Hierarchical based Routing Protocol in WSN

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ABSTRACT
Recent advancements in wireless sensor network focuses on which real life applications such as military, environmental, health, vehicular, mechanical stress levels on attached objects, disaster management etc. These applications are using routing concept for forwarding and collecting the information among sensor nodes present in the network. These protocols are classified based on data centric, hierarchical routing, and location based routing which is depending on network structure. This paper presents brief introduction, characteristics and issues on WSN's. Further work is critically reviewed and discussed briefly. Further this paper focuses on hierarchical based routing protocols in which LEACH, PEGASIS, TEEN, APTEEN, HEED are highlighted.

Keywords
WSN; hierarchical routing protocol

General Terms
Elementary basic, routing protocols.

1. INTRODUCTION
The wireless sensor networks made by large number of small sensors and these sensors transceivers with low-power for gathering the data in a variety of environments and used for monitoring the areas and report these data to the base station (BS) [9]. The environmental conditions measuring by wireless sensor network likes temperature, sounds pollution levels, humidity, wind speed and direction, pressure etc, there must be designed the message passing process to protect the limited energy resources of the sensors and they are communicate with data of the cluster heads and after that these [10, 11] cluster heads working with an aggregated data to the processing centre which has may be save energy. For saving of energy and avoidance of energy consumption designing the routing protocols in wireless sensor network which are classified as data-centric, hierarchical and location based protocols depending on the network structure and applications as shown (figure 1.) [4]. In this paper the main centre of attention on hierarchical based routing protocol which has performs hierarchical clustering. The Hierarchical clustering in WSN is an energy efficient protocol through three main elements: Sensor Nodes (SN), Base Station (BS) and Cluster Heads (CH) [7]. The SNs are sensors deployed in the environment to assemble data. The main assignment of a sensor node in a sensor field is to detect actions, perform quick home data processing, and transmit the data. The BS is the data dispensation point for the data received from the sensor nodes, and starting where the data is accessed by the end-user. The cluster head acts as a gateway between the sensor nodes and base station. The cluster head is the sink for the cluster nodes, and the base station is the sink for the cluster heads. This structure created between the sensor nodes, the sink and the base station can be simulated many times, creating the dissimilar layers of the hierarchical WSN [7].

The rest of the paper is organized as follows: section 2 present the review the literature, section 3 focused on types of hierarchical based routing protocol, section 4 compared table of advantage and disadvantages, by section 5 characterized hierarchical routing protocol, study about some challenges and design issues are discussed in section 6, and section 7 finally concluded this paper.

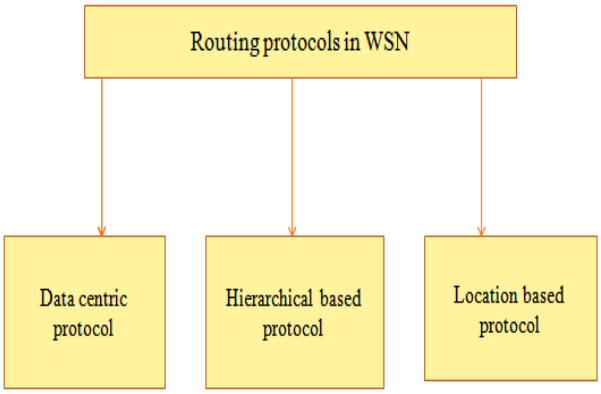

Figure: 1 Types of routing protocols in WSN's

2. LITERATURE REVIEW
According to **JAMAL N. AL-KARAKI et al**. In this paper the author present a survey of state-of-the-art routing techniques in WSNs. Firstly outline the design challenges for routing protocols in WSNs. Also study the design trade-offs between energy and communication overhead savings in every routing paradigm. And finally highlight the advantages and performance issues of each routing technique [1].

According to **Gergely ´ Acs, Levente Butty´an et al**. In this paper the author propose taxonomy of sensor network routing protocols, and classify the main stream protocols proposed in the literature using this taxonomy. Author distinguish five families of protocols based on the way the next hop is selected on the route of a message, and briefly describe the operation of a representative member from each group [2].

According to **Shio Kumar Singh, M P Singh et a**l. In this paper the author surveyed a sample of routing protocols by taking into account several classification criteria, including location information, network layering and in-network processing, data centricity, path redundancy, network dynamics, QoS requirements, and network heterogeneity. For each of these categories, the author has discussed a few example protocols [3].

According to **DaWei Xu, Jing Gao,a et al**, in this paper introduced the advantages and Disadvantages and applications of several typical hierarchical routing protocols in detail, which are analyzed and compared based on performance parameters, and finally summarizes the problems of routing

protocols and possible research direction in future combined with the current research status [4].

According to V**.Chandrasekaran, Dr.A.Shanmugam** in this paper mainly deals with Hierarchical Routing in which nodes are grouped into squads which perform data aggregation and multi hop communication. By performing the above process, the number of transmitted

messages to the base station is reduced for the benefit of system scalability and energy efficiency [5].

According to **Sandeep Verma, Richa Mehta et al**, in this paper the author overviewed the deployment phase, applications of WSNs and sensor node with its architecture. Then author has discussed a clustering approach that is being adopted to increase the life time of the network. After surveying various hierarchical routing protocols authors has concluded that it is not possible to develop a précised routing protocol which has feasibility for all applications. Instead the author found that these routing protocols are developed based on the application like TEEN which is very much suitable for time critical application [6].

According to **Parvathi C, Dr. Suresha** , in this paper ,a review on routing protocol in WSNs is carried out which are classified as data-centric, hierarchical and location based depending on the network structure. Then some of the multipath routing protocols which are widely used in WSNs like Multipath Multispeed Protocol (MMSPEED), Braided Multipath Routing Protocol, and Energy-Aware Routing to improve network performance are also discussed by author [7].

According to **Shio Kumar Singh et al,** In this Paper the author surveyed and summarized recent research works focused mainly on the energy efficient hierarchical cluster-based routing protocols for WSNs. Based on the topology, the protocol and routing strategies can be applied. The factors affecting cluster formation and CH communication are open issues for future research. Moreover, the process of data aggregation and fusion among clusters is also an interesting problem to explore [8].

3. HIERARCHICAL BASED ROUTING PROTOCOL

Hierarchical routing protocol has become the center of attention of the routing technology with the compensation of suitable topology management, high-efficiency energy utilize, and trouble-free data fusion [4]. Based on its architecture, several hierarchical routing protocols have been residential to deal with the scalability and energy consumption challenges of WSNs [4,7].

several of the hierarchical protocols planned for sensor networks are classified as Low-Energy Adaptive Clustering Hierarchy (LEACH), Power-Efficient Gathering in Sensor Information Systems (PEGASIS), Threshold-Sensitive Energy-Efficient Sensor Network (TEEN), Adaptive Threshold-sensitive Energy-Efficient sensor Network (APTEEN), and Hybrid, Energy-Efficient Distributed Clustering (HEED) [7].

3.1 Low energy adaptive cluster hierarchy (LEACH)

LEACH is an initial energy efficient routing protocol which is avoided an energy consumption and improved network lifetime. LEACH algorithm considers homogenous wireless sensor network where the base station is positioned in the centre of the simulation region and bounded by multiple clusters. The selection of the cluster head is forever done depending on the highest residual energy. The cluster head uses TDMA scheduling to combine the physical data from the member nodes on single cluster. The whole operation of the LEACH is voted for using set up phase and steady phase [7]. In the setup phase each node creates the random number between 0 and 1 as shown in above fig 3.1 and evaluate this random value with the threshold value if the random number is lesser than the threshold value than for the current round node becomes a cluster head (CH) [1, 21]. There is an equation for calculated the threshold value are as follows:

$$A(s)=\begin{cases}\frac{P}{1-P\left(n \bmod \frac{1}{P}\right)} if\ s \in G \\ 0 \qquad otherwise\end{cases}$$

Where,

P = desired percentage of CH

r = count of present round

G = group of sensor nodes that are not CHs in the previous 1/p round.

The cluster head node broadcasts the message of it suitable cluster head to the whole network, every node decides to fasten together which cluster based on the power of information received, and respond to the equivalent cluster head. Then in the subsequently phase, every node uses the technique TDMA to transmit data to the cluster head node, the cluster head sent the fusion data to the sink node. Between the clusters, every cluster completes communication channel through CDMA protocol. After a phase of steady phase, the network enters the subsequently round of the cycle again, nonstop cycle. The technique of cluster head selected aimlessly avoids too much consumption of energy, improves the network lifetime, data fusion reduce the traffic successfully, but the protocol silently uses the hop communication, although the transmission interruption is small, nodes require a high power communications, development is poor, it is not appropriate for major networks; even in minor networks, the nodes out of away from the sink node communicating with each other in high power can lead to a shorter endurance time; frequent selecting cluster head will guide to the traffic costing of energy [1,4,7].

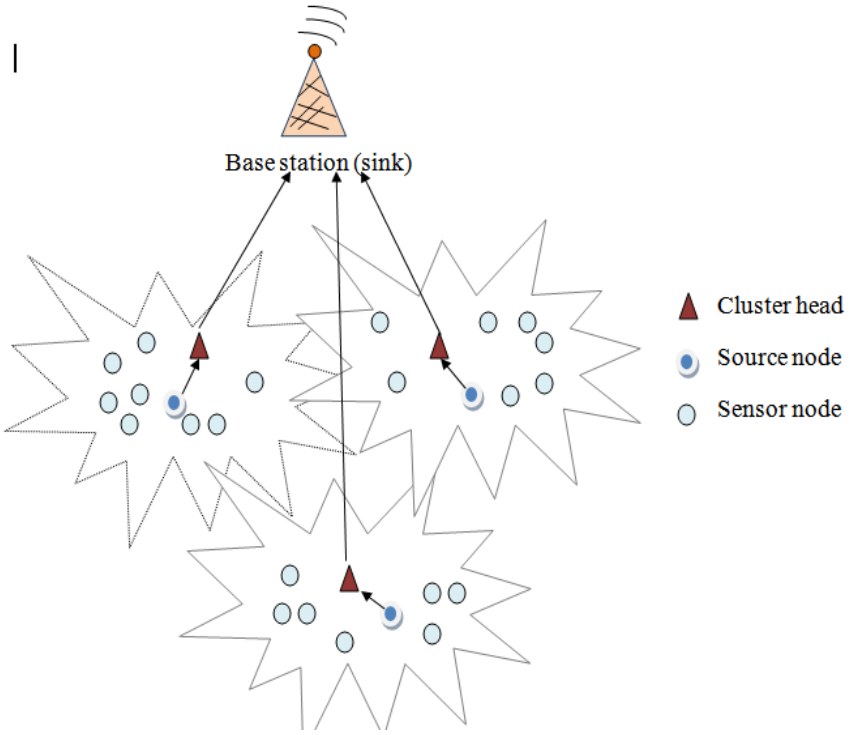

Figure: 3.1 Structure of LEACH routing protocol

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

It is also a superior version of LEACH routing protocol where the result shows that energy efficiencies capabilities are doubled up even compared to conservative LEACH. The aggregated data are not forwarded to base station in direct manner, in unkindness; the aggregated data are transmitted throughout communication channel to the fellow citizen networks, at last which is forwarded to the base station. The event of cluster formation is evaded in PEGASIS and considers that every sensor nodes have previous information about the wireless sensor network using greedy algorithm [7, 4].

(Figure: 3.2) shows the chain construction is performed according to a greedy algorithm, where nodes choose their adjoining neighbors as next hops in the chain. It is implicit that the nodes have an overall knowledge of the network and the chain construction starts as of the nodes that are farthest away from the sink. As a result of chain operation, in its place of maintaining cluster formation and membership, every one node only keeps path of its previous and next neighbor in the chain [7].

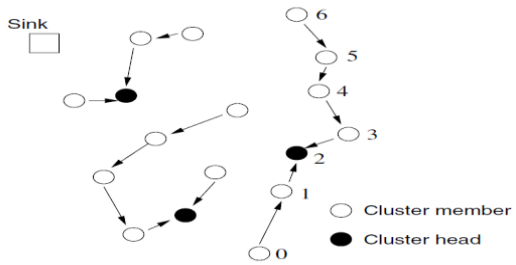

Figure: 3.2 Chain operation in PEGASIS

3.3 Threshold sensitive energy efficient sensor Network protocol (TEEN)

The LEACH and PEGASIS protocols hold up applications where information from sensor nodes is rarely transmitted to the sink. Therefore, the information pleased from multiple nodes is decreased throughout aggregation method. Though, these protocols may not be reactive to event-based applications, where information is generated only when assured events take place. The TEEN protocol aims to give event-based release in the network [7].

This protocol organizes the sensor nodes into various levels of hierarchy. In this hierarchical architecture, data are transmitted earliest by sensor nodes to cluster heads, which gather, aggregate, and transmit these data to a superior level cluster head until the base station is reached. In sort to consistently distribute the energy consumption, the cluster heads from time to time changed inside the cluster [7,4].

3.4 The adaptive Threshold sensitive Energy Efficient sensor Network protocol (APTEEN)

APTEEN protocol [7] is the addition protocol of the TEEN protocol, which correct the parameters issued through the cluster head, which can change associated parameters according to the requests of users, together with a set of physical attributes uttered that users expect to get; hard and soft threshold; operation mode (TDMA); counting time (CT), the mainly time period represented successful data communication of a node [4].

APTEEN moreover used superior TDMA scheduling thus allocating a specific slot for transmission for preventing data redundancies. Figure 3.4 shows Hierarchical architecture of TEEN and APTEEN [7].

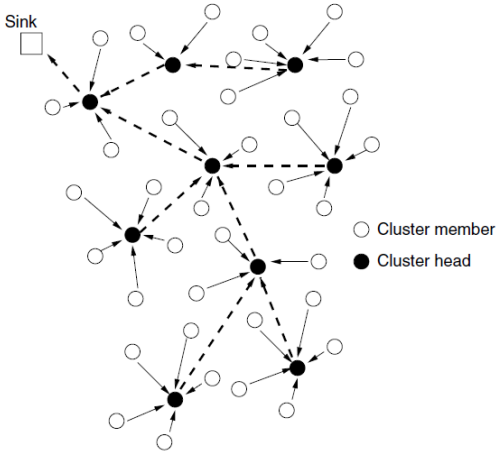

Figure: 3. Hierarchical architecture of TEEN and APTEEN

3.5 Hybrid, Energy-Efficient Distributed Clustering (HEED)

HEED is an improved version of LEACH routing protocols that considers residual power with node density like a collection criteria of cluster head. The result of the HEED routing protocol is set up with better energy efficiencies even compared to LEACH by better reduction in transparency and maximizing the network lifetime [7].

In this all nodes are implicit to be homogenous that is all sensor nodes are set with same initial energy. But, in this paper the author has study an impact of heterogeneity in conditions of node energy. So suppose that a percentage of the node residents is set with more energy than the rest of the nodes in the same network - this is the folder of heterogeneous sensor networks. Since the lifetime of sensor networks is imperfect there is a need to recuperate the sensor network by adding other nodes. These nodes will be set with more energy than the nodes that are previously in use, which creates heterogeneity in conditions of node energy, leads to the beginning of H-HEED protocol [7].

4. COMPARISON OF HIERARCHICAL BASED ROUTING PROTOCOLS

Protocol	Advantage	Disadvantage
LEACH	• High Scalability • Very long Life Time • Very high Energy Efficient • Latency involved loosely • Higher Throughput	• LEACH assumes every nodes to be Homogeneous which is almost not usual as heterogeneity in energy is the mainly common case. • Single Hop Communication leads to hot spot problem.
PEGASIS	• Improve Life Time of network double as compare to LEACH • Decreases the amount of Transmission and reception with data aggregation. • Clustering transparency is avoided. • Avoids a large amount of clustering.	• It wants dynamical topology adjustment which causes major transparency. • It assumes each node to be of equal energy which is not practically achievable. • Delay occupied is concerning problem here.
TEEN	• Modification can be made in the value of hard and soft threshold Values in order to manage the number of Packet transmissions. • correct for time critical application	• It is not correct for applications, where periodic reports are necessary.

APTEEN	• APTEEN security lower energy dissipation and a bigger number of sensors active. • The performance of APTEEN is better than LEACH and TEEN by comparison of energy dissipation and network lifetime.	• Complexity is used in forming clusters in several levels and also in implementation of threshold based function.
HEED	• Communication cost is less. • Usual updating of neighbor positions in multi hop environment by time to time transmitting and Receiving messages.	• It is unsuitable for the requirements of WSN.

Table: 4.1 comparison between hierarchical routing protocols

5. CHARACTERISTICS OF HIERARCHICAL BASED ROUTING PROTOCOL

- Hierarchical based routing protocol usually divided in to several cluster to reduce the energy consumption in the wireless sensor network [4].
- Hierarchical routing is based on the local topology information [4].
- Hierarchical based routing is use multi-hop communication mode for saving communication energy [4].
- It has data-based, minimize data transmission, and reduce information redundancy through data fusion [4].
- This type of routing protocols use distributed operation mode [4].
- The type of routing mechanism must have some fault tolerance [4].

6. CHALLENGES AND DESIGN ISSUES IN HIERARCHICAL BASED ROUTING PROTOCOL

Issues [12,7]:

- Node deployment
- Energy Consumption without losing accuracy
- Data Reporting Method
- Node/Link Heterogeneity
- Scalability
- Network Dynamics
- Transmission Media
- Coverage
- Data Aggregation
- QoS

Challenges:

- Some cluster based algorithms are suitable for small area or small number of nodes (LEACH) [12].
- Some are appropriate only for static deployment of nodes and degrades in the case of node mobility [7,12].
- In some algorithm cluster heads distribution is determined in one area [4, 12].
- Some cluster based algorithms are not appropriate for time critical application [12].
- All previous Cluster based algorithms are top down approach, which requires re clustering [7, 12].
- Some algorithms permit all CH to send data to base station that incur more energy dissipation [7, 12].

7. CONCLUSION

Hierarchical based routing method has unique assistance of scalability and efficient communication. Hierarchical routing maintains the energy consumption of sensor nodes and performs data aggregation which helps in declining the number of transmitted information to base station. Mainly the routing protocols need location information for sensor nodes in wireless sensor networks to determine the distance between two exacting nodes on the basis of signal strength in order that energy consumption can be expected.

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