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Performance Comparison of Different Hierarchical Routing Protocols for Wireless Sensor Networks Subject to Different Location of Base Station

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***Abstract-* In this project we consider the problem of positioning Base Station (BS) in the case of hierarchical routing protocol of Wireless Ensor Networks (WSNs) which are either cluster based or chain based or combination of both under their heterogeneous settings. We show that in general, the choice of positions has a marked influence on the data rate, the power efficiency, and the life time, stability period of the WSNs. The WSNs is assumed to be static, and each sensor uses power at some rate, which can depend on the sensor, to transmit messages to other sensors within some range. Every sensor's messages must be routed to some BS where data can be processed. Some hierarchical routing protocols provide high stability period than other hierarchical routing protocol when BS is located at the center of the sensor field coordination. Again some hierarchical routing protocols provide comparatively higher stability period when BS is located far from the sensor fields than those hierarchical routing protocols which provide high stability period when BS is located at the center of the sensor fields. In our simulation result it is revealed that the performance of any considered routing protocols can either improve or degrade as compared with another in terms stability period depending on the location of the base station which would be either inside or outside of the sensor field.**

***IndexTerms*— WSN, Routing Protocol, Clustering, BS.**

I. Introduction

Wireless sensor networks are network systems that involves information gathering, processing and then forwarding them to a nearby base station. Each of the networks involves multiple sensing nodes which are scattered in a geographical area. WSNs consists of spatially distributed autonomous sensors to cooperatively monitor Physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants [1] [2].

The development of wireless sensor networks was motivated by military applications such as battlefield surveillance. They are now used in many industrial and civilian application areas, including industrial process monitoring and control, machine health monitoring, environment and habitat monitoring, healthcare applications, home automation and traffic control [1],[3].

A sensor node might vary in size from that of a shoebox down to the size of a grain of dust [1], although functioning "motes" of genuine microscopic dimensions have yet to be created. The cost of sensor nodes is similarly variable, ranging from hundreds of dollars to a few pennies, depending on the size of the sensor network and the complexity required of individual sensor nodes [1]. Size and cost constraints on sensor nodes result in corresponding constraints on resources such as energy, memory, computational speed and bandwidth [1]

A wireless sensor network typically consists of a large number of inexpensive, small, low-power communication devices called sensor nodes and one or more computing center. Advances in energy-efficient design and wireless technologies have enabled the manufacture of the small devices to support several important wireless applications, including real-time multimedia communication [4], medical application, surveillance using WSNs [5,7,8,9], and home networking applications [6,10].In WSNs, the sensor nodes have the ability to sense, process data, and communicate with one another. Sensor nodes can be imagined as small computers, extremely basic in terms of their interfaces and their components. They usually consist of a *processing unit* with limited computational power and limited memory, *sensors* (including specific conditioning circuitry), a *communication device* (usually radio transceivers or alternatively optical), and a power source usually in the form of a battery.

Most applications fall into one of four classes: environmental data collection, security monitoring, node tracking, and hybrid networks. In environmental data collection, a scientist wishes to collect several readings from sensor nodes over a long period of time (i.e. several months or years) in order to detect trends and interdependencies. This type of application is characterized by a large number of randomly deployed nodes continually sensing and transmitting data to a base station that stores the data to be analyzed later. The Great Duck Island project is one example of this class of applications.

In the context of Bangladesh, WSNs could play an very important role in the safe and secured monitoring and surveillance of constructed roads, highways and bridges, As a typical example, it was known from the printed news media that a **c**rack of half inches wide and seven feet long was found in between the 36th and 37th pillar of the pride Bangbandhu Jamuna Bridge. The initial stage of cracking was not reported timely to the Bangabundhu Jamuna Bridge Authority In order to ascertain the reason for the crack in the bridge of 4.8 kilometers long; the Bangabundhu Jamuna Bridge Authority has called upon the TYL International Company of England [11]. However, this crack could have been detected at its initial stage if the bridge had been equipped with a **Wireless Sensor Networks(WSNs).** Such a network would have provided enough lead time to either shut down the bridge or to trigger a precautionary maintenance to prevent the crack.

II. LITERATURE REVIEW

The main task of wireless sensor network is to forward the data gathered by sensor nodes in the sensing fields to the BS. One simple approach to the fulfillment of this task is direct data transmission. In this case, each node in the network directly sends sensing data to the BS. As observed in LEACH [3], the direct approach would work best if the BS is located close to the sensor nodes or the cost of receiving is very high as compared to the cost of transmitting data. However, if the BS is remote from the sensor node, the node will soon die for suffering excessive energy consumption for delivering data. To solve this problem, some algorithms that are aimed to save energy have been proposed one after another. In the most of proposed protocols it is assumed that the BSs are located at the fixed location either near or far from the sensors fields. In PEGASIS authors assumed that the BS is fixed and located far from the senor field.

It is seen that LEACH, SEP protocols transmit the sensed data to the BS through the collection of cluster head (CH). So the number transmissions from the sensor nodes to the BS are much by the CH. So energy drains from the sensor nodes are much more when sensor nodes transmit information to the BS. For this reason, location of BS has a great impact on the drainage of the residual energy of the sensor nodes. But in the case of PEGASIS and, the data transmission scenario is different than that of the SEP, LEACH.

In some applications like weather monitoring in some special places, the detection of ambient conditions such as temperature, movement, sounds, and light or the presence of specific objects to collect some information from remote locations where human access is not permitted frequently. In that type of applications BS should be positioned in such a place that the BS will be far from the sensor field where user can easily collect data for further processing. But some applications, such as target filed imaging, intrusion, and crack detection in objects, inventory control, and disaster management where there is a close relation between the sensor fields and the user. In that type of case it is more feasible to position the BS close to the sensor fields. In the next section we will determine which BS positioning for our considered protocols will be best suited in terms of stability period for any specific applications.

III. SIMULATION SCENARIO

We assumed that 100 sensor nodes are randomly scattered in a two-dimensional square field, and the sensor network has the following properties:

• This network is a static densely deployed network. It means a large number of sensor nodes are densely deployed in a two-dimensional geographic space, forming a network and these nodes do not move any more after deployment.
• There exists only one BS, which is deployed at a fixed place either inside or outside the square fields. • The energy of sensor nodes cannot be recharged.

The network parameters are summarized in Table 1. Actually, all the protocols are considered based on using the characteristic parameters of heterogeneity, namely the fraction of advanced nodes (m) and the additional energy factor between advanced and normal nodes (a). Details about characteristics parameters of heterogeneity can be found in [4]. In our simulation study, we consider the value of m=0.2 and a=1 all over our simulation work.

Table1: Network parameters used in the scenario

Parameters	**Value**
The network size	100×100 meter

Location of the sink	(50,50),(50,100), (50,150),(50,200), (50,250)
Number of nodes	100
The initial energy of nodes	0.4 joule
Data packet length	4000 bit
Transmitter/Receiver Electronic	50 nj / bit
Aggregation energy, E_{DA}	5 nj / bit
Transmit amplifier, ε_{fs}, if $d_{to\ BS} \leq d_0$	10 pj/ bit/ m^2
Transmit amplifier, ε_{fs}, if $d_{to\ BS} \geq d_0$	0.0013 pj/ bit/ m^2

IV. SIMULATION RESULT

From Figure4.2 which shows the SEP protocol with base station at different positions .from the figure it is clear that the stability period for SEP protocol depends greatly on the positioning of the base station. The SEP protocol achieves maximum stability when the base station is at point (50, 50). Worst case of stability occurs when the base station is poised at (50,250) other positioning of the base station results in a varying degree of stability decreasing from (50.50). The percentage of increase in terms of performance is about 312.18% for (50,50) 0ver the (50,250) for the SEP protocol

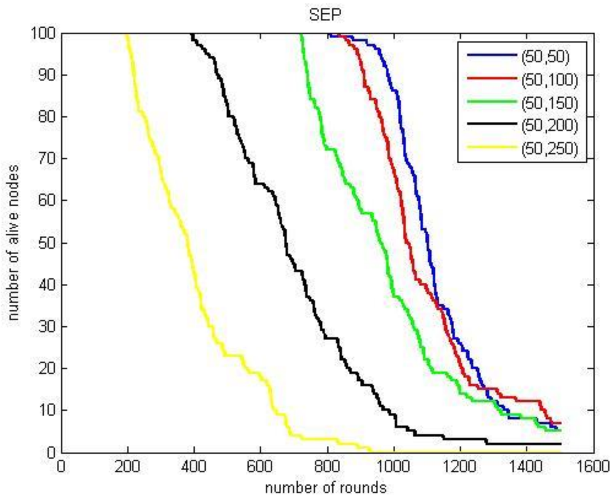
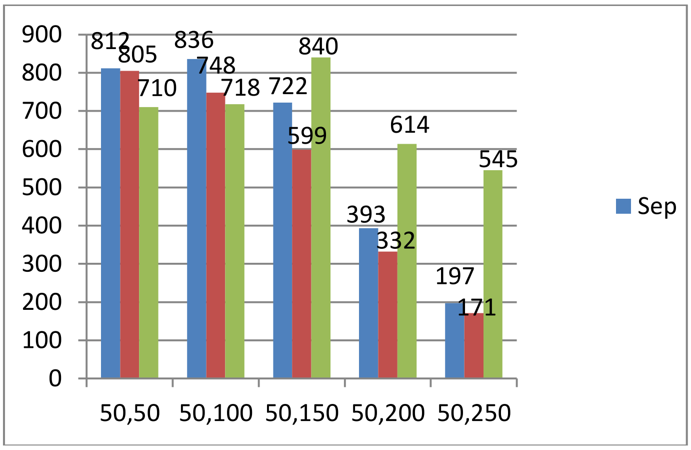


Figure 4.2 Simulation result of the sample network lifetime using SEP protocol with varying position of base station

For instance, when BS is located at the coordination (50,50) i.e. at the center of the network dimension, SEP protocol outperforms by increasing the stability period of the typical network approximately by 0.86% (LEACH), 14.36% by (PEGASIS). For that reason, SEP protocol is considered best to provide longer stability period when BS is located at the center of the network dimension. But this scenario change when we place the BS far from the network area like at the coordination of the BS at (50,250). In that case, PEGASIS significantly outperforms than all other routing protocols to provide longer stability period. It is seen from the Figure 4.6 that when we gradually place the BS far away from the center of the network dimension then comparative stability period of that network is significantly improved by PEGASIS over other considered routing protocols with their BS at the same location.



It is clearly observed that when BS is located at the coordination (50,250), PEGASIS protocol outperforms by increasing the stability period of the typical network approximately by, 218 %(LEACH), 176.6 % (SEP). Figure 5 illustrates the simulation results of the sample network with different protocols at the time when the BS is located at (50, 250).

V. CONCLUSION

In this project, we have compared the performances of different hierarchical routing protocols for wireless sensor networks in terms of energy sustainable which mainly focuses on the positioning of the base station. By our simulation results, we have shown that the performance of any considered routing protocols can either improve or degrade as compared with another in terms stability period depending on the location of the base station which would be either inside or outside of the sensor field.

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