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Comparative Study of LEACH, SEP, TEEN, DEEC, AND PEGASIS IN WIRELESS SENSOR NETWORK

POOJA GIRI[1], DR. ANJALI POTNIS[2] , PRIYANKA TRIPATHI[3]

[1,3]MTECH, NITTTR, Bhopa , India
[2]Assistant Professor, NITTTR, Bhopal, India

Abstract: *In recent period of time in history Wireless Sensor Network(WSNs) have interested as a new powerful technology such as surveillance system, military operation, intelligent transport systems(ITS)etc. The basic operation of these type network is divided into two parts, first is data gathering network and second one is data distributing network. These networks consists of sensor nodes which is totally depends on electrical storage device, due to limitation of energy, energy efficiency is an important point which should be taken care at time of designing of energy efficiency routing protocols is the fact that the SNs are worked on the battery which is discharges quickly after each operation. In this paper we reviewed different types of energy protocols such as LEACH, SEP, TEEN, DEEC, and PEGASIS. And conclude in last section, all these routing protocol with the help of different parameters such as energy efficiency, network life time, data aggregation, scalability and etc.*

Key Words: *wireless sensor networks, sensor nodes, routing protocol, energy efficiency etc.*

1. INTRODUCTION

As we all know that wireless sensor network is the network which is operated on tiny, low battery powered sensor node with limited storage, on-board processing and radio capabilities. The sensor networks are positioned indoor and outdoor sides and are anticipated to work unattended, monitoring the region and informing to the base station. The network must acquire self-configuration capabilities as the position of distinctive sensor node is not pre-calculated. The designing protocols used for sensor networks has to be energy aware in order to prolong the life time of network because once sensor network have been installed, replacement of the embedded battery is very difficult and for proper monitoring the WSNs should utilize their network energy in an efficient way. A sensor node is mainly consists of four components namely- sensing element, processing unit, transceiver unit, and power unit. WSNs may also have additional application-dependent components such as power generator, location finding system and mobilizer. In this paper we reviews energy efficient existing routing protocols such as LEACH, SEP, PEGASIS, DEEC, and TEEN.

I. LEACH

Leach stands for Low Energy Adaptive Clustering Hierarchical protocol. Leach protocol is a distinctive representative of hierarchical routing protocols. Leach protocol also defined as self-adaptive and self-organized protocol. With the help of Leach protocol energy is reduced significantly. The whole operation of the leach protocol is defined as two phases name as-set up phase and steady phase.

- Set up phase: In this phase clusters are formed and cluster head are elected.
- Steady phase: In this phase the data transmission between cluster head and base station is taken place.

Algorithm for LEACH protocol is as follows:

As we know that the basic operation of LEACH protocol is divided into rounds and each round is divided into two phases first to set up phase and then steady state phase. The systematic representation of LEACH protocol is shown in figure below.

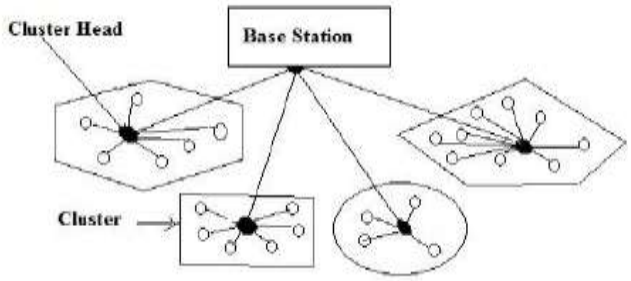

Figure.1 LEACH Protocol Architecture[1].

The first phase that means set up phase having three fundamental steps, namely—

i. Cluster Head Advertisement
ii. Cluster Setup
iii. Creation of Transmission Schedule

During the first step cluster head (CHs) sends the advertisement packet to the cluster nodes to informs that they have become a cluster head on the basis of the following formula given below. Let x be any random number between 0 and 1.

$$T(n)=\begin{cases}\frac{p}{1-p\left(r \bmod \frac{1}{p}\right)} & if\ n \in G \\ 0 & otherwise\end{cases} \quad \ldots\ldots(1)$$

where n is the given node, p is the probability, r is the current, G is the set of nodes that were not cluster heads in the previous round, T(n) is the threshold.[11] The process of cluster head selection is such that the node becomes cluster head for the current round if the number is less than threshold T(n)[1].

In the second steps the cluster head send advertisement to the non-cluster head nodes, and then send join request to the cluster head update that they are the members of the cluster under that cluster head [6]. With the help of second step these non-cluster head nodes saves a lot of energy by turning off their transmitter all the time and when they have something to transmit to the cluster head then only it turn ON its transmitter.

In the third step, using TDMA scheduling each of the chosen cluster head create a transmission schedule for the member nodes of their cluster.

The second phase of LEACH is the Steady state phase as mention above in this phase transmission of data is going on between cluster heads to the base station.

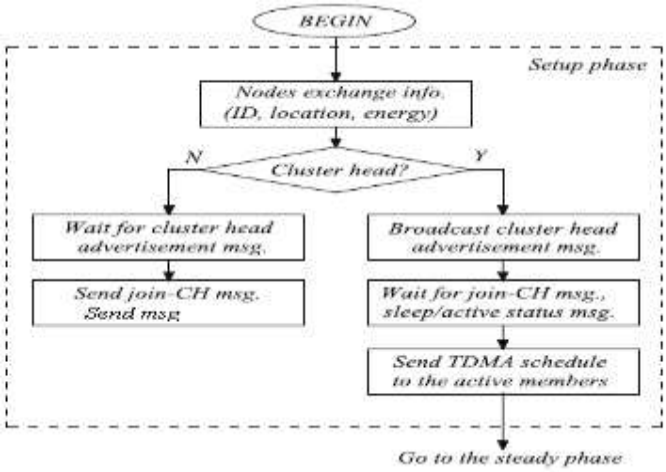

Figure 2. Flow Chart Of LEACH Protocol

II.Stable election protocol (SEP)

SEP is also known as heterogeneous aware protocols; here the meaning of heterogeneous is that not all the nodes in the field have the same initial energy. With respect to prolong the stable region, SEP attempts to preserve the constraint of sufficiently balanced energy consumption[8]. Instinctively, advanced node have to become cluster heads more often than the normal nodes, which is correspondence to a fairness restriction on energy use . Sep[7] is a two-level heterogeneous proactive network protocol (in proactive network NODES in network keep on sensing and provide a continuous report of data to the BS). It assumes that each node in the network has different energy level. Therefore in SEP there are two types of nodes are present; normal nodes and advanced nodes. Usually the advanced nodes are nodes which are having more energy as compared to normal nodes. Let us discuss about the system energy of both nodes (normal and advanced) – suppose that $E°$ is the initial energy of each normal sensor node. The energy of each advanced node will be $E°.(1+\alpha)$.

The total energy of the new heterogeneous setting is shown in given equation-

$$n.(1-m).E° + n.m.E°.(1+\alpha) = n.E°.(1+\alpha.m) \quad \ldots(2)$$

As we see from the above equation, the total energy of the system is increased by 1+ α . m times. Here, n is the no. Of sensor node in the network and m be the fraction of advanced nodes, which are occupied with α time more energy than the normal nodes

E_0 is the initial energy of the each normal nodes and $E_0(1+\alpha)$ is the energy of advanced nodes. Based on its initial energy, SEP assign a weighted probability to each node. By decreasing the CH epoch interval of advanced nodes it ameliorates the cluster formation i.e., advanced nodes get more chance to become a CH (cluster head). Given below the weighted probabilities for normal nodes and advanced nodes respectively, are:

$$P(normal\ node) = \frac{P}{1+\alpha.m} \ldots\ldots(3)$$

$$P(advanced\ \ node) = \frac{P}{1+\alpha.m} * (1+\alpha) \ldots\ldots(4)$$

In SEP, for cluster formation one important parameter into consideration is the threshold value and it is depends on the probability of node. Using threshold values cluster formation is taking place, each node generates a random number and that random number is compared with threshold value, if the generated value is less than threshold then that node will becomes CH. The threshold calculation equation for both the nodes equations is shown in equation (5). Threshold calculation for normal nodes is shown in equation(6):

$$T(s) = \begin{cases}\frac{pnrm}{1-pnrm*(r \bmod \frac{1}{pnrm})} & if\ Snrm \in G' \\ 0 & otherwise\end{cases} \quad \ldots(5)$$

Threshold calculation for advanced nodes is shown in equation (6):

$$T(s) = \begin{cases}\frac{padv}{1-padv*(rmod\frac{1}{padv})} & if\ Sadv \in G'' \\ 0 & otherwise\end{cases} \quad \ldots\ldots(6)$$

Where, r is the current round, G' is the set of normal nodes and G" is the set of advanced nodes that are not become cluster heads within last $1/_{Pnrm}$ and $1/_{Padv}$ rounds,

respectively. The algorithm flow chart of SEP protocol in shown in below-

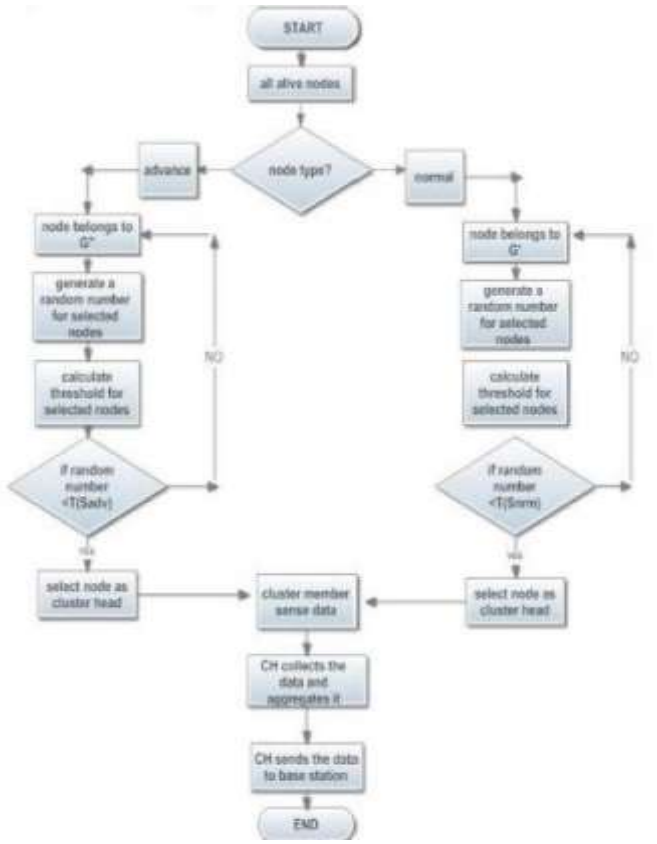

Figure.3- Flow chart of SEP protocol

III. Threshold sensitive energy efficient sensor network (TEEN) PROTOCOL

In this section we discuss another hierarchical based clustering protocol name as TEEN protocol. Teen protocol also defines in terms of reactive networks. The functionality operation of TEEN protocol is that at every cluster change time, in addition to the characteristic, the cluster-head broadcasts to its cluster member by the following:

- Hard threshold: The hard threshold is refers as a threshold value for the sensed attribute. It is the complete value for the attributes besides which, the node sensing this value in the same time sensor nodes must switch ON its transmitter and report to its cluster head.

- Soft threshold: The soft threshold is refers as a small change in the value of the sensed attribute which provokes the node to switch on its transmitter and transmit.

The schematic representation of TEEN protocol is shown below-

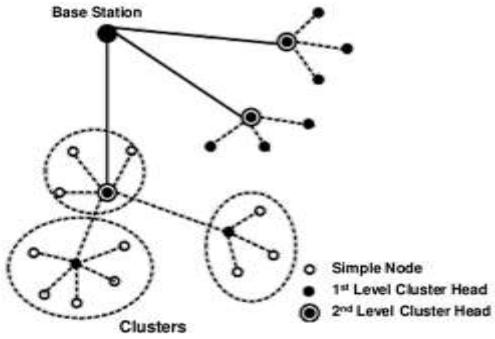

Figure.4- TEEN protocol achitecture

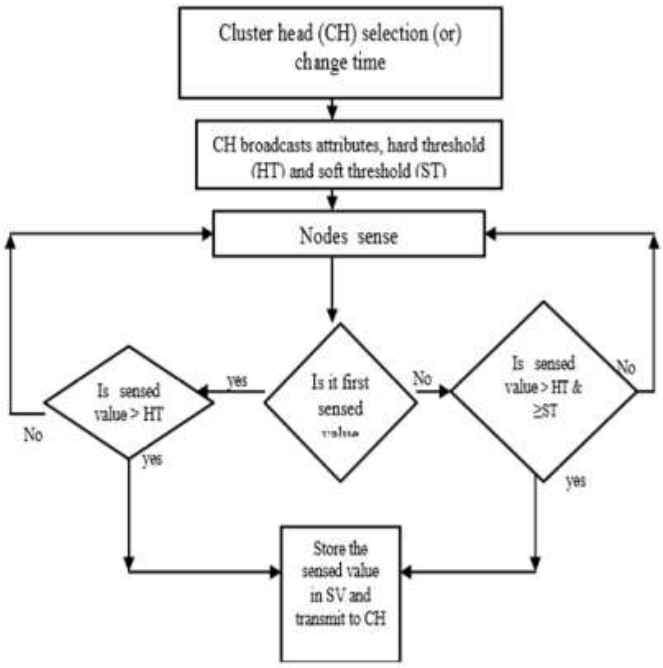

Figure.5- Operation flow chart of TEEN

The nodes continuously sense their environment. The node switches ON its transmitter and sends the sensed data, when the first time a parameter from the attribute set commands its hard threshold value. An internal variable in the node is used for stored the sensed value (SV) which is sensed by the sensor nodes. When the both the given below conditions are true, then only the nodes will next transmit data in the current cluster period

i. When the current value of the sensed attribute is greater than the hard threshold.
ii. The sensed attributes of the current value is differ from the SV by an amount equal to or greater than the soft threshold.

The main drawback of this protocol is that whenever the threshold is not reached, the nodes will never get communicate because of this the user will not get any data from the network.

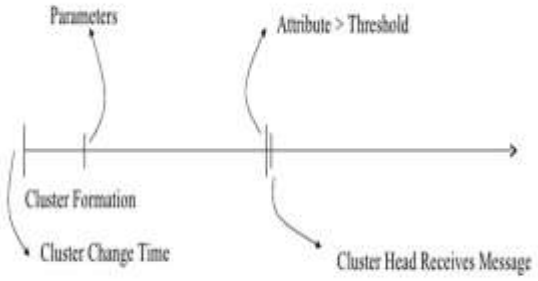

Figure.-6 Time Line Representation Of TEEN Protocol

IV. Distributed energy-efficient clustering (DEEC) protocol

In DEEC, formation of cluster heads is done using the initial and residual energy level of all nodes. DEEC measure the ideal value of network lifetime to estimate the reference energy that each node should spend during each round. In a two-level heterogeneous network, where we have two nodes namely one is normal node m, with initial energy $E^{\circ}.(1+\alpha)$ and advanced nodes N, with their initial energy (1-m).N

The value of total energy is given as

$$E(total) = N.(1-m).E^{\circ} + N.m(1+\alpha) \quad \ldots \quad (7)$$

The average energy of r^{th} round is-

$$E(r) = \frac{1}{N}.E(total)(1-R) \qquad \ldots\ldots \qquad (8)$$

R, denotes the total rounds of the network life time and is defined as-

$$R = \frac{E(total)}{E(ROUND)} \qquad \ldots\ldots \qquad (9)$$

power-efficient gathering in sensor information systeM (PEGASIS) protocol

PEGASIS is the remotest preferred chain based hierarchical protocol. In this protocol, the nodes are organized in the form of a chain for the transition and gathering of the data establishment of chain can be centralized based on the application. PEGASIS is based on the opinion that global knowledge of network is accommodate to all the nodes. The PEGASIS protocol representation is shown below in fig-

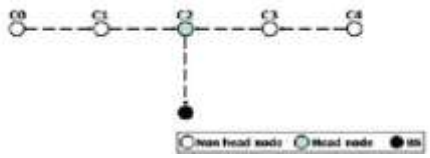

Figure.-7 PEGASIS Protocol Architecture

The formation of chain starts from the endmost node from sink and its immediate neighbor are elected as next node in chain and so on. The node before sink acts as a leader of the node and the last node must be the sink. The operation like data-processing and data aggregation are adopted by leader node, due to time varying topology (or) dynamic behavior of network, PEGASIS is not so relevant routing protocol.

The algorithm of PEGASIS protocol-

The algorithm of PEGASIS is just subjected on the LEACH protocol. The main idea in PEGASIS is to compose a chain between all the sensor nodes. So that energy node can assembly from and transfer to the nearest neighbor. The aggregated data moves from node to node, it get combined, and thereafter a cluster head transmits these aggregate data to the BS (base station) .

CONCLUSION

On studying the entire algorithms a conclusion table can be made on the basis of various parameters which is stated below in table (1).

Parameter	LEACH	SEP	PEGASIS	DEEC	TEEN
Data Delivery Model	Clustered Head	Clustered Head	Chain Based	Clust-ered Head	Active Threshold
Data Aggregat-ion	Yes	Yes	No	Yes	Yes
Energy Efficiency	Good	Good	Very Good	Good	Good
Scalability	Low	-	Low	-	Good
Network Lifetime	Good	Good	Very Good	Good	Good
Mobility Of Nodes	Nodes Are Stationary	Nodes Are Statio nary	Nodes Are Stationary	Nodes Are Stationary	Nodes Are Statio nary
Network Type	Homog eneous	Heter ogen eous	Homogen eous	Hetero geneo us	Homo geneo us

TABLE.-1

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