahra Beiranvand, Ahmad Patooghy, and Mahdi Fazeli have prposed I-Leach. It has three phases. During cluster head selection phase this protocol has modified the threshold value by considering various properties of sensor nodes such as their current energy level, number of neighbour nodes, and their distances to base station. It also considers average energy of the network, average number of neighbour nodes in the network, average distances of nodes from base station. In cluster formation phase nodes take into account the distances of cluster heads from the base station. In Data transmission phase cluster heads transmit data to the base station after collecting data from their local cluster members. Nodes which are very nearer to base station they are allowed to transmit data to the base station directly, it has reduced extra transfers. Therefore average consumed energy reduces and prolonged the WSN lifetime [15].

9. *LEACH-A (Advanced Low Energy Adaptive Clustering Hierarchy):*

Authors [16] proposed LEACH-A protocol. This protocol proposed a heterogeneous energy protocol for decreasing the node's failure probability and for prolonging the time interval before the first node dies which called as stability period. By the use of a synchronized clock, each sensor node would about to know the starting of each round for transferring of information. The maximum energy nodes are selected as cluster head for each cluster and these nodes are

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 22, April 2016

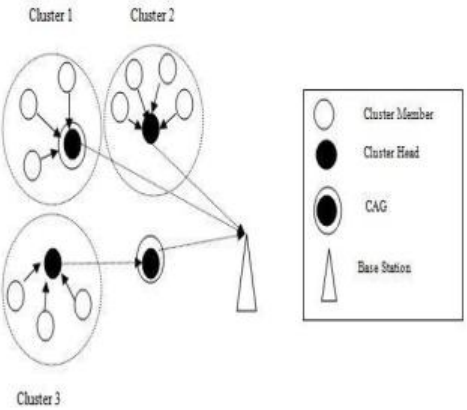


Fig. 8 LEACH-A Protocol Model

10. Cell-LEACH (Cell Low Energy Adaptive Clustering Hierarchy):

This is proposed by Yektaparast, A., Nabavi, F.H., Sarmast. In Cell-LEACH, WSN is divided into number of clusters where each cluster is further divided into 7 sections called cells. Several sensors are included within each cell from which one sensor node is selected as cell-head. No re-clustering and re-celling is done once formed. Each cell node sends data to the cell head at its designated time given by TDM. Data aggregation function is performed by cell heads and processed data is sent to cluster heads. Cluster heads perform the same function as cell heads and transfer data to the base station [13]. After first round, the cell head and the cluster head will be determined randomly.

11. V-LEACH (Vice Cluster Head Low Energy Adaptive Clustering Hierarchy):

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 [16]. V-LEACH improves this drawback having vice-cluster head in each cluster that takes the role of cluster head when cluster head dies. In this way, this 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. Hence network lifetime increases.

12. W-LEACH (Decentralized Algorithm)

Authors in [17] present improved model of W-LEACH to a new protocol called W-LEACH decentralized to increase network lifetime without the use of maps. Working of W-LEACH decentralized algorithm is similar to LEACH, W-LEACH decentralized algorithm is divided into rounds, where each round begins with a setup phase in which CH are selected and clusters are formed. Then comes the steady-state phase in which the data transmitted to the BS. Just before the beginning of data transmission, each node determines its neighbours according to a welldetermined distance which organizes the density of nodes so the neighbouring nodes do not transmit the same data. According to the number of neighbours, the node members decide their status as being in an active state or they remain in a sleep state during this round, so a sensor with low densities (has a lot of neighbours) stays alive as long as possible. In this way, the allocations of sensors densely send data to their CHs have probably leaded to minimize redundant data CH and they always share in sending data with their CH. Thereafter the total energy consumption of the network is minimized, so we increase lifetime of network. During each round in the network, there are member nodes which are selected into two groups: sleeping nodes and active nodes. In [17] a result show, W-LEACH decentralized saves more energy compares to LEACH protocol, finally in this paper we give the time line of LEACH and its descendant protocols in table 1

VI. COMPARISON

In classical leach protocol researchers made many enhancements and proposed modified algorithms. These algorithms are made considering cluster head selection, energy aware and optimization of CH selection. And we have different versions of modified LEACH protocol. The following table summarizes the various comparisons of parameters made by enhanced LEACH algorithm.

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 22, April 2016

TABLE 1: COMPARISONS OF LEACH PROTOCOL AND THEIR ADVANCES

Routing protocol	year	Mobility	Scalability	Self organization	Distributed	Hop count	Homogeneous	Use of location information
LEACH	2002	Fixed BS	Limited	Yes	Yes	Single Hop	Yes	No
LEACH-C	2002	Fixed BS	Good	Yes	No	Single Hop	Yes	Yes
LEACH-F	2002	Fixed BS	Limited	No	No	Single Hop	Yes	Yes
LEACH-B	2003	Fixed BS	Good	Yes	Yes	Single Hop	Yes	Yes
TL-LEACH	2005	Fixed BS	Very Good	Yes	Yes	Single Hop	Yes	Yes
LEACH-E	2007	Fixed BS	Very Good	Yes	Yes	Single Hop	Yes	Yes
MH-LEACH	2007	Fixed BS	Good	Yes	Yes	Multi Hop	Yes	Yes
LEACH-M	2008	Mobile BS and Nodes	Very Good	Yes	Yes	Single Hop	Yes	Yes
I- LEACH	2009	Fixed BS	Very Good	Yes	Yes	Single Hop	Yes	Yes
LEACH-A	2010	Fixed BS	Good	Yes	Yes	Single Hop	No	No
Cell-LEACH	2012	Fixed BS	Very Good	Yes	Yes	Multi Hop	Yes	Yes
V-LEACH	2013	Fixed BS	Very Good	Yes	Yes	Single Hop	Yes	Yes
W-LEACH	2015	Fixed BS	Very Good	Yes	Yes	Multi Hop	Yes	Yes

VII. CONCLUSION

Use of energy efficiently in the network has been the main issue in WSNs for increasing lifetime of the network. One of the most energy efficient routing protocols introduced in WSN is LEACH. In this survey, we have seen wireless sensor network and routing protocols used in WSN. An overlook on various improved versions of LEACH protocol with classical LEACH has been done; there is still some energy efficient protocols are to be studied in future.

REFERENCES

[1] Alakesh Braman, 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, Vol. 3, Issue 2, February 2014, pp. 5683-5690

[2] Monica R Mundada, Savan Kiran, Shivanand Khobanna, Raja Nahusha Varsha and Seira Ann George, "A STUDY ON ENERGY EFFICIENT ROUTING PROTOCOLS IN WIRELESS SENSOR NETWORKS", International Journal of Distributed and Parallel Systems (IJDPS) Vol.3, No.3, May 2012, pp. 311-330.

[3] Neetu Kumari1, Nikita Patel2, Satyajit Anand3, Partha Pratim Bhattacharya, "Designing Low Power Wireless Sensor Networks: A Brief Survey" International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 2, Issue 9, September 2013, pp 4447-4456.

[4] 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, April 2012 pp- 160-166.

[5] Monica R Mundada1, Savan Kiran1, Shivanand Khobanna1, Raja Nahusha Varsha1 and Seira Ann George1, "A STUDY ON ENERGY EFFICIENT ROUTING PROTOCOLS IN WIRELESS SENSOR NETWORKS", International Journal of Distributed and Parallel Systems (IJDPS) Vol.3, No.3, May 2012, pp 311-330.

[6] Christo Ananth, A.Nasrin Banu, M.Manju, S.Nilofer, S.Mageshwari, A.Peratchi Selvi, "Efficient Energy Management Routing in WSN", International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE), Volume 1, Issue 1, August 2015,pp:16-19

[7] Nishi Sharma*, Vandna Verma, "Energy Efficient LEACH Protocol for Wireless Sensor Network", International Journal of Information & Network Security (IJINS), Vol.2, No.4, August 2013, pp. 333-338.

[8] Wendi B. Heinzelman, " Application Specific Protocol Architectures for Wireless Network", Department of Elecrical Engineering and Computer Science, Massachusetts Institute of Technology, 2000.

[9] J.Gnanambigai, Dr.N.Rengarajan, K.Anbukkarasi, "Leach and Its Descendant Protocols: A Survey", International Journal of Communication and Computer Technologies Volume 01 – No.3, Issue: 02 September 2012.

[10] V. Loscrì, G. Morabito, S. Marano, "A Two-Levels Hierarchy for Low-Energy Adaptive Clustering Hierarchy (TL-LEACH)", in Proc. IEEE 62nd Vehicular Technology Conference, 2005.

[11] Mian Ahmad Jan, Muhammad Khan, "A Survey of Cluster-based Hierarchical Routing Protocols", IRACST – International Journal of Computer Networks and Wireless Communications (IJCNWC), ISSN: 2250-3501 Vol.3, No2, April 2013.

International Journal of Computer Applications (0975 – 8887) Volume 95– No.21, June 2014

[17] Descendant of LEACH Based Routing Protocols in Wireless Sensor Networks Rajendra Prasad Mahapatra, Rakesh Kumar Yadav* 3rd International Conference on Recent Trends in Computing 2015 (ICRTC-2015)