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DEEC Protocol for WSNs

M.M. Prasada Reddy[1], S.Varada Rajan[2]

[1]Assoc Professor,DIET, Hyd

[2]Professor & Secretary , APSHEC,Hyd

ABSTRACT

Wireless sensor Networks (WSN) advancements have been employed in recent years for monitoring purposes in various areas from building industry to our home surroundings because of their capacity to brilliantly screen remote areas. In this paper, we have built up an absolutely deterministic model that uses clustering to sort out the WSN. We propose a deterministic energy efficient clustering protocol that is dynamic, distributive, self-sorting out and more energy efficient than the current protocols. It uses a simplified approach which minimizes computational overhead-cost to self-sort out the sensor arrange. Our simulation result demonstrates a superior execution concerning energy utilization, which is reflected in the system lifetime in both homogeneous and heterogeneous settings when contrasted and the current protocols. It is deserving of note that our approach approximates a perfect answer for balanced energy utilization in hierarchical WSN.

I.INTRODUCTION

As of late ,the advances in smaller scale chip configuration have brought forth exceptionally light weight sensor nodes manufacture. These sensor nodes can be deployed for monitoring applications, for example, in horticultural farmlands, human services frameworks and disaster management so on. Regularly, the bottleneck of deploying WSN lies on the management of the battery life. The impediment of the battery limit in WSNs could make it costly and difficult to deploy on a large scale. Accordingly, building up a protocol that can enhance the energy utilization has been the concentration of a few authors in [1], [6], [9]. It has been demonstrated by [6] that ai energy aware protocol that is self-configuring can significantly beat a convention that is absent to a very much controlled energy consumption. One of the principle traits of these protocols, such as, LEACH [6] is that they use clustering schemes to work together among the sensors in the network. This has been demonstrated to significantly improve the WSN performance when compared with current protocols.

Authors in [1], [2], [5], [7], [9], [10] have utilized clustering to manage WSNs. Clustering process involves choosing leaders among the sensor nodes. Once the cluster heads(CHs) are chosen, they accumulate the data from their respective cluster members(CMs), refine it utilizing data compression methods and after that report the aggregated information to the base station (BS). However, being a CH could be an energy consuming task, as in [5]. By pivoting the CH could have much energy gains than if it somehow managed to be fixed. Thus, a standout amongst the most essential figures deciding the achievement of a decent protocol design for distributive WSNs is how capable it is able to manage energy consumption. previously, the pivot of CHs is carried out in a randomized way and the election is not ensured to be optimal. In this paper, a deterministic energy efficient clustering protocol that guarantees a superior election of CH is proposed. This proposed protocol utilizes the sensor node's residual energy (RE) solely as the election criterion .Simulation results show that the proposed model is able to maintain energy consumption better and accomplishes the desired result for

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WSNs. This paper is organized in four sections. Section II presents relevant studies on WSN models. Section III presents our proposed algorithm. In section IV simulation results are compared with other existing protocols. Section V concludes this work suggesting future scope .

II. WSN MODELS

Probability based model in [1],[6],[8],[9] and [11] mainly focussed on to extend the life time of WSNs using residual energy(RE) of each node. The downside of such protocols is that there is no guarantee that the elected CH will have enough energy to perform its duty as a leader. [4] uses deterministic CH selection algorithm that can outperform a probabilistic based algorithm in terms of energy consumption and network life time. However the proposed model is still probabilistic based though deterministic components are introduced. Hence this model suffers from unguaranteed CH election per round like other probabilistic based models. Although, LEACH introduced an optimal setting that can guarantee teh superior performance using their stochastic model, but most of the time the result could be sub optimal due to the uncertainties in CH election process. A probabilistic model used by these protocols is given in equation (1)

$$T_{(n_x)} = \left\{ \begin{array}{ll} \dfrac{P_x}{1 - P_x \left[rmod \left(\frac{1}{P_x} \right) \right]} \times Q & if\ n_x \in G' \\ 0 & otherwise \end{array} \right\} \qquad (1)$$

where x could be normal (nrm), intermediate (int) and advanced (adv) nodes respectively and Q is an additional quantity that can be defined as the ratio of residual energy (RE) of each node or just a constant value. In [1],[6],[9] Q is fixed to 1.[4] used a deterministic quotient for the value of Q, which is computed per round for all teh nodes in order to improve on LEACH protocol. According to threshold indicator(TI) function in equation(1) each node decides to be CH for every round r, the sensor node chooses a random number between 0 and 1 .If this value is lower than threshold for a node n ,T(n).The sensor node becomes a cluster head(CH),where G represents a set of non elected cluster members(CMs) and P_x is the probability of being elected as CH.SEP[9] improved LEACH by considering a two node heterogeneous environment. Similarly, SEP-E[1] improved both SEP and LEACH by introducing a three tire heterogeneous environment. Both SEP and SEP-E protocols adapted the indicator function in equation (1) to suit this model estimations by using intermediate and advanced nodes .These studies also defined different probabilities P_x for variety of nodes used in the network to achieve improved life time .

In these protocol, the operation of clustering process starts with a setup phase where all the nodes use teh indicator function for election as CHs. The elected CHs broadcast ADV message using non persistent carrier sense multiple access (CSMA MAC) protocol. This message contains the CHs ID and a header that indicates it as an announcement message. CMs determine their cluster by choosing teh CH with minimum communication cost on received signal strength of the ADV message. CMs send join request to their CH using CSMA MAC protocol. This message contains the CM ID,CH ID and teh header that indicates the message as a request .The CHs setup TDMA for their intra cluster communication, which closes the setup phase. The steady state phase starts when sensed data are sent from CMs to CHs and from CHs to BS. The inter cluster communication can be achieved using direct sequence spread spectrum (DSSS).Motivated by these studies, we have proposed a deterministic based model, which yield a better life time .In deterministic model the node with higher residual energy will be elected as CH. This technique provide an ideal solution for energy consumption in WSNs.

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A. Network model

In[1],[4],[6],[8] and[9] considered an energy dissipation and data aggregation model as shown in figure 1.

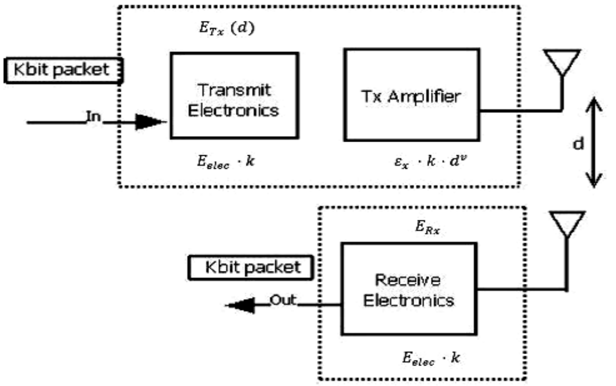

Figure 1.Network model diagram

To transmit the data bits over a distance (d) with an acceptable SNR the amplification energy (ϵ) is expended to overcome either free space (f_s) or multipath(mp) loss based on transmission distance. so to transmit k bits the energy consumption is

$E_{Tx(k,d)} = E_{Tx} - elec(k) + E_{Tx} - amp(k,d)$

$$E_{Tx(k,d)} = \begin{Bmatrix} kE_{elec} + k\epsilon_{fs}d^2 & if\ d < d_0 \\ kE_{elec} + k\epsilon_{mp}d^4 & if\ d \geq d_0 \end{Bmatrix} \quad (2)$$

where E_{elec} = Energy dissipation per bit for transceiver circuit

$d_0 = \sqrt{\frac{\epsilon_{fs}}{\epsilon_{mp}}}$ =Distance threshold for swaping amplification models

to receive a k-bit message teh radio will expend $E_{Rx}(k) = E_{elec}\,k$

we also consider that the same amount of energy is required to transmit a k bit message from node A to B and vice-versa.

III. PROPOSED DETERMINISTIC MODEL

Proposed DEEC protocol determines CH election depends on the residual energy (RE) of every node.

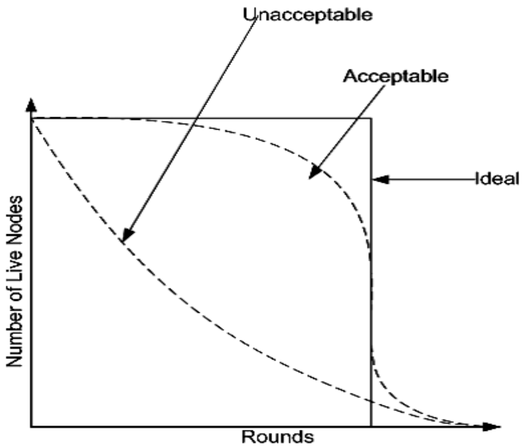

Figure 2: Behaviour of node energy consumption over time

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The threshold function in equation (1) is completely abandoned due to uncertainties in CHs election process and under utilization of protocol for life time maximization in clustered WSN.DEEC model has minimized the uncertainty in CH election process. The setup phase in LEACH is modified but steady phase remains same. since nodes energy can be determined a priori, the CH election process is reorganized to only use the RE of every node. In DEEC at round m the BS elects

N_{opt} CHs for the network. The BS can be involved only in teh election of CHs if and only if $m = 1$.The elected CHs sends an advertisement msg using CSMA MAC similarly as in LEACH. Unlike LEACH ,in DEEC join request message will contain CMID,CH-ID,CM-RE and teh header that indicates it as a request. This way the RE information of CMs is known by their respective CHs thus localized and it can be used for CH rotation in subsequent rounds .After the setup phase completes ,the steady state phase starts, but before the end of this phase teh current CHs checks the piggy backed CM-REs information received to determine whether they will remain as CHs. After this decision is made for new CHs and all the data from current round is communicated to teh BS. The current round (r=m) ends. The next round r=m+1 starts, but since teh new CH is already elected in the previous round, they broadcast their role in the new round. CMs join their cluster as explained above. The steady phase starts again. This process repeats in every round until the last node dies. Using this method, the life time of the battery in WSNs is significantly optimized. The flow chart of DEEC algorithm is shown in the figure 3.Simulation results indicate the significance of DEEC protocol.

- The CH election is locally decided depends on each nodes RE and each round is independent of teh subsequent round unlike in LEACH,SEP and SEP-E
- DEEC assumes each node a chance of election as long as its RE is higher than its neighbours
- DEEC ensures a fixed N_{opt} Ch is chosen
- DEEC significantly reduces the overhead cost of computation associated with CH search in the current protocols by refining this search to cluster N_i at round m
- DEEC guarantees that every CH has enough energy to play its role, until at least teh end ofthe network life time ,unlike in LEACH

A. Simulation setup

DEEC convention is verified utilizing simulations and its performence is compared with existing protocols such as LEACH, SEP and SEP-E. The performence measurements utilized as a part of [1], [4], [6], [9], are defined as FND (First Node Dies, otherwise called sstabilty period), PNA (90, Percent Nodes Alive) and LND (Last Node Dies, otherwise called instability period). Regular parameters utilized as a part of this study are appeared in Table I. These protocols are compared in both homogeneous and heterogeneous setups. The LEACH protocol is used as representation of homogeneous environment, since this is the reason for which it was planned by the authors in [5]. Similarly, SEP, SEPE and LEACH are utilized as representation of heterogeneous setup, particularly, since both SEP and SEP-E are designed by their authors [1], [9] to be robust to heterogeneity.

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Parameter	Values
E_{elec}	50nJ/bit
E_{DA}	5nJ/bit/message
E_o	0.5J
k	4000
P_{opt}	0.1
ϵ_{fs}	10pJ/bit/m^2
ϵ_{mp}	0.0013pJ/bit/m^4
n	100

Table-1:Parameter setting

We test these protocols using two setups:

Setup 1: A $100m \times 100m$ of randomly scattered homogeneous nodes, each with 0.5J of energy and BS situated at the focal point of the network system.

Setup 2: A 100m×100m of randomly scattered heterogeneous nodes with energies changed between 0.5J to 2.25J and BS located at the centre of the network system. For quickness, the total energy of the network for every protocol are assumed to be the same, we utilize total energy of 102.5J. In LEACH, SEP-E and DEC, 20% of the nodes are equipped with 2J of energy, 30% with 1.25J of energy and half with 0.5J of energy. However in SEP two sorts of nodes are assumed. So as to be reasonable, 30% of the nodes are equipped with 2.25J of energy and 70% with 0.5J of energy. The total energy of the system stays 102.5J. The ideal parameters of these protocols are utilized in order to yield their respective highest performances.

B. Analysis of optimum cluster-heads

In DEEC, the clustering algorithm was developed to ensure that the expected number of Chs per round is fixed as N_{opt}, which can be set from the earlier. In Fig. 4, we utilize a probabilistic-based model, for example, LEACH, to investigate the quantity of elected Chs per round. The solid curve, which represents LEACH protocol demonstrates the inherent uncertainities in the model, the result is that the required fixed number of CHs election can not be ensured per round. Because of this, in a few adjusts not very many group heads are chosen, and the CMs should transmit at an any longer distances to reach their CHs. In like manner, if the number of elected CHs is higher, very little data aggregation will be done, since the cluster size is littler. Hence, more energy will be consumed for transmitting. This is one of the significant disadvantage of this model. Another detriment of this model is that, the energy consumption across nodes become increasingly uneven as the network progress . This phenomenon is clarified later in the accompanying subsection.

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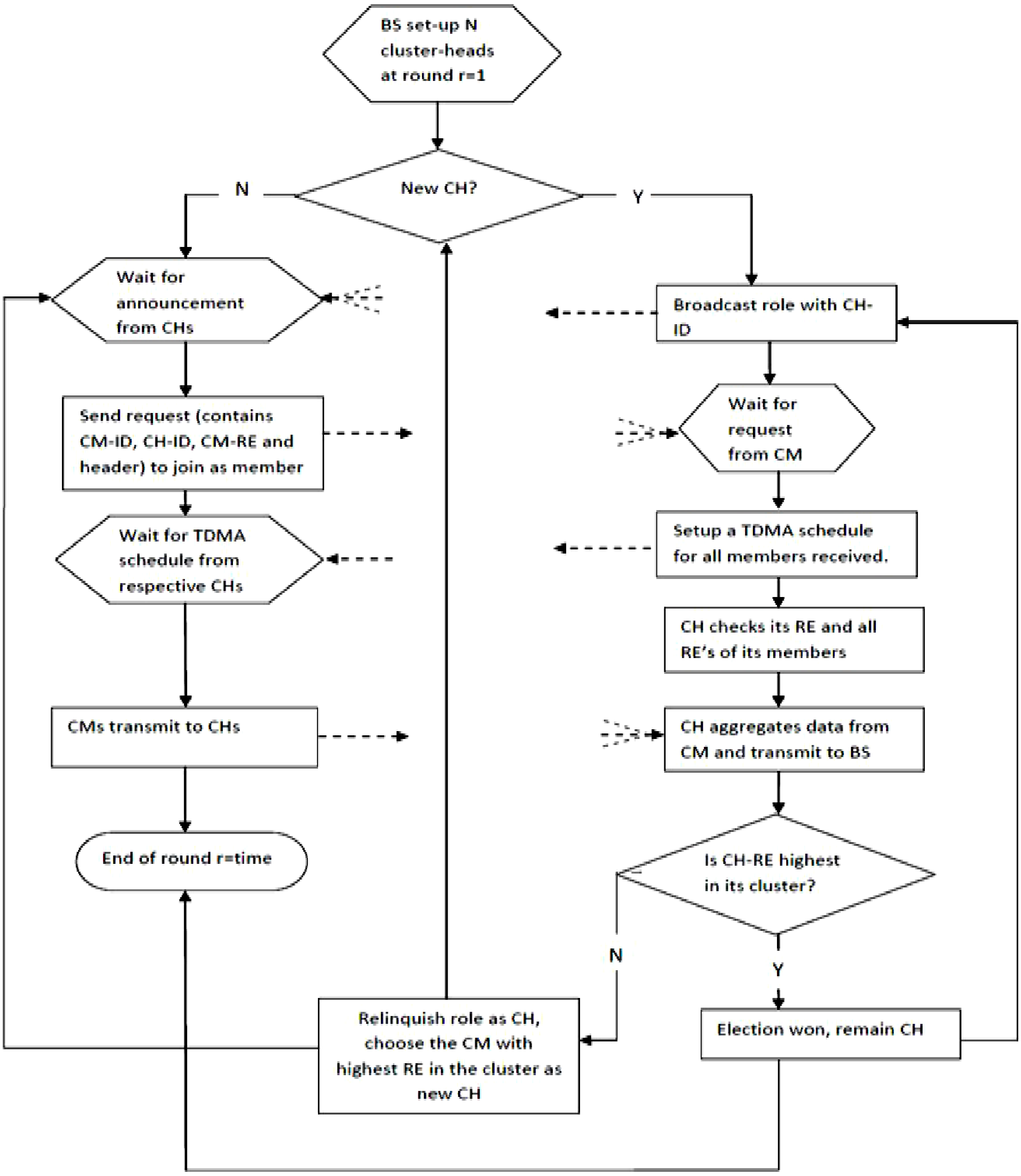

Fig. 3. Flowchart of DEC algorithm

Fig. 4 plots the number of chose CHs over time as given by LEACH [5] and DEC. The dotted line represent the DEC protocol which reveals that the instabilities in the CHs election has been totally wiped out. This guarantees, for any network size, once the N_{opt} is chosen at the start of the network operation, our DEEC protocol ensures that the number of CHs election remain fixed at N_{opt}. The benefit of this behaviours that, the energy across node is balanced as the system advances and for most of the time the CMs will have moderately shorter distances to transmit to their CHs. The energy gain is reflected in the simulation results in support of the DEEC convention. This makes DEEC to be very close to a perfect clustering solution for WSN.

Further, the optimal number of CH N_{opt} is empirically decided as shown in Fig. 5. The number of CH is fluctuated somewhere around 1 and 30, as the CHs increase, the FND enhances significantly till the CH number achieves 10. The DEC's curve is flat between 10 and 20 CHs with little spikes in the middle. Beyond 20 CHs,

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the bend begin descending. The optimality of N_{opt} lies around 16 CHs. As discussed above, when there are few CHs, non CH nodes will regularly transmit information extremely far to their CHs, this depletes their energy quicker. When there are more CHs (from 10 to 20), non-CH nodes can easily find a close-by head. But, when the number of CHs increments past 20, there is very little data aggregation is performed, consequently more energy will be consumed because of the size of the cluster is reduced . DEEC is steady when the number of CHs shifts between 10 to 20, this demonstrates the robustness of DEEC to variable number of CH election.

C. Energy Consumption Analysis

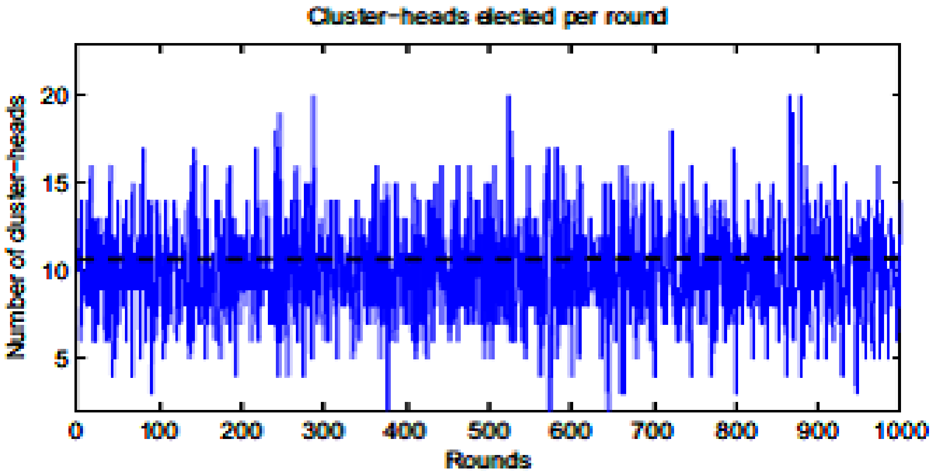

Fig.4. Number of cluster-heads per round. The solid line represent a LEACH, which does not guarantee the election of a fixed number of cluster-heads per round. The dotted line represent the DEC protocol, which guarantees a fixed number of cluster-head election per round.

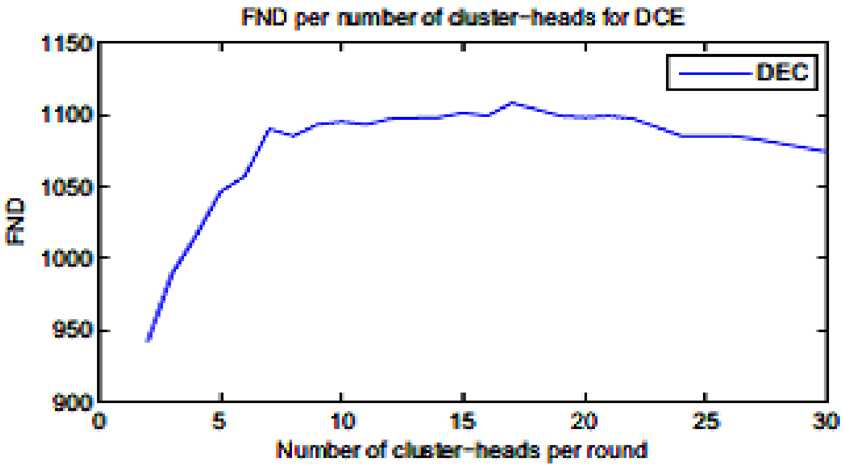

Fig. 5. FND in DEC as the number of cluster-head varies from 1 to 30. This graph shows that DEC is more efficient when cluster-heads are between 10 and 20 and the optimality lies around 16 clusters in homogeneous setup.

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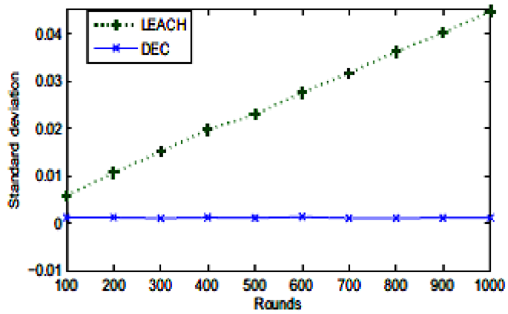

Fig. 6. The residual energy standard deviation across the sensor nodes at rounds 100, 200...1000, in Setup 1.

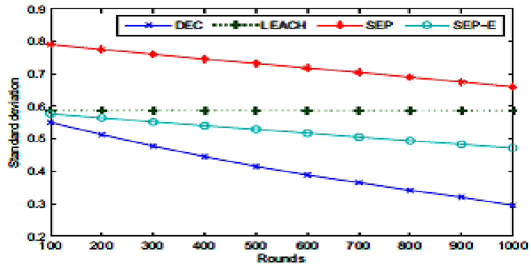

Fig. 7. The residual energy levels across the sensor nodes at rounds 100, 200...1000 in Setup 2.

C. Energy consumption Analysis

We study the RE of every node during the network operation ,by observing the variation of energy levels between the nodes at100 round intervals in between 100 to 1000 rounds. Standard deviation is used to check these differences among the nodes using setup 1 and setup 2.Our aim is to check the relative energy consumption pattern across teh sensor nodes. This indicates us whether energy in the system evenly consumed across the nodes. with setup1(figure 6) DEEC has a flat and much lower standard deviation overtime compared with LEACH which increases as network go from 100 to 1000 rounds. This is obvious that the energy is not evenly consumed among the nodes as the network evolves in LEACH. This is because of random election process of CH in LEACH, this makes the entire network operation unstable. Using setup 2 we notice a similar phenomenon in DEEC,SEP-E,SEP and LEACH. Once again standard deviation is computed for RE among the nodes of each protocol as shown in figure 7.The quick fall in DEEC curve from 100 to 1000 rounds shows obviously that DEEC balances the energy consumption in the network better than other protocols.

Protocols	FND	PNA	LND
LEACH	995	1089	4585
SEP	1385	1423	5050
SEP-E	1450	1650	3751
DEEC	1839	2100	2350

Table-2:Average of network life time of the sensor for 50 trials with total energy of 102.5J,when the BS is located inside the sensing region

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By adapting well to heterogeneity, as the network go from 100 to 1000 rounds, DEEC reduces energy gap within the network by assuming that nodes with higher RE are chosen often than nodes with lower RE, hence lower standard deviation at 1000 round than other protocols. Though SEP and SEP-E adapt to energy heterogeneity, they are very much slower in coping with this phenomenon. It is clear that LEACH protocol is indifferent to heterogeneity, as there is no response to different energy levels in the network. The performance of DEEC compared with other protocols is significant. The DEEC protocol has proved its well balanced energy consumption pattern across the nodes regardless of energy hierarchies in the network system. The results encourage our proposed model ofa fixed elected number N_{opt} of CHsin every round as utilized by DEEC protocol to balance energy consumption among the nodes .We examine the number of active nodes per round for both homogeneous and heterogeneous environments. The simulation results are discussed below.

Setup-1:

The network life time of DEEC and LEACH is shown in the figure 8.DEEC beat LEACH protocol by improving the lifetime in homogeneous environment. DEEC mimics the ideal solution as shown in the figure 2.By prolonging the knee point as desired by our model estimation. Though the performance of LEACH is also acceptable. But a critical application needs 90-100% monitoring requirement. DEEC proves to be more appropriate. For less critical applications with about 70 percent monitoring requirements LEACH is still considerable .

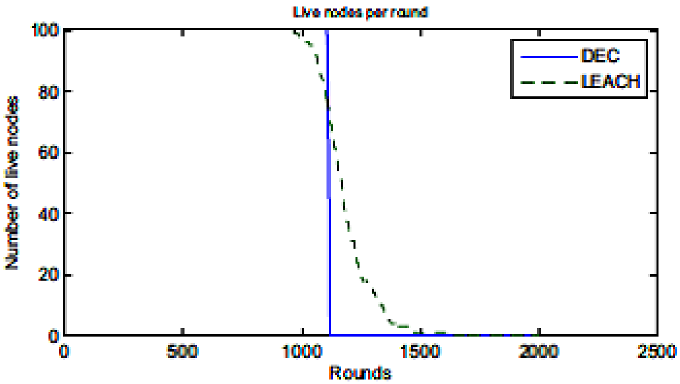

Figure 8:Performence of the protocols using setup-1

Setup-2:

The summary in table 2 shows significant results for DEEC model. DEEC enhances teh WSN lifetime compared to SEP,SEP-E and LEACH up to a magnitude of45%,24% and 21% respectively. Figure 9 represents teh behaviour of these protocols to energy heterogeneity. DEEC curve is at right angle to the knee point, the gradual fall at the start is as a result of various energy levels of the nodes in the network. DEEC proves to be superior up to when 60% of the nodes are active. SEP,SEP-E and LEACH fall slowly till the end of the network, though SEP and SEP-E beat teh LEACH protocol. This is because LEACH is intended for homogeneous environment .For minimum monitoring requirement LEACH,SEP and SEP-E are suitable. But most of the applications will introduce new nodes as the network evolves, which makes DEEC more appropriate for WSNs.

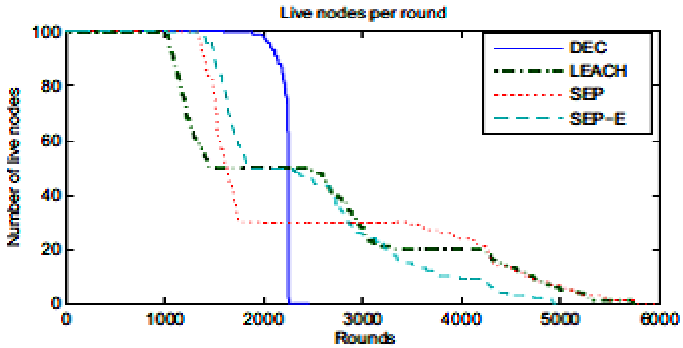

Figure 9: performance of protocols using setup-2

IV. CONCLUSION

In this paper the proposed DEEC protocol better utilizes energy in WSNs. DEEC beat the probabilistic based models we considered, by ensuring that a fixed number of CHs and elected per round. At different rounds CHs are chosen using RE within each clusters to elect the appropriate CHs. Simulation results proved that DEEC evenly distributed the energy consumption among the nodes in WSNs. Hence nodes die out almost at the same time. This characteristic of DEEC is highly desirable and is close to an ideal solution. Even though we change number of CHs per round, DEEC proves to be more stable and robust than probabilistic models .DEEC enhances the life time of WSN by an order of magnitude which is significant when compared with LEACH,SEP,SEP-E.DEEC make use RE ofeach node to optimize teh energy consumption in both homogeneous and heterogeneous setup as we consider, irrespective of the level of the energy hierarchies in the network. In the future work DEEC protocol can be implemented to a real world applications such as agricultural farmland for fertilizer spraying operations. We hope that this method can provide more insight into optimizing WSN energy consumption in real world applications.

REFERENCES

[1] F. A. Aderohunmu, J. D. Deng, and M. K. Purvis. Enhancing Clustering in Wireless Sensor Networks with Energy Heterogeneity. International Journal of Business Data Communications and Networking-(Accepted, to appear in the forthcoming issue, 2011.

[2] F. Comeau. Optimal Clustering in Wireless Sensor Networks Employing Different Propagation Models And Data Aggregation Techniques. PhD thesis, Dalhousie University, Halifax, Nova Scotia, 2008.

[3] S. Gamwarige and C. Kulasekere. An algorithm for energy driven cluster head rotation in a distributed wireless sensor network. In Proceeding of the International Conference on Information and Automation, pages 354–359, Dec 2005.

[4] M. Haase and D. Timmermann. Low energy adaptive clustering hierarchy with deterministic cluster-head selection. In IEEE Conference on Mobile and Wireless Communications Networks (MWCN), pages 368–372, 2002.

[5] W. R. Heinzelman, A. Chandrakasan, and H. Balakrishnan. Energy efficient communication protocol for wireless microsensor networks. In Proceeding 33rd Hawaii International Conference on System Sciences, 2000.

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346
[6] W. R. Heinzelman, A . Chandrakasan, and H. Balakrishnan. An Application-Specific Protocol Architectures for Wireless Networks. IEEE Transactions on Wireless Communications, 1:660–670, 2002.

[7] C. Li, M. Ye, and G. Chen. An Energy-Efficient Unequal Clustering Mechanism for Wireless Sensor Networks. In Proceeding of IEEE MASS05, pages 3–17, 2005.

[8] L. Qing, Q. Zhu, and M. Wang. Design of a distributed energy-efficient clustering algorithm for heterogeneo us wireless sensor networks. Computer Communication, 29:2230–2237, 2006.

[9] G. Smaragdakis, I. Matta, and A. Bestavros. SEP: A Stable Election Protocol for clustered heterogeneous wireless sensor networks. In Proceeding of the International Workshop on SANPA, 2004.

[10] F. Xiangning end S. Yulin. Improvement on LEACH Protocol of Wireless Sensor Network. In SENSORCOMM '07: Proceedings of the 2007 International Conferenceon Sensor Technologies and Applications, pages 260–264, Washington, DC, USA, 2007. IEEE Computer Society.

[11] O.YounisandS.Fahmy. HEED: AHybrid ,Energy-Efficient,Distributed Clustering Approach for Ad Hoc Sensor Networks. IEEE Transactions on Mobile Computing, 3:366–379, 2004.