International Journal of Current Engineering and Technology
ISSN 2277 - 4106

Available at http://inpressco.com/category/ijcet

Research Article

An Amend Implementation on LEACH protocol based on Energy Hierarchy

Krishna Gopal Vijayvargiya[a*] and Vishal Shrivastava[a]

[a]Arya College of engineering &IT.

Accepted 15 Dec. 2012, Available online 21Dec. 2012, **Vol.2, No.4(Dec. 2012)**

Abstract

we study the impact of heterogeneity of nodes, in terms of their energy, in wireless sensor networks that are hierarchically clustered. In these networks some of the nodes become cluster heads, aggregate the data of their cluster members and transmit it to the sink. We assume that a percentage of the population of sensor nodes is equipped with additional energy resources—this is a source of heterogeneity which may result from the initial setting or as the operation of the network evolves. We also assume that the sensors are randomly (uniformly) distributed and are not mobile, the coordinates of the sink and the dimensions of the sensor field are known. Classical clustering protocols assume that all the nodes are equipped with the same amount of energy and as a result, they cannot take full advantage of the presence of node heterogeneity. We propose An Amend LEACH, a heterogeneous aware protocol to prolong the time interval before the death of the first node (we refer to as stability period), which is crucial for many applications where the feedback from the sensor network must be reliable. A-LEACH is based on weighted election probabilities of each node to become cluster head according to the remaining energy in each node

Keywords: *LEACH, Wireless Sensors*

1. Introduction

Wireless Sensor Networks are networks of tiny, battery powered sensor nodes with limited on-board processing, storage and radio capabilities (I. Akyildiz, W. Su et , 2012). Nodes sense and send their reports toward a processing center which is called sink. The design of protocols and applications for such networks has to be energy aware in order to prolong the lifetime of the network, because the replacement of the embedded batteries is a very difficult process once these nodes have been deployed. Classical approaches like Direct Transmission and Minimum Transmission Energy (T. J. Shepard et al, 1999) do not guarantee well balanced distribution of the energy load among nodes of the sensor network. Using Direct Transmission (DT), sensor nodes transmit directly to the sink, as a result nodes that are far away from the sink would die first(W. R. Heinzelman et al, 2000). On the other hand, using Minimum Transmission Energy (MTE), data is routedover minimum-cost routes, where cost reflects the transmission power expended. Under MTE, nodes that are near the sink act as relays with higher probability than nodes that are far from the sink. Thus nodes near the sink tend to die fast. Under both

DT and MTE, a part of the field will not be monitored for a significant part of the lifetime of the network, and as a result the sensing process of the field will be biased. A solution proposed in, called LEACH, guarantees that the energy load is well distributed by dynamically created clusters, using cluster heads dynamically elected according to a priori optimal probability. Cluster heads aggregate reports from their cluster members before forwarding them to the sink. By rotating the cluster-head role uniformly among all nodes, each node tends to expend the same energy over time.

Most of the analytical results for LEACH-type schemes are obtained assuming that the nodes of the sensor network are equipped with the same amount of energy—this is the case of *homogeneous* sensor networks. In this paper we study the impact of heterogeneity in terms of node energy. We assume that a percentage of the node population is equipped with more energy than the rest of the nodes in the same network— this is the case of *heterogeneous* sensor networks. We are motivated by the fact that there are a lot of applications that would highly benefit from understanding the impact of such heterogeneity. One of these applications could be the re-energization of sensor networks. As the lifetime of sensor networks is limited there is a need to re-energize the sensor network by adding more nodes. These nodes will be equipped with more energy than the nodes that are already in use, which creates heterogeneity in terms of node energy. Note that due to practical/cost constraints it is not always possible to satisfy the constraints for optimal distribution between different types of nodes as proposed in (V. Mhatre et al, 2005).

* Corresponding author's Email: krish_er@rediffmail.com

There are also applications where the spatial density of sensors is a constraint. Assuming that with the current technology the cost of a sensor is tens of times greater than the cost of embedded batteries, it will be valuable to examine whether the lifetime of the network could be increased by simply distributing extra energy to some existing nodes without introducing new nodes.Perhaps the most important issue is that heterogeneity of nodes, in terms of their energy, is simply a result of the network operation as it evolves. For example, nodes could, over time, expend different amounts of energy due to the radio communication characteristics, random events such as short term link failures or morphological characteristics of the field.

Our Contribution: In this paper we assume that the sink is not energy limited (at least in comparison with the energy of other sensor nodes) and that the coordinates of the sink and the dimensions of the field are known. We also assume that the nodes are uniformly distributed over the field and they are not mobile. Under this model, we propose a new protocol; we call A-LEACH, for electing cluster heads in a distributed fashion in two-level hierarchical wireless sensor networks. Unlike prior work, A-LEACH is heterogeneous-aware, in the sense that election probabilities are weighted by the initial energy of a node relative to that of other nodes in the network. This prolongs the time interval before the death of the first node (we refer to as *stability period*), which is crucial for many applications where the feedback from the sensor network must be reliable.

2. Heterogeneous WSN model

In this section we describe our model of a wireless sensor network with nodes heterogeneous in their initial amount of energy. We particularly present the setting, the energy model, and how the optimal number of clusters can be computed. Let us assume the case where a percentage of the population of sensor nodes is equipped with more energy resources than the rest of the nodes. Let *m*be the fraction of the total number of nodes *n n*, which is equipped with α times more energy than the others. We refer to these powerful nodes as advanced nodes, and the rest (1-m) ×n as normal nodes. We assume that all nodes are distributed uniformly over the sensor field.

Clustering Hierarchy

We consider a sensor network that is hierarchically clustered.

The LEACH (Low Energy Adaptive Clustering Hierarchy) protocol (W. R. Heinzelman et al, 2000) maintains such clustering hierarchy. In LEACH, the clusters are re-established in each round. New cluster heads are elected in each round and as a result the load is well distributed and balanced among the nodes of the network. Moreover each node transmits to the closest cluster head so as to split the communication cost to the sink (which is tens of times greater than the processing and operation cost.) Only the cluster head has to report to the sink and may expend a large amount of energy, but this happens periodically for each node. In LEACH there is an optimal percentage p_{opt}(determined a priori) of nodes that has to become cluster heads in each round assuming uniform distribution of nodes in space (S. Bandyopadhyay et al, 2003).

If the nodes are homogeneous, which means that all the nodes in the field have the same initial energy, the LEACH protocol guarantees that everyone of them will become a cluster head exactly once every 1/ p_{opt}rounds. Throughout this paper we refer to this number of rounds, 1/ p_{opt}, as epoch of the clustered sensor network.

Initially each node can become a cluster head with a probability p_{opt}. On average, n ×p_{opt} nodes must become cluster heads per round per epoch. Nodes that are elected to be cluster heads in the current round can no longer become cluster heads in the same epoch. The non-elected nodes belong to the set G and in order to maintain a steady number of cluster heads per round, the probability of nodes ЄG to become a cluster head increases after each round in the same epoch. The decision is made at the beginning of each round by each node s Є G independently choosing a random number in [0, 1]. If the random number is less than a threshold T(s) then the node becomes a cluster head in the current round. The threshold is set as:

$$T(s) = \begin{cases} \dfrac{P_{OPT}}{1 - P_{OPT}(r mod\ 1/P_{OPT})} if s \in G \\ 0 \qquad Otherwise \end{cases}$$

Where, r is the current round number (starting from round 0.) The election probability of nodes Є G to become cluster heads increases in each round in the same epoch and becomes equal to 1 in the last round of the epoch. Note that by round we define a time interval where all cluster members have to transmit to their cluster head once. We show in this paper how the election process of cluster heads should be adapted appropriately to deal with *heterogeneous* nodes, which means that *not* all the nodes in the field have the same initial energy.

Optimal Clustering

Previous work have studied either by simulation (W. R. Heinzelman et al, 2000), or analytically (S. Bandyopadhyay et al, 2003) the optimal probability of a node being elected as a cluster head as a function of spatial density when nodes are uniformly distributed over the sensor field. This clustering is optimal in the sense that energy consumption is well distributed over all sensors and the total energy consumption is minimum. Such optimal clustering highly depends on the energy model we use. For the purpose of this study we use similar energy model and analysis as proposed in .

According to the radio energy dissipation model illustratedin Figure 1, in order to achieve an acceptable Signal-to-NoiseRatio (SNR) in transmitting an L-bit message over a distance*d*,The energy expended by the radio is given by:

$$E_{T2}(l,d) = \begin{cases} L.E_{elec} + L.\in_{fs}.d^2 if d \le d_0 \\ L.E_{elec} + L.\in_{mp}.d^4 if d > d_0 \end{cases}$$

Where E_{elec} is the energy dissipated per bit to run the transmitter or the receiver circuit, $\in_{fs}$ and $\in_{mp}$ depend on the transmitter amplifier model we use, and *d* is the distance between the sender and the receiver, By equating the two expressions at *d* = *d0*, we have$d_0 = \sqrt{\in_{fs}/\in_{mp}}$.To receive an L-bit message the radio expends $E_{Rx} = L.E_{elec}$

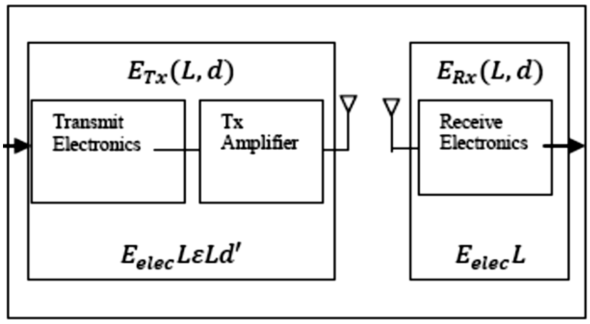

Figure1.Radio Energy Dissipation Model

Table1. Parameter settings of the first-order radio model

Parameters	Values
Initial energy (*E0*)	0.5 J/node
Transmitter Electronics *Eelec*)	50 n J/bit
Receiver Electronics (*Eelec*)	50 n J/bit
Data Packet Size (*l*)	2000 bits
Transmitter Amplifier (*εfs*) if *d≤d0*	10or100pJ/bit/m^2
Transmitter Amplifier (*εmp*) if *d≥d0*	0.0013 p J/bit/m^4

3. Methodology

- Method is applied in a Sensor Field of Area 100×100 m.
- The base Station is Placed at the Centre of Sensor Field initially, however we can change the Position of base Station.
- Number of Nodes in the field is 100.
- Initial Energy of a Node is 0.5 joule.
- Advanced Node Have α time more energy than a normal node.
- Hence Energy of Advanced Node becomes = initial Energy× (α).Total = initial Energy× (1+α).
- Initially the dissipated energy is Zero & residual energy is the Amount of initial energy in a Node, Hence Total energy E_t also the Amount of residual energy because it is the sum of dissipated & residual energy.
- average distance between the cluster-head and the base station is calculated by D_{bs}= (0.765×one dimension of field)/2
- Optimum Number Of Clusters are calculated byK_{opt}= $\sqrt{\frac{(0.5 \times n \times thresholddistance \times \pi) \times onedimensionoffield}{(Dbs)^2}}$
- the average distance between the cluster members and the cluster-head is calculated by D_{ch} = $\frac{\text{one dimension of field}}{\sqrt{2\times\pi\times Kopt}}$
- the total energy dissipated in the network during a round is calculated by Et=$bitsdata \times (2 \times n \times Etx + n \times Eda + Kopt \times Emp \times Dbs^4 + 4 \times n \times Efs \times Dch^2)$
- Also we calculated the average energy Ea of a Node after the particular round with the Knowledge of Total Energy and a particular number of round numbers. $Ea = Et \times \left(\frac{1-(r/Rmax)}{n}\right)$
- We calculated the Dead Statistics before assigning a Cluster Head, and its value renewed every new round.
- The New Expression for Optimum Probability can be calculated from Different Energy Levels and Optimum Probability Defined Earlier. $p(i) = \frac{p \times n \times currentEnergy \times residualenergy}{totalenergy \times averageenergy}$
- Here, an Advanced will becomes Cluster Head, if a Temporary number assigned to it is Less than the Probability Structure Below,

$$T(s) = \begin{cases} \frac{P_{(i)}}{1 - P_{(i)}\left(rmod\ 1/P_{(i)}\right)} & if s \in G \\ 0 & Otherwise \end{cases}$$

Here, *Pi* is come out from New Expression for Optimum Probability *P(i)*

- After an Advanced becomes Cluster Head, Energy Models are applied to calculate the Amount of Energy Spent by it on that Particular Round and complete the round of steady state phase.

$$E_{Tx}(l,d) = \begin{cases} lE_{elec} + l\varepsilon_{fs}d^2, & d < d_0 \\ lE_{elec} + l\varepsilon_{mp}d^4, & d \geqslant d_0 \end{cases},$$

If a Node will Not an Advanced node and Discarded from the criteria above, than it goes to a Set of Normal node, and follow the behavior of normal node and complete the round of steady state phase

4. Results

After starting a round, firstly checking if there is a dead node in the Sensor Field, and Checking this criteria After Every round.

Election of Cluster Heads for normal nodes and Advanced Node are done in Different Loops Which depends On the Election Probability used.

After a Cluster Head sent its Data to Sink, Calculation of Energy dissipated is done, through energy models considered in the Project, in Order to calculate How Much Energy Dissipated after a Steady State and whether a

Cluster head is eligible to transmit data in the next round too. This Energy thoroughly depends upon the Distance between BS and CH

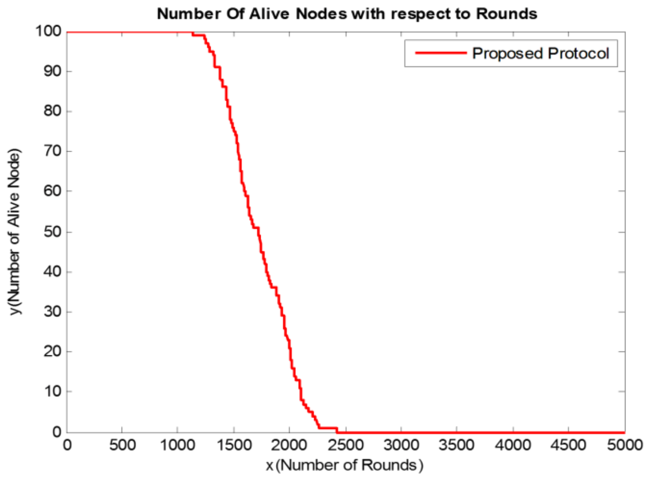

Figure2. Line view of Number of Alive nodes in our protocol with rounds

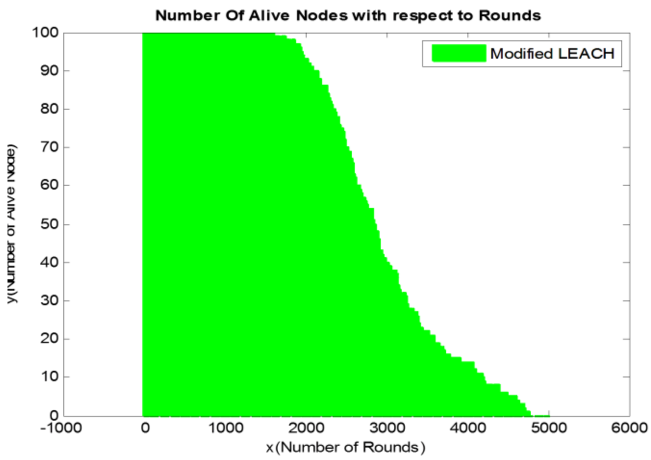

Figure2. Number of Alive nodes in our protocol with rounds

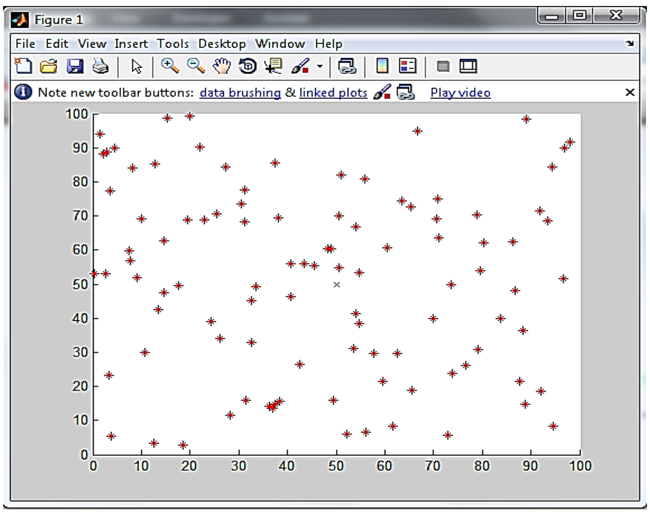

Figure3. Placement of Nodes in Sensor field of wireless Network

Table2. Comparison of network lifetimes (number of rounds) while comparing with previous research work

BS (25,y)	Protocol	Prob.	Nodes Dead			
			1%	20%	50%	100%
25	LEACH	0.05	1467	1618	1691	1850
	LEACH-GA	0.1307	1610	1732	1818	2040
	A-LEACH	0.05	1620	1937	2209	2536
50	LEACH	0.05	1438	1583	1661	1874
	LEACH-GA	0.0946	1512	1663	1717	2078
	A-LEACH	0.05	1608	1906	2186	2452
100	LEACH	0.05	1346	1473	1543	1787
	LEACH-GA	0.0334	1356	1482	1554	1815
	A-LEACH	0.05	1512	1801	2077	2209
150	LEACH	0.05	951	1027	1098	1298
	LEACH-GA	0.0181	927	1108	1205	1357
	A-LEACH	0.05	1481	1756	1889	2049
250	LEACH	0.05	540	576	616	718
	LEACH-GA	0.010	686	874	971	1106
	A-LEACH	0.05	1108	1383	1499	1549
350	LEACH	0.05	220	247	283	360
	LEACH-GA	0.010	407	574	660	757
	A-LEACH	0.05	806	967	1041	1096

Conclusion

This work proposed an amend implementation on leach protocol which is further compared by Genetically Optimized improved LEACH. This protocol is used to determine the optimal probability for cluster formation in WSNs. As simulation results shows that in terms of network lifetime, since the use of the optimal probability yields optimal energy-efficient clustering.

Our protocol successfully extends the stable region by being aware of heterogeneity through assigning probabilities of cluster-head election weighted by the relative initial energy of nodes. Proposed algorithm is implemented using MATLAB and tested multiple times and results are satisfactory.

References

I. Akyildiz, W. Su, Y. Sankarasubramaniam, and E. Cayirci (August 2002), A survey on sensor networks, *IEEE Communications Magazine*, vol. 40, no. 8 pp. 102–114,

T. J. Shepard, A channel access scheme for large dense packet radio networks, in *Proceedings of ACM SIGCOMM*, September 1996, pp. 219–230.

W. R. Heinzelman, A. P. Chandrakasan, and H.Balakrishnan(Jan2000),Energy efficient communication protocol for wireless microsensor networks, in Proceedings of the 33rd Hawaii International Conference on System Sciences (HICSS-33).

An application-specific protocol architecture for wireless microsensor networks, *IEEE Transactions on Wireless Communications,* vol. 1, no. 4, pp. 660–670

V. Mhatre and C. Rosenberg (June 2004), Homogeneous vs. heterogeneous clustered sensor networks: A comparative study, in *Proceedings of 2004 IEEEInternational Conference on Communication.s*

S. Bandyopadhyay and E. J. Coyle (April 2003), An energy efficient hierarchical clustering algorithm for wireless sensor networks, in Proceedings of *INFOCOM* 2003.

Minimizing communication costs in hierarchically-clustered networks of wireless sensors, *Computer Networks*, vol. 44, no. 1, pp. 1–16.

WendiRabinerHeinzelman,AnanthaChandrakasan,and Hari Balakrishnan (2000), Energy-Efficient Communication Protocol for Wireless Microsensor Networks, *33rd Hawaii International Conference on System Sciences*

Stephanie Lindsey, Cauligi S. Raghavendra (Mar 2002), PEAGASIS: Power-Efficient Gathering in Sensor Information Systems. *Proceedings of IEEE Aerospace Conference,* pp. 1125-1130.

S. Lindsey, and C. S. Raghavendra, and K. Sivalingam (Apr 2001), Data Gathering in Sensor Networks using the Energy*Delay Metric, *Proceedings of the 15thInternational Conference on Parallel and Distributed Processing Symposium*, pp. 2001-2008.

R. Ramanathan, and R. Hain, Topology Control of Multihop Wireless Networks using Transmit Power Adjustment, *Proceedings of the 19th IEEEInternational Conference on Computer Communication*, pp. 404-413, Mar. 2000.

L. Klein (1993), Sensor and Data Fusion Concepts and Applications, SPIE-The *International Society for Optical Engineering*, Press.

F. Akyildiz, W. Su, Y. Sankarasubramaniam, and E. Cayirci (Ma2 2002), Wireless sensor networks: a survey, *Computer Networks,* Vol. 38, No. 4, pp. 393-42.

Jenn-Long Liu and Chinya V. Ravishankar Apr (Apr 2011), *Member*, *IEEE*, LEACH-GA: Genetic Algorithm-BasedEnergy-Efficient Adaptive Clustering Protocolfor Wireless Sensor Networks*International Journal of Machine Learning and Computing*, *Vol.1*, *No.1.*