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Extended Stable Election Protocol for increasing lifetime of the WSN

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Abstract—
Recently wireless sensor networks (WSN) became an interesting topic because of its increasing usage in many fields; medical systems, environment monitoring, military applications and video surveillance. Usually sensors are placed in the desired locations to gather information frequently and then transfer it to the observers. WSN consists of a collection of application specific sensors, a wireless transceiver and a simple general purpose processor. In heterogeneous wireless sensor network, researchers found many challenging issues including the limited energy, the efficient usage of the energy, and the problem with the hierarchy of the network as imbalance network. Many studies indicated that the node clustering is a promising solution for such issues. Clustering has been shown to increase the efficacy of the energy consumption where clusters are formed dynamically with neighboring sensors and the power is assumed to be distributed equally among nodes. One of the nodes is considered as the cluster head that is responsible for transferring data among the neighboring sensors. In this paper, we propose a modification based on SEP protocol. ESEP aims to prolong the stable period of the sensor network by maintaining balanced energy consumption. ESEP routing protocol compare with SEP protocols in terms of energy consumption, no of dead nodes, end to end delay and PDF the simulation parameters has been carried out using NS 2
Keywords: Wireless Sensor network, SEP, Energy Consumption, ESEP

I. INTRODUCTION

Hierarchical clustered WSN architecture

In general, the network structure or architecture in WSNs can be divided into flat network structure, hierarchical network structure and location-based network structure. The hierarchical or cluster-based network architecture, originally proposed for wired networks, comprises well-known techniques with special advantages related to scalability and energy-efficient communication. The concept of hierarchical architecture is also utilized in WSNs to perform energy-efficient routing. In a hierarchical architecture, higher energy nodes can be used to process and send the information while low energy nodes can be used to perform the sensing in the proximity of the target. This means that creation of clusters and assigning special tasks to CHs can greatly contribute to overall system scalability, lifetime and energy efficiency.

A hierarchical clustered approach breaks the network into clustered layers. Nodes are grouped into clusters with a CH that has the responsibility of routing from the cluster to the other CHs or BSs. Data travel from a lower clustered layer to a higher one. Although, it hops from one node to another node, but as the hops increase from one layer to another layer it covers larger distances. This moves the data faster to the BS. Theoretically; the latency in such a model is much less than in the multi-hop model. Clustering provides inherent optimization capabilities at the CHs. This model is better than single hop or multi-hop model for flat routing architecture. Homogeneous vs. heterogeneous architectures

In terms of the component nodes, the WSNs can be classified in two categories: homogeneous WSN and HWSN. In homogeneous WSN architecture, the sensor nodes have identical capabilities and functionality with respect to the various aspects of sensing, communication, and resource constraints. In HWSN architecture, each node may have different capabilities and execute different functions in terms of energy heterogeneity, link heterogeneity and computational heterogeneity may have different capabilities and execute different functions in terms of energy heterogeneity, link heterogeneity and computational heterogeneity. The general typical wireless sensor networks model is shown in figure 1.1.

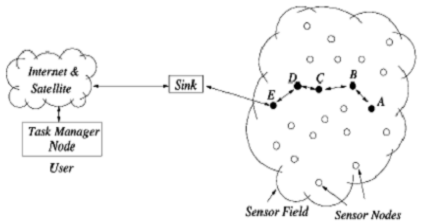

Figure 1.1: A typical Wireless Sensor Network

II. Stable Election Protocol (SEP)

A heterogeneous aware protocol is to prolong the time interval before the death of the first node, which is crucial for applications where the feedback from the sensor network must be reliable. SEP is based on weighted election probabilities of each node to become cluster head according to the remaining energy in each node.

SEP protocol was improved of LEACH protocol. Main aim of it was used heterogeneous sensor in wireless sensor networks. This protocol has operation like LEACH but with this difference that, in SEP protocol sensors have two different level of energy. Therefore sensors are not homogeneous. In this protocol with suppose of some sensors have high energy therefore probability of these sensors as cluster head will increased. But in SEP and LEACH, cluster heads aren't choose base of energy level and their position. This is main problem of these methods, so their operations are static.

III. Extended Stable Election Protocol

the authors have analysed a three-tier node scenario in a heterogeneous sensor network environment. There are p and k percentage of moderate and advanced nodes having a and b times more energy than the normal nodes that are distributed randomly over the sensor field. A cluster head election process is considered based on the battery power and residual energy of the node. In our approach, moderate and advanced nodes have higher probabilities to become a cluster head in a particular round than the normal nodes. The proposed heterogeneous network model doesn't affect on the spatial density of the network but changes the total initial energy of the network. We have individual initial energy equations for moderate and advanced nodes as follows:

$$E_1 = E_{0.}(1+a) \;\ldots\ldots\; (1)$$

$$E_2 = E_{0.}(1+b) \;\ldots\ldots\; (2)$$

Where,
E0=Energy of a normal node
E1=Energy of a moderate node
E2=Energy of an advanced node
The total initial energy of three types of nodes is as follows

$$E_{t0} = n.E_{0.}(1-p-k) \;\ldots\ldots\; (3)$$

$$E_{t1} = n.p.E_{0.}(1+a) \;\ldots\ldots\; (4)$$

$$E_{t2} = n.k.E_{0.}(1+b) \;\ldots\ldots\; (5)$$

Where,
Et0=Total initial energy of normal nodes
Et1=Total initial energy of moderate nodes
Et2=Total initial energy of advanced nodes
The total initial energy of the new heterogeneous sensor network model is given by equation (11):

$$E_t = n.E_{0.}(1-p-k) + n.p.E_{0.}(1+a) + n.k.E_{0.}(1+b) \;\ldots\ldots\; (6)$$

$$E_t = n.E_{0.}(1+p.a+k.b) \;\ldots\ldots\; (7)$$

In this work, we have approached to assign a weight to the optimal probability of a sensor node (popt) to become cluster head in a particular round. This weight must be equal to the division of the initial energy of each node by the initial energy of a normal node. If all the nodes are homogeneous, according to all the nodes will become cluster head once every 1/popt round which is coined as epoch of the network in. In order to maintain the minimum energy consumption in each round within an epoch, the average number of cluster heads per round per epoch must be constant and equal to popt.n. In our approach the average number of cluster heads per round per epoch is equal to n.(1+p.a+k.b). The weighted election probabilities for normal and advanced nodes are defined. In our three tier node scenario, the weighted election probabilities for the normal, moderate and advanced nodes are as follows:

$$P_{nrm} = \frac{p_{opt}}{1+p.a+k.b}$$

$$P_{\text{mod}} = \frac{p_{opt}}{1+p.a+k.b}.(1+\text{a})$$

$$P_{adv} = \frac{p_{opt}}{1+p.a+k.b}.(1+\text{b})$$

We further define the thresholds T(snrm), T(smod), T(sadv) for the normal, moderate and advanced nodes. In equation (1) we have replaced popt by the weighted probabilities of normal, moderate and advanced nodes to obtain the threshold that is used to elect the cluster head in each round. Thus, the threshold for the normal nodes to become cluster head can be evaluated by the following equation

$$T(s_{nrm}) = \begin{cases} \dfrac{p_{nrm}}{1-p_{nrm}.(r.\text{mod}.\dfrac{1}{p_{nrm}})}, & ifs \in G' \\ 0, & otherwise \end{cases}$$

Where r is the current round number and G is the set of nodes that have not become cluster head within the last 1/popt rounds. At the beginning of each round, each node which belongs to the set G selects a random number 0 or 1.

If the random number is less than the threshold T(s) then the node becomes a cluster head in the current round.

IV. Results and Discussions

The performance of the SEP and ESEP protocols simulation results has been carried out using the NS 2 simulator. In this paper simulation results are shown by varying number of nodes. The simulation parameter was shown in table 4.1.

Table 4.1: SIMULATION PARAMETERS

Simulation parameter	**Value**
Routing Protocols	SEP, ESEP
Simulation area	1000×1000 sq.m
Number of Nodes	50,60,70,80,90,100
Traffic Type/ CBR Rate	CBR / 0.05 MBPS
Simulation time	100 sec
Energy	20J
Antenna	Omni Directional
Propagation mode	Propagation/TwoRayGround

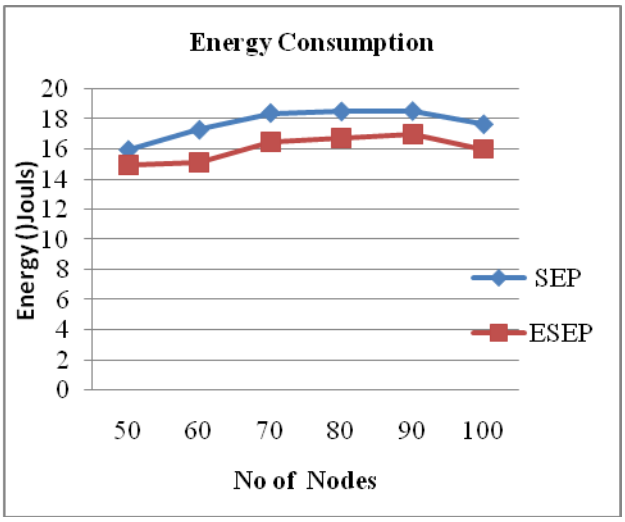

Figure 4.1: Energy Consumption vs No Nodes

The Figure 4.1 shows the Power Consumption of SEP and ESEP protocols for varying number of nodes. Their comparison is given by the superimposed plot shown in Figure 4.3. We can observe from the graph that the Power Consumption of SEP is much higher than ESEP. Hence ESEP is more energy efficient than SEP protocol because of it consumes less power than SEP protocol by varying number of nodes. The number of nodes varied from 10 nodes to 100 nodes as shown in below figure 4.1

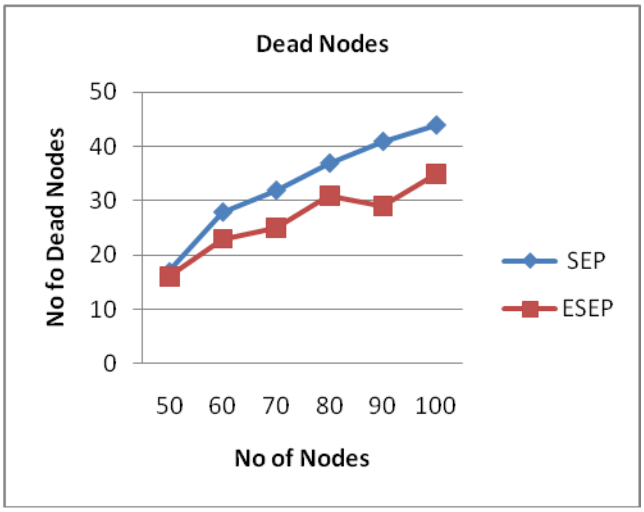

Figure 4.2: Dead nodes Vs No Nodes

The comparison is given by the superimposed plot shown in Figure 4.2 We observed from the graph that the number of dead nodes of ESEP is always lower than that of SEP which makes it more desirable for increasing the network lifetime is always higher in ESEP than SEP protocol by varied number of node in wireless sensor network .The transmission from sensors nodes to sink node happens either between cluster node and its head or between cluster head and sink node.

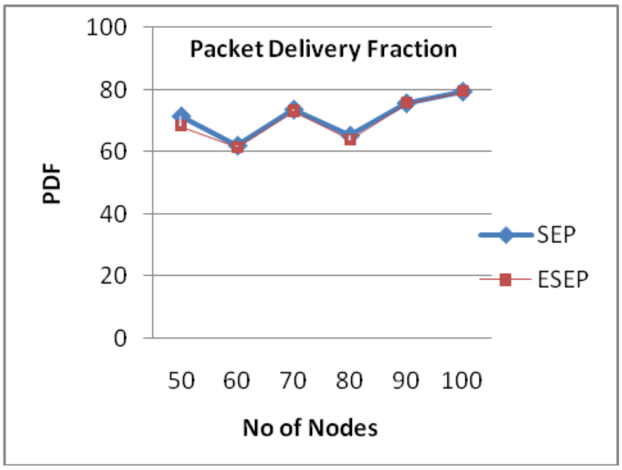

Figure 4.4: Packet Delivery Fraction Vs No Nodes

The figure 4.4 shows that Packet Delivery Fraction in case of SEP and ESEP protocols at 50, 60, 70, 80, 90, and 100 nodes. Results show that the ESEP is having more PDF compared to SEP when no of nodes increases.

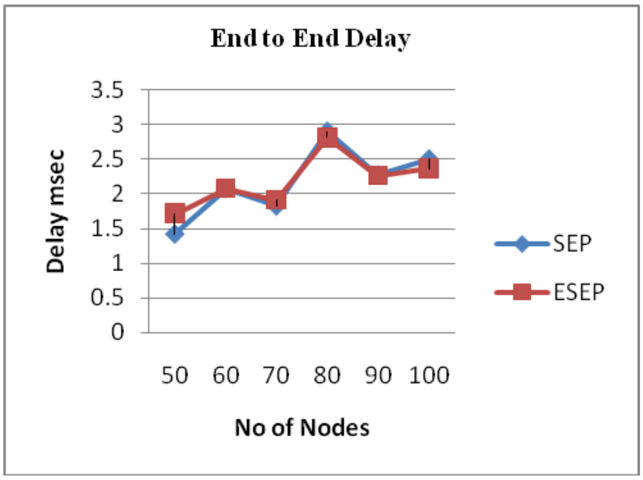

Figure 4.4: Average End to End Delay Vs No Nodes

The figure 4.4 shows that Average End-to-End Delay in case of SEP and ESEP protocols at 50, 60, 70, 80, 90, and 100 nodes. Results show that the ESEP is having less delay compared to SEP when no of nodes increases.

CONCLUSIONS

In this paper, we proposed ESEP protocol a modification of the SEP protocol to further increase life time of the network by efficient clustering method. ESEP protocol deals with the network as a number of clusters while introducing an efficient mechanism for communications among nodes. ESEP protocol increases the stable period of the sensor network by assigning a three level of energy to the sensors. ESEP is compared with the SEP protocol by using performance parameters, Energy consumption and Dead node with respect to number of nodes and node speed variation. About 8-9% improvement in energy consumption, 10-11% improvement in dead nodes has been achieved by using ESEP protocol when compared to SEP protocol. The packet delivery fraction and average end to end delay almost same in SEP and ESEP but no of nodes increases in network it varied. When Increasing nodes ESEP protocol for given better performance than SEP.

REFERENCES

[1] Laveena Mahajan, Narinder Shanna "Improving the Stable Period of WSN using Dynamic Stable Leach Election Protocol" 2014 International Conference on Issues and Challenges in Intelligent Computing Techniques (ICICT), pp. 393 -401, 2014 IEEE.

[2] Arafat Abu Malluh, Khaled M. Elleithy, Zakariya Qawaqneh, Ramadhan J. Mstafa, Adwan Alanazi "EM-SEP: An Efficient Modified Stable Election Protocol", Proceedings of 2014 Zone 1 Conference of the American Society for Engineering Education (ASEE Zone 1), 2014 IEEE.

[3] Arafat Abu Malluh, Khaled M. Elleithy, Zakariya Qawaqneh, Ramadhan J. Mstafa, Adwan Alanazi, "EM-SEP: An Efficient Modified Stable Election Protocol", Proceedings of 2014 Zone 1 Conference of the American Society for Engineering Education (ASEE Zone 1), 2014 IEEE.

[4] Dahlila P. Dahnil, Yaswant P. Singh, Chin Kuan Ho "Energy-Efficient Cluster Formation in Heterogeneous Wireless Sensor Networks: A Comparative Study" ICACT2011, Feb. 13-16, 2011.pp no. 746-751.

[5] Simranjit Singh, Kanwaljit Singh, "Energy Efficient Election Probability and Cluster Head Selection for Enhancement of SEP-E in Wireless Sensor Networks", 2013 International Conference on Machine Intelligence Research and Advancement, pp. 82-87. Feb. 13-16, 2011 ICACT2011.

[6] D.P. Dahnil, Y. P. Singh, C. K. Ho, "Analysis of adaptive clustering algorithms in Wireless Sensor Networks", IEEE Conference on Communication Systems, Nov 2010

[7] G. Anastasi, M. Conti, and M. Di Francesco, "Extending the lifetime of wireless sensor networks through adaptive sleep", IEEE Trans. Industrial Informatics, vol. 5, no. 3, pp. 351–365, 2009.

[8] Haosong Gou, Younghwan Yoo, Hongqing Zeng, "A Partition Based LEACH Algorithm for Wireless Sensor Networks" Ninth IEEE International Conference on Computer and Information Technology 2009, CIT '09, vol. 2, pp. 40-45, 11-14 Oct. 2009 doi: 10.1109/CIT.2009.21

[9] A. Koucheryavy and A. Salim, "Cluster head selection for homogeneous wireless sensor networks" 11th International Conference on Advanced Communication Technology, 2009. ICACT 2009, vol. 3, pp. 2141-2146.

[10] G. Anastasi, M. Conti, and M. Di Francesco, "Extending the lifetime of wireless sensor networks through adaptive sleep," IEEE Transactions on Industrial Informatics, vol. 5, no. 3, pp. 351 –365, August 2009.

[11] O. Younis, S.Fahmy Heed, " HEED: A hybrid, energy-efficient distributed clustering approach for Ad Hoc Sensor Networks," IEEE Transactions on Mobile Computing, Vol. 3, No. 4, pp. 660-669, 2004.