International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 08, August-2016

Analysis of Energy Efficient Protocols in WSN Network

Apneet Kaur[1]
Research Scholar,
Bahra University, Wakhnaghat,
Shimla

Dr. Sonia Vatta[2]
Professor & Head,
CSE Department, Bahra University,
Shimla

***Abstract*: In this paper we have proposed different models for energy efficiency in Wireless Sensor Networks. We have analyzed and optimized the performance of the LEECH algorithm for different parameters. In this paper the proposed models have been applied on the 100 node network and the performance of the same has been calculated and shown with the help of results. Analysis of LEACH protocol is done using a 100-node network. It has been shown that cluster head drains the battery of that node. So in order to spread energy usage among multiple nodes, role of cluster head is rotated. Thus, a set of C nodes might elect themselves as cluster heads at time t, but at time $t + d$ a new set C' of nodes elect themselves as cluster.**

1. INTRODUCTION

A wireless sensor network mainly consists of nodes that are organized into a cooperative network. Each node has the ability to process (one or more microcontrollers, CPUs or DSP chips), it may contain different types of memory, RF transceiver, power source like batteries and accommodate different sensors and the actuators. The nodes communicate wirelessly and self-organize in an ad hoc fashion after being deployed. Systems of 1000s or even more than 10,000 nodes are expected. Such systems can alter the way we work and live. Currently, It is not unreasonable to expect that in upcoming years that the world will be covered with wireless sensor networks with access to them through the Internet. This can be considered as the Internet becoming a giant physical network.

A wireless sensor network is a self-controlled network which consists of large number of sensor nodes that are densely deployed in the region of interest. The main task of a WSN is to collect information about the target, perform aggregation or other processing, and transmit this information to the base station. Sensor networks consists of four basic components: the first one is an assembly of distributed sensors, an interconnecting network, a central point for clustering of information and a set of computing resources at the central point for data compression, status querying etc. The capability of sensor nodes can vary widely in WSNs, that is, simple sensor nodes may be able to monitor single phenomenon, while complex devices may combine different types of sensing techniques, like optical, acoustic or magnetic. Some sensors may also be provided with additional units like GPS, allowing them to accurately determine their position. There are 5 types of Wireless Sensor Networks [1]: Terrestrial WSN, Underwater WSN, Underground WSN, Multi-media WSN and mobile WSN.

Terrestrial wireless sensor network [2] consists of hundreds to thousands of sensor nodes which are deployed in ad-hoc or in pre-planned manner in the target area. In terrestrial networks, reliable communication is very important, that is, nodes must be able to effectively communicate and transfer the data to the base station. Since battery power in sensor nodes is limited, so sensor nodes can be equipped with additional power source like solar cells. In a terrestrial WSN, energy can be conserved with short range transmission, multi-hop routing, eliminating data redundancy, delay minimization and using low duty cycle operations.

- In underground sensor networks [3], sensor nodes are buried underground to monitor underground conditions. Additional sink nodes are deployed above ground to route the data from the sensor nodes to the base station. Underground sensor networks are more costly because appropriate equipments are required to ensure communication through soil, water and rocks. Careful planning is required for deployment of an underground WSN. Energy and cost considerations must be taken into account while deploying underground WSNs.
- In underwater WSNs [4, 5], sensor nodes are deployed under water. In comparison with terrestrials WSNs, these networks are more expensive. Autonomous underwater vehicles are used for data gathering and exploration from sensor nodes. Opposing to terrestrial WSNs, lesser number of nodes are deployed underwater. Underwater wireless communication takes place through transmission of acoustic waves. But acoustic communication suffers from several challenges like limited bandwidth, signal fading issue, long propagation delay and environmental conditions. Underwater sensor nodes must be able to adapt to ocean environment and like other sensor nodes, these are also equipped with limited battery power, energy efficient networking techniques should be developed.
- Multimedia sensor networks [6] consist of sensor nodes equipped with cameras and microphones. These networks have enabled tracking and monitoring of events in the form of multimedia such

as audio, video and imaging. Sensor nodes are deployed in a pre-planned way to ensure full coverage. Multimedia information such as video requires very high bandwidth for the information to be delivered, thus leading to more energy consumption. So transmission techniques supporting low power consumption and high bandwidth have to be developed. Quality of Service provisioning is also a challenging task in these networks due to variable channel capacity and data delay. So certain level of quality of service must be achieved for reliable communication. Further, in-network processing, compression and filtering can also improve the performance of the network in terms of extracting redundant information and merging contents. Also, cross layer interaction among the layers of WSN can improve further processing and delivery process.

Mobile sensor networks consist of mobile sensor nodes which can move on their own and interact with the environment. They have all the capabilities of static nodes in addition to the ability of repositioning and organizing itself in the network. Another difference is data distribution. Instead of fixed routing or flooding used in static WSNs, dynamic routing is used in mobile WSN. Challenges faces by mobile sensor networks include localization, maintenance, coverage, self-organization, energy, navigation and control, deployment and data process. Mobile WSNs can be used for many applications. For example, in environmental monitoring in disaster areas applications, manual deployment of sensor nodes might not be possible. In that case, mobile sensor nodes can be used, they can move to the target area after deployment to provide the required coverage. Similarly in military surveillance and tracking mobile sensor nodes can achieve higher degree of connectivity and coverage compared to static sensor nodes.

Sensor networks monitor a wide range of ambient conditions like temperature, humidity, pressure, vehicular movements, lightening conditions, noise levels etc. It supports variety of applications in different fields, ranging from habitat monitoring to battlefield management or from perimeter security to inventory management and from environmental sensing to vehicle tracking

Fault tolerance is the ability to sustain the functionalities of the sensor network without any interruption due to failure of sensor nodes. The hardware and the software constraints greatly affect the failure rate of a sensor node. Since sensor nodes are embedded with the low cost devices, so majority of the node failures are caused by hardware problems. The deployment environment of the target region also greatly affects the sensor nodes. For example, indoor applications result in less environmental interference and hence failure late in indoor applications is low. On the other hand, applications where sensors are deployed outdoors suffer from high node failure rate.

The fault tolerance of a sensor network is also application dependent, for example, if sensor nodes are deployed in home applications, the fault tolerance requirement may be low because here sensor network is not easily damaged. But if sensor nodes are deployed in military applications, then the fault tolerance requirement will be high because sensor nodes can be destroyed by hostile action. The fault tolerance of a sensor network can be improved by depending on more than a single node. As a result, even if a sensor node dies then other nodes can be used for connectivity of the network.

Sensor network mainly consists of a large number of sensor nodes. More the number of sensor nodes used, more will be the overall cost of the network. The overall cost of the sensor networks must be justifiable in comparison with traditional networks. Also, a sensor node may additional units like mobilize or location finding system depending on the application which adds cost to the sensor devices. As a result cost of the sensor network is a very challenging issue with respect to the number of functionalities.

A WSN mainly consists of large number of sensor nodes which collaborate together to form a communication network to provide reliable networking service. It is likely that data collected from one sensor is highly correlated with the data collected from its neighboring (next) nodes, so in that case data aggregation can reduce the redundant information to be transmitted in the network. Clustering allows splitting the transmission of data into inter and intra-cluster communication. This help in saving energy because radio unit is the main unit which consumes maximum energy. Aggregating nodes in clusters has many advantages [7]:

- The size of the routing table stored at each node gets reduced.
- Communication bandwidth can be conserved since inter-cluster interactions become limited to cluster heads and hence avoid redundant exchange of information among sensor nodes.
- Since transmission distance for every node gets reduced, energy consumption is less and hence network lifetime increases.
- Data aggregation performed on cluster heads reduces the number of redundant packets. Energy consumption rate can also be decreased by scheduling activities in the cluster.

2. MOTIVATION OF RESEARCH WORK

Much of the recent research work in the area of cluster-based wireless sensor networks has extensively focused on lifetime, stability, energy efficiency and scalability. In the past few years, numerous energy efficient clustering algorithms have been proposed for a wide range of applications. Prasad et.al [8] had presented a framework for fault revoking and homogeneous distribution of randomly the sensor nodes, so that the cluster head within various clusters consume equal amount of energy. Deployment area was first divided into clusters of equal size. Mobile sensor nodes were deployed in the deployment area with the help of parachutes and each of the mobile sensor nodes was embedded with a static sensor node that can be used to replace the dead sensor nodes in the network. The total number of mobile sensor nodes was equal to the total number of clusters and the number of mobile sensor nodes which were required for fault revoking depends on the number of clusters and the size of deployment area. In a cluster if a sensor node gets damaged then its location id was sent to the mobile sensor node by the base station. The affected sensor node was replaced by mobile sensor node, thus increasing the lifetime of the network. Rashed et.al [9] had proposed an energy efficient routing protocol called Weighted Election Protocol (WEP). It is a scheme of combining clustering strategy with chain routing algorithm for satisfying both energy and stable period constraints under heterogeneous environment. Weight was assigned to the optimal probability for each node and this weight was kept equal to the initial energy of each node divided by initial energy of the normal node. After assigning weight, cluster head election was done in the same way as in LEACH. Said et.al [10] had proposed an improved and balanced clustering algorithm called IB-LEACH. In this scheme, some high energy nodes known as normal node/cluster head/gateway nodes i.e NCG nodes, were made cluster heads to aggregate the data of their cluster members and transmit the data to the chosen gateways that requires the minimum communication energy in order to reduce energy consumption of cluster head and to decrease probability failure of nodes. It was more effective in prolonging lifetime and stability period than LEACH and Stable Election Protocol (SEP). Nazir et.al [11] had presented an energy efficient multi-hierarchy clustering protocol. In this protocol, in addition to normal nodes, sensor nodes with more energy called super nodes were deployed to cater hotspot problem and prolong network lifetime. Super nodes act as local sink at top level in the multi-level hierarchy, normal nodes as cluster heads at middle level and normal nodes as cluster member at lowest level. Both coverage and residual energy were used as selection parameter for CH. After CH selection, sleep/wakeup schedules for nodes were defined by CHs. Nodes covering same area were made to sleep and wake alternately. TDMA scheduling was done by CHs to avoid interference in transmission.After that data was sent from cluster members to CH using single hop and from CH to BS using multi-hop communication. Elbhiri et.al [12] had discussed another clustering protocol for heterogeneous wireless sensor networks called stochastic Distributed Energy Efficient Clustering DEEC (SDEEC) protocol. The cluster head election was based on residual energy of the nodes. This protocol was based on DEEC with new strategies. The stochastic energy was the main idea where the intraclusters transmission was reduced. This protocol also considers two-level heterogeneity, but unlike DEEC energy consumption was reduced by making non-CH nodes sleep. The drawback in this protocol was that if non-CH nodes turn off their radios when CH is performing data aggregation, how they would come to know about the next round of CH selection. ZhouHaibo et.al [13] had presented a self-adaptive clustering routing protocol called EDFM. It is different from other energy efficient protocols in terms of CH election. It was based on one step energy consumption forecast method. Considering the energy consumption in sequential rounds is correlative, EDFM used average power consumption of two types of CHs in previous round, firstly as power consumptions for the second round to forecast the CHs. To evaluate performance, time intervals before first node dead (stable state period) and half nodes dead (normal state period) were recorded. EDFM balanced the energy consumption in each round very well and has increased the lifetime as well as stable period of the network. Yassein et.al [14] presented another clustering protocol called V-LEACH in which besides having a cluster head, a vice-cluster head was also elected that performed the role of cluster head when it was dead. Advantage of this protocol was reliable data transmission to the base station and there was no need of electing new cluster head each time when a cluster head was dead. Kumar [15] et.al presented an extension of Stable Election Protocol. EEHC is an energy efficient clustering protocol for heterogeneous WSNs. This scheme extended the network lifetime by introducing three degrees of heterogeneity(normal, super and advanced nodes). For each type of nodes optimal percentage to become CH was defined. Principle of EEHC was kept same as that of SEP with addition of one more node type. Network lifetime achieved was more than that achieved using SEP. Varma [16] had presented a base station initiated dynamic routing protocol in which nodes possessing higher computational capability and more power were elected as cluster heads. A reference level was defined as the distance from base station to CH. A CH was considered in low level if it was near to the base station. Base station was set at 0 level and the communication was initiated by the BS by broadcasting a packet for CHs. Level of CHs was set according to the packets received. Selected first level CHs broadcasted their level to the lower level CHs. In the similar manner the transmitting powers of all the CHs was set according to their parents. Then sensor nodes would join their CHs according to RSS of different CH and the data transmission would take place. Communication between CH and sensor nodes was single hop while communication between CH and BS was multi-hop.

3. ENERGY EFFICIENT CLUSTERING PROTOCOL

There are various energy efficient clustering protocols as mentioned in the literature.

1. Some of them are LEACH, SEP and EEHC. Another popular node clustering algorithm is HEED [17] (hybrid, energy efficient and distributed) clustering approach. HEED periodically selects cluster heads on the basis of two parameters. Residual energy of the each sensor node is the primary i.e. priority parameter and then the second parameter is the intra-cluster communication cost. Residual energy is used to probabilistically select the initial set of cluster heads while the secondary parameter is used for

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 08, August-2016

breaking the ties. The algorithm is divides into 3 phases.

In the initialization phase, as in LEACH initial percentage of cluster heads Cprob is already selected. Using this Cprob each sensor node sets the probability CHprob of becoming CH as follows

$$CH_{prob} = C_{prob} \cdot \frac{E_{residual}}{E_{max}} \quad (1)$$

whereEresidual is the current residual energy and Emax is the reference maximum energy of the node. This CHprob value must be greater than a threshold pmin, which is inversely proportional to Emax.

In repetition phase, every sensor node goes through several iterations until it finds the CH to which it can transmit data with least power consumption. If it hears no message from any CH, then it elects itself as the CH and sends an announcement message informing about its changed status. Then each node doubles its CHprob value and goes to the next iteration. This process continues till CHprob of node reaches 1. There are 2 types of cell head status announced by sensor:

a) Tentative Status: If CHprob of a node is less than 1, then it becomes a tentative CH. It can change its status to regular node later if it finds a lower cost CH.
b) Final Status: the sensor permanently becomes a CH, it its CHprob reached 1.

In the finalization phase, each node makes a final decision. It either pronounces itself as CH or picks the least cost CH. Clustering by HEED improves the network lifetime over LEACH because in LEACH, CHs are selected randomly, which may results in faster death of some nodes.

1. Threshold sensitive Energy Efficient sensor Network [18] is a cluster based hierarchical protocol based on LEACH. This protocol is used for time-critical applications. In this protocol, data transmission is not soo frequent but the nodes sense the medium continuously. The network consists of first level and second level cluster heads. First level CHs are formed away from the base station and second level CHs are formed near to the base station. Cluster head sends two types of data to its neighbours i.e. the hard and soft threshold.

In the hard threshold, nodes transmit the data, and if it is in the range of interest and thus it reduces the number of transmission and in soft threshold, any small change in the value of sensed attribute is transmitted. Nodes sense their environment continuously and store the sensed value (SV) for transmission. Then node transmits the sensed value only when one of the following conditions is satisfied:

$$Sensed\ Value > Hard\ Threshold$$
$$Sensed\ Value - Hard\ Threshold \geq Soft\ Threshold$$

The main drawback of TEEN is that, if the thresholds are not upto the level, the nodes will never communicate and the user will not get any data from the network and never come to know if all the nodes die. Thus, this scheme is not suited for applications where the user needs to get data on a regular basis.

1. Adaptive TEEN [19] is an improved version of TEEN. It is a hybrid clustering protocol that allows the sensor to sense the data periodically (as in LEACH) and also reacts to any sudden change in the value of the sensed attributes (as in TEEN). APTEEN supports 3 types of queries:

- Historical analysis of past values.
- Snapshot of the current network view.
- Continuous monitoring of an event over a period of time.

In each round, after the cluster head selection, following parameters are broadcasted by the Cluster Head:

- Attributes (for example, physical parameters),
- Hard and Soft threshold values,
- Time slot information using TDMA, and
- Maximum time period lapsed between two successive reports sent by a node called as count time.

If data is not sent for a time period equal to count time, the node is forced to sense and retransmit the data for maintaining energy consumption. Since it is a hybrid protocol, it can imitate both proactive and reactive networks. The main drawback of APTEEN is, for implementation of threshold function and count time features additional complexity is required. Figure 3.1 shows TEEN and APTEEN protocol.

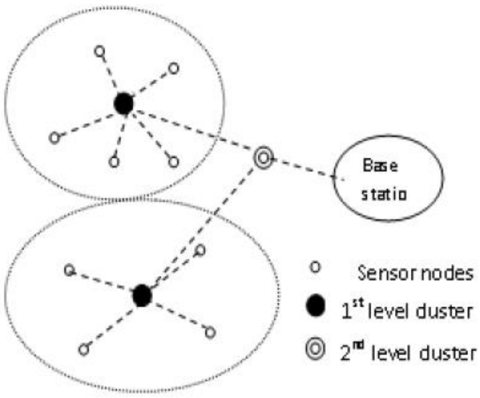


Figure 3.1: Hierarchical Clustering in TEEN and APTEEN [20]

4. SIMULATION MODELS

We have implemented the various models and compared their performance in wireless sensor networks which are being used for the proposed work.

4.1. Channel Propagation Model

The channel between transmitter and receiver could be as simple as a line of sight, but mostly electromagnetic waves bounce off objects in the environment and reach the receiver following multiple paths. This electromagnetic wave propagation can be modeled as a power law function of distance between the transmitter and the receiver for simulation of different protocols both free space model and multipath models were used, depending on the distance between transmitter and receiver, as defined by channel propagation model in [21].

If the distance between transmitter and receiver is less than certain cross-over distance, the Friss free space model is used, and if the distance is greater than cross-over distance, two ray ground propagation models is used. The cross-over distance is given by:

$$d_{crossover} = \frac{4\pi\sqrt{L}h_r h_t}{\lambda} \quad (2)$$

where $L \geq 1$ is the system loss factor, h_r and h_t is the height of transmitting and receiving antenna above the ground and λ is the wavelength of the carrier signal.If distance is less than $d_{crossover}$, the transmit power is attenuated according to the Friss free space equation as follows:

$$P_r(d) = \frac{P_t G_t G_r \lambda^2}{(4\pi d)^2 L} \quad (3)$$

where$P_r(d)$ is the received power, P_t is the transmit power, G_t and G_r are the gains of transmitting and receiving antenna respectively, d is the distance between the transmitter and receiver.If the distance is greater than crossover distance, the transmit power is attenuated according to the two-ray ground propagation equation as follows:

$$P_r(d) = \frac{P_t G_t G_r h_t^2 h_r^2}{d^4} \quad (4)$$

whereh_t and h_r are the heights of transmitting and receiving antenna.

4.2. Radio Energy Model

Before discussing further step-by-step simulation of the proposed protocol, it is important to select good models for all aspects of communication. Here, a simple model is assumed where transmitter dissipates the energy to run the radio electronics in the power amplifier and receiver dissipates the energy to run the radio electronics. The power attenuation is dependent on the distance between transmitter and receiver. For short distances, the propagation loss is inversely proportional to d 2, other way for longer distances; it is inversely proportional to d4. Thus to transmit an l-bit message to distance d, the radio expends:

$$E_{Tx}(l,d) = E_{Tx}(l) + E_{Tx-amp}(l,d) \quad (5)$$

$$E_{Tx}(l,d) = \begin{cases} lE_{elec} + l\varepsilon_{friss-amp}d^2, & d < d_0 \\ lE_{elec} + l\varepsilon_{two-ray-amp}d^4, & d \geq d_0 \end{cases} \quad (6)$$

whered_0 is crossover distance and is given by:

$$d_0 = \sqrt{\frac{\varepsilon_{friss-amp}}{\varepsilon_{two-ray-amp}}} \quad (7)$$

If distance is less than d_0, free space model is used; otherwise two ray ground model is used. To receive this message, radio expends:

$$E_{Rx}(l) = E_{Rx-elec}(l) \quad (8)$$

This radio energy dissipation model is shown in figure 4.1.

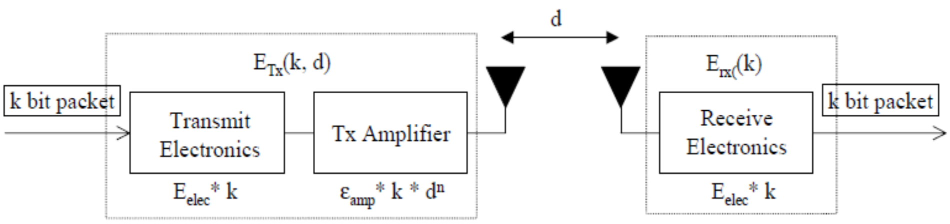


Figure 4.1: Radio Energy Dissipation Model [22]

The electronics energy, E_{elec} depends on the factors such as modulation, digital coding and filtering of the signal before it is sent to the transmit amplifier. The parameters $\varepsilon_{friss-amp}$ and $\varepsilon_{two-ray-amp}$ will depend on the required receiver noise figure and receiver sensitivity, as there is need to adjust the transmit power so that power at the receiver is above a certain threshold.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 08, August-2016

5. RESULTS AND DISCUSSION

5.1. Radio Parameters

For the simulation of proposed protocol in MATLAB, a random, 100 node network as shown in figure 5.1 is used. The radio parameters used for simulation are given in table 5.1.

Table 5.1: Radio Parameters Values

Description	Parameter	Value
Crossover distance for free space and two-ray ground attenuation model	d_0	86.6m
Radio Electronics Energy	E_{elec}	50nJ/bit
Energy for Beam Forming	E_{DA}	5nJ/bit
Radio Amplifier Energy	ϵ_{fs} ϵ_{mp}	10pJ/bit/m^2 0.0013/bit/m^4
Antenna Gain Factor	G_t, G_r	1
Antenna height above the ground	h_t, h_r	1.5m
Bit Rate	R_b	1Mbps

The base station was placed at the centre of the network, at location (x=50, y=50). The bandwidth of the channel is set to 1Mbps, and the processing delay on the transmitting side and receiving side was 25µs. each data message was 4000 bits long. The radio electronics energy was set to 50nJ/bit. The energy for beam forming computations to aggregate data was set to 5nJ/bit. Super cluster head election radius is taken as 30m. The characteristics of the test network are summarized in table 5.2. We have assumed heterogeneity parameters as $€_{ft1}$=1, $€_{ft2}$=$€_{ft1}$*2 and p_{opt}=0.1.

Table 5.2: Characteristics of the Test Network

Nodes	100
Network Size	100*100
Base Station Loaction	(50,50)
Radio Propagation Speed	3x10^8 m/sec
Processing Delay	25µs
Radio Speed	1Mbps
Data Size	4000 bits

5.2 Mobile Node Parameters

Linear Velocity, $v = v_l$.

Angular Velocity, $\omega = \frac{v_R - v_l}{W}$

where v_l =rotation speed of left wheel

$v_{R=}$rotation speed of right wheel

W= track width

Speed of two dc motors is regulated by pulse width modulation, the PWM value is directly used to represent the motion speed. When PWM value is set, mobile node will reach a speed of 3.33m/sec. the power increases steadily and linearly as the speed increases. Communication range is set 20m. Speed can be calculated as follows:

Let motor rpm=5000

Wheel radius = 4cm

Tangential Velocity= $\frac{5000 \times 4}{20 \times 100} = \frac{3.33m}{sec}$.

So the time pause is calculated as= $\frac{20}{3.33} = 6\ seconds$

So after 6 seconds MSN will be able to replace the CH or MCH that begins to die.

5.3 Performance Metrics

The different performance metrics are being used to analyze different protocols are:

- Network Lifetime: It is the period from the start of the network operation till the death of the last node.
- Instability Period: It is defined as the period from the first node dead till the last node dead.
- Stability Period: It is defined as the period from the start of the network operation till the death of the first node.
- Energy Consumption: It is the total energy dissipated per round during the simulation.

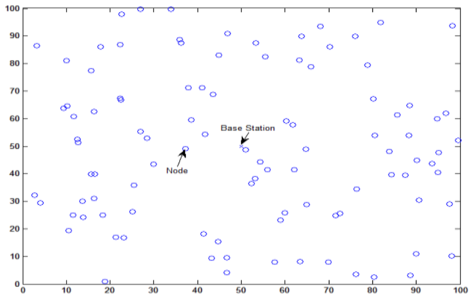
In the subsequent sections results of all the simulated protocols will be discussed using these performance metrics.

5.4 Analysis of LEACH Protocol

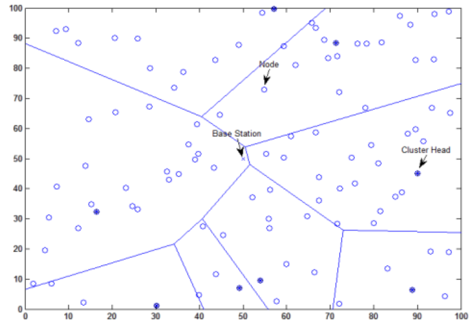
Analysis of LEACH protocol is done using a 100-node network model as shown in figure 5.1. As already discussed, being a cluster head drains the battery of that node. So in order to spread energy usage among multiple nodes, role of cluster head is rotated. Thus a set of C nodes

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 08, August-2016

might elect themselves cluster heads at time t, but at time t+d a new set C' of nodes elect themselves as cluster head as shown in figure 5.1. Non-CH nodes are represented by 'o' and CHs are represented by '*'.



(a)



(b)

Figure 5.1: LEACH Simulation Network (a) Test Network Model (b) Cluster Formation

5.4.1 Network Lifetime

Network lifetime is the time period from the start of the network operation till the death of the last node. It is determined by the number of nodes alive per round as shown in figure 5.1. Performance of a clustering protocol is also determined by duration of stable and unstable period. Analysis of network lifetime is represented in table 5.3

Table 5.3: Network Lifetime Analysis of LEACH for €$_{ft1}$=1

Round for first node dead	**Round for first 10 nodes dead**	**Round for half of the nodes alive**	**Round for All nodes dead**	**Stability Period**	**Instability Period**
911	1008	1179	2041	911 rounds	2041-911=1130 rounds

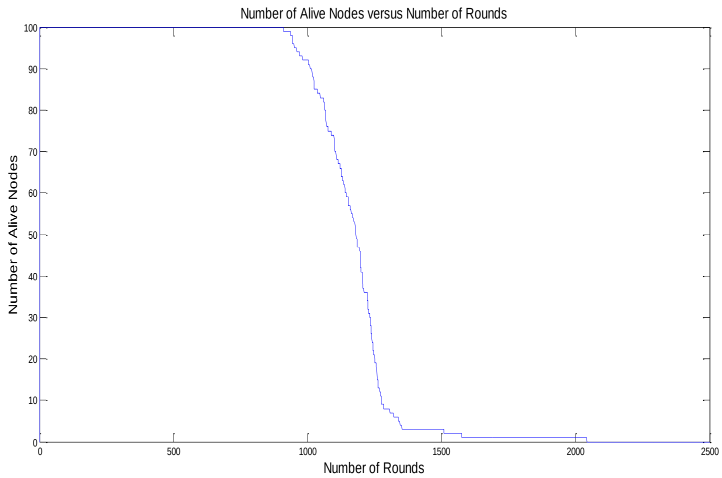
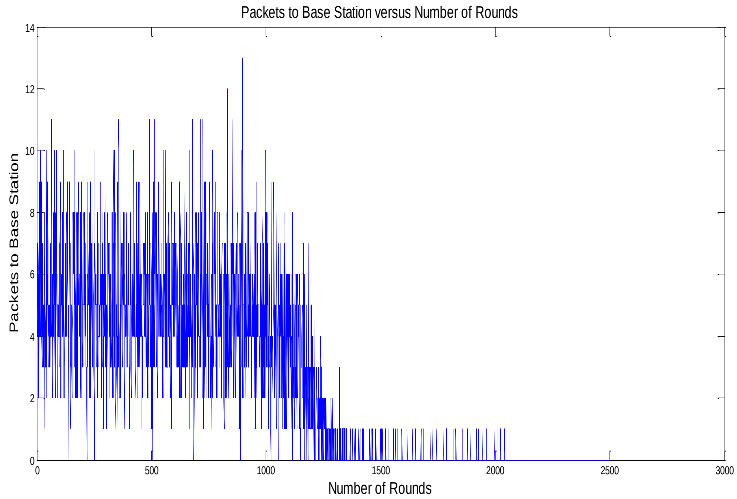


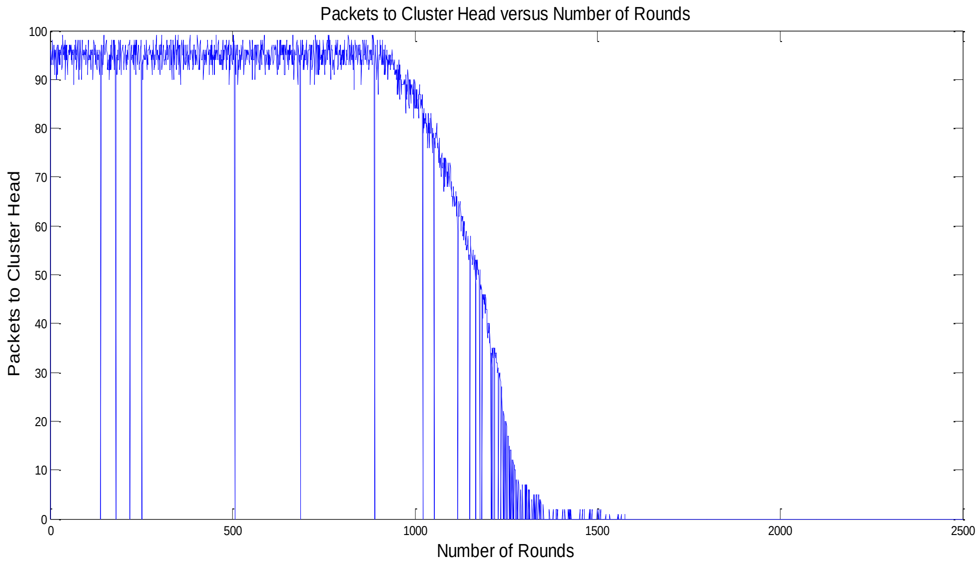
Figure 5.2: Network Lifetime of LEACH Protocol for €$_{ft1}$=1

5.4.2 Throughput

Throughput is defined in terms of packets sent from nodes to cluster head and from cluster heads to base station. As the network operation start processing, nodes start dying. With decreasing nodes, packets transmission from nodes to sink also decreases. Figure 5.3 shows the number of packets sent from base cluster head to base station and figure 5.4 shows the number of packets sent from nodes to cluster head.



(a)



(b)

Figure 5.3: Throughput of LEACH Protocol: (a) Packets to Base Station versus Number of Rounds (b) Packets to Cluster Head versus Number of Rounds

6. CONCLUSION

In this paper we have proposed different models for energy efficiency in Wireless Sensor Networks. We have analyzed and optimized the performance of the LEECH algorithm for different parameters. In this paper the proposed models have been applied on the 100-node network and the performance of the same has been calculated and shown with the help of results. Analysis of LEACH protocol is done using a 100-node network. It has been shown that cluster head drains the battery of that node. So in order to spread energy usage among multiple nodes, role of cluster head is rotated as shown in results. Results prove that a set of C nodes might elect themselves cluster heads at time t, but at time $t + d$ a new set C' of nodes elect themselves as cluster.

REFERENCES

[1] Varma, S., Nigam, N. and Tiwary, U. S., 2008. "Base station initiated dynamic routing protocol for Heterogeneous Wireless Sensor Network using clustering", Proceedings of Fourth International Conference on Wireless Communication and Sensor Networks, pp. 1-6.

[2] Heinzelman, W. B., Chandrakasan, A. P., and Balakrishnan, H., 2002. "Application specific protocol architecture for wireless microsensor networks", IEEE Transactions on Wireless Networking, Vol.1, No. 4, pp. 660-670.

[3] He, T., Krishnamurthy, S., Stankovic, J. A., Abdelzaher, T., Luo, L., Stoleru, R., Yan, T., Gu, L., Zhou, G., Hui, J. and Krogh, B., 2006. "VigilNet: an integrated sensor network system for energy-efficient surveillance" ACM Transactions on Sensor Networks, pp. 1–38

[4] Mhatre, V. P. and Rosenberg, C., 2004. "Homogeneous vs Heterogeneous Clustered Sensor Networks: A Comparative Study", Proceedings of IEEE International Conference on Communications, pp. 3646-3651.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 08, August-2016

[5] Li, C., Ye, M. and Chen, G., 2005. “An Energy-Efficient Unequal Clustering Mechanism for Wireless Sensor Networks”, Proceeding of IEEE MASS, pp. 3-17, 2005

[6] Li, X., Huang, D. and Sun, Z., 2007. “A Routing Protocol for Balancing Energy Consumption in Heterogeneous Wireless Sensor Networks”, In proceedings of 3rd International Conference on Mobile ad-hoc and sensor networks, pp. 79-88.

[7] L. B. Ruiz , J. M. Nogueira , and A. A. F. Loureira , “ Sensor network management ” , SMART DUST: Sensor Network Applications, Architecture, and Design (edited) , CRC Press , Boca Raton, FL , 2006

[8] Prasad, D., Gupta, M., Patel, R. B., 2011. “Framework for Fault Revoking and Homogenous Distribution of Randomly Deployed Sensor Nodes in Wireless Sensor Networks”, International Journal of Computer Science, Vol. 8, No.2 , pp. 189-197.

[9] Rashed, G., Kabir, M. H., and Ullah, S. E., 2011. “WEP: An energy efficient protocol for cluster based heterogeneous wireless sensor network,” International Journal of Distributed and Parallel Systems (IJDPS), Vol.2, No.2, pp. 54-60.

[10] Said, B. A., and Abdellah, E., 2010. “Improved and Balanced LEACH for heterogeneous wireless sensor networks,” (IJCSE) International Journal on Computer Science and Engineering, Vol. 2, pp. 2633-2640.

[11] Nazir, B. and Hasbullah, H., 2010. “Energy Efficient Multi Hierarchy Clustering Protocol for Wireless Sensor Network”, Proceedings of International Conference on Intelligence and Information Technology, pp. 609-614.

[12] Elbhiri, B., Saadane, R. and Aboutajdine, D., 2009. “Stochastic Distributed Energy-E cient Clustering (SDEEC) for heterogeneous wireless sensor networks”, ICGST-CNIR Journal, Vol. 9, No. 2, pp. 11-17

[13] Yassein, M. B., Al-zou'bi, Khamayseh, A. Y., and Mardini, W., 2009. “Improvement on LEACH protocol of Wireless Sensor Network”, International Journal of Digital Content Technology and its Applications, vol.3, pp. 132-136.

[14] S. Misra et al. (eds.), Guide to Wireless Sensor Networks, Computer Communications and Networks,DOI: 10.1007/978-1-84882-218-4 4, Springer-Verlag London Limited 2009

[15] ZhouHaibo, Yuanming, Wu. andXieGuangzhong,. 2009. “EDFM: A Stable Election Protocol Based on Energy Dissipation Forecast Method for Clustered Heterogeneous Wireless Sensor Networks”, Proceedings of 5th International Conference on Wireless Communication, Networking and Mobile Computing, pp. 1-4

[16] Zheng, J., and Jamalipour, A., 2009. “Wireless Sensor Networks: A Networking Prespective”, A John Wiley and Sons Publication, pp. 2-3.

[17] Burrell, J., Brooke, T. and Beckwith, R., 2004. “Vineyard Computing: Sensor Networks in Agricultural Production” IEEE Pervasive Computing, Vol.3, No.1, pp. 38-45.

[18] Warneke, B. and Pister, K. S. J. “MEMS for Distributed Wireless Sensor Networks” In proceedings of 9th International Conference on Electronics, Circuits and Systems

[19] F. Akyildiz, W. Su, Y. Sankarasubramaniam, and E. Cayirci, “A survey on sensor networks”, In proceedings of IEEE Communications Magazine, 40(8):102–114, August 2002

[20] Burrell, J., Brooke, T. and Beckwith, R., 2004. “Vineyard Computing: Sensor Networks in Agricultural Production” IEEE Pervasive Computing, Vol.3, No.1, pp. 38-45.

[21] Heinzelman, W. R., Chandrakasan, A., and Balakrishnan, H., “Energy-Efficient Communication Protocol for Wireless Microsensor Networks”, In proceedings of 33rd Hawaii International Conference on System Sciences, pp. 3005-3014.

[22] Mainwaring, A., Polastre, J., Szewczyk, R., Culler, D. and Anderson J., 2002. “Wireless sensor networks for habitat monitoring”, In proceedings of 1st ACM International Workshop on Wireless Sensor Networks and Applications, pp. 88–97