Survey of Routing Protocols in Wireless Sensor Network (LEACH, TEEN, APTEEN)

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Abstract – Wireless sensor network is composed of minute sensor nodes distributed in large sensor terrain. Network duration and energy efficiency are of major importance in wireless sensor network. Wide practice of wireless sensor network (WSN) is the reason of development of many routing protocols. Routing as one input technologies of wireless sensor network has currently become a hot research because the applications of WSN is everywhere, it is impossible that there is a routing protocol suitable for all applications In WSN, due to limited power of sensor nodes, one of the key challenge is to achieve minimum energy consumption in order to maximize network lifetime [1]. In this paper we propose energy efficient routing protocol naming LEACH, TEEN and APTEEN. In APTEEN although the nodes react to time critical situation but also it gives a total overview of Network at regular intervals.

Index Terms – Terrain, LEACH, TEEN, APTEEN

1. INTRODUCTION

The term wireless sensor network is formalize as self-methodized as well as infrastructure-less process in wireless networks to counsellor the environmental and physical state acting as pressure, temperature and some other are sound and vibration as pollutants. At various operation estate wireless sensor network have attain appreciable popularity by cause of their flexibility to deal with problem and also retain the help to development in our lives in many ways. Wireless sensor network has been prosperously adapted in different operation estate being military application, transportation, application area, Health applications. To revive the data collaboratively via network to essential location where data in complemplated and then analysed. A sink or the base station hook up with network and user.one can repossess essential data from network by implant queries and association outcome from sink. Wireless sensor network have many sensor nodes. Through the radio-signal sensor nodes are communicate between themselves. Sensor nodes have some limitations such as processing speed, communication bandwidth and storage capacity. The sensor nodes may be continuous or event driven. The location and positioning data can be obtain by global positioning system and local positioning algorithm..

Wireless sensor network ability to advanced applications and need non-conventional prototype for protocol arrangement. This instigates a great effort in standardization process, research activities.

2. ROUTING PROTOCOLS

In wireless sensor network the main objective for the sensor node is to sense data and dispatch it to the base station in multi hop environment for which routing path is vital for enumerate the routing path from the source node to the base station there is a huge number of proposed routing protocols exist.

The design of routing protocols for wireless sensor network, must consider the power and resources limitations of the network nodes, the time-varying quality of the wireless channel, and the possibility for packet loss and delay.

The first class of routing protocols acquires a flat network architecture in which all nodes are reviewed peers. Flat network architecture has several advantages including minimal overload to maintain the infrastructure.

The second class of routing protocols, network nodes are organized in cluster in which a node with higher residual energy.

The 3rd class of routing protocols uses location to address a sensor node location-based routing is useful in applications where the position of the node within the geographical coverage of the network is relevant to the query issued by the source node.

The 4th class of routing protocols uses a data-centric approach to disseminate internet within the network. The approach uses attribute-based naming where by a source node queries an attribute for the phenomenon rather that an individual sensor node.

2.1 LEACH (Low Energy Adaptive Clustering Hierarchy)

The first protocol of hierarchical routing proposing data fusion is/was leach protocol. Hierarchical protocols are aimed at reducing energy consumption by assembling data and reducing transmissions to the base station. It is self-adaptive and self-organized [2]. Leach protocol is a TDMA based MAC protocol. The prime focus of this protocol is to enhance the lifetime of wireless sensor networks by decreasing the energy needed to generate and sustain Cluster Heads. The features of node are as follows:-

1) The inherent features of all the nodes are similar.

2) The starting energy of all the nodes is equal.

3) Nodes and clusters do not change.

4) Transmission takes place directly by normal nodes to the cluster heads inside the range of a particular cluster.

5) Multi hop routing is used by cluster heads to broadcast data to the sink [4].

There are two phases for leach protocol:

1) Set-up phase

2) Steady phase

In LEACH protocol round is used as a unit, each round consist of cluster set up and steady state depository for the motive of diminishing energy costs which are not required. Steady phase takes longer time unlike setup phase.

However the set up phase is more vital, in this the sensor nodes are permitted to choose themselves as cluster-heads haphazardly, which is further segmented into clusters. Each node which develops into a cluster head (CH) will generate a TDMA schedule for the sensor nodes inside the cluster that permits the radio components of every non-CH-node to be switched off at all times leaving during their transfer time.

LEACH protocol consists of following phases:

A. Set- up phase-In set up phase, the primary objective is to create cluster and choose the cluster head for every cluster by electing sensor node having optimum energy. Set up phase is having three elementary steps:

1. Advertisement of cluster head

2. Set up of cluster

3. Transmission schedule creation

In the first step transmission of cluster head packets take place from the cluster head to tell cluster nodes their task of becoming a cluster head is accomplished according to the formula:-

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

If there be a random number x within 0 and 1. where n denote a given node, P denote probability, r denote current round G represents the collection of nodes which did not represent cluster heads previously, T(n) denotes threshold if the threshold T(n) is greater than number than node change into cluster in current round. The election of a particular node as cluster head prohibits its use as another cluster heads unless all the other nodes have been selected as cluster head at one time. This is beneficial for adjusting the energy.

In step two, cluster head send advertisement to the non-cluster head then cluster head receive the join request from the non-cluster head telling that they are the members of cluster head. the transmitter is switched off of non-cluster head, in this way they save large amount of energy and switch on the transmitter when they are required to transmit something to the cluster head.

In step three, all the selected cluster head generate a transmission schedule for member nodes of cluster. The generation TDMA schedule is term on the basis of the count of nodes in cluster.

B. Steady phase

In steady phase, cluster nodes send their data to the cluster head. The member sensors in each cluster can convey only with the cluster head via a single hop transmission. Cluster head aggregates all the collected data and forwards data to the base station either directly or via other cluster head along with the static route defined in the source code. After predefined time, which is decided beforehand, the network again goes back to the set-up phase.

The various advantages of LEACH protocol are:

1. The Cluster Heads aggregates the whole data which lead to reduce the traffic in the entire network.

2. Energy is saved as there is single hop routing from nodes to cluster head.

3. Lifetime of sensor network is increased.

5. LEACH is completely distributed as it does not need any control information from the base station as well as no global knowledge of the network is required [3].

DEMERITS-

1. LEACH does not give any suggestion about the number of cluster heads in the network.

2. One of the biggest disadvantage of LEACH is that when due to any reason Cluster head dies, the cluster will become useless because the data gathered by the cluster nodes would never reach its destination i.e. Base Station.

3. Clusters are divided haphazardly, which produce in unbalanced dissemination of Clusters. For e.g. some clusters have more nodes and some have lesser nodes. Few cluster heads at the middle of the cluster and some cluster heads may be in the boundary of the cluster; this occurrence can cause an increase in energy consumption and have great impact on the performance of the entire network transmit time.

LEACH is a MAC protocol, it contains many advantages like it does not need any control information, it saves energy, it is completely distributed and also contain many disadvantages like if cluster head dies then cluster become useless, clusters

are divided randomly etc. various advancements are done on LEACH protocol and so there are assorted version of LEACH protocol.

2.2 TEEN (Threshold-sensitive Energy Efficient Sensor Network)

TEEN is the first protocol made for reactive networks. Hierarchal approach and data centric method is being used by cluster based TEEN. TEEN is apt for time critical application as it is event driven and a reactive protocol. TEEN is suitable for time critical applications and works efficiently in case of energy consumption and response time.it permits the user to take control of energy consumption and accurately suit the application [5]. Transfer of data is based on the values of hard threshold and soft threshold as data centric method is being used for which data is vital and solicited on the basis of attribute value intrusion detection, explosion detection etc. are the application of this protocol. Cluster head formation of TEEN protocol is similar to that of LEACH. In the beginning cluster formation takes place, then two threshold values are broadcasted by the CH to its respective member nodes: hard threshold (HT) and soft threshold (ST) on not attaining the threshold values, communication between nodes will not take place. Whenever there is a change of time in cluster these two attributes are broadcasted by the CH.

FUNCTIONING

In this technique, when the cluster is about to change, with respect to its attributes, broadcasting takes place from the cluster head to its respective members, Hard threshold (HT): sensed attribute has this threshold value.

Soft threshold: occurrence of small change in the usefulness of the sensed attribute which occurs triggering of the node which switches the transmitter on and transmit.

Continuous sensing of the environment takes place by the nodes. When a parameter from the attribute set meets its hard threshold value, the transmitter is switched on by the node and the sensed data is delivered. Storage of sensed value takes place in the internal variable of the node, which is the sensed value (SV). The next transmission of data from the node will take place, during the existing cluster period, only when both of the condition is true:

1) The current value of the sensed attribute is greater than the hard threshold.

2) The present value of the sensed attribute vary from sensed value by an quantity equal to or exceeding the soft threshold.

Whenever transmission of data takes place by the node, SV is set equal to the current value of the sensed attribute.so, the number of transmission is reduced by hard threshold by permitting the nodes to transmit data only when the sensed attribute is within the range of interest. The soft threshold further decreases the number of transmissions by removing all the transference which might have otherwise happened when there is minor or no change in the sensed attribute once the hard threshold [6].

IMPORTANT FEATURE

This scheme has the following vital feature:

1) User receives time critical data spontaneously. So, this plan is remarkably acceptable for time critical data sensing applications.

2) More energy is consumed in message transmission than in data sensing. Therefore, even after continuous sensing of nodes, consumption of energy of this scheme could potentially be much less in comparison with proactive network, for the data is not transmitted frequently.

3) The soft threshold can be varied, depending on the criticality of the sensed attribute and the target application.

4) If the value of soft threshold is small then it will give more precise view of network, at the cost of energy consumption which has increased.

5) Whenever there is a change in cluster time, broadcasting of the attributes takes place again so, and change can be made by the user as and when necessary.

The main shortcoming of this technique is that, if the thresholds are not satisfied, the nodes shall not communicate; the user will not receive any data from the network at all and will never come to know even if all the nodes die. Thus, this scheme is not well suited for applications where the user needs to get data on a regular basis. Another accessible difficulty with this program is that a practical application would have to safeguard that there are no collisions in the cluster. TDMA scheduling of the nodes can be used to avoid this problem. This will however initiate a delay in the announcement of the time-critical data. CDMA is another possible solution to this problem. The main shortcoming of this technique is that, if the thresholds are not satisfied, the nodes shall not communicate; the user will not receive any data from the network at all and will never come to know even if all the nodes die. Thus, this strategy is not suitable for applications where the user requires to get data on a regularly. Another possible problem with this scheme is that a practical implementation would have to ensure that there are no collisions in the cluster. TDMA scheduling of the nodes can be used to evade this problem. This will however introduce a delay in the reporting of the time-critical data. CDMA is another possible solution to this problem [7].

2.3 APTEEN (Adaptive Periodic Threshold-sensitive Energy Efficient Sensor Network Protocol)

APTEEN is a reactive network protocol which is periodic threshold sensitive energy efficient sensor network protocol. Hybrid networks are a combination of the best features of

proactive and reactive networks, while limiting their drawbacks. Periodic transmission of data takes place in this type of network by the nodes taking relatively longer duration, at similar time data transmission takes place when the sensed value is more than its threshold. Therefore sensor energy is utilized methodically by depreciating the number of conveyance of non-critical data .amendments can be made by the user in periodicity, threshold value and parameter accordingly to be sensed in different regions. Either of the proactive or reactive networks can be emulated by this network by duly changing its periodicity or threshold values by varying the various parameters this type of network could be used in any kind of application. However the veracity and flexibility increases the complexity of the sensor .so a new hybrid network protocol called APTEEN is introduced. There are certain applications for which the user requires time critical data and wants to question the network for analysing the conditions apart from collection of time critical data. So, in other way we can also say that a user wants a network that responds quickly to time critical data and at regular intervals we can get a overall picture of the network, so that analysis queries could be answered. Having their own limitations, both jobs cannot be done satisfactorily by the above mentioned sensor networks. APTEEN is capable of combining the finest attribute of proactive and reactive network while reducing their capabilities to create a new kind of network called hybrid network. In this network, along with sending data periodically, they also react to unanticipated changes in attributes values. So, in this manner it can work both as a proactive and reactive network protocol. APTEEN uses the same model as teen protocol. On finalizing the CH in APTEEN, the following proceedings occur in every single cluster period [9]. The following parameters are being broadcasted by the cluster head.

Attributes: These are the physical parameters in which the user takes interest in gaining data about.

Thresholds: The parameter comprises of hard threshold (HT) and soft threshold (ST). HT is a specific value of an attribute more than which the node is stimulated to relay data. St is a slight change in the worth of an attribute which can cause triggering of node to transfer data again.

Schedule: This schedule is similar to TDMA schedule which is allocating a slot to individual node.

Count time (CT): It is the utmost time period between two consecutive reports dispatched by the node. It could be of numerous of the TDMA schedule length, accounting for the proactive part. Sending periodic data, gives an overall picture of the network. It also reacts quickly to the extreme changes, thus making it reactive to time critical situations. Therefore, combining both reactive and proactive strategies.

Flexibility is given to the user for setting the time interval (TC) and threshold values for the attributes. Count time and threshold values could control the energy consumption. Proactive or reactive network could be emulated by the hybrid network, by setting the count time and threshold values correctly.

The main disadvantage of this scheme is the supplementary complexity needed to apply the threshold functions and the count time. However, this is a reasonable trade-off and provides additional flexibility and versatility [8].

3. CONCLUSION

The protocols examined in this paper have distinct benefits and perils. On the basis of the topology, the protocol and routing approach can be exercised. The factors stirring the formation of cluster and CH communication are open matter for future exploration. Moreover, the mechanism of data aggregation and fusion among clusters is also an captivating problem to analyse. One of the chief challenges in the blueprint of routing protocols for WSN is energy efficiency due to the deficient energy resources of sensors. For awareness of sensor networks, it is required to fulfil the constraints instigated by factors such as fault tolerance, scalability, cost, topology change, environment, and power consumption. Routing in sensor networks is a fresh research area, with a restricted but speedily growing set of outcome. In this paper, hierarchical based routing protocols are explored on the basis of network structure. They have the common goal of trying to expand the lifespan by minimizing the energy depletion of the sensor network.

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