Energy Schemes For Multiple Mobile Base Stations In Wireless Sensor Network

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ABSTRACT: The main design issues for a sensor network are conservation of the energy available at each sensor node. We propose to deploy multiple, mobile base stations to prolong the lifetime of the sensor network. In this paper, we look at communication protocols, which can have significant impact on the overall energy dissipation of these networks. We propose LEACH (Low-Energy Adaptive Clustering Hierarchy), a clustering-based protocol and integer linear programming, flow based routing protocol. Integer linear program is determine the new locations for the base stations and a flow-based routing protocol to ensure energy efficient routing during each round and LEACH protocol that utilizes randomized rotation of local cluster base stations (cluster-heads) to evenly distribute the energy load among the sensors in the network. We compare the three schema result by using three methods.

Keywords : WSNs,Energy efficiency,LEACH,interger linear programming,flow based routing,base station,multiple mobile base station

1 INTRODUCTION

The main design issues for a sensor network are conservation of the energy available at each sensor node. We propose to deploy multiple, mobile base stations to prolong the lifetime of the sensor network**.** In this paper, we look at communication protocols, which can have significant impact on the overall energy dissipation of these networks. We propose LEACH (Low-Energy Adaptive Clustering Hierarchy), a clustering-based protocol and integer linear programming, flow based routing protocol. Integer linear program is determine the new locations for the base stations and a flow-based routing protocol to ensure energy efficient routing during each round and LEACH protocol that utilizes randomized rotation of local cluster base stations (cluster-heads) to evenly distribute the energy load among the sensors in the network. We compare the three schema result by using three methods.We show that employing multiple, mobile base stations in accordance with the solution given by our schemes would significantly increase the lifetime of the sensor network.

2 First Order Radio Model

Currently, there is a great deal of research in the area of low-energy radios. Different assumptions about the radio amplifier to achieve an acceptable Eb /No (see Figure 1 and Table 1). These parameters are slightly better than the current state-of-the-art in radio design.We also assume an r^2 energy loss due to channel transmission. Thus, to transmit k-bit message a distance d using our radio model, the radio expends: characteristics, including energy dissipation in the transmit and receive nodes, will change the advantages of different protocols. In our work, we assume a simple model where the radio dissipates E_{elec}=50NJ/bit to run the transmitter or receiver circuitry and E_{amp}=100 pJ/bit/m^2 for the transmit and to receive this message, the radio expends:

$$E_{Tx}(k,d) = E_{Tx-elec}(k) + E_{Tx-amp}(k,d)$$
$$E_{Tx}(k,d) = E_{elec} * k + \epsilon_{amp} * k * d^2 \qquad (1)$$

$$E_{Rx}(k) = E_{Rx-elec}(k)$$
$$E_{Rx}(k) = E_{elec} * k \qquad (2)$$

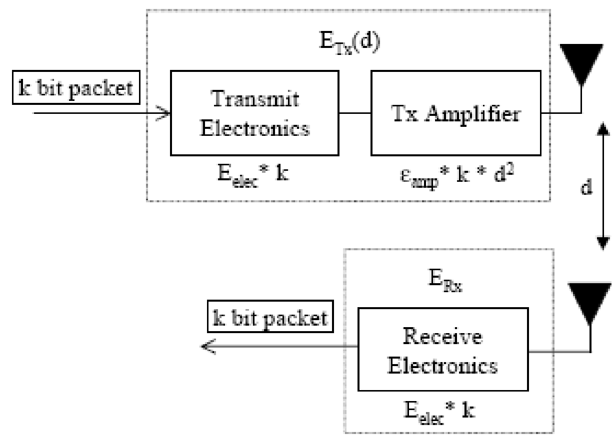

Fig 1 First order radio model

Operation	Energy Dissipated
Transmitter Electronics ($E_{Tx-elec}$) Receiver Electronics ($E_{Rx-elec}$) ($E_{Tx-elec} = E_{Rx-elec} = E_{elec}$)	50 nJ/bit
Transmit Amplifier (ϵ_{amp})	100 pJ/bit/m^2

Table 1 Radio charactersics

3 Advantageof Employing Multiple Base Stations

Consider two different sensor network deployments as shown in Figure 2. In Figure 2(b) sensor node A is one hop away from its nearest base station when two base stations are deployed. For sensor node B the hop-count from its nearest base station is same in both the cases. Thus, by employing two base stations instead of one we have effectively either reduced or retained the hop count of each sensor node in the network. Since the energy consumed in routing a message from any sensor node to its nearest base station is proportional to num-

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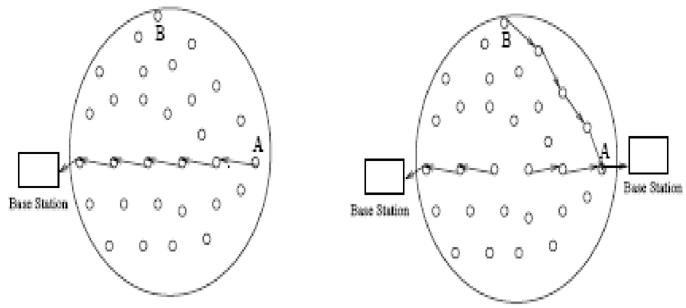
ber of hops the message has to travel, employing multiple base stations effectively reduces the energy consumption per message delivered.



(a) Circular Sensor Field (Single Base Station) (b) Circular Sensor Field (Two Base Stations)

Fig 2 Circular Field of Interest

4 Three Stages for problem formation

For problem formulation we used three solution for solving energy scheme in sensor network.These are as:
4.1 ILP
4.2 Flow based routing protocol
4.3 LEACH protocol

4.1 ILP: Integer Linear Program

An integer linear program formulation let y_i be a 0-1 integer variable for each i v_f such that yi = 1 if a base station is located at feasible site l;0 otherwise.

$$\text{Minimize} \quad E_{max}$$

$$\sum_{j \in N(i)} x_{ij} - \sum_{k \in N(i)} x_{ki} = T, \ i \in V \quad (1)$$

$$E_t \sum_{j \in N(i)} x_{ij} + E_r \sum_{k \in N(i)} x_{ki} \leq \alpha RE_i, \ i \in V \quad (2)$$

$$\sum_{l \in V_f} y_l \leq K_{max} \quad (3)$$

$$\sum_{i \in V_s} x_{ik} \leq T|V_s| y_k, \ k \in V_f \quad (4)$$

Assuming no data aggregation, the balance of flow of messages at each node is represented by (1), where Xij represents number of messages node i transmits to node j in a particular round. Let Er be the energy spent by a sensor node in receiving a message. and Et be the energy spent by a sensor node in transmitting. Er and Et can be calculated from antenna characteristics. Then the total energy spent by all the nodes during a particular round is bound by (2). The number of feasible sites selected to locate the base stations is limited to at most Kmax in equation (3).

4.2 Flow based routing protocol

Sensor nodes can use the flow information obtained by solving the integer linear program to route messages in an energy efficient manner. Consider sensor node A with it incoming and outgoing number of messages as shown in the.fig Once a sensor node has this information it would perform its routing as described below.

- For every outgoing link a counter is maintained. The value of the counter is set to the floor of the flow going out on that particular link.
- Whenever a node needs to transmit its packets, it would select one of the outgoing links in a round robin fashion.

If the counter value of the selected link is greater than the number of packets that have to be transmitted, then all the packets are transmitted on that link and counter value is decremented by the number of pakcetstransmitted; otherwise the number of packets equal to the counter value of the link are transmitted along the link and its counter values is set to 0. To transmit the remaining messages outgoing links are selected in a round robin fashion.(v) If the counter value of all the outgoing links is zero then a link is selected arbitrarily and all the packets are transmitted on this link

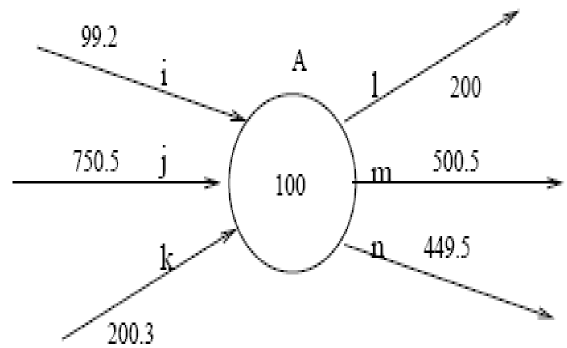


FIG 3 FLOW BASED ROUTING

(v) If the counter value of all the outgoing links is zero then a link is selected arbitrarily and all the packets are transmitted on this link Example: Suppose the node A in Figure 2 had 250 packets to transmit. If link l was selected then 200 packets would be transmitted on this link and its new counter value would be set to 0. The remaining 50 packets would be transmitted on m and its counter values would be updated to 450. The main idea behind this heuristic is that when the number of packets to be transmitted is large, the routes taken by the packets closely follow the flow information on the outgoing links

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4.3 LEACH: Low-Energy Adaptive Clustering Hierarchy

LEACH is a self-organizing, adaptive clustering protocol that uses randomization to distribute the energy load evenly among the sensors in the network. In LEACH, the nodes organize themselves into local clusters, with one node acting as the local base station or *cluster-head*. If the cluster heads were chosen a priori and fixed throughout the system lifetime, as in conventional clustering algorithms, it is easy to see that the unlucky sensors chosen to be cluster-heads would die quickly, ending the useful lifetime of all nodes belonging to those clusters. Thus LEACH includes randomized rotation of the high-energy cluster-head position such that it rotates among the various sensors in order to not drain the battery of a single sensor. In addition, LEACH performs local data fusion to “compress” the amount of data being sent from the clusters to the base station, further reducing energy dissipation and enhancing system lifetime. Sensors elect themselves to be local

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cluster-heads at any given time with a certain probability. These cluster head nodes broadcast their status to the other sensors in the network. Each sensor node determines to which cluster it wants to belong by choosing the cluster-head that requires the minimum communication energy. Once all the nodes are organized into clusters, each cluster-head creates a schedule for the nodes in its cluster. This allows the radio components of each non-cluster-head node to be turned off at all times except during its transmit time, thus minimizing the energy dissipated in the individual sensors. Once the cluster-head has all the data from the nodes in its cluster, the cluster-head node aggregates the data and then transmits the compressed data to the base station. Since the base station is far away in the scenario we are examining, this is a high energy transmission. However, since there are only a few cluster-heads, this only affects a small number of nodes .As discussed previously, being a cluster-head drains the battery of that node. In order to spread this energy usage over multiple nodes, the cluster-head nodes are not fixed; rather, this position is self-elected at different time intervals.

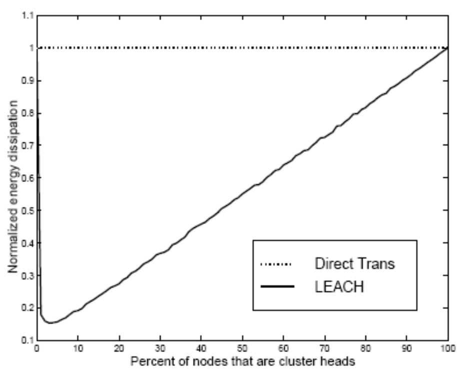


Figure 4. Normalized total system energy dissipated v/s the percent of nodes that are cluster-heads. Note that direct transmissionis equivalent to 0 nodes being cluster-headsor all the nodes being cluster-heads.

5 Simulation result

To compare the proposed solutions, we simulated a sensor network of 30 nodes randomly distributed in a 30 X 30 meter square sensor field. 20 feasible sites were located randomly on the periphery of the sensor field. A maximum of 3 base stations were made available. Each sensor node was provided with an initial energy of 0.5 J. The transmission range of each sensor node was set to 10 meters. The energy spent in transmitting a bit over a 1 meter distance is taken as 0.1 nJ/bit^2 and the energy spent in receiving a bit is set to 50 nJ/bit . The packet length is fixed at 200 bits. Each round lasts 1000 time-frames. On this simulated sensor network we implemented following schemes for a comparative study.

(a) *Scheme 1.* A single, static base station.
(b) *Scheme 2.* Three static base stations.
(c) *Scheme 3.* Three mobile base stations with random positioning among the 30 feasible sites.

Scheme 1. A single, static base station

In scheme1 has single static base station is used .when we deploy 30 nodes randomly . Apply two protocols(leach and flow based routing) then we obtained output as fig51 of network graph. Fig 6 has energy graph is shown in this graph has energy is inversely proportional to the round when the number of round are increase then the energy will also decrease. In fig 7 has show the dead nodes graph .this graph has show the nodes are dead which round.

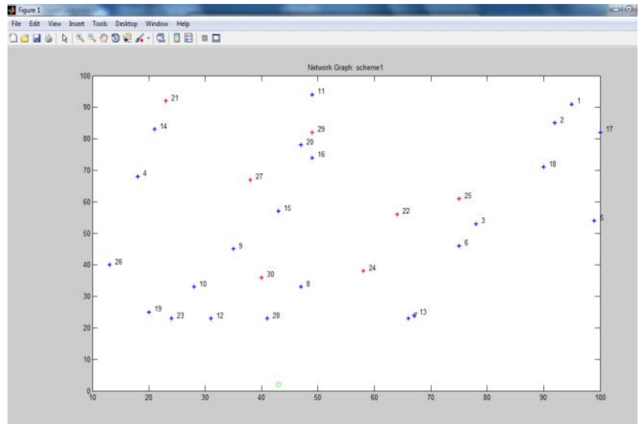
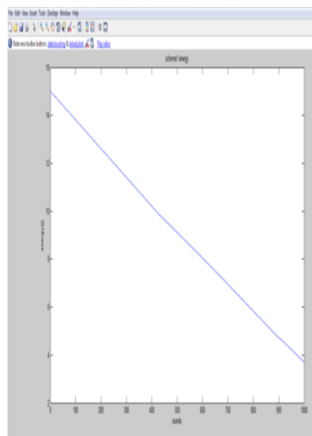


fig 5 of network graph



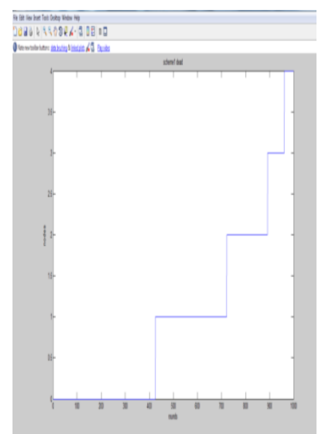


Fig 6 of energy graph **Fig 7** dead node

Scheme 2. Three static base stations.

In scheme2 has three static base station is used .when we deploy 30 nodes randomly . Apply two protocols(leach and flow based routing) then we obtained output as fig 4 of network graph.Fig 9 has energy graph is shown in this graph has energy is inversely proportional to the round .when the number of round are increase then the energy will also decrease. In fig 10 has show the dead nodes graph.

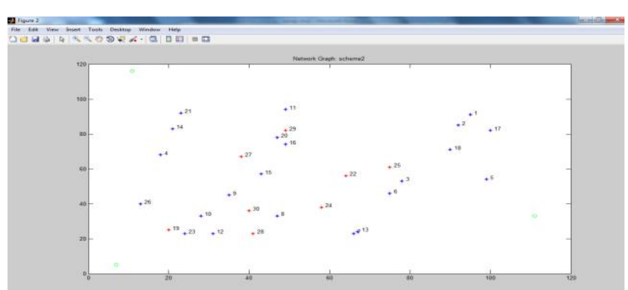
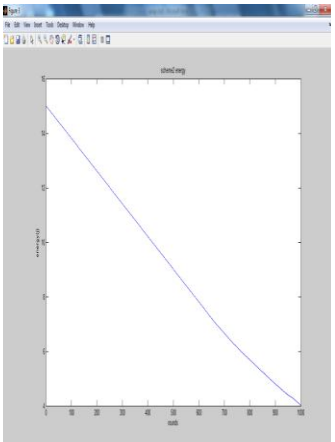


Fig 8 of network graph



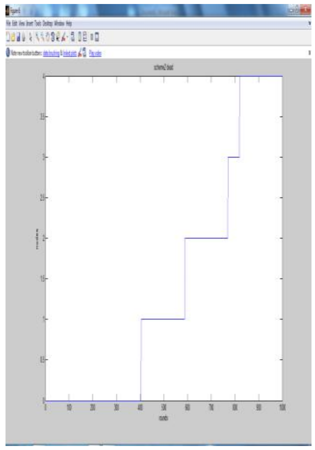


Fig 9 of Energy Graph **Fig 10** of Dead Node

Scheme 3. Four mobile base stations with random positioning among the 30 feasible sites.

In scheme3 has Four mobile base station is used .when we deploy 30 nodes randomly . Apply two protocols(leach and flow based routing) then we obtained output as fig 11 of network graph. Fig 12 has energy graph is shown in this graph has energy is inversely proportional to the round when the number of round are increase then the energy will also decrease. In fig 13has show the dead nodes graph .this graph has show the nodes are dead which round.

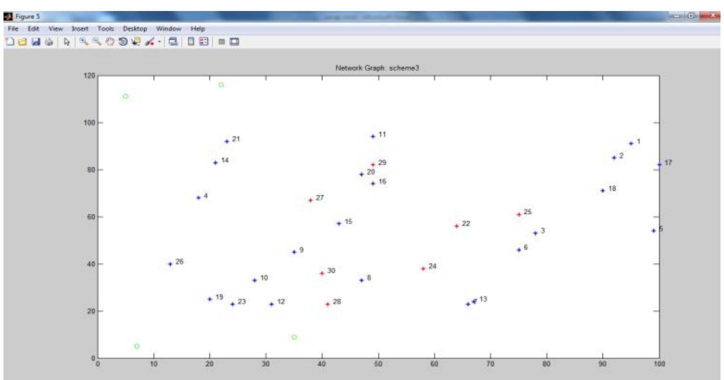
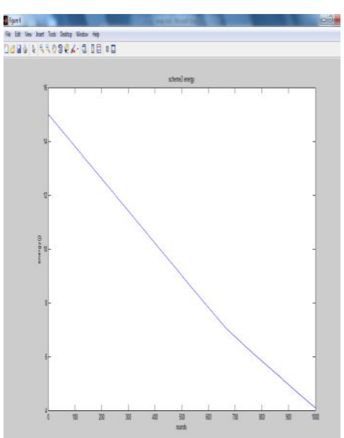


Fig 11 schema 3 Network Graph



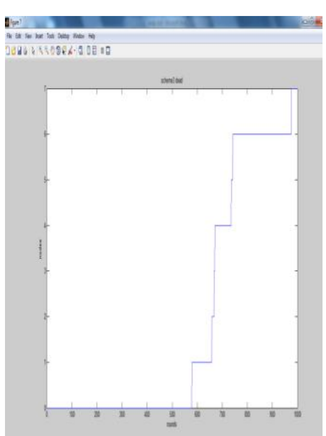


Fig 12 of energy graph **Fig 13** of Dead Node

6 Conclusions and Future Scope

In this paper we have proposed an energy efficient usage of multiple, mobile base stations to increase the lifetime of wireless sensor networks. Our approach uses an integer linear program to determine the locations of the base stations and a flow-based routing protocol and LEACH protocol that utilizes randomized rotation of local cluster base stations (cluster-heads) to evenly distribute the energy load among the sensors in the network. We conclude that using a rigorous approach to optimize energy utilization leads to a significant increase in network lifetime.A challenging and promising direction for future work is to explore the use of graph partitioning algorithms, particularly those for finding balanced partitions within such a framework.

7 End Sections

7.1 Acknowledgments

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