A Survey on Leach-Energy Based Routing Protocol

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Abstract-- A wireless sensor network is a collection of nodes organized into a cooperative network. Each sensor is equipped with programmable computing, multiple sensing and communication capability. Sensors sense data at a fixed rate and always have to send data to the end-user. The most energy efficient routing protocols can be used for minimizing the energy consumed in collecting and disseminating. Leach is one of the fundamental protocols based on clustering technique. We have surveyed the different hierarchical routing protocols that have been developed from the LEACH. This paper highlights some of the pros and cons of the descendants protocols.

Keywords-- Wireless sensor networks, Cluster Head, Hierarchical Routing, LEACH.

I. INTRODUCTION

Routing is main challenge faced by wireless sensor network. It is more complex in WSN due to dynamic nature of WSN, limited battery life, computational overhead, self-organization and limited transmission range of sensor nodes.

Routing protocols in WSNs

- Network structure
  - Flat network routing
  - Hierarchical network routing
  - Location based routing
- Protocol operation
  - Negotiation based routing
  - Multipath based routing
  - Qos based routing
  - Coherent based routing

Fig.1 Routing protocol is based of two ways network structure and protocol operation. Here we discuss one of the routing protocol which follows hierarchical routing.

1. Leach

LEACH stands for Low-Energy Adaptive Clustering Hierarchy. This WSN is considered to be a dynamic clustering method. The LEACH Network is made up of nodes, some of which are called cluster-heads. The job of the cluster-head is to collect data from their surrounding nodes and pass it on to the base station. LEACH is dynamic because the job of cluster-head rotates. The LEACH network has two phases:

1) The set-up phase
2) The steady-state

Set-up phase:

Cluster-heads can be chosen stochastically (randomly based) on this algorithm:
Where \( n \) is a random number between 0 and 1
\( P \) is the cluster-head probability
\( G \) is the set of node

- If \( n < T(n) \), then that node becomes a cluster-head. The high energy cluster head position rotates among the various sensors in order to not to drain the battery of a single sensor. (currently just random).
- Each node takes the decision independent of the other nodes to become cluster head. It is based on the percentage determined a priori and round number.

Steady phase:

Nodes transmit data based on TDMA schedule. After data has been received, cluster head perform signal processing/compression and send to basestation. After a certain time (determined a priori) a new turn begins. Main energy saving is due to combining lossy compression with the data routing and tradeoff between quality of output and amount of compression resulting in substantial reduction of overall energy dissipation.

1.1 LEACH-A (Advanced Low Energy Adaptive Clustering Hierarchy)

The data is processed using mobile agent technique based on Leach. Advanced Leach[2], a heterogeneous energy protocol is proposed for the purpose of decreasing the node’s failure probability and for prolonging the time interval before the death of the first node. By using a synchronized clock, each sensor knows the starting of each round. Let \( n \) be the total number of nodes and \( m \) be the fraction of \( n \) that are equipped with a time more energy than others. These nodes are called CAG nodes, the nodes selected as cluster heads or gateways and the rest (1-\( m \)) \times \( n \) as the normal nodes. The CAG nodes will become the cluster head for the data aggregation and transmit to the sink.

\[
T(n) = \begin{cases} 
P & \text{if } \forall n \in G \\
1-P*(r \mod p^{-1}) & \text{otherwise} 
\end{cases}
\]

1.2 LEACH-F (Fixed number of clusters)

A stable clusters and rotating cluster head concept is used by Leach-F in which cluster once formed is maintained stable throughout the network lifetime in order to avoid re-clustering.

In Leach-F new nodes cannot be added to the system and do not adjust their behaviour based on nodes dying. Only the cluster head position is rotated among the nodes within the cluster.

1.3 TL-LEACH (Two-Level)

Authors introduced a new version of LEACH called Two-Level LEACH[5]. In this protocol, a CH collects data from other cluster members as original LEACH does. However, rather than transfer data to the BS directly, it uses one of the CHs in the path to the BS as a relay station.

1.4 LEACH-L (Low Energy Adaptive Clustering Hierarchy)

Leach-L is an advanced multihop routing protocol[5] and considers only the distance. It is suitable for large scale wireless sensor network and the optimum hop counts are deduced. The cluster heads can communicate directly to the base station when they are located close to it. When they are located far away from the base station, they can communicate by the method of multi-hop way and the shortest transmission distance is limited. In this, the sensors are allowed to use different frequencies and gaps to communicate with base station. The clusters re-established in each round. And in each round new cluster heads are elected and the load is distributed and balanced among the nodes in the network.

1.5 LEACH-S (Solar-aware centralized leach)

In solar-aware Centralized LEACH [7] cluster head are selected by Base station with help of improved Central control algorithm. Base station normally select solar powered nodes as these have maximum residual energy. In solar aware LEACH, nodes transmit their solar status to base station along with energy and nodes with higher energy are selected as cluster-head. The sunduration increases the lifetime of the sensor network. The cluster head handover takes place if the sunduration is smaller.
Table 1: Comparision Between Leach Protocols

<table>
<thead>
<tr>
<th>PROTOCOL</th>
<th>HOP COUNT</th>
<th>CH SELECTION</th>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEACH-A</td>
<td>Single hop</td>
<td>Residual Energy Level</td>
<td>Heterogeneous energy protocol is proposed for the purpose of decreasing the node’s failure</td>
<td>Consumes much energy to transmit data to Base Station</td>
</tr>
<tr>
<td>LEACH-F</td>
<td>Single hop</td>
<td>Random</td>
<td>No need of re-clustering cluster members.</td>
<td>1) Node mobility cannot be handled. 2) Less energy saving.</td>
</tr>
<tr>
<td>LEACH-L</td>
<td>Multi hop</td>
<td>Based on distance</td>
<td>All nodes in the sensor are homogeneous and energy constrained.</td>
<td>It demands each sensor node to record its own location information and the information of candidate routing CH increasing the storage</td>
</tr>
<tr>
<td>LEACH-TL</td>
<td>Multi hop</td>
<td>Based on distance</td>
<td>New level of hierarchy used to transmit Information to Base Station (BS) over two different levels</td>
<td>Extra overhead for electing secondary CHs and cluster formation.</td>
</tr>
<tr>
<td>LEACH-S</td>
<td>Single hop</td>
<td>Residual Energy Level</td>
<td>Base station selects the cluster head with the help of improved central control algorithm.</td>
<td>If there’s a change in the sun status, the solar nodes need to send a “change status” to itself, these decreases its energy level</td>
</tr>
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</table>

II. CONCLUSION

Energy constraint is one of the major research topics in WSN. The routing consumes the largest amount of energy in WSN, so the routing protocol used for communication should be energy efficient. Here we discussed cluster-based routing protocols which the reduces communication energy by as much as 8 times compared to direct transmission and the first node death in LEACH occurs over 8 times later, and last node death occurs over 3 times later than any other protocol. With the number of advantages of LEACH protocol it also comes with some disadvantages. Also in future different ideas is to be applied on clustering based protocols and to increase the lifetime of the WSNs.

REFERENCES


