International Journal of Engineering Applied Sciences and Technology, 2016
Vol. 1, Issue 8, ISSN No. 2455-2143, Pages 145-148
Published Online June - July 2016 in IJEAST (http://www.ijeast.com)

A SURVEY ON CLUSTER HEAD SELECTION TECHNIQUES

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Abstract— **Low energy adaptive Hierarchical clustering Protocol (LEACH) is used to transfer the data to sink node by utilizing minimum amount of energy. It forms clusters of nodes that can adapt according to the various parameters like energy etc. TO enhance the network lifetime various modifications are proposed to the LEACH. These modifications include different procedures to form clusters and to select cluster head. . Stable Election Protocol (SEP), Distributed Energy-Efficient Clustering (DEEC), Developed DEEC (DDEEC), Enhanced DEEC (EDEEC) and Threshold DEEC (TDEEC) are algorithms designed for heterogeneous WSN. This paper evaluates the performance of DEEC clustering algorithms on the basis of stability period, network life time and throughput for different level of heterogeneous wireless sensor networks.**

KEYWORDS: Wireless Sensor Network, Clustering, LEACH, E-LEACH, C-LEACH

I. INTRODUCTION

Wireless sensor networks are usually consists of thousands of inexpensive, low-powered sensing devices having limited battery and communication resources [1,2]. These networks offer a good range of applications in the military as well as in civilian applications. The most signification feature of the WSN is the low deployment cost that results in several limitations like limited battery life etc. The network life can be prolonged by saving the battery. Therefore, in order to reduce the power consumption of wireless sensor networks, several mechanisms are proposed such as control packet elimination, topology control, and data aggregation [3]. Data aggregation targets to combine and summarize data packets of several sensor nodes so that amount of data transmission is reduced [1].

II. CLUSTERING

All nodes can transmit their data to the sink node but it will increase the network traffic So to decrease the network traffic i.e. to reduce the energy consumption the several Clustering technique are used. In these techniques a group of nodes is formed and they select a Cluster Head (CH) for transmission. All nodes within the cluster transmit their data to CH, where, it aggregates data and send to the Base Station (BS). Now the cluster head will transmit at large distance so, less energy is consumed. A clustered protocol shows better performance in terms of energy consumption when compared to other protocols. Clustering networks are classified in two types i.e. homogeneous and heterogeneous network [4]. All clustering techniques consist of two phases; setup phase and steady state phase. In setup phase, formation of clusters and election of CHs is performed and in steady state phase, nodes transmit data to CH and it aggregates the data for sending to BS.

Clustering techniques are of three type active, passive and hybrid. In active clustering scheme, all the sensor nodes are synchronized to maintain the clusters. While in the passive technique, no control packets are used. It exploits the data packets to transmit neighbor's information. Hybrid approaches use a combination of active and passive techniques [5].

3.1 Active Clustering

In this technique hello packets are used to collect information about the network. Active clustering algorithms use various criteria for the selection of a cluster-head Lowest-ID and use the identifiers of nodes and the number of neighbors. Basu et al.[6] adds the degree of mobility to the LEACH. It also assigns different roles to distinct nodes according to the Round-Robin policy management. Bagrodia et al.[7] said these algorithms require two phases: Neighbor discovery and cluster formation phase. However, nodes are assumed fixed over the steps and synchronization between them is necessary for the success of these algorithms. In addition, following each change of network topology these steps are repeated periodically, which degrades the stability of clusters.

3.2 Passive Clustering PC

Passive clustering [8] is the demand cluster formation protocol that does not use any protocol-specific control packets. In this data packets are used to transmit neighbor's information. Clusters are formed flooding the data message. It reduces the initial set-up period that results in reduction of the total energy consumed as the main function of the clusters is to optimize the exchange of flooded messages. Passive Clustering uses the MAC frame to encode the state of a network node. Passive Clustering uses two bits to encode four

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states (1) Initial, (2) Cluster head, (3) Gateway and (4) Ordinary [5].

III. LEACH AND ITS DESCENDANT

3.1 LEACH

Low Energy Adaptive Clustering Hierarchical Protocol (LEACH) uses the following techniques to achieve the design goals: randomized, self-configuring and adaptive cluster formation, Local control for data transfers and low-energy media access control and application specific data processing [11]. LEACH protocol has many rounds and each round has two phases, a setup phase and steady state phase, in set up phase it provides cluster formation in adaptive manner and in the steady state phase transfer of data takes place. LEACH uses a TDMA or a CDMA MAC to reduce inter-cluster and intra cluster collisions. Cluster formation based on many properties such as the number and type of sensors, communication range and geographical location. The energy consumption of the information gathered by the sensors node to reach the sink will depend on the number of cluster heads and radio range of different algorithms, because the energy consumption can be reduced by organizing the sensor nodes in the clusters [12].

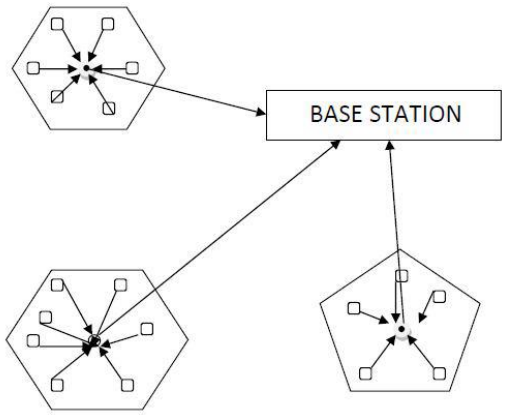

Fig.1: Leach protocol architecture[13]

3.2 Enhanced-leach (E-LEACH)

E-LEACH basically removes overload energy consumption problem of the LEACH. The E-LEACH adopts the same round concept with the original LEACH. E-LEACH selects optimal number of cluster-heads to enhance the performance. If the number of cluster-heads is less then each cluster-head covers larger region, this will lead the problem that some cluster-members get far from their cluster-heads and consume much more energy. When the numbers of cluster heads are less then more energy is consumed in the communication between cluster heads and the base station. Therefore, it is necessary to select optimal cluster head number to make the energy consumption minimum. In the E-LEACH minimum spanning tree between cluster heads is used. The node with largest residual energy is selected as the root node [13].

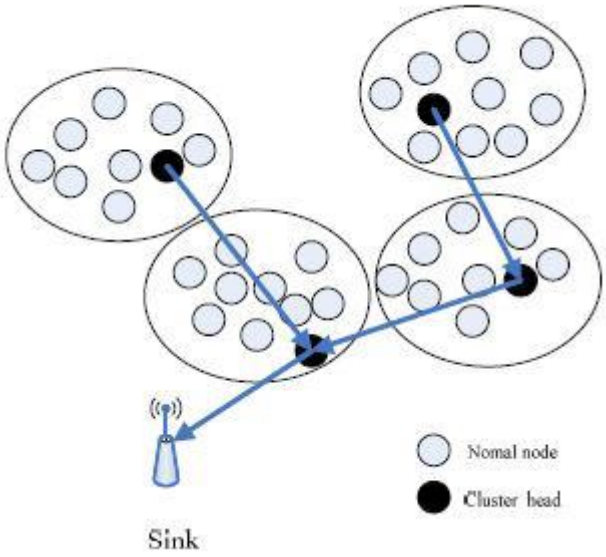

Fig.2: Architecture of E-LEACH [13]

3.3 LEACH-C(Centralized Low Energy Adaptive Clustering Hierarchy)

It involves a centralized clustering algorithm. The steady state of LEACH-C will remains same as LEACH whereas the setup phase is different. In the setup phase of LEACH-C each node within the network transfers the information about the current location and energy level to the base station. The base station uses this information to produce better clusters that requires the less energy for data transmission [14].Each sensor node is equipped with GPS to track the location. The base station elects the cluster head on the basis of energy level of node. Leach-C has a deterministic threshold algorithm to form the cluster and to elect the cluster head [14].

3.4 LEACH-F

LEACH-F, here F stands for the fixed. In this technique the number of clusters remains fixed throughout the network lifetime and the cluster heads rotated within its clusters. As the Steady state phase forms the clusters so the steady state phase of LEACH-F is similar to that of LEACH. LEACH-F can provide the energy savings but doesn't support flexibility. In other words LEACH-F doesn't provide mechanism to add or remove sensor nodes from the sensor networks [11].

IV. HETEROGENEOUS WIRELESS SENSOR NETWORK MODEL

We assume N number of nodes placed in a square region of dimension M×M. Heterogeneous WSNs contain two, three or multi types of nodes with respect to their energy levels and are

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termed as two, three and multi level heterogeneous WSNs respectively.

4.1Two Level Heterogeneous WSNs Model

Two level heterogeneous WSNs contain two energy level of node, normal and advanced nodes. Where, E_o is the energy level of normal node and $E_o(1 + a)$ is the energy level of advanced nodes containing a times more energy as compared to normal nodes. If N is the total number of nodes then Nm is the number of advanced nodes where m refers to the fraction of advanced nodes and $N(1 - m)$ is the number of normal nodes. The total initial energy of the network is the sum of energies of normal and advanced nodes.

$$\begin{aligned} E_{total} &= N(1-m)E_o + Nm(1+a)E_o \\ &= NE_o(1-m+m+am) \\ &= NE_o(1+am) \end{aligned}$$

(5.1)

The two level heterogeneous WSNs contain am times more energy as compared to homogeneous WSNs.

4.2Three Level Heterogeneous WSN Model

Three level heterogeneous WSNs contain three different energy levels of nodes i.e normal, advanced and super nodes. Normal nodes contain energy of E_o, the advanced nodes of fraction m are having a times extra energy than normal nodes equal to $E_o(1 + a)$ whereas, super nodes of fraction m_o are having a factor of b times more energy than normal nodes so their energy is equal to $E_o(1 + b)$. As N is the total number of nodes in the network, then Nmm_o is total number of super nodes and $Nm(1 - m_o)$ is total number of advanced nodes. The total initial energy of three level heterogeneous WSN is therefore given by

$$E_{total} = N(1-m)E_o + Nm(1-m_o)(1+a)E_o + Nm_oE_o(1+b)$$

(5.2)

$$E_{total} = NE_o(1 + m(a + m_o b))$$

(5.3)

The three level heterogeneous WSNs contain (a + mob) times more energy as compared to homogeneous WSNs.

V. CONCLUSION

Clustering can be done in two types of networks i.e homogenous and heterogeneous networks. Nodes having same energy level are called homogenous network and nodes having different energy levels called heterogeneous network. Low-Energy Adaptive Clustering Hierarchy (LEACH), Power Efficient Gathering in Sensor Information Systems (PEGASIS), Hybrid Energy-Efficient Distributed clustering (HEED) are algorithms are described. Each of the routing protocol has its own advantages compared to the fundamental leach routing protocol. The drawbacks and issues addressed by the LEACH protocol are also discussed. We have found that the some energy efficient algorithms increase the network lifetime.

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