

POWER SAVING AND ENERGY EFFICIENT ROUTING PROTOCOLS IN WNS: A SURVEY

Rachna¹, Nishika²

¹ M.Tech student, CBS Group Of Institutions (MDU,Rohtak)

²Assistant Professor, CBS Group Of Institutions (MDU,Rohtak)

¹ phouatrachna@gmail.com, ² ngulia5101989@gmail.com

Abstract— Wireless sensor networks with hundreds of sensor nodes have emerged in recent years as important platforms for a wide spectrum of monitoring tasks ranging from environmental to military applications. Its growth is expeditiously increasing and that's why there is an immense field for research in this area. A sensor network is a static ad hoc network which consists of hundreds of sensor nodes that can be deployed on the fly operation being not attended so the main design issue for a sensor network must be conservation of the energy available at each sensor node. Wireless Sensor Network depends on nodes have limited energy, memory, computational power, range and it is important to increase energy efficiency by saving the battery power so as to extend the life time of the given WSN deployment. In WSN, data is measured by nodes and same is send to Base Station at regular interval. Different protocols are used for energy consumption, in wireless sensor network. Sensors depend entirely on the trust of their battery for power, which cannot be revitalized or substituted. So the design of energy aware protocol is essential in respect to enhance the network lifetime. LEACH, LEACH C and HEED, TEEN, VGA, PEGASIS are energy- efficient hierarchical based protocols that balances the energy expense, saves the node energy and hence prolongs the lifetime of the network. So this paper presents a detailed review and analysis of these energy efficient protocols.

Keywords— Wireless sensor network, Energy conservation, PEGASIS; LEACH, LEACH C, HEED, TEEN, VGA, cluster head etc.

INTRODUCTION

A wireless sensor network (WSN) is a specialized wireless network that composes of a number of sensor nodes deployed in a specified area for monitoring environment conditions such as temperature, air pressure, humidity, light, motion or vibration, and so on. The sensor nodes are usually programmed to monitor or collect data from surrounding environment and pass the information to the base station for remote user access through various communication technologies. Figure 1 shows general wireless sensor network architecture.

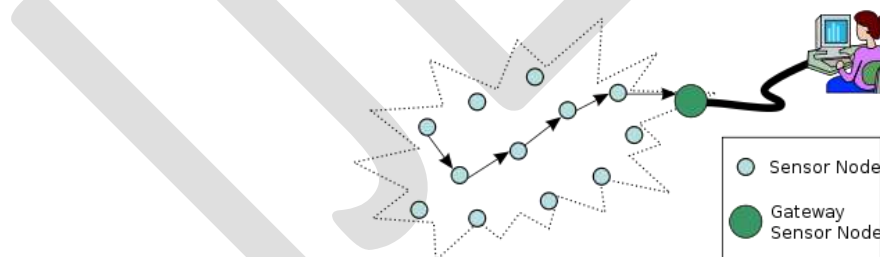


Fig.1. WNS ARCHITECTURE

WSNs architecture is shown in Figure 1 which contains all major components. A sensor node is a node in a wireless sensor network that is capable of performing some processing, gathering sensory Information and communicating with other connected nodes in the network. A sensor field is the location where the nodes are organized. A gateway sensor node is a sensor node with the specific task of transceiver and managing data from the other sensor nodes.

Some applications of wireless sensor network:

- Healthcare management
- Earth sensing

- Vehicular telemetric
- Military application
- Commercial purpose

Some benefits of wireless sensor network:

- Autonomous node
- Monitor device with GPS
- Easy, fast and reliable communication
- Flexibility for new device deployment
- Controlling through gateway or sink node

Some drawbacks of wireless sensor network:

- High cost infrastructure
- Atmospheric effects
- Maximum error possibility
- Energy management for sensor node

Routing Protocols in WSN

In recent years, many clustering routing protocols are used in wireless sensor network. In our study the main focus is on LEACH, LEACH-C, PEGASIS, HEED, TEEN, VGA routing protocols.

LEACH (Low-Energy Adaptive Clustering Hierarchy) Protocol:

It is hierarchical routing algorithm based on clustering. In each round every node has the probability to get selected as cluster head. It proposes the concept of round for the implementation of periodicity. It involves two phases in every round: cluster set-up phase and steady data transmission phase. In sensor network algorithm is used to divide into clusters. So the communication loads are shared and the energy consumption of every part of the network is balanced. The network topology shaped by LEACH is shown:

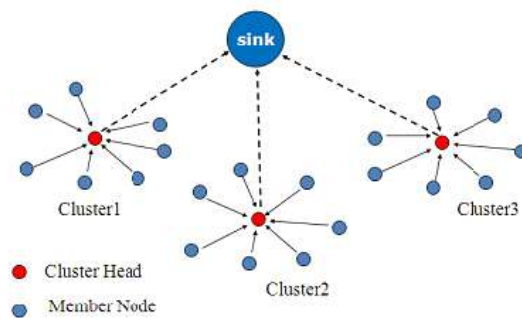


Fig.2. Leach Protocol

1. The setup phase, the clusters are organized and the cluster heads are selected. In every round, a stochastic algorithm is used by each node to check whether it will become a cluster head. If a node can be a cluster head once, it can't become a cluster head again for P rounds, where P is the percentage of these cluster heads.

2. The Steady Phase: In this phase, the data is transmitting to the base station. The duration of this phase is much longer than the duration of the above phase in order to reduce overhead.

LEACH is a protocol that uses to reduce energy consumption in a wireless sensor network. However, LEACH uses Single-hop routing in which every sensor node sends information directly to the cluster-head or the Sink. Therefore, it is not recommended for networks that are delivered in large areas.

LEACH-C protocol:

As compare to the “LEACH”, the base station is used to develop the C.H, instead of nodes will be configured themselves into the C.H. How the BS (Base Station) will work in this regard to develop the C.H? Firstly the BS obtains data as per the location & energy level of every node in the network. On the second stage it will find a recent number of C.H and the after that it will be organizes the network into the clusters. It has been completed in respect to curtail the energy, mandatory for non CH nodes to convey their information to their particular cluster heads.

Following are the improvements as compare to “LEACH”:

- The BS uses its universal knowledge of the network to create clusters that necessitate less energy for data broadcast.
- In “LEACH-C” the number of C.H in each round equals a prearranged optimum value.

PEGASIS (Power-Efficient Gathering in Sensor Information Systems):

PEGASIS (Power-efficient Gathering in Sensor Information Systems) is a greedy chain-based power efficient algorithm. Also, PEGASIS is based on LEACH. The key features of PEGASIS are

- The Base Station is fixed at long distances from the sensor nodes.
- The sensor nodes are alike and energy constrained with consistent energy.
- No mobility of sensor nodes.

PEGASIS is based on two ideas; chaining, and data fusion. In PEGASIS, each node can take turn of being a leader of the chain, where the chain can be constructed using greedy algorithms that are deployed by the sensor nodes. PEGASIS assumes that sensor nodes have a global knowledge of the network, nodes are stationary (no movement of sensor nodes), and nodes have location information about all other nodes. PEGASIS performs data fusion except the end nodes in the chain. PEGASIS outperforms LEACH by removing the overhead of cluster formation, decreases the sum of distances that non leader-node must transmit, less the number of transmissions and receives all nodes, and use only one transmission to the BS per round. PEGASIS has the same problems that LEACH suffers from. Also, PEGASIS does not scale, cannot be applied to sensor network where global knowledge of the network is not easy to get. Power efficient Gathering in Sensor Information Systems (PEGASIS) is an enhancement of the LEACH protocol. Rather than designing multiple clusters, PEGASIS makes chains of sensor nodes so that every node transmits and receives from a neighborhood and only one node is picked up from that chain to transmit to the base station. Collected data transfer from node to node, aggregated and eventually sent to the base station. The chain designing is achieved in a greedy way. Node c0 transmit its data to node c1. Node c1 combine node c0 data with its own and then passes it to the leader. After node c2 passes the token to the node c4, node c4 transfer its data to node c3. Node c3 combines node c4's data with its own and then passes to the leader. Node c2 waits to receive data from both neighborhood and then attached its data with its neighborhood data. Finally, node c2 pass one message to the base station.

TEEN (Threshold sensitive Energy Efficient sensor Network protocol):

After the groups are formed, the cluster head transfers two thresholds to the nodes. These are soft and hard thresholds for sensed characteristic. Hard threshold is the lowest possible value of an attribute to activate a sensor node to change on its transmitter and transmit to the group head. Thus, the hard threshold permits the nodes to transfer only when the sensed characteristic is in the range of interest, thus decreasing the amount of transmissions importantly. Once a node senses a value at or without the hard threshold, it transmits data only when the values of that characteristic changes by an amount greater than or equal to the soft threshold.

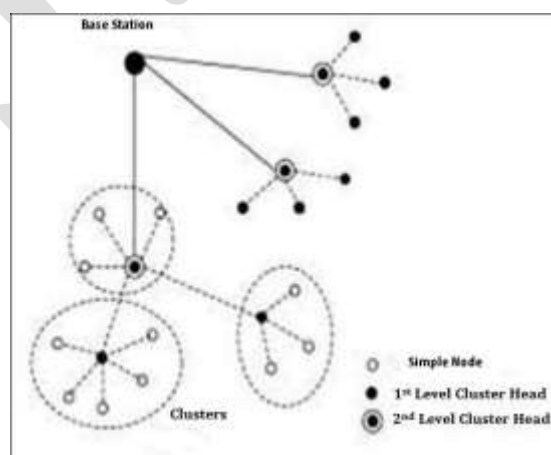


Fig 3: TEEN

HEED Protocol:

Hybrid Energy Efficient Distributed clustering (HEED) is a multi-hop wireless sensor network clustering algorithm that brings an energy-efficient clustering routing with explicit consideration of energy. Different from Leach in the way of elections the cluster head, HEED does not select in the cluster head in randomly manner. Is performed the cluster method based on the hybrid combination of the two parameters. The first parameter depends on the residual energy of the node, and the second parameter is considering the cost of communications within the intra-cluster. Elected cluster head in HEED, depending high average of residual energy compared to MNs.

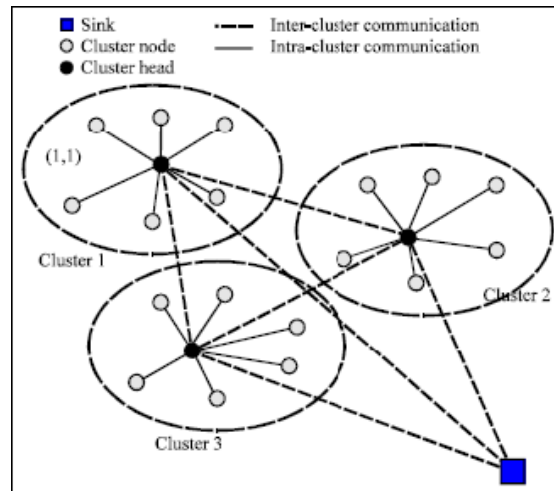


Fig 4: HEED

A node considers itself covered if it has heard from either a tentative _CH or a final _CH. If a node completes HEED execution without selecting a cluster head that is final _CH, it considers itself uncovered, and announces itself to be a cluster head with state final _CH. A tentative _CH node can become a regular node at a later iteration if it finds a lower cost cluster head. HEED protocol depend on residual energy, and communication cost to select cluster head. The communication cost is the minimum power levels required by all nodes within the cluster range to reach the cluster head. The communication cost uses to allow a node that belong to several CHS choose the best one. In HEED protocol each node can join only to one cluster head with one hop only. After a cluster formation, each node can be either elected to become a CH due to a probability or join a cluster according to CH messages.

LEACH-FL (Low-Energy Adaptive Clustering Hierarchy using Fuzzy Logic):

This method, improves the LEACH protocol by using fuzzy logic on LEACH protocol. Selection of cluster head is based on three variables –battery level of node, node density and distance from base station. In this system, we assume that all the nodes can get their coordinates in WSN. LEACH-FL has three parts-four fuzzification, functions, an inference engine (include 27 rules) and defuzzification module

VGA (Virtual Grid Architecture Routing):

VGA associates the “data combination and in-network processing” to get energy efficient system and expansion of network lifetime. This whole scheme can be distributed into two phases, first is “clustering” and the other is “routing of aggregated data”. In the first phase, sensors are organized in a fixed topology because many applications require stationary sensors. Inside each cluster there is a CH, recognized as “local aggregator (LA)”, which performs the aggregation. A subdivision of this LA is designated to perform “global or in-cluster aggregation” and its associates are named as “master aggregator (MA)”. In the second phase, some heuristic are suggested which may provide effective, modest, efficient and an optimal solution. The core benefit of this protocol is that it can achieve energy efficiency and can expand the network lifetime, but the problem of optimal selection of LAs as MAs is a solid problem.

TABLE I. HIERARCHICAL ROUTING SCHEMES COMPARISON

Scheme	Advantages	Drawbacks	Scalability
LEACH	Low energy, ad-hoc, distributed protocol	It is not applicable to networks deployed in large regions and the dynamic clustering brings extra overhead	Good
LEACH-C	The energy for data transmission is less than LEACH	Overhead	Good
PEGASIS	The transmitting distance for most of the node is reduced	There is no consideration of the base station's location about the energy of nodes when one of the nodes is selected as the head node	Good
TEEN	It works well in the conditions like sudden changes in the sensed attributes such as temperature	A lot of energy consumption and overhead in case of large network	Good
VGA	It may achieve energy efficiency and maximization of network lifetime	The problem of optimal selection of local aggregators as master aggregators is NP- hard problem	Good

Conclusion:

One of the main challenges in the WSNs is energy efficiency, due to the constant insufficient energy resources of sensors. The ultimate objective behind the routing mechanism design is to keep the sensors operating for as long as possible, thus extending the network lifetime. Due to complexity in WSNs operations, what is required is the use of energy-efficient routing techniques and protocols, which will assure the network connectivity and routing of information with less required energy. In this paper, our focus was on the energy efficient hierarchical protocols that have been developed for WSNs. We can conclude that the hierarchical protocols are appropriate for sensor networks with the heavy load and wide coverage area. So in order to develop a scheme that will prolong the lifetime of the WSNs is needed to increase the energy consumption of the sensors with in the network. Therefore, the application of the appropriate routing protocol will enhance the lifetime of the network and at the same time it will guarantee the network connectivity and effective and efficient data delivery.

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