A Survey of routing protocol LEACH for WSN

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Abstract- Wireless sensor network consists of spatially distributed sensor nodes which sense physical and environmental condition like sound, pressure, temperature etc and pass the data to the main location through the network. In WSN network life time and node energy efficiency are two most important terms. One major issue in wireless sensor networks is developing an energy-efficient routing protocol which has a significant impact on the overall lifetime of the sensor network. Clustering based Energy efficient LEACH (Low-Energy Adaptive Clustering Hierarchy) protocol can effectively increase WSN performance by dynamically changing cluster head. This paper surveys working of LEACH protocol, its limitations and advancements done in LEACH to improve its performance.

Index terms- wireless Sensor networks, Routing protocols**,** LEACH, Energy efficiency, Number of Cluster head NCH, network lifetime.

I. INTRODUCTION

Wireless Sensor networks have emerged as a promising tool for monitoring (and possibly actuating) the physical conditions, utilizing self-organizing networks of battery-powered wireless sensors that can sense, process and communicate. The requirements and limitations of sensor networks make their architecture and protocols both challenging and divergent from the needs of traditional Internet architecture.

A sensor network [1] [4] is a network of many tiny disposable low power devices, called nodes, which are spatially distributed in order to perform an application-oriented global task. These nodes form a network by communicating with each other either directly or through other nodes. One or more nodes among them will serve as base station (BS) they communicate with the user either directly or through the existing wired networks. The primary component of the network is the sensor, essential for monitoring real world physical conditions such as sound, temperature, humidity, intensity, vibration, pressure, motion etc. at different locations.

Each node typically consists of the four components: sensor unit, central processing unit (CPU), power unit, and communication unit.

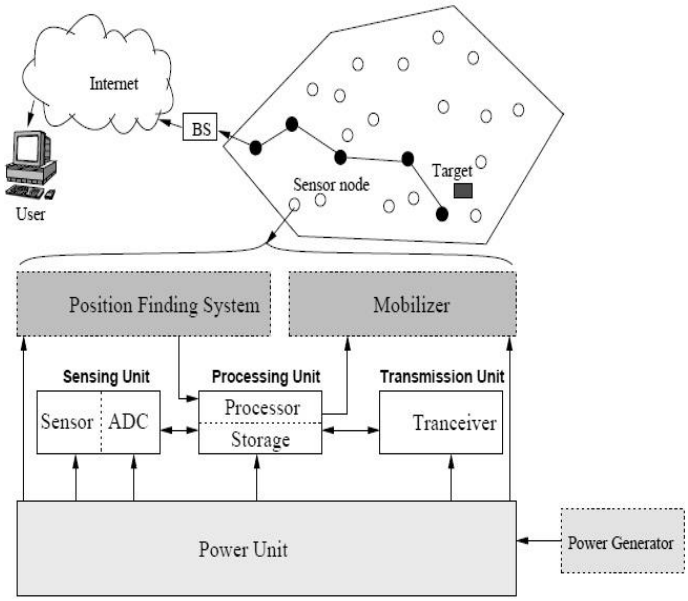

Figure 1: Structural view of sensor network

The sensor unit consists of sensor and ADC that is Analog to Digital Converter. The sensor unit is responsible for collecting information as the ADC requests, and returning the analog data it sensed. ADC is a translator that tells the CPU what the sensor unit has sensed, and also informs the sensor unit what to do. Communication unit is tasked to receive command or query from and transmit the data from CPU to the outside world. CPU is the most complex unit. It interprets the command or query to ADC, monitors and controls power if necessary, processes received data, computes the next hop to the sink, etc. Power unit supplies power to sensor unit, processing unit and communication unit. Each node may also consist of the two optional components namely Location finding system and Mobilizer. If the user requires the knowledge of location with high accuracy then the node should pusses Location finding system and Mobilizer may be needed to move sensor nodes when it is required to carry out the assigned tasks.

II. APPLICATION OF SENSOR NETWORK

1) Military: Military situation awareness. Sensing intruders on basis. Battle field surveillances [5].

2) Emergency situation: Disaster management. Fire/water detectors [2]. Hazardous chemical level and fires [4].

3) Physical world: Habitual monitoring. Observation of biological and artificial systems. Environmental monitoring of water and soil.

4) Medical and health: Sensors for blood flow, respiratory rate, ECG (electrocardiogram), pulse oxymeter, blood pressure and oxygen measurement. Monitoring people's location and health condition.

5) Industrial: Factory process control and industrial automation [6]. Monitoring and control of industrial equipment [2].

6) Home network: Home appliances, location awareness (blue tooth [2]). Person locator.

7) Automotive: Tire pressure monitoring [2]. Active mobility. Coordinated vehicle tracking [6].

III. LEACH PROTOCOL

LEACH, which was presented by Heinzelman [9], is a low-energy adaptive clustering hierarchy for WSN. The operation of LEACH can be 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 form the nodes to the cluster head and on to the base station.
Its Main objectives are extension of network life time, reduced energy consumption, use data aggregation to reduce the number of communication massages.

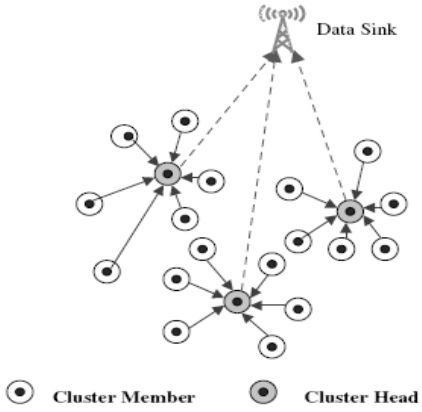

Figure 2: LEACH network model

LEACH adopts a hierarchical approach to organize the network into a set of clusters. Each cluster is managed by a selected cluster head. The cluster head assumes the responsibility to carry out multiple tasks.
The first task consists of periodic collection of data from the cluster members. Upon gathering the data, the cluster head aggregates it in an effort to remove redundancy among correlated values. The second main task of a cluster head is to transmit the aggregated data directly to the base station. The transmission of the aggregated data is achieved over a single hop. The third main task of the cluster head is to create a TDMA-based schedule whereby each node of the cluster is assigned a time slot that it can use for transmission.

The cluster head advertises the schedule to its cluster members through broadcasting. To reduce the likelihood of collisions among sensors within and outside the cluster, LEACH nodes use a code-division multiple access–(CDMA) based scheme for communication.

IV. LEACH OPERATION

The basic operations of LEACH are organized in two distinct phases as shown in figure.
(1)Setup phase: cluster-head selection and cluster formation.
(2)Steady-state phase: data collection, aggregation, delivery to the base station.

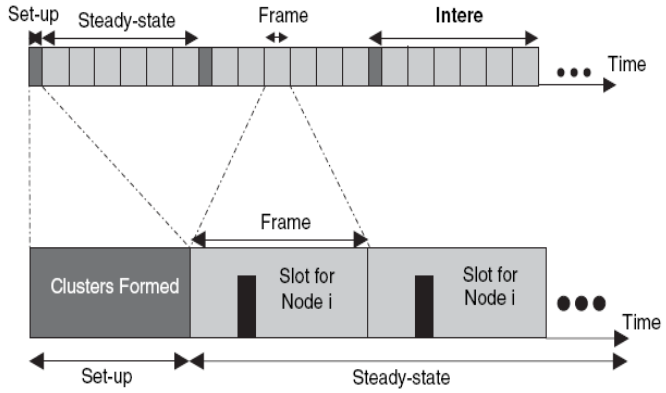

Figure 3:LEACH phases

The duration of the setup is assumed to be relatively shorter than the steady-state phase to minimize the protocol overhead.

V. LEACH ALGORITHM DETAIL

The operation is divided into rounds, where the each round starts with a set-up phase, when the clusters are organized, followed by the steady-state phase as shown in algorithm. In order to minimize the load ,the steady-state phase is long compared to set-up phase. The basic flow chart of the LEACH protocol is shown in the figure.

A. Advertisement phase

Initially, each node decides whether or not to become a cluster-head for the current round. This decision is based in the determined a priori [8] and the number of times the node has been a cluster-head. This decision is made by selecting the node n choosing a random number between 0 and 1. If this is less then threshold T(n),the node becomes cluster-head for the current round. The threshold level is set by:

$$T(n) = \frac{p}{1 - p * \left(r \bmod \left(\frac{1}{p}\right)\right)}, \quad if\ n \epsilon G$$

$$= 0 \qquad \text{otherwise}$$

Where the p = desired percentage of cluster heads (in our work p= 0.05),
r = the current round, and
G is the set of the nodes that have not been cluster-heads in the last rounds.
The nodes which are being cluster-head for the current round broadcast advertisement message to rest of the nodes with same transmit energy. There must be receiver of the non cluster-head on while advertising.

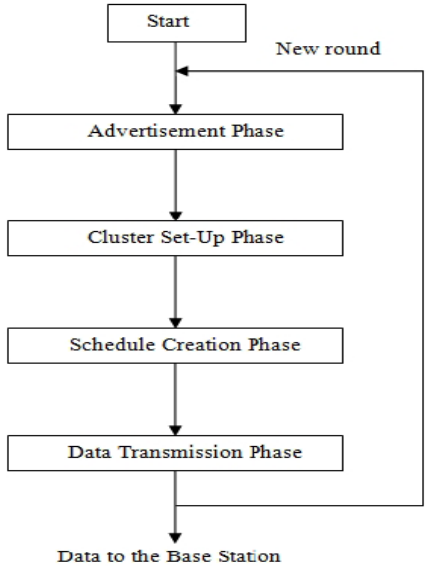

Figure 4:LEACH algorithm flow chart

After this, each node decide to which it would belongs base on receiving signal strength of advertising signal. Random cluster-head is chosen in case of the ties.

B. Cluster Set-up Phase

After decided that nodes which it belongs to, it would request to cluster-head to be part of that cluster. During this phase ,the receiver of all the cluster-head must be on.

C. Schedule Creation

The cluster-head receives all the messages as request to be part of that cluster. Based on the number of nodes in cluster, it would creates a TDMA schedule to tell when it can transmits. This schedule is broadcasted back to nodes in that cluster.

D. Data Transmission

As and when TDMA schedule is fixed, data transmission can begin. The data aggregation occurred before transmitting the data to the base station. Finally the compressed data send to the base station by the cluster-head. This is the steady state operation of sensor network using LEACH protocol. After certain time these four phase would be repeated.

VI. DISADVANTAGES OF LEACH

1 LEACH does not provide clarity about position of sensor nodes and the number of cluster heads in the network. [9]

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.

VII. LEACH IMPROVEMENT TECHNIQUES

Many techniques proposed as new modification for LEACH to provide more security & to reduce energy consumption

(1) S-LEACH
Here we introduced a secure hierarchical protocol called S-LEACH, which is the secure version of LEACH. S-LEACH improves the method of electing cluster heads and forms dynamic stochastic multi-paths cluster heads chains to communicate to the base station, In this way it improve the energy-efficiency and hence prolong the lifetime of the network.

(2) R-LEACH
Secure solution for LEACH has been introduced called RLEACH in which cluster are formed dynamically and periodically. In RLEACH the orphan node problem is raised due to random pair-wise key scheme so they have used improved random pair-wise key scheme to overcome. RLEACH has been used the one way hash chain, symmetric and asymmetric cryptography to provide security in the LEACH Hierarchical routing protocol.

(3) LEACH-CC (LEACH-Centralized with Chain)
However, using a central control algorithm to form the clusters may produce better clusters by dispersing the cluster-head nodes throughout the network. Then a chain routing between cluster-heads is established to reduce the amount of nodes which communicate with the base station. Further improvement in energy cost for data gathering can be achieved if only one cluster-head transmits to base station and if each cluster-head transmits only to local neighbor cluster-heads in the data fusion phase.

(4) LEACH-SM
First completely analyze the basic distributed clustering routing protocol LEACH (Low Energy Adaptive Clustering Hierarchy), then proposed a new routing protocol and data aggregation method in which the sensor nodes form the cluster and the cluster-head elected based on the residual energy of the individual node calculation without re-clustering and the node scheduling scheme is adopted in each cluster of the WSNs. In the node scheduling scheme

(ACTIVE and SLEEP mode) the energy efficiency is increased near to 50% than LEACH protocol and lifetime of the networks also increased.

VIII. CONCLUSON

In this paper, one of the main challenges in the design of routing protocols for WSNs is energy efficiency due to the scarce energy resources of sensors. The ultimate objective behind the routing protocol design is to keep the sensors operating for as long as possible, thus extending the network lifetime. The energy consumption of the sensors is dominated by data transmission and reception. Therefore, routing protocols designed for WSNs should be as energy efficient as possible to prolong the lifetime of individual sensors, and hence the network lifetime. Because of this reason LEACH protocol selected. It gives better performance in energy efficiency and network life time. We can say the advantage of LEACH overcome the problem of WSN and So LEACH modified further for future work. This modified or improved LEACH gives more better result than normal LEACH.

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