

A Survey on Multi-hop Chain Routing Protocol in Wireless Sensor Networks

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Abstract

Recent researches in Wireless Sensor Networks (WSN) have introduced a number of protocols mainly designed for the sensor networks. The main motive of these protocols is to minimize the energy usage of the sensor devices present in the network. Energy optimization has been an important drawback in the Wireless Sensor Networks. Wireless Sensor Networks (WSN) consists of a number of small nodes with the capabilities of sensation, computation, and communication. They have some limitations such as the energy optimization, memory size and the processing power to be dealt with. So, energy optimization is an important issue to be addressed. Many protocols have been designed in order to handle energy optimization. The effectiveness of the protocol depends mainly on how the various parameters have been used in the application. This paper deals with the various hierarchical multi-hop chain based routing protocols being designed to handle energy optimization.

Key Words: Energy Optimization, Routing Protocol, Wireless Sensor Networks, Hierarchical Chain Based Routing Protocol

1 Introduction

Wireless Sensor Networks is defined as a network which consists of a group of nodes which are found to be connected to a wireless network and are located randomly. Every sensor node is found to communicate over a short distance through the radio transmission and collaborates to perform a common task. In the wireless network, the sensor nodes present in the network communicates with each other or communicates directly with the base station. Data delivery is done by the network layer with the help of the addressing scheme in order to complete the task. Routing the transmitted data is considered as one of the main drawbacks in the Wireless Sensor Network as they have very less limited energy source. This paper is mainly found to deal with the routing technique which works in a way to reduce energy consumption by choosing the correct way of routing the information to the Base Station, as a result of which the battery life of the nodes is extended to a great extent. There are many routing protocols present in the wireless network as follows: flat based, hierarchical based, localization based and QOS based routing protocol [1].

In Hierarchical based routing, LEACH is the first protocol being introduced. Here many nodes present in the network are grouped together to form clusters and a Cluster Head is selected for every cluster and the data are routed through these Cluster Heads to the Base Station. Every Cluster Head gathers the data from every other node present in the cluster.

2 Hierarchical Routing Protocols

Hierarchical Routing protocols are also named as the cluster-based routing. The various classification of hierarchical routing protocols are as follows [2]:

- Single-hop cluster routing
- Multi-hop cluster routing
- Multi-hop chain routing
- Multi-hop grid routing

There are two types of single hop clustered routing which includes LEACH and LEACH-C. Multi-hop clustered routing classifications consist of the following protocols TEEN, APTEEN, BCDCP, HEED, EEUC, ELCH, and SHPER. The multi-hop chain routing includes the following protocols PEGASIS, SLEEP/WAKE Scheduling, PEDAP and GSTEB. The multi-hop grid-based routing includes the following protocols VGA, TTDD, and GBDD.

The main advantage includes the scalability and also energy efficient routing in the Wireless Sensor Network (WSN). In this type of routing, the nodes with maximum energy are used to process and send information and the nodes with minimum energy are used to sense the proximity of the target node in the network. The concept of creating clusters thus help in increasing the lifetime of the network. In Hierarchical routing the data are aggregated and fused in order to minimize the number of messages that are being transmitted to the Base Station (BS). It mainly consists of 2 phases of routing where the first phase is used in cluster head selection and the another phase is used for routing messages.

3 Multi-hop Chain Routing Protocols

In Multi-hop chain routing protocol, the nodes present in the network form a chain to communicate with other nodes and to transmit data. Every node in the wireless network aggregates the data on its route and forwards the aggregated data to the next node. Figure 1 gives the various multi-hop chain routing protocols discussed.

3.1 PEGASIS

PEGASIS(Power-Efficient Gathering Sensor Information System) is a type of Hierarchical Based Routing Protocol [3]. In PEGASIS, the nodes are found to communicate only with the nearest node and then it transmits to the Base Station, thus decreasing the amount of energy spent in each round and also distributing the energy load evenly among the various sensor nodes present in the network. The nodes form a chain, which is achieved by the nodes themselves or even the Base Station can take the responsibility of managing the chain and broadcasting the message. PEGASIS works in a way, where every node receives data from the nearest neighbor node,

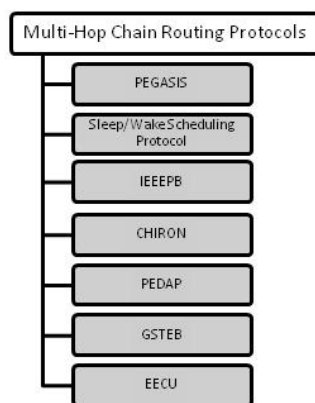


Figure 1: Multi-hop Chain Routing protocols

combines its data with the data received and transmits that data to the other nearest neighbor. Data fusion is performed at each node other than the end nodes in the chain. Every node uses its nearest neighbor data and combines its own data to generate the message to be transmitted and then sends it to the other nearest neighbor node. Thus, in this type of routing protocol, every node generates one packet of message every round.

3.2 Sleep/Wake Scheduling Protocol

Sleep/Wake Scheduling Protocol helps to function in low energy consumption. The communication signal is kept in sleep mode when the nodes in the network are in an idle state and are kept in wake mode once the message transmission takes place in the network [4]. Data synchronization accuracy that occurs between the sender and the receiver is mainly found to be focused in this protocol. By this, they help themselves to switch between the sleep and wake modes simultaneously between in the communication process. This protocol is designed in such a way that the effect of synchronization errors is being addressed correctly.

3.3 IEEPB

IEEPB(Improved energy-efficient PEGASIS-based protocol) was implemented in order to get rid of the disadvantages of PEGASIS [5]. This algorithm uses a more reasonable method to form a chain which simplifies the process of chain construction and helps us to get rid of the formation of LL (long link). IEEPB involves the leader selection phase. In the leader selection phase, IEEPB uses a special type of method in which the energy of the node present in the network and the distance between the nodes and also the Base Station parameters in order to select a more suitable leader and also help in energy optimization.

3.4 CHIRON

CHIRON(Chain-Based Hierarchical Routing Protocol) acts as energy efficient Chain-based routing protocol [6]. It has been developed to get rid of issues like data propagation delay and redundancy in transmission. CHIRON works on the concept of sensing field. Once the field is sensed then the area is split into areas. It creates many chain-like structures so that the delay in transmission is avoided and efficient routing happens in the network. As a result, they help in conserving the node energy to a greater extent and also increase the network lifetime of the nodes. CHIRON is considered to be more efficient than the PEGASIS in the data propagation delay, redundant transmission path and also in improving the lifetime of the nodes present in the network.

3.5 PEDAP

PEDAP (Power Efficient Data Gathering And Aggregation Protocol) consist of the neighbor nodes that organize themselves and form a group of the node where one of the node acts as a parent node and the other nodes acts as a children node and this will be considered based on the amount of the residual energy of the nodes present in the network. The parent nodes are responsible for transferring the packets to the root node where the data gets fused there and gets forwarded to the sink. An important issue in PEDAP is that this algorithm employs Prims minimum spanning tree approach from the source node to reach the sink. The transmission

distance will be reduced here and thus this protocol is considered to use less energy and increases the lifetime of the network.

Protocol	Advantages	Disadvantages
PEGASIS	• Network energy dissipation is balanced	• Long chain formation • Delay can be high in bigger networks
Sleep/Wake Scheduling protocol	• Energy is saved by putting the radio to sleep during idle times	• Lack of synchronization may create issues
IEEPB	• Balanced energy consumption and prolonged lifetime of WSN • Avoids formation of Long Link(LL)	• Low scalability • No failure recovery
CHIRON	• Data propagation delay and redundant transmission are reduced	• A number of short chains are formed
PEDAP	• Needs less communication time to forward packets to destination	• Fails to achieve Power-Aware Reliable Communication
GSTEB	• Better performance in terms of throughput, energy consumption	• High packet dropping ratio as time increases
EEUC	• Avoids hotspot problem	• Less reliable

Figure 2: Advantages and disadvantages of the various Multi-hop Chain Routing protocols

3.6 GSTEB

GSTEB (General Self-Organized Tree-Based Energy-Balanced Routing Protocol) is mainly used to increase the lifetime of the network [7]. At certain time interval, the Base Station is found to change the root node in the network depending on the residual energy and also its broadcast ID and its coordinates to all of its sensor nodes. This protocol uses a dynamic root, not with a minimum delay. Every node has the right to select its parent node based on the neighbors information including the energy level of the node in the network. Root nodes are responsible for the data fusion and then the fused

data are forwarded. The node with the high energy is named as the root node. The parent node is selected based on the energy level and also the energy level of the neighbor.

3.7 EEUC

EEUC (Energy-Efficient Unequal Clustering Mechanism) is a multi-hop routing protocol. In EEUC, the clusters present near the Base Station are smaller in size when compared to the clusters present far away from the Base Station. Hotspot problem is avoided as a result of the above condition. Every Cluster Head present in the network has the lists of all its adjacent Cluster Head in the network. Once the Cluster Head is selected, the node present in the networks joins the nearest Cluster. The Intra-cluster selection works in the same way as the LEACH. In the case of inter-cluster selection, the distance between the nodes and the Base Station is considered. If the distance between the node and the Base Station is less than the threshold distance then the data is forwarded or else another node is used to forward the data to the Base Station.

Figure 2 gives the advantages and disadvantages of the various Multi-hop Chain Routing protocols

4 Proposed Idea

From this study of Multi-hop chain routing protocol, energy is an important factor that drains the nodes sensor network. So, to minimize the energy of the node in Multi-hop chain routing we introduce a cutting edge approach that reduces the dissipation of energy. In the proposed system, a cluster was formed using a popular clustering algorithm. We introduce an algorithm that provides a Multi-hop path to transmit the data to the sink. This algorithm reduces the energy of temporal and spatial activity in the sensor node. This mechanism reduces the energy used by all the nodes in the network.

5 Conclusion

Wireless Sensor Networks are an important area widely used nowadays. And it is important to maintain energy efficiency and secure

routing through the network to ensure data security and also to maintain the lifetime of the nodes present in the network. Many routing protocols exist and based on the working functionality chain-based routing is one of the important type of routing used in energy optimization of the network. Various details like the working functionalities, phases, advantages and disadvantages have been discussed in the paper. Some of the challenges we still face include the chain construction, deployment of node, head node selection, location awareness and few more to add to it.

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