A Survey on LEACH Protocol and its Successors

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ABSTRACT

Wireless sensor network (WSN) is playing an important role in the information industry in the 21st century and is widely applied in military, medical care, environmental monitoring, smart home applications, and in many other fields also. WSN is a distributed system consisting of many sensor nodes and a sink node that collects data from the sensor nodes. Sensor nodes of a WSN have limited power and energy constraint so it is mandatory to efficiently use these resources. Therefore, sensor nodes have emerged as a research hotspot. The most important power consuming component in WSN is the routing protocol as it require power when receiving and transmitting the data of other nodes. This drawback revealed the requirement of tailored routing protocol which reduces the power usage to prolong the lifetime of sensor nodes. A cluster-based network structure can balance the energy consumption of network nodes. Low-Energy Adaptive Clustering Hierarchy (LEACH) protocol is one of the first clustering protocols for WSNs and is one of the most famous clustering techniques. So by using this protocol the major issue of power consumption can be solved, this is the basic protocol and research is in progress to improve its capability and improve the energy efficiency of the WSNs.

Keywords: - *LEACH, Energy Efficient, Routing Protocol, Clustering Hierarchy.*

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1. INTRODUCTION:

A wireless sensor network (WSN) is a wireless network consisting of spatially distributed autonomous devices using sensors to monitor physical or environmental conditions. [6] A WSN system incorporates a gateway that provides wireless connectivity back to the wired world and distributed nodes. WSN has wide application possibilities, such as temperature, pressure, humidity and habitat monitoring, disaster management, military reconnaissance, forest fire-tracking, security surveillance and many more. In most scenarios, sensor nodes are randomly deployed with limited battery power. The selection of routing techniques is an important issue for the efficient delivery of sensed data from its source to the destination. A lot of energy-efficient routing protocols have been proposed and developed for WSN, depending on their application and network architecture. The flow of data transmission is a very important aspect in WSN. There are several routing protocols which are responsible for determining the flow of data across the network. The routing protocols in WSN are divided in Flat, location-aware and hierarchical on the basis of network structure.
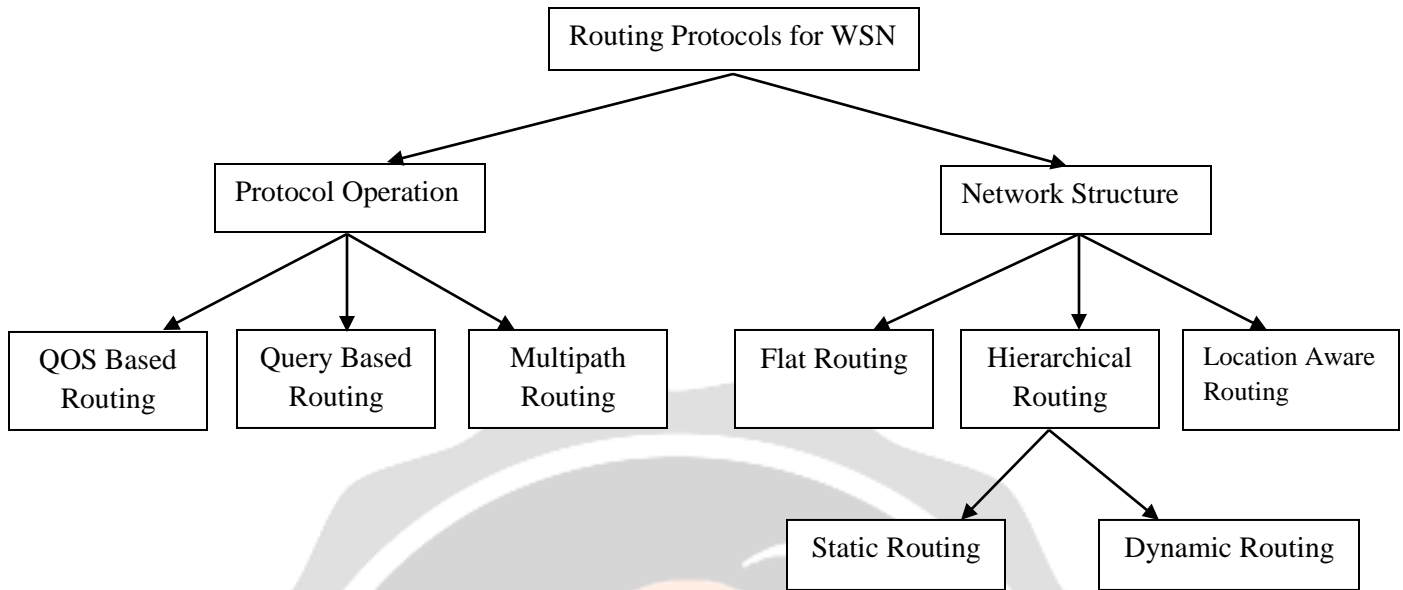
Fig.1 Classification of routing protocols [1]

Hierarchical routing provides better energy efficiency and scalability due to its architecture. In this type of protocol, the whole network is divided into clusters and some nodes are chosen as special nodes based on certain criteria. These special nodes called cluster heads (CHs) collect, aggregate and compress the information received from neighbor nodes, and finally transmit the compressed information to the BS.

The first hierarchical routing protocol was proposed by Heinzelman et al. known as LEACH (Low Energy Adaptive clustering Hierarchy). LEACH is a pioneer clustering routing protocol for WSN. The main objective of LEACH is to increase the energy efficiency by rotation-based CH selection using a random number. LEACH works in two different phases viz. set-up and steady-state phase.
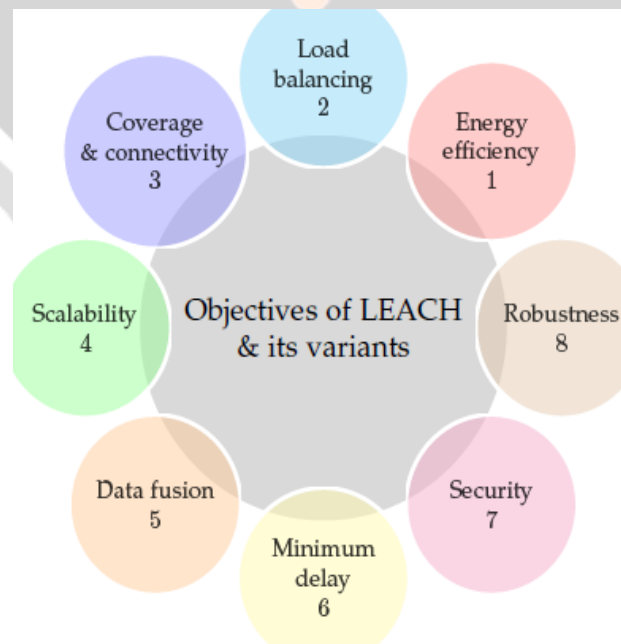

Fig.2 Objectives of LEACH [7]

In rest of the paper, section II gives the literature review of different research papers containing the successors of LEACH Protocol, section III gives the comparative study of the different research study discussed in section II, & section IV is about conclusion and future work of LEACH protocol.

2. LITERATURE REVIEW:

- In Recent years, there have been many papers published on successors of LEACH protocol for energy efficiency through routing protocols in Wireless Sensor Network. Routing protocol has emerged has a research hotspot, which is attracting researchers to contribute their work in this field. Below is the brief discussion about the methods used by different researchers for routing protocols in WSN's.

2.1 LEACH: An Energy Efficient Routing Protocol using Omnet++ for Wireless Sensor Network [1].

- Deepak M. Birajdar and Sharwari S. Solapure presented the detailed working of LEACH protocol using Omnet++ simulator. LEACH works in two different phases viz. set-up and steady-state phase. LEACH periodically do the rotations among cluster-head nodes in such a way that every node gets a chance to become cluster head and distributes energy consumption between the nodes in the network which reduces the power utilization, increasing the lifetime of the network. LEACH is better than the classic approaches like SPIN, GAF, TEEN, and APTEEN etc.

2.2 Improving Lifetime of Wireless Sensor Networks by Mitigating Correlated Data using LEACH Protocol [2].

- Rajat Kandpal & Rajesh Singh proposed a new improved version of LEACH as IL-LEACH (Improved Lifetime Low Energy Adaptive Clustering Hierarchy). Sensor nodes placed in vicinity sense correlated data which is sent to the cluster head. IL-LEACH aims to mitigating the correlated data transmissions by forming groups of nodes into virtual correlated cluster (VCC) and allowing only one node to send data. The grouping is done based on calculation of a threshold sensing coverage (TSC) and Euclidean distance. IL-LEACH improves the lifetime of sensor network at an average of 30.006% with respect to existing LEACH protocol.

2.3 H-LEACH: Hybrid-Low Energy Adaptive Clustering Hierarchy for Wireless Sensor Networks [3].

- Abdul Razaque and his team proposed a new approach H-LEACH (Hybrid Low Energy Adaptive Clustering Hierarchy), this is used to solve problems of energy considerations while electing a channel head. H-LEACH considers residual and maximum energy of nodes for every round while electing a channel head using threshold condition. In this paper, the proposed algorithm is used to find the life time of the nodes in terms of rounds when the proposed threshold and energy conditions are considered. The nodes with energy less than to that of the (Etr) minimum energy required for transmitting and receiving signals is made to die as it lacks energy to do it. Total numbers of alive nodes are calculated for every round so as to have a track on the life time of the network. H-LEACH, being the combination of HEED and LEACH overcomes the node energy issues, which is the major disadvantage of the LEACH protocol.

2.4 OE-LEACH: An Optimized Energy Efficient LEACH Algorithm for WSNs [4].

- Sapna Gambhir and Parul proposed a new approach OE-LEACH (Optimized Energy Efficient LEACH) it aims to minimize the energy consumption in order to improve the time delay, network stability period and network lifetime of WSNs. There are many situations where the sensor nodes do not have data to send regularly as they may be event driven. So in that case data are available only when they sense the event. So, the sensor nodes do not need to listen the channel at all times. Energy is wasted more on idle listening than that dissipated in transmitting and receiving. This method takes advantage of using the slots belong to the node having no data to send. Slots are not allocated to the nodes which have no data to send and free slots are converted into useful slots, which reduce the idle listening problem, and also decrease waiting time.

2.5 LEACH-T: LEACH Clustering Protocol Based on Three Layers [5].

- Mustafa A. Al Sibahee and his team proposed a new approach LEACH-T (Leach Three Layers). Power consumption increases massively as the distance between sink node and cluster heads (CHs) increases. This

drawback introduces distance as one major issue in LEACH. In this work, a LEACH based protocol consisting of three layers is proposed. Each layer has its own CHs. The layers attempt to reduce the distance between sink node and CHs. The third layer is utilized if the distances between CHs and sink node exceed a threshold value.

3. COMPARATIVE TABLE:

Sr. No.	Paper Title	Method Used	Advantages	Disadvantages
1.	LEACH: An Energy Efficient Routing Protocol using Omnet++ for Wireless Sensor Network[1]	Low Energy Adaptive clustering Hierarchy	1: Periodic rotation among cluster head nodes so every node gets a chance to become cluster head. 2: distribution of energy consumption between nodes.	Some of cluster heads concentrate in a particular area of the network. Therefore some non-cluster head nodes may become orphan nodes
2.	Improving Lifetime of Wireless Sensor Networks by Mitigating Correlated Data using LEACH Protocol[2]	Improved Lifetime Low Energy Adaptive Clustering Hierarchy	The correlated data transmissions is reduced which helps in energy conservation and less congestion in the network. The proposed approach helps improve lifetime of a wireless sensor network at an average of 30.006 %.	Grouping through TSC can lead to exclusion of an node with high power which is outside its coverage range
3.	H-LEACH: Hybrid-Low Energy Adaptive Clustering Hierarchy for Wireless Sensor Networks[3]	Hybrid low energy adaptive clustering hierarchy.	The disadvantages of HEED is overcome i.e. it cannot be operated for different levels of energy considerations from the first round	Node is declared dead if it lacks in energy
4.	OE-LEACH: An Optimized Energy Efficient LEACH Algorithm for WSNs[4]	Optimized Energy- Low Energy Adaptive Clustering Hierarchy	1: Enhancement of steady phase of LEACH Method. 2: Improvement in terms of stability period, network lifetime and throughput of the network.	Overhead of frames, and only for the idle nodes in the network.
5.	LEACH-T: LEACH Clustering Protocol Based on Three Layers[5]	Low Energy Adaptive Clustering Hierarchy-Three Layer	Eliminates the distance issue of LEACH protocol	Only suitable if the distance between nodes is long.

Table -1: Comparative Table

4. CONCLUSION:

This paper presents a comprehensive and state-of-the-art survey of LEACH and its successors. It is evident that the different successors of LEACH are an improvement over the basic LEACH protocol. A major goal of any newly designed protocol in WSN is energy efficiency apart from performance factors. LEACH has been a creative field of

research over the years. All LEACH-related protocols discussed in this paper offer a promising improvement over conventional LEACH; however, there is still much room for developing convenient and efficient LEACH variants.

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