A LEACH Protocol for Wireless Sensor Network: A Review

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ABSTRACT
Advance wireless sensor network (WSN) technology is Low-power electronics and Low-power radio frequency design has enabled the development of small, relatively inexpensive & low-power sensor technology. The important challenges in design of network are two key resource1) Energy 2) Communication bandwidth. LEACH (Low Energy Adaptive Clustering Hierarchical) protocol are used to design energy efficient system depending upon energy levels of cluster head and cluster-members .So appropriate energy protocol to get balance between lifetime of sensor nodes and latency become key solution. This paper basically a review on LEACH protocol for Wireless Sensor Nodes in Network Simulator (NS2) to reduce average latency and increases life of sensor nodes.

Keywords
LEACH protocol, Wireless Sensor Network , Energy Efficient

1. INTRODUCTION
With the recent technological advances of wireless sensor network, it is becoming an integral part of our lives. Wireless Sensor Networks hold the promise of delivering a smart communication paradigm which enables setting up an intelligent network capable of handling applications that evolve from user requirements.

Wireless Sensor Network composed of large number of sensor nodes that are deployed in wide area with very low powered sensor nodes. It is self-configured, self-healing, self-optimization and self-protection capabilities, dense deployment. But, it severs limitation in energy capacity, computing power, memory and transmits power. The battery is an important component of the sensor so focus is on innovative energy-optimized solutions at all levels of the system hierarchy, from the physical layer and communication protocols up to the application layer. The sensor nodes can communicate among themselves using radio signals. Node is equipped with sensing and computing devices, radio transceivers and power components. [2]

Wireless sensor networks (WSNs) enable new applications and require non-conventional paradigms for protocol design due to several constraints. Routing is the mechanism responsible for determining the path that a packet traverses from the source node to the destination node.

Routing protocols in WSN can classify as Data centric protocol, Hierarchical protocol, Location Based protocol. Hierarchical routing efficiently involves proper energy consumption, data aggregation and fusion. LEACH [1] has been an inspiration for many hierarchical routing protocols. It provides several factors for reduction in energy dissipation compared to direct communication [2]

2. LITRATURE REVIEW
Weidi B. Heinzelman & Anantha P.Chandrakasan[1] in 2002 have described, networking together hundreds or thousands of cheap sensor nodes allows users to accurately monitor a remote environment by intelligently combining the data from the individual nodes. These networks require robust wireless communication protocols that are energy efficient and provide low latency. In this paper, develop and analyze low-energy adaptive clustering hierarchy (LEACH), a protocol architecture for sensor networks that combines the ideas of energy-efficient cluster-based routing and media access together with application-specific data aggregation to achieve good performance in terms of system lifetime, latency, and application-perceived quality.

Yuhua Liu &Yongfeng Zhao &Jingju Goa[2]in 2009 have described, analyses the cluster-heads generating algorithm among LEACH and presents improved approach that adjusting the nodes, Threshold function. When non cluster-heads choose optimal cluster-head they consider comprehensive nodes residual energy and distance to base-station.

Beibei Wang & Chong Shen& Jing Li[3]in 2009 have described, analyzes the clustering mechanism in LEACH. One of problems in the LEACH protocol is that it depends on the time period to re-establish new clusters among whole network without considering the differences of energy consumption between the various clusters. In improved LEACH protocol, after clusters are established. Improved LEACH protocol effectively prolongs the network lifetime and effectively improve node's energy efficiency.

V. Loscrì, G. Morabito, S. Marano[4] in 2005 have described, a two-level hierarchy to realize a protocol that saves better the energy consumption. TL-LEACH uses random rotation of local cluster base stations (primary cluster-heads and secondary cluster-heads). Where it is possible, a two-level hierarchy. This permits to better distribute the energy load among the sensors in the network especially when the density of network is higher. TL-LEACH uses localized coordination to enable scalability and robustness. They evaluated the performances of our protocol with NS-2 and observedthat protocol outperforms the LEACH in terms of energy consumption and lifetime of the network.

Haosong Gou & YounghwanYoo[5]in 2010 have described, the energy efficiency is critical for the lifetime and cost of WSN. The low-energy adaptive clustering hierarchy (LEACH) and another improved centralized LEACH deploys randomized rotation of cluster-heads to evenly distribute the energy load among all sensors in a WSN. This paper proposes an improved LEACH (LEACH-C) algorithm called partition-based LEACH (pLEACH), which firstly partitions network into optimal number of sectors, and then selects the node with the highest energy as the head for each sector, using the centralized calculations.

Mohammad Mehdi Shirmohammadi, Mostafa Chhardoli, Karim Faez [6]in 2009 have introduced, a new protocol called CHEFC (Cluster Head Election Full Coverage) is able to tackle with the problem of CH vacancy in the different parts of the network. The function of this protocol is as follows: each sensor should usually have a CH in it vicinity, and unlike the previous

protocol, there is no need for each sensor spends more energy to be connected with its own CH located in a farther distance. This protocol which acts on a distributed basis will lengthen the lifetime of the wireless sensor network as well as fully covering the CH in the network.

Mortaza Fahimi Khaton Abad, Mohammad Ali Jabraeil Jamali[7] in 2011 have introduced, In this work, an energy efficient clustering algorithm for sensor networks based on the LEACH protocol. LEACH uses a TDMA based MAC protocol, and In order to maintain a balanced energy consumption. The proposed protocol adds feature to LEACH to reduce the consumption of the network resource in each round. The proposed protocol is simulated and the results show a significant reduction in network energy consumption compared to LEACH.

Ms. V. Muthu Lakshmi [8] have described, LEACH have One deficiency that affects the performance of the protocol is existence of very large and very small clusters in the network at the same time. This leads to the decrease in lifetime of WSNs. In this paper, the proposed and analyzed a new energy efficient clusters protocol (Improved FZ-LEACH) that eliminates the above problem by forming Far-Zone. Far-Zone is a group of sensor nodes which are placed at locations where their energies are less than a threshold. The communication between nodes and Sink is based on the energy consumption and the minimum distance.

Nishi Sharma, Vandna Verma[9] have described, real life applications deal with Heterogeneity rather than Homogeneity. In this paper, a protocol is proposed, which is heterogeneous in energy. First completely analyzes the basic distributed clustering routing protocol LEACH (Low Energy Adaptive Clustering Hierarchy), which is a homogeneous system, then study the impact of heterogeneity in energy of nodes to prolong the life time of WSN. Simulation results using MATLAB

3. ROUTING PROTOCOL

Classification of routing protocols can accord network structure as data centric protocol, hierarchical protocol, Location Based protocol.

3.1 Data Centric Routing Protocol

In this sink ask for particular node data by broadcasting message. After this messages is reached to the specific node which sink is interested in its data. It will send the information back to sink.

3.2 Hierarchical Routing Protocol

The hierarchical routing protocols are intended to increase the network efficiency and scalability. In hierarchical routing protocols, clusters are created and a head node is assigned to each clusters.

3.3 Location Based Routing Protocol

The sensor nodes in the location based routing protocols are addressed by means of their locations. In order to save energy, as many as sleeping nodes in the network as possible, more energy saving can be achieved.

4. LOW ENERGY ADAPTIVE CLUSTERING HIERARCHY (LEACH) PROTOCOL

As we know, all the networks have a certain lifetime during which nodes have limited energy by using that, the nodes gather, process, and transmit information. This means that all aspects of the node, from the sensor module to the hardware and protocols, must be designed to be extremely energy-efficient. Decreasing energy usage by a factor of two can double system lifetime, resulting in a large increase in the overall usefulness of the system. In addition, to reduce energy dissipation, protocols should be robust to node failures, fault-tolerant and scalable in order to maximize system lifetime [3].

LEACH is the first network protocol that uses hierarchical routing for wireless sensor networks to increase the life time of network. All the nodes in a network organize themselves into local clusters, with one node acting as the cluster-head. All non-cluster-head nodes transmit their data to the cluster-head, while the cluster-head node 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-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 ability [6][8].

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 [5]. 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 [4].

4.1 Set-up Phase

In LEACH, nodes take autonomous decisions to form clusters by using a distributed algorithm without any centralized control. Here no long-distance communication with the base station is required and distributed cluster formation can be done without knowing the exact location of any of the nodes in the network. In addition, No global communication is needed to set up the clusters. The cluster formation algorithm should be designed such that nodes are cluster-heads approximately the same number of time, assuming all the nodes start with the same amount of energy [8]. Finally, the cluster-head nodes should be spread throughout the network, as this will minimize the distance the non-cluster-head nodes need to send their data. A sensor node chooses a random number, r, between 0and 1.

Let a threshold value be $T(n)$

$$T(n) = \begin{cases} \frac{p}{1-p*\left[r \bmod \left(\frac{1}{p}\right)\right]} & n \varepsilon G \\ 0 & otherwise \end{cases}$$

This random number is less than a threshold value, $T(n)$, the node becomes a cluster-head for the currentround. The threshold value is calculated based on the above given equation that incorporates the desired percentage tobecome a cluster-head, the current round, and the set of nodes that have not been selected as a cluster-head in the last(1/P) rounds, p is cluster head probability. After the nodes have elected themselves to be cluster-heads, it broadcasts an advertisement message (ADV). This message is a small message containing the node's ID and a header that distinguishes this message as an announcement message. Each non-cluster-head node determines to which cluster it belongs by choosing the Cluster head that requires the minimum communication energy, based on the received signal

strength of the advertisement from each cluster-head. After each node has decided to which cluster it belongs, it must inform the cluster-head node that it will be a member of the cluster. Each node transmits a join-request message (Join-REQ) back to the chosen cluster-head. The cluster-heads in LEACH act as local control centers to co-ordinate the data transmissions in their cluster [9]. The cluster-head node sets up a TDMA schedule and transmits this schedule to the nodes in the cluster. This ensures that there are no collisions among data messages and also allows the radio components of each non cluster-head node to be turned off at all times except during their transmit time, thus minimizing the energy dissipated by the individual [8][10].

4.2 Steady-State Phase

The steady-state operation is broken into frames where nodes send their data to the cluster-head at most once per frame during their allocated transmission slot. The set-up phase does not guarantee that nodes are evenly distributed among the cluster head nodes. Therefore, the number of nodes per cluster is highly variable in LEACH, and the amount of data each node can send to the cluster-head varies depending on the number of nodes in the cluster. To reduce energy dissipation, each non-cluster-head node uses power control to set the amount of transmits power based on the received strength of the cluster-head advertisement. The radio of each non-cluster-head node is turned off until its allocated transmission time. Since all the nodes have data to send to the cluster-head and the total bandwidth is fixed, using a TDMA schedule is efficient use of bandwidth and represents a low latency approach, in addition to being energy-efficient[5][9]. The cluster-head must keep its receiver on to receive all the data from the nodes in the cluster. Once the cluster-head receives all the data, it can operate on the data and then the resultant data are sent from the cluster-head to the base station.

5. SIMULATION PLATFORM

NS2 (Network Simulator 2) developed by UC Berkeley is kind of open-source free software simulation platform in allusion to network technology. It is discrete event simulator. There is virtual clock in itself and all the simulation is driven by discrete events.NS2 now has become one of the first selected software to implement network simulation in the academic field.

6. DISADVANTAGE OF LEACH

[1] LEACH does not provide clarity about position of sensor nodes and the number of cluster heads in the network.

[2] Each Cluster-Head directly communicates with BS no matter the distance between CH and BS. It will consume lot of its energy if the distance is far.

[3] The CH uses most of its energy for transmitting and collecting data, because, it will die faster than other nodes.

[4] The CH is always on and when the CH die, the cluster will become useless because the data gathered by cluster nodes will never reach the base station.

7. COMPARISION STUDY

Table 1 Comparison of different LEACH Protocols

Routing Protocols / Parameters	**LEACH -A**	**LEACH -F**	**LEACH –L**
	Advance Low Energy Adaptive Clustering Hierarchy	Fixed No. of cluster LEACH	Low Energy Adaptive Clustering Hierarchy
Hop Count	Single hop	Single hop	Multi hop
Cluster Head Selection	Residual energy levels	Random	Based on distance
Advantages	Heterogeneous energy protocol is proposed for the purpose of decreasing node failure	No need of re-clustering cluster head	All nodes in the sensor are homogeneous and energy constrained.
Disadvantages	Consumes much energy to transmit data to Base Station	1)Node mobility cannot be handled. 2) Less energy saving.	It demands each sensor node to record its own location information and the information of candidate routing CH increasing the storage Extra overhead for electing

8. CONCLUSION

Hierarchical routing protocol is one of the simplest and most commonly used in Wireless Sensor Network. For reduce the average latency LEACH protocol provide standard solution. But we observed that most of them facing problem of network lifetime. So we propose new design of energy efficient LEACH protocol for wireless sensor network. We will use NS2 platform for simulation & performance analysis. We expect the result with reduce the average latency per packet and increases lifetime.

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