International Journal of Engineering Applied Sciences and Technology, 2016
Vol. 2, Issue 1, ISSN No. 2455-2143, Pages 132-135
Published Online November-December 2016 in IJEAST (http://www.ijeast.com)

STUDIES ON THE PERFORMANCE OF LEACH, TEEN AND APTEEN PROTOCOLS IN WIRELESS SENSOR NETWORKS

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Abstract— **The present paper is aimed at the study and performance of different wireless sensors in the sensor networks with different wireless routing protocols. The detailed description about the classification of different routing protocols and the difference for making the classification and need for classification of these routing protocols for wireless sensor networks was explained. Around four types of routing protocols in sensor networks were explained and the need for their classification was discussed. The advantages and disadvantages of each protocol and their real time applications were explained in detail. The various applications where these routing protocols can be used and the advantages we can get from using these protocols were explained in this paper. The performance of the sensor network in terms of using the several sensor network protocols like LEACH, TEEN and APTEEN was discussed in detail. At last the performance was studied and analyzed in terms of graphical representation in terms of round and dead nodes for all these three protocols. This paper is about the wireless sensor networks in environmental monitoring applications.**

Keywords— **LEACH, TEEN, APTEEN, Wireless Sensor Networks, Routing Protocols, Reactive Protocol, Proactive protocol, Hybrid Protocol, dead node.**

I. INTRODUCTION

In the age of twenty first century, several technologies for working on the wired and wireless networks are available for the users, among those available network models wireless sensor networks is one of the mostly used and important network available for the users. It is highly used for the data that is needed to be collected form the various places with various environments where the human beings cannot afford to reach. It is being considered as one of the most useful technology in terms of wired or wireless network model. The sensors in the wireless sensor network will have several properties like cost of maintenance is at low cost, consuming power is in less quantity, the sensor works at several multi functions and these sensors will work at various calculation competencies.

These sensor networks are used for various applications and the functioning of several devices and various environments can be monitored. Some of the tasks performed by these sensors are observing the changes in environment, surveillance for the military applications and for other purposes and the control and security of several devices in the industry and it is used for research purposes too [3]. As the placing of the sensor nodes was not in the fashion of proper planning the expected results may not be obtained from these sensor networks. At present the sensor networks can be treated and used as a trusted tools and applications for the working of several devices. These networks and nodes can be used for watching the performance of several real time world applications, these sensors can be able to observe the working of the self-devices and other devices which works on self-battery and self-power supply. Every sensor node and its related network will have its own requirements and limitations based on the constraints and the situation dependent requirements. Hence, these features make it different from other networks and other sensors based on their different architectures and other protocols which were being used for the working of Internet and its related applications [2] [3].

II. CLASSIFICATION OF ROUTING PROTOCOLS

A routing protocol is used for the routing of the data in terms of packets between the nodes in a network. These protocols will postulate the routers of the way these routers transfer the data between them and distribution of information which allows those routers to select the available routes for transferring the data between these nodes. The routing algorithms will play a vital role in the implementation and working of the routing protocols. These routing algorithms will define and determine the routes of the choice which provides guarantee of data transfer. There are several topologies that were available for the users to arrange the nodes in wireless sensor networks. Some of the topologies that were being used mostly in these wireless sensor networks are the star topology and the mesh topology. Two points are to be considered as very important and the challenging operation in

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the working and functioning of a wireless sensor network. Several sensor nodes will have various characteristics which make it differ from modern-day communication and wireless ad hoc networks. As these sensor nodes will have no proper infrastructure, it becomes very much difficult and unfeasible to construct addressing which is acceptable globally and various algorithms which were conventional for the internet protocol.

1. Routing protocols are of three types. These protocols are classified into three types on the basis of the way the source identifies the destination to be reached. The three types of protocols are proactive, reactive and hybrid protocols. A proactive protocol identifies and sets the paths for routing and states for routing only before the when there is a request for routing traffic. The routing paths identified and fixed were maintained even no traffic at all in the routes. The reactive routing protocol working is different compared to the proactive protocols. In this type of protocols, the routing of the packets or the data is sent when there is a need for the data transmission and it is being distributed to other nodes.

i. In proactive protocols, all the routes that were needed to be sent are calculated beforehand when those were needed to be send
ii. In reactive protocols, the routes for sending the data or packets are to be calculated and identified at the time only if they were needed to be transmitted
iii. Hybrid protocols are the third type protocols which is an amalgamation of the above two types of protocols.

2. The routing in the wireless sensor networks can be divided in to three types based on the structure the network was constructed or the network was developed. The first type of routing in the wireless networks was the flat based routing. In this type of routing model the nodes were present in the network are the nodes that were connected in the network will work in the same role or in same functioning. The second type of routing in the wireless sensor networks is the hierarchical based routing in which all the nodes present in the network are assigned with several functions based on the hierarchy of the nodes in the network. The third type of routing model in the wireless sensor network is the location based routing. In this model of routing the paths for the routing mechanism was identified and sent based on the position of the sensor nodes in the area they need to be placed or intended to work on the area.
3. Another model of classifying the routing protocols was based on the initiation of the protocol i.e., the protocol was either initiated towards destination or initiated towards source. Routing paths will be set up by the source initiated protocol when it gets the request from the source node and starts the node from the source. The source will make a publicity of the data it is having and starts delivering the data at the destination. The destination initiated protocol works on the basis of setting a path from the destination node.
4. Another model of classifying the routing protocols was based on the operation of the protocol. Several model or types of protocols were being classified in this model, they are multipath based routing protocols, query-based routing protocols, negotiation-based routing protocols, QOS based routing protocols, or coherent based routing protocols.

a. In multipath-based routing type of protocols, numerous paths are being used by the several users for the enhancement of the network performance.
b. In negotiation-based routing type of protocols, various high data level descriptors are used by the designers and the users of the network such that to reduce the redundancy in the data that was being available for the transmission.
c. In Quality of Service based routing protocols, the data will have an equilibrium among the ingestion and data excellence is sustained.
d. In coherent-base routing, the data is aggregated with minimum processing before forwarding. Here energy efficiency is achieved by path optimality.

III. LEACH PROTOCOL

Energy saving is one of the important and major consideration for the usage of this protocol. In Proactive Networks, the transmission of the data will be done only when the node senses the value of the attribute at period of time. The remaining time will be treated as free time and the sensor will be switched off such that to reduce the power consumption. This model of network models are highly suited and can be used for the networks or applications which require the examination is done at a period of time. In real world applications, one can use this type of protocol in the applications like monitoring the working of machinery for identifying the problems in the working of the machinery and finding the suitable solutions for the existing problems. LEACH is one of the mostly used and famous algorithms for this type of applications which stand as Low Energy Adaptive Clustering Hierarchy which is a proactive network protocol.
To reduce the energy used for working of a sensor network, the time interval in the middle of the transmissions is increased which affects in delay in the receiving of data by the user at the destination. If the time interval of the transmission is reduced, the data that has to be reached to the user will receive with late or delay in the data which results in not fitting for the time related applications. But, this increases the number of data transmissions and the energy consumption, hence reducing the network life. LEACH is a good approximation of a proactive network protocol, with some minor differences. Once the clusters are formed, the CHs broadcast a TDMA schedule giving the order in which the cluster members can transmit the data. Every node in the cluster is assigned a slot in the frame, during which it transmit

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data to the cluster head. When the last node in the schedule has transmitted its data, the schedule is repeated. The report time is equivalent to the frame time in LEACH.

The frame time is not broadcast by the CH but is derived from the TDMA schedule. However, it is not under user control. Also the attributes are predetermined and are not changed after initial installation. This network can be used to monitor machinery for fault detection and diagnosis. It can also be used to collect data about temperature or pressure or moisture change patterns over a particular area. But data collection is done periodically and centralized. Therefore it is most appropriate only for constant monitoring of networks. In most cases, the uses does not always need all that data, therefore periodic data transmission are unnecessary. It consumes more energy at each sensor.

IV. TEEN PROTOCOL

TEEN protocol which stands for Threshold sensitive Energy Efficient sensor Network is a reactive protocol. In this type of sensor networks, the sensor nodes uninterruptedly sense the signal and identify the signal from the nature and communicate the data or value shortly to the receiving station whenever the data limitation surpasses the threshold value which was declared or specified by the user. With this type of feature, these sensor models and network models are used highly for critical applications which runs on the basis of time or time dependent applications. Nevertheless, if the required or the thresholds values are not reached, the user cannot be able to find or identify the state or the status of the network, which makes it poor for applications that work on the data being updated from time to time. In this scheme, at every cluster change time, in addition to the attributes, the CH broadcast the following message to its members:

Hard threshold (HT): This is a threshold value for the attributes which were sensed and established for reactive networks. It is the absolute value of the attributes, from where the node senses the present particular value should switch on its transmitter and report the data to its CH.

Soft threshold (ST): This is the value that was observed which is very small in the value attribute which triggers the node in the on mode of its transmitter and transmits the data.

The HT tries to reduce the number of transmission by allowing the nodes to transmit only when the sensed attribute is in the range of interest. The ST further reduces the number of transmissions by eliminating all the transmissions which have otherwise occurred when there is little or no change in the sensed attribute once the HT. But the main drawback of this algorithm is that if the thresholds are not reached, the nodes will not communicate, the user will not get any data from the network, and will not come to know even if the nodes die. Therefore this scheme is not suited for applications where it is necessary to get data on a regular basis. Advantage of this scheme is it is eminently suited for time critical data sensing application. Energy consumption in this scheme can be much less than in proactive network because data transmission consumes more energy than data sensing and in this scheme data transmission is done less frequently.

V. APTEEN PROTOCOL

A reactive network protocol called APTEEN is Adaptive periodic threshold sensitive energy efficient sensor network protocol. Hybrid Networks combine the best features of proactive and reactive networks, while minimizing their drawbacks. Nodes in such a network transmit data periodically at relatively longer intervals while at the same time transmitting data when the sensed value goes beyond its threshold. Thus, the sensor energy is used very efficiently by reducing the number of transmissions of noncritical data. The user can change the periodicity, threshold value(s) and the parameter to be sensed in different regions. This network can emulate either the proactive or the reactive network by suitably changing the periodicity or threshold values. Thus, this network can be used in any type of application by suitably setting the various parameters.
However, this flexibility and versatility does increase the complexity at the sensor. Here a new protocol APTEEN (Adaptive Periodic Threshold-sensitive Energy Efficient sensor Network Protocol) is introduced for hybrid networks. There are applications in which the user wants time critical data and also wants to query the network for analysis of conditions other than collecting time critical data. In other words, the user might need a network that reacts immediately to time critical situations and gives an overall picture of the network at periodic intervals, so that it is able to answer analysis queries. None of the above sensor networks can do both jobs satisfactorily since they have their own limitations. APTEEN is able to combine the best features of proactive and reactive networks while minimizing their limitations to create a new type of network called a hybrid network. In this network, the nodes not only send data periodically, they also respond to sudden changes in attribute values. In this way it works as a proactive protocol as well as reactive protocol. This uses the same model as the TEEN protocols with the following changes. In APTEEN, once the CHs are decided, the following events take place in each cluster period. The CH first broadcasts the following parameter.

Attributes: This is a set of physical parameters which the user is interested in. Thresholds: This parameter consists of a HT and a ST. HT is a value of an attribute beyond which a node can be triggered to transmit data. ST is a small change in the value of an attribute that can trigger a node to transmit.

Schedule: This is a TDMA schedule, assigning a slot to each node.

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Count time: This is the maximum time period between two successive reports sent by a node. It can be a multiple of the TDMA schedule length, and it introduces the proactive component in the protocol.

However, only those nodes that sense a data value at or beyond the hard threshold transmit. Furthermore, once a node senses a value beyond HT, it next transmits data only when the value of that attributes changes by an amount equal to or greater than the ST. Since nodes near each other may fall in the same cluster and sense similar data, they may try sending their data simultaneously, leading to collisions between their messages. Hence, a TDMA schedule is used and each node in the cluster is assigned a transmitter slot. The main features of the scheme are as follow.

i. By sending periodic data, it gives the user a complete picture of the network, like a proactive scheme. It also senses data continuously and response immediately to drastic changes, making it responsive to time critical situations. Thus it behaves as a reactive network.
ii. It offers a lot of flexibility by allowing the users to set the count time interval and the threshold values for the attributes.
iii. Changing the count time as well as the threshold values can control energy consumption and can support proactive and reactive behavior in a sensor network.

VI. RESULTS AND CONCLUSIONS

The analysis was performed to analyze the performance of these protocols. Several considerations can be observed for the verification of the performance of these protocols. We had implemented the scenario in terms of dead nodes and the number of routes of the sensor nodes. The x-axis was represented with the number of rounds and y-axis will represent he dead nodes number. The total simulation was carried in MATLAB software and the result was presented in the graphical representation in the figure 1. The performance of the these protocols was observed here as the LEACH protocol first dead node at 400 round and total dead nodes after 1000 rounds are 60. For TEEN protocol first dead node at 600 rounds and total dead nodes after 1000 rounds are 54. For APTEEN protocol first dead node at 200 round and total dead nodes after 1000 rounds are 81.

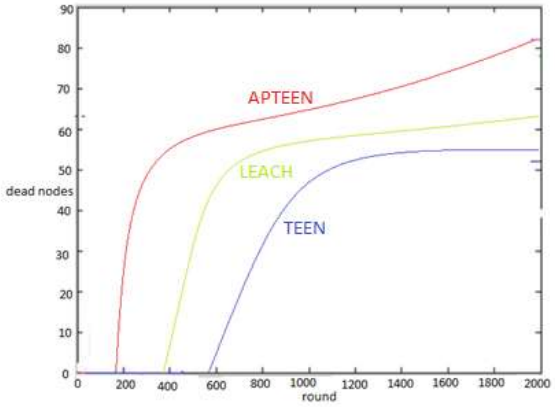

Figure 1. Performance between round Vs dead nodes

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