ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 5, Issue 2, February 2016

CH (Cluster Head) Election Techniques with Energy-Efficient Protocols Based on Distance for WSNs: A Survey

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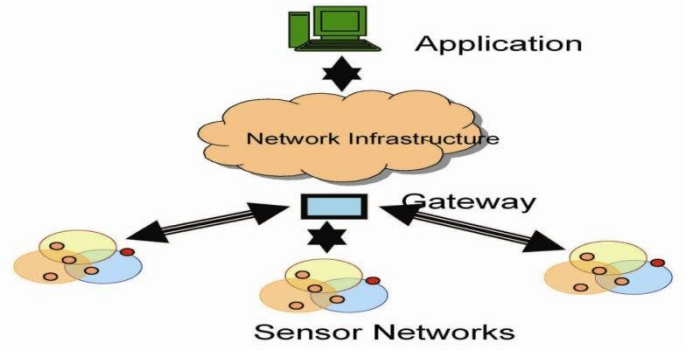
***Abstract*—To increase lifetime of wireless sensor networks, control on the accessibility of minor and low-cost sensor nodes is needed with ability of monitoring, detecting, observing and the location, beside with processing information or data and communication. This study is dedicated to a distance based CH selection technique. Consumption of energy is an issue for the election of a Cluster Head. An Energy Efficient Algorithm for Cluster-Head election in Wireless sensor networks is required to increase the network lifetime. Various energy efficient protocols are explored and studied in this survey. The application of WSN has fully-grown in the past years, indicating the necessity for accessible, energy-efficient routing, data gathering and aggregation protocols in parallel large-scale environments. This paper presents a survey of energy efficient power aware routing or multiple routing protocols on the basis of Cluster Head Selection Techniques Based on Distance for Wireless Sensor Networks for the LEACH protocol.**

Keywords*—Distance-based; DBEA-LEACH; Low Energy Adaptive Clustering Hierarchy; Wireless Sensor Network, WSN;MANET, Energy Efficient Routing Protocol, Energy Consumption etc.

I. INTRODUCTION

Wireless Sensor Network with Leach Protocol

WSNs can be well-defined as collection of lots of sensor nodes which intercommunicate through wireless technology, and can work together in actual time observing, perceiving and collecting information from numerous environmental or observing objects and transfer this information to the base station. The smart sensors nodes works on command controlled strategies that have one or more memory unit, sensors, processor, an actuator and power supply [4].



In wireless sensor networks, sensor nodes are controlled w.r.t communication bandwidth, processing power and storage space which are mandatory to be very efficient as a source of operation. In Wireless sensor networks, the sensor nodes are frequently assembled into distinct split sets called a cluster. It is advantageous to use clustering in WSNs, as it is control the scalability, resource sharing & energy efficient use of controlled resources that provides network or web topology stability & energy saving attributes. The Clustering structure provides decrease communication overheads, and efficient resource allocations thus reducing the complete energy consumption and decreasing the interferences between sensor nodes.

Generally a wireless sensor network is divided into equally loaded clusters of sensor nodes, as shown in Fig: 1. A cluster in a sensor network resembles a field in a network. On the other hand, nodes are introduced in the zone of a predefined area, forming a cluster. Thus, a sensor network is usually cluster based and has unequal topology. The most effective wireless system in sensor networks is normally based on the energy (battery level) of nodes. In such protocol schemes, the best path has the highest quantity of total energy. The network of such sensing nodes is built with equal sensor nodes, regardless of the size of the network.

In Figure 1, three clusters are intersected to the central base station; each cluster contains a cluster head liable for routing data from its corresponding cluster to a base station.The sensor-node lifetime depends on the battery lifetime. Considering the occurrence of dead nodes is important to decide the topological changes and may affect overall energy consumption of a wireless sensor network. As an analysis, power management is a key problem in organization policy, node design, and communication protocol development. At last, an efficient energy-conscious clustering and clustering protocols can potentially prolong the network lifetime. Among the several routing protocols proposed for WSNs, cluster-based algorithms are more effective in meeting WSNs requirements, mainly energy consumption [2-5]. By clustering of sensor nodes into some groups called clusters, SNs of each cluster send their data to specific SNs in the cluster called Cluster Heads (CH). Then CH nodes transmit gathered information to the BS. Since CH nodes play an important role in the performance of cluster-based routing algorithms, the policy of CH node selection deeply affects network parameters.

II. LEACH PROTOCOL

The LEACH (Lower Energy Adaptive Clustering Hierarchy) is a cluster-based protocol for WSNs. LEACH reduces energy dissipation by isolating WSNs into clusters to shrinkage the number of messages and limit the direct communication between micro-sensor nodes and the BS [5, 6]. The nos. of CHs and CM (cluster members) created by LEACH are significant parameters for succeeding better performance. The CH node's energy is quickly fatigued since it has to process extra effort than other nodes. In order to overawe this issue, after being the cluster head for a positive time, the CH node permits this role to another node to balance energy depletion between all nodes in the WSN.

The Setup Phase

Cluster-Head Selection

During this stage, every applicant node chooses a random number between 0 and 1 (e.g. 0.05) and associates it with a control threshold value Pt (n). If the random number is lower than the threshold value Pt (n), then that nominee node will become the CH in the current round. This threshold probability is given by the formula:

$$P_t(n) = \{k/1-k(r \bmod 1/k), \text{ if } n \in G_t(n)$$

$$0 \qquad , \text{otherwise}$$

where k is the probability value or preferred percentage of the applicant node that wants to become the CH; r indicates the current round in the network; Gt(n) is the set of nodes, in which it was resolved that node n was not a CH in the most recent 1/k rounds, and Pt(n) is the threshold probability value for applicant node n to develop a CH at round r in time t. Calculation (1) guarantees which certain CHs in the most new 1/k rounds will not be CH in the present round. The node directly declares its CH status to its neighbor nodes by airing a cluster head-endorsement message.

The Steady-State Phase

The sensor nodes begin sensing in their range and send data to their CH within the TDMA time slot allocated. The CH node will receive sensed data from all members in its group, then compress or aggregate them by data fusion technique and transmit to the BS. The state of the network will return to Step 1 of the setup phase and a new round is started. Figure. 2 show the two phases of the operation in a round of LEACH [5].

Routing is one of the key issues in MANETs due to their highly vigorous and dispersed nature. In particular, energy efficient routing may be the most important architecture norm for MANETs since mobile nodes will be powered by batteries with limited capacity. Power collapse of a mobile node not only alters the node itself but also its ability to forward packets on behalf of others and thus the comprehensive network lifetime.

For this comprehension, many research attempts have been devoted to flourish energy aware routing protocols. Based on the afore mentioned deliberations, this paper surveys and classifies numerous energy efficient routing mechanisms proposed for MANETs [4-5]. They can be broadly categorized based on when the energy optimization is performed. A mobile node depletes its battery energy not only when it actively sends or receives packets but also when it stays abortive listening to the wireless medium for any possible communication requests from other nodes. Thus, energy efficient routing protocols curtail either the active communication energy required to transmit and receive data packets or the energy during sluggisperiods.

III. LITERATURE SURVEY

In this section we briefly describe various techniques related to our work energy efficient routing protocol. Different routing protocols have been projected in the literature survey to reduce the energy consumption. Many energy-efficient routing protocols have been surveyed, developed, modifying the routing metric to take energy costs into account. These protocols either explore routes with maximum hindrance residual energy at one of the intermediate nodes; minimize the total end-to-end transmission energy for a packet, or a (weighted) consolidation of both. The objective is typically to reduce energy consumption and to increase nodal lifetime, resulting in heightened network lifetime and performance. However, minimizing transmission energy only diverge from shortest-hop routing if nodes can adjust transmission power levels, such that multiple short hops are more advantageous, from an energy context, than a single long hop.

A. LEACH (Low-Energy Adaptive Clustering Hierarchy)

Heinzelman et al. [3] presented or described Low-Energy Adaptive Clustering Hierarchy (LEACH) protocol. LEACH is a famous cluster-head election method that establishes a basis for numerous other approaches as specified in literature. It is the first important protocol that goals to minimize the complete energy used in data congregation operations in WSNs. LEACH is a circulated algorithm which creates local decisions to elect cluster-heads [4]. If the cluster-heads are designated for once and do not change throughout the network lifetime, then it is observable that these static cluster-heads die previously than the normal nodes. Thus, LEACH contains randomized spin or rotation of cluster-head locations to consistently distribute the

energy dissipation over the network. LEACH also achieves local data compression in cluster heads to decrease the quantity of data that is progressive to the base station. In LEACH, cluster-head election is done sometimes to allow randomized rotation of cluster heads. Each round involves of two phases, namely set-up phase and steady-state phase. In set-up phase, cluster-heads are elected and clusters are molded. In steady-state phase, data transfer to the base station is achieved in the clustered network.

B. LEACH-C

Heinzelman et al. [4] recommended LEACH-Centralized (LEACH-C) it is a centralized clustering algorithm in which the throughout cluster formation stage, remains the same as LEACH. Sink localize node or Base station has universal knowledge of location & energy of sensor nodes in the network. During set up phase, each node sends its current location (maybe using GPS Receiver) & energy level to base station. Base station calculate average node energy and this average node energy will be exploited as a threshold value for the selection of a Cluster Head. LEACH-C transports around 40% more data per unit energy than LEACH. The disadvantage with LEACH-C is that the numbers of nodes in different clusters fluctuating so that more the CH members outcomes in CH overload and early it will reduce its energy [4].

C. Deterministic LEACH

Handy et al. [7] proposed deterministic LEACH. In this protocol the probability factor as well as the remaining energy is also measured to select the cluster heads.
Like in LEACH, it is observable that a stochastic cluster-head selection will not mechanically lead to smallest energy consumption during data transfer for an agreed set of nodes. All cluster-heads can be situated near the edges of the network or nearby nodes can developed cluster heads. In these cases specific nodes have to bridge long distances to reach a cluster-head. In this protocol the threshold value of LEACH is increased with an issue that characterizes the remaining energy of the node with respect to its initial energy. Such an alteration of the cluster-head threshold increases the lifetime of a LEACH micro sensor network by 30 % for First Node Dies (FND) and more than 20 % for half of the Nodes Alive (HND) [7].

D. SEP (Stable Election Protocol)

Smaragdakis et al. [8] this author proposed SEP protocol. Stable Protocol Election is an energy-aware protocol for heterogeneous WSNs. Stable Protocol Election is used for selecting CH in two-level hierarchical wireless sensor networks. This rules or protocol is grounded on weighted election contingency of every node to become cluster head according to the residual energy in each node. SEP develops the stable area of the clustering hierarchy process using the portion of advanced nodes. Since advanced nodes had more energy than normal nodes, so advanced nodes are selected as cluster heads more regularly than the normal nodes. It was completed by increasing the epoch (no. of rounds) of the sensor network in quantity to the energy increase. On the other hand, SEP cannot be deployed for multi-level heterogeneous wireless sensor networks.

E. EEHC (Energy Efficient Heterogeneous Clustering)

Kumar et al [9] offered Energy Efficient Heterogeneous Clustering (EEHC) method for wireless sensor networks. The foremost knowledge is to present heterogeneous nodes in the network on energy base. This work mostly focuses on selection probability of cluster head. Here, three types of heterogeneity presented in this paper as computational, link and energy. In this protocol different types of nodes are used for sensing an environment such as super nodes, advanced nodes and normal nodes. This methodology allocates a weight to the optimal probability. This weight must be equal to the initial energy of each node separated by the initial energy of the normal node. EEHC extend the lifetime of the network by 10% as paralleled to LEACH.

F. Fuzzy LEACH

Gupta et al. [12] this research deals with fuzzy logic in the area of wireless sensor networks built on LEACH protocol. As in LEACH cluster heads are selected using a static threshold value but in this planned approach fuzzy logic used for Cluster head selection process to remove the problems faced by pure probabilistic methods like poor clustering. In this system fuzzy logic device is implemented using three fuzzy captions such as energy, concentration and importance for successful clustering process. Node centrality variable designate how central the node is to the cluster can intended on the basis of the sum of the squared distance of other nodes from the given node. So that this method increases the lifetime of the sensor network but only limited to fixed nodes.

G. DEEC (Distributed Energy Efficient Clustering)

Qing, Li, Qingxin Zhu, and Mingwen Wang [14] suggested an energy-aware adaptive clustering protocol used in heterogeneous wireless sensor networks. In DEEC protocol, each sensor node (SN) individually selects that one as a cluster-head based on its original and residual energy. To control the energy disbursement of nodes by means of an adaptive approach, DEEC use the average energy of the network as the reference energy. Thus, DEEC does not necessitate any total knowledge of energy. Different SEP and LEACH, DEEC can achieve well in multi-level heterogeneous wireless sensor networks.

H. DB-LEACH

In DB-LEACH, a node is more likely to be selected as a cluster head if the distance of it from the BS is nearly equal to the average distance of the network sensor nodes to the BS. In CH nodes selection phase of DB-LEACH algorithm, each SN generates a random number between 0 and 1. Then the random number is compared with
improved threshold. This threshold value depends on the geographical distance between sensor node and the BS and the residual energy of the candidate node.

IV. CHALLENGES

As we know, the stage of sensor nodes can be used over years; though, it also depends on the node functions, and naturally the sensing does not put away much energy but not the transmission procedures. For this motive, designing a WSN routing and transmission protocol, increasing energy efficiency and spreading the lifetime of the WSN are the best significant challenges for researchers.
Energy aware routing in wireless sensor networks is the main problem to conclusion energy efficient routes that maximize the network lifetime without the information energy position of nodes in network. The distance restraint and condition defense arise in actual communication state. For this problem once associating among the given value with the same initial energy and altered value in the initial energy, more cluster heads are certain and have higher possibility to be designated when the initial energy value is changed.

V. IMPORTANCE

The importance of construction of WSNs through Low-Energy Adaptive Clustering Hierarchy (LEACH) and LEACH with deterministic cluster head selection in over some of the cluster head algorithms that allow enhancing power consumption of WSN.

- There are numerous factors like density & distance, threshold based, power efficiency.
- Load balancing and scalability are the other factors which plays significant role in the selection of Cluster head.
- In case of LEACH the CH will die previous than the other nodes in the cluster because of its process of sending, receiving and overhearing. When the cluster head die, the cluster will become unusable because the data assembled by cluster nodes will never reach the base station because of sensor node have resource constraint in the network.
- Therefore selection of cluster head become important, cluster head is selected based on the energy and that sensor node is selected as a CH (cluster-head). While processing of Cluster head node the energy become decrease, so if the energy of CH is becomes less to the non-cluster head nodes energies means following round should be managed.
- The sensor nodes of the WSN permits random deployment in inaccessible terrains, this means protocol of the wireless sensor is self-coordinated; another important feature of the wireless sensor network is cooperative effort of the sensor nodes. Sensor nodes are saving data about environment, after collecting it they process it and then transmit to the base station. Base station or sink node will be responsible for an interface between user and internet.

VI. DISSCUSSION

In literature survey given above various cluster head selection techniques are conferred by many authors, we analyzed various existing research concept in terms of energy consumption, routing protocols, low energy routing method which are given us to emerging method about network node operation on the basis of energy theme that provide consistent communication and along with being aware the energy. In WSNs environment every node is maximizing the information delivery in each session and will increase the performance of the network like packet delivery magnitude relation, throughput, network life time and minimize the end-to-end delay, jitter, routing packet overhead. Energy efficient routing protocol provides every node's energy info in joule, needed transmission power and receiving power.

VII. CONCLUSION

In this study, on the basis of traditional LEACH protocol, we have reviewed the different clustering algorithms in the field of wireless sensor networks alongside with LEACH and descending reported in the literature of WSNs till today and presented the comparison of different LEACH descendant. In this review paper we deliberate about

LEACH protocol and we also capable to decide cluster based protocol and its stages. Here we also considered numerous better versions of LEACH Protocol which we do the qualified study of numerous developed form of LEACH with the important one. We have also examined the it challenges and importance that is very important part of the review. At the last, it can be designed from given survey that for an energy efficient wireless sensor network, still it is needed to find more and more efficient, scalable and robust clustering scheme for better outcome.

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