

Cluster Head Selection Protocols in Wireless Sensor Networks

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Abstract: *Wireless sensor network is a wireless network with sensors. In Wireless sensor network, nodes are distributed randomly. The nodes are with sensors. Sensors can collect various temperature, humidity etc. Then nodes must be distributed in a simple manner, which is easy for communication. It is called clustering. There are different protocols for clustering. Some protocols are discussed here. Then find the finest one among them.*

1. Introduction

Wireless networks are network that use wireless data connections for connecting network nodes. When wireless network consists of sensors. It is called wireless sensor networks. Wireless sensor networks are used to applications, such as disaster management, military reconnaissance, security surveillance, health and medical, industrial automation, habitat monitoring.

In Wireless sensor networks (WSN), clustering is an important procedure. Clustering is defined as the dividing of sensor networks into small manageable units. Clustering approach is to improve the scalability of network (prolong). One node will act as a cluster head (CH) in cluster & remaining nodes will act as member nodes (CM). Clustering helps to reducing number of exchanged communications in network. Each communication in cluster, is handled by cluster head (CH).

A cluster head (CH) is selected for each cluster based on the energy level of the node or distance based also. The important aim is to make only the cluster head communicate with the base station (BS) so that the remaining node can be put to a sleep state. Selection of cluster head has a vital role in clustering. Selection of cluster head is good manner, then communication between clusters is easily taken. There is chance of errors in cluster head selection. There is a chance for cluster head to be malicious.

2. Related Work

Arboleda *et al.* [4] presented a survey of different clustering protocols. The authors discussed basic concepts related to the clustering process, such as

cluster types, cluster structure, clustering advantages, and analyzed LEACH based protocols as well as reactive and proactive algorithms in Wireless Sensor Networks. Characteristics of protocols were compared and the evidences where they can be used currently were outlined.

Kumarawadu *et al.* [5] surveyed the clustering algorithms available for Wireless Sensor Networks and Cluster Head selection criteria and classified them based on the parameters. The authors of the survey also studied the key design challenges and discussed the performance issues related clustering protocols based on the classification of identity based clustering algorithms, neighbourhood information based clustering algorithms, probabilistic clustering algorithms and biologically inspired clustering algorithms.

3. Clustering

The In network, the clustering should have minimum capacity. Cluster Characteristics is given below.

a) Variability of Cluster Count:

Clustering schemes will be classified based on variability of cluster count into two types: variable and fixed ones. In the former scheme, the set of cluster head are planned and the no of clusters is fixed. However, the number of clusters is variable within the latter scheme, in which Cluster Heads are selected, randomly or primarily based on some rules, from the deployed sensor nodes.

b) Uniformity of Cluster Sizes:

In the light of uniformity of size of cluster, clustering routing protocols in Wireless Sensor Networks will be classified into different classes: uneven and even ones, respectively with the completely different size clusters and same size clusters within the network. In general, clustering with completely different sizes clusters is used to attain additional uniform energy consumption and avoid energy hole.

c) *Intra Cluster Routing:*

Considering to the methods of inter cluster routing, clustering routing manners in Wireless Sensor Networks additionally include different classes: single hop intra cluster routing ways and multiple hop ones. In intra cluster single hop, all Member Nodes in the cluster transmit data to the corresponding Cluster Head directly. Instead, data relaying is used once Member Nodes communicate with the corresponding Cluster Head within the cluster.

d) *Inter Cluster Routing:*

Based on the inter cluster routing, clustering routing protocols in Wireless Sensor Networks include different classes: single hop inter cluster routing manners and multiple hop ones. In inter cluster single hop, all Cluster Heads communicate with the BS directly. In contrast to it, data relaying is used by Cluster Heads within the routing scheme of inter cluster multiple-hop.

4. Clustering Protocols

There are different protocols for clustering in wireless sensor networks. They are given below.

A. LEACH

Heinzelman *et al.* [1] introduced LEACH. LEACH means Low Energy Adaptive Clustering Hierarchy. LEACH selects the nodes as CHs randomly. Due to selection of CHs randomly, the high energy is dissipated in communication to the Base Station is distributed in network of nodes. LEACH has two phases, first is Set-up phase and second is Steady-state phase. In set-up phase all nodes in cluster decides to become CH or not for that round. The decision of CHs is determine by percentage of Cluster Heads in network and how many times the node become a Cluster Head.

Advantages of LEACH:

- 1) *In LEACH, If the node becomes Cluster Head than for later round it cannot be Cluster Head.*
- 2) *By the utilization of schedule of TDMA avoidance of needless collisions for Cluster Heds are done.*
- 3) *Members of cluster are close or open communication. Due to this, a prevention of extreme energy dissipation is takes place.*

Disadvantages of LEACH:

- 4) *LEACH is not suitable for long-range networks.*

5) *Dynamic clustering in LEACH, brings extra overhead.*

B. TL-LEACH

TL-LEACH proposed by Loscri *et al.* [2], is an extension algorithm of LEACH. TL-LEACH is Two-Level Hierarchy LEACH. TL-LEACH uses following two techniques to achieve latency efficiency and energy: adaptive, randomized, localized control and self-configuring cluster formation for data transfers. In TL-LEACH, a Cluster Head collects data from Member Nodes as LEACH Algorithm, but for transmitting data to the Base Station directly, it uses a part of Cluster Heads that lies between Cluster Head and Base Station as relay station.

Two-level hierarchy of TL-LEACH as shown in Fig 1: top level Cluster Heads called primary CHs (CH_i), second level represented from secondary CHs (CH_{ij}) and Ordinary Nodes. The algorithm is consists of four phases: advertisement phase, cluster setup, schedule creation and then data transmission phase. In the first phase, each node decides whether it become a primary Cluster Head, secondary Cluster Head or ON (ordinary node) in each round which is the same as that of LEACH. If a node is elected a primary Cluster Head, it must advertise to other nodes. In this phase carrier sense multiple access (CSMA) mechanism is used. Then, secondary Cluster Head nodes send advertisement to ONs. In this phase, each secondary CH decides to which primary Cluster Head it belongs and then sends an advertisement message to its primary Cluster Head(CH). In the same way, each Ordinary Nodes must decide which secondary Cluster Head it belongs to and informs it through an opposite message. In third phase, each primary Cluster Head creates a schedule(TDMA) assigning each node in its group a slot to transmit. Each primary Cluster Head chooses a code(CDMA) and informs all the nodes at second level in its group to use this code.

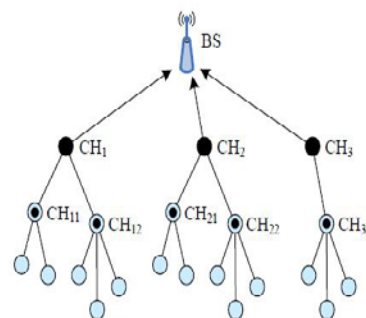


Fig. 1. The Two-level Hierarchy in TL-LEACH.

Advantages of TL-LEACH:

- TL-LEACH uses random rotation of local cluster Base Stations, i.e., primary Cluster Heads and secondary Cluster Heads. it will cause higher energy load distribution within the network;
- TL-LEACH uses localized coordination, which means conducive to scalability and robustness in the network;
- Compared with LEACH, the scheme of two levels clustering leads to low average transmission distance, and low nodes are needed to transmit so much distances to the Base Station via TL-LEACH. This effectively reduces total energy consumption.

Disadvantages :

- The average transmission distance is limiting in comparison with LEACH, the two hop inter cluster routing of TL-LEACH is still not applicable to high range networks, because it uses only two hops for information transmission from sources to Base Station, and long distance communications can breed a lot of energy consumption;
- Cluster Head election without energy concerns assumes associate ideal homogeneous network and can not guarantee real load balancing just in case of nodes with completely different quantity of initial energy.

C. BCDCP

BCDCP proposed by Muruganathan et al. [6], is a centralized clustering protocol with the base Station being capable of advanced computation. BCDCP is Base-Station Controlled Dynamic Clustering Protocol. The main idea of BCDCP is that the cluster formation wherever every Cluster Head serves an almost equal number of Member Nodes to balance Cluster Head overload and uniform Cluster Head placement throughout the network.

At the beginning of cluster setup, the Base Station receives information on the residual energy from all the nodes within the network. Based on this info, the Base Station first computes the average energy of all the nodes within the network, and then chooses a group of nodes whose energy levels are higher than the average value. Only the nodes from chosen set, i.e., those with required energy, can be elected Cluster Heads for this round, while those with low energy will prolong their time period by performing the task of ordinary Nodes. Based on the chosen set, the Base Station computes the no of clusters and

performs clustering. it is accomplished in terms of an iterative cluster splitting algorithm. Fig. 2. shows the topology of the network in BCDCP.

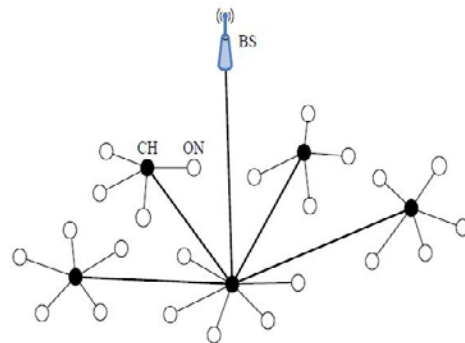


Fig. 2. The Topology of the Network in BCDCP.

D. HEED

Younis *et. al*[1] introduced HEED. HEED is a Hybrid Energy-Efficient Distributed clustering. HEED is a multi-hop clustering algorithm. It gets an energy efficient clustering with unambiguous concern of energy. HEED is different from LEACH, because it does not selects Cluster Head randomly. The way of construction of cluster is achieved on the fusion combination of two factors. One factor is communication cost of intra cluster and second factor is residual energy. In HEED algorithm, chosen Cluster Head have comparatively high average residual energy related to Member Nodes. Getting an evenly distributed Cluster Heads all over the networks. In HEED algorithm, two parameters are used to select the Cluster Heads, one is residual energy and other is intra cluster communication cost of applicant nodes.

Advantages of HEED:

- 1) *HEED contains fully distributed clustering method by using two parameters for the Cluster Head selection.*
- 2) *Provides Cluster Head distribution, load balancing within the network.*
- 3) *HEED provides multi-hop communication between Cluster Heads and Base Station to support more energy conservation and scalability difference from single-hop.*

Disadvantages of HEED:

- 1) *HEED undergoes a consequent overhead meanwhile it needs some iteration to form cluster.*

- 2) The Cluster Heads which are near to the sink node dies earlier because of it has extra load.
- 3) HEED causes visible energy dissipation. it causes to decrease the lifetime of network.

E. SFDCH

Secure and fault tolerant clustering (SFDCH)[3] algorithm used for cluster head selection in wireless sensor network. Secure And Fault Tolerant Clustering Algorithm selects the nodes having the threshold value above the average. From the selected nodes, the node with maximum throughput, maximum available energy, at a minimum distance is selected as the cluster head. SFDCH algorithm is dynamic in nature as selection process is refreshed periodically.

To select cluster head (CH), high energy, high throughput, min distance are major factors. Selection of the Cluster Head is a tedious job in wireless networks. This protocol method selects the most eligible node as cluster head, where the criteria for cluster head is as follows. The eligible node for the Cluster Head should have

- Threshold value above average of all the participating nodes.
- Highest energy available.
- Highest throughput.
- Minimum distance from the sink node.

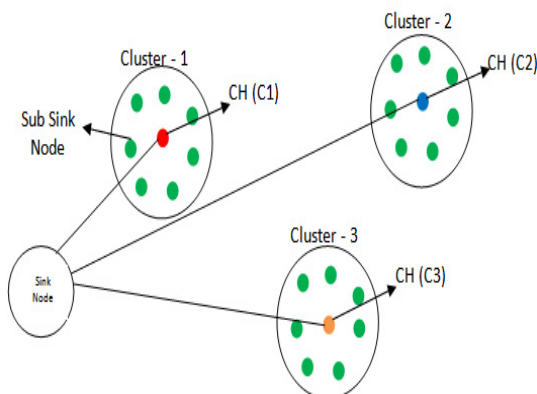


Fig. 3. Cluster Formation

Network of sensor nodes is divided into different clusters. Every cluster chooses its Cluster Head(CH) & others act as cluster members. CH of each clusters communicates with the sink node. There are 3 clusters are shown in fig. 3. Cluster-1 (C1), Cluster-2 (C2), Cluster-3 (C3) are three clusters. A node is eligible to become a cluster head (CH) if it has the highest available energy, highest throughput,

minimum distance from the Base Station or sink node and high throughput value as depicted in fig 4.

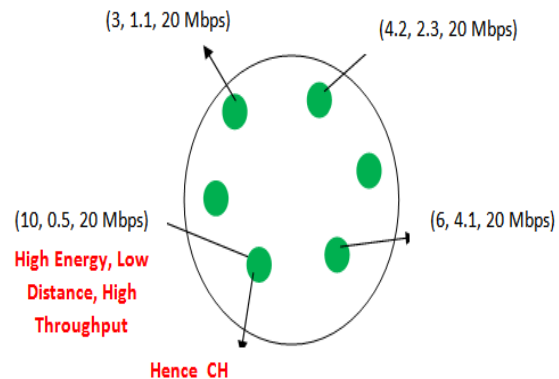


Fig. 4. Cluster Head Selection

Here shows cluster head selection from cluster members (CM). In each cluster (energy, distance, throughput) is calculated & evaluated. In figure all nodes have same throughput. If throughput same for all nodes, then consider another parameters. In the fig 5. Highest energy & minimum distance from BS is shown. Then node (10, 0.5, 20Mbps) is selected. Because the node have high energy, low distance from base station (BS), high throughput compared to other nodes.

5. Conclusion

Protocols in Wireless Sensor Networks must be energy efficient, to become prolong network lifetime. First clustering protocol is LEACH. LEACH choose Cluster Head randomly. Wireless Sensor Network is a wide area, this paper has included only few routing protocols.

The protocols have different features separate advantages and drawbacks. Here SFDCH is considered more parameters than LEACH, TL-LEACH, BCDP, HEED. SFDCH select CH which have average threshold, high energy, throughput and minimum distance. So from study of clustering protocols, SFDCH is relatively efficient and accurate compared to others.

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