

COMPARATIVE ANALYSIS OF NETWORK LIFE AND RESIDUAL ENERGY AMONG VARIOUS VARIANTS OF LEACH PROTOCOL

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ABSTRACT

Wireless Sensor Network is a gathering of specific transducers generally termed as sensor for observing and recording the happening at unreachable places. The functioning of these sensors nodes mainly depends upon battery capacity and life. The major difficulty in WSNs is to replace or recharge the discharge battery. The efficiency of WSNS can be enhanced using the different routing protocols by reducing the battery usage and increasing the data transmission rate. In the present paper, the comparative analysis among LEACH, H-LEACH and IB-LEACH Protocols has been carried out in terms of transmission of data. The simulated results have been carried out with MATLAB.

Keywords: *Wireless Sensor Networks (WSNSs); LEACH; IB- LEACH; H-LEACH; C-LEACH; T-LEACH*

INTRODUCTION

Wireless Sensor Networks are finding their wide application in monitoring and sensing operations in environment, health, military and industries [1]. WSNs are mainly consisting of battery powered tiny sensor nodes having sensing and processing capabilities [2]. The rapid development of micro electro-mechanical system (MEMS) results in inexpensive sensor nodes of tiny size. Therefore, it is become easy to set up large-scale wireless sensor networks in areas of concern compared to wired networks [3]. The major drawback of WSNs is discharge of battery after certain time period and it is difficult to replace or install new batteries [4]. The main attention of the researcher is to increase the battery life and reduce the energy consumption. The Directed Diffusion protocol [5] employs the direct communication of nodes with the base station which is further linked to user via internet. It consumes a huge amount of energy by transmitting the information from sensor node which is located far away from the Base Station (BS).

Clustering [6] plays an important role in enhancing the energy efficiency of WSNs. Clustering involves the dividing the whole network into groups called clusters. These clusters are further consisting of cluster head and a number of nodes of known as members. The node with high energy is elected as Cluster Head (CH) and of low energy is taken as members. X.H Wu [7] introduced LEACH-C called LEACH-Centralized it involves the participation of base station during the process of cluster head selection. Base Station remains aware about the residual energy of all the member nodes and their location. Accordingly, BS chooses the most appropriate nodes as cluster heads, and distributes remaining sensor nodes among cluster heads to create clusters. Improved and balance LEACH (IB-LEACH) minimizes the total energy utilization by using a variety of energy banks that save energy and acts as energy nodes. These energy nodes save the energy in each round of routing and clustering phase leads to enhance the lifetime of the network [8]. O Younis et al., [9] presented, Hybrid clustering protocol (HEED) in which cluster heads are elected on the base of their remaining energy probabilistically, and nodes linked with cluster heads such that their communication cost is minimized. Power-Efficient Gathering in Sensor Information Systems (PEGASIS) [10] is a chain based routing protocol, that work on the principal by setting the node signal strength such that it can reach only to its neighbour node. In this way a continual chain is created and a head is chosen that can only transmit the information to its nearby node. Increase of life cycle of WSNS is possible in two ways. First is by increasing the number of sensor nodes but it increases the trafficking towards the base station and more collisions. Second way is to use the heterogeneous network instead of homogenous network [11]. A comparative analysis among LEACH, H-LEACH, C-LEACH, T-LEACH and IB-LEACH protocols is carried out in this paper

After giving the brief introduction of WSNs in the introduction section, further paper is divided into three sections. Sections after introduction cover the study of different routing protocols, results with discussion and conclusion.

VARIANTS OF LEACH PROTOCOLS

LEACH Protocol

Heinzelman et al., [12] introduced the LEACH, popular clustering algorithm which increases the reliability of the WSNs. It divides the whole process into two phases, set up phase and steady state phase. The limitation of LEACH is that node with low energy can be selected as cluster head which die quickly resulting in failure of WSNs. Two levels LEACH performs better than LEACH. In order to increase the battery life the cluster head formation is divided into Primary and secondary level. Second level cluster head interacts with prime level which further interacts with base station [13].

IB- LEACH

Improved and balance LEACH (IB-LEACH) minimizes the total energy utilization by using a variety of energy banks that saves energy and acts as energy nodes. These energy nodes saves the energy in each round of routing and clustering phase leads to enhance the life time of the network

[14]. IB-LEACH is a self-organizing, adaptive clustering protocol under which high energy cluster head position is continually rotated in the network. The sensor node can declare them as a gateway node at any time. Base station confirmed the selection of the gateway node [15].

H - LEACH

Hetero means different i.e. the networks consisting of two or more than two types of nodes having diverse abilities to route the information. There can be two types of nodes named as type 0 and type 1 which act as pure sensor nodes and Cluster Head [16]. The CH in this type of network is prearranged and sensor nodes use single hop communication to arrive at the CH, the sensor nodes in close to proximity of cluster have the use of higher energy among all sensor nodes. As a result of this, the battery discharging occurs and hence wastage of energy takes place in the sensor nodes which are placed near the cluster head [17]. Heterogeneity can be of three types mainly, Computational, Link and Energy. In Computational Heterogeneity, the heterogeneous node has more computation resources and memory which result in more bulky and costly network. In link heterogeneity, the heterogeneous nodes have high band width and more network coverage capacity Transceiver. In Energy heterogeneity, Heterogeneous nodes have different energy levels [18].

C-LEACH

X.H Wu introduced LEACH-C called LEACH-Centralized. Base station plays the major role in formation of the clusters of the nodes. Base station chose the appropriate sensor nodes as cluster heads in certain regions depending upon the residual energy and collaborate the remaining nodes to that cluster head to form clusters. The simulated results of the LEACH-C show significant improvement over the traditional LEACH in term of less number of dead nodes and high data transmission rate. Initial phase of the LEACH and LEACH-C are similar but the process of electing the cluster head is different. LEACH-C works in better way at low load condition because the base station has to interact with less number of nodes but with heavy load base station has to interact with lot of nodes that increase the trafficking in the network which made the network inefficient.

T-LEACH

Two levels LEACH is an enhanced version of traditional LEACH protocol. It creates the cluster head in two levels, primary and secondary levels. Secondary levels cluster head are meant to interact with the cluster member to draw the information and then with the primary cluster head. It ensures the effective flow of the information and reduces the trafficking in the network.

RESULTS AND DISCUSSION

Figure 1 shows the comparative analysis among various variants of LEACH protocol on the basis of average network lifetime.

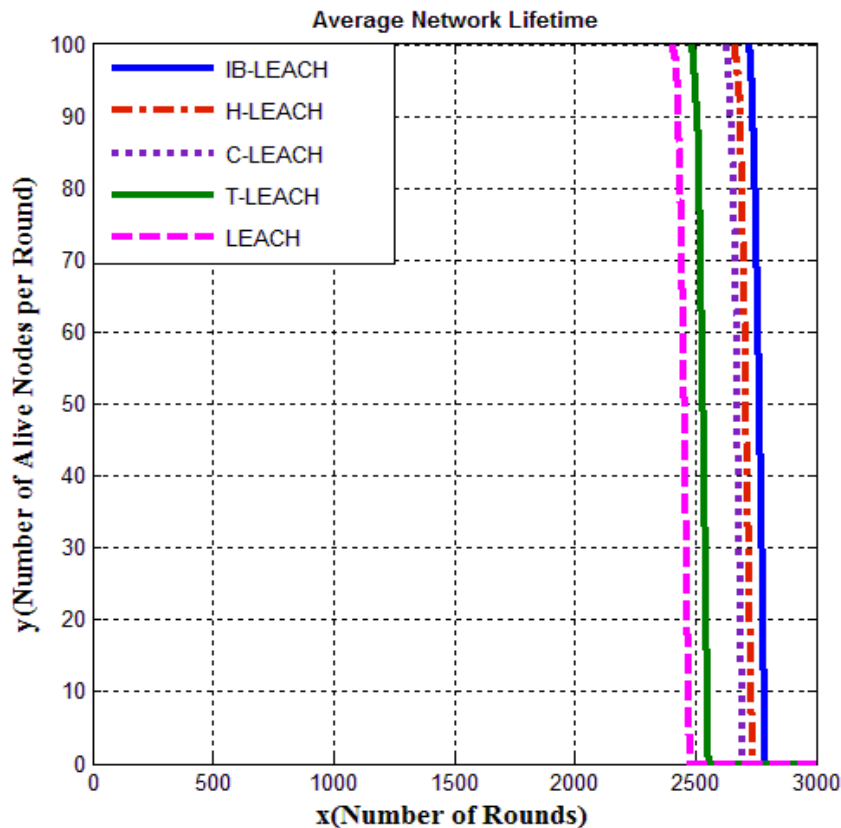


Figure 1. Average Network Lifetime

The nodes in various variants of LEACH protocol behave in an arbitrary manner. It can easily be concluded from the above figure that the nodes in IB-LEACH protocol are covering the maximum distance in terms of number of rounds because of its highly proficient nature. The nodes in IB-LEACH protocol are heterogeneous in nature on the basis of energies given to various nodes and also, cluster head formation depends on the energy level of nodes. The nodes in IB-LEACH protocol are covering 2800 rounds. On the other hand, in H-LEACH protocol the nodes are 2750 rounds which are lesser in number than that of IB-LEACH protocol. Also, in H-LEACH protocol the nodes are heterogeneous in nature, but the nodes become unaware regarding the efficient cluster head formation. C-LEACH covering the 2600 rounds and T-LEACH covers the 2550 rounds. At last, the conventional LEACH protocol is showing the least efficient behavior by covering maximum of 2400 rounds.

Figure 2 shows the residual energies of all of the three variants of LEACH protocol in which the IB-LEACH protocol outshines among all of the three variants. With the help of remaining energy, the IB-LEACH protocol can force its nodes to cover 2700 more rounds which are more than H-LEACH, C-LEACH, T-LEACH and LEACH protocols having 2600, 2400, 2300 and 2000 rounds respectively.

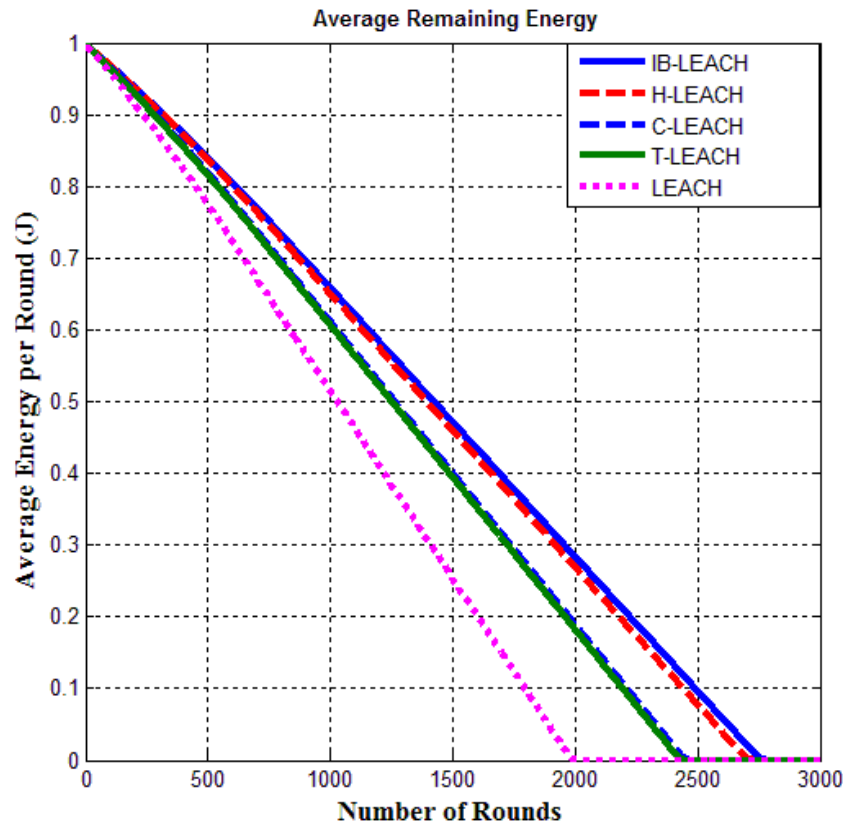


Figure 2. Residual Energy

CONCLUSION

Comparative analysis among the LEACH, T-LEACH, C-LEACH, H-LEACH and IB-LEACH shows that IB-LEACH performs better than the traditional LEACH and its variants. LEACH is outperformed by all its variants. Continuous development in LEACH makes it a base for each researcher to enhance the efficiency of sensor networks. In IB-LEACH the network is self-organized and nodes continue to transfer the position of gateway node to the higher energy nodes, thus reducing the chance of failure of sensor network due to energy lapse of gateway node.

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