Advanced Threshold Sensitive Stagnant Election Protocol For Heterogeneous Wireless Sensor Network

Pragati Tiwari, Mr. Ramesh Mishra

***Abstract*— A key concern in WSN technology is to enhance the network lifetime and to reduce the energy consumption of the sensor network. Wireless sensor nodes are dispersed typically in sensing area to monitor earthquake, battle field, industrial environment, and habitant monitoring agriculture field, physical atmosphere conditions and smart homes. Sensor nodes sense the environment, gather information and transmit to BS through wireless link.**

Energy efficiency of the proposed approach can be improved through Multiple Cluster Heads. The efficient routing protocol in a cluster plays an important role in energy saving and stability of the cluster and its nodes.

In this paper we proposed Enhance Threshold Sensitive Stable Election Protocol (ETSSEP) for heterogeneous wireless sensor network. It is based on dynamically changing cluster head election probability. The ETSSEP is simulated using MATLAB and found that it performs better than Stable Election Protocol (SEP) and Threshold Sensitive Stable Election protocol (TSEP) in terms of stability and network lifetime. A Wireless Sensor Network (WSN) is composed of multiple numbers of nodes each of which consists of sensing devices to collect data from environment. Clustering has been proven as one of the most effective technique for reducing energy consumption of the wireless sensor networks. In this paper, we are displaying a survey on hierarchical routing protocols based on LEACH (Low Energy Adaptive Clustering Hierarchy) protocol.

***Index Terms*— Clustering, Routing, Stable Election Protocol, Heterogeneous environment, Energy, efficiency, Wireless sensor network.**

I. INTRODUCTION

Wireless Sensor network is composed of many small distributed sensor nodes that provide the reliable monitoring in various environments such as military battlefield surveillance, drug identification, recognition security and civil application and automatic security. In WSN every sensor node contains specific hardware, memory & processing unit. Tiny sensor nodes process the data and send it to base station called as sink. For communication of data between nodes and sink many routing technologies are used, such as multi-hop data transmission and direct communication.

The main constraint in WSN is limited battery power which plays a great influence on the lifetime and the quality of the network. Several routing protocols have been intended to satisfy energy consumption and efficiency requirement of WSN. By using hierarchical routing efficiency, lifetime and scalability of wireless sensor network can be improved. Here, sensors are organized themselves into clusters and each cluster represented by its cluster head [1].The main role of cluster head is to provide data communication between sensor nodes and the base station efficiently [2]. Lifetime of WSN can be enhanced with help of heterogeneity of nodes in WSN Heterogeneous WSN consists sensor nodes with different ability like different sensing range and computing power. Clustering techniques can be of two types: homogeneous clustering scheme i.e. applied in homogeneous sensor networks and heterogeneous clustering schemes. i.e. is applied in the heterogeneous sensor networks. LEACH consists same energy level nodes . The energy saving schemes for homogeneous wireless sensor networks not well performed on heterogeneous wireless sensor network. Thus, for the characteristic of heterogeneous wireless sensor networks energy efficient clustering protocols should be designed.

In clustering, the entire sensor network is divided into number of clusters. Each clusters may contain multiple nodes, however, one node out of these is selected as cluster head. The cluster head is responsible for the communication with the nodes outside the cluster.

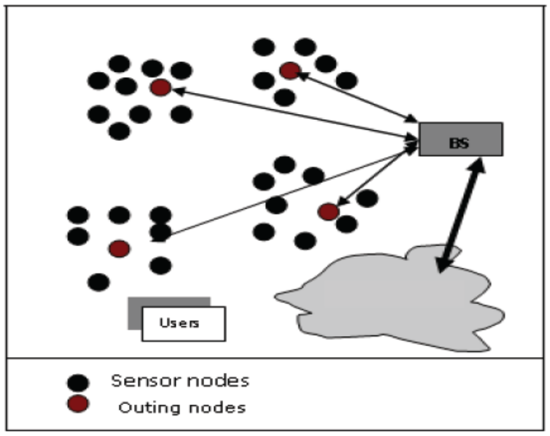

Figure 1: Wireless Sensor Network Structure

The most prominent method to divide the nodes of a WSN in to clusters is LEACH (Low Energy Adaptive Clustering Hierarchy) [1]. To reduce energy of wireless sensor network LEACH protocol has been used. It introduces concept of rounds. The aim of leach is to design the nodes into clusters and evenly distribute the energy among the sensor nodes in the network. In each cluster there is an elected node called cluster head or gateway.

Recent advances in wireless communication technologies have enabled the development of large-scale wireless sensor

Pragati Tiwari, M.Tech Student, Dept of Electronics and Communication Engineering, , Institute of Engineering and Technology, RMLU, Ayodhya, India.

Ramesh Mishra, Assistant Professor, Dept of Electronics and Communication Engineering, , Institute of Engineering and Technology, RMLU, Ayodhya, India.

network that consist of many low-powers, low-cost and small-size sensor nodes. Sensor network hold the promise of facilitating large-scale and real-time data processing in complex environments. Key management is crucial to the secure operation of wireless sensor network.

II. Literature Review

A. Ahlawat et al. [1] has proposed a new technique in which concept of Vice Cluster head has been taken out. Vice Cluster head has been selected as alternate head that has worked when the cluster head has fallen down. Criteria for the selection of vice cluster head have set up on the basis of three factors i.e. Minimum distance, maximum residual energy, and minimum energy. Improvement in the network life has been obtained because of the cluster head has not dead ever. As a cluster have head has been died it has been replaced by its vice

Cluster head. Bakr et al. [2] have made focus mainly on extending the WSN lifetime. Lifetime has been extended by making WSNs redundant by adding spare nodes. The passive (switched off) spares has been made available to become active (be switched on) whenever any active WSN node energy exhausted. A new proposed LEACH-SM (LEACH Spare Management) has modified the prominent LEACH protocol by enhancing it with an efficient management of spares. Addition of the spare selection phase has been done in LEACH; this functionality has been named as spare management features in LEACH-SM. During Spare Selection phase, each node has been decided in parallel whether it would be become an active primary node, or a passive spare node.

The nodes decided spares go asleep, while the WSN as the whole has been maintained the required above-threshold target coverage. (The spares have awakened when the probability that any primary node exhausted its energy reaches a predefined value.) Identification of spares alone has been increased energy efficiency for WSNs as proved, Decentralized Energy efficient Spare Selection Technique has been used in spare selection phase by spare manger. Reduction in the duration of the active interval for cluster heads has been observed, considered as a side effect. Reduction energy consumption by cluster heads has been observed mainly.

Chen and Wang (2012) [3] have explained an improved model in WSN which has been based on heterogeneous energy of nodes for same initial energy and multiple hop data transmission among cluster heads is proposed.

New threshold has been introduced on the basis of current energy and average energy of the node to cluster head election probability and provide reliability that higher residual energy have greater probability to become cluster heads than that with the low residual energy. Problem of number of cluster heads reduces with the increase of the number of rounds. Confirmation has been provided with the approach that nodes with higher residual energy have greater probability to become cluster heads than that with the low residual energy. Extension in the network lifetime and guarantees a well distributed energy consumption model been demonstrated.

III. Clustering

Manufacturing of cheap wireless sensor nodes having sufficient computation and transmit- ting/ receiving powers are available now. Hence hundreds of nodes can be deployed in a network for any required application. These sensor nodes have a limited power which must be utilized in very precise manner to increase nodes life. No doubt efficient circuit is necessary for efficient use of energy, however, routing protocol running on the network plays a vital role in bandwidth consumption, security and energy conservations as well (considering WSNs).

WSN is large scale networks of small embedded devices, each with sensing, computation and communication capabilities. They have been widely discussed in recent years. Micro-Electro-Mechanical System (MEMS) sensor technology has facilitated the development of smart sensors, these smart sensors nodes are small devices with limited power, processing and computation resources. Smart sensors are power constrained devices that have one or more sensors, memory unit, processor, power supply and actuator. In WSNs, sensor nodes have constrained in term of processing power, communication bandwidth, and storage space which required very efficient resource utilization. Clustered [1] sensor networks can be classified into two types, homogeneous [10] and heterogeneous wireless sensor networks. In a homogeneous network, all the nodes are identical in terms of energy. On the other side, in a heterogeneous network, different types of nodes in terms of energy levels are used.

Clustering drastically reduces the energy consumption and improves the network lifetime. In this approach different protocols are used. The protocols for such types of networks must be energy efficient due to non-replacement of batteries in nodes after its deployment. Protocols are classified into two categories according to their applications, proactive protocols and reactive protocols. In former, sensor nodes sense the data from different locations and continuously transmit that data to the cluster head, then cluster head transmits to the base station either it is needed or not, while in later, the cluster head transmits the data only if there is a drastic change in the sensed value.

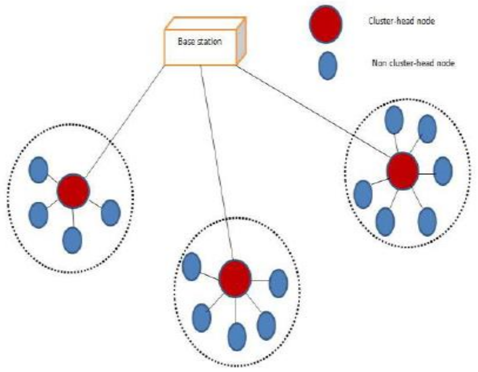

Figure 2: Cluster based wireless sensor network

Clustering is mainly divided into three phases: cluster head (CH) selection, cluster formation and data transmission. The first part is CH selection, in which cluster heads are elected on the basis of the probability of being a cluster head [3]. Once the cluster head is elected, it broadcasts advertisement to the nodes to form a cluster formation; the sensor nodes in the cluster send their sensed value to the cluster head during their time slots. The cluster head receives all the data from sensor nodes and aggregate it before transmitting to the sink. Clustered sensor networks can be classified into two categories in terms of energy. In a heterogeneous network, different nodes are at the different energy levels while in a homogeneous network, all the nodes are having the same energy levels

In routing protocols, cluster head election reduces energy consumption and enhances the network life time. Classical approach like direct transmission (DT) and minimum energy transmission (MTE) does not guarantee well distribution of energy load of sensor nodes.

IV. LEACH Schemes

Low-Energy Adaptive Clustering Hierarchy is one of the most popular clustering approaches for WSN. It is an application specific architecture. In LEACH, the nodes organize themselves into local clusters, with one node acting as the cluster head and others as member nodes. All member nodes transmit their data to their respective CH, and on receiving data from all member nodes the cluster head performs signal processing functions on the data (e.g., data aggregation),and transmits data to the remote BS. Therefore, being a CH node is much more energy intensive than being a member node.

The main objective of leach is to select sensor nodes as cluster heads by rotation. In this way, the energy load of being a cluster head is evenly distributed among the nodes. The operation of LEACH is divided into rounds. Each round begins with a set-up phase followed by steady state phase. In the set-up phase the clusters are organized, while in the steady-state phase data is delivered to the BS. Initially CH is selected, based on the signal energy of nodes. The nodes with higher energy are selected as CH.

Each sensor node n generates a random number between 0 and 1 and compares it to a pre-defined threshold T (n). If random<T (n), the sensor node becomes CH in that round, otherwise it is member node. Where P is the desired percentage of CHs, *r* is the current round, and *G* is the set of nodes that have not been elected as CHs in the last 1/ *P* rounds. LEACH is a completely distributed approach and requires no global information of network. LEACH can guarantee not only the equal probability of each node as CH, but also relatively balanced energy consumption of the network nodes.

However, there exist a few disadvantages in LEACH as follows:

1) LEACH assumes a homogenous distribution of sensor nodes in given scenario, which is not very realistic

2) Some clusters will be assigned with more number of nodes; this could makes CH nodes run out of energy quickly.

3) CH has the extra burden of performing long range transmission to the distant BS, which results in too much energy consumption. Various modifications have been made to the LEACH protocol, which form LEACH family, such as TL-LEACH, E-LEACH, M-LEACH, LEACH-C, V-LEACH, etc

V. System Description

We have considered a heterogeneous network. A heterogeneous network is one in which all the nodes does not it have equal energy. Let us assume that the total number of nodes is n & m fraction of the nodes has α time more energy than the other nodes. They are called as advanced nodes.

Therefore, Number of normal nodes = (1-m) x n Energy per normal node = e_o Number of advanced nodes = m x n Energy per advanced node = e_o x (1 + α)

Hence the total energy of the network = ((1-m) x n) x e0 + (m x n) x (e_o x (1 + α)) In this approach the same procedure as in the normal LEACH protocol is followed i.e., the formation of the clusters is same in this heterogeneous system and also the cluster head selection by comparing the residual energy of the individual in every round. The structure of the proposed Leach-Heterogeneous system for wireless sensor networks is shown in Fig. 4.

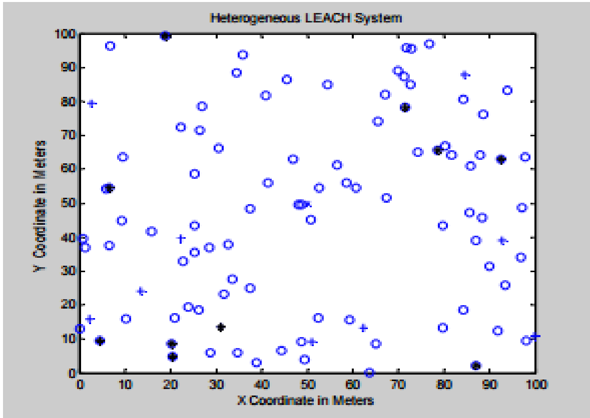

Figure 4: Proposed Heterogeneous LEACH System "+" symbol indicates advance Node

VI. PROPOSED ALGORITHM

We present details about proposed protocol ETSSEP. It is based on TSEP [9]. ETSSEP is a cluster based reactive routing protocol with three level of heterogeneity. For three levels of heterogeneity, nodes with different energy levels are: advance nodes, intermediate nodes and normal nodes.

The energy of advance nodes are greater than all other nodes and a fraction of nodes which have more energy than normal node and less energy than advance nodes are called intermediate nodes, while rest of the nodes are called normal nodes

The main objective of these algorithms is to design mechanisms that prolong network lifetime by employing mobile sinks to gather information from the sensors. Assume that β = α/2. In ETSSEP the total energy distributed over different types of nodes is computed.

For normal Node:

$$E_{nrm} = n.b.(1+\beta) \quad (1)$$

For Intermediate Node:

$$E_{int} = n.(1-m-bn)\, E_o \quad (2)$$

For Advance Node:

$$E_{adv} = n.m(1+\alpha)\, E_o \quad (3)$$

Total energy E total for all the nodes is calculated as

$$\begin{aligned} E_{total} &= n \cdot (1 - m - bn) \cdot E_0 + n \cdot m \cdot (1 + \alpha) \cdot E_0 + n \cdot b \cdot (1 + \beta) \\ &= n \cdot E_0 (1 + m \cdot \alpha + b \cdot \beta) \end{aligned} \quad (4)$$

Where, m and b denotes the advance nodes and intermediate nodes fraction of total number of nodes n.

VII. RESULTS

A set of experiments is conducted to test the performance of schemes, we consider the above network features and parameters, ETSSEP is implemented and examined using MATLAB. We considered two scenarios for simulation. Initially, the experiment is performed with diverse number of nodes ranging from 25 to 400 placed in 100 m 9 100 m area. Each sensor node is assumed to have initial energy 0.5 J. Next we compare the performance of ETSSEP with Stable Election Protocol (SEP) and Threshold Sensitive Stable Election Protocol (TSEP). In comparisons, we consider 100 sensor nodes placed in 100 m 9 100 m area. In both scenarios, the position of the base station is taken in the middle of the sensing area, and the performance of protocols is given in terms of stability period, network lifetime and throughput.

In this heterogeneous wireless sensor network, we use radio parameters which are shown in Fig. 1 for deployment of different protocols, and estimate the performance of three level of heterogeneity.

Figure 3, It describes the stability of ETSSEP, and it clearly shows that as we increase the number of nodes the stability of protocol changes randomly. When there are 25 nodes its stability is highest, it falls steeply from 25 to 50 nodes, then it rises uniformly from 50 to 100 nodes, thereafter it remains almost constant from 100 to 200 nodes, and then after 200 it drastically fall down.

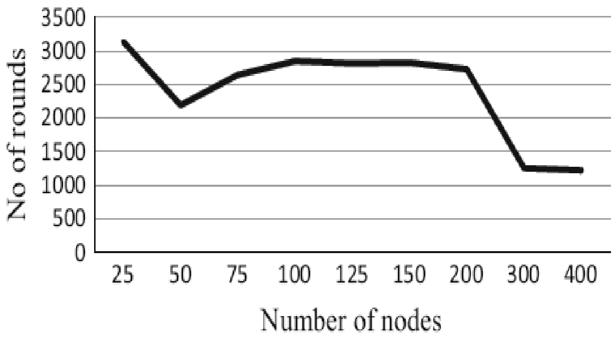

Figure 3: Stability of ETSSEP after incrementing number of nodes

Figure 4, It describes the life span of ETSSEP as we increase the number of nodes successively, and shows that at 25 nodes life time of network is highest, between 50 and 100 nodes life time increases uniformly, thereafter it remains almost unchangeable from 100 to 200 nodes but then after 200 it decreases very gradually.

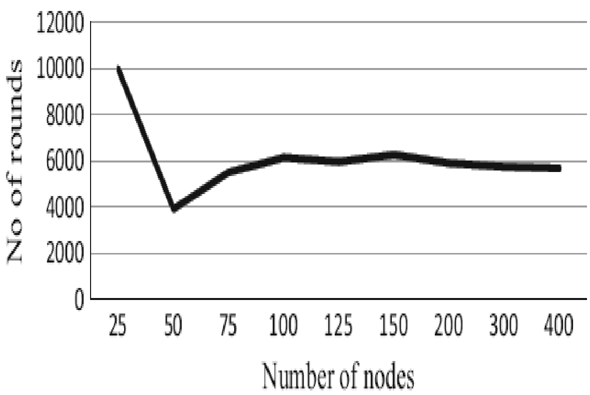

Figure 4: Life-span of ETSSEP after incrementing number of nodes

Figure 5**,** It displays the throughput of the ETSSEP. The throughput of protocol increases gradually from 25 to 150 nodes, and thereafter the increase in throughput are rising steeply.

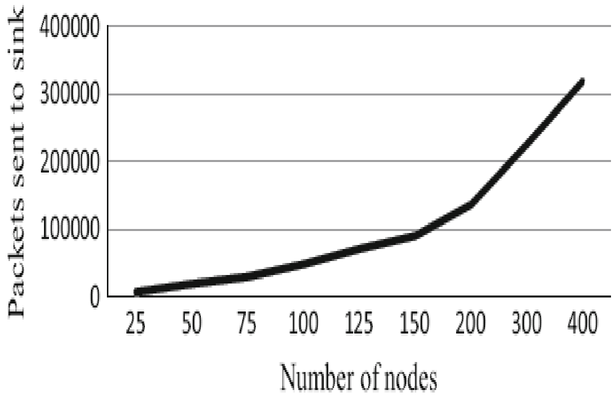

Figure 5: Number of packets sent to base station (throughput) of the ETSSEP

Figure 6 shows the number of alive nodes per round, it shows that nodes die more slowly in ETSSEP in comparison to other two protocols discussed in this paper. In SEP, TSEP and ETSSEP the first node die at the round number 974, 2068 and 2762 respectively.

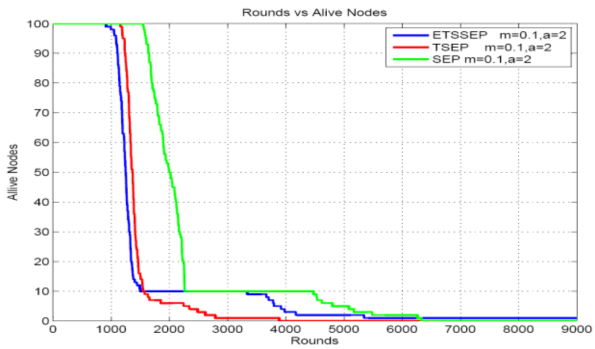

Figure 6: Number of alive nodes during rounds

Figure 7 shows the number of dead nodes over the number of rounds, it shows that in SEP, TSEP and in ETSSEP all nodes die after 1667, 4908 and 6763 number of rounds respectively.

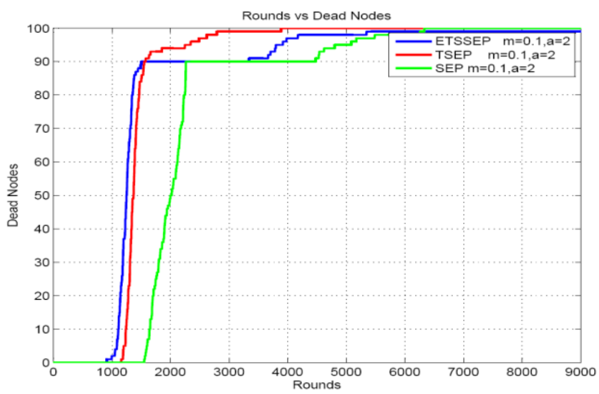

Figure 7: Number of dead nodes during rounds

Figure 8 Describes the number of packets sent to the base station, and clearly specify that throughput of ETSSEP is far better than SEP and TSEP. The number of packets sent to the base station in SEP, TSEP and ETSSEP are 23,715, 25,000 and 48,000 respectively.

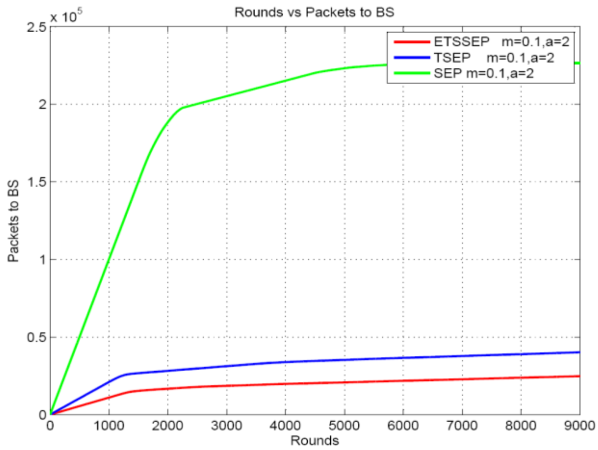

Figure 8: Throughput of the protocols

VIII. Conclusion

Stability period and network life time is one of the key issues for designing the WSN protocols. In this paper, energy aware reactive routing protocol for heterogeneous networks (ETSSEP) presented and compared with SEP and TSEP. ETSSEP increases he stability period and network lifetime of sensor networks as 33.5 and 37.79 % in comparison to TSEP, and more than twice and about thrice in comparison to SEP. In addition to this it is also analyzed that the performance of ETSSEP in terms of stability, network lifetime and throughput with number of nodes successively in the same environment. The proposed protocol is best suited for the WSN environment.

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Pragati Tiwari, M.Tech Student, Dept of Electronics and Communication Engineering, , Institute of Engineering and Technology, RMLU, Ayodhya, India.

Ramesh Mishra, Assistant Professor, Dept of Electronics and Communication Engineering, , Institute of Engineering and Technology, RMLU, Ayodhya, India.