

Energy Efficient Data Assembly in Gateways with Mobile Sink in Wireless Sensor Network

Narendran M.[§] and Dr. P. Prakasam^{*}

[§]Research Scholar, Anna University, Chennai, India.

^{} Director/ CLT, SNS college of engineering, Coimbatore, India.*

Abstract

Energy efficient and mobility information is a key problem in wireless sensor networks. Save more energy in network processing such as mobility, data aggregation and gateway deployment is a widely used technique. The large-scale deployment of wireless sensor networks and the need for data aggregation, mobility controlling and also necessitate to deploying the gateways among the network, for the purpose of balancing the load and prolonging the lifetime. In this paper, a new approximation algorithm named as Mobile Sink Clustering Algorithm (MSCA) to propose approach the mobility control of sensor nodes. The controlling methods of gateway deployment and handing over the path for mobile sink travel and collect the data from different gateways are aggregated by exploit redundancy with the objective of minimizing energy consumption in transmission. According to the recent study, it has been proved that the sink mobility along a constrained path, can improve energy effectiveness in wireless sensor networks. Due to path constrained the mobile sink has collected the data from the gateways, which are placed at random. The performance of proposed system also has been discussed. Also extend the analysis to improve the energy calculating and show the data aggregation.

Keywords: Sensor Nodes, Gateways deployment, Data Aggregation, Mobile Sink, Approximation Algorithm.

INTRODUCTION

Wireless sensor networks (WSNs) consist of hundreds to thousands of battery-powered tiny sensors that are endowed with a multitude of sensing modalities including environmental monitoring and security surveillance purposes [1]. Although there have been significant progress in sensor fabrications including processing design and computing advance of battery technology still lag behind, making energy resource the fundamental constraint. To maximize the network lifetime, energy conservation is of paramount importance in WSNs. Most existing studies assume that the sink (the base station) in WSNs is static, which is a gateway between the sensor network and users and all sensing data from the sensors are relayed to it through multi-hop relays. As a result, the sensors near to the sink become the bottlenecks of energy consumption since they have to relay the data for other remote sensors. Once they deplete their energy, the sink will be disconnected from the rest of the network while the rest of sensors are still fully operational with sufficient residual energy [1]. To mitigate this static sink neighborhood problem, new strategies have been developed by exploiting the mobility of a sink to better balance the energy consumption among the sensors. That is, the mobile sink traverses the monitoring region and sojourn at some locations to collect sensed data. It has been demonstrated that sink mobility is a blessing rather than a curse to network performance including the network lifetime also scalability and throughput.

The fundamental goal of a sensor network is to produce, over an extended period of time, globally meaningful information from raw local data obtained by individual sensor nodes [2]. Importantly, this goal must be achieved in the context of prolonging as much as possible the useful lifetime of the network and ensuring that the network remains highly available and continues to provide accurate information in the face of security attacks and hardware failure [2]. The unique number of sensor nodes in a sensor network combined with the unique characteristics of their operating environment (anonymity of personage sensors, limited power resources and a possibly hostile environment), pose unique challenges to the designers of protocols. For one thing, the limited power budget at the individual sensor node level mandates the design of ultra-light weight data gathering, fusion, and communication protocols [2].

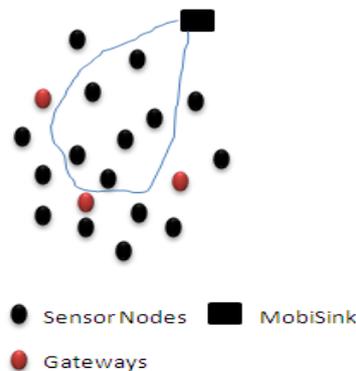


Figure 1. Network Model

An important guideline in this direction is to perform as much local data processing at the sensor level as achievable, avoiding the transmission of raw data through the sensor network. Recent advances in hardware technology are making it plain that the biggest challenge facing the sensor network community is the development of ultra-lightweight communication protocols ranging from guidance, to identity organization, to network protection, to security, to data gathering and fusion, to routing, along with many others. Most research works for wireless sensor networks often assume that the data collected by sensors are transmitted to one or several sink nodes in some specific location in the WSNs. It was noticed that the sensors closest to the sink tend to deplete their energy budget faster than other sensors [3], which creates an energy hole approximately the sink. Once an energy hole appears, no more data can be transmitted to that sink. Accordingly a considerable amount of energy is wasted and the network lifetime ends prematurely. Experiments in [3] showed that there is still a great amount of energy left unused after the network lifetime is over for large-scale networks, which can be as much as 90% of total initial energy. Accordingly, improving the energy efficiency and prolonging the lifetime of networks is a key problem.

Sensor networks are quintessentially event-based systems. Sensor network consists of one or more “sinks” which subscribe to specific data streams by expressing interests or queries [4]. The sensors in the network act as “sources” which detect environmental events and push relevant data to the appropriate subscriber sinks [4].

In most of previous studies, the static sink was widely adopted to conduct data collection in WSNs [5]. Due to the multihop data transmission style, however, severely unbalanced energy consumption is caused with the node-to-sink traffic flow [5]. Sensor nodes close to the sink node have to carry much more traffic overhead compared with distant sensor nodes [5]. Since sensor nodes are highly restricted to the limited battery power furnish, such unbalanced energy consumption results in the quick power depletion on part of the network, and dramatically shortens the lifetime of the network as a whole [5]. To reduce the negative impact, recent research works introduce the mobile sink as a potential solution to the data collection problem.

Each mobile node is assumed to have a portable set with transmission, reception, and processing capability. In addition, each has a low-power global positioning system (GPS) receiver on board, which provides position in order within at least 5 m of accuracy [6]. The recent low-power implementation of a GPS receiver makes its presence a viable option in minimum energy network design.

Our major contributions in this paper are as follows. In this first formulate a joint optimization problem, referred to as the mobile sink problem, by providing a Mobile Sink Energy Clustering algorithm solution. Due to its NP hardness, we then propose a novel three-stage heuristic that exhibits low computational complexity and high scalability. That is, it first calculates the nodes time profile at each potential nodes location. It then finds a feasible nodes tour for the mobile sink such that the sum of nodes times at the chosen nodes locations is maximized, subject to the mentioned constraints. It finally makes a nodes time scheduling for the mobile sink by determining its exact nodes time at each chosen nodes location. The experimental

results demonstrate the solution delivered by the heuristic is nearly the optimal, while the heuristic only takes a small fraction of running time of the Mobile Sink Energy Clustering algorithm formulation of the problem. The fundamental operation in such applications is data gathering, i.e., collecting sensing data from the sensor nodes and conveying it to a base station for processing. In this process, data aggregation can be used to fuse data from different sensors to eliminate redundant transmissions. The critical issue in data gathering is conserving sensor energy and maximizing sensor lifetime. For example, in a sensor network for seismic monitoring or radiation level control in a nuclear plant, the lifetime of each sensor significantly impacts the quality of surveillance.

The main contributions of this paper are as follows: first consider the deployment of wireless sensor networks with a mobile sink for large-scale monitoring, by proposing a heterogeneous architecture, where the mobile sink travels along a predetermined trajectory for data collection. Under this paradigm of data gathering, formulate a novel, the Mobile Sink Energy Clustering algorithm problem, for which we devise approximation algorithms with guaranteed approximation ratios. Finally, we evaluate the performance of the proposed algorithms through experimental simulation. In the case of arbitrary gateway capacities this contrasts our theoretical results which show that the approximation ratio is at most linear in the number of gateways. The proposed algorithms are the first approximation algorithms for this fundamental problem, and our techniques may be applicable to other constrained optimization problems beyond wireless sensor networks.

The rest of the paper is organized as follows. Section II discusses the related work. Section III introduces the system model and defines the problem. Section IV formulates the problem with Mobile Sink, Gateway deployment, and method of data aggregation ratio. Section V evaluates with the performance measures. Section VI in that performance of proposed algorithm is computed through the experimental simulations. Section VII concludes the paper.

RELATED WORK

Extensive studies on optimizing critical network resources in wireless sensor networks with mobile sinks, such as maximizing the network lifetime and/or minimizing the number of mobile sinks employed, have been conducted in the past few years. For example, the studies in [3], [18], [19], [20], [25], and [29] focus on the network lifetime maximization, while other studies focus on minimizing the travel distance of mobile sinks [21]. Very few take both of the aspects into consideration [16], [17]. Most of these studies are based on homogeneous sensor networks that consist only of one type of sensor. Although the homogeneous architecture works very well for small to medium-size networks, it may not be appropriate for large-scale monitoring due to poor scalability, long data delivery delay, and so on. With the increase of network size, the average length of routing paths from remote sensors to the mobile sink(s) (in terms of the number of hops) is longer, and the chance of link failures increases, leading to a much longer data delivery delay. When deploying

wireless sensor networks for large-scale monitoring to mitigate the drawbacks of homogeneous architectures, heterogeneous sensor networks with mobile sinks have been introduced and studied [7], [13], [26]. In [13] and [26], it is assumed that the speed of each mobile sink is controllable. This implies that the amount of data collected by each mobile sink from a gateway is controllable through adjusting the speed of the mobile sink. In [13], Xing et al. consider the network lifetime maximization problem by devising an approximation algorithm for finding an optimal trajectory for the mobile sink, subject to the trajectory length constraint. The approximate solution obtained is based on a tree routing structure with the assumption that the forwarding load of each relay node is identical, independent of the number of descendants the relay node has. In contrast to this, by assuming that the mobile sink travels along a predetermined trajectory with constant speed, Gao et al. [7] develop a genetic algorithm for allocating sensor nodes to different gateway nodes to form a forest that minimizes the total energy consumption of sensors when routing sensing data. Based on assumptions similar to those in [7], Xu et al. [32] and [33] propose several heuristics for finding a forest of routing trees that minimizes the routing cost, by incorporating data correlation among sensors. However, there is no guaranteed bound on how far the solutions obtained are from being optimal.

LEACH is one of the most famous hierarchical routing protocols for wireless sensor networks, which can guarantee network scalability and prolong network lifetime up to 8-fold than other ordinary routing protocols. The energy can be well balanced among sensors takes turn to become the cluster head at different rounds. However 5% of cluster head nodes are randomly chosen and the cluster heads use direct transmission to send their data to the sink node.

First proposed the basic idea of mobile sink for wireless sensor networks where the authors call them. The mules use random walk to pick up data in their close range and then drop off the data to some access points. The energy consumption for sensors can be largely abridged the transmission range is short.

SYSTEM MODEL

Suppose a stationary sensor network that consists of a large number of low-cost sensor nodes for sensing and a few powerful, large-storage gateway nodes has been deployed for the purpose of monitoring a region of interest. The sensing data generated by the sensors will be immediately relayed to their nearby gateways. The gateways are used to store the sensing data temporarily, perform data aggregation if needed, and eventually transmit the stored data to mobile sinks when the mobile sinks are within their transmission range. There is no energy constraint on the gateways, assuming that they can be recharged either by mobile sinks or renewable energy sources such as solar energy. It is assumed that there are mobile sinks that travel along predetermined trajectories (tours) to collect data from the gateways on the trajectories. We further assume that the speed at which a mobile sink traverses along its trajectory is fixed and does not vary from tour to tour. The data collected by the mobile sinks is finally uploaded to a mainframe computer for further processing. In other words, this

heterogeneous and hierarchical wireless sensor network architecture consists of three-tiers: the top tier, consisting of a mobile sink (or a set of mobile sinks) used to collect data directly from the gateways; the bottom tier, consisting of many sensors that sense and transmit data to the gateways; and the middle tier, consisting of gateway nodes storing sensing data temporarily and transmitting the stored data to mobile sinks. The advantage of this heterogeneous wireless sensor network architecture is its capability to deliver a desired tradeoff between the energy consumption of sensors and the data delivery latency, making it appropriate for large-scale monitoring. For simplicity, in the remainder of this paper, assume that there is only one mobile sink. However, our discussion and the presented approximation algorithms can be adapted to networks with mobile sinks

A. Network Design

Considering till now functions for involving the usage are more than one variable. For example, the area of coverage is a function of two variables. If G be a function of two variables N and S . Let s assume the functional relation as

$$G = (N, S) \quad (1)$$

Here N alone or S alone or both N and S simultaneously may be varied and in each case a change in the value of G will be different in each of these three cases, Since N and S are independent, N may be supposed to vary, when S remains constant.

Where,

N - Node is varies, S – Mobile Sink. G - Approximate Rate Just wrote relation with Function of,

$$G = f(N, S) \quad (2)$$

Let assign the function of approximate rate with n number of range

$$G_n = f(N, S) \quad (3)$$

∂N and ∂S are said to be differentiate in N and S if they be any two small quantities such that the ratio of ∂S and ∂N is the derivative,

$$G_n = \frac{\partial G}{\partial N} \cdot \frac{dN}{dt} + \frac{\partial G}{\partial S} \cdot \frac{dS}{dt} \quad (4)$$

$$\Delta G = \left(\frac{\partial G}{\partial N} + \epsilon \right) \Delta N + \left(\frac{\partial G}{\partial S} + \delta \right) \Delta S \quad (5)$$

Where, ϵ and δ are very small variables.

$$\epsilon = \Delta N, \delta = \Delta S$$

Here Formulate the ΔG ,

$$\Delta G = \left(\frac{\partial G}{\partial N}\right) \Delta N + \left(\frac{\partial G}{\partial S}\right) \Delta S \quad (6)$$

First, it will describe the general assumptions about the WSN models. Let the set of sensor nodes be denoted by N . For experimental convenience, suppose they are uniformly randomly deployed into a circular area with radius R . Let the center of the disk be the origin. Each node i is assumed to generate data at a constant rate of d_i during its life span and the initial energy of i is denoted by E_i . Furthermore, the nodes have the ability of adjusting their transmission power level to match the transmission distance. Similar to [14], the energy required per unit of time to transmit data at the rate of x_{ij} from node i to j can be determined as follows.

$$E_{ij}^t = C_{ij}^t \cdot x_{ij} \quad (7)$$

Where C_{ij}^t is the required energy for transmitting one unit of data from node i to j and it can be modeled as follows.

$$C_{ij}^t = \alpha + \beta \cdot d(i, j)^e \quad (8)$$

Where $d(i, j)$ is the Euclidean distance between node i and j , α and β are nonnegative constants, and e is the path loss exponent. Typically, e is in the range of 2 to 6, depending on the environment. Here, the energy cost per unit of data does not depend on the link rate, and this is valid for the low rate regime. Hence, need to assume that the traffic rate x_{ij} is sufficiently small compared to the capacity of the wireless link. The energy consumed at node i per unit of time for receiving data from node k is given by

$$E_{ki}^r = \gamma \cdot x_{ki} \quad (9)$$

Where γ is a given constant, Hence the total energy consumption per unit at node i is

$$\sum_{j \in N} E_{ij}^t + \sum_{k \in N} E_{ki}^r = \sum_{j \in N} C_{ij}^t \cdot x_{ij} + \sum_{k \in N} \gamma \cdot x_{ki} \quad (10)$$

Assume that each sensor node has the same transmission range. We define the neighbors of node i as $N(i) = \{ j \in N \mid d(i, j) \leq \bar{d} \}$, when the transmission range is \bar{d} .

MOBILE SINK , GATEWAY DEPLOYMENT AND DATA AGGREGATION

Compared with the traditional static data collection setting, data collection performed by the mobile sink is more complicated in the following two aspects: mobile sink trajectory planning and network load balancing [5]. According to the typical moving velocity of a mobile sink is around 0.1~2.0 m/s. It will lead to an extremely long data collection delay if the mobile sink visits a large portion of the network, which is normally unable to meet the delay requirement of many practical applications [5]. As a matter of fact, the small moving velocity is the fundamental design restriction, since increasing the moving speed of the mobile sink will lead to a significantly increased manufacturing cost and energy consumption.

Mobile sink and relay nodes can achieve balanced energy consumption by relieving heavily loaded areas or paths in a way dual to the optimization deployment. However, additional mechanisms need to be devised to support node mobility [13].

B. Static Sink Model

In the Static Sink Model (SSM), the sink is located at the origin and remains stationary during the operation of the WSN. Data originated from the sensor nodes flow into the sink in a multi-hop fashion. As soon as the data becomes available at a node, it gets transmitted toward the sink. Typically, the rate at which each sensor node i harvests data from the outside world is a constant. It denotes it by d_i . The problem of maximizing the lifetime in this model is formulated as follows.

Max

$$\text{s.t. } \sum_{j \in N(i)} x_{ij} - \sum_{k: i \in N(k)} x_{ki} = d_i, \quad j, k \in N \quad (11)$$

$$\left(\sum_{j \in N(i)} C_{ij}^t \cdot x_{ij} + \sum_{k: i \in N(k)} x_{ki} \cdot \gamma \right) \cdot T \leq E_i \quad (12)$$

The constraint (11) is the “flow conservation constraint”, which states that, at a node i , the sum of all outgoing flows is equal to the sum of all incoming flows plus flows generated at node i itself, or d_i . The inequality (12) is the energy constraint and it means that the total energy consumed by a node during the lifetime (T) cannot exceed the initial energy of the node. With this formulation, the routing is dynamic and allows multipath communications. There is no assumption on fixed path routing, such as the shortest path routing. The above optimization problem can be easily converted into a linear programming (LP) problem.

C. Mobile Sink Model

In the mobile sink model (MSM), assume that the sink can move around within the sensor field and stop at certain locations to gather the data from the sensor nodes. It ignores the traveling time of the sink between locations. Let L be the set of possible locations where the sink can stop. The sink does not necessarily stop at (i.e., stays for a positive duration) all locations in L in the interest of maximizing the network lifetime [1], [9]. In this model, the order of visit to the stops has no effect on the network lifetime and can be arbitrary. The sink node time at a location $l \in L$ is denoted by z_l ; it is the time that the sink spends at l to collect data from the sensor nodes. The overall network lifetime $T = \sum_{l \in L} z_l$. To find the optimal network lifetime, in this case, we need to consider the routing of the traffic as well as the duration of stay by the sink at each stop [9], [2], [1], [7]. Let $x(l)_{ij}$ be the flow rate from node i to j while the sink is at stop l . Let $\hat{N} = N \cup L$. The lifetime maximization problem can be formulated as follows.

$$\text{Max } T = z_1 + z_2 + z_3 + \dots + z_n \quad (13)$$

$$\text{s.t. } \sum_{j \in N(i)} x_{ij}^{(l)} - \sum_{k: i \in N(k)} x_{ki}^{(l)} = d_i, k \in N, j \in \check{N}, l \in L \quad (14)$$

$$\sum_{l=1}^{|\tau|} Z_1 \left(\sum_{j \in N(i)} C_{ij}^{(l)} \cdot x_{ij}^{(l)} + \sum_{k: i \in N(k)} x_{ki}^{(l)} \cdot \gamma \right) \leq E_i \quad (15)$$

The energy required for transmitting one unit of data when the sink is at L can be expressed as,

$$C_{ij}^{(l)} = \begin{cases} C_{ij}^t & \\ \infty & \text{if } j \in L \\ C_{il}^t & \end{cases} \quad (16)$$

Where C_{ij}^t is the same as in the SSM.

The entire networks is divided into several clusters, in each cluster there is one gateways for data collection and the rest of the sensors are called as ordinary nodes. The sensor nodes is determined by the residual energy among sensors and the gateways send aggregated data to the relevant MobiSink by adopting clustering techniques, network scalability and easier management can be guaranteed. If the clustering algorithm is well designed with Gateways located in a geographically more uniform ways, energy consumption can be balanced and reduced , causing a much prolonging network lifetime.

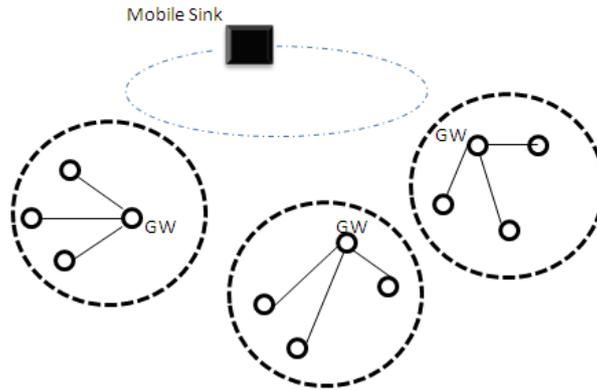


Figure 2. Cluster formation with Gateways

In fig.2 Mobile sink started to collect the data from the gateways of each cluster. Each cluster will maintain some equal number of alive nodes. The data's are collected by the sensor nodes and it will aggregated by the gateway. Aggregated data's are stored are transmit to the mobile sink.

Each cluster selects a MobiSink to send aggregated data. The reducing method to balancing of the energy consumption is the primary concern. For Gateways the energy

consumption to sink node base station is represented as,

$$E(\text{GW}_n, \text{BS}) = \begin{cases} lE_{\text{elec}} + lE_{\text{fs}} d(\text{GW}_n, \text{BS}), & d < d_0 \\ lE_{\text{elec}} + lE_{\text{fs}} d(\text{GW}_n, \text{BS}), & d \geq d_0 \end{cases} \quad (17)$$

Shows that the smaller $d(\text{GW}_n, \text{BS})$ is the smaller $E(\text{GW}_n, \text{BS})$ will be inter-cluster algorithm can be formulated as to find the $\text{Min}(d(\text{GW}_n, \text{BS}_k))$

In many clustering algorithm, such as LEACH some sensor node in the same cluster send data directly to the Gateways. Due to the fact of various locations, certain sensor nodes may consume large amount of energy based on long distance transmission. Therefore the multi-hop method is used here. For any member node S_i in a cluster the energy consumption to send data to its GW_n is represented as:

$$E(\text{GW}_n, S_i) = \begin{cases} lE_{\text{elec}} + lE_{\text{fs}} d(\text{GW}_n, S_i), & d < d_0 \\ lE_{\text{elec}} + lE_{\text{fs}} d(\text{GW}_n, S_i), & d \geq d_0 \end{cases} \quad (18)$$

In the meantime, S_i tries to find another sensor node S_j to relay data to save energy by avoiding directly communication with GW. To deliver a l - length packet to the Gateway, the energy consumption $E_2(S_i, S_j, \text{GW}_{S_i})$ is calculated as and the optimal relay node is determined based on the smallest value of $E_2(S_i, S_j, \text{GW}_{S_i})$

$$E_2(S_i, S_j, \text{GW}_{S_i}) = E_{\text{TX}}(l, d(S_i, S_j)) + E_{\text{RX}}(l) + E_{\text{TX}}(l, d(S_i, \text{GW}_{S_i})) \quad (19)$$

As the mobile sink nodes are randomly deployed then in practice some nodes may consume less energy through sending data directly to the MobiSink.

The moving velocity V of the sink is predetermined A sink node only needs to broadcast across the network to inform all sensor nodes of its current location p_0 at the very beginning for just one time. Later on, ass sensor nodes keep record of the original location of the sink; they can reduce the changed angle θ after a time interval Δt .

$$V = \theta * R / \Delta t \equiv \theta = \frac{V * \Delta t}{R} \quad (20)$$

P_0 is known the new location $P_{\Delta t}$ can be determined.

D. Gateway Deployment

To route the sensing data from the chosen sensors to the gateways, we will adopt routing tree structures. Assuming that there are m gateway nodes, a collection of m routing trees needs to be found. Each tree contains exactly one gateway node, which is its root, and together the trees span the gateways and the set of chosen sensors. To minimize the cost of routing the sensing data generated by the chosen sensors to the gateway nodes, extra relay nodes that are not among the chosen sensors may be

employed. This enables the communication of chosen sensors and with gateways that are not within the transmission range and also allows us to minimize the number of relay nodes that are needed. We will use the Euclidean distance between two nodes (chosen sensor nodes or gateway nodes) to approximate the number of relay nodes needed. This approximation has been justified in densely deployed sensor networks (see [31]). The total routing cost is minimized because of assigning the chosen sensors into different gateways; it's based on the gateways capacity constraints, in that it's denoted the $c(g)$ – Capacity of gateway (g), Number of sensor that can continuously transmit their data to g within the duration of t .

Assume that the subset of sensors has been identified, and we focus on assigning the chosen sensors to different gateways such that the total routing cost is minimized, subject to following gateway capacity constraints.

The value of $c(g)$ is determined by the transmission rate ∂g of gateway g the time duration t of the mobile sink. With the transmission range of gateway (i.e),

$$c(g) = \left\lfloor \frac{D_{out}(g)}{t} \right\rfloor = \lfloor t g \cdot \partial g \rfloor. \quad (21)$$

We assume without the loss of generality that a single reading is generated that a single reading is generated per time unit.

E. Data Aggregation

Note that even though the objective of several protocols was not to maximize network lifetime, lifetime improvements can still be achieved if data aggregation is exploited and the network is clustered periodically

Data aggregation has been put forward as an essential paradigm for wireless routing in sensor networks [3, 6]. The idea is to combine the data coming from different sources enroute – eliminating redundancy, minimizing the number of transmissions and thus saving energy. This paradigm shifts the focus from the traditional address-centric approaches for networking (finding short routes between pairs of addressable end-nodes) to a more data-centric approach (finding routes from multiple sources to a single destination that allows in-network consolidation of redundant data).

Data from different sources are aggregated by exploiting redundancy with the objective of minimizing energy consumption in transmissions. The work in [4], [2], and [7] explores the possibility of avoiding energy holes in data-gathering sensor networks through traffic compression and data aggregation.

Data aggregation design algorithm for data aggregation whose time complexity and message complexity are within constant factors of the optimum. The minimum energy data aggregation can be done using minimum cost spanning tree (MST). We show that no data aggregation algorithm can achieve approximation ratio ϑ_T for time complexity and ϑ_E for energy complexity with $\vartheta_T \times \vartheta_E = O(\Delta)$. We then show that our data aggregation algorithm has energy cost within a factor $O(\Delta)$ of the optimum. In other words, our method achieves the best trade-offs

among the time complexity, message complexity, and energy complexity with $\vartheta_T = O(1)$, $\vartheta_E = O(\Delta)$ and $\vartheta_M=1$.

The operation of Optimal clustering algorithm is divided into number of rounds. Each round starts with a set-up phase when the clusters are organized and cluster head are selected, followed by a steady-state phase when data are transferred from the nodes to the cluster head and on to the BS. The steady-state phase of Optimal clustering algorithm is equal to that of LEACH.

Assumed that each node in the network retains sensing data of the last N times and the set of monitored target in the system is $t_j \{t_1, t_2 \dots t_n\}$, where t_n is the monitored target n . For any node we can get $P_{tj} = N_{tb}/N$ from N times monitor results, where N_{Ob} is the number of times t_b occurred. Thus according to the set of monitored target T_b , we gain the probabilistic set NodeB $\{P_{t1}, P_{t2} \dots P_{tn}\}$, for nodes all targets observed by nodes B.

Assumed that the probabilistic set of each target observed by two adjacent nodes A and B is Node A $\{P_{t1}, P_{t2} \dots P_{tn}\}$ and Node B $\{P_{t1}, P_{t2} \dots P_{tn}\}$, then the explanation of information similarity for two nodes is:

$$S_{ab} = 1 - \frac{1}{n} \sum |P_{atk} - P_{btk}| \quad (22)$$

As you can see, information similarity is used to measure the probability of detecting the same target for two adjacent nodes. When the occurrence of targets have area characteristic, the higher probability means the neighbors would have an increasing possibility of obtaining similar data at one point.

$$S = \frac{2}{k(k-1)} \sum S_{ab} \quad (23)$$

F. Mobile Sink Clustering Algorithm

In offline, distance based clustering algorithm, called Mobile sink Clustering (MSC), which is based on Distance [17]. The 'range' here refers to the radio transmission range of a sensor node. The main steps of MSC are presented in Algorithm 1. The time complexity of MSC is $O(n^3) \sim O(\text{Diameter function})$.

Input: G , The Node Set
 R , Sensor Node's Communication Range
Output: Set of Clusters and Centers

1. While ($|G_1| > 0$)
2. For each $i \in G$
3. Set $A_i = \{i\}$
4. Set $L_i =$ set of nodes in $G - A_i$ in increasing order of distance from i
5. For each successive $j \in L_i$ and ($A_i \neq G$)
6. If ($\text{Diameter}(A_i \cup \{j\}) \leq 2R$)
7. Set $A_i = A_i \cup \{j\}$
8. End If
9. End For
10. End For
11. Identify set $C \in \{A_1, A_2, \dots, A_{j \in G}\}$ with maximum cardinality
12. Output C as a cluster
13. $G = G - C$
14. End While
15. Obtain centers of the clusters through the Diameter function again

It is assumed that the set L_i for each node is precomputed, with time complexity of $O(n^2 \log(n))$ and space complexity of $O(n^2)$. The definition of the Diameter affects the complexity. Important the cluster diameter as the maximum distance between any two pair of points in the cluster takes an $O(n^2)$ computation and can also result in wrong solutions wherein the cluster diameter is $2R$, but all nodes are out of range of the center. Instead, we model this as the minimum circle fitting problem [29]–[31], that can be solved using existing algorithms with complexity of $O(n)$ [32]. The Diameter function is based on this computation. Fitting a circle it also gives us the cluster center directly. This will ensure that all nodes in all clusters are covered. There are other ways of modeling this problematic, e.g. the convex hull of the point set. However, such algorithms may have higher time complexities, lose out on coverage or result in extra clusters and hence we use the minimum fitting circle model.

PERFORMANCE MEASURES

In exploring the gains and tradeoff involved in data collection approach, it's need to specify performance measure of interest four are examined in some details in this paper,

Energy Saving: By aggregating the data coming from the sensor nodes, the number of transmission is reduced, translating to saving in energy.

Gateways deployment: The subset of sensors has been identified and focuses on assigning the chosen sensors to different gateways the capacity of gateway g , which is the number of sensor and continuously transmit their data to g within the duration of τ .

Mobile sink: The sink can move to several locations to collect data. When the sink is at each location, all sensors participate in the communication, sending and relaying traffic in to the sink.

Node Mobility: Node mobility can affect the performance of topology control algorithm. In the presence of node mobility topology control algorithm require frequent message exchanges or continuously update topology changes. This could entail significant message overheads and increases energy consumption. A simple topology control algorithm that exchanges few messages with neighbors requires little maintenance in the presence of mobility.

SIMULATION RESULTS

There are 200 sensor nodes deployed in a (300,300) to (500, 500) networks with mobile sink nodes placed either inside or along the periphery of the area. The maximum transmission range is assumed to be 100 meters to cover the data travel length. Each node takes turn to transmit a 6- bit message to their nearby gateways using either direct transmission or multi-hop transmission.

Table No 1. Simulation parameters

| Parameters | Values |
|--------------------|-------------|
| Number of Nodes | 200 |
| Number of Gateways | 20 |
| Number of Sink | 01 |
| Eelec | 100nJ / bit |
| Initial Energy | 10J |
| Threshold | 75m |
| Round (T) | 10 TDMA |
| Packet header size | 50 bytes |
| Data Packet Size | 100 bytes |

The two algorithms are compared with other popular algorithm like LEACH in the terms of energy consumption and network lifetime. The total energy consumption in the unit of joule unit it will measure the MSCA algorithm under different sensor

networks. The whole is divided into several clusters and the mobile sink nodes are randomly deployed in the networks.

In Fig 3 show that the energy controlling method implemented with the process of Number of Gateways will collected the data from the sensor nodes and the gateways will started to transmitted to mobile sink .The mobile sink will assign the path, before the data collection are performed.

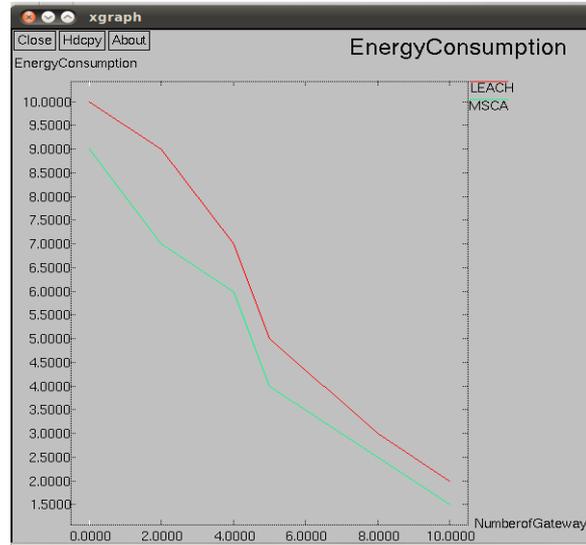


Figure 3. Number of Gateways Vs Energy Consumption

It can be seen that the total energy consumption units decreases as the number of gateways increases when 3 or 4 gateways are deployed, the decreasing rate of energy consumption becomes relatively small even if more gateways nodes are added later.

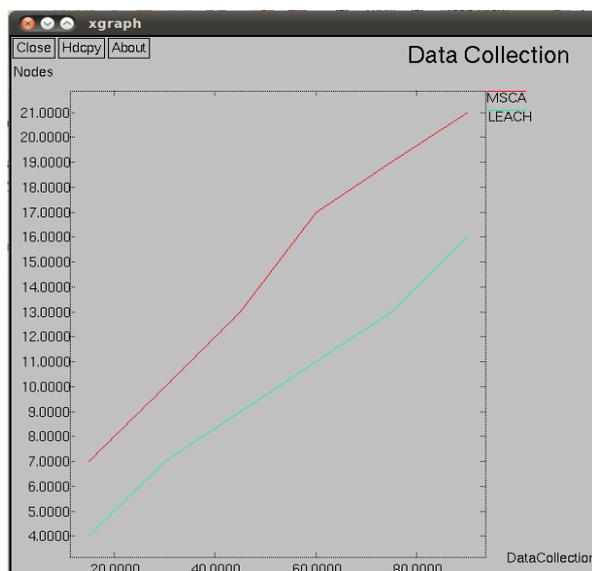


Figure 4. Data Collection Vs. Node

Even though the introduction of more GW can save more energy, the cost of gateways $C_{gateways}$ is usually much higher than the cost of sensor nodes C_{sensor} . Thus, the optimal Gateways numbers under different scale networks need to be found.

Here, a metric termed EXC is defined Where E is the energy consumption, C is set as With N sensor and K gateways.

$$E_{XC} = \left(1 + \frac{C_{Gateways}}{N * C_{Sensor}} \cdot K \right) \quad (24)$$

As the cost ratio between Gateways and sensor become larger (eg: 50:2), it's clear that the deployment of 3 Gateways nodes under such networks has the best performance.

There are 200 nodes randomly deployed in a $R = 500$ m circular sensor networks. The mobile sink node can either move with different direction or move along the periphery of each circle with different direction.

The total energy consumption decreases as the sensor nodes mobility speed decreases as the sensor nodes mobility speed decreases.

In that Fig.4 shows that the data collected from sensor nodes are calculated with the process of sensor nodes coverage data. If mobility speed control mobile sink are deployed the total energy consumption became small enough that introduction of mobile sink will hardly make any reduction of energy consumption. Thus it is concluded that mobile sink are actually enough regarding $R = 200$ m and $R = 400$ m networks. Finally the influence of mobile sink nodes on network lifetime is studied under $R = 200$ m in sensor networks.



Figure 5. No of Node Vs. Speed of mobility

It can be seen that the MECA has much better performance than LEACH in terms of number of nodes alive and average of residual energy. If network lifetime is defined as the time when the first nodes dies out of energy, the lifetime of MECA is two times (1500 rounds) longer than LEACH (600 rounds), the average residual energy of LEACH also decreases more sharply than MECA, which means that the LEACH consumes more average energy than MECA during data collection process.

Data aggregation results in fewer transmission, there is a trade-off potentially greater delay in the case of some aggregation function because data from nearer sources may have to be held back at an intermediate node in order to be aggregated with data coming from source that are faster away. In the worst case the latency due to aggregation will be proportional to the number of hops between the sink and the farthest source.

In that Fig.5 shows that the mobility control in the form of energy usage and speed of mobility parameters are process to calculated the mobility usage. One way to quantify the effect of aggregation delay is to examine the difference Max (di) and Min (dj). Similar figures obtain for the random source model as well. The upper curve in all these representative of the latency delay in DC Scheme with non-trivial aggregation function and the lower curve is representative of the latency delay in AC Schemes.

CONCLUSION

In this paper the deployment of wireless sensor networks with mobile sinks for large – scale monitoring. The proposed an approximation algorithm named as MSCA (Mobile Sink Energy Algorithm) to approach the mobility control of sensor nodes. The Gateway deployment and assigning the path for mobile sink travelled. Devised approximation algorithm for instances where all gateways have uniform capacities. Mobile Sink Clustering algorithm methods consists of sensor gateways and mobile sink , where the mobile sink travel along predetermined trajectories to collect data from the gateways. The experimental results demonstrate that the inputs are improving the energy controlling and show the aggregation ratio. To validate the proposed framework, conducted extensive experiments and found the proposed framework to the models. The lifetime gain of the proposed model is significant when compared to other models.

REFERENCES

- [1] YoungSang Yun and Ye Xia “Maximizing the Lifetime of Wireless Sensor Networks with Mobile Sink in Delay-Tolerant Applications” IEEE Transactions on Mobile Computing, Vol.9, Issue.9, pp., 1308 - 1318 Sept. 2010.
- [2] Xiang-Yang Li, Yajun Wang, and Yu Wang “Complexity of Data Collection, Aggregation, and Selection for Wireless Sensor Networks” IEEE

- Transactions on computers, Vol. 60, No. 3, pp., 386-399, March 2011.
- [3] Krishnamachari, B. ; Cornell Univ., Ithaca, NY, USA ; Estrin, D. ; Wicker, S. "Impact of Data Aggregation in Wireless Sensor Networks" 22nd International Conference on Distributed Computing Systems Workshops, pp., 575 – 578, 2002.
 - [4] Hongbo Jiang, Shudong Jin, Chonggang Wang "Prediction or Not? An Energy-Efficient Framework for Clustering-Based Data Collection in Wireless Sensor Networks" IEEE Transaction on parallel and Distributed systems, Vol. 22, No. 6, pp., 1064 – 1071, June 2011.
 - [5] Weifa Liang, Pascal Schweitzer, and Zichuan Xu "Approximation Algorithms for Capacitated Minimum Forest Problems in Wireless Sensor Networks with a Mobile Sink" IEEE Transactions on Computers, Vol. 62, No. 10, pp., 1932-1944, October 2013.
 - [6] S. Basagni, A. Carosi, E. Melachrinoudis, C. Petrioli, and Z.M. Wang, "Controlled Sink Mobility for Prolonging Wireless Sensor Networks Lifetime," Wireless Networks, vol. 14, no. 6, pp. 831-858, 2008.
 - [7] K. Altinkemer and B. Gavish, "Heuristics with Constant Error Guarantees for the Design of Tree Networks," Management Science, vol. 34, no. 3, pp. 331-341, 1988.
 - [8] S. Gao, H. Zhang, and S.K. Das, "Efficient Data Collection in Wireless Sensor Networks with Path-Constrained Mobile Sinks," IEEE Trans. Mobile Computing, vol. 10, no. 4, pp. 592- 608, Apr. 2011.
 - [9] A. Kansal, A.A. Somasundara, D.D. Jea, M.B. Srivastava, and D. Estrin, "Intelligent Fluid Infrastructure for Embedded Networks," Proc. Second Int'l Conf. Mobile Systems, Applications, and Services (MobiSys), pp. 111-124, 2004.
 - [10] W. Liang and J. Luo, "Network Lifetime Maximization in Sensor Networks with Multiple Mobile Sinks," Local Computer Networks, pp. 354-361, 2011.
 - [11] W. Liang, J. Luo, and X. Xu, "Prolonging Network Lifetime via a Controlled Mobile Sink in Wireless Sensor Networks," Proc. IEEE Global Telecomm. Conf. (GLOBECOM), pp. 1-6, 2010.
 - [12] J. Luo and J.-P. Hubaux, "Joint Mobility and Routing for Lifetime Elongation in Wireless Sensor Networks," Proc. IEEE INFOCOM, pp. 1735-1746, 2005.
 - [13] J. Luo and J.-P. Hubaux, "Joint Sink Mobility and Routing to Maximize the Lifetime of Wireless Sensor Networks: The Case of Constrained Mobility," IEEE/ACM Trans. Networking, vol. 18, no. 3, pp. 871-884, June 2010.
 - [14] J. Luo, J. Panchard, M. Piórkowski, M. Grossglauser, and J.-P. Hubaux, "MobiRoute: Routing Towards a Mobile Sink for Improving Lifetime in Sensor Networks," Proc. IEEE Second Int'l Conf. Distributed Computing in Sensor Systems (DCOSS), pp. 480- 497, 2006.

- [15] Y. Shi and Y.T. Hou, "Theoretical Results on Base Station Movement Problem for Sensor Network," Proc. IEEE INFOCOM, pp. 376-384, 2008.
- [16] A.A. Somasundara, A. Kansal, D. Jea, D. Estrin, and M.B. Srivastava, "Controllably Mobile Infrastructure for Low Energy Embedded Networks," IEEE Trans. Mobile Computing, vol. 5, no. 8, pp. 958-973, Aug. 2006.
- [17] M. Ma and Y. Yang, "SenCar: An Energy-Efficient Data Gathering Mechanism for Large-Scale Multihop Sensor Networks," IEEE Trans. Parallel and Distributed Systems, vol. 18, no. 10, pp. 1476- 1488, Oct. 2007.
- [18] Z.M. Wang, S. Basagni, E. Melachrinoudis, and C. Petrioli, "Exploiting Sink Mobility for Maximizing Sensor Networks Lifetime," Proc. 38th Ann. Hawaii Int'l Conf. System Sciences (HICSS), 2005.
- [19] G. Xing, T. Wang, W. Jia, and M. Li, "Rendezvous Design Algorithms for Wireless Sensor Networks with a Mobile Base Station," Proc. ACM MobiHoc, pp. 231-240, 2008.
- [20] X. Xu and W. Liang, "Data Quality Maximization in Sensor Networks with a Mobile sink," Proc. IEEE Int'l Conf. Distributed Computing in Sensor Systems (DCOSS), pp. 1-8, 2011.
- [21] X. Xu, W. Liang, and T. Wark, "Monitoring Quality Optimization in Wireless Sensor Networks with a Mobile Sink," Proc. 14th Int'l Conf. Modeling, Analysis and Simulation of Wireless and Mobile Systems, pp. 77-84, 2011.
- [22] X. Xu, J. Luo, and Q. Zhang, "Delay Tolerant Event Collection in Sensor Networks with Mobile Sink," Proc. IEEE INFOCOM, pp. 2471-2479, 2010.
- [23] Y. Yun and Y. Xia, "Maximizing the Lifetime of Wireless Sensor Networks with Mobile Sink in Delay-Tolerant Applications," IEEE Trans. Mobile Computing, vol. 9, no. 9, pp. 1308-1318, Sept. 2010.
- [24] X. Xu, X.-Y. Li, X. Mao, S. Tang, and S. Wang, "A Delay Efficient Algorithm for Data Aggregation in Multi-Hop Wireless Sensor Networks," IEEE Trans. Parallel and Distributed Systems, vol. 22, no. 1, pp. 163-175, Jan. 2011.
- [25] Pooja Kannadas "Energy Efficient Conflict Free Query Scheduling For Wireless Sensor Networks" International Journal of Engineering and Advanced Technology, Vol.1, No.5, pp., 320-324, June 2012.
- [26] Zahra Rezaei "Energy Saving in Wireless Sensor Networks" International Journal of Computer Science & Engineering Survey, Vol. 3.No. 1, pp. 23-37, Feb 2012.
- [27] A. Alshaihi, P. Vial & M. Ros, "Hybrid power saving technique for wireless sensor networks," IEEE International Conference on Wireless Information Technology and Systems, pp., 1-6, 2012.
- [28] Alexandre M Melo Silva, Christiano C Maciel, Suelene do Carmo Correa

- “Multi-hop Energy-efficient Control for Heterogeneous Wireless Sensor Networks Using Fuzzy Logic,” JSCSE Vol. 3, No. 3, Jan 2014.
- [29] N. Akilandeswari, B. Santhi and B. Baranidharan “A Survey on energy conservation Techniques in Wireless Sensor Networks” ARPN Journal of Engineering and Applied Sciences ,Vol. 8, No. 4,,pp., 265-269, April 2013
- [30] Chandrika M. Dixit “Modified Long Lifetime Routing in Unreliable Wireless Sensor Networks” International Journal of Advance Innovations, Thoughts & Ideas, Vol. 1 No. 5, pp., 1-10. Sep/Oct 2012.
- [31] MahimaYadav “Energy Conservation Topology for Wireless Sensor Network using Manual Power Control” International Journal of Computer Applications, Vol. 77, No.5, pp., 1-5. Sep 2013.
- [32] Gurpreet Kaur,Mandeep Kaur Sekhon “Heterogeneous Enhanced Energy Efficient Protocol with Static Clustering in Wireless Sensor Networks,International Journal of Applied Research and Studies, Vol 3,Issue.1, Jan 2014.