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A REVIEW ON ROUTING PROTOCOLS OF WIRELESS SENSOR NETWORK

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ABSTRACT

A network which is made-up of wireless devices i.e. tiny nodes is known as wireless sensor network. These nodes are sprinkled in large region to collect data from different environments. Each sensor transmitted collected data to the base station, which sends the data to the end user. There are many issues in wireless sensor network such as lifetime, reliability, security etc. to address the issue of lifetime balancing, many routing protocols are listed in this literature .We are reviewing routing protocols especially hierarchy base routing protocols that are widely used to give better lifetime of WSNs.

Keywords*: *APTEEN, LEACH, LEACH-C, PEGASIS, TEEN, WSN

I. INTRODUCTION

A wireless sensor network is a collection of small sensor nodes which are able to detect or sense sound, light, temperature, motion and processing of data [1]. Sensor node is also known as small processor which includes three key components: a sensing subsystem which gather data from the physical surrounding environment, a processing subsystem for processing the local data and its storage, and a subsystem of wireless communication for transmission of data over the network [2].

1.1 The specific characteristics of Wireless Sensor Networks are as follows

1.1.1 Sensor nodes has restrictions over power, computation capability and memory to store data.

1.1.2 Sensor nodes may have an issue of global identification due to large number of sensor nodes.

1.1.3 Sensor nodes mainly use broadcasting technique for communication.

As sensor nodes have limited lifetime, so in order to find out how to enhance it, we had gone through the literature based on routing protocols which ensures about the increased lifetime. These are categorized on the basis of their network structure model, communication model, topology and reliability. Hierarchical routing protocols come under network structure model.

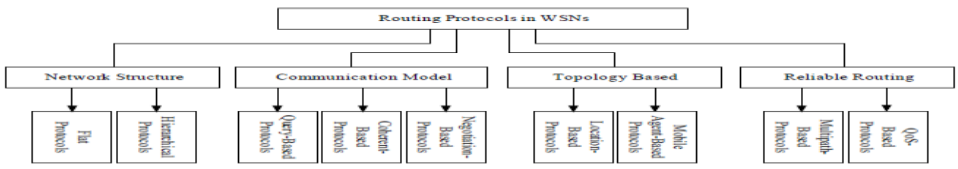

Fig.1 Routing Protocols in Wireless Sensor Network

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1.2 Network Structure based protocols

The structure of a network implies the manner in which the nodes are connected to each other and routes the information which is related to the network architecture.

1.2.1 Flat Protocols

In these protocols, all the sensor nodes perform same functionality in a WSNs and cooperate together to perform their task, this reduces the overhead to preserve infrastructure among communicating nodes [2].

1.2.2 Hierarchical Protocols

In this, all the nodes are grouped to form cluster. In these clusters a node which have higher residual energy is expected to play the role of cluster head. These protocols are used to achieve more productive, balanced and extensible WSN [2].

1.3 Communication model based protocols

This model provides the method in which the main action of the protocol is to route the packets in the network. In this category the routing protocols can deliver more information with less energy. But ratio of delivery is not very high.

1.4 Topology based routing protocols

These protocols rely on the law that all sensor nodes in the WSNs maintains the topological information and the procedure of the protocol operation based on network topology. In these protocols, the nodes do not maintain any routing table.

1.5 Reliable routing protocols

These protocols are more reliable. It reduces the chance of failure of routes by achieving a load balanced route. In hierarchy based structure the lower level nodes transmits the data to the higher level nodes, and then the higher level nodes will forward it to base station, this results into stabilized energy structure of the network. Therefore, they tend to have better lifetime. This motivated us to know more about them.

1.6 Basic Terminologies

1.6.1 Sensor node

Sensor nodes are essential to WSNs. Many functions are performed by a sensor nodes like sensing, storing, processing and routing of data [1].

1.6.2 Base station

Base station (Sink) is intermediary between wireless sensor network and end user to communicate and to do transmission of data or information. [2].

1.6.3 Clusters

Clusters are ordered (Hierarchical) units for wireless sensor network. A large sensor network is divided into subgroups to provide simple and easy interaction between the sink and the cluster head.

1.6.4 Cluster heads

Leader node of a cluster is called cluster Head. The main duties of cluster head includes gathering of data, organizing of data and broadcast the schedule of communication of a cluster [1].

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1.6.5 End user

The WSN generates data in response to received queries from an end user

II. RELATED WORK

2.1 Hierarchical Routing Protocols

These protocols are termed as Cluster Based Routing Protocols. In this technique we divide large network into a smaller groups which is known as cluster. The nodes which have high remaining or unused energy than other nodes can be chosen to process and send the data to the Base. In other words, the sensor nodes which have higher energy than other sensor nodes in a cluster are chosen as Cluster Head. In direct transmission data are send directly to the sink, so the number of packets flowing through the networks are large and each packet has to travel a long distance ,so their energy get consumed very soon whereas in multi-hop transmission data send via number of intermediate nodes lies between source node and Sink. This technique results into lower power consumption and decreases the no. of messages which are sent to the sink by implement data aggregation and fusion while in direct transmission. In this, the data transmitted from lower level cluster to higher level cluster and so on.

In this paper, we have included five hierarchical routing protocols which are as follows:

2.1.1 Low Energy Adaptive Clustering Hierarchy (LEACH)

2.1.2 Low Energy Adaptive clustering Hierarchy Centralized (LEACH-C)

2.1.3 Power Efficient Gathering In Sensor Information System (PEGASIS)

2.1.4 Threshold Sensitive Energy Efficient Network Protocol (TEEN)

2.1.5 Adaptive periodic threshold sensitive energy efficient sensor network protocol (APTEEN)

2.1.1 LEACH

In this, Sensor nodes nominate themselves randomly as cluster heads with some probability and advertise their decision to all other nodes in the network. After that each and every sensor node selects the cluster to which it wants to be a part, on the basis of minimum communication energy required to communicate with the cluster head. This algorithm runs repeatedly and the possibility of becoming a cluster head for each round is chosen to ensure that every sensor nodes become a cluster heads at once within 1 rounds, where is desired percentage of cluster heads. There is a positive fact about the LEACH is that the sensor nodes will irregularly consume their power supply and therefore they should irregularly die throughout the network, while the randomly selected cluster head will make it very difficult to achieve optimal results since random numbers are utilized, the performance of the system will vary according to the random number generation. LEACH integrates local data to compress the amount of data being sent from the clusters to the base station.

LEACH has two phases: set-up phase and steady-state phase.

2.1.1.1 Set-up phase

In set-up phase cluster heads are selected. In the set-up phase each node generates its own random number between 0 and 1. If the random number is lesser than the threshold value, that node becomes cluster head. The threshold value is calculated on the basis of following equation that is given below:-

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$$T(n) = \begin{cases} \frac{p}{p-1} * \left(r * mod \frac{1}{p}\right) & if\ n \in S \\ 0, otherwise \end{cases}$$

Where is a random no. between 0 and 1 and is cluster head probability and is the set of nodes that were not cluster head in the last $1/$ rounds [6].

If $n < T($, then that node becomes a cluster head .

2.1.1.2 Steady-state phase

During steady phase, nodes send their data to the leader node (cluster head) using a Time Division Multiple Access schedule. This schedule allots time slots to every node. The cluster head collects the data and send it to the base station [6].

2.1.1 Weakness:-

1. LEACH is suitable only tiny networks.
2. In LEACH, all sensor nodes have time slots to send data, even the nodes which doesn't have any data
3. All sensor nodes are continuously listening.
4. It is not useful when its battery is discharge.

2.1.2 LEACH-C

It uses a centralized algorithm for cluster formation. In LEACH-C we also include two phases first is set-up and second is steady-state. Its second phase is same as LEACH protocol. In first phase of LEACH centralized sensors transmit their present position and remaining energy level to BS. The BS applies the centralized algorithm to the formation of the cluster and also find out the CHs and clusters for that round. LEACH centralized picks CHs randomly and BS makes sure that only those sensors which have higher energy as compare to other sensors in WSNs are participating in the formation of cluster head. When clusters are created then, the BS broadcasts the notification to all sensors in WSNs. Except CH all sensors determines TDMA slot for data transmission.

Weakness: When the charge of energy for communication with the BS is high as compare to energy cost, LEACH centralized does not provide good performance.

2.1.3 PEGASIS

It is a close ideal chain based routing protocol for gathering the data in a WSNs that is an enhancement over LEACH protocol. The main scheme of PEGASIS protocol is the making of a chain among sensors so that all sensors sends their data to its closer neighbor node and also receive their data from its closer neighbor node. In this protocol, it is considered that each and every sensor in a WSNs has the facility of data transmission to BS directly, So a network node is randomly chosen that take turns for being a chain leader for data transmission to sink node [4]. This method share out load of energy equally to the sensors. Greedy algorithm is used by the sensors which are randomly located in the area to arrange themselves in the form of chain, alternatively the base station this chain and broadcasts it to each and every sensors. In PEGASIS, each and every node receives data from its closer sensor node and perform data fusion and send to the next closer node in the chain. This protocol uses an approach i.e. a token passing. It is very simple approach and started by the leader to perform the transmission of data from the end point of the chain, then the leader node forwards the data to the BS [5].In

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each round an arbitrarily selected node from the chain sends data after aggregation to the Base Station, so it is helpful to reduce the consumption of energy per round in comparison to LEACH.

2.1.3.1 Weakness:-

1. It is not suitable for changeable topologies.
2. Network is not very scalable and long delay can cause a node to become a bottleneck.

2.1.4 TEEN

It is designed to handle the situations such as rapid changes in the attributes which is already sensed like temperature, vibration etc. The architecture of TEEN protocol is follow the concept of hierarchical cluster formation scheme where neighbor nodes forms clusters and whole process move on the next level until we reached the sink. In this, the cluster-head advertised two threshold values to its cluster members i.e. Hard Threshold value and the Soft Threshold value. Hard Threshold value is consummate value of the particular characteristic beyond which the sensors sense this characteristic value must provoke its transmitter and inform related CH. The ST is a tiny change in sensed attribute value which instruct the sensor to provoke its transmitter and transmit. If the thresholds value does not meet, the sensors do not interact. The end user will not get any data from WSNs and will not get the status of all the nodes. So the end user will not be able to differentiate between alive nodes or non-alive sensor nodes in the wireless network. The nodes sense their surrounding atmosphere regularly. The node provokes its transmitter and transmit data when one of the parameter from the set of characteristics reaches its HT value.

2.1.4.1 Weakness:-

1. In large area networks, due to long distance transmission it turns to consume a lot of energy.
2. Data Communication when thresholds meet i.e. nodes performs transmission on the basis of thresholds so data may be lost.

2.1.5 APTEEN

Before knowing about APTEEN, we should learn about proactive and reactive routing protocols.

Proactive protocols conserve fresh lists of destinations and their routes by repeatedly disseminating routing tables all over the network. Reactive routing protocol finds out a route on demand by sending a lot of Route Request packets to the network.

APTEEN is a hybrid protocol which is the combination of key functionalities of both proactive and reactive protocols. APTEEN reduces their drawbacks to form a hybrid network. The APTEEN focuses on both summarizing and responding. This summarize the collection of data periodically and responding to time-critical actions. In APTEEN, as soon as the CH selected, the CH first advertise the following parameters:

Attributes or characteristics (A):-It is a collection of similar type substantial parameters in which User is concerned to obtain the data.

Thresholds: it is made-up of two values i.e Hard and Soft Threshold values.

Schedule: Time division multiple access schedule is used to assign a time slice to each and every sensor node in a wireless network.

Count Time: Greatest time period between two consecutive reports which is sent by a sensor is known as Count Time. Count time is represented by CT.

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In this routing protocol, the sensors are not only forward data sporadically, but they also instantly respond to rapidly changed attribute values. In this manner it acts like a pro-active protocol as well as reactive protocol. When Data values exceed the range of threshold value then it will known as critical data. Only those sensors which sense the value at the HT value can transmit the information. Once a sensors senses a value beyond Hard Threshold value then next transmission start only, when that attribute value changes by value equal to or greater than the ST.

The exemption to this law is that, if a sensors doesn't transmit any data or information for a particular time period which is equivalent to CT, then a sensor node is forcefully sense data and retransmit the information which is not related to the sensed attribute value. Sensors are more nearer to each other so they may be present in the identical cluster and sense just alike information, they may try to send data at the same time, so this will lead to collision between sensors messages. To avoid the collision problem, APTEEN assign a time slot to each and every node using TDMA.

2.1.5.1 Advantages:

1. APTEEN uses the features of both proactive policies and reactive policies. So, it is suitable in all proactive and reactive application.
2. It expresses lots of flexibilities and set the CT interval and the threshold values for the energy consumption by changing the count as well as the threshold values.

2.1.5.2 Disadvantages:

1. In APTEEN supplementary complexity is present to implement both CT and threshold functions.
2. Actually, each TEEN and APTEEN has the indistinguishable limitations of additional overhead and complexity of cluster construction in multiple levels.

III. ISSUES IN CLUSTER BASED PROTOCOLS

So far, we have seen how clustering based protocols help in reducing the energy consumption, but many drawbacks exist in clustering techniques that should be addressed in future researches as [3]:

3.1 Degree of Node and CH Rotation

Decision making of cluster size and optimum degree of a node on the basis of transmission range can be the future challenge for the researchers.

3.2 Scalability

A proper investigation is required to check the extensibility of clustering techniques. It is generally required to expand the monitoring area surrounded by new nodes in a few large deployments.

3.3 Redundancy Management

In order to make the authentic and adequate broadcasting backbone, the use of redundant nodes must be minimized i.e. we should minimize the selection frequency of a particular node. The data aggregated by the CH broadcasted to Base Station must be investigated further.

3.4 Reliability

A short term fault management in clustering based routing algorithms requires much more attention.

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IV. COMPARATIVE STUDY

The Comparison of various Cluster based routing protocols on the basis of Power Management, Network Lifetime, Scalability, Data Aggregation, and Classification [4].These protocols are has a fixed base station, very good network life time, good scalability, resource awareness, no multipath and does not support Query based routing. There are minor differences among these protocols in terms of classification and data aggregation in "TABLE 1".

Table 1. Comparison table

Protocols	Classification	Data Aggregation
LEACH	Clustering	No
LEACH-C	Clustering	No
TEEN	Reactive/Clustering	Yes
APTEEN	Hybrid	Yes
PEGASIS	Reactive/clustering	Yes

V. CONCLUSION

After review of many papers, we have concluded that the clustering is better approach for developing wireless sensor networks as compared to other techniques used for balancing network lifetime. In clustering algorithms, LEACH assumes every nodes to be homogeneous which is almost not usual as heterogeneity in energy is the mainly common case, LEACH is not suitable for large regions. Single hop communication leads to hot spot problem. PEGASIS improves lifetime of network double as compare to LEACH decreases the amount of Transmission and reception with data aggregation. PEGASIS is good for large region WSNs. PEGASIS needs some improvement in terms of time delay.

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