Improved Performance of LEACH for WSN Using Precise Number of Cluster-Head and Better Cluster-Head Selection

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Abstract – Wireless microsensor systems will facilitate the reliable monitoring of a variety of environments for several applications like as civil and military. In this paper, we look at modified LEACH protocol. This paper presents a new approach to clustering wireless sensor networks and determining cluster heads. LEACH is a hierarchical cluster algorithm in which Cluster-Heads are randomly selected from the nodes. Here, I apply new approach for selection of Cluster-Head according to their initial and residual energy of all the nodes and according to their initial and residual energy nodes are eligible for cluster head in the next round. Results of new approach of LEACH protocol compared with Conventional routing protocol.

Keywords: Clustering, Energy Consumption, Lifetime, Routing, Wireless sensor network.

I. INTRODUCTION

The basic idea of anytime and anywhere computing leads to the new field called mobile computing. The advances in the wireless technology are also one of the major growths of mobile computing. But here in this ubiquitous computing environment we can't follow the normal architecture and protocols which have been used in the fixed network due to its battery powered devices involved in the computing and transmission of the data. The advancement in these miniature computing model and wireless transmission techniques lead to the development of the wireless sensor networks. Sensor networks are needed in the applications like environment monitoring, industrial control units, military applications and in the context aware computing environments [1].

Since the entire sensor nodes are battery powered devices, energy consumption of nodes during transmission or reception of packets affects the life-time of the entire network. To make routing, an energy efficient one, number of protocols like LEACH and PEGASIS were developed.

Though they have achieved efficiency by more than 8 times than the previous protocols, still these are used for only static sensor nodes. In this paper we have proposed a novel approach to develop an energy efficient routing for the mobile sensor networks [4]. LEACH uses the following clustering-model: Some of the nodes are elect themselves as cluster-heads. These cluster-heads collect data from other node and aggregated data transfer to the Base Station. Since data transfers to the base station require much energy. The nodes take turns with the transmission – the position of cluster head is rotate. For balanced energy consumption all nodes have rotation for the cluster-heads. Hence to a longer lifetime of the network. Modification of LEACH's cluster head selection algorithm to reduce energy consumption.

II. BACKGROUNGD

To meet the distinctive requirements of wireless sensor networks, we established Low Energy Adaptive Clustering Hierarchy , application-specific protocol architecture. The task that sensor networks carry is observing of a remote environment. Since individual nodes' data are often interrelated in a sensor network, the end user does not necessitate all the data; rather, the end user needs a high-level function of the data that describes the actions occurring in the environment. Because the very strong correlation is essential between data signals from nodes situated near to one another, we chose to use a clustering arrangement as the basis for Low Energy Adaptive Clustering Hierarchy. This allows all data from nodes within the cluster to be process locally, sinking the data set that needs to be transmitted to the end user. Data aggregation methods can be used to combine several interrelated data signals into a smaller set of information that maintains the useful data (i.e., the information content) of the original signals. Therefore, less amount of actual data requires to be transmitted from the cluster to the base station (BS) [3][5].

For the sensor nodes, we assume that all nodes can transmit with enough power to reach the Base Station if needed, that the nodes can use power control to vary the amount of transmit power, and that each node has support different MAC protocols and perform signal processing functions. For the network, we use a model where nodes always have data to send to the end user and nodes located close to each other have correlated data. Although Low Energy Adaptive Clustering Hierarchy is optimized for this situation, it will continue to work if it were not true. The nodes sort out themselves into local clusters, with one node acting as the cluster head (CH) [6][7].

All non-cluster head nodes send their data to the CH, while the CH node receives data from all the cluster members, performs signal processing functions on the received data using different data aggregation methods, and transmits data to the remote Base Station. So, being a cluster head (CH) a sensor node is much more energy demanding than being a non-cluster head node. If the cluster heads were get selected before, these nodes would rapidly use up their limited energy & get exhausted. Once the cluster head has no energy, it is no longer outfitted, and all the nodes that

belong to the cluster lose their communication ability [2].

Thus, LEACH includes a totally randomized rotation of the cluster head's position, having the high-energy, among the sensors to avoid exhausting the battery of any one sensor in the network. 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 when the clusters are organized, followed by a steady-state phase when data are transferred from the nodes to the cluster head and on to the BS, as shown in fig 1.

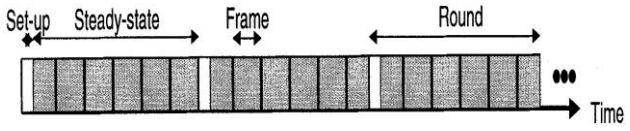

Figure1:- Adaptive Clusters are formed during the Set-Up Phase and Data Transfers Occur during the Steady-State Phase

III. CLUSTER HEAD SELECTION ALGORITHMS

Low Energy Adaptive Clustering Hierarchy arranges & makes clusters by using a distributed algorithm. In which node can make self-determining decisions without any centralized control. Their goal is to design an algorithm for cluster formation, in which there are certain number of clusters, k in each rounds. Low Energy Adaptive Clustering Hierarchy operation provides a conception of round, with every round there are set-up phase and steady-state phase [9][12].

A. Set-up Phase

In case of set-up phase, each node decides whether or not become a cluster head for current round. This decision based on random number between 0 and 1,if the number is less than a threshold T(n) in (1),the node become a cluster head for the current round. A flowchart of this distributed cluster formation algorithm is shown in Figure 3 [9][10].

$$T(n)=\begin{cases}\dfrac{P}{1-P[r*\bmod(1/P)]} & if\ \ n\in G\\ 0 & otherwise,\end{cases} \quad (1)$$

Figure1:-Cluster head set up a TDMA schedule, this schedule is transmit to all other node in the cluster.

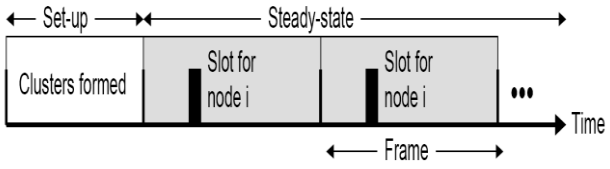

Figure2:- Time Line Operation of Leach

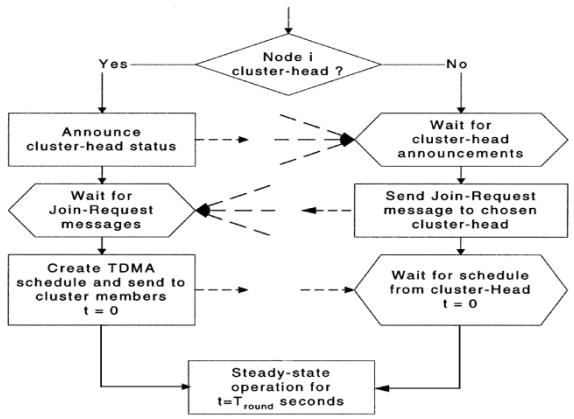

Figure3:- Flow Chart of the Set-Up Phase of Leach

B. Steady State Phase

In the state the operation divides into the frames, where nodes send their data to the cluster head at each once per frame during their allocated slot shown in Figure 1.Each non cluster head node can be turned off until the node's allocated transmission time. Cluster head receive all the data from the node in the cluster.

When all the data has been received, cluster head node performs signal processing functions to data into single signal shown in Figure 4. This composite final signal is sent to the BS. Figure. 2 shows the time line for one round of LEACH [8][11].

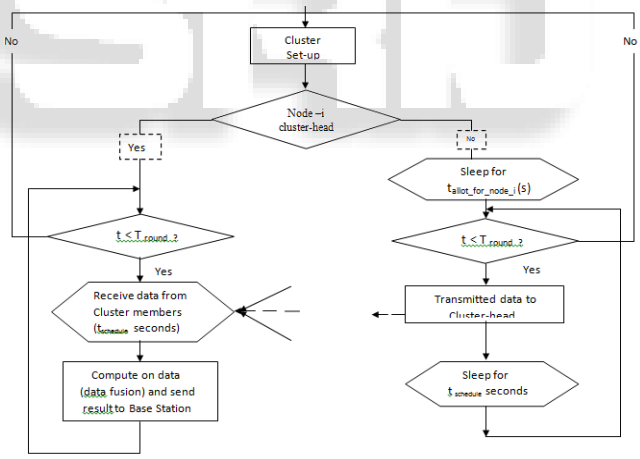

Fig. 4: Flow Chart for Steady State Phase

IV. PROPOSED METHOD OF LEACH PROTOCOL

The number of cluster-head nodes is the prerequisite to implement clustering, LEACH protocol has not given the numerical computation method to determine the number of cluster-head nodes explicitly.

The cluster-head Selection is depending on the selection of random number from 0 to 1. If the threshold value for the node is more than the random number then the node can become a cluster-head for the current round. Limiting the number of cluster heads per round or in other words dividing the area into the finite number of grids. By doing this we are controlling the energy distribution between the nodes & making it even.

Here I have analyzed the cases with optimum number of cluster-head.

A. Limiting Number of Cluster-Head to 4 & 5 Cluster-Head

In this case fixed 4 & 5 CH per round will announced for cluster-head for current round in cluster rest of nodes in the cluster will join them for the current round. In each round cluster-head will be fixed 4 CH and 5 CH and all other nodes in the cluster are cluster nodes. According to the fixed number of cluster will improve the life span of the cluster because in every round only 4 and 5 nodes will be selected as cluster-head so rest of nodes transfer to data to only those 4 and 5 CH. In the case of 5 CH less energy require for transferred to data to base station so less energy will require compared to 4 CH.

A. Limiting Number of Cluster-Head 4% & 5% Cluster-Head

In this case fixed 4% & 5% CH of total nodes per round will announced for cluster-head for current round in cluster rest of nodes will join them. In this case only 4% and 5% of the all nodes will selected for cluster-head for the current round and rest of nodes transfer data to those cluster-head for the current round. In this case 5% CH less energy require for transferred to data to base station so less energy will require compared to 4% CH.

B. Modified LEACH

In this modified LEACH, Selection of cluster head is based on initial and residual energy of the nodes. In each round cluster head will be selected bases on the below equation (2) and according to this equation (2) maximum amount of energy nodes selected as cluster head for the current round. Using this equation require less energy to transmit data to the base station.

$$T(n) = \frac{p}{1 - p(r \bmod (1/p))} * [\frac{Eresidual}{Einitial} + [1 - \frac{Eresidual}{Eaverage}]] \quad (2)$$

Where Eresidual is available energy of node, Einitnal is total energy given to node at initial stage, Eavrage is total average energy of all live nodes.

V. SIMULATION, EXPERIMENTAL RESULTS & ANALYSIS

To validate the performance of proposed LEACH-sub-CH protocol, we simulate the protocol and utilize a network with 100 nodes randomly deployed between (x=0, y=0) and (x=100, y=100) and base station at (50,175). The bandwidth of channel is set to 1 Mb/s; each data message is 500 bytes long. The initial power of all nodes is considered to be 2J and duration of each round is 20s.

A. Optimum Number of Cluster-Head

In LEACH, the cluster formation algorithm was created to confirm that the estimated number of clusters in sensor network per round is k, a system parameter. We can analytically determine the optimum value of k in LEACH using the computation and communication models. Assume that there are N nodes distributed uniformly in an M x M region. If there are k clusters, there are on average N/k nodes per cluster (one cluster head and (N/k)-1non-cluster head nodes). Each cluster head scatters energy receiving signals from the nodes, aggregating the signals, and transmitting the aggregate signal to the base station.

B. For 4 & 5 Cluster-Head

Figure1:- shows the number of the alive nodes with time in the network based on rounds. It can be seen that the LEACH protocol has emerged that total data received at the base station is more in 4 CH compare to LEACH. In Fig 4 total energy require for that transited data to the base station. According to the Fig 5 and Fig 6 total received at base station is nearby same but in the case of 5 CH less energy will be require for transmitted data to base station.

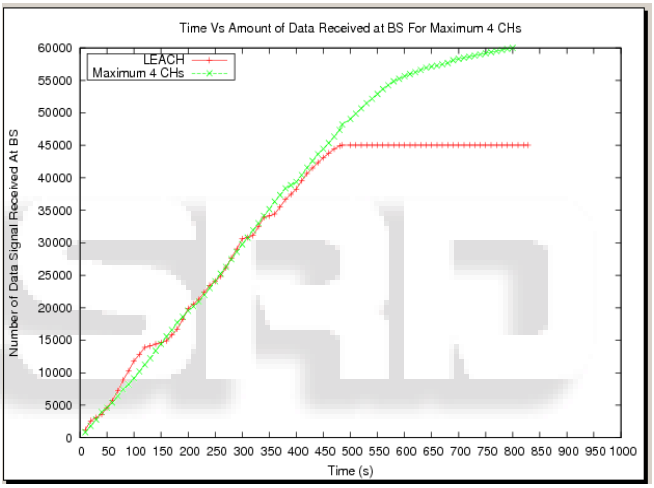

Figure. 5: Comparison of LEACH & Maximum (4 CHs) Round for Time Vs Number of Data at BS.

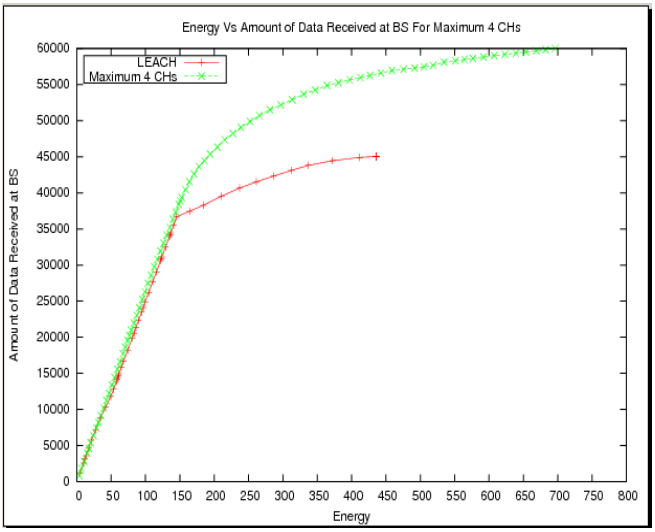

Figure. 6: Comparison of LEACH & Maximum (4 CHs) Round for Energy Vs Number of Data at BS.

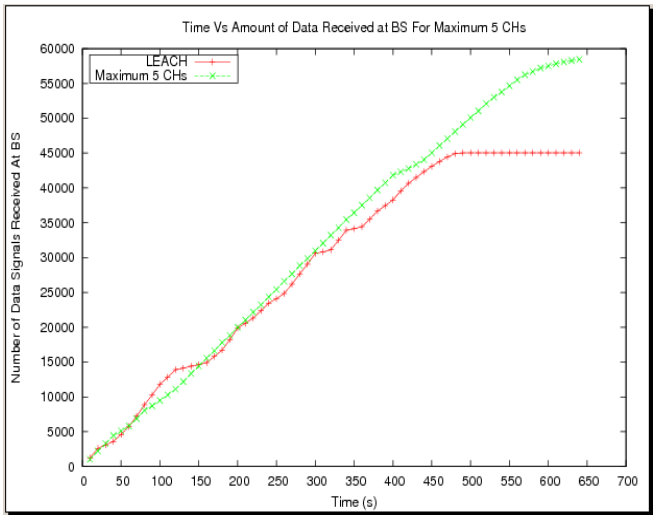

Figure. 7: Comparison of LEACH & Maximum (5 CHs) Round for Time Vs Number of Data at BS.

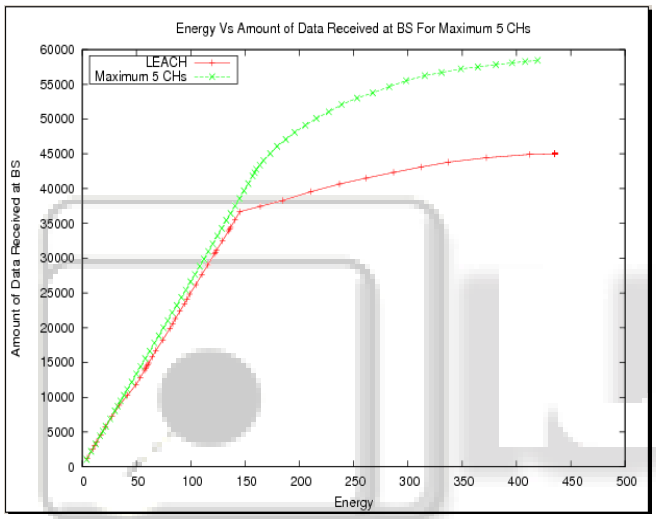

Figure. 8: Comparison of LEACH & Maximum (5 CHs) Round for Energy Vs Number of Data at BS.

In Fig 13 and Fig 14 shows that total data received at station is more in 4 CH compare to the 5 CH and LEACH but total life span of the network in case of 5 CH is better than the 4 CH and LEACH.

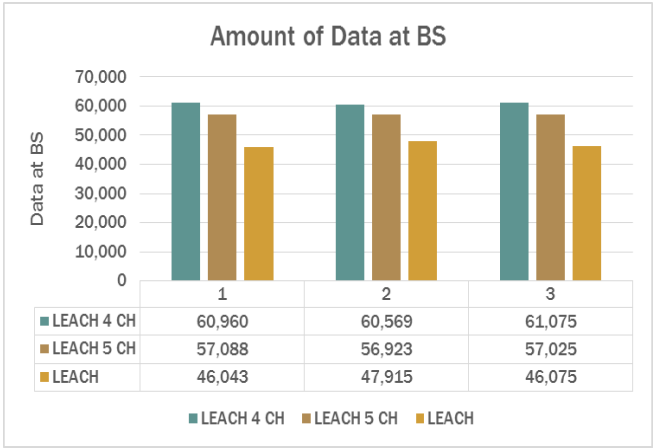

Figure. 9: Comparison of Total Amount of Data Received At BS for LEACH & 4 CHs-5CHs/Round - Number of Simulation

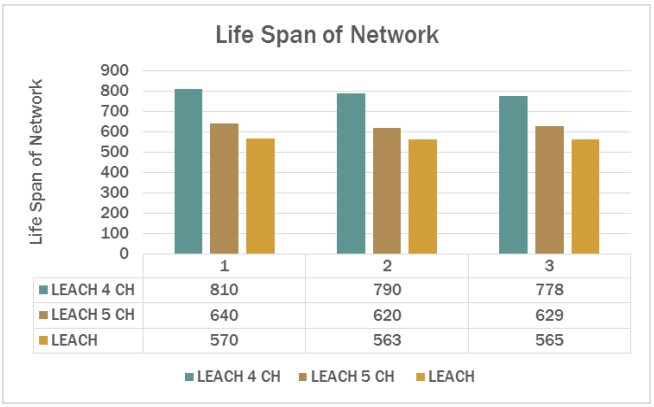

Figure. 10: Comparison of Life Span of Network for LEACH & 4 CHs-5 CHs/Round - Number Of Simulation

C. For 4% & 5% Cluster-Head

Figure 10 shows the number of the alive nodes with time in the network based on rounds. It can be seen that the LEACH protocol has emerged that total data received at the base station is more in 4% CH compare to LEACH. In Fig 10 total energy require for that transited data to the base station. According to the Fig 11 and Fig 12 total received at base station is nearby same but in the case of 5% CH less energy will be require for transmitted data to base station.

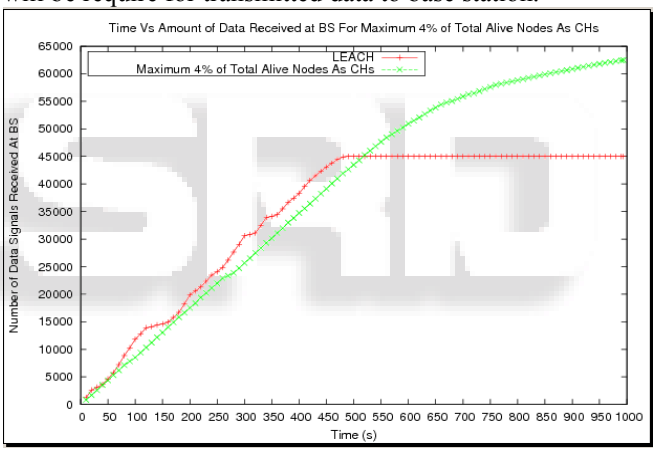

Figure. 11: Comparison of LEACH & Maximum (4% CHs) Round for Time Vs Number of Data at BS.

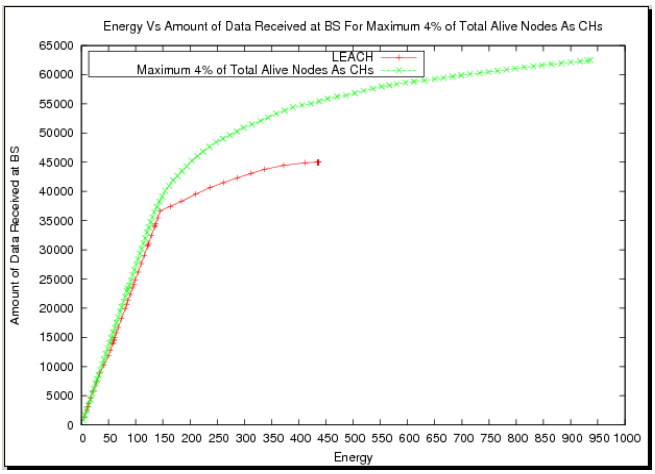

Figure. 12: Comparison of LEACH & Maximum (4% CHs) Round for Energy Vs Number of Data at BS.

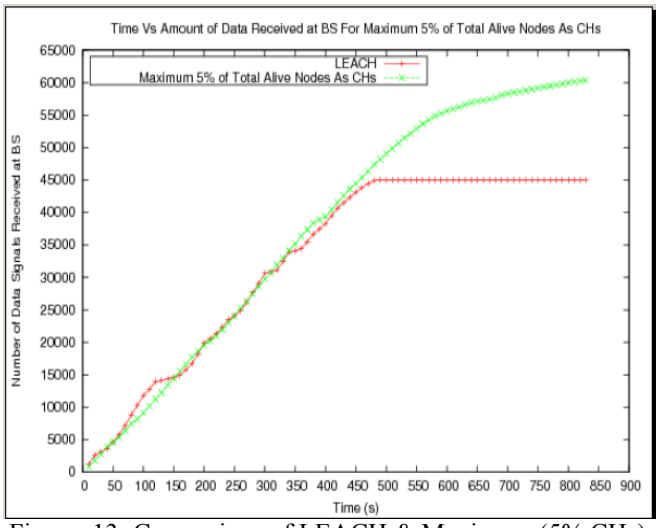

Figure. 13: Comparison of LEACH & Maximum (5% CHs) Round for Time Vs Number of Data at BS.

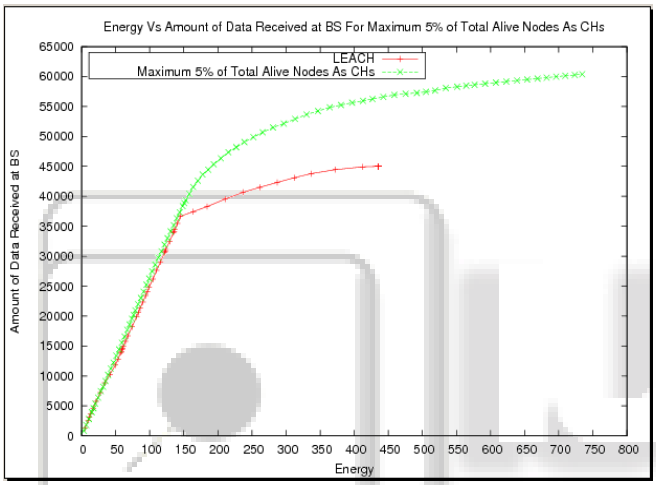

Figure. 14: Comparison of LEACH & Maximum (5% CHs) Round for Energy Vs Number of Data at BS.

In Fig 13 and Fig 14 shows that total data received at station is more in 4% CH compare to the 5% CH and LEACH but total life span of the network in case of 5% CH is better than the 4% CH and LEACH.

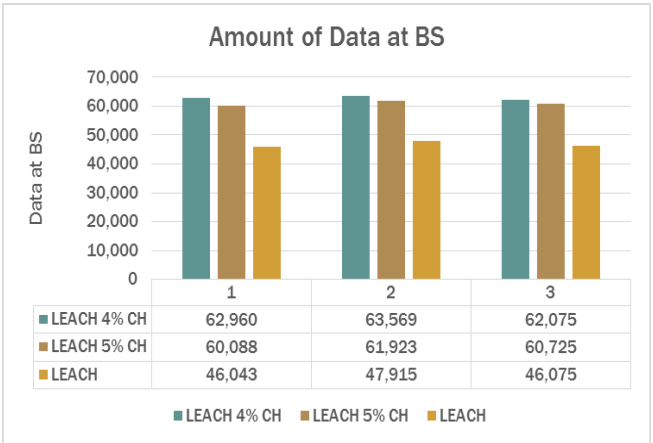

Figure. 15: Comparison of Total Amount of Data Received At BS for LEACH & 4% CHs-5% CHs/Round - Number of Simulation

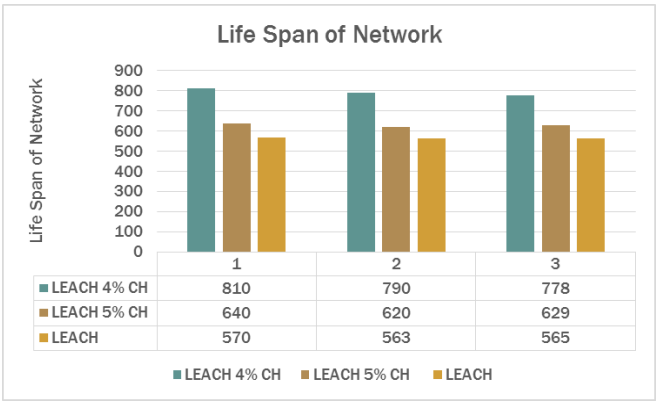

Figure. 16: Comparison of Life Span of Network for LEACH & 4% CHs-5% CHs/Round - Number Of Simulation

D. Modified LEACH

In Modified LEACH Cluster-Head selection based on the initial and residual energy of the nodes. In this Modified LEACH in each round cluster-head will be selected based on intimal and residual energy of the nodes according to the equation (2). Results prove that Modified LEACH work better than the LEACH Protocol. In Fig 15 and Fig 16 shows that data transmitted at base station is more compare to LEACH and also less energy will be require for that.

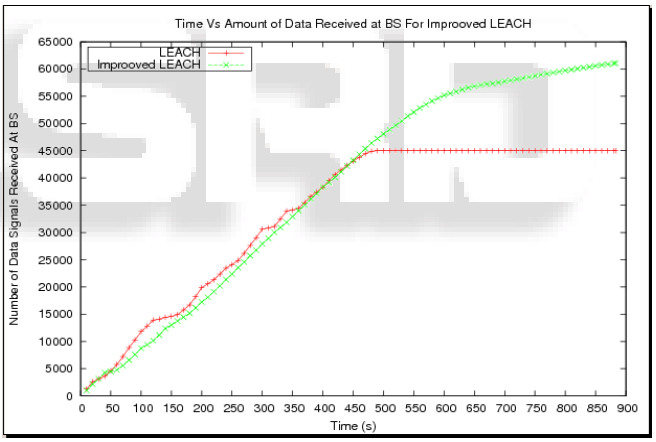

Figure. 17: Comparison of LEACH & Modified LEACH Round for Time Vs Number of Data at BS.

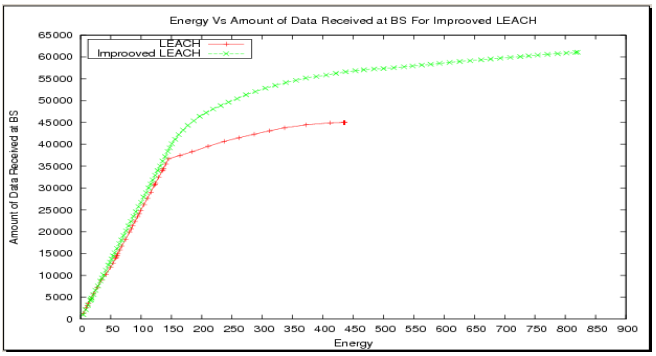

Figure 18: Comparison of LEACH & Modified LEACH Round for Energy Vs Number of Data at BS.

In Fig 17 and Fig 18 shows that total data received at station is more in Modified LEACH compare to LEACH

and total life span of the network in Modified LEACH better than the LEACH.

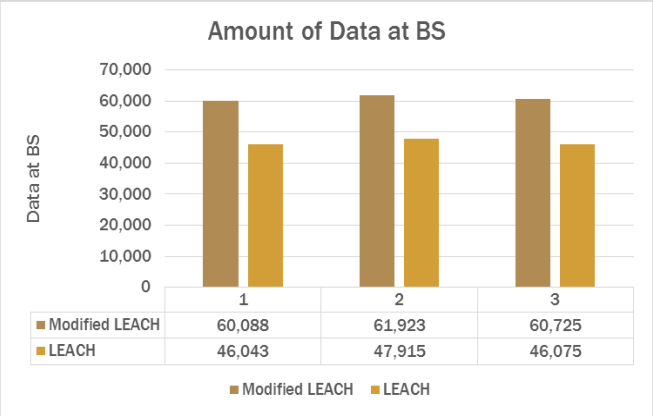

Figure. 19: Comparison of Total Amount of Data Received At BS for LEACH & Modified LEACH Round - Number of Simulation

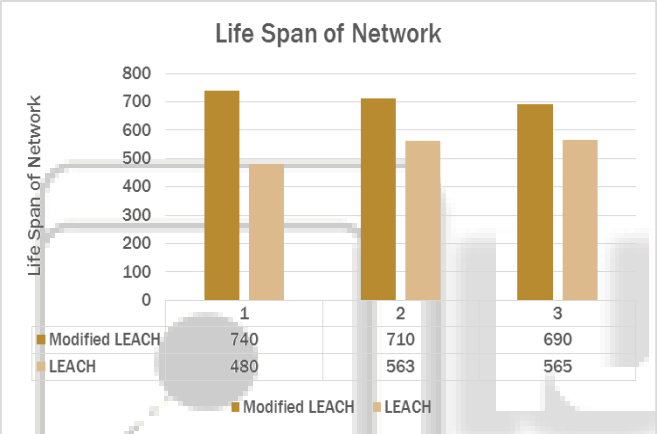

Figure. 20: Comparison of Life Span of Network for LEACH & Modified LEACH/Round - Number Of Simulation

VI. CONCLUSION

The Simulation shows that Modified LEACH based on new approach for selection of Cluster-Head and overall performance of modified LEACH is better than the Conventional LEACH. Total data transmitted at the base station is more and life span of the network is better than LEACH. In this paper Modified LEACH indicates the optimal number of cluster-heads in a network and considers residual energy in the stage of cluster-heads selection and modified LEACH can prolong lifetime and reduce the energy consuming, it has better performance than LEACH protocol

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