A REFORMED CLUSTER-HEAD OF LEACH PROTOCOL AND PERFORMANCE ANALYSIS WITH CONVENTIONAL ROUTING PROTOCOL FOR WSN

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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. The routing protocols applied for the other networks cannot be used here due to its battery powered nodes. Unlike other wireless networks routing in wireless sensor network should be the energy efficient one. This paper gives performance analysis of reformed cluster-head of LEACH Protocol and conventional routing protocol for wireless sensor network. Using reformed cluster-head in LEACH protocol reduce total amount of energy for data transmitted at base station. Simulation shows that reformed LEACH can achieve increase the overall performance of the sensor network.*

Keywords—Energy, Lifetime, Node, Throughput, Wireless sensor network.

I: INTRODUCTION

Recent research in many scientific areas, like physics, microelectronics, control, material science etc. and the collaboration of scientists which used, traditionally, to work towards totally different directions, has lead to the creation of the Micro-Electro-Mechanical Systems, commonly referred to as MEMS [1]. MEMS have succeeded in augmenting the limits of what was considered to be a System-On-a-Chip (SoC). Indeed, MEMS have enabled chips, which were formerly assumed to carry only logic functions, to sense the real word and even to react. Measuring of physical parameters and actuating is now possible via integration of sensors and actuators to silicon.

MEMS are not the only part of the silicon industry that has made astonishing strides. RF technology and digital circuits have also progressed spectacularly. Lower power and higher frequency transceivers are implemented on chips, while digital circuits tend to shrink and be fabricated more and more densely.

The collaboration and interaction of sensing, processing, communication and actuation is the next step to exploit the inheritance of this new technology. The opportunities and challenges offered by this field both in theory and in practice are widely recognized and many research teams and companies are active in the design and implementation of units that encompass these four attributes. Devices of this kind, which are created either as prototypes or as commercial products, are generally referred to as "motes". A mote is an autonomous, compact device, a sensor unit that also has the capability of processing and communicating wirelessly. Despite the autonomy they present, the big strength of motes is that they can form networks and co-operate according to various models and architectures. These networks, known as wireless sensor networks, have been the focus of considerable research efforts in the areas of communications (protocols, routing, coding, error correction etc), electronics (energy efficiency, miniaturization) and control (networked control system, theory and applications).

Recent advances in micro-electro-mechanical systems (MEMS) technology, wireless communication, and digital electronics have enabled the development of low-cost, low-power, multifunctional sensor nodes that are small in size and communicate untethered in short distances. These tiny sensor nodes, which consist of sensing, data processing, and communicating components, leverage the idea of sensor networks based on collaborative effort of a large number of nodes. Sensor networks represent a significant improvement over traditional sensors, which are deployed in the following two ways:

- Sensors can be positioned far from the actual phenomenon, i.e., something known by sense perception. In this approach, large sensors that use some complex techniques to distinguish the targets from environmental noise are required.
- Several sensors that perform only sensing can be deployed. The positions of the sensors and communications topology are carefully

engineered. They transmit time series of the sensed phenomenon to the central nodes where computations are performed and data are fused.

Realization of sensor network applications requires wireless ad hoc networking techniques. Although many protocols and algorithms have been proposed for traditional wireless ad hoc networks, they are not well suited for the unique features and application requirements of sensor networks. To illustrate this point, the differences between sensor networks and ad hoc networks [2, 3] are outlined below:

- The number of sensor nodes in a sensor network can be several orders of magnitude higher than the nodes in an ad hoc network.
- Sensor nodes are densely deployed.
- Sensor nodes are prone to failures.
- The topology of a sensor network changes very frequently.
- Sensor nodes mainly use broadcast communication paradigm whereas most ad hoc networks are based on point-to-point communications.
- Sensor nodes are limited in power, computational capacities, and memory.

II: BACKGROUND

Wireless micro sensor networks will enable reliable monitoring of remote areas. These networks are essentially data gathering networks where the data are highly correlated and the end user requires a high level description of the environment, the nodes are sensing. In addition, these networks require ease of deployment, long system lifetime, and low-latency data transfers. This is a very different paradigm than traditional wireless networks that require point-to-point connectivity, have uncorrelated data, and often can rely on a fixed infrastructure. The limited battery capacity of micro sensor nodes and the large amount of data that each node may produce translates to the need for high application, perceived performance at a minimum cost, in terms of energy and latency. Cross-layer or application-specific protocol architecture can meet these specifications by exposing lower layers of the protocol stack to the requirements of the application. To meet the requirements of wireless micro sensor networks, I have analyzed LEACH Low-Energy Adaptive Clustering Hierarchy, application-specific protocol architecture. LEACH is a clustering based protocol that includes the following features [5].

- Randomized, adaptive, self-configuring cluster formation,
- Localized control for data transfers,
- Low -energy media access, and
- Application, specific data processing, such as data aggregation

LEACH includes adaptive cluster formation; localized control for data transfers at low-energy media access and application specific data processing the application that typical micro sensor networks support is the remote monitoring like as measuring temperature, pressure of an environment. Since individual nodes in cluster data are interrelated in a micro sensor network, the end-user or base station does not require all the sensed data; rather, the end-user needs a high-level function of the data or aggregated data that describes the events occurring in the environment. Because the correlation is strongest among data signals from nodes located close to each other, the authors have elected to use a clustering infrastructure as the basis for LEACH. This allows all data from nodes within the cluster to be processed locally, in cluster non-cluster-head nodes transmit data to only cluster head, reducing the energy of nods, the data set that needs to be transmitted to the end-user. In particular, using data aggregation methods to combine several interrelated data signals into a smaller set of effective data, i.e. the information content, of the original signals. Therefore much less actual data needs to be transmitted in cluster from the cluster head to the base station. If the cost in terms of energy dissipation of communicating data is greater than the cost of computing on the data, considerable energy savings can be achieved by locally aggregating a large amount of data into a smaller set of data before transmission to the base station.

In LEACH, the nodes organize themselves into local clusters, with one node acting as the cluster-head. All non-cluster head nodes must transmit their data to the cluster head, while the cluster head node must receive data from all the cluster members, perform signal processing functions on the data e.g., data aggregation, and transmit data to the remote base station. Therefore, being a cluster-head node is much more energy for transmitted data to base station intensive than being a non-cluster-head node. In the scenario where all nodes are energy limited, if the cluster heads were chosen a priori and fixed throughout the system lifetime, as in a static clustering algorithm, the cluster head sensor nodes would quickly use up their limited energy. Once the cluster head runs out of energy, it is no longer operational.

Thus, when a cluster head node dies in cluster, all the nodes that belong to the cluster lose communication ability. Thus LEACH incorporates randomized rotation of nodes of the high-energy cluster-head position such that it rotates among the sensor nodes in order to avoid draining the battery of any one sensor node in the network. In this way, the energy load associated with being a cluster-head is evenly distributed among the sensor nodes [6].

Media access in LEACH was select to reduce energy dissipation in the non-cluster-head nodes in cluster. Since the cluster-head node knows all the cluster members [9-10], it can create a TDMA schedule that tells each node exactly when to transmit its data in allocated time slot. This allows the nodes to remain

in the sleep state, with internal modules powered down, as long as possible. In addition, using a TDMA schedule for data transfer prevents intra cluster collisions [8].
The operation of LEACH is divided into rounds. Each round begins with a setup 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 on to the base station, as shown in Fig 1[13].

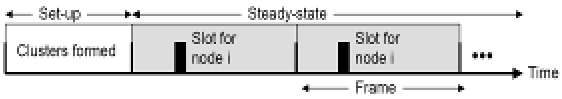

Fig 1. Time Line operation of LEACH

LEACH routing protocol's operations are based on rounds, where each round normally consists of two phases; setup phase and steady state phase. In former phase, cluster and CHs are formed. Whole network nodes are divided into multiple clusters. Some nodes elect themselves as a CH independently from other nodes. These nodes elect themselves on behalf of suggested percentage, p, and its previous record as CH. Nodes which are not selected as CH in previous 1/p rounds generate a number between 0 to 1. If it is less than threshold, T (n), then a node becomes a CH. Threshold value is set through following formula [12].

$$T(n) = \begin{cases} \dfrac{p}{1 - p * \left[r \bmod \left(\frac{1}{p}\right)\right]} & , n \in G \\ 0 & , Otherwise \end{cases} \quad (1)$$

where, G is set of nodes which are not selected as CH in previous 1/p rounds, p is suggested percentage of CH and r denotes is current round. A node becomes a CH in current round and it will be CH after next 1/p rounds. This indicates that every node can serve as a CH equally, thus energy dissipation is uniform throughout the network [4].

III: REFORMATION OF CLUSTER-HEAD

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 case with 4% cluster-head, 5% cluster-head.
In case of 4% & 5% CH per round 4% nodes & 5% nodes 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% or 5% of) 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% nodes & 5% nodes will be selected as cluster-head so rest of nodes transfer to data to only those 4% cluster-head. Only 4% cluster-head & 5% cluster-head is transferred to data to base station so less energy will require for that.

IV: SIMULATION AND RESULTS

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. It has revealed analytically that the number of clusters for above assumptions is optimized for $1 < k < 6$. So for the rest of the experiment, we set k=5. These parameters are summarized in Table1.

Table.1: Summery of the parameters used in the simulation experiments.

Number of Nodes	100
Network size	100m * 100m
Base station location	(50,175)
Radio propagation speed	$3*10^8$ m/s
Processing delay	50 µs
Radio speed	1 Mbps
Data size	500 bytes
Initial node power	2 Joules
Simulation time	900 sec

We evaluate the lifetime of sensor network using NS-2. In the simulation the size of network is 100m × 100m and the size of a packet is 500byte.

1) **Optimum no of clusters**

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.

2) Limiting Number of CH to 4% and 5%

Fig. 2 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 the first dead node at nearby time and in the modified LEACH at 5% CH, but in 4% CH LEACH lifetime of the node id more compare to both previous case. The lifetime is longer in modified LEACH (4% CH) than the LEACH's. Modified LEACH (4%CH) shows better performance than LEACH.

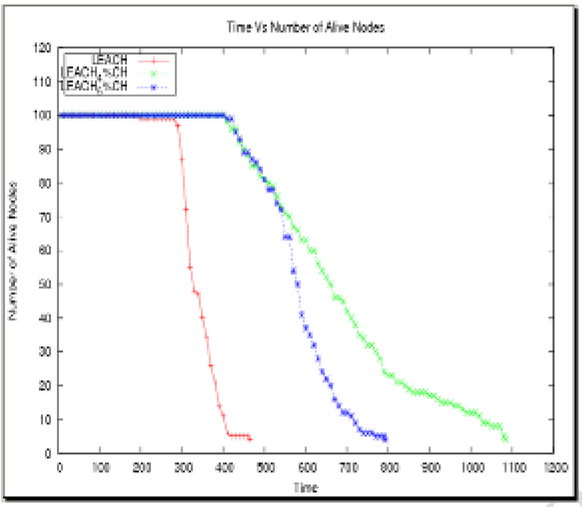

Fig 2. Comparison of LEACH & Maximum (4% CHs & 5% CHs) Round for Time Vs Number of Alive Nodes

Fig. 3 shows that number of data received at base station with respect to time. It can be seen that at near 490s number of data received at base station 36000 bytes and in modified LEACH (5% CH) at 550s & LEACH (4% CH) at 1080s number of data received at base station is 57000 bytes & 62000 bytes. The datarate is higher in modifies LEACH (4% CH) than the LEACH (5% CH) and LEACH.

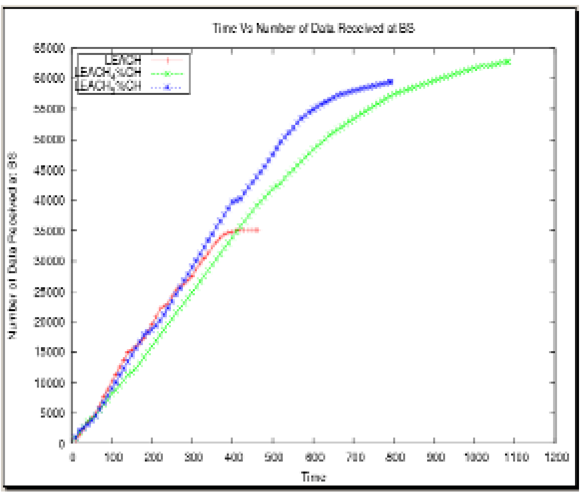

Fig 3. Comparison of LEACH & Maximum (4% CHs & 5% CHs) Round for Time Vs Number of Data Received at BS

Fig. 4 shows number of alive nodes with number of data at base station. In which total number of alive nodes in modified LEACH (4% CH) is more than the LEACH. Data received at base station is higher than the LEACH. In fig. 5 shows amount of data received at base station. In modified LEACH (4% CH) the total number of alive nodes is more so data received at base station is high than the LEACH.

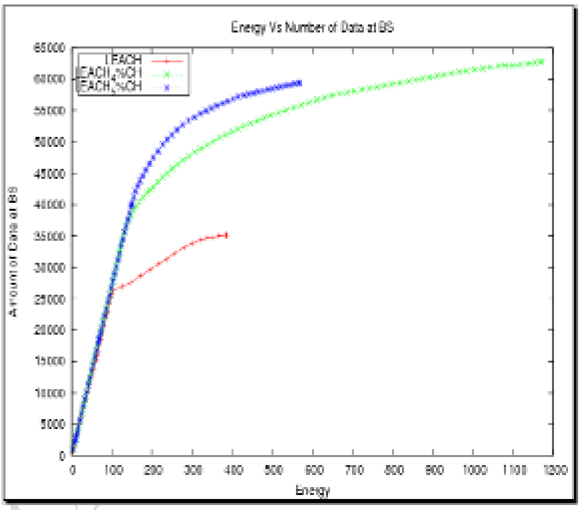

Fig 4. Comparison of LEACH & Maximum (4% CH & 5% CH) Round for Energy Vs Amount of data received at BS

Fig. 5 shows that amount of data at base station in which I have simulate 4%-CH LEACH, 5%-CH LEACH and LEACH 3 rounds. Also define the round wise result of 4%-CH LEACH, 5%-CH LEACH and LEACH in which I analyzed the total number of data received at base station is higher than the LEACH. In Fig 6. shows that life span of the network in which same process as follow describe in previously in that life span of network is more in 4%-CH LEACH than the LEACH's.

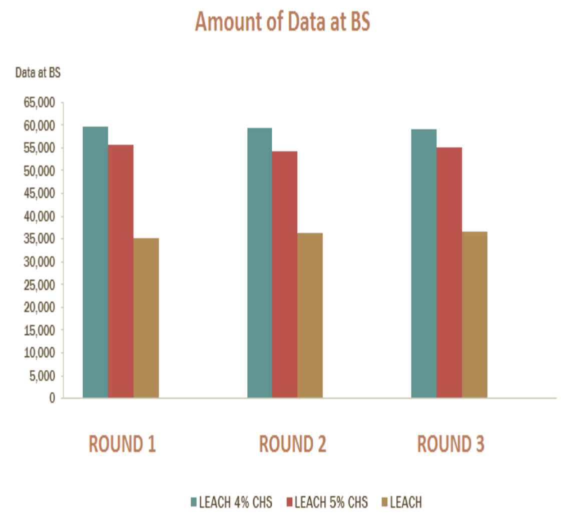

Fig 5. Comparison of Total Amount of Data Received At BS for LEACH & 4% CHs-5%CHs/Round - Number of Simulation

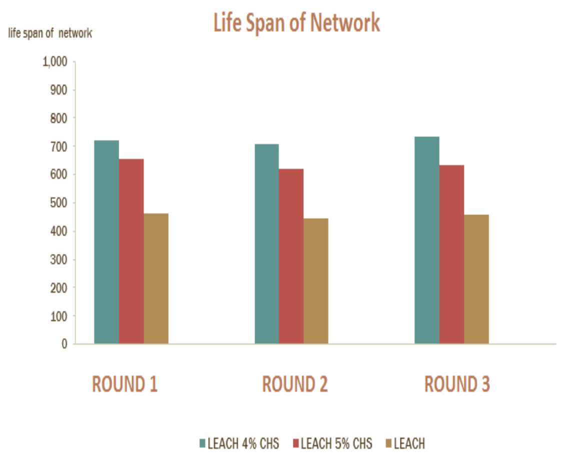

Fig 6. Comparison of Life Span of Network for LEACH & 4% CHs- 5% CHs/Round - Number Of Simulation

V: CONCLUSION

An improved protocol based on LEACH, Modified LEACH with 4% & 5% Cluster-head protocol is presented in this paper Modified LEACH (4% CH) protocol indicates the optimal number of cluster-heads in a network and considers residual energy in the stage of cluster-heads selection. Simulation results show that the modified LEACH (4% CH) can prolong lifetime and reduce the energy consuming, it has better performance than LEACH protocol.

REFRENCES

[1] F. Akyildiz, W. Su, Y. Sankarasubramaniam, and E. Cayirci, "Wireless sensor networks: a survey", Computer Networks 38, Elsevier, pp. 393–422, 2002.

[2] Y. Yao and J. Gehrke, "The cougar approach to in-network query processing in sensor networks", in SIGMOD Record, September 2002.

[3] Sun Limin, Li Jianzhong, and Chen Yu. wireless sensor network[M]. BeiJing: Tsinghua University Press.2005.

[4] F Akylidiz, W.Su, Y Sankarasubramanyam, and E.Cayirci. Wireless Sensor Network:a survey[J]. Computer Networks. 2002.38(4):393-422.

[5] Lilin Wang, Jie Liu, Wei Wang. "An Improvement and Simulation of LEACH Protocol for Wireless Sensor Network" International Conference on Pervasive Computing, Signal Processing and Applications, 2010.

[6] Heinzelman WR, Chandrakasan A, Balakrishnan H. energy-efficient communication protocol for wireless microsensor networks[C]. In Proceedings of the Hawaii International Conference System Sciences, 2000.

[7] Younis O, Fahmy S. Heed: A hybrid, energy-efficient, distributed clustering approach for ad-hoc sensor networks [J]. IEEE Transaction on Mobile Computing. 2004.3(4):660-669.

[8] Shen Bo, Zhang Shi-Yong and ZhongYi-Ping. Cluster-Based Routing Protocols for Wireless Sensor Networks [J]. Jouranl of Software. 2006. 177）:1587-1600.

[9] WANG Jun,Zhang Xin, Xie Junyuan, Mi Zhengkun, "A Distance-based Clustering Routing Protocol in Wireless Sensor Networks" Important national science technology specific projects 2011.

[10] W. Heinzelman, J. Kulik, and H. Balakrishnan, "Adaptive Protocols for Information Dissemination in Wireless Sensor Networks," Proc. 5th ACM/IEEE Mobicom Conference (MobiCom '99), Seattle, WA, August, 1999. pp. 174-85.

[11] Wendi B Heinzelman, A P Chandrakasan, Hari Balakrishnan,"An application-specific protocol architecture on wireless microsensor networks", IEEE transaction on wireless communications, 2002, PP. 660-670.

[12] V. Loscr, G. Morabito, S. Marano, "A Two-Levels Hierarchy for Low-Energy Adaptive Clustering Hierarchy (TL-LEACH)", Vehicular Tech-nology Conference, 2005.

[13]Linlin Wang, Jie Liu, Wei Wang, "An Improvement and Simulation of LEACH Protocol for Wireless", First International Conference on Per-vasive Computing, Signal Processing and Applications, 2010.