International Journal of Innovative Research in Advanced Engineering (IJIRAE) ISSN: 2349-2163
Volume 1 Issue 6 (July 2014) http://ijirae.com

Performance Evaluation of LEACH Protocol for Wireless Sensor Network

Leena Y.Barai
PG Student, M-Tech (Electronics)
B. D. College of Engineering
Sewagram (Wardha)
Maharashatra (India)

Mahendra A. Gaikwad
Principal
B. D. College of Engineering
Sewagram (Wardha)
Maharashatra (India)

Abstract ---This paper gives performance of LEACH protocol. LEACH is the first network protocol that uses hierarchical routing for wireless sensor networks to increase the life time of network. All the nodes in a network organize themselves into local clusters, with one node acting as the cluster-head. All non-cluster-head nodes transmit their data to the cluster-head, while the cluster-head node receive data from all the cluster members, perform signal processing functions on the data (e.g., data aggregation), and transmit data to the remote base station. Therefore, being a cluster-head node is much more energy-intensive than being a non-cluster-head node. Thus, when a cluster-head node dies all the nodes that belong to the cluster lose communication ability. This paper gives performance of LEACH protocol considering parameters i) Packet Delivery Ratio ii) Throughput iii) Delay iv) lifetime.

Keyword: -LEACH protocol, WSN, energy-efficient.

I. INTRODUCTION

A Wireless Sensor Network (WSN) holds the promise of a smart communication paradigm which enables setting up an intelligent network capable of handling application that involve from user requirements. However due to nature of WSN researches face new challenges related to the design of algorithm and protocol.

Wireless Sensor Networks (WSNs) can be defined as a self-configured and infrastructure-less wireless networks to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants and to cooperatively pass their data through the network to a main location or sink where the data can be observed and analyzed. A sink or base station acts like an interface between users and the network. One can retrieve required information from the network by injecting queries and gathering results from the sink. Typically a wireless sensor network contains hundreds of thousands of sensor nodes. The sensor nodes can communicate among themselves using radio signals. A wireless sensor node is equipped with sensing and computing devices, radio transceivers and power components. The individual nodes in a wireless sensor network (WSN) are inherently resource constrained: they have limited processing speed, storage capacity, and communication bandwidth. After the sensor nodes are deployed, they are responsible for self-organizing an appropriate network infrastructure often with multi-hop communication with them.

Thus, the sensor network is a bridge between the real world and computation world. Some important properties for a good sensor network protocols are:

a) Ease of deployment: Sensor nodes may communicate in absence of established network also.
b) System lifetime: Sensor networks must extremely energy efficient.
c) Latency: Communication between nodes and base station should be timely manner.
d) Quality of service: End user does not require all data in the network so data aggregation is important issue in quality of service.

Wireless sensor network enable new application and require non-conventional paradigms for protocol design due to several constrains. Owing to the requirements for low device complexity together with low energy consumption and long network lifetime. So nowadays most of the researches concentrated at design of energy efficient protocol.

II. Review of LEACH Protocol:-

This review paper is built on the work mentioned in [1],[2]. LEACH comes under the family of proactive network protocols, with small changes. In proactive protocols [3]the node sense and send it to the base station periodically. Whereas reactive network protocols like TEEN performs instantaneously for critical data. For achieving the design goal for LEACH protocol, the following techniques are

i) Randomized and self-configuring formation
ii) Data aggregation
iii) Local control on data transmission.

LEACH is the first hierarchical cluster based routing Protocol, distributed algorithm is used to form clusters in network area. For each cluster there is a cluster head node which is responsible for data aggregation and sends the important data in its TDMA (Time Division Multiple Access) slot to the base station, where these data is needed using CDMA (Code Division Multiple

Access).Few numbers of nodes become the cluster head which act as the router to the base station. Energy dissipation is less as data transmission is done by only cluster head node. Data aggregation technique is used, because there is a possibility of correlated data in neighboring nodes of the same cluster. So data is processed locally in LEACH protocol.

Assumptions for development of LEACH:-

The sensor nodes and the underlying network model. For sensor nodes assume that all nodes can transmit with enough power to reach the BS if needed, that nodes can use the power control to vary the amount of transmit power and computational power to support MAC protocol and perform signal processing computations. For the network model, where the nodes always have data to send to the end user and nodes and nodes located close to each other have correlated data.

Stages in LEACH:-

LEACH

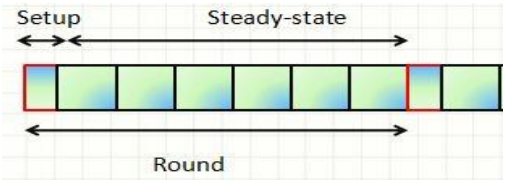
Cluster Set-up

1) Cluster Head selection
2) Advertisement phase
3) Cluster formation
4) Schedule creation

Steady State

1) Data communication to CH
2) Data fusion.
3) Data communication to BS

Timeline of LEACH protocol:-



4. (A) Set-up phase

In LEACH, nodes take autonomous decisions to form clusters by using a distributed algorithm without any centralized control. Here no long-distance communication with the base station is required and distributed cluster formation can be done without knowing the exact location of any of the nodes in the network. In addition, No global communication is needed to set up the clusters. The cluster formation algorithm should be designed such that nodes are cluster-heads approximately the same number of time, assuming all the nodes start with the same amount of energy [8]. Finally, the cluster-head nodes should be spread throughout the network, as this will minimize the distance the non-cluster-head nodes need to send their data. A sensor node chooses a random number, r, between 0 and 1.

Let a threshold value be $T(n)$

$$T(n) = \begin{cases} \frac{p}{1-p*\left[rmod\left(\frac{1}{p}\right)\right]} & \text{----} \quad n\varepsilon G \\ 0 \end{cases}$$

Otherwise

This random number is less than a threshold value, $T(n)$, the node becomes a cluster-head for the current round. The threshold value is calculated based on the above given equation that incorporates the desired percentage to become a cluster-head, the current round, and the set of nodes that have not been selected as a cluster-head in the last(1/P) rounds, p is cluster head probability. After the nodes have elected themselves to be cluster-heads, it broadcasts an advertisement message (ADV). This message is a small message containing the node's ID and a header that distinguishes this message as an announcement message. Each non-cluster-head node determines to which cluster it belongs by choosing the Cluster head that requires the minimum communication energy, based on the received signal strength of the advertisement from each cluster-head. After each node has decided to which cluster it belongs, it must inform the cluster-head node that it will be a member of the cluster. Each node transmits a join-request message (Join- REQ) back to the chosen cluster-head. The cluster-heads in LEACH act as local control centers to co-ordinate the data transmissions in their cluster [9]. The cluster-head node sets up a TDMA schedule and transmits this schedule to the nodes in the cluster. This ensures that there are no collisions among data messages and also allows the radio components of each non cluster-head node to be turned off at all times except during their transmit time, thus minimizing the energy dissipated by the individual [8][10].

4 (B) Steady-State Phase

The steady-state operation is broken into frames where nodes send their data to the cluster-head at most once per frame during their allocated transmission slot. 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.
Simulation Parameter:-

Sr.No	No. of Item description specification	No. of Item description specification
1	Simulation Area	300 X 300
2	No. of nodes	11
3	Channel type	Channel / Wireless channel
4	Simulation time	300ns
5	Antenna model	Antenna / Omni antenna
6	Link Layer Type	LL
7	Energy Model	Battery
8	Communication model	Bi-directional
9	Interface queue type	Queue / drop tail / priqueue

Evaluation of LEACH protocol:-
Performance of LEACH protocol evaluated in NS2 simulator by following
I) Throughput ii) Energy of cluster heads iii) Packet Delivery Ratio iv) End to end delay

i) Throughput is the average data packets received at the destination (i.e at base station). Throughput usually measured in data packets per second (Bits/sec or bps)

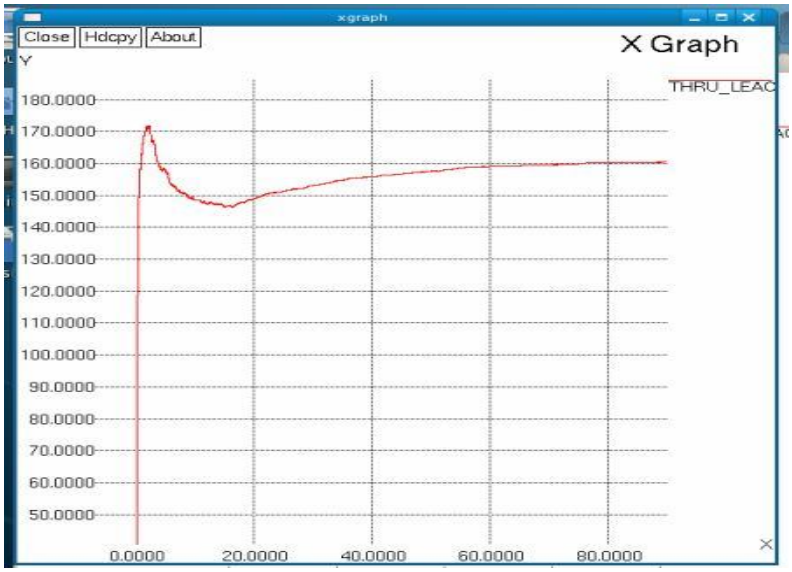


Fig. Time Verses Throughput

From above graph up to 40 seconds all packets not delivered at base station from 0 to 40 seconds maximum packets drop but after 40 sec to 100 sec maximum packets delivered at destination.

ii) Packet Delivery Ratio is the ratio of packets send to the number of packets received at destination. The greater value of packet delivery ratio means better performance of protocol.

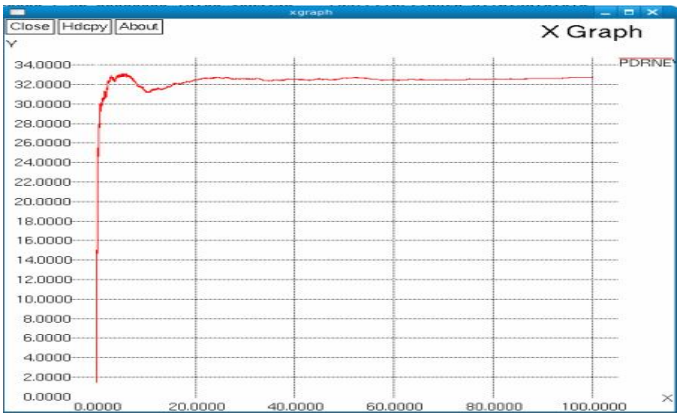


Fig :- Time Verses Packet Delivery Ratio

From above figure Packet delivery ratio for LEACH protocol evaluate graph shows that maximum packets delivered at destinations .As greater value of packet delivery ratio means better performance of protocol.

iii) Energy of clusters head

As we focus on energy efficiency of wireless sensor network so energy of sensor node is important parameter

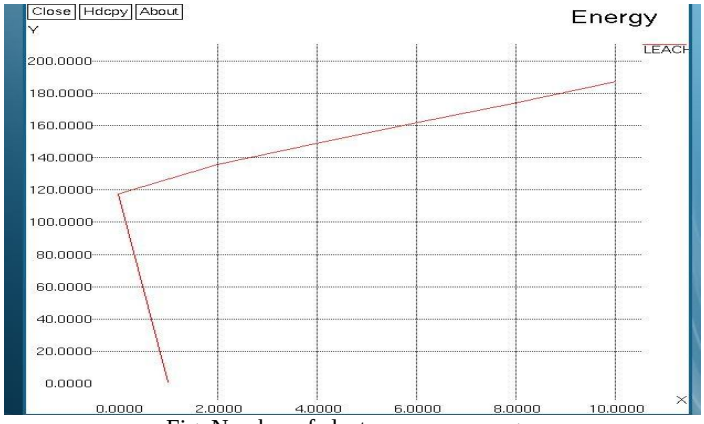


Fig. Number of clusters verses energy

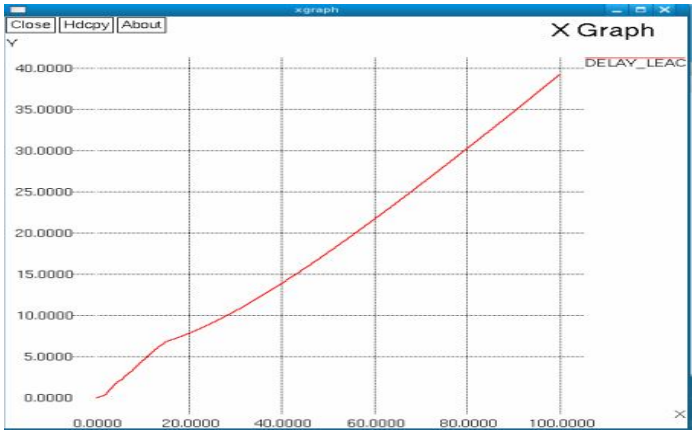


Fig 4:- Time Verses Delay

Total energy of network during communication with base station not possible evaluate in LEACH because of LEACH elect cluster heads in random fashion .So above graph drawn between no. of clusters verses energy

iv) End to end delay is average packet to arrive in destination .It also included delay caused by route discovery process and queue in the data packet transmission. Only data packets that successfully delivered to destination that counted Figure shows that end to end delay which the average data packet to arrive at the destination. From above graph end to end delay increases with time which is limitation of LEACH protocol.

LEACH Assumptions/ Limitations:-

As LEACH is (Low Energy Adaptive Clustering Hirarchy) protocol is able to increase network life time but there are still some factors to improve in assumptions of LEACH protocol. LEACH assumes that homogeneous distribution of sensor nodes in the given area. But it not realistic. LEACH assumes that nodes in always have data to send to the end user have correlated data. It is not possible no of clusters heads uniformly distributed throughout network. It may possible that all cluster heads placed nearby due to this information other part of network unable to reach to the destination.

CONCLUSION:-

Wireless Sensor Network (WSN) consists of base stations (BS) and several nodes which are unattended and have limited resource and they can work until the energy exists inside them. In this paper we take overview of LEACH protocol with its assumptions and performance evaluated considering some properties throughput, packet delivery ratio, energy of cluster head, end to end delay. But out of these properties we observed end to end delay is linearly increases with time. So this is drawback that must be overcome to increase lifetime of network and make LEACH protocol energy efficient.

VIII. REFERENCES

[1]Heinzelman.W.B.,Chandrakasan.A.P.,Balakrishnan.H"An application-specific protocol architecture for wireless microsensornetworks"IEEE transactions on Wireless Communication, Vol. 1, Issue. 4, 2002, pp 660-670

[2]Yuhua Liu, Yongfeng Zhao, JingjuGao**,** "A New Clustering mechanism based on LEACH Protocol", 2009 International Joint Conference on Artificial Intelligence, 2009. JCAI '09. pp 715-718

[3]Beibei Wang & Chong Shen& Jing Li " Study and Improvement on LEACH protocol in WSN'S International Jouranal of Wireless Communication and Networking ISSN :0975-7163

[4]V. Loscrì, G. Morabito, S. Marano, "A two levels hierarchy for low energy adaptive clustering hierarchy (TL-LEACH)", Vehicular Technology Conference, 2005, Vol. 3, pp 1809-1813

[5]Haosong Gou and YounghwanYoo"An Energy Balancing LEACH Algorithm for Wireless Sensor Networks **"**978-0-7695-3984-3/10 $26.00 © 2010 IEEE

[6] Jlan-FengYann& Yuan-Liu Liu"Improved LEACH Routing Protocol ForLarge Scale Wireless Sensor Networks Routing" 978-1-4577-0321-8/11/$26.00 ©2011 IEEE

[7] Ms.V.MuthuLakshmi "Advanced LEACH Protocol in Large scale WirelessSensor Networks" Volume 4, Issue 5, May-2013 ISSN 2229-5518

[8] NavneetVerma, Dr. Devendra Prasad, MukeshChawla "Energy and Throughput of Hierarchical Routing Protocol Leach and Leach-C for WSNS: A Review" International Journal of Research in Management, Science & Technology Vol.1, No. 1

[9]Meenakshi Sharma, Anil Kumar. Shaw "Transmission Time and Throughput analysis ofEEE LEACH, LEACH and Direct TransmissionProtocol: A Simulation Based Approach"Advanced Computing: An International Journal (ACIJ), Vol.3, No.5, September 2012.

[10] Rajesh Patel, Sunil Pariyani "Energy and Throughput Analysis of Hierarchical Routing Protocol (LEACH) for Wireless Sensor Network" International Journal of Computer Applications (0975 – 8887) Volume 20– No.4, April 2011

[11]M.Shankar, Dr.M.Sridar, Dr.M.Rajani"Performance Evaluation of LEACH Protocol inWireless Network" International Journal of Scientific & Engineering Research, Volume 3, Issue 1, January-2012ISSN 2229-5518

