



A Review on LEACH and its Descendants

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Abstract

Wireless Sensor Network is a multihop network in which large number of homogeneous sensor nodes connected wirelessly for collection of data. But for this transmission, there are some constraints like energy efficiency and life of network. The life of network is depending on life of sensor node. Several solutions are proposed for energy efficiency and life of network. Nowadays clustering algorithms are designed for reduction of energy and traffic into network. We have read many routing protocols that are developed from leach and save energy up to some extent. Some of them are discussed in this paper.

Keywords: leach, Wireless Sensor Network.

[1] Introduction:

Wireless Sensor Network is a self coordination in which Wireless Sensor Network formed by large number of sensors with limited energy. Nowadays, Wireless Sensor Network is widely used for the connection between physical world and information world of industrial application. [1] Each sensor node act as both a sensor and router in sensor network with limited power supply, communication ability and limited storage capacity.

Wireless Sensor Network plays an important role in many applications such as military sensing, air traffic control, security, industrial and



manufacturing automation, traffic surveillance, structural monitoring and environment monitoring etc .[3] Sensor nodes are responsible for sensing abnormal conditions like fire or for collection of environmental sensed data when this Wireless Sensor Network is deployed in sensing field. When sensor node detect an abnormal condition or it is set to report periodically sensed data then it will send message hop-by-hop to an uncommon node known as sink node. This sink node then informs the controller through internet. [4]

Wireless Sensor Networks have power efficiency and fault tolerance as crucial properties in order to manage network functioning properly in case of energy depilation, communication link problems or events, hardware failure that are likely to occur quite frequently in Wireless Sensor Networks.

In customary wireless networks, mechanism of error correction like automatic repeat request (ARQ) and forward error correction (FEC) were employed to migrate the performance losses of codeword error rate. Regrettably, they could not perform well taking into account time delay, robustness and consumption of energy. [2]

[2] LEACH Protocol:

Low Energy Adaptive Clustering Hierarchy (LEACH) is the best defined clustering protocol for Wireless Sensor Network. it makes clusters for transmission of data and use Cluster Head nodes as gateways to Base Station. All the operations available on data are made within cluster. In LEACH initially a node will decide to be a Cluster Head accompanied by probability P and broadcast its decision. Periodic re-election of Cluster Head is rotated among nodes of cluster in order to maintain the load. This Cluster Head selection is made on the basis of probability and its residual energy. [5] Every node selects itself as a Cluster Head once every $1/p$

rounds. A node generates a random number between 0-1. If the generated random number is less than a predefined threshold $T(s)$ value then the node becomes Cluster Head.

$$T(s) = \begin{cases} \frac{p}{1-p \times (r \bmod (1 \div p))} & \text{if } s \in C \dots \dots \dots (1) \\ 0 & \end{cases}$$

p = Desired percentage of CHs , r = Current round no. , C = Set of nodes not elected as CH in current round

LEACH constructs single hop topology in which each node transmit data to Cluster Head and Cluster Head send that data to Base Station directly.

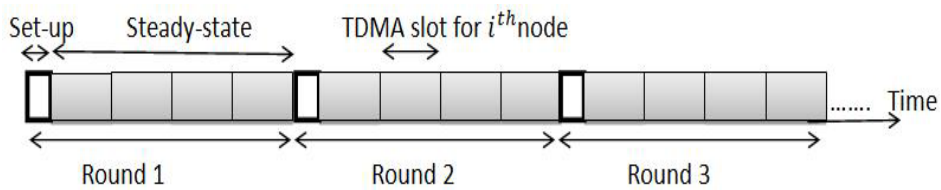


Fig. shows the time line operation of LEACH. In this fig. there are two states:

1. Set Up state
2. Steady state
 1. In Setup state Cluster Head nodes are chosen randomly among network nodes and dynamically many clusters are formed. Every node generates random numbers 0 and 1. If it is less than threshold $T(i)$ that node considers itself as a cluster head for that current round.
 2. Steady State based on the schedule that each member node transmits sensed data to its correspondent Cluster Head node. Once Cluster Head collect whole data from their members then it will send that data to base station.



[3] F-LEACH:

F-LEACH is fixed number of cluster Low Energy Adaptive Clustering Hierarchy. It is single-hop and random selection of cluster head is possible. The elementary concept of cluster formation in LEACH-F is starting of network setup and after that is fixed. Similar to LEACH, Cluster Head position in F-LEACH rotates among nodes within cluster. Main advantage of this F-LEACH is that there is no setup phase overhead like LEACH in every round. Main disadvantage of F-LEACH is that it does not allow addition of new nodes in network due to fixed clusters. When any node dies then it does not adjust their behaviour. Once fixed number of clusters is formed they work throughout life of network. So, re-clustering process also removed by F-LEACH. [6]

[4] I-LEACH (Integrated Low Energy Adaptive Clustering Hierarchy):

It chooses the Cluster Head which has vast amount of residual energy as root node. In I-LEACH, load of energy is uniformly distributed throughout network. some additional parameters are required for Cluster Head selection process. Main aim behind this algorithm is improved Cluster Head selection algorithm is rejection of lower residual energy nodes and selection of higher consumed energy nodes for Cluster Head. [7]

In Steady State phase, every node send collected information during its TDMA slot. When all Cluster Heads get this information the Base Station analyze data and transfer data for communication when this broadcasting is done then Cluster Heads ready for next round. [8]

I-LEACH added delay aware routing for emergency information directly to Base Station. Emergency packets and normal packets are differentiated as “prioritized” and “non- prioritized”. In prioritized algorithm, a packet is made prioritized (emergency) packets from sensor nodes with the process of selecting a packet with value that return zero when MOD operation is



carried out. Normal packet (non-prioritized) should received in the Cluster Head, if it will not wait for reception of another packet in Cluster Head. [9]

[5] K-LEACH (Kmedoids LOW ENERGY ADAPTIVE CLUSTERING HIERARCHY):

It improves clustering and Cluster Head selection procedure. K-LEACH is divided into rounds. Every round has setup phase and steady state phase. In setup phase, K-medoids algorithm is used for formation of clusters which conforms uniform clustering. In this Cluster Head selection is made using Euclidian distance at centre or near to cluster gives better energy efficient solution. [10] In Steady-State phase, nodes send data according to TDMA schedule, Cluster Head receives data and assemblage data Cluster Heads directly send their data to Base Station.[11] Data is collected from cluster nodes and collected data is sent to Base Station in efficient way. K-LEACH consists of rounds, all sensor nodes take part in re-election of clusters in each round and this will consume lot of energy. K-LEACH provides an efficient transmission of data to Base Station and life time also enhanced in this LEACH.

[6] L-LEACH (Energy Balanced Low Energy Adaptive Clustering Hierarchy):

It is multi-hop and distance based protocol. This proposes an energy balance algorithm. This algorithm considers distance factor and residual energy as main factors for Cluster Head election. Each node consumes energy in balanced way. [12] Different frequencies are used to communication with Base station. Two phases Setup phase and Steady state phase are available in each round. In every round new Cluster Head is elected and load is distributed among nodes in network. It distributes equal power to all sensor nodes in network. [13]



[7] W-LEACH (Weighted Low Energy Adaptive Clustering Hierarchy):

W-LEACH is a centralized algorithm and handles non-uniform distribution of sensor nodes.[14] This protocol is centralized because the base station is responsible for selection of sleep and active nodes. [15] Like as LEACH, W-LEACH has two phases i.e. Setup phase and Steady state phase. In Setup phase, W-LEACH calculates weight of each node then assigns it to each sensor node. In this Cluster Head election is made on the basis of weights. Nodes with higher weight have more chances to be Cluster Head. When all Cluster Heads are chosen then clusters are formed such that every sensor assigned to its nearest Cluster Head. Calculation for weight is:

$$W = \left\{ \begin{array}{ll} e_i * d_i & \text{if } d_i > d_{\text{thresh}} \\ d_i & \text{otherwise} \end{array} \right\}$$

$d_i = (1 + \text{no of alive sensors in range } r) / n$ is density of the sensor s_i , r is range that is reachable by sensor s_i .

d_{thresh} density threshold to define the set of sensors in low density area.

In Steady State phase, W-LEACH chooses number of sensor nodes in cluster for transmission of data to Cluster Head. Data transmission is also made on the basis of weights. Nodes having less weight are better candidates to send data. Energy recovery is main advantage of W-LEACH. This protocol is based on awareness of nodes location for selection of nodes between transmission nodes and sleep nodes.



[8] Conclusion:

Due to limited energy resources, energy efficiency becomes main challenge of network. Even various routing protocols are designed for Wireless Sensor Networks, less consumption of energy becomes most important due to limited energy resources. Main objective of designing of routing protocols is to enhance life of network and reduction in consumption of energy. In this paper, descendant of LEACH protocol has been discussed in brief and these protocols solved disadvantages of LEACH protocol.

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