A Study on Data Aggregation Technics for Wireless Sensor Networks

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Abstract: This paper analyzes the data aggregation and routing mechanisms which are mainly used by the basic LEACH(Low Energy Adaptive Clustering Hierarchy) and improved LEACH algorithms, as the LEACH is considered as a benchmark in the wireless sensor domain and, highlight the advantages and disadvantages of these algorithms. Also, this paper suggests some of the recommendations to these existing algorithms so that, the data aggregation can be further simplified and in turn the overall lifetime of the sensor network can be improved.

Keywords- Data aggregation, Wireless Sensor Network, Network Lifetime, LEACH

I INTRODUCTION

Wireless sensor networks comprises of a large number of sensor nodes, each consisting of a small battery, transmitter, receiver, sensor and a camera in some cases. The main functionality of a sensor node is to sense the signals or information, receiving it and, transmitting it to a base station. To accomplish this task, various technics that fit in to the Wireless sensor domain. LEACH is a dominant protocol and also it is used as a benchmark in wireless sensor domain to compare and assess the performance of any other data aggregation and routing protocol[1][7].

In this paper we are mainly concentrating on the data aggregation and the power efficiency related issues. We have identified the advantages and drawbacks of the basic LEACH protocol and its improved version. Also, we have suggested some of the guidelines to improve data aggregation and overall lifetime of the network.

II BASIC LEACH PROTOCOL

The main idea behind the basic LEACH protocol is to divide the sensor nodes in to clusters[1] where, the cluster head is selected randomly. Here, all the nodes will get the equal opportunity to elect as a cluster head. The energy consumption of entire network is averaged. LEACH algorithm is cyclical[1][3], it provides a conception of round. It runs with many rounds. Each round has two states: cluster setup state and steady state. In cluster setup state, it forms different clusters in an dynamic or self adaptive manner. In steady state, it collects data from all the nodes and transfers data to the base station. The latter state occupies more time than the first state for saving the protocol payload. By using the below given formula, a decision is made to select a cluster head[7],

i) If 'n' belongs to 'G', then $T_n = p/1-p*(r*mod1/p)$

ii) If 'n' doesn't belongs to 'G', then $T_n = 0$.

Where, p-> Desired number of cluster heads

r-> Current round

G-> Set of nodes that are not cluster heads in the last 1/p rounds.

Using this threshold, each node will be a cluster head within 1/p rounds. There is a restriction that, any node can become a cluster head only once[1][2]. A sample cluster is shown in fig.1 below:

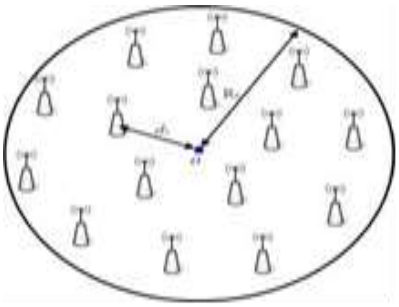

Fig.1:Sample Cluster

A. Advantages:

- Algorithm is very simple.
- Easy to implement
- Ideally suited for sensor domain

B. Disadvantages:

- Consumes more power.
- Cluster head is randomly selected.

- Un-even distribution of wireless sensor nodes.

C. Suggestions:

- Nodes should be distributed evenly.
- All the cluster heads need not send data to the base station. One nearest cluster head can send all the aggregated data to the base station.
- The node having maximum energy should become the cluster head.

III IMPROVED LEACH PROTOCOL

This protocol is designed to overcome some of the major shortcomings of the basic LEACH protocol. Here, consideration is given for the remaining energy of each node and the overall network[3].

i.e. Impact factor $(1 – E_a / E_n)$ and

Distance factor $(1 – d_n / R_c)$

Where, E_{ce}-> Remaining energy in cluster

E_n -> Remaining energy of node 'n' within the cluster

R_c -> Radius of the circle

d_n -> Distance between node 'n' and cluster head(centre)

To calculate the minimum value of the remaining energy of every node and the centre of cluster circle,

$$E_{ce} = \min(E_n)$$

Contains all the nodes inside the cluster with the least radius of the circle, Rc.
To find the threshold, the improved LEACH formula is given by,

i) if 'n' belongs to "G, then
$T_n = \{p / 1-p*(r*\text{mod}1/p) * [(1- E_{ce}/E_n)+(E_{ce}/E_n)(1-d_n/R_c)]$,
ii) if 'n' doesn't belongs to 'G',
$T_n=0$.

A. Multi-hop routing of cluster head using Centralised Chain:
In order to solve the un-even distribution of nodes in basic LEACH, here we can use the concept of chain that connects all evenly distributed clusters. Here, all the nodes will send data to the cluster head, from there it will be sent to either the nearest cluster head or to base station depending on which is near to that cluster head[5]. There only one node will be ultimately sending all the aggregated data. This algorithm also takes care of selecting the best path that results in energy saving.

The architecture of the wireless sensor network is shown below in fig.2:

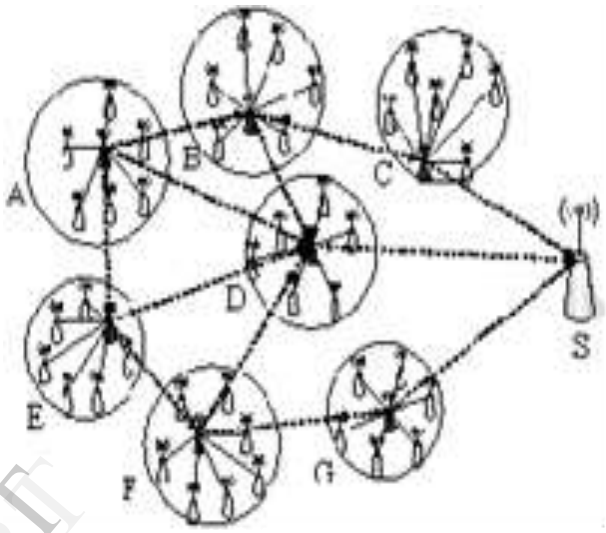

Fig. 2: The Wireless Sensor Network Architecture

B. Advantages:

- Even distribution of nodes.
- Considerably less energy consumption for data aggregation.
- Increased network life time

C. Disadvantages:

- It will not address node localization issues.
- Some times cluster heads may run out of energy.

D. Suggestions:

- Need to improve the battery life of a sensor node, especially cluster heads require more energy[6].
- Solar cells can be used to solve the energy problem.

IV Conclusion:

In this research paper, we are comparing and identifying the advantages and drawbacks of both the LEACH and its improved version. Improved LEACH has solved some of the problems of the basic LEACH, such as- uneven distribution of nodes, more energy for data aggregation etc. . Centralised chain concept of multi-hop routing

technique helps in reducing the energy consumption of overall network and thus increases the network life-time.

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