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Comparison of Energy Efficient Clustering Protocols in Wireless Sensor Networks - A Review

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Abstract: Wireless sensor networks with hundreds of sensor nodes have emerged in recent years as important platforms for a wide spectrum of monitoring tasks ranging from environmental to military applications. Its growth is expeditiously increasing and that's why there is an immense field for research in this area. Sensors depend entirely on the trust of their battery for power, which cannot be revitalized or substituted. So the design of energy aware protocol is essential in respect to enhance the network lifetime. LEACH, LEACH C and HEED are energy- efficient hierarchical based protocols that balances the energy expense, saves the node energy and hence prolongs the lifetime of the network. So this paper presents a detailed review and analysis of these energy efficient protocols. Comparison of various network parameters is done in the form of tables and graphs. In the last of the paper conclusions is drawn.

Keywords— Routing, LEACH, LEACH C,HEED, Number of Cluster head NCH ,Wireless Sensor Networks (WSN).

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1. Introduction

A wireless sensor network (WSN) is a specialized wireless network that composes of a number of sensor nodes deployed in a specified area for monitoring environment conditions such as temperature, air pressure, humidity, light, motion or vibration, and so on[2]. The sensor nodes are usually programmed to monitor or collect data from surrounding environment and pass the information to the base station for remote user access through various communication technologies. Figure 1 shows general wireless sensor network architecture.
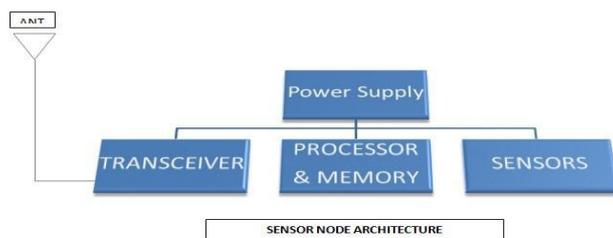
[fig1]

 Typically, a sensor node is a small device that consists of four basic components as shown in Figure

1) sensing subsystem for data gathering from its environment, 2) processing subsystem for data processing and data storing, 3) wireless communication subsystem for data transmission and 4) energy supply subsystem which is a power source for the sensor node. However, sensor nodes have small memory, slow processing speed, and scarce energy supply. These limitations are typical characteristics of sensor nodes in wireless sensor networks.

The wireless sensor network has many sensor nodes; these nodes can forward the information and cooperate with each other to accomplish some specific tasks through the application of communication for wireless self organization [1].The application of sensor nodes can be used in many areas, such as the military monitoring, environmental, industry, medical, industry and agriculture [2]. Because the sensor nodes have small size, cost and other factors. Sensor node has a battery with limited bandwidth and the capacity. Usually the sensors are arranged in very bad condition. So we consider about the limited energy of sensors, if we went to design any wireless sensor network protocol. A cluster head is the main issue in WSN, Many of clustering algorithms [3], [4] and LEACH [3] is one these algorithms dependent on the Clustering in WSN. LEACH algorithm use randomly strategy to selected cluster-heads (CH), to enhance the lifetime and energy consumption of sensors network. LEACH has many improvement protocols [3] [4] which considering the residual energy of the nodes, to select the cluster head.

HEED [6] protocol considers the residual energy and communication cost to select cluster heads. In this work, we compare our proposed, LEACH and HEED Protocols. The remainder of this paper is organized as follows. Section 2 introduces a related work, describes the LEACH and HEEDS protocol in Section 3 and 4, Section 5 shows the proposed work and section 6 shows conclusion and future work.

2. Related Work

[5] In this paper author discussed that Data aggregation protocols are required in Wireless Sensor Networks (WSNs) to improve the data accuracy and extend the network lifetime by reducing the energy consumption. The existing Data Aggregation-Optimal LEACH (DAO-LEACH) protocol for WSN is enhanced in terms of security and fault-

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tolerance based on Gracefully Degraded Data Aggregation (GDDA) to ensure the integrity of the aggregated data and Hybrid Layer User Authentication (HLUA) to ensure the confidentiality of the aggregated data. This data aggregation scheme rejects the false data from compromised and malfunctioning Sensor Nodes (SNs) [5].

In [7], authors discussed advantages of maintenance, scalability and less overheads of wireless sensor network clustering. This proposed depend on eight clustering attributes to classification of wireless sensor network clustering, and then analyzed six clustering algorithms of wireless sensor network clustering, such as LEACH, HEED, PEGASIS, and etc.,the authors depend on various attributes to compare clustering algorithms of wireless sensor network.

In [8], discussed some clustering protocols operations and analyzed clustering algorithms advantages and

limitations. The authors The studded seven algorithms of WSNs clustering, such as LEACH, TEEN, APTEEN, TL-LEACH, and etc. proposed compared the clustering algorithms of In addition, the survey compared to assemble these protocols in terms lifetime of network and energy consumption.

The authors [9], presented the WSNs clustering algorithms, they discussed the major challenges of clustering algorithms, such as HEED, LEACH and EECS. This proposed considered the residual energy, cluster size, cluster distance and delay as a main metrics to compared clustering algorithms for wireless sensor networks.

Another simple survey on clustering routing algorithms was given by Joshi [10]. Only eight popular clustering routing protocols are covered in this survey, such as LEACH, PEGASIS, TEEN, APTEEN, *etc*. The authors of the survey briefly compared these clustering routing approached based on energy conservation and the network lifetime.

An overview of Haneef and Deng [11] focuses on design challenges and comparative analysis of WSN clustering routing algorithms for improving the network lifetime. The authors of the overview analyzed many challenging factors that influenced design of routing protocols in WSNs, and presented a simple classification of routing protocols. Besides, many efficient clustering based classical WSN routing protocols with comparative analysis were discussed in the overview.

3. LEACH Protocol

Low Energy Adaptive Clustering Hierarchy (LEACH) is the first hierarchical cluster-based routing protocol for wireless sensor network which partitions the nodes into clusters, in each cluster a dedicated node with extra privileges called Cluster Head (CH) is responsible for creating and manipulating a TDMA (**Time division multiple access**) schedule and sending aggregated data from nodes to the BS where these data is needed using CDMA (**Code division**

multiple access). Remaining nodes are cluster member. In the first phase, close nodes make a cluster dynamically, and one node will be selected as cluster head randomly; in the second phase, every node send their data to cluster head, then cluster head collect the data and sends it to the sink node[fig2].

This protocol is divided into rounds; each round consists of two phases;

Set-up Phase
(1) Advertisement Phase
(2) Cluster Set-up Phase
Steady Phase
(1) Schedule Creation
(2) Data Transmission
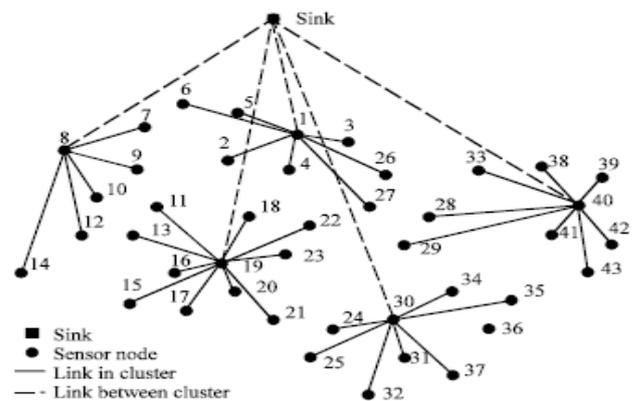
[fig2]
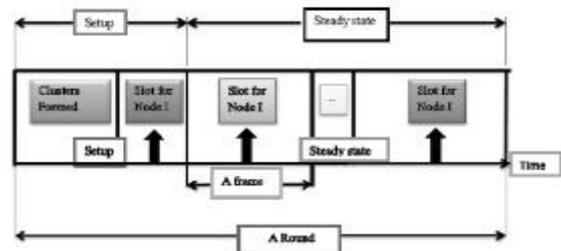
[Fig3]

3.1 Setup Phase

Each node decides independent of other nodes if it will become a CH or not. This decision takes into account when the node served as a CH for the last time (the node that hasn't been a CH for long time is more likely to elect itself than nodes that have been a CH recently).

In the following advertisement phase, the CHs inform their neighborhood with an advertisement packet that they become CHs. Non-CH nodes pick the advertisement packet with the strongest received signal strength.

In the next cluster setup phase, the member nodes inform the CH that they become a member to that cluster with "join packet" contains their IDs using CSMA. After the cluster-setup sub phase, the CH knows the number of member nodes and their IDs. Based on all messages received within the cluster, the CH creates a TDMA schedule, pick a CSMA

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code randomly, and broadcast the TDMA table to cluster members. After that steady-state phase begins[fig3].

3.2 Steady-state phase:

Data transmission begins; Nodes send their data during their allocated TDMA slot to the CH. This transmission uses a minimal amount of energy (chosen based on the received strength of the CH advertisement). The radio of each non-CH node can be turned off until the nodes allocated TDMA slot, thus minimizing energy dissipation in these nodes. When all the data has been received, the CH aggregate these data and send it to the BS. LEACH is able to perform local aggregation of data in each cluster to reduce the amount of data that transmitted to the base station.

Although LEACH protocol acts in a good manner, it suffers from many drawbacks such like;

• CH selection is randomly, that does not take into account energy consumption.

• It can't cover a large area.

• CHs are not uniformly distributed; where CHs can be located at the edges of the cluster.

Since LEACH has many drawbacks, many researchers have been done to make this protocol performs better.

4. LEACH-C protocol

LEACH offers no guarantee about the placement and/or number of cluster heads. The protocol, called LEACH-C, uses a centralized clustering algorithm and the same steady-state phase as LEACH. LEACH-C protocol can produce better performance by dispersing the cluster heads throughout the network. During the set-up phase of LEACH-C, each node sends information about its current location (possibly determined using GPS) and residual energy level to the sink. In addition to determining good clusters, the sink needs to ensure that the energy load is evenly distributed among all the nodes. To do this, sink computes the average node energy, and determines which nodes have energy below this average.

Once the cluster heads and associated clusters are found, the sink broadcasts a message that obtains the cluster head ID for each node. If a cluster head ID matches its own ID, the node is a cluster head; otherwise the node determines its TDMA slot for data transmission and goes sleep until its time to transmit data. The steady-state phase of LEACH-C is identical to that of the LEACH protocol.

5. HEED Protocol

Hybrid Energy Efficient Distributed clustering (HEED) [6], is a multi-hop wireless sensor network clustering algorithm that brings an energy-efficient clustering routing with explicit consideration of energy. Different from Leach in the way of elections the cluster head, HEED does not select in the cluster head in randomly manner. Is performed the cluster method based on the hybrid combination of the two

parameters. The first parameter depends on the residual energy of the node, and the second parameter is considering the cost of communications within the intra-cluster[fig4]. Elected cluster head in HEED, depending high average of residual energy compared to MNs.
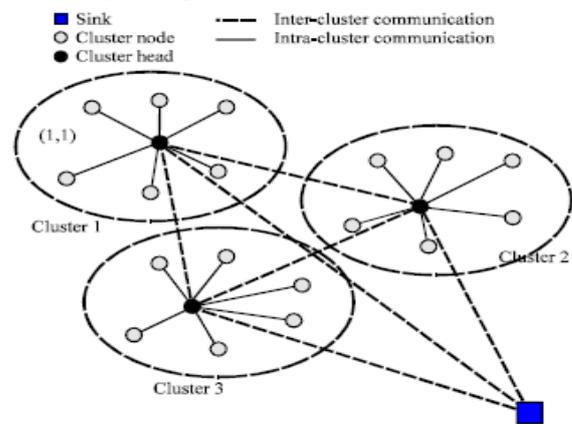
[fig4].

A node considers itself covered if it has heard from either a tentative_ CH or a final _CH. If a node completes HEED execution without selecting a cluster head that is final _CH, it considers itself uncovered, and announces itself to be a cluster head with state final_ CH. A tentative _CH node can become a regular node at a later iteration if it finds a lower cost cluster head. HEED protocol depend on residual energy, and communication cost to select cluster head.

The communication cost is the minimum power levels required by all nodes within the cluster range to reach the cluster head. The communication cost uses to allow a node that belong to several CHS choose the best one. In HEED protocol each node can join only to one cluster head with one hop only. After a cluster formation, each node can be either elected to become a CH due to a probability or join a cluster according to CH messages.

6. Proposed Work

Network and Energy Configurations

All the nodes are equipped with some amount of initial energy to be able to take the costs of communication throughout the actual experiments, which usually consist in two rounds of operation. The initial energy can be homogeneous or heterogeneous across the nodes, meaning that, in case of homogeneous energy initialization, all the nodes have the same – maximum – level of energy when starting the operation. In contrast to this, in case of heterogeneous energy initialization, nodes are equipped with a uniformly randomly produced energy level from the range of being depleted to being fully charged.

Earlier this stage it will be necessary to re-intensify the operation of each algorithm to implement, understand and identify each mechanism / technique specified, so that it can, where possible, to generalize operations or interfaces in

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order to reuse for other algorithm. Thus, this phase will require a learning / knowledge of each algorithm, also contributing to the expertise in this field. . The simplest approach for routing protocols is the One-hop that has been implemented for this work since it is a good simulation to see whether the compared protocols are energy-efficient or not and how much they elongate the batteries lifetime

Using the tools provided by the platform, it should be possible at the end of implementation, to systematize the simulations, in order to extract results.

These results, by itself, the algorithms must characterize safety and whether the correction certain parameters, namely:

- Protocol correct,
- Analysis of energy consumption;
- Reliability and Delivery of messages;
- The correction of events;
- Latency.

Simulations will be carried out in MATLAB that helped us to exploit the benefits of the propagation channels for longevity of the energy constrained network
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7. Conclusion And Future Scope

Finally it is concluded from the survey that, still it is needed to find more scalable, energy efficient and stable clustering scheme, for data gathering in wireless sensor networks. . The result of our experimental work to shows the comparing which protocol is more energy efficient routing protocol for wireless sensor network in the form of energy consumption and cost of sensor nodes.

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