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A Comparative Study on LEACH Protocol for Wireless Sensor Network

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ABSTRACT: A Wireless Sensor Network becomes a vital part of modern technology like communication, security, military, environment etc.,. This network is composed of a large number of sensor nodes. It requires continuous monitoring of the field under test. Hence a suitable algorithm protocol is required for the sustained operation of the entire network. LEACH is a one such protocol which is low energy adaptive clustering hierarchy protocol. It is a data aggregation algorithm that minimizes the data transmission by reducing the size of the data and also reduces the power consumption in the network. This paper attempts to make a comparative study of the different LEACH protocol methods adopted in various applications.

KEYWORDS: Wireless Sensor Networks, PROTOCOL , LEACH protocol

I. INTRODUCTION

To scale the growth of a country, its development in science and technology is the dominating factor. Technological development mainly relies on development in communication, digital electronics and analog electronics. For cost effective implementation of these technology, it requires Wireless Sensor Network (WSN) [1]. These networks effectively monitor physical or environmental conditions like as temperature, sound, vibration, pressure, motion etc. As shown in the Fig.1 ,these wireless sensor network collects data from a domain, process it and transmit it to the application domain. To communicate among these, the collaboration of nodes is required to ensure that distant nodes communicate with application domain [2][3].

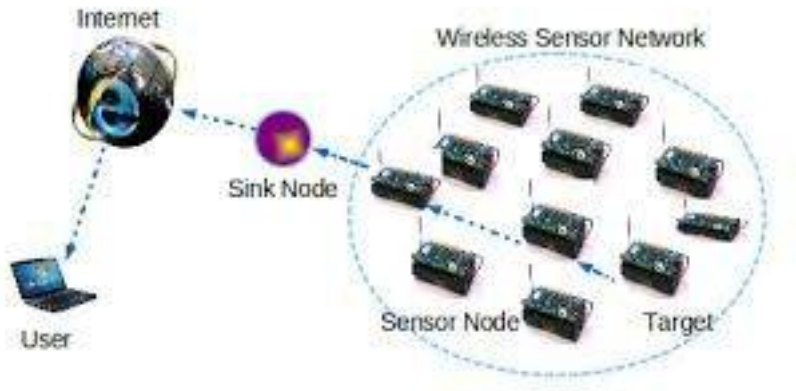

Fig .1

In WSN, routing strategies and security issues are most important and now are great research challenge [4]. The routing protocol in WSN must always concern the core problem of reducing energy consumption and prolonging

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network life time. Well-designed network protocols can reduce energy consumption and prolong network life time. In general, the routing protocol is classified as flat routing protocol and hierarchical routing protocol. Hierarchical protocols are defined to reduce energy consumption by aggregating data and to reduce the transmissions to the base station. The best algorithm is Low Energy Adaptive Clustering Hierarchy (LEACH) algorithm.

In LEACH protocol, the cluster heads form a higher layer network thus the functions of the cluster members become simple relatively, which greatly reduces the number of routing control information .This is clearly visualized in fig.2. However, the protocol also exists some problems such as large energy consumption and energy imbalance. To solve the above problems, LEACH protocol has been improved through analysis of the classic clustering routing protocol LEACH, and mainly for the purpose of reducing power consumption, achieving energy balance, and extending the network lifetime.

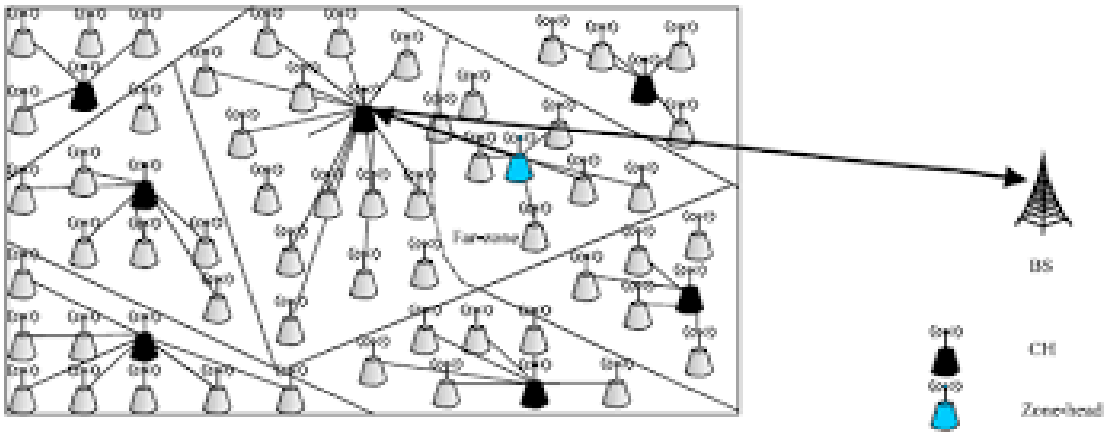

Fig . 2

Many researchers focussed on this LEACH protocol and overcoming the difficulties in each and every one. This paper aims to review few algorithms proposed by several researchers.

II. LEACH ALGORITHM TECHNIQUES

LEACH protocol [4] is typical representative of hierarchical routing protocols. It is self adaptive and self organised. It employs a cyclic process that involves cluster set up stage and steady state stage. The steady state stage must be longer than the set up stage so as to reduce unnecessary energy costs.

At the stage of cluster forming, a node randomly picks a number between 0 and 1. This number is compared to the threshold values. If the number is less than the threshold values , it becomes cluster head in the cycle otherwise it becomes common mode**.** This is illustrated in the Fig.3.

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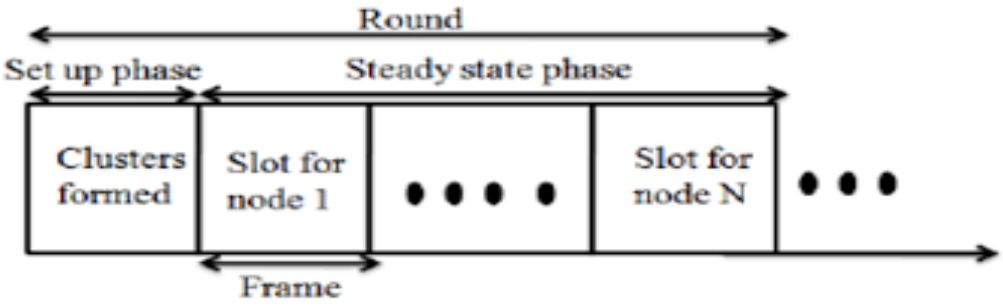

Fig.3

When clusters have formed, the nodes start to transmit the inspection data. Cluster heads receive data sent from the cluster members, the received data was sent to the gateway after fused. This is a frame transmission. In order to reduce unnecessary energy costs , steady state stage is composed of multiple frames.

The execution process of the Wireless Sensor Network with LEACH is explained as follows.

Step1: construct the motes and frame the network.

Step2: select the cluster heads among the Wireless nodes.

Step3: Divide the network in to various clusters.

Step4: At the end of first round, check the energy consumption of every node. If the energy level is too low, then go to step2 otherwise proceed the output through selected cluster head.

The above process is pictorially represented in the fig.4

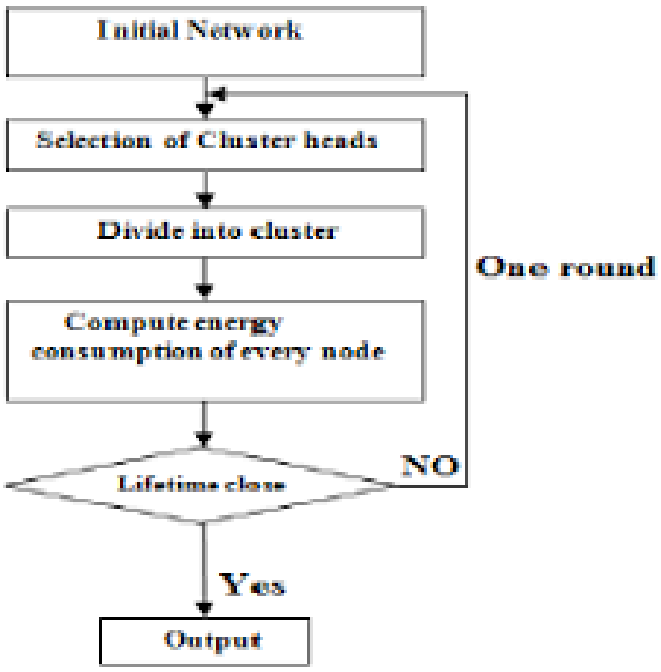

Fig . 4

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III . LITERATURE REVIEWS

1. LEACH – TLCH

It is a two levels cluster head LEACH protocol proposed by Chunyan and others. Same process of selection and cluster formation is adopted in this method. For collecting and fusing data from the member nodes, secondary cluster head is used and it sends them to its cluster head. The cluster head plays an important role to send this data to base station. In case of cluster without secondary cluster head, the cluster head is responsible for collecting data from the member node , fusing the data and sending them to base station.

In the first order energy transfer model, for long distance data transfer, the energy consumption for data collection and fusion is less than that of data transfer. So the life of clusters with secondary cluster heads will not be extended so as to bring new energy imbalance of consumption of entire network. Hence the main problem of energy consumption can be solved by this LEACH-TLCH protocol.

2. LEACH - P

Nidhi Guptha , Harish Guptha and Ram Lal [5] proposed a protocol known as LEACH-P protocol. In WSN, some of the nodes become cluster heads, aggregate the data of the cluster members and transfer it to the sink. So the source of heterogeneity arises from initial setting. The LEACH protocol assumes all the nodes are supplied with same amount of energy that results instability in heterogeneity. In LEACH- Proposed (LEACH-P) protocol, the stability of clustering hierarchy is improved using the concept of heterogeneity by implementing advanced nodes and common nodes. In this protocol, they proposed stable election protocol to increase the time interval of the death of first node by 8 times. This reduces communication energy by 8 times compared with direct transmission and minimum energy transmission routing.

3. MS-LEACH

It is modified version of S-LEACH which enhances the security of S-LEACH by providing data confidentiality node-cluster head authentication proposed by Mona and Eman [6]. This can be done by using pair wise keys shared between cluster heads and their cluster members. MS-LEACH provides pair wise key with no communication overhead in addition to the two symmetric keys used in S-LEACH.

MS-LEACH is superior than S-LEACH in terms of power consumption, network lifetime network through put and routing level.

4. LEACH-SM Protocol

LEACH-SM [7] is a protocol used for space management. It modifies LEACH by enhancing it with an efficient management of spares. It is also designed for static sensor nodes and static targets. The LEACH-SM protocol achieves the following objectives:

- Extending WSN lifetime.
- Maintaining the above-threshold coverage throughout the WSN lifetime.
- Reducing transmission of redundant data to cluster heads.
- Allowing all sensor nodes in all clusters to decide in parallel if they become primaries or spares.
- Maintaining scalability by using only local information.

LEACH-SM adds a phase, called the spare selection phase, to the original LEACH protocol. It follows the setup phase, and is followed by the regular operation of the WSN. Spare management is carried out by spare selection performed during the spare selection phase by the Decentralized Energy-efficient Spare Selection technique (DESST). DESST extends WSN lifetime since the nodes that become spares go asleep, while the WSN as the whole maintains the required above-threshold target coverage.

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5. AQM-LEACH

To monitor the air pollution, LEACH protocol can be employed and it is known as Air Quality Monitoring LEACH (AQM – LEACH) . This protocol is developed by Hanady et al [8]. In LEACH protocol, the data is sent to base station after fusion at the end of every round. But in this model it is not so unless it is required and saves energy. The data transmission depends on the Air Quality Index (AQI).

If the AQI is in good level then less data should be sent since no harm on human health is expected, and hence, no alarms are needed to be raised. Whenever the AQI values are higher and mapped to be in levels with more effect on human health, then more data must be collected as the situation is considered unusual and need to be precisely addressed. The main goal of collecting more data is to reflect the exact air quality situation. The frequency of collecting data reaches its maximum when the air is in hazardous level. Using this strategy, the power consumption in the network is clearly reduced due to the fact that the network has low data transmission since the normal case for air quality is having most of the readings in good/moderate status. Therefore ,the network lifetime is increased.

6. ARMOR-LEACH:

M.A. Abuhelaleh , T. M. Mismar and A. A. Abuzneid proposed **ARMOR-LEACH [9],** a hybrid technique which combines both the solutions provided by Sec-LEACH and TCCA in one complete solution. Sec-LEACH protect the network from various attacks such as spoofing, jamming etc especially the sinkhole and selective forwarding attacks. Time-Controlled Clustering Algorithm (TCCA) controls the formation of clusters using message time-to-live and time stamp.TCCA allows multi-hop clusters.

Armor-LEACH saves high energy and high performance, three times better when compared to LEACH and Sec-LEACH. It also Provides high level of security than LEACH and TCCA

7. LEACH - B

To overcome the problems available in LEACH, especially in the cluster head selection and the ignorance of their energy, Mu Tong and Minghao Tang proposed LEACH – B protocol [10].

This enhanced algorithm considers the residual energy of the node at each round choose the cluster head based on the optimal number.

After the selection of first cluster head, a second selection is done at each round , based on the nodes residual energy in order to modify the number of cluster head.

IV. CONCLUSION

Though the LEACH protocol is the first hierarchal protocol it has both advantages and disadvantages. The various advantages of LEACH protocol are:

1. The Cluster Heads aggregates the whole data which lead to reduce the traffic in the entire Network.
2. As there is a single hop routing from nodes to cluster head it results in saving energy.
3. It increases the lifetime of the sensor network.
4. In this, location information of the nodes to create the cluster is not required.
5. LEACH is completely distributed as it does not need any control information from the base station as well as no global knowledge of the network is required.

Its disadvantages are as follows:

1. LEACH does not give any idea about the number of cluster heads in the network.
2. One of the biggest disadvantages of LEACH is that when due to any reason Cluster head dies,

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the cluster will become useless because the data gathered by the cluster nodes would never reach its destination i.e.Base Station .

3. Clusters are divided randomly, which results in uneven distribution of Clusters. For e.g. some clusters have more nodes and some have lesser nodes. Some cluster heads at the centre of the cluster and some cluster heads may be in the edge of the cluster .This phenomenon can cause an increase in energy consumption and have great impact on the performance of the entire network.

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