International Journal of
Emerging Research in Management &Technology
ISSN: 2278-9359 (Volume-4, Issue-5)

Research Article | **May 2015**

Improvement in E - LEACH Routing Protocol with Vice Cluster Head in Wireless Sensor Network

[1]Rahul Verma, [2]Somnath Gupta
[1]Dept. of Computer Applications, Kanpur Institute of Technology, Kanpur, India
[2]Assistant Professor, Dept. of Computer Applications, Kanpur Institute of Technology, Kanpur, India

Abstract—

Wireless sensor network (WSN) is the collection of two or more interconnected sensor nodes wirelessly. In WSN, the sensor nodes have a limited transmission range, and their processing and storage capabilities as well as their energy resources are also limited. Routing protocols for wireless sensor networks are responsible for maintaining the routes in the network and have to ensure reliable multi-hop communication under these conditions. In this paper, Enhance - Low Energy Adaptive Clustering Hierarchy routing protocols (E - LEACH) with Vice Cluster Head has been introduced for routing in Wireless Sensor Network and comparing their strengths and limitations.

Index Terms— WSN, LEACH, Cluster-head selection; Vice Cluster Head

I. INTRODUCTION

Wireless sensor network (WSN) [4] is a self-organized network composed by a large number of micro sensors that are deployed in monitoring regional through wireless communication. With its wide application in medical aid, military reconnaissance, logistics management, environmental monitoring, agriculture and other commercial areas,

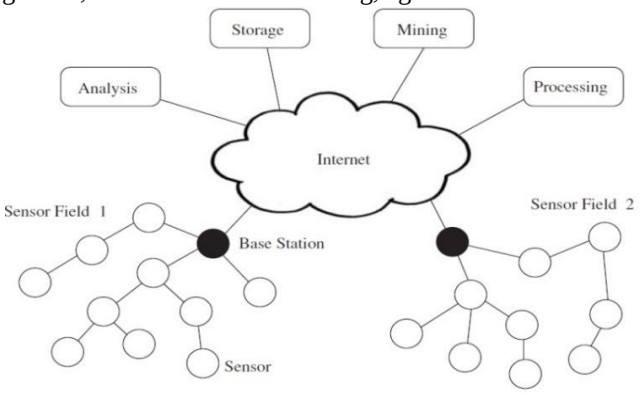

Fig.1. Wireless Sensor Network

By the use of above diagram we can easily understand the working of the WSN where Sensor nodes communicate not only with each other but also with a base station (BS) using their wireless radios, allowing them to disseminate their sensor data to remote processing, visualization, analysis, and storage systems.
Sensor nodes rely on battery power supply, their communication capability and energy storage capacity are very limited, so main objectives in WSN is to efficiently use the energy of nodes, balance the energy consumption and extend the network lifetime has become a primary design objective. Clustering routing technology is the most widely influential. Low-Energy Adaptive Clustering Hierarchy (LEACH) is a classical clustering routing in wireless sensor networks.
In this paper first section focuses on the introduction second is for the study of LEACH and Enhanced- Low-Energy Adaptive Clustering Hierarchy (E-LEACH) protocol, third is for the problem identification and after that the proposed improved energy balanced clustering algorithm.

II. RELATED WORK

LEACH stands for Low-Energy Adaptive Clustering Hierarchy [8] it is clustering based routing protocol to collect data from wireless sensor network. The reason we need network protocol such as LEACH is due to the fact that a node in the network is no longer useful when its battery dies. This protocol allows us to balancing the energy efficiency in WSN. In this algorithm formation of clusters is done on the basis of the received signal strength. The main objective of LEACH is to provide data aggregation for sensor networks.
The LEACH Network is made up of nodes, some of which are called *cluster-heads* the job of the cluster-head is to collect data from their surrounding nodes and pass it on to the base station. LEACH is *dynamic* because the job of cluster-head rotates.

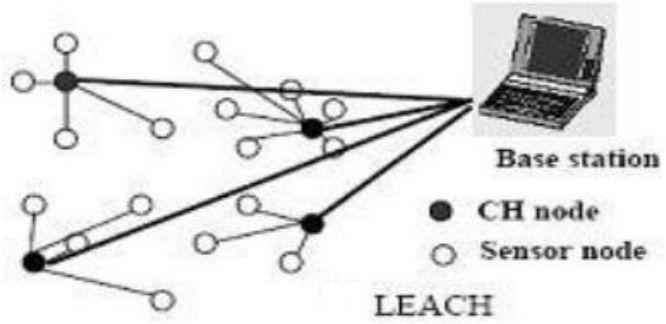

Fig.2. Basic LEACH [5]

The cluster head [5] can be selected randomly and then rotate this role to evenly distribute the energy load among the sensors in the network. The node n chooses a random number between 0 and 1 and the nodes becomes a cluster head for the current round if the number is less than the threshold T (n).

$$T(n) = \begin{cases} \dfrac{P}{1 - P * \left(r \bmod \frac{1}{P}\right)}, & \text{if } n \in G \\ 0 & \text{otherwise} \end{cases} \quad (1)$$

Where

- *P* is the desired percentage of CH nodes in the sensor population
- *R* is the current round number
- *G* is the set of nodes that have not been CHs in the last 1/*p* rounds

Operation of LEACH

The operation of LEACH [20] is divided into two phases.

- the set-up phase
- steady-state phase

Setup Phase In setup phase, the clusters are organized and cluster heads are selected. Each node decides independent of other nodes if it will become a CH or not. This decision is based on when the node served as cluster head for last time; the node that has not been cluster head for long time has more probability to elect. In advertisement phase cluster head send the advertisement packet to inform their neighbors that they become cluster head. Non cluster head nodes pick the advertisement packet on the basis of received signal strength.
In Cluster setup phase, the non-cluster head nodes inform the cluster head by sending the message which contains their IDS.
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. 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[5,9]. The cluster-head must keep its receiver on to receive all the data from the nodes in the cluster. Once the cluster-head receives all the data, it can operate on the data and then the resultant data are sent from the cluster-head to the base station.

E-LEACH is based on LEACH [11] protocol to balance the energy consumption of sensor nodes in order to solve the overload energy consumption problem. The E-LEACH adopts the same round concept with the original LEACH. In hierarchical routing protocols, the number of cluster-heads is a key factor that affects the performance of routing protocols. If the number of cluster-heads is less, each cluster-head needs to cover larger region, this will lead the problem that some cluster-members get far from their cluster-heads and consume much more energy. As the communication between cluster heads and the base station needs much more energy than common nodes, the excessive number of cluster-heads will increase the energy consumption of the whole network and shorten the network lifetime. Therefore, it is necessary to select optimal cluster head number to make the energy consumption minimum. In the E-LEACH minimum spanning tree between cluster heads is used, choose the cluster head which has largest residual energy as the root node [12].

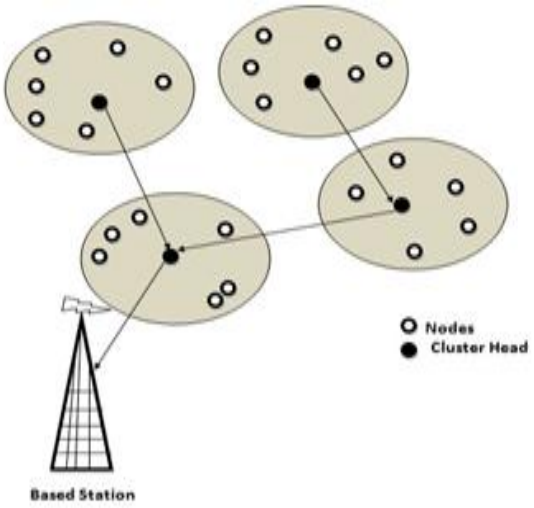

Fig.3 Architecture of E-LEACH

A new formula [20] for cluster head selection in E-LEACH is defined below:

$$T(n) = \begin{cases} \dfrac{P}{1 - P * \left(r \bmod \frac{1}{P}\right)} * \dfrac{E_{current}}{E_{initial}}, & \text{if } n \in G \\ 0 & \text{otherwise} \end{cases} \quad (2)$$

Where the Ecurrent is the residual energy of nodes at the r round, Einitial is the initial energy of nodes. By using T (n), the possibility for low residual energy nodes being cluster head is greatly reduced and the possibility for high residual energy nodes being cluster head is increased.

III. PROBLEM IDENTIFICATION

Although LEACH and E-LEACH protocols act in a good manner but the both protocols also suffer from many drawbacks like the following.

- LEACH assumes that each node can communicate with each other and can reach to BS. It is not possible in large network.
- In setup phase CH is selected randomly without considering the residual energy of the nodes.
- E-LEACH solves the issue of energy loss while CH directly connects to BS but even there is a new issue has been raised in E–LEACH because as the fig.3 shows each CH is connected to Bs via CH nearest to BS which causes extra energy loss of nearest CH to BS.
- LEACH and E-LEACH improved energy efficiency in WSN but the issue is that the every time whenever CH dies the whole process of setup and steady phase start again.

IV. PROPOSED WORK

In order to overcome the problem identified one scheme is proposed in this paper which helps to overcome existing problems in LEACH and E-LEACH. Motivated by the original LEACH, E-LEACH and other improvement protocols [15, 16], in this paper a modification to the steady phase by selecting Vice Cluster Head to reduce the energy consumption. For a micro sensor network, we first make the following assumptions.

- Base station (BS) is located far from the sensors.
- All nodes in the network are homogenous and have limited energy with an indentify ID.
- Each CH is communicating to the BS via nearest CH to BS
- CHs perform data compression and aggregation.

In this paper we also use the basic clustering ideology of LEACH and E-LEACH like Set-up Phase and Steady-Phase. Set-up Phase will use improved formula of E-LEACH protocol to select the CHs and as we know that the CHs will consume more energy as compare to other non-CH nodes. In LEACH and E-LEACH the main issue is that the every time whenever the CH down than the rebuilding of clusters start again, it consumes more energy.

However in this paper we use member nodes information achieved by cluster heads in the Steady-Phase and in later period the member node will take over the responsibility form CH and became the Vice Cluster Head (VCH). Comparing this scheme with the traditional LEACH and E-LEACH, the VCHs proposed will diminish the frequency of re-clustering in the same interval and prolong the time of being in steady-state phase, which will prolong the lifecycle of the whole network.

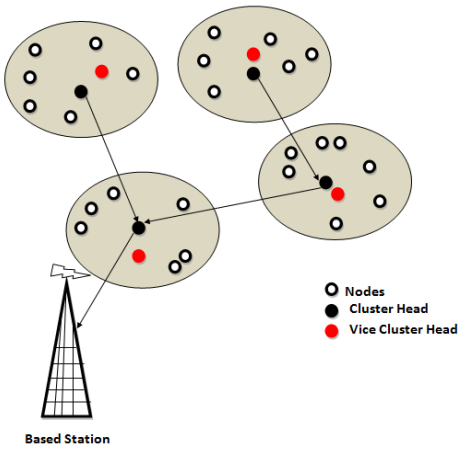

Fig.4 Architecture of Proposed Algorithm

Cluster Heads (CHs) selection in the Set-Up Phase. Based on the fact that LEACH does not take into account the residual energy of the nodes during the selection of cluster heads in the set-up phase, we develop the current energy and the times being selected CH or VCH which will be shown later in the paper. We first consider that the threshold $T(n)$ is modified to the following equation:

$$T(n) = \begin{cases} \dfrac{P}{1 - P * \left(r \bmod \frac{1}{P}\right)} \times \\ 0 \\ \left[\dfrac{E_{current}}{E_{initial}} + \left(1 - \dfrac{E_{current}}{E_{initial}}\right)\right. \\ \left. \times \dfrac{P}{CH_{times} + VCH_{times} + 1}\right] \end{cases} \begin{matrix} \\ \\ , \text{if } n \in G \\ \\ \text{otherwise} \end{matrix} \quad (3)$$

Where p is the percentage of cluster heads over all the nodes in the network, R is the number of rounds selection in current time. G is the set of nodes that have not been selected as cluster heads in round $1/p$. Ecurrent is the residual energy of the node and Einitial is the initial energy of every node. CH times (VCH times) is the times of being selected CH (VCH times) once. Deducing from (3), we can obtain that the larger the En current, the larger the $T(n)$. So we can infer that the node which has more energy will have a bigger probability to become the cluster head in the current round.. After finishing the selection of cluster heads in the set-up phase by using the improved equation and simulated annealing algorithm, the steady-state phase of a round begins.

In this paper we used a new scheme that has been used to stretch the time of being in steady phase and diminish the frequency of re-clustering. Proposed scheme has been defined below.

Vice Cluster Heads' (VCHs') Establishment during the Steady-State Phase.

When the communication is in the steady-state phase, Ch can learn the status of its each member because each member sends the data to its CH. So CH can record the real time information of the nodes dynamically and the format of the information is like this _id, E_, which means the member node id has the residual energy E. In this way Ch can have the global energy information about its each member nodes. In order to stretch the time of being in steady-state phase and delay a new round's coming, CH will choose a member node with having maximum energy in cluster and in later period when the CH will consume too much energy than selected member node will become the VCH for the current round and take all the responsibility of the CH. In order to make the rest of member nodes get the *id* of VCH, the CH will broadcast this message containing the VCHs *id* to other member nodes. After that, the CH itself will become a normal member node in the cluster. After that all the nodes will sends their data to VCH, and will work as the CH to handle all the communication in steady phase. We can observe that the establishment of VCH in cluster can prolong the communication time of being in steady-state phase and delay the coming of a new round. But after some time, VCH will also consume more energy than the other member nodes due to the huge tasks. To avoid making the VCH die early, a new round of selecting CHs in the set-up phase will start among all the nodes. So we can call the whole communication in our improved protocol as the cycle of "CH-VCH-CH". It can be described using the Figure 4. In the proposed scheme, we take the measure of selecting a VCH for each cluster in the later period of the steady state phase in a round by using the energy information achieved by CH, which can diminish the frequency of reclustering and prolong the time of being in steady-state phase. In the whole communication phase of a round, CH and VCH have the same role to undertake collecting data from member nodes and relaying them to BS. The difference is that the CH takes the responsibility in the earlier stage of the steady-state phase in a round, while VCH replaces the CH and works in the later stage of the steady

phase. Also, the CHs selection originates the competition among all the nodes in the set-up phase. However, VCH is established directly by CH in the later stage of the steady-state phase in a round.

We can obtain that the method of establishing VCH is simple and rapid comparing with the generation and cooperation of random numbers in the set-up phase. They all have a good benefit to the saving of energy in the whole network.

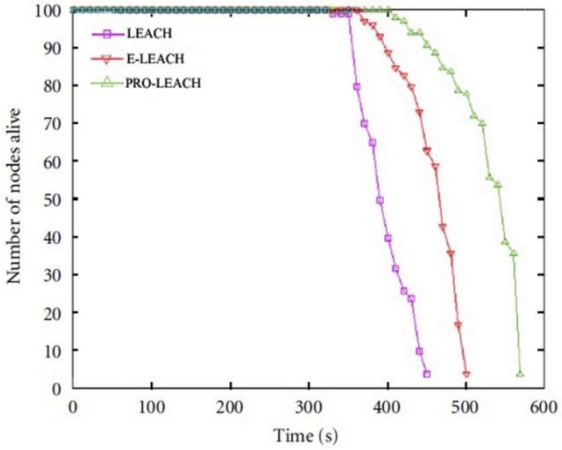

Fig.6 Graphical representation of Alive nodes in Proposed Algorithm

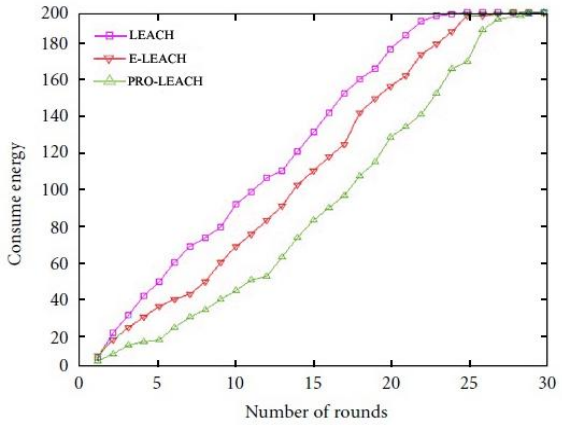

Fig.6 Graphical representation of energy consumption in Proposed Algorithm

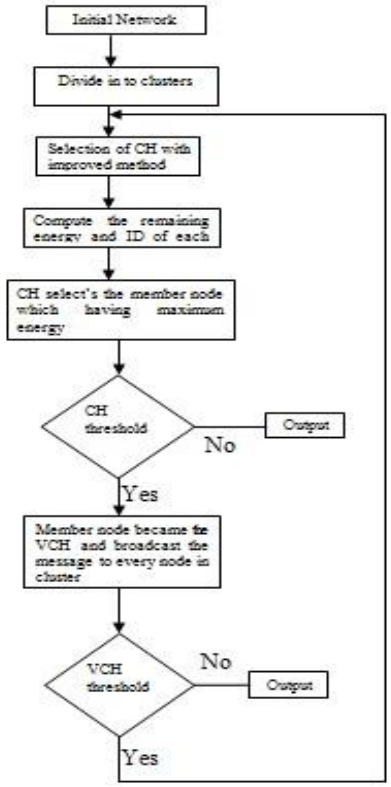

Fig.5 flow chart for Proposed Algorithm

V. CONCLUSION AND FUTURE WORK

Energy is one of the most important aspects in Wireless sensor Network. Because sensor nodes in the Wireless Sensor Network are relay on battery and when the battery dies than the nodes are no longer in use so there is a need of routing protocol for the effective utilization of sensor nodes. In this paper we proposed an Enhanced LEACH Routing Protocol with Vice Cluster Head which helps in efficient utilization of network energy consumption. By using this protocol it makes optimum utilization of the network and increases the lifetime of network.

REFERENCES

[1] Fundamentals Of Wireless Sensor Networks Theory And Practice Waltenegus Dargie Technical University Of Dresden, Germany Christian Poellabauer University Of Notre Dame, Usa A John Wiley and Sons, Ltd., Publication

[2] Chunyao FU1, Zhifang JIANG1, Wei WEI2and Ang WEI*3 "An Energy Balanced Algorithm of LEACH Protocol in WSN" IJCSI International Journal of Computer Science Issues, Vol. 10, Issue 1, No 1, January 2013M. J. Handy, M. Haase, D. Timmermann "Low Energy Adaptive Clustering Hierarchy with Deterministic Cluster-Head Selection" Fourth IEEE Conference S. 368-372, ISBN 0-7803-7606-4 September 2002

[3] Qian Liao, Hao Zhu "An Energy Balanced Clustering Algorithm Based on LEACH Protocol" Proceedings of the 2nd International Conference On Systems Engineering and Modeling (ICSEM-13)

[4] RFID and sensor Network Architecture, Protocols, Security and integration

[5] Meena Malik1, Dr. Yudhvir Singh2 , Anshu Arora3 "Analysis of LEACH Protocol in Wireless Sensor Networks" IJARCSSE Volume 3, Issue 2, February2013 ISSN: 2277 128X

[6] "Simulation of LEACH for Wireless Sensor Network" IJARCSSE Volume 3, Issue 7, July2013 ISSN: 2277 128X

[7] Neha Raithil, Jyoti Saraswat and Partha Pratim Bhattacharya "A Review On Routing Protocols For Application In Wireless Sensor" Department of Electronics and Technology IJDPS

[8] Nishanth T S, Rajesh A N K S, Aditya Bharadwaj B N, Nikhil Chakravarthi "Implementation and Comparison of LEACH and Non LEACH Protocols in Wireless Sensor Networks" Dept. of Information Science Engineering, Reva Institute of Technology and Management, Bangalore, INDIA

[9] Rajesh Patel, Sunil Pariyani, Vijay Ukani," Energy and Throughput Analysis of Hierarchical Routing Protocol(LEACH) for Wireless Sensor Networks", International Journal of Computer Applications Volume 20- No. 4 (April 2011)

[10] Arti Khatri "Cluster Head Election Using Wireless Sensor Network" DCRUST. (Murthal), South Point Institute of Technology and Management, Sonipat, India

[11] Ravneet Kaur1, Deepika Sharma2 and Navdeep Kaur3 "Comparative Analysis of Leach And Its Descendant Protocols In Wireless Sensor Network" International Journal of P2P Network Trends and Technology- Volume3Issue1- 2013

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

[13] G. Ran,H. Zhang, and S. Gong, "Improving on LEACH protocol of wireless sensor networks using fuzzy logic," *Journal of Information and Computational Science*, vol. 7, no. 3, pp. 767– 775, 2010.

[14] M. B. Yassein, A. Al-zou'bi, Y. Khamayseh, and W. Mardini, Improvement on LEACH protocol of wireless sensor network," *Journal of Digital Content Technology and Its Applications*,

[15] G. Ran,H. Zhang, and S. Gong, "Improving on LEACH protocol of wireless sensor networks using fuzzy logic," *Journal of Information and Computational Science*, vol. 7, no. 3, pp. 767–775, 2010

[16] M. B. Yassein, A. Al-zou'bi, Y. Khamayseh, and W. Mardini, "Improvement on LEACH protocol of wireless sensor network," *Journal of Digital Content Technology and Its Applications*, vol. 3, no. 2, pp. 260–264, 2009.

[17] Jia Xu,Ning Jin, Xizhong Lou,Ting Peng,Qian Zhou,Yanmin Chen " Improvement of LEACH protocol for WSN" 2012 9th International Conference on Fuzzy Systems and Knowledge Discovery (FSKD 2012)

[18] H. Abusaimeh and S. H. Yang, "Dynamic cluster head for lifetime efficiency in WSN," *International Journal of Automation and Computing*, vol. 6, no. 1, pp. 48–54, 2009.

[19] T. Murata and H. Ishibuchi, "Performance evaluation of genetic algorithms for flowshop scheduling problems," in *Proceedings of the 1st IEEE Conference on Evolutionary computation*

[20] Jia Xu,Ning Jin, Xizhong Lou,Ting Peng,Qian Zhou,Yanmin Chen "Improvement of LEACH protocol for WSN" 2012 9th International Conference on Fuzzy Systems and Knowledge Discovery (FSKD 2012)

