

# A Novel Approach to Energy Efficient Three – Level Co - Centric Clustering Heterogeneous Routing Protocol for Wireless Sensor Network (EETCHR)

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Received 14 September 2018 ▪ Revised 23 October 2018 ▪ Accepted 24 November 2018

**Abstract:** With growing innovation in ubiquitous computing, WSN and IoT's have become the hot topic of research in the past few years. WSN's generally grouped into two groups, first one is Homogeneous WSN, comprises of similar types of nodes and second one is Heterogeneous WSN includes several and different types of sensor nodes. In this paper, an improved version of an energy efficient three-level hierarchical heterogeneous based routing protocol is proposed where cluster heads are elected among super nodes, advanced nodes and less advanced ones using the method of weighted election probability. Within the network nodes are utilized in a co-centric circle. In this paper, sensor nodes get accommodate their positions in three-level hierarchical manner. The major purpose of this protocol aims to improve the network lifetime and stability period in order to minimize the communication cost. The simulated results of proposed protocol are evaluated with SEP protocol using MATLAB.

**Keywords:** Three-level, Energy- Efficiency, Heterogeneous, Hierarchical, Clustering, Routing Protocol, WSN.

## INTRODUCTION

The micro-sized electro-mechanic devices known as sensor nodes are accountable for sensing, communicating and aggregating the data among other nodes present inside or outside the network [1]. Every sensor node comprised of a processing unit, memory resources and power batteries. The size of each sensor node is variable based upon the operational area. WSN have an extensive series of applications in different area, For Example, military applications for monitoring and surveillance in the battlefield, in case of tracking and monitoring in an ecological region, for habitat monitoring applications and industrial based applications [2]. Generally, thousands of sensor nodes are placed in application areas to implement the network structure. Sensor nodes can communicate to another node and base station using single-hop communication (directly to the base station) or can communicate using multi-hop via CH(Cluster Head ) or another intermediate node. The CH accumulates the data from different nodes and transmit the complete message further to sink node, as depicted in Figure 1. Homogeneous WSN composed of similar types of sensor nodes having similar attributes and infrastructure, whereas in case of Heterogeneous network consist different types of sensor nodes with un-familiar attributes like energy resources, node type etc. The sensor nodes communicate and aggregate the information via un-rechargeable batteries. These un-rechargeable batteries get charged before deployment, if the battery is left with no more energy than the network will not be functional anymore, which is the most important flaw in the network constitution of WSN. Eventually, the goal of specific routing based protocol must be to maintain the sensor network alive for a maximum span of time such that network can become energy efficient. Clustering based routing protocols are very much valuable to compose the network energy efficient and to enhance the system life span. Till now, a lot of clustering based routing protocols which had been suggested for two of them Homogeneous as well as Heterogeneous WSN. But out of them, Heterogeneous routing protocols have proved to be advantageous over Homogeneous WSN [3].

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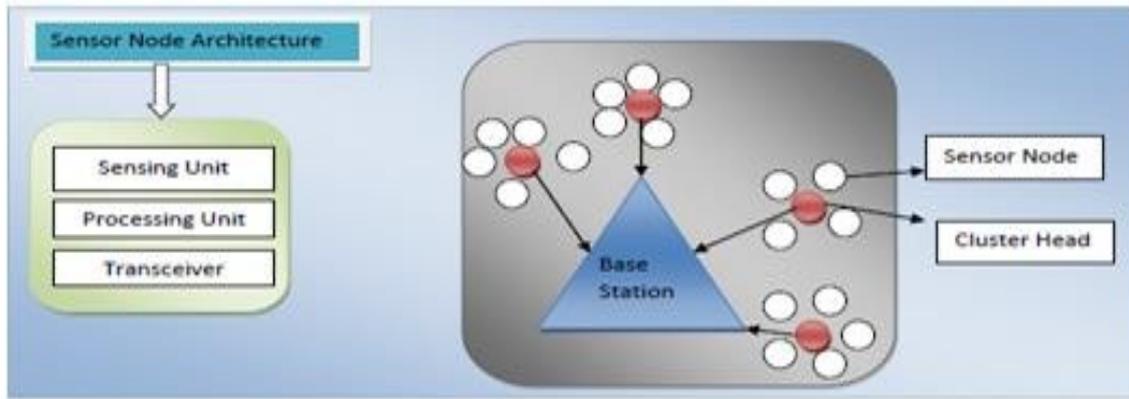


Fig. 1: Network Architecture of WSN

Here in this text, a constructive energy efficiency approach for routing the data has been introduced. The proposed clustering protocol is the enhanced version of LEACH and SEP protocol where three-level hierarchical approach is used, where at each level three types of heterogeneous nodes are there. The node having highest amount of remaining energy, is nominated as the CH for communication and aggregation. EETCHR protocol follows the same energy model as used in Homogeneous WSN. It is assumed that every node send and receive the data within the range of transmission. According to radio energy model two types of transmission energy model were introduced one is a free space model and the second is a path loss model [4]. Assuming that there is a threshold distance  $d_o$ , such that if packets are transmitted within the range of  $d_o$ , then path loss exponential is  $d^2$  also amplifier energy will be  $\epsilon_{fs}$  and if the range is exceeded, then distance is  $d^4$  also amplifier energy will be  $\epsilon_{mp}$ . Now, every node during the transmission of data packets requires some transmission energy, i.e.  $T_z$  and receiving energy i.e.  $E_x$  is the energy expended by radio in equation 1.

$$E_x(n, d) = \begin{cases} n \cdot E_{elc} + n \cdot \epsilon_{fs} \cdot d^2; & d < d_o \\ n \cdot E_{elc} + n \cdot \epsilon_{mp} \cdot d^4; & d \geq d_o \end{cases} \quad (1)$$

$n$  number of bits to transmit over distance  $d$  and  $E_{elc}$  is energy degenerated for execution of transmitter and receiver circuit.

This paper is structured into majorly five sections. First section demonstrates the introduction as well as motivation to the research work. In successive section the related work of previous research study in the field of energy efficient protocols are discussed. Section 3 explains the proposed multilevel hierarchical based routing protocol with conceptual theory. Section 4 illustrates the results. In last section present the conclusion of the work and discusses future scope of the proposed protocol.

## RELATED WORK

Till now, many protocols suggest the energy consumption techniques for routing the data inside the network, since data communication and aggregation is the basic task for every sensor node. Thus, mainly routing protocol come across for energy consumption and network lifetime issues arises inside the network. The first hierarchical routing protocol was LEACH (Low Energy Hierarchical Clustering) Protocol [5]. This protocol has many advantages over classically used protocols like DT and MTE protocol. LEACH is based upon the basic concept of stochastic algorithm where nodes are elected a CH amongst them randomly, in such a way, so as, if chosen number of the node is lesser than the threshold value than the node is nominated as the CH. The elected CH accumulates data from each node then transmits it to sink node. Here the probability distribution method among  $n$  nodes in equation 2.

$$Th(n) = \begin{cases} \frac{p_R}{1 - p_R^{(R \cdot \text{mod} \frac{1}{R})}} & \text{if } si \in S, \text{ else} \\ 0 & \end{cases} \quad (2)$$

$Th$ , is the threshold value of  $n$  nodes, where  $n$  is defined as amount of nodes,  $Pr$  defined as probability for every CH, count of every round is denoted by  $R$ ,  $S$  is defined as the every remaining nodes which was not assigned CH in last  $1/R$  number of rounds.

The first two-tiered heterogeneous protocol, SEP has extended form of LEACH [6]. In SEP [7], Type-1 nodes (normal nodes) having low energy and computation power as compared to type-2 nodes (advanced nodes) deployed. Type-2 nodes have  $(1+\alpha)$  amount more initial energy  $E_o$  in comparison with

normal nodes, assuming that, advanced nodes fraction comes out to be  $m$  out of  $n$ , sensor nodes inside the network. SEP follows the same energy model used for LEACH protocol for transmission and receiving of data. If  $P_n$  is denoted as normal node's probability also  $P_{av}$  defined for advanced nodes. Then the probability of election of cluster heads for normal and advanced nodes is stated in equation 3 and 4 as illustrated below.

$$P_n = \frac{P_o}{(1+\alpha m)} \quad (3)$$

$$P_{av} = \frac{P_o(1+\alpha)}{(1+\alpha m)} \quad (4)$$

CMHT [8] is multi-hop transmission protocol proposed to remove the flaws of LEACH protocol. This protocol uses two types of nodes, First types of nodes are those who cannot transfer the data directly to sink and another type of nodes include the direct transmission of data to sink. The second type of nodes is generally more powerful than the first type of nodes. This protocol is different from earlier protocols as it used weighted probability method for election of cluster heads.

EECDA [9] is not only energy efficient protocol, but also focus on the data aggregation mechanism. This protocol introduces 3-level heterogeneity in the network to overcome the disadvantages of existing protocols. The initial energy of nodes are defined by equation 5.

$$E_i \times (1+a) \text{ and } E_i \times (1+b) \quad (5)$$

Assume that advanced nodes and super nodes have  $a$  and  $b$  times more energy than the normal node. Also  $N$ ,  $M$ ,  $M_i$  is the number of normal and advanced nodes. The total initial energy of the new heterogeneous network setting is given by equation 6.

$$N \times E_i \times \{(1-M) + M \times \{(1-M_i) \times (1+a) + M_i \times (1+b)\}\} = N \times E_i \times (1 + M \times (a - M_i \times (a-b))) \quad (6)$$

CH election is based upon weighted election probability also route is selected for transmission of energy.

ATEER is explained in [10] is 3-level heterogeneous WSN with super advanced, advanced, normal nodes. The Radio energy model is used for communication to the base station and network model is used for deploying the nodes inside the network. Here every sensor nodes are static by nature the communication between the sensor nodes and CH. As in other protocols after the cluster formation, CH sends the message to other members for joining the respective cluster within communication range. The proposed algorithm performs better as compared with DEEC, EDEEC, EEHC. This proposed algorithm is for reactive and proactive network environments. But performance indicates this protocol doesn't perform better for the optimal number of CHs.

## THE PROPOSED PROTOCOL

This is an enhanced version of LEACH protocol where sensor nodes have different capabilities for sensing, storing and computing, as compared to LEACH protocol. The three-level clustering protocols composed of the hierarchical structure in which normal, advanced and super nodes are deployed within circular network structure nodes are deployed randomly inside the network. In set-up phase, clusters are formed in a similar technique as in LEACH.

The election of CH among all the layers is done by the Weighted Election Probability method. After cluster arrangement, CHs are elected from three types of heterogeneous nodes which acquiring the highest amount of residual energy. In every round residual energy is calculated and CH is elected with higher residual energy.

In LEACH protocol if CH dies the sensor nodes become unable to send the data, but in this case, our protocol completely overcomes the LEACH as well as SEP in case of parameters like network lifetime, packet delivery ratio and average energy utilization. So, this approach takes the advantages of both SEP and LEACH protocol as well this protocol is not restricted to only three level multi-level nodes can be engaged.

This co-centric hierarchical approach reduces the communication cost and minimizes the delay. According to the protocol network is divided into three-level concentric circle. In each co-centric circle the nodes are equally divided as per assumption. In this protocol the main advantage is that load is uniformly divided among entire nodes inside the network where as, structure of proposed algorithm is shown in Figure 2.

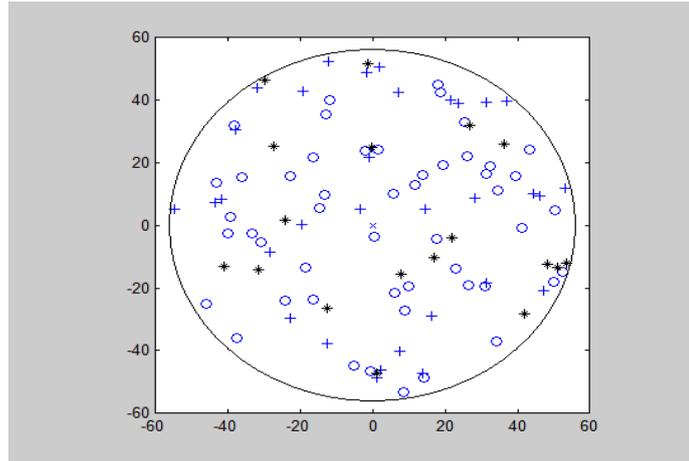


Fig.2: Simulated Network Structure the parameters used for proposed technique are demonstrated in the Table 1.

Table 1: The parameters used for proposed protocol

S.No	Parameters	Values
1.	Number of Nodes	100
2.	Network Size	60*60
3.	Base Station	30,30
4.	Radio Propagation speed	3*10 <sup>8</sup> m/s
5.	Initial Energy	0.5μj

### RESULTS

To verify the performance of EETCHR, simulation of protocol is done in MATLAB and comparing it with known heterogeneous protocols LEACH as well SEP. For this, 100 nodes are deployed randomly in the area of 60\*60m. The experiments were conducted for 3000 number of rounds. The parameters used for evaluating the efficiency is throughput, packet delivery ratio, network lifetime, stability period, average energy utilization. In this paper, the energy efficiency scheme is presented based upon weight election protocol. The comparison is done between the SEP and EETCHR as shown in Figure 2, 3, 4 and 5. It has been observed that with the increase in energy heterogeneity first nodes die and average energy utilization is better. Figure 2 shows the throughput of the simulated network per round. Figure 3 shows that packet to CH per round. Figure 4 shows that number of nodes alive as per each round and figure 5 displays that number of CHs per round.

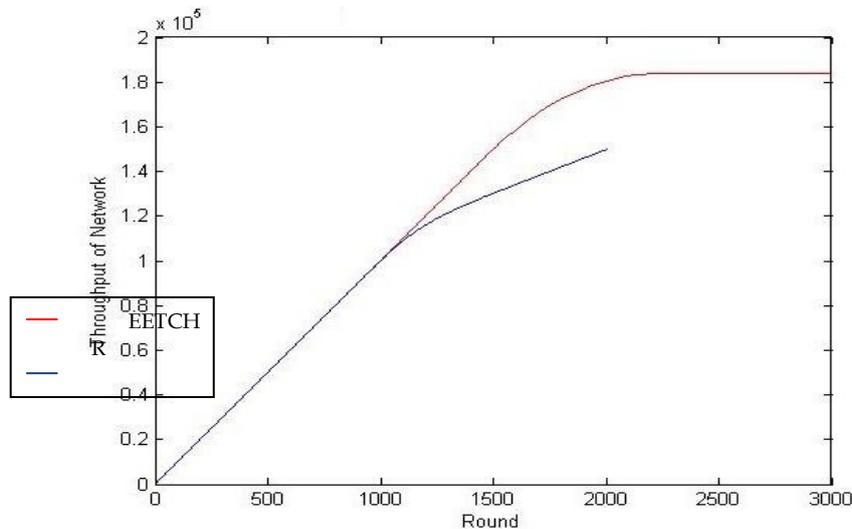


Fig. 2: Throughput of the network per round

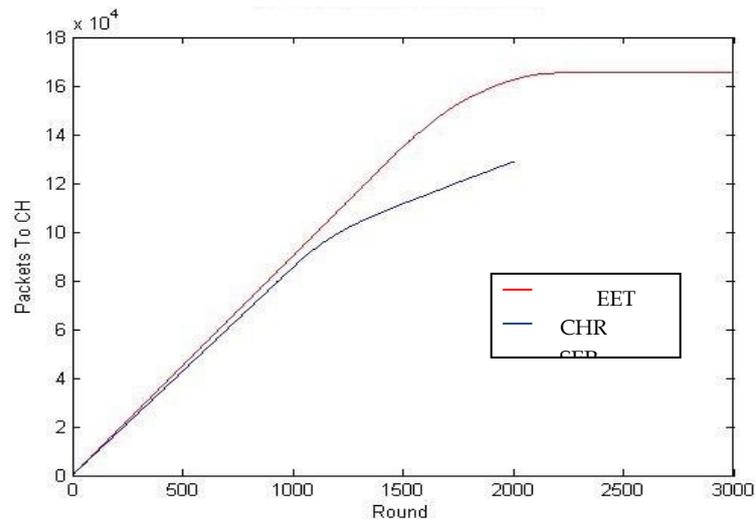


Fig. 3: Packets to CH per round

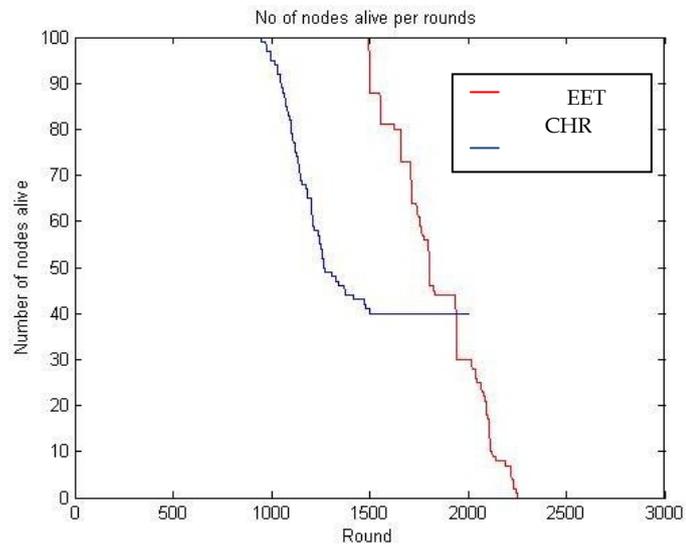


Fig.4: Number of nodes alive per round

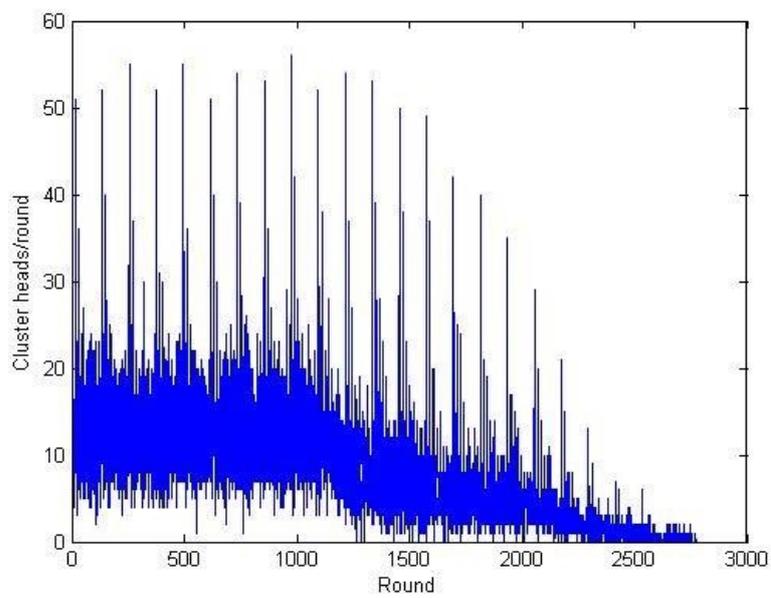


Fig.5: Cluster Head per round

## CONCLUSION AND FUTURE SCOPE

Due flexibility in network structure, high sensitivity, high stability and better network lifetime are the certain factor through which area of interest has been increased in various application domains [11]. With the increase in the advancement of sensor technology in the era digital computing, consumption of energy as well as balancing the load inside the network are the major problems. This paper focuses on the energy efficiency and network lifetime of the network. Here, optimal CH is elected using weighted election probability of all the nodes. The experimental results have proved the proposed protocol performs better as compared to other protocols. In future, the work will be extended up to k-level heterogeneous nodes, also will extend our work on multiple mobile cluster-head and mobile sink for more energy efficient network structure.

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