Survey of energy efficient leach protocol in WSN

[1]Diksha sharma, [2]Kamal
[1]Research scholar, [2]Director,
[1]Department of Electronics and Communication Engineering
[1]Emax institute of technology & mang, Ambala, India

***Abstract* - Wireless sensor networks (WSNs) are cluster of sensor nodes that co-operate together to monitor an environment or a system. It include of large number of sensor nodes, which sense and measure various physical phenomena related parameters and hand over the measured data towards the base station by making use of the neighbouring nodes acting as relay nodes. It rely on various resource constrained nodes with limited energy, range, memory and computational power it is essential to conserve battery energy so as to extend the life time of the given WSN deployment. These sensor nodes works on limited battery source, one of the factor to be consider while designing a WSNs protocol is by efficient use of available energy resources to prolong network lifetime. One of the efficient WSNs protocol is Low Energy Adaptive Cluster Hierarchy (LEACH). In this paper we present leach protocol and we use heterogeneous nodes for data transmission through the optimal path between cluster heads (CHs) and the base station (BS). In LEACH, Non-Cluster head Nodes decide to link a cluster head based on Received Signal Strength (RSS) of receiving packets from CHs.**

***Index Terms* - Wireless sensor network (WSN), LEACH protocol.**

I. INTRODUCTION

Wireless Sensor Networks (WSNs) (1) are networks of light-weight sensors that are battery powered consumed majorly for monitoring purposes. WSNs are growing equipped to handle some of these complex functions, in-network processing such as data aggregation, information fusion, computation and transmission activities requires these sensors to consume their energy efficiently in order to extend their effective network life time. Sensor nodes are ready to energy drainage and failure, and their battery source might be irreplaceable, instead new sensors are deployed. Thus, the stable re-energizing of wireless sensor network as old sensor nodes die out and/or the uneven terrain of the scope being sensed can lead to energy imbalances or heterogeneity among the sensor nodes. This can negatively impact the stability and execution of the network system if the extra energy is not properly utilized and leveraged.

WSNs are being used in many applications such as process monitoring, health care, environment monitoring, forest fire detection, landslide, industrial management, and military applications. In recent years wireless sensor networks (WSNs) (3) has gained much attention due to the increase demand in the field of medicine, battle fields, identification of contaminated environments, environmental monitoring, analysis of structural conditions of buildings, roads and highways etc. These networks are distributed embedded system consisting of large collection of short range sensor nodes collectively work together to monitor a system or an environment. These nodes will sense, and gather information from the environment or system and transmit the data to Base Station. The nodes consist of the sensor module which senses the environment, the processor and memory which perform local computation on the sensed data and store data, the transceiver responsible for exchange information with neighbor nodes and a power supply unit for node's energy system; an energy homogeneous system where a node is not likely to fail due to uneven terrain, failure in connectivity and packet dropping. But more recent protocols like SEP considered the reverse that is energy heterogeneity where the factors described above is a possibility, which is more applicable to real life scenario for WSN. Thus, energy heterogeneity should therefore be one of the key factors to be considered when designing a protocol that is robust for WSN. A good protocol design must be able to scale well both in energy heterogeneous and homogeneous settings, meet the demands of various application scenarios and guarantee reliability.

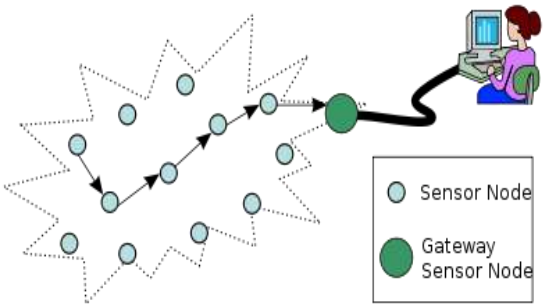

Figure 1.1: Typical Wireless Sensor Network Architecture

Wireless Sensor Networks are characterized by:

- Limited power they can yield or store.
- Ability to cope with node failures.

- Heterogeneity of nodes.
- Large scale of deployment.
- Mobility of nodes.
- Communication failures.
- Dynamic network topology.
- Ability to withstand harsh environmental conditions.

II. WSN APPLICATION

WSN applications (4) can be classified into two categories: monitoring and tracking. Monitoring applications comprise indoor or outdoor environmental monitoring, health and wellness monitoring, power monitoring, inventory location monitoring, factory and process automation, and seismic and structural monitoring. Tracking applications include tracking objects, animals, humans, and vehicles. While there are many different applications, below we describe a few example applications that have been expand and tested in the real environment. Wireless sensor networks has been widely applied in the field of medical health, Including patient monitoring, disease diagnosis, hospital drug management, remote monitoring of human physiological data, tracking and monitoring of hospital doctors and the patient's activities. The physiological data of sensor network collected can be stored for a long used in medical research. University of California is proposed a human health monitoring platform CusMed which is based on wireless sensor network. Using wearable sensor node, sensor types include pressure, skin reactions, telescopic, a piezoelectric film sensor, and temperature sensor etc. Node using the University of California, Berkeley developed; of the company Crossbow produced the dot-mote node, through the pocket PC machine you can conveniently view the current situation of human body.

In the medical field, because of the small size of the wireless sensor network nodes and wireless communication technology, and they are portability, real-time monitoring, low power consumption, location compared with fixed medical equipment. So they can provide new solutions and techniques for tele monitoring, first aid, etiological diagnosis, and medical equipment tracing and medication management. It is important for innovating medical model, raising the level of treatment and diagnosis, solving the problems of the aging of population caused by social problems. Medical parameters monitoring relates to the lives of patients, so the reliability is very important. Reliability of wireless sensor networks involves the transmission of real-time data, the accuracy of the data communication, information privacy and security; it is the key technology of the whole system.

III. RELATED WORK

Ravi Kishore Kodali (1) proposed that multi-level hierarchical data centric routing protocol. Clusters are formed and first level CHs are elected. Among these CHs, the second level CHs are elected in turn. Each CH distributes the TDMA schedule among its member nodes. According to query sent by the BS, event information is passed to the BS by following the path in the opposite direction. The advanced and improved LEACH protocols proved to be better than LEACH, i.e., TL-LEACH, M-LEACH, DD-LEACH. This is due to their clustering nature, two-level hierarchy of nodes, undergoing multiple hops among CHs transmitting the interested data, and following an optimal path. These factors make the improved LEACH protocols to better the energy usage and to prolong the network lifetime. In the proposed DD-TL-LEACH protocol, simulation shows better results than other two level LEACH protocol.

Chinchu T Sony (3) proposed that Modified LEACH and Modified Multi-hop LEACH protocol for small and large area networks respectively. Three modification are done on LEACH to make this protocol much more energy efficient. The first modification includes CH election procedure with additional parameter node energy level. Secondly allocating idle TDMA of a node to next node if the corresponding node has no data to send and finally the third is multi-hop technique. We done Simulation for LEACH, Modified LEACH and Modified Multi-hop LEACH protocol. Simulation results showed that Modified LEACH protocol have 25% better network lifetime than existing LEACH protocol.

Versha Sharma (5) proposed that two types of nodes are standard nodes and high energy nodes. The improvement in single hop clustering energy efficient LEACH protocol in terms of preventing the collisions, covering the maximum number of nodes in the network and also avoiding the overlapping of the clusters. She considers the heterogeneous nodes over the homogeneous nodes in the network to improve the stability, scalability of the network and network lifetime. LEACH is one of the most popular distributed hierarchical cluster-based, energy efficient routing protocol that has been proposed for minimization of energy consumption and to increase the life span of the network

Saghar (6) proposed that different LEACH extensions in various WSN topologies. The LEACH protocol is self-organizing and is characterized as an adaptive clustering protocol which uses randomly distributes energy load among nodes. By using cluster heads and data aggregation excessive energy consumption is avoided. In this paper we analysed LEACH and its extensions like LEACH-C and LEACH-F using Formal modelling techniques. By using formal verification one can precisely confirm the authenticity of results and worst case scenarios, a solution not possible using computer simulations and hardware implementation.

Naveen Kumar Aravapalli (7) proposed that the multi-level Hierarchical routing protocol is more energy efficient when compared to the LEACH. The lifetime of the network also gets extended. As the deployment area of WSN increases, the 3L-LEACH and 4L-LEACH perform well when compared to the 2L-LEACH.

Bassam Al-Kasasbeh (10) proposed that four different DoS attacks against LEACH protocol. The simulation experiments showed a significant fall in the packet delivery ratio, which consequently is affecting the whole service provided by WSN. Also, it has been concluded that the impact of an attack becomes severe as its intensities are increased. Moreover, a new attack called Scheduling attack is introduced. We found that the scheduling attack clearly affects the scheduling process in the setup phase of LEACH protocol. This attack has reduced the packet delivery by increasing the percentage of conflicts in the network. Also, it has a negative impact on prolonging network lifetime. In the future, we plan to create a specialized dataset for detecting and classifying different DoS attacks.

IV. WSN PROTOCOL

a. Direct Transmission Protocol

In Direct Transmission (6) Protocol the packet transmission only involves the source and destination nodes. A node transmits data directly to BS while the other neighbouring nodes are nowhere linked in this transmission process, and can thus be put in sleep state for energy conservation. In case of nodes deployed over large areas, the direct transmission protocol cannot stand for long time as nodes drain off energy quickly. More specifically, the direct transmission drains significant energy of the farthest nodes from the BS and these nodes die soon.

b. Minimum Transmission Energy Protocol

Minimum Transmission Energy (MTE) (6) protocol is a flat topology based. The data is gathered by the nodes and the same is forwarded using multi-hop wireless links towards the BS. In MTE model, a node forwards the sensed data to one of its neighbouring nodes which is closer to the BS. The data propagates from source to the BS using multiple hops from one node to another until it reaches the BS. In MTE protocol the data is sent to the BS using various alternate paths. In this technique, the data is aggregated and the same is sent and thereby improving the energy efficiency. In this, a routing table is maintained by each node. These tables contain neighbouring node related information using an optimal path is used in forwarding the data with reduced latency. In addition to sending its own data each node also forwards the data of its neighbouring nodes. In case of any node dies, topological changes happen automatically the data is sent using alternate paths.

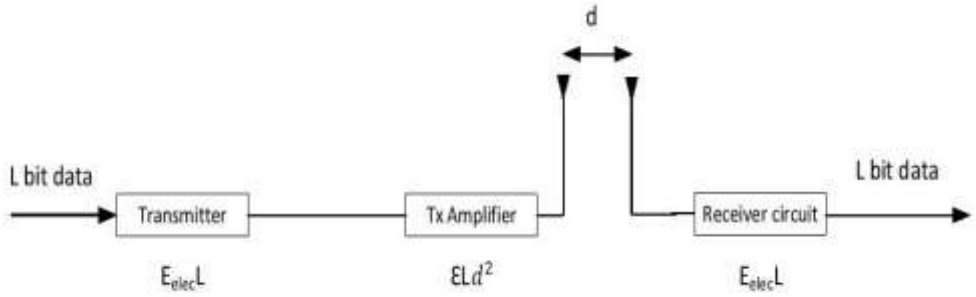

Figure. 1.2: Wireless communication model

V. LEACH PROTOCOL

LEACH is the (6) first and foremost single-hop clustering routing protocol for WSN; it saves a large amount of network energy in comparison with non-clustering algorithms. This protocol falls under hierarchal networks. It is self-organizing and is characterized as an adaptive clustering protocol which uses randomly distributes energy load among nodes. Dense network of sensor nodes form clusters and each cluster consists of members called Cluster Members or Normal Nodes and a coordinator node called the Cluster-Head, CH. Cluster-heads consume more energy than non-cluster heads. Whenever some emergency affairs happen in the monitoring area of a node it triggers the node which then sends its data to the CH. Cluster-heads collect the data and forward the message to the BS (Base Station). The base station is fixed and is away from the sensor nodes as shown in Figure 1.3.

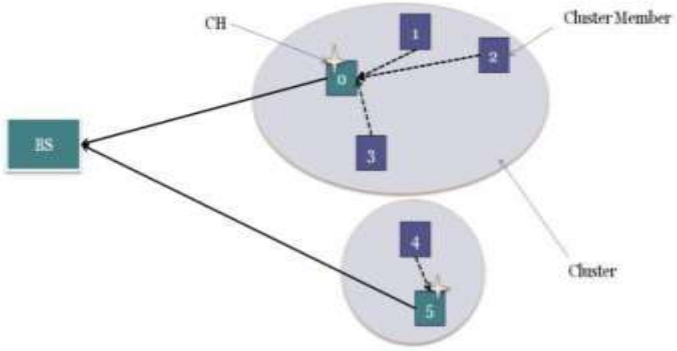

Figure 1.3: LEACH basic architecture

Low Energy Adaptive Clustering Hierarchy (LEACH) protocol (2) uses hierarchical topology using which the data is aggregated and the same is sent to the BS. It is self-adaptive and self-organized. The nodes are divided into groups or clusters with identical size, and a CH is elected for every cluster. The nodes collect physical phenomena related data and send the identical to their respective CHs using TDMA schedule. If a node continues to remain as a CH, its energy is drained and the node dies sooner. In

order to avoid such a situation, the CH role is rotated after each round of operation. A node forwards the data to its CH and the CH gathers the data from each node supported by it and the CH computes the aggregate of the collected data and the same is forwarded to the BS.
The LEACH operation is generally divided into two phases:
1) Setup phase
2) Steady state phase

1) Setup phase:
In this phase, the nodes (2) are divided into several clusters dynamically and a CH is chosen randomly among the cluster nodes for each cluster. While forming clusters, a number in the range 0 to 1 is chosen randomly and the same is compared with a threshold, t(s). The node is made as a CH for the current round, if chosen value < t(s); otherwise, the node continues to remain as a member node. Once various CHs are elected, advertisement messages are broadcast by the CHs. These messages are heard by many of the nearby nodes and discover the presence of one or more CHs. A node can choose one of the CHs, in case more than one CH exist, based on the received signal strength indication (RSSI). Each node sends a join request message along with its ID to its chosen CH. A non-CH node transmits a join request message containing its ID using CSMA. After the setup phase, each CH knows its members and their respective node IDs.

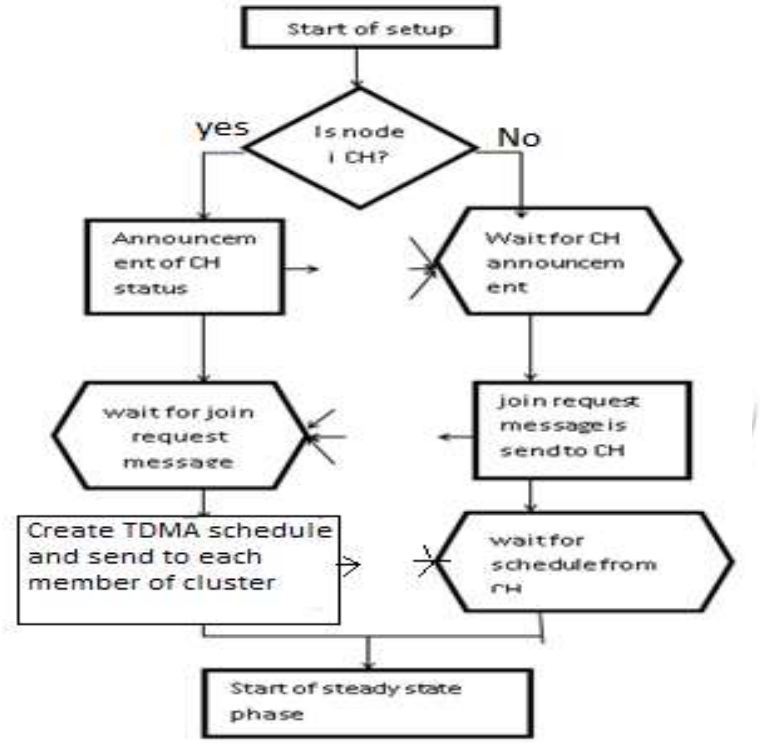

Figure 1.4: set up phase in LEACH

2) Steady State Phase
After cluster formation (2), a CH allocates its TDMA schedule to the nodes supported by it. Based on this schedule a node sends its sensed and stored data to its CH in the respective. Once a CH collects all the data from its members, it computes the aggregate of data of other nodes and its own data and sends the aggregate values to the BS. . Normally, the steady state phase duration is longer than that of the setup phase. After each round, new CHs are elected the time line operation consisting of setup and steady state phases of the LEACH protocol.

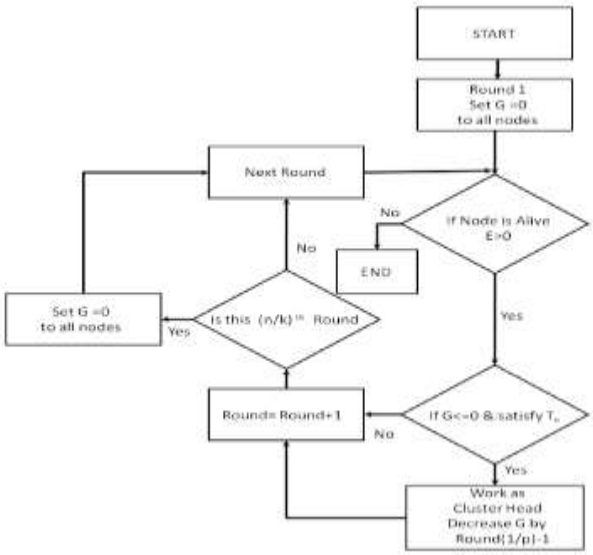

Figure 1.5: LEACH algorithm flowchart

VI. CLUSTERING

WSN consists (8) of a large number of sensor nodes, moreover these sensor nodes run on non-rechargeable batteries. So to help the objective of fault-tolerance, load balancing and network connectivity, grouping of nodes is required. Clustering is a process of dividing sensor nodes into groups on the basis of various parameters, and selecting a group leader from every group. The groups are called clusters and group leaders are called Cluster Heads (CHs) of the clusters. Parameters for forming the clusters include distance between cluster head and its member, intra- cluster communication cost, remaining energy of sensor nodes, location of node with respect to BS etc.

Data transmission (9) in cluster-based routing protocols is divided into two main stages namely intra-clustering data transmission and inter-clustering data transmission. Intra-clustering communication, where member nodes transmit collected data to their respective cluster-heads. All member nodes are mostly two hops away from their cluster-heads, while in some cases one or multiple hop(s) is required for members to reach their destination. On the other hand, in inter-clustering communication cluster-heads transmit their data with the gathered data from their respective members in order to deliver it to a faraway base-station. LEACH (Low Energy Adaptive Clustering Hierarchy) is a usual example for cluster-based routing protocols which uses inter and intra Clustering. LEACH uses one hop inter-clustering to reach the base-station, which misses the cooperation among cluster-heads.

VII. CLUSTER FORMATION IN LEACH

Low Energy Adaptive Cluster Hierarchy (LEACH) (3) is the fundamental and most commonly used cluster based routing protocol. The main advantage of this protocol is improved lifetime of WSN by reducing energy consumption. As LEACH is a cluster based protocol it organize the nodes into clusters which helps to distribute the energy among the sensor nodes in the network. Every cluster has a Cluster Head (CH) and Cluster Members (CM) as shown in Figure1.8. LEACH randomly selects nodes as Cluster Heads and performs periodic re-election, so that every node in the network is selected as CH. Each iteration of CH selection is called a round. The operation of LEACH based on several rounds. Every round consists of setup phase and steady state phase.

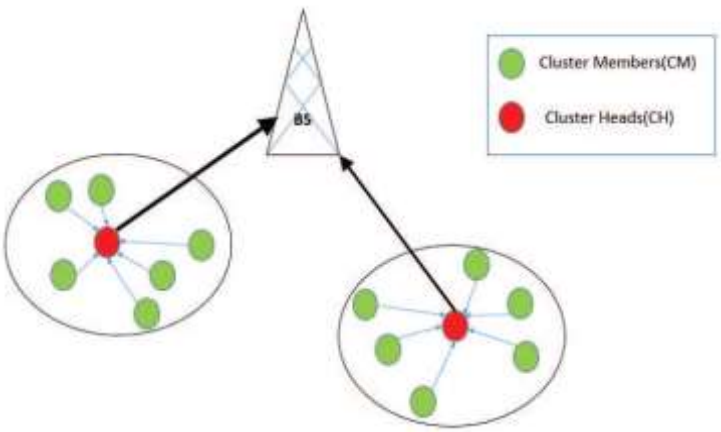

Figure 1.6: Cluster formation in LEACH

VIII. CONCLUSION

In this paper we study wireless sensor network and an energy efficient protocol LEACH. The most important conflict in designing routing protocols for WSNs is energy efficiency. Efficient use of energy in the network has been the fundamental issue for extending the network lifetime. It is self-organizing and is characterized as an adaptive clustering protocol which uses randomly distributes energy load between nodes. By using cluster heads and data aggregation excessive energy consumption is avoided.

REFERENCES

[1] Mrs. Asha Ahlawat, Ms Vineeta Malik "An EXTENED VICE-CLUSTER SELECTION APPROACH TO IMPROVE V LEACH PROTOCOL IN WSN" 2013 Third International Conference on Advanced Computing & Communication Technologies.

[2] Ravi Kishore Kodali, Venkata Sai Kiran A., Shikha Bhandari and Lakshmi Boppana, "Energy Efficient m− level LEACH protocol", 978-1-4799-8792-4/15/$31.00_c 2015 IEEE.

[3] Chinchu T Sony, Sangeetha C P "Multi-hop LEACH Protocol with modified Cluster Head selection and TDMA schedule for Wireless Sensor Networks , Proceedings of 2015 Global Conference on Communication Technologies(GCCT 2015).

[4] Shiwei Zhang, Haitao Zhang, "A Review of Wireless Sensor Networks and Its Applications" in 2012 IEEE.

[5] Versha Sharma and Davinder S Saini "Performance Investigation of Advanced Multi-hop and Single-hop Energy Efficient LEACH Protocol with Heterogeneous nodes in Wireless Sensor Networks", 2015 Second International Conference on Advances in Computing and Communication Engineering.

[6] A. Ihsan , K. Saghar and T. Fatima, "Analysis of LEACH Protocol(s) using Formal Verification" Proceedings of 2015 12th International Bhurban Conference on Applied Sciences & Technology (IBCAST).

[7] Naveen Kumar Aravapalli," Multi-level LEACH Protocol model using NS-3",2014 IEEE International Advance Computing Conference (IACC).

[8] Dr. Jibi Abraham , "Selection of effciently Adaptable Clustering Algorithm upon Base Station Failure in Wireless Sensor Network".

[9] Mahmoud M. Salim1, Hussein A. Elsayed2, Salwa H. El Ramly," C22. PR-LEACH: Approach for Balancing Energy Dissipation of LEACH Protocol for Wireless Sensor Networks" 31st National Radio Science Conference (NRSC2014).

[10] Iman Almomani, Bassam Al-Kasasbeh "Performance Analysis of LEACH protocol under Denial of Service Attacks" 2015 6th International Conference on Information and Communication Systems (ICICS).