

ENERGY EFFICIENT AND CLUSTER BASED ROUTING PROTOCOL FOR WIRELESS SENSOR NETWORK:A REVIEW

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ABSTRACT

Wireless Sensor Network consists of spatially circulated sovereign sensors to politely monitor physical conditions. Wireless Sensor Networks have gained a lot of interested in the research field in last few years. To increase the lifetime of the whole networks energy attentiveness is the necessary consideration to design and analyze the routing protocols. In this paper we present a study of different protocols which are used in increasing energy efficiency of the Wireless Sensor Network such as LEACH(Low Energy Adaptive Clustering Hierarchy),CB-DHRP(Cluster Based Directed Hierarchical Routing Protocol),BCBE(Balanced Cluster and Balanced Energy). Finally conclude this paper with future research and challenges.

Keywords: Wireless Sensor Network, Energy Efficient Routing, Network Lifetime, Balanced Cluster.

1. INTRODUCTION

Wireless Sensor Network consists of spatially distributed autonomous sensors to cooperatively monitor physical or environmental conditions such as temperature, sound, vibration, pressure, motion or pollutants. Sensor networks are the key to gathering the information needed by smart environments, whether in buildings, utilities, industrial, home, shipboard, moving systems automation, or elsewhere. Recent terrorist and guerilla warfare countermeasures require distributed networks of sensors that can be deployed using, e.g. aircraft, and have self-organizing capabilities. A sensor network is required that is fast and easy to install and maintain A sensor node is composed of four major blocks: sensing unit, processing unit, power unit and communication unit.The sensing unit is a sensor that measures a certain physical condition like temperature and pressure. The processing unit is responsible for collecting and processing signals captured from sensors. The wireless communication unit transfers signals from the sensor to the user through the base station(BS).All previous units are supported by the power unit to supply the required energy in order to perform the mentioned tasks. Wireless Sensor Networks contain hundreds or thousands of sensor nodes and these sensors have the ability to communicate each other or directly to the Base Station.

Following are the key features of a sensor network:

- 1) Increase network lifetime.
- 2) Increase energy efficiency.
- 3) Nodes in a network may not have global identification because of large amount of overhead and large number of sensors.
- 4) Data in sensor network are bound either downstream to nodes from a sink or upstream to a sink from nodes. Wireless sensor network are a kind of application specified network.

In this paper we present the study of different energy efficient routing protocols of

wireless sensor network. Energy is the necessary consideration of wireless sensor network when we design or analyze the routing protocols for the wireless sensor network. There are some Energy Efficient routing protocols which have been proposed for wireless sensor network such as LEACH (Low Energy Adaptive Clustering Hierarchy), CB-DHRP (Cluster Based Directed Hierarchical Routing Protocol), BCBE (Balanced Cluster and Balanced Energy).

2.LEACH (Low Energy Adaptive Clustering Hierarchy)

LEACH is a classic clustering based routing protocol that minimizes the energy dissipation in sensor network. LEACH is a self organizing clustering routing protocol for wireless sensor network. LEACH uses randomization to distribute the energy load between the sensors in the network. In LEACH, nodes are organized into local clusters where one node act as the local base station or a cluster head. If we choose the cluster head a priori and fixed it throughout the system lifetime it is easy to see that the unlucky sensors chosen to be cluster heads would die quickly ending the useful time of all nodes belonging to those clusters. In LEACH, it includes the randomized rotation of the maximum energy cluster head position that it rotates between the various sensors in a way so the battery of a single node should not be drain. LEACH performs local data fusion to compress the amount of data which is sent from the clusters to the base station to reducing the energy dissipation and enhance the lifetime of the system.

2.1 LEACH ALGORITHM

The operation of LEACH is broken up into rounds, where each round begins with a set up or advertisement phase to organize the clusters, it is followed by the steady state phase to transmit the data to the base station. To minimize the overhead the steady state phase is long as compared to the set up phase.

2.1.1 Advertisement Phase

When clusters are being created, each node decides whether or not to become a cluster head for the current round. This decision is based on the suggested percentage of cluster heads for the network and the number of times the node has been a cluster head. This decision is made by the node n choosing a random number between 0 and 1. If the number is less than a threshold $T(n)$, the node becomes a cluster head for the current round. The threshold is set as:

$$T(n) = \begin{cases} \frac{P}{1 - P \times (r \bmod \frac{1}{P})} & \text{if } n \in G \\ 0 & \text{otherwise} \end{cases}$$

where P =desired percentage of cluster heads, r =current round and G is the set of nodes that have not been cluster heads in the last $1/P$ rounds. Using this threshold each node will be a cluster head at some point within $1/P$ rounds. The nodes that are cluster head in round 0 cannot be cluster head for the next $1/P$ rounds, since there are fewer nodes that are eligible to become the cluster heads.

Each node that has elected a cluster head for the current round broadcast an advertisement message to the rest of the nodes. For this "advertisement phase", the cluster heads use a CSMA MAC protocol. The non cluster head nodes keep their receivers to hear the advertisement of all the cluster head nodes. After the completion of this phase, each non cluster head node decides the cluster to which it will belong for this round.

2.1.2 Cluster Set up Phase

When each node has decided to which cluster head node it belongs, it must inform the cluster head node that it is a member of the cluster head node. Each node transmits this information back to the cluster head node using the CSMA MAC protocol. All the nodes must keep their receivers on.

2.1.3 Schedule Creation

The cluster head node receives all the messages for the nodes that would like to be included in the cluster. Based on the number of nodes in the cluster, the cluster head nodes creates a schedule which inform each node when it can transmit the data, it is known as the TDMA schedule.

2.1.4 Data communication

After creating clusters and its arrangement by the TDMA schedule, data communication begins. Assuming all nodes have data to transmit and they transmit the data to the cluster head on their scheduled time. This communication uses a minimal amount of energy. The cluster head node must keep their receivers on to receive the data from the nodes in the cluster. When all data has been received cluster head node performs signal giving out functions to compress the data into a single signal. Then the composite signal has sent to the base station.

3. BCBE (Balanced Cluster and Balanced Energy)

In LEACH, each cluster head directly send the fused data to base station(BS), thus it extends the lifetime of major nodes. But it has some drawbacks, one is that the cluster head may not well distributed and the another is the number of nodes in each cluster is distributed unequally. This protocol present some method to overcome the shortcomings of LEACH protocol.

BCBE (Balanced Cluster and Balanced Energy) is a routing protocol for wireless sensor network. This protocols overcome the shortcomings of the LEACH protocol. BCBE is a clustering based routing protocol that tries to minimize the energy dissipation in sensor networks. The advantage of this protocol is that we only have to know the location of two nodes to locate the other sensor nodes.

3.1 Routing Protocol

3.1.1 Initialization of Clusters

In BCBE routing protocol, we have to know the location of two nodes to locate the other nodes. In beginning all the nodes turn up their receivers. Both the base station(BS) and the two nodes send message about their location, According to the location information of these three nodes all the nodes know their location information. Nodes near the optimal position competed to be cluster head by comparing distance.

3.1.2 Cluster Set-up Phase

Cluster head(CH) send the message to tell the other nodes within the range. The node send the "ACK" message if they want to join the cluster. If the node receives more than one message than it will choose the cluster head according to the distance and energy means choose the cluster head with optimal distance.

3.1.3 Data Transmission Phase

In the beginning of every round, all the nodes must turn up their receiver, then the cluster head will broadcast message about the TDMA time slot information. Each cluster member will know the time slot of themselves and the cluster number will keep the transceiver off until its time slot. In its time slot, the cluster members transmit the sensing data to the cluster head. In this phase the cluster head transmit the data directly to the base station(BS).

4. CB-DHRP (Cluster Based Directed Hierarchical Routing Protocol for Wireless Sensor Networks)

CB-DHRP Protocol is similar to the LEACH protocol but the different in the assumption of the node transmission range and the formation

method of routing structure creation. CB-DHRP always constructs the energy efficient transmission paths that are capable of transferring the data toward the base station (BS). In CB-DHRP we assume that the transmission ranges of all sensor nodes are identical and fixed so the sensor nodes can not transmit their data to the nodes which are located out of its transmission range.

The operation of CB-DHRP protocol consist of three phases:

- 1) Cluster Formation :- In this phase some node become as Cluster Heads and the other join the cluster their respective cluster heads to form clusters. This phase might generate some isolated nodes.
- 2) Routing Structure Creation:-In this phase, CB-DHRP constructs the routing paths for cluster and isolated nodes.
- 3) Data Dissemination:-In this phase, CB-DHRP protocol transmit their sensing data toward the base station via multilevel routing architecture.

4.1 Cluster Formation

CB-DHRP protocol is similar to the LEACH protocol, a minor difference can be distinguished from the delivery method of $T(n)$ value. In LEACH protocol, the calculation of $T(n)$ is conducted in each sensor node, but in CB-DHRP protocol, the value of $T(n)$ is generated and broadcast by the base station for the network synchronization. Once a sensor node received the broadcasting message from the sink, it saves the $T(n)$ value for later comparison with its random number and by the received signal strength, the sensor node also figures the approximate distance ($Dis_{node-bs}$) from itself to the sink. After that the formation of clusters is same as the LEACH protocol.

4.2 Routing Structure Creation

The main aim of this phase is organizing a multilevel routing structure for data dissemination. There are two critical issues that should be taken into considerations-The communications carried out on isolated nodes and between clusters.

4.2.1 The Communication of Isolated Nodes

In CB-DHRP after the formation of cluster, the isolated nodes broadcast the message to all the nodes located within transmission range for acquiring its down stream relaying node.

The value of the neighboring node is find by the $Dis_{node-bs}$ and is less than that the isolated node and closest to the isolated node, that node will be elected as its next-hop relaying node. This process will construct a directed transmission can send data back to the sink with least energy cost.

4.2.2 The Communications of Inter Clusters

CB-DHRP protocol provided a solution to the isolated nodes connections to avoid the great amount of energy is consumed by using the way

that the cluster heads(CHs) transmit their data directly to the base station with the help of the other cluster heads(CHs). CB-DHRP introduced isolated nodes because cluster heads(CHs) can not communicate directly with each other. For this CB-DHRP uses the following method to construct the links between isolated clusters.

Firstly, the cluster head can not transmit the data directly to the base station, it broadcast the message for requesting the $Dis_{node-bs}$ values from its neighboring nodes. The neighboring node which has the smallest $Dis_{node-bs}$ values i.e. the node which is nearest to the base station will be elected as the CH's relaying node. At this moment, the node which is selected as a relaying node may be in one of the following two states.

- 1) The selected relaying node is belonging to the other cluster. In such situation, the CH can forward the aggregated data smoothly to the base station with the picked up relaying node without altering the original transmission direction of the picked up node.
- 2) The picked up relaying node is belonging to the same cluster as the CH locates. In such situation, the picked up relaying node must alter its original transmission direction so that the cluster head(CH) can transmit the data directly to the base station.

4.3 Data Dissemination

As the formation of routing structure completed, the data dissemination phase begins. In this phase of CB-DHRP protocol, sensor nodes send the data with their relaying nodes in hop-by-hop manner. To reduce the energy which is consumed in the formation of routing structure, we specify the long time interval for this phase. After the expiration of this duration, the structure creation phase starts.

5. CONCLUSION

In the last few years, the routing protocol in Wireless Sensor Networks has become one of the most important research area. There are great research achievements which have been existed in this field. In this paper, we make a great deal of analysis and research and present the study of cluster based routing protocol in wireless sensor network such as LEACH, BCBE and CB-DHRP. BCBE and CB-DHRP routing protocol provides improvement over LEACH and achieve the longer network lifetime. There are still many issues and challenges that need to be solved in the sensor networks.

The main issues are:-

- Security:-how to secure the wireless sensor network and assure that the data which have transmitted are not damage and eavesdropped
- Effectiveness:-how to effectively utilize the bandwidth and energy for specific application

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