

## A Survey on Energy Efficient Network Based Hierarchical Routing Protocols

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**Abstract:** Inside the recent years research on Wireless sensor network plays significant role in lots of the research fields. Wireless Sensor Network stationed in the fields endures from energy efficiency. Occasionally its battery gets exhausted and so losing its network connectivity. In order to keep up with the energy level of a node energy-efficient protocols being proposed. This paper, presents a survey on energy efficient routing protocol that uses hierarchical routing protocol.

**Key terms:** WSN, LEACH, PEGASIS, H-PEGASIS, TEEN, CH, BS

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### I. Introduction

Wireless sensor network has seen a flourishing development in Military applications, Environment monitoring systems and Health care systems. WSN varieties a brilliant network which contains thousands and hundreds of small low cost and limited energy devices called sensors. These Detectors/Devices can sense information in a fast manner and delivery of the information in the same way by either directly or indirectly communicating with the base station. Generally there by the energy usage in sensor nodes are high due to data transmission, reception and processing that takes place in each node.

To bring out the sensor with increased/improved life time we need to offer energy efficient protocols to prolong the network life time. However the energy can be proficiently maintained by using the techniques namely duty cycle scheduling, energy efficient MAC (medium access control), energy efficient routing, energy harvesting and so on. Wireless sensor Network architecture depicted in figure 1 describes the communication between nodes and the base station. Moreover each sensor node present in the architecture can take its decision on quest, the current information they have, its computing knowledge, communication, energy resources and possess the capability to communicate and send the information to the other sensor nodes or to the fixed/mobile base station (BS) which is capable of connecting the sensor network to an existing communication framework or web, where user have access to the reported data.

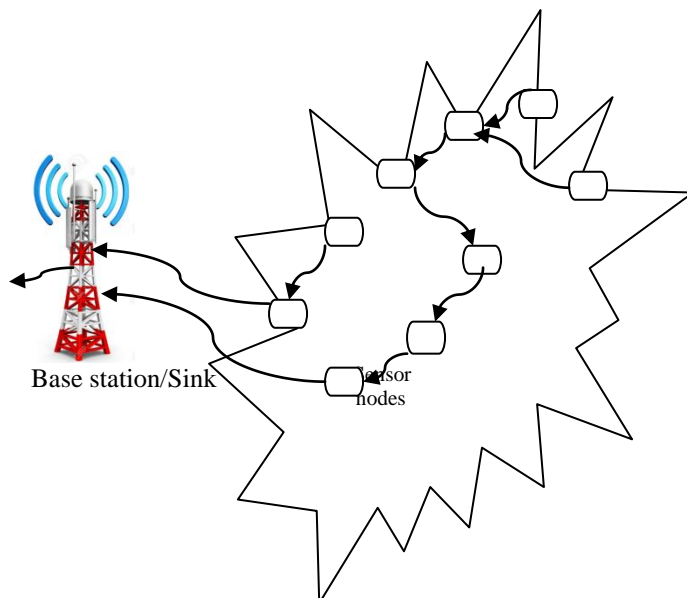


Fig 1 WSN communication architecture

Aim of this paper presents the survey on the classification of network based Hierarchical protocol along with its routing protocols. The paper is prepared and presented with the following sections. Section 2 describes the related work carried out in other papers were brought in. Section 3 describes the Classification of Routing Protocols. Section 4 brings out the energy efficient routing protocols for WSN. Section 5 explains the design issues and routing challenges. Section 6 illustrates the analysis of hierarchical routing protocols and finally Section 7 presents the conclusion of the paper with future enhancement.

## II. Related Work

Numerous research in networking gains the attention of many researchers in introducing the routing protocols and its category. These protocols are advertised based on their network architecture and applications [2]. Many factors are need to be considered in the development of routing protocol, of which minimum ingestion of energy i.e., Energy efficiency by sensor node affects the network lifetime, stability and throughput of the network. A survey on energy efficient protocols is made to understand its characteristics and advantages [1]. Even though there are some prior efforts on survey of energy efficient routing protocols were made, the proposed paper centers around network based hierarchical routing protocol.

The classifications of routing protocols are created based on the network structure namely flat, hierarchical and network based [5]. Furthermore, the network structure is classified into multipath based, query based, negotiation, QOS and coherent depending on their operation. Based on this classification a thorough study was made on the design trade-offs between energy and communication overhead. Moreover, comparative analysis of routing techniques for WSN and their classifications also were made and distinguish by the way it chooses the next hop on the route of a communication. In addition to that this paper [6] discusses the advantages and performance issues of each routing techniques. Even though variety of routing protocols were discussed in [4] along with their classification, approaches each routing protocol is defined in a appropriate manner with the possible future research areas.

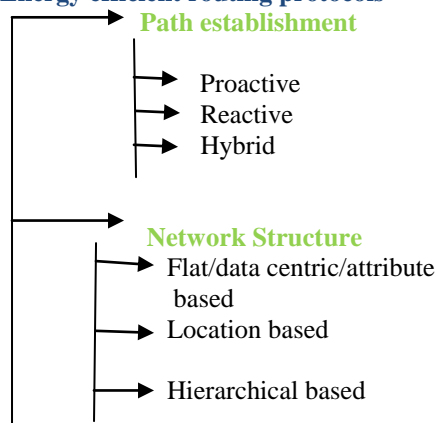
Study on hierarchical routing protocols [8] such as LEACH, TEEN and AP-TEEN describes its characteristic, performance and advantages. Approaches towards the review and comparison is learnt from the increased versions of Power Efficient Gathering In Sensor Information System (PEGASIS) protocol illustrates the method for achieving prolonged communication in a Wireless Sensor Network with minimal energy consumption [9].

## III. Classification of Routing Protocols:

The classification of energy efficient routing protocols presented in figure2 describes path establishment, network structure and protocol operation. Path establishment is characterized into proactive, reactive and hybrid. Categorization of Network was made either into Flat or Data centric or attributes based ,location based and hierarchical based. Finally, Protocol operation is segregated into query, multipath, mobility and QOS.

Figure 3 illustrates the hierarchical routing protocols the protocols namely LEACH, PEGASSIS, H-PEGASSIS and TEEN. LEACH is a self organized energy efficient routing protocol based on clustering method. PEGASSIS works with chain construction and data aggregation. H-PEGASSIS. LEACH works by selecting CH's and do data aggregation to forward the data to the BS. PEGASSIS uses chain/train construction and data aggregation to forward the data to the BS. H-PEGASSIS is an upgraded version of PEGASSIS in which the hierarchical structure is fashioned by the sensor nodes. TEEN is a hierarchical network protocol it works extraordinarily by sensing the environment where sudden changes are happened.

### Energy efficient routing protocols



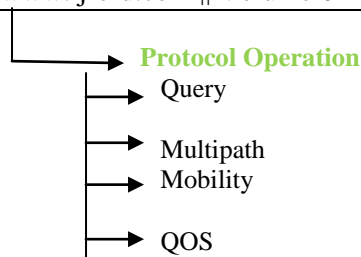


Figure 2-Classification of energy efficient routing protocols

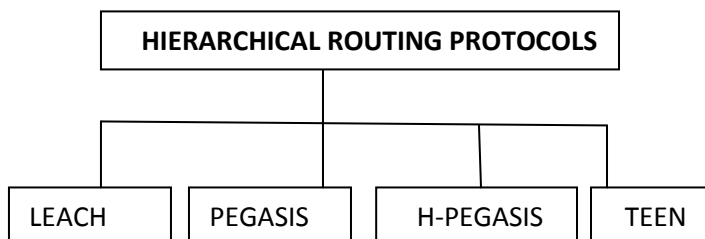


Figure 3-Classification of Hierarchical routing protocols

#### IV. Energy Efficient Routing Protocols In Wsn

Routing protocols have the wider scope in the region of studies to manage the power efficiently. Routing protocol primarily categorizes into three major aspects namely, path establishment, network structure and protocol operation. Amongst this protocol, this paper presents the network based hierarchal routing protocol with their characteristic functions, advantages and disadvantages.

##### Network Structure Protocol:

This routing protocol purely depends on the network structure and behaves with respect to the design constraints for that network. Network structure protocol may further be classified according to their functionality as Flat or Data centric or Attributes based protocol, Location based protocol and Hierarchical based routing protocol. In data centric protocols when the source node sends data to the base station, intermediate nodes perform some process on the data and send the processed data to the base station. Location based routing also termed as geographic routing. The location of sensor nodes have the primary role. The locations of sensor nodes are used to route the data in the network. The distance between two nodes can be calculated on the basis of incoming signal intensity. In hierarchical routing sensor nodes perform different functions in the network. Hierarchical routing is based on clustering mechanism. Clustering is the prominent technique for the enhancement of network lifetime by efficient utilization of the energy of the sensor nodes.

##### 4.1 HIERARCHICAL ROUTING PROTOCOLS:

Hierarchical routing protocol has been proposed earlier for wire line information exchange in which its significant advantages of scalability and lower power consumption were discussed [3]. Hence it is decided to deploy Hierarchical Routing Protocols in WSN to provide high scalability with less power consumption. Hierarchical routing protocol performs the routing based on the clustering, wherein the higher energy nodes are termed as cluster heads (CH) and the CH can be modified and reassigned to the node with high energy. The nodes within each cluster receive and transmit the records to the respective CH. The CH is responsible to carry out statistical aggregation and fusion thereby reducing the data to be dispatched to the base station (BS).

##### 4.1.1 LEACH - Low Energy Adaptive Clustering Hierarchy:

LEACH is the protocol most popular hierarchical routing protocol which has the self organizing and energy efficient capability to extend the network lifetime. For data fusion this protocol will give better performance.

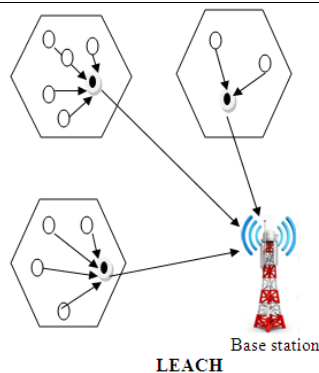
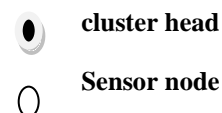


Figure 4 – LEACH



LEACH protocol is based on clustering method in which the network of sensors are divided into multiple clusters and for every cluster a CH is elected based at the energy level of the sensor nodes. Among the total nodes present in the WSN maximum of 5% of clusters can be formed and CH nomination is done as described earlier. This can be done in two phases namely setup phase and steady state phase.

**SET-UP PHASE:** Organizes the network into cluster and generates the random number between 0&1 then allocates the number for every sensor and the sensor that is less than the threshold value can be the CH for that precise round. After the selection of CH, it informs to all the neighbouring members through an advertisement packet. The sensors, who wish to sign up as participants may send a link packet that consists of the identification's which can be dispatched using TDMA, CSMA issued.

**STEADY STATE PHASE:** The data transfer to CH covers the area sounded by TDMA. The radio will be turned on until the TDMA allotted for the sensor. As a result saving energy in my opinion. When all data are accumulated it's been aggregated, compressed and transmitted to the BS.

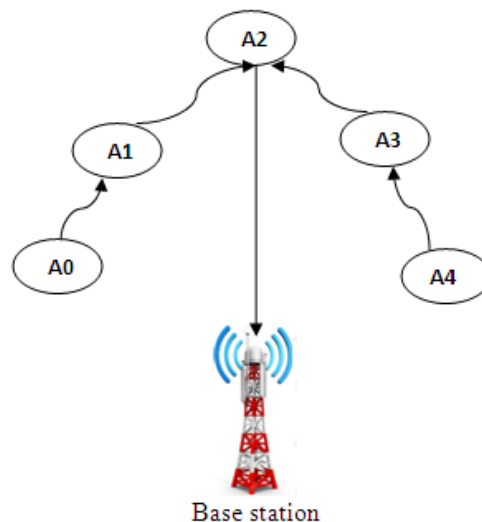
#### 4.1.2 PEGASIS – Power Efficient Gathering In Sensor Information System:

PEGASIS is close to and favourable for the data gathering programs in sensor networks. PEGASIS performs efficaciously whilst in comparison to LEACH (i.e.) it indicates a 100 to 300 % overall performance improvements when taken into consideration with energy level. In PEGASIS the sensor nodes speak with each other and bureaucracy a chain and finally it reaches the bottom station. It takes place in two phases (i) chain/train creation (ii) records aggregation.

##### (i) CHAIN/TRAIN CONSTRUCTION:

In the first section the sensor node transmits the data to the neighbour node, the neighbour node does data fusion (or) aggregation and sends the data to the subsequent neighbouring node and consequently it paperwork a chain.

**(ii) DATA GATHERING:** A leader node is chosen amongst them by computing residual energy calculation and ultimately the chief/leader transmits the aggregated data to the BS.



**Figure 5 - PEGASIS**

Unlike LEACH, here the performance benefit is executed through the elimination of CH formation as in LEACH and is achieved by means of maximizing the data aggregation.

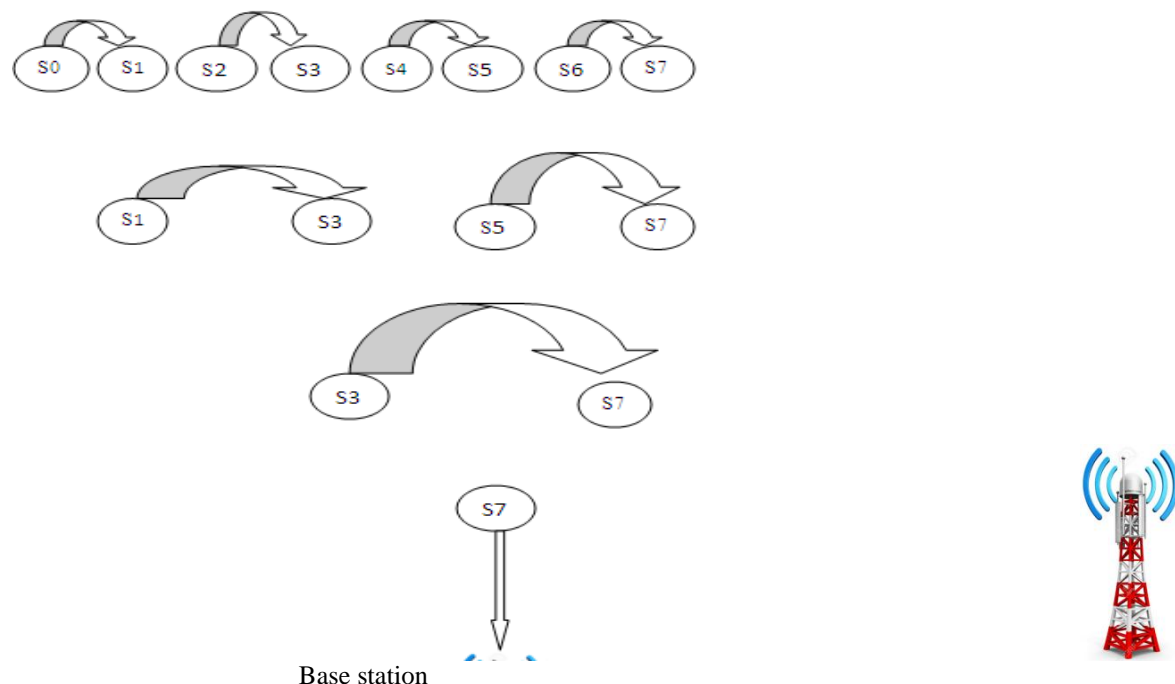
The essential drawback hired in this protocol is that for big network it introduces larger postpone and the idea of single chief/leader will become a problem.

**(c) HIERARCHICAL-PEGASIS:**

Hierarchical-Pegasis is an upgraded version of PEGASIS. In which the hierarchical structure is fashioned by the sensor nodes. At each level a cluster head is chosen. CH collects the statistics from the neighbouring nodes.

Each odd nodes are selected and the even nodes send the facts to the closest bizarre nodes. The subsequently to pick the odd nodes wherein the data are aggregated and it is despatched to the next degree and finally given to the next degree.

The limitation related right here is that every node has to realize about the energy stage of the nearest neighbouring nodes. Since it has to direction its very own datas.



**Figure 6 – Hierarchical PEGASIS**

**(d) TEEN – THRESHOLD SENSITIVE ENERGY EFFICIENT SENSOR NETWORK:**

TEEN is a hierarchical network protocol it works extraordinarily by sensing the environment where sudden changes are happened. This protocol hospitalize the network to operate in the reactive node.

There are two levels, **LEVEL 1**: The cluster formation is done and the CH is selected and all the sensor nodes send the sensed information to the CH in the first level. These first level CH communicate with the **LEVEL 2** CH, this process continues until the data reaches the BS. The CH sends two threshold values to the nodes (i) **hard threshold**: is the accurate value of the sensed attribute at which the sensor should transmit the data. (ii) **soft threshold**: the sensor send the value at (or) beyond the threshold value. With these techniques the number of transmissions can be minimized and hence the energy can be saved.

**V. Design Issues and Routing Challenges:**

In defiance of incalculable applications of WSN, these WSN has many confinements. The design of WSN has many challenges and design issues, especially when it is with energy consumption, when communication takes place to extend the lifetime of the networks. There are many issues as follows:

- Node deployment
- Energy consumption
- Fault tolerance
- Connectivity
- QOS

**VI. Analysis of Hierarchical Routing Protocols:**

Analysis of hierarchical routing protocols such as LEACH, PEGASIS, H-PEGASIS, TEEN is made with necessary parameters such as classification, life time of network, gathering of datas, awareness of resources, energy efficiency, data delivery, power consumption and mobility.

**Table-1 Comparative Analysis of Hierarchical routing protocols**

Hierarchical Routing Protocols	LEACH	PEGASIS	H-PEGASIS	TEEN
classification	Hierarchical	Hierarchical	Hierarchical	Hierarchical
Life time of network	Very good	Very good	Very good	Very good
Gathering of datas	Yes	Yes	Yes	Yes
Awareness of resources	Yes	Yes	Yes	Yes
Energy efficiency	Good	Very good	Very good	Excellent
Data delivery	Cluster based	Train based	Train based	threshold
Power consumption	maximum	maximum	maximum	High
Mobility	Fixed base station	Fixed base station	Fixed base station	Fixed base station

**VII. Conclusion**

With this paper, the classification of energy efficient routing protocols were made. Among these classification, the network based hierarchical routing protocols such as LEACH, PEGASIS, H-PEGASIS and TEEN were considered and their characteristics were discussed. In section-V the open design issues of WSN were mentioned. Finally the analysis report on these protocols based on a parameters are given. The future work will be on some of the other hierarchical protocols, their characteristics and the routing protocols based on protocol operations.

**VIII. References:**

- [1]. Alaaudin Ibrahim, Malik Kemal Sis and Sen Cakir, "Integrated Comparison of Energy Efficient Routing Protocols in Wireless Sensor Network: A survey" 2011 IEEE Symposium on Business, Engineering and Industrial Applications (ISBEIA), Langkawi, Malaysia.
- [2]. Priyanka Sharma, Inderjeet Kaur, "A Comparative Study on Energy Efficient Routing Protocols in Wireless Sensor Networks" IJCSI International Journal of Computer Science Issues, Volume 12, Issue 4, July 2015 ISSN (Print): 1694-0814 | ISSN (Online): 1694-0784.

- [3]. Navdeep Kaur, Deepika Sharma and PrabhdeepSingh,” Classification of Hierarchical Routing Protocols in Wireless Sensor Network: A Survey”, International Journal of P2P Network Trends and Technology Volume3Issue1- 2013
- [4]. Parul Khurana,Inderdeep Aulakh,” Wireless Sensor Network Routing Protocols: A Survey”, International Journal of Computer Applications (0975 – 8887) Volume 75– No.15, August 2013.
- [5]. jamal n. al-karaki,ahmed e. kamal, “routing techniques in wireless sensor networks: a survey”, IEEE Wireless Communications,December 2004,1536-1284.
- [6]. G.H.Raghunandan,B.N.Lakshmi,” A Comparative Analysis of Routing Techniques for Wireless Sensor Networks”, Proceedings of the National Conference on Innovations in Emerging Technology-2011 Kongu Engineering College, Perundurai, Erode, Tamilnadu, India.17 & 18 February, 2011.pp.17-22.
- [7]. Prathap U, Deepa Shenoy P and Venugopal K R “Wireless Sensor Networks Applications and Routing Protocols: Survey and Research Challenges”, , 2012 International Symposium on Cloud and Services Computing, 978-0-7695-4931-6/12 \$26.00 © 2012 IEEE DOI 10.1109/ISCOS.2012.21
- [8]. Jigisha Parmar, Ashishgoud Pirishothm “Study of Wireless Sensor Networks Using LEACH,TEEN AND APTEEN Routing Protocols”,2011 IEEE Symposium on Business, Engineering and Industrial Applications (ISBEIA), Langkawi, Malaysia, 978-1-4577-1549-5/11/\$26.00 ©2011 IEEE
- [9]. Kalkandha, Charu Wahi, Seema Sharma, Sanjay K. Sonbhadra, Priyanka ”Current State of Art of Energy Efficient PEGASIS Routing Protocols in WSNs”, Volume 5, Issue 12, December 2015 ISSN: 2277 128X, International Journal of Advanced Research in Computer Science and Software Engineering
- [10]. Amandeep Kaur, Kamaljit Kaur, " A Review of Different Energy Efficiency Techniques in Wireless Sensor Networks" Volume 5, Issue 6, June 2015, ISSN: 2277 128X, International Journal of Advanced Research in Computer Science and Software Engineering.
- [11]. Ajay jangra, Amisha Dhiman," A Review on Low Energy Adaptive Clustering Hierarchy (LEACH) Routing Protocol in WSN" ,Volume 3, Issue 6, June 2013, ISSN: 2277 128X, ISSN: 2277 128X, International Journal of Advanced Research in Computer Science and Software Engineering.