Performance comparison between EEE-Leach and EECCRP in Wireless Sensor Networks

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Abstract— *In this paper, we have proposed an energy efficient cooperative communication routing protocol (EECCRP) which is an enhancement over EEE-LEACH protocol. Only two parameters were considered in previous work i.e. energy and distance. EEE-LEACH protocol has some limitations like it used chain based communication, also it does not use any chain formation techniques. Hence low energy nodes in the chain will die sooner thereby breaking the chain and isolating the cluster information from the networks. EECCRP considered three parameters-energy, distance and node density. Energy efficient clustering is being adopted. Hence, this protocol increased the reliability of the network, Reduces the energy consumption of nodes. Adds scalability to the network as chain based topology is not favored for large area network.*

Keywords— Energy, Distance, node density, EECCRP, EEE-LEACH, Chain Based.

I. INTRODUCTION

Wireless sensor networks (WSNs) may comprise of several thousands of homogeneous or heterogeneous sensors that may collect reliable and sense correct information in distant and dangerous environments. Wireless Sensor Networks are generally assumed to be energy restrained because of sensor node's small operating power capability. DC supply or replacement of its energy source is not possible. Most commonly battery is employed to supply electricity to the deployed nodes, therefore it's important to route the motes to efficiently utilize its power. A basic wireless sensor network requires very small infrastructure. In one such network, nodes can be deployed in an ad hoc fashion. However, the sensor network deployed to sense information from the environment may require a large number of sensor nodes, depending on the area to be covered. Due to large numbers of nodes the management of network becomes difficult, and sophisticated structure is needed.

There are various methods of topology to cluster the deployed nodes in a network and how data aggregation can takes place between the deployed nodes. These sensor nodes are energy constrained and the sensor nodes can perform information aggregation in order to use energy efficiently. The energy required to send data depends on the distance between the nodes and the number of bits which are being transmitted. The energy required for receiving the data also depends on the number of bits being received. The energy required for transmitting and receiving the data can be outlined as in below equations.

$$E_{tx}(l, d) = lE_{elc} + lE_{efs}d^2 \text{ for } d<d_o \quad (1)$$

$$E_{tx}(l, d) = lE_{elc} + lE_{efs}d^4 \text{ for } d>d_o \quad (2)$$

$$E_{rx}(l) = lE_{elec} \quad (3)$$

The process of data aggregation also consumes some energy given by equation (4).

$$E_{dx}(l) = mlE_{da} \quad (4)$$

Where E_{elec} is the energy being dissipated to run the transmitter, E_{amp} is the energy dissipation of the transmission amplifier,K is the length of the message in bits, d is the distance between transmitter and receiver.

If data collected by many nodes is same. In such cases, redundant data transmission can be eliminated by forming group of nodes called clusters and by electing one node among the nodes in the cluster to be cluster head. All nodes can send data to the cluster head where the aggregation of data can takes place.

Clustering techniques depends upon the type of network. In homogeneous sensor networks, homogeneous clustering schemes is adopted, and the clustering technique applied in the heterogeneous sensor networks is so called as heterogeneous clustering schemes. If we have used fixed node as the cluster head, then it has to collect data from all of its child nodes and has to process the data for all the time period. This leads to faster battery drainage in the fixed cluster head. Even if one cluster head dies, it will affect the working of the network. By choosing dynamic cluster head, this problem can be eliminated. LEACH is one of the clustering protocol for wireless sensor network which consider homogeneous sensor networks where all sensor nodes are designed with the same battery energy. PEGASIS, HEED are also clustering algorithms.

LEACH (Low Energy Adaptive Clustering Hierarchy) which is the first protocol of hierarchical routing which

proposed data fusion, it has vital significance in clustering routing protocol.

All the nodes in a network combine together to form cluster, with one node selected as cluster head. All other member node of that cluster transmit their data to the cluster head, while the CH node receive data from all the cluster members, aggregate the data, perform signal processing functions on aggregated data and communicate data with remote base station. Therefore, being a cluster head node is much more energy intensive than being a non-cluster head node. Thus, when a cluster head node dies, all the nodes that belong to the cluster lose communication. The problem of LEACH protocol is balance the energy consumption, network energy consumption.

LEACH minimize the communication energy that is dissipated by the cluster heads and the cluster members as much as 8 times when compared with direct transmission and minimum transmission energy routing.

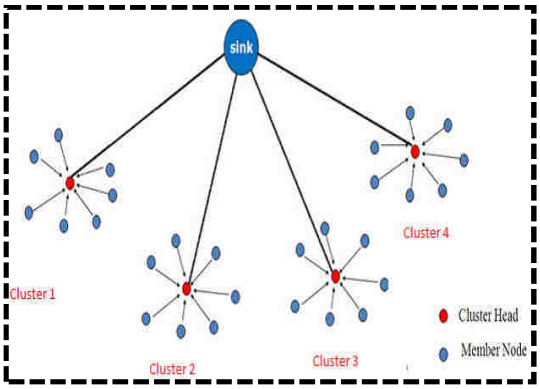

Fig. 1: LEACH Protocol

LEACH incorporates randomized rotation of the high-energy cluster-head position such that it rotates among the sensors in order to avoid draining the battery of any one sensor in the network. In this way, the energy load associated with being a cluster-head is evenly distributed among the nodes. Since the cluster-head node knows all the cluster members, it can create a TDMA schedule that tells each node exactly when to transmit its data. In addition, using a TDMA schedule for data transfer prevents intra-cluster collisions. The operation of LEACH is divided into rounds. Each round begins with a **set-up phase** when the clusters are organized, followed by a **steady-state phase** where several frames of data are transferred from the nodes to the cluster-head and onto the base station.

In the **set-up phase**, the clusters are arranged and cluster-heads are chosen. In the first round, each node selects a random number between 0 and 1 and compares it to the threshold T(n) given in (5) and if the number is less than a threshold, the node becomes a cluster head.

$$T(n) = \frac{P}{1-P*\left(r*\mathrm{mod}\frac{1}{p}\right)} \text{if } n \in G, \text{ 0otherwise} \quad (5)$$

Where *p* is the desired percentage of cluster heads, *r* is the current round,*G* is the set of nodes that have not been cluster heads in the last 1/p rounds

In each round, selected cluster-heads broadcast an advertisement message to all the nodes in the network, informing their new status. After receiving this message, each of the non-cluster-head nodes can determine to which cluster they belong to based on the strength of the received signal. Then, according to the number of nodes in a given cluster, that cluster's cluster-head generates a TDMA (Time Division Multiple Access) schedule, and broadcasts a transmission time window to its CHs.

TDMA is a scheme where all concerned earth stations use the same carrier frequency and bandwidth with time sharing, non-overlapping intervals.

In the steady state phase. nodes in each cluster can begin sensing the information and transmitting sensed information to their own cluster-head throughout the distributed transmission time. The cluster-head node conducts the data fusion, aggregating, compressing and then sending the aggregated data to the base station. Since the BS is usually far from the field, communicating to the base station will consume a lot of the cluster-heads energy. When the designated transmission time is over, the steady state phase finishes and the network retreats into the setup stage and begins an alternate round, starting with choice of new cluster heads.

II. COMPARISON BETWEEN ARCHITECTURES

The comparison between architectures of EEE-LEACH and the proposed technique is being discussed in the fig. 2. The proposed technique employs the co-operative MIMO technique.

The previous topology used in EEE-LEACH uses chain based topology.

COMPARISON BETWEEN PREVIOUS AND NEW TECHNOLOGY

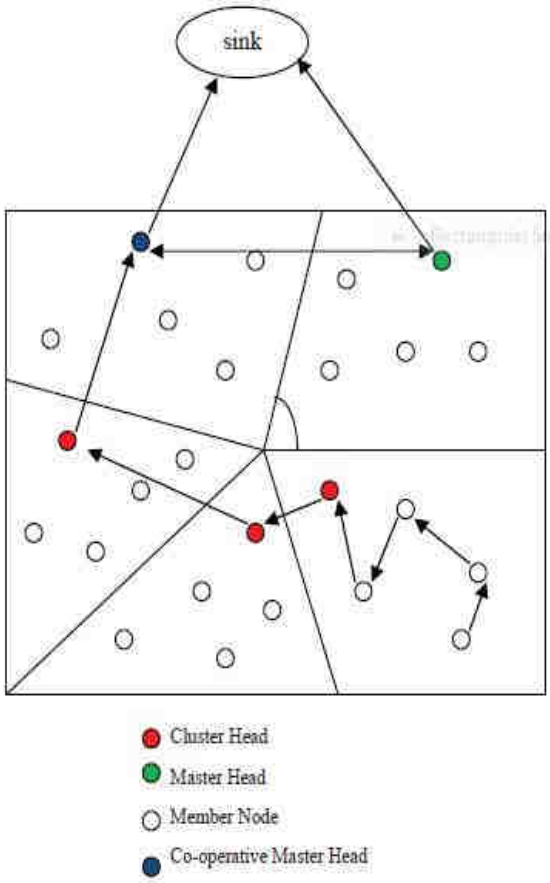

Fig.2: Previous Work

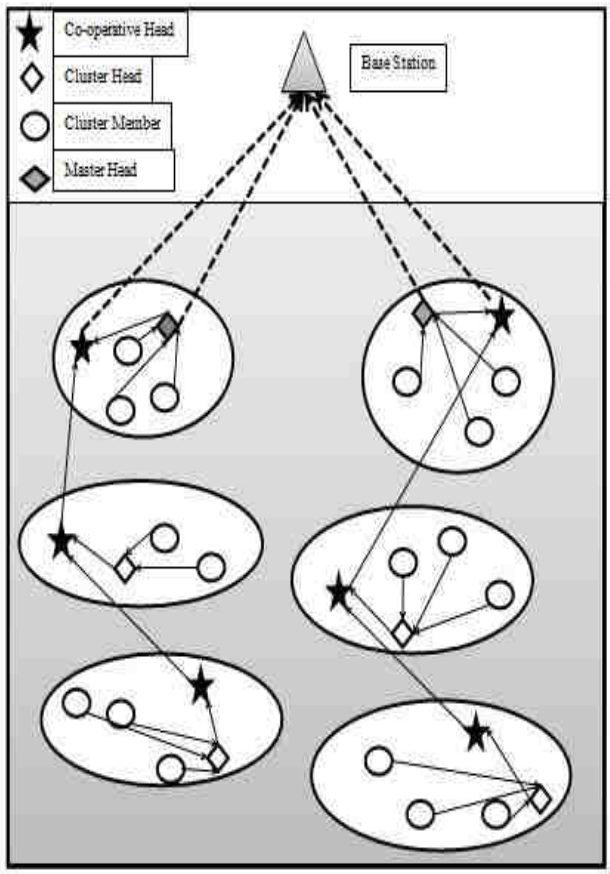

Fig.3: Proposed Co-operative MIMO communication

III. RESULTS AND DISCUSSION

To propose and implement EECCRP is based on LEACH ROUTING PROTOCOL for the selection of cluster head, Master cluster head, Cooperative master head. This protocol is implemented by using parameters Distance, energy and node density. Performance metrics are Network Remaining Energy, Dead Nodes, Alive Nodes and Throughput of network.

Performace metrices and their graphs are shown below. These are Network lifetime, alive nodes vs. rounds, dead nodes vs. rounds and networks throughput.

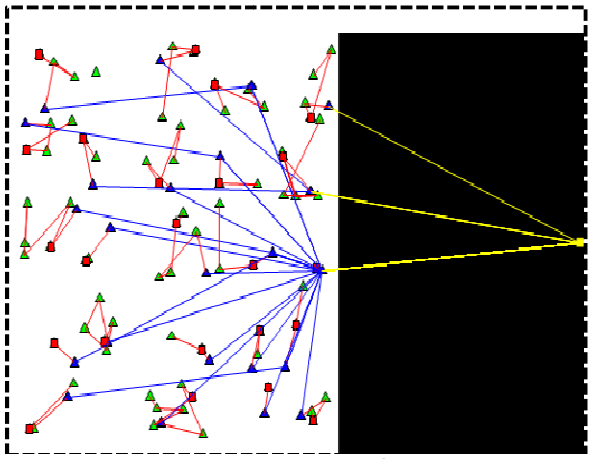

Fig. 4: Simulation Scenarion of EEE-LEACH

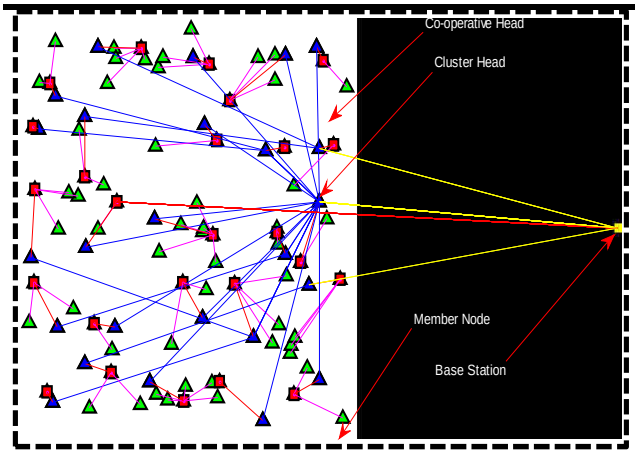

Fig.5: Simulation Scenario of Proposed

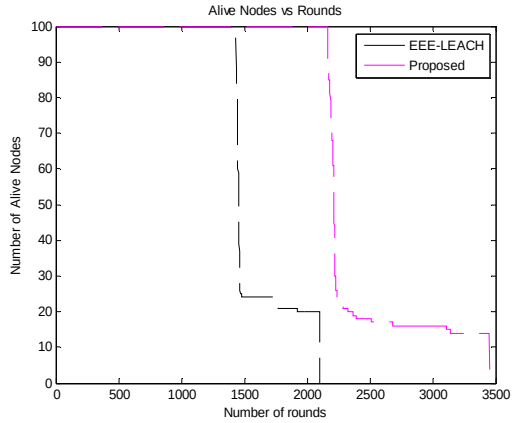

Fig. 6: Graph of Alive Nodes Vs Rounds

In figure 6, alive node vs. rounds is shown. Energy of nodes is consumed considerably and nodes remain alive for long period of time. In the previous work, nodes remain alive till max 2000 rounds whereas in proposed work, nodes play their role till 3500 rounds. Hence it is clearly shown this approach have better results.

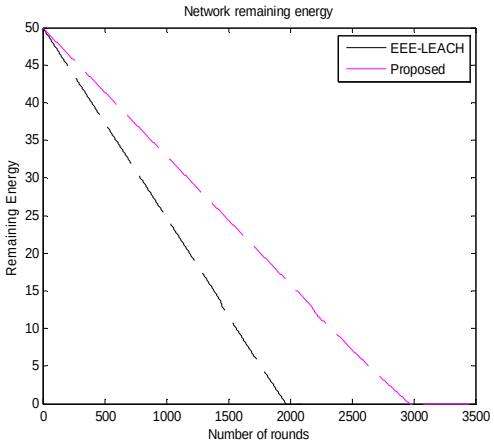

Fig.7:Network's Remaining Energy

In figure 7, Networks remaining energy is shown. By implementing EEE-Leach protocol, Network had energy till 2000 rounds but in EECCR protocol, networks energy is used efficiently and communication took place till 3000 rounds. Hence it is clearly shown that networks residual energy is quite more.

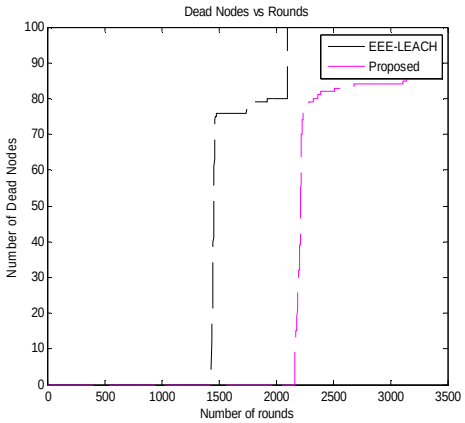

Fig. 8:Graph of Dead Nodes vs Rounds

In figure 8, Dead node vs. rounds is shown, In the previous work, nodes started dying from about 1500 rounds and the whole networks dies at 2000 rounds. On the other hand in proposed work, network dies after 3500 rounds.

By making cooperative head and master head, load of nodes is divided and hence there probability of dying soon also decreases.

In figure 9, throughput of network is shown. Network of previous work give throughput till 2100 rounds and with proposed methodology throughput increased to 3500 rounds.

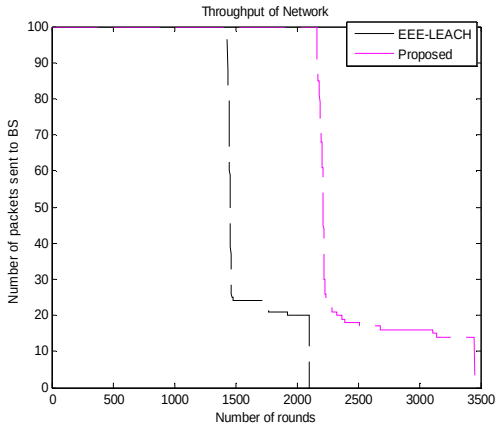

Fig.9: Throughput

Moreover, according to the literature survey, implementation of co-operative clustering and comparison

with existing work has shown that this methodology brings better results.

3.1 Performance Parameters

There are some performance metrics which are taken into consideration for evaluation of proposed protocol. These are following:

a. Stability Period
b. Half Nodes dead
c. Network Lifetime

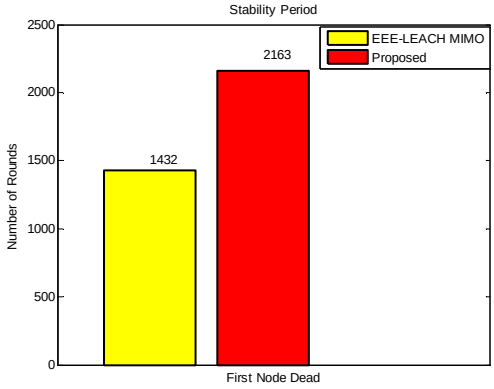

Fig.10: Stability Period

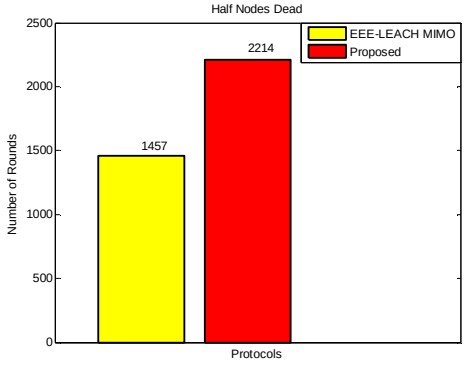

Fig.11: Half Nodes Dead

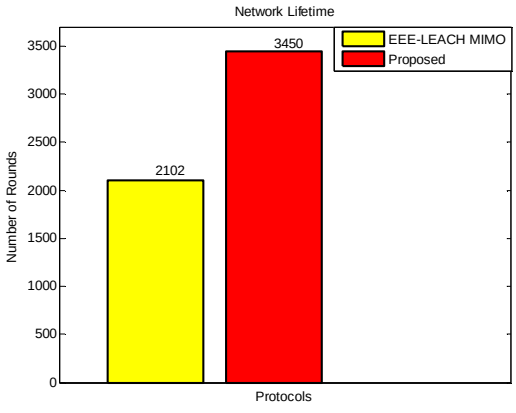

Fig.12: Network Lifetime

It can be seen from the Fig.10-12 that the proposed protocol has outperformed the EEE-LEACH protocol in terms of Stability Period, Half Nodes Dead and Network Lifetime.

Table 1: Comparison of Proposed protocol with EEE-LEACH

Parameters	EEE-Leach	EECCRP	Improvement (%)
Stability Period	1432	2163	51%
20% Dead Nodes	1444	2185	51.31%
HND	1457	2214	52%
80% Dead Nodes	1925	2329	21%
Network Lifetime	2102	3450	64%

IV. CONCLUSION AND FUTURE SCOPE

Wireless sensor network has been making its presence felt almost in every sector of modern era. The one of the most important concern has been routing in WSN which has become significant due to its goal of achieving the enhanced network lifetime. In this paper, the clustering is made efficient by selecting the Cluster Head (CH) which is surrounded by more number of nodes along with the energy. It not only reduces the energy consumption of nodes but also adds scalability to the network. Co-operative communication ensures the energy balancing in the network. Load of each cluster is divided among MH (Master Head) and CMH (Cooperative Master Head). CH will collect the data and inter cluster communication is performed by CMH. It is seen that 64% network lifetime is enhanced by the proposed network topology and stability period is escalated by 51%. So it can be concluded that the proposed protocol outperforms the EEE-LEACH protocol. The future work in the proposed protocol may be extended by the introduction of mobility in the network by using the mobile sink. It will enhance the reliability to the much greater level by diminishing the Hot-Spot problem.

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