REVIEW OF WIRELESS SENSOR NETWORK AND HIERARCHICAL ROUTING PROTOCOLS

Jaspreet Kaur¹, Dr. Parminder Singh²,

¹M.Tech student *, jaspreetsohi0@gmail.com, CEC Landran, Mohali (Punjab)
²Associate Professor, singh.parminder06@gmail.com, CEC Landran, Mohali (Punjab)

ABSTRACT

A Wireless Sensor Networks (WSNs) is a specialized wireless network made up of large number of sensors and at least one base station. A wireless sensor network is a collection of nodes organized into a cooperative network. The study of wireless sensor networks is challenging in that it requires an enormous breadth of knowledge. Wireless sensor network have gained enormous attention for their wide range of applications such as environment monitoring, military surveillance, health care, disaster management etc. Sensor nodes have a resource constraint (i.e. battery power, storage and communication capability). These sensor nodes are set with radio interface by which they are communicated with one to another. In this Paper we discussed hierarchical based routing protocols. The goal of this Paper is to present the comprehensive review of various aspects of WSN and discuss some hierarchical energy efficient routing protocols in wireless network.

Keywords: Wireless Sensor Network, Sensor node, Energy-efficiency, Routing protocols, Network lifetime.

I. INTRODUCTION

A Wireless Sensor Network is consisting of small and spatially distributed nodes which can cooperatively sense physical phenomena around them [5]. It consists of several thousands of sensor nodes are densely deployed throughout the sensor field [1]. Each sensor node is connected to one (or sometimes several) sensors. Each node in sensor network has several parts: power radio transceiver with an internal antenna connected to an external antenna, a microcontroller, an electronic circuit for interfacing with sensors and an energy source. A general approach employed in data gathering and data aggregation is to construct a spanning tree which is rooted and constructs the sink and connects all sensor nodes in the network [7]. If one node fails, the new topology will be recognized into a new topology.

The sensor nodes are scattered in sensor field. Each scattered sensor nodes has the capabilities to collect the information and route information back to the sink and to the end user. The information is routed back to the end user by multi hops infrastructure over the sink as given in Fig 1. The sink may communicate with task
manager node via Internet and Satellite. The Task Manager Node (user) performs the tasks in data storage, analysis and display. The task manager or base station is centralized point of control within the public network which extracts the information from the network.

Figure 1: Wireless Sensor Network [9]

II. ARCHITECTURE OF SENSOR NODE

A Sensor node is usually composed of four components:

a. Processing unit
b. Sensing unit
c. Power unit
d. Transceiver unit

Processing unit is typically an 8-16 bit, 1-24 MHz microcontroller with 1KB-4MB onboard memory. Sensing unit collects the data (analog signal) and it’s analog to digital converter (ADC) converts the data to digital. The Power unit consists of one or more batteries, providing 3V- 4.5V with a capacity ranging between 1700mAh – 2700mAh. The transceiver unit sends and receives the data to neighboring sensor [5].

Fig 2: Architecture of Sensor Nodes
III. HIERARCHICAL PROTOCOLS IN WSN

A. LEACH

Leach is Low Energy Adaptive Clustering Hierarchy Protocol. It is self-adaptive and self-organized in nature. The nodes in LEACH are branched into cluster and each cluster reside the member called Cluster Member and leader node is called a Cluster Head, CH. They often are required to organize the activity of cluster. LEACH selects the Cluster head in randomly manner. The cluster head in LEACH protocol is selected by using the threshold value. It is a clustering based technique and cluster head directly communicate with the base station in single hop. LEACH is a TDMA (Time Division Multiple Access) based MAC protocol which integrates with clustering and a simple routing protocol in Wireless Sensor Networks (WSNs). The goal of Leach is to lower the energy consumption required to create and maintain the clusters in order to improve the life time of the wireless sensor network. LEACH, which was presented by Heinzelman [20], is a lower energy adaptive clustering hierarchy for WSN. The operation of Leach can divide into two phases. Each round starts with set-up phase when cluster are organized, followed by the steady state phase.

In set-up phase the nodes are organized into cluster and cluster head are selected. The election of cluster head relay upon decision made 0 and 1. The node is selected as a cluster head for the current round if random number is less than the threshold value $T(n)$, is given by

$$T(n) = \begin{cases} \frac{P}{1-p*(r \mod 1/p)} & \text{if } n=G \\ 0 & \text{else} \end{cases}$$

Where, $P$ is desired percentage of cluster head (e.g. $p=0.05$), $r$ is the current round and $G$ is set of nodes that have not served as cluster head in past $1/p$ rounds. Then Cluster Head allocates time slots to nodes with its cluster. LEACH clustering is shown in fig 3.

![Fig 3: Clustering in LEACH Protocol](image-url)
In steady state phase operation broken into frames where nodes send their data to cluster head at most once per frame during their allocated transmission slot using TDMA. When cluster head get data from its cluster and it aggregates the data and send the data to base station. Base station is far away from the CH, it needs high energy for transmitting the data.

B. PEGASIS

PEGASIS is stands for Power-Efficient Gathering in Sensor Information Systems. In PEGASIS [7-8] each node communicates only with a close neighbor and takes turns transmitting to the base station thus reducing the amount of energy spent per round. It is a near optimal and chain-based power efficient protocol based on LEACH [7]. PEGASIS presume that all of the sensor nodes have the same level of energy and they are possible to die at the same time. As all nodes are static and overall knowledge about the network, so the chain can be build up easily by using greedy algorithm. This protocol follows the greedy algorithm starting from the farthest node and all sensor nodes from its close neighbor. There is a leader in the chain which is responsible for the transmission of the combined data to the sink node [4]. Node i (mod N) is the leader in i round. The chain resides of those nodes which are closest to each other and form a path to the base station. The leader node sends the aggregated to the base station.

Thus, in PEGASIS each node will receive and transmit one packet in each round and be the leader once every 100 rounds [10]. Data fusion occurs at each node (except end nodes) in the sensor network.

![Fig 4: Connection between base station and nodes for a PEGASIS](image)

C. TEEN

TEEN stands for Threshold sensitive Energy Efficient sensor Network Protocol [7]. TEEN is a first Threshold Sensitive Protocol Developed for reactive networks. TEEN is a cluster based routing protocol which is based on the LEACH. The network consists of simple sensors nods are grouping into the clusters, after the forming of clusters TEEN divided into first-level Cluster heads and second-level cluster heads. In the first level the CHs is
farthest from Base station and in second level the CHs are near to the Base station. The Base station transmits data to all nodes in the network directly. A wireless sensor network is shown in fig 4.

Thus, the Hard Threshold decreases the number of transmission by granting the nodes to transmit when sensing attribute is present in range of interest. The soft threshold is small change in value of sensed attribute which trigger the node to switch on its transmitter to transmit. The smaller value of the soft threshold gives the accurate framework of the network. Thus, the user controls the trade of energy efficiency. At the time of clustering the attributes are broadcast so the user can change them required.

D. APTEEN

APTEEN is an Adaptive Threshold sensitive Energy Efficient sensor Network Protocol [8]. It is advancement over TEEN Protocol. This protocol is used for comprehensive information retrieval. APTEEN aims to both capturing the periodic data collections and reacting to time- critical events. In APTEEN once the CH are decided, in each cluster period the cluster head are broadcast the parameters: attributes, threshold, schedule, count time.

- Attributes: it is a physical parameter in which user obtaining the information.
- Threshold: the hard threshold (HT) and soft threshold (ST).
- Schedule: use a TDMA schedule and assign the time slots to each node.
- Count time (CT): the maximum time between two successive reports sent by node.

If a node does not send data for time period is equal to the count time, then it forces to retransmit the data so maintaining the energy consumption. Thus, APTEEN is a hybrid clustering-based routing protocol. It can make a copy of reactive and protective network which depend upon the count time and threshold. The architecture of
APTEEN is same as in TEEN, which uses the hierarchy clustering energy efficient communication between source sensor and sink.

APTEEN is a query based protocol. It support the three different query types are
- Historical query: It analyzes the historical data that is stored in a sink.
- One-time query: It gives the overview about the network.
- Persistence query: This query monitor the event over the time period.

E. HEED

Younis, S. Fahmy et.al. [4] Projected Hybrid Energy Efficient Distributed clustering Protocol. HEED is better cluster-based protocol it elect the cluster heads on the basis of residual energy and node degree as a metric for selection of cluster to achieve power balancing. It is designed to select the different cluster heads in a field according to their amount of energy that can be distributed in relation to neighboring node. HEED does not select cluster head in randomly manner.

In HEED, proposed algorithm periodically which CHs is based on the hybrid combination of two parameters. The First is depend upon the residual energy and second is cost of communication within the intra-cluster. The first one is select an initial set of CHs while the second one is used for breaking ties.

In HEED, the clustering process at each sensor node has several rounds. Every round is long to receive the messages from neighbor node within the clustering range. The parameter Cprob is only used for initial CH it cannot direct impact on the final cluster structure. In HEED, each sensor node set the probability CHprob of becoming CH follows:

\[
CHprob = Cprob \cdot \frac{E_{residual}}{E_{max}}
\]

Where Eresidual is estimate current residual energy of sensor node and Emax is maximum energy of fully charged battery which is normally equal for homogeneous sensor nodes.

IV. COMPARIRIVE STUDY OF ROUTING PROTOCOLS

The Energy-efficient routing protocols for wireless sensor networks discussed in the above section developed for different applications. Here table 1 gives the comparisons of these routing protocols according to their performance based on the different parameters.

<table>
<thead>
<tr>
<th>Routing Protocols</th>
<th>LEACH</th>
<th>PEGASIS</th>
<th>TEEN</th>
<th>APTEEN</th>
<th>HEED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data delivery model</td>
<td>Cluster based</td>
<td>Chain based</td>
<td>Hybrid</td>
<td>Hybrid</td>
<td>Cluster based</td>
</tr>
<tr>
<td>Classification</td>
<td>Hierarchical</td>
<td>Hierarchical</td>
<td>Hierarchical</td>
<td>Hierarchical</td>
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</tr>
<tr>
<td>Mobility</td>
<td>Fixed BS</td>
<td>Fixed BS</td>
<td>Fixed BS</td>
<td>Fixed BS</td>
<td>Stationary</td>
</tr>
<tr>
<td>Data Aggregation</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Energy efficient</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Network Lifetime</td>
<td>Very good</td>
<td>Very good</td>
<td>Very good</td>
<td>Very good</td>
<td>Very good</td>
</tr>
<tr>
<td>Power Usage</td>
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<td>Max</td>
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<td>High</td>
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<tr>
<td>Cluster Stability</td>
<td>Moderate</td>
<td>N/A</td>
<td>High</td>
<td>High</td>
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</tr>
<tr>
<td>Multi-hop</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Scalability</td>
<td>Good</td>
<td>Chain based</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
</tbody>
</table>

V. CONCLUSION

In this paper we discussed some hierarchical based energy efficient routing protocol. Each protocol designed for wireless sensor networks, it should be energy efficient and it wills extent the lifetime of each sensors and lifetime of the network. Each routing protocol have major objective to reduce the energy consumption and increase the lifetime of network. Hence for future scope modifying the above hierarchical routing protocols such that these modify protocols are making more energy efficient maintaining energy consumption.

REFERENCE


