

Energy trends in wireless sensor networks

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Abstract—Energy consumption is a major issue in WSN as sensor nodes are battery operated. This problem is also stated as “lifetime problem of WSN”. There are many ways to overcome from this lifetime problem. One such solution is advancements in routing protocols so that the energy consumption by sensor nodes (SNs) is reduced. This is the major research area for the researchers to make advancements in routing protocols. The major and basic protocol for all the other advanced protocols is LEACH (Low energy adaptive clustering hierarchy) based on clustering. In this paper with LEACH the other protocols like FAIR, SEP ACT, EEOC, PEGASIS are also discussed WHICH ARE HELPFUL to increase the energy efficiency of sensor nodes in WSN

Keywords — LEACH, CH, PEGASIS, TCB, ACT, BEENISH, FAIR, SEP

I. INTRODUCTION

Wireless sensor networks consists of small sensor nodes, computations, and wireless communication capabilities as shown in fig1.1.

Many routing protocols are designed for WSNs where energy efficiency is an important strategy[9]. WSN consists of sensor nodes which gathers the information from the environment and communicates to the base station. These nodes have certain issues regarding energy on which many researches are going on. LEACH make a choice of its cluster heads periodically and energy distributes is done uniformly by rotation. To get a chance to become a Cluster Head (CH) for next rounds is very difficult once a CH is formed. In every round, cluster heads are also changed and the design of the protocol is also changed. WSNs can be categorised into reactive, proactive and hybrid networks depending on their mode of functioning

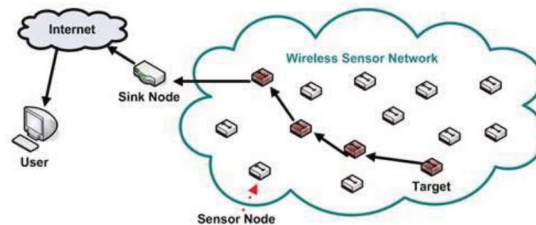


Figure 1. Wireless sensor networks

The extension to LEACH protocol is Modified LEACH protocol has been analytically and critically analysed. Increasing the initial energy will give more net lifetime of the network, as the number of alive nodes will be more. The Modified LEACH protocol outperforms the traditional LEACH in every aspect Ref. [8].

The protocols will classify the nodes into different energy levels depending on the energy of SNs. Depending on this we have the BEENISH (Balanced Energy Efficient network integrated super Heterogeneous) and m-BEENISH where the nodes are divided into four energy levels.

Some other kinds of protocols will make the routing of the data to the sensor nodes in different manner. These kinds are Chain based routing, Tree based routing, Grid based routing, and Area based routing. In each kind of routing method some protocols are there and comparison based on energy is considered.

This paper is an effort to recollect the technique to make efficient use of energy consumption in SNs. This survey study tells about some of the protocols like LEACH, PEGASIS, ACT, FAIR, SEP, HEED, GSTEB, TCB, and BEENISH etc

II. LOW ENERGY ADAPTIVE CLUSTERING HIERARCHY (LEACH)

This protocol is great invention in the field of WSN, which is base for the other protocols Ref. [7]. This is the distributed protocol having setup phase and steady state phase. In setup phase all sensor nodes in the field form cluster regions. One node will become a cluster head at a time and rest all are normal nodes. Cluster head collects the information from the other nodes and send it to the sink node.

III. FAIR

In this protocol guaranteed number of cluster nodes are there, which are distributed in WSN. The protocol is obtained by changing value of m where m is fraction of N. some nodes should have more initial energy. Ex: 10 nodes out of 100 should have more initial energy and are called advanced nodes.

Number of Advanced nodes: $m*N$

Number of Normal nodes: $(1-m)*n$

Starting energy of Normal nodes: E_0

Starting energy of a Advanced nodes: $E_0*(1+\alpha)$

The number of cluster heads decision is done at the starting. Information received at the sink node, performance wise this protocol is better.

IV. SEP (A STABLE ELECTION PROTOCOL):

This protocol will balance the energy consumption of SNs. SEP works on weighted election probabilities. In this protocol the cluster head (CH) is decided depending on measure of the rest energy in SNs. There are some First advanced nodes and second normal nodes in SEP protocol. Depending on energy values the advanced nodes will become the cluster head.

V. PEGASIS (POWER EFFICIENT GATHERING IN SENSOR INFORMATION SYSTEM)

Routing protocol makes decides about the route of the packets for communication between transmitter and receiver. Wireless Sensor Network consists of nodes which are battery operated; means should work within the limit of the power and low bandwidth. Because of this we need to find the optimal route for communication. PEGASIS protocol is one such protocol which is having hierarchical network architecture. This protocol uses Greedy chain strategy for communication Ref. [5]. The main idea is each node will receive and transmit the data to the neighbor node and then transmitted to the base station. In this protocol energy is distributed among all SNs uniformly Ref. [6]. The nodes are organized to form a chain, using greedy strategy. Starting with some node the organized nodes start making chain of SNs. The other way is, the sink node itself can compute the chain and broadcast it to all the SNs. Compared to LEACH this protocol will give better results with respect to life span of WSN and the overhead of clustering is reduced. Clustering scheme improves the energy efficiency of PEGASIS protocol.

CCS (Concentric Clustering Scheme), CHIRON (Chain based Hierarchical routing protocol) EBCRP (energy balanced chain cluster routing protocol), are the other chain based protocols

VI. ACT (ARRANGING CLUSTER RANGE AND TRANSMISSION RANGES)

This is an adaptive clustering protocol, which reduces load on the cluster near base station. These clusters will exhaust their energy quickly since they are heavily loaded. In this protocol data transmission is not directly from Cluster Head (CH) to Base Station (BS), but data is transferred from one level to another level. In this, the first level is near BS, second level means next to the first level and so on. With this type of working ACT will increase the lifetime of overall network. In this protocol the cross level communication is allowed, which improves the overall network quality.

The network is deployed with multi hop communication to reduce the energy consumption by the SNs. In this protocol the cluster size and the CH location is to be decided to balance the load over cluster head. This itself is a hectic job in ACT protocol.

VII. HEED (HYBRID ENERGY-EFFICIENT DISTRIBUTED CLUSTERING) PROTOCOL

The improvement in LEACH protocol is done in HEED protocol in which the CH selection technique is different. The residual energy of each SN is observed and depending on that the cluster head is selected. The residual energy is also called node degree or node proximity. Compared to LEACH, HEED protocol is efficient in energy consumption.

On the basis of amount of energy distributed among the node, different cluster heads in a field are selected using this protocol HEED protocol. There are three phases in the protocol,

I. Initialization phase: In this phase based on the following parameters, the Cluster Head is elected.

II. Repetition phase: In this phase its stops execution when CHprob reaches 1. The two states of this phase are,

III. Finalization phase: During this phase, each sensor makes a final decision based on its status.

VIII. GSTEB (GENERAL SELF-ORGANIZING TREE BASED ENERGY BALANCE ROUTING PROTOCOL)

The data transmission is performed using the multi hop communication from node to BS using intermediate node i.e. CH. The cluster head act as a relay node in the transmission Ref. [11]. The selection of CH is same as the HEED protocol by using the residual energy of the node and the geographic location of the sensor node. In this protocol the BS sends its location to the every node of the network and initiates the routing procedure. Each node finds its neighbours and maintain routing table. The largest energy of the node from the neighbours table consider as a parent. In such away each node finds its parent using energy level and location of the BS.

This protocol consists of four phases.

Initialization Phase:

The parameters of network are introduced in this phase. To consider parameters i.e., required area, number of nodes, initial energy, radio model, packet size, maximum packet size, routing protocol and so on. Following these assumptions, Base Station (BS) sends packet to all sensor nodes in specific area to inform regarding the starting time. Each sensor nodes send its location awareness to all sensor nodes i.e., in the specific radius circle. This packet consists of node ID, Energy Level (EL) and distance of nearest nodes. *Tree constructing phase:*

In tree constructing phase, each node elect parent node from its neighbors according to Energy Level (EL) and every node records its neighbors' neighbor information. The parent node is selected within the cluster by using EL. Lowest energy level nodes are acting as child nodes. These child nodes send packets to their parent node. That parent nodes send packet to their respective CH Ref. [4]. CH sends the packets to BS. So distance will be reduced. Energy levels should not be suddenly decreased.

Self organized data collection and transmission:

After construction of tree, each node gathers information and it will produce data packet. The data packet of child node sends to CH through parent node. CH sends packet to Base Station. Nodes are self organized with respect to the EL.

Information exchange phase:

In this phase, parent node is exchanged when node exhausts its energy. After recognition of EL reduced, the parent node is exchanged in the next round of this phase. All nodes are monitoring the neighbouring nodes. Automatically nodes are updating changes. All packets are sent then it will move to next round.

IX. TREE BASED CLUSTERING (TCB)

This protocol is also improved version of LEACH Ref. [2]. The network is divided into several clusters and each cluster is associated with CH. Nodes in the cluster forms a tree within cluster and CH act as a root node. Each node of the network is location aware, it can estimate the distance from root to itself. The clusters are divided into some layers on the basis of distance between node and root. The CH is at level 0 and node in level L (i) will choose the node in L (i)-1 and nearest to itself as its parent node. TCB is best protocol in which each node maintains their neighbour's information and construct the routing tree as in the GSTEB protocol but some cluster-heads in the network consume more energy than other nodes when BS is located far away.

X. BEENISH (BALANCED ENERGY EFFICIENT NETWORK INTEGRATED SUPER HETEROGENEOUS)

This protocol performs the classification of nodes into four energy levels. The election of the overall Cluster-head is done by considering the centrality in the location of the node and its energy capability is an advancement proposed. This not only improves efficiency but also maintains reliability over an extended lifetime Ref. [3].

In this protocol the clustering is implemented by classifying the nodes into four categories. They are the normal nodes, advance nodes, super nodes and the ultra-super nodes. To efficiently transfer the data across base stations we need several cluster heads; also required for a smooth transmission. The probability of the residual energy is calculated for every node which acts as a parameter to determine the cluster head. There is a need for an overall cluster head to manage the efficient transfer of the sensed information to the base station. The selection process uses the distance between source and destination as additional criteria. It also makes use of the correlation between probabilities of energy in each node with the average probability of the entire cluster. Once all the data reaches the overall cluster head, it is efficiently transferred to the destination.

XI. COMPARISON OF DIFFERENT ROUTING PROTOCOLS

The comparison of different routing protocols is presented in table 1.1, which will give some idea about different scenarios of protocols Ref. [1].

TABLE I. COMPARISON OF DIFFERENT PROTOCOLS

PROTOCOLS	Control manner	CLASSIFICATION	Data aggregation	Energy Efficiency	Scalability	Delivery delay	Load balancing	Algorithm complexity
LEACH	Distributed	Hierarchical	Yes	low	Moderate	Moderate	Moderate	LOW
FAIR	Distributed	Hierarchical	Yes	low	Moderate	Moderate	Moderate	Low
SEP	Distributed	Hierarchical	Yes	Moderate	Moderate	Moderate	Moderate	LOW
PEGASIS	Centralized	Chain	Yes	Very low	Very low	Very large	Moderate	High
HEED	Distributed	Hierarchical	Yes	low	Moderate	MORE	GOOD	LOW
GSTEB	Distributed	Hierarchical	Yes	more	Moderate	LESS	GOOD	LOW
TCB	Distributed	Tree	Yes	MORE	Very low	LARGE	Moderate	Moderate
BEENISH	Distributed	Hierarchical	Yes	Moderate	Moderate	LESS	GOOD	Moderate

XII. CONCLUSION

WSN is emerging technology which is base for many other technologies like IOT and having many applications in medical, military, marine etc.. In WSN there are many issues like energy consumption, routing protocols, packet delivery, scalability, lifetime of the network etc. This paper is the survey on different recent protocols to enhance the energy efficiency. Finally the comparison of all the protocols. We will leave the researchers to discover more efficient protocol. The distributed and hierarchical protocols will give better results. Some protocols will concentrate on one issue and others on different issues. We are not having a protocol or a technique which will be good or best in all aspects, which may be the future enhancement for the researchers.

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