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# An Analytical Approach for Optimal Clustering Architecture for Maximizing Lifetime in Large Scale Wireless Sensor Networks

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## Abstract

***Many methods have been researched to prolong sensor network lifetime using mobile technologies. In the mobile sink research, there are the track based methods and the anchor points based methods as representative operation methods for mobile sinks. However, the existing methods decrease Quality of Service (QoS) and lead the routing hotspot in the vicinity of the mobile sink. In large scale wireless sensor networks, clustering is an effective technique for the purpose of improving the utilization of limited energy and prolonging the network lifetime. However, the problem of unbalanced energy dissipation exists in the multi-hop clustering model, where the cluster heads closer to the sink have to relay heavier traffic and consume more energy than farther nodes. In this paper we analyze several aspects based on the optimal clustering architecture for maximizing lifetime for large scale wireless sensor network. We also provide some analytical concepts for energy-aware head rotation and routing protocols to further balance the energy consumption among all nodes.***

## Keywords

***Sensor Network; Mobile Sink, large scale, wireless sensor networks, lifetime prolonging***

## 1. Introduction

In recent years, many clustering-based data gathering protocols of wireless sensor networks have been presented [1], in which the data is transmitted to sink through multi-hop communication of cluster-heads [2].process viewing is information summarization. A filter removes information. In contrast to that, a summarization makes it more compact by aggregating structures. Besides, process views can also support the translation of information. Wireless sensor networks (WSN) that are composed of over hundreds to thousands of nodes, gathers environmental data on comprehensive field of interest and builds network enabling multi-hop communication of gathered data. The sensor networks can be utilized in various applications such as the observation of wildlife's habitat, monitoring the status of the buildings, military applications, and monitoring of disaster[3][4].Wireless Sensor Networks (WSNs) [5][6] have been extensively explored recently due to their wide applications like military surveillance, home network, healthcare, inventory management and monitoring etc. The sensor nodes will sense, process and then transmit the data to certain remote sink node (or base station) in an autonomous and unattended manner.

Among the hierarchical structured energy efficient routing protocols, LEACH [7] is the most popular and representative one. Energy consumption is balanced via the rotation of 5% of the cluster heads and it is greatly reduced by data aggregation inside each cluster head. PEGASIS [8] is an improved version of LEACH which adopts the chain-based routing mechanism. Messages can get aggregated along the chain and finally be sent to the sink node via direct transmission by one random node on the chain. HEED [9] can not only minimize the control overhead during communication process but also prolong network lifetime since the cluster heads are well distributed. PEBECS [10] reduces and balances energy consumption by considering node's residual energy, degree and relative location during selection of cluster head nodes. Recently, energy efficiency network protocol development became core design issue and hot ongoing research in WSN. In this context, data gathering and routing is one of the core area, where good protocol can achieve maximum energy efficiency. Most of the existing methods transmit mobile sink nodes along certain routes based on specific tracks or anchor points and collect data. However, general applications do not need data of all sensor nodes. Queries requiring monitor of events or collection of data on certain fields need data transmission only from specific nodes of network. Therefore, the existing methods that use the mobile sink based on certain routes fail to reflect environmental features and consequently, result in reducing Quality of Service (QoS). Thus, the residual energy of the remaining alive nodes will be wasted, which is not desirable.

In this paper we find some analytical aspects to set data centric path of a mobile sink to improve the QoS of a query result and maximizes the merits of applying a mobile sink by considering network environments and features of data creation.

We provide here an overview of several aspects about

Optimal Clustering Architecture and there lifetime. The rest of this paper is arranged as follows: Section 2 introduces Wireless Sensor Network; Section 3 describes about Mobile Sink; Section 4 shows the lifetime prolonging and clustering; Section 5 describes about recent scenario. Section 6 describes Conclusion and outlook.

## 2. Wireless Sensor Network

wireless sensor network (WSN) consists of spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants and to cooperatively pass their data through the network to a main location. The more modern networks are bi-directional, enabling also to control the activity of the sensors. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance; today such networks are used in many industrial and consumer applications, such as industrial process monitoring and control, machine health monitoring, and so on. Fig 1 provides the overall working phenomenon of wireless sensor network (WSN).

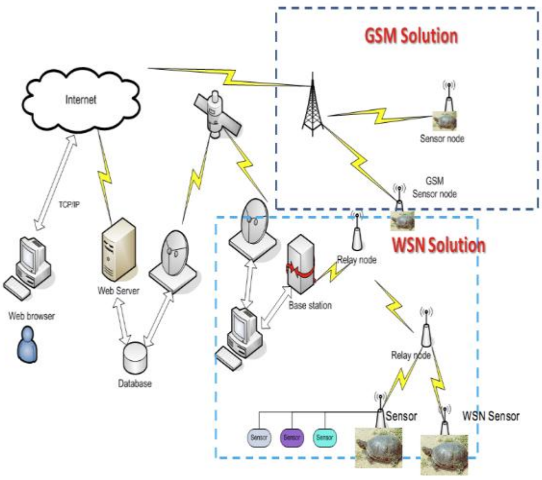


**Fig 1. WSN Solution**

The WSN technology being proposed provides the best of both the above-mentioned existing technologies. GPS positioning gives accurate position information that can be stored on the sensor node, whereas the RF transceiver can be used to transmit the data at desired intervals. This way, data collection & transmission can happen without human intervention. Hence, this technology promises enhanced tracking of wildlife.
WSN (Wireless Sensor Networks) provides an advanced solution for species tracking. The wireless sensor network is composed of sensor nodes, relay nodes, and the base station. Cellular networks can also be used considering the difficulty of achieving the necessary radio range coverage. The WSN displays precise turtle locations and movement. By using the RSSI (Received Signal Strength Indicator), the trilateration method can be used to accurately locate the turtle. The WSN also can facilitate the mobility of the network, which is normal when tracking the turtles. Turtles' movements will cause a handover to occur between different clusters.

The base station will receive the sensing data from distributed relay nodes. The base station can use cellular networks or satellites to transmit the data to the end user, where the user-friendly web-based applications are provided. Users can not only get the real-time display of the turtles' position but also dynamically configure the information of interest on the web application.

**Advantages of Wireless Sensor Networks**
-Greater resolution both in time and space
-WSN facilitates the collection of diverse types of data at frequent intervals over large.
-WSN enables ecologists and field biologists to unobtrusively collect new types of data, providing new insights on processes.
-Real-time data flows allow researchers to react rapidly to events, thus extending the laboratory to the field.
-The numbers and locations of sensors can be chosen/optimized/changed.
-In general, the system is fault-tolerant. Any failure can be detected in real time.
-Observing under extreme conditions.
-Reacting to events as they unfold
-Controlled sensing: Sensing parameters can be remotely changed/ modified (e.g., frequency of sensing, data rate, type of data, sensing features, etc.).

**Challenges**
Using WSN technology for tracking turtles involves some challenges:
1. GPS & RF signals would be difficult to track while the turtles are under water. Hence, the tracking & transmission is done opportunistically, when the transceivers & antennas are exposed out of water.
2. Battery life is the biggest challenge in any WSN. Hence careful design & rigorous testing is involved to ensure the desired lifetime for the sensor node can be achieved.
3. Since tracking each turtle is important, the scenario of node failure is unacceptable.
4. In order to minimize the power consumption, the protocols used for RF communication have to be carefully chosen to ensure data is communicated accurately & in a timely manner.

## 3. Mobile Sink

The main function of the network layer is routing packets from the source machine to the destination machine, often requiring multiple hops. For broadcast networks routing is an issue if source and destination are not on the same network. The routing algorithm is that part of the network layer software responsible for deciding which output line an incoming packet should be transmitted on. With VC's networks one speaks of session routing, because a route remains in force for an entire user session (e.g. a login session or a file transfer). The following properties are desirable in a routing algorithm:

- Correctness and simplicity.
- Robustness, against software and hardware failures, traffic changes and topology changes for very long periods.
- Stability, some algorithms never converge to equilibrium.
- Fairness and optimality, which are conflicting goals.

Intuitively, increasing the sink velocity v will improve the system efficiency, since in unit time interval the mobile sink can meet more sensors and gather more information throughout the sensor field. However, we should carefully choose this parameter as explained follows. On the one hand, the higher mobile sink velocity, the higher the probability for static sensors to meet mobile sinks. On the other hand, when mobile sinks are moving too fast across the effective communication region of static sensors, there may not be a sufficient long session interval for the sensor and sink to successfully exchange one potentially long packet. In other words, with the increase of sink velocity, the “outage probability” of packet transmission will arise. . Therefore, finding a proper value for sink velocity must be a tradeoff between minimizing the sensor-sink meeting latency and minimizing the outage probability.

With mobile phones acting as mobile sinks in mWSN sensors will deliver the gathered information towards mobile phones regarding mobile phones as cluster-heads. As energy efficiency is one of the focal design goals of mWSN system, sensors should choose the most energy-efficient clustering/routing strategy to deliver the collected data. Apparently, the most economic way is to let the sensor node hold sensed data in its buffer until the sink approaches, similar to the proposals in [11] and [12].

## 4. Lifetime Prolonging and Clustering

Energy is a critical resource in wireless sensor networks, even when it is possible to harvest energy from the external environment.

How to minimize the energy consumption of sensor nodes while meeting application requirements? To answer the above question it is important to know how much power each node component dissipates during normal operating conditions, i.e., which are the power dissipation characteristics of sensor nodes.

Obviously, the power breakdown heavily depends on the specific node. In [13] it is shown that the power characteristics of a Mote-class node are completely different from those of a Stargate node. However, the following remarks generally hold [1].

• The radio subsystem is the component that accounts for the largest energy consumption. A comparison of computation and communication costs has shown that transmitting one bit over a distance of 100 m consumes approximately the same energy as executing 3000 instructions. Therefore, to reduce energy consumption the number of communications should be minimized, even at the cost of increasing data processing.

• Due to the small transmission distances, typically the power consumed for receiving may be greater than the power consumed for transmitting. Therefore, there is no real advantage in minimizing the number of transmissions. Instead, a power-efficient design should minimize the number of receptions.

• The power consumed when the radio is idle (i.e., it is neither receiving nor transmitting data) is approximately the same as in transmit/receive mode. Therefore, there is no real advantage in maintaining the radio in idle mode.

The power consumption of the sensor node depends on the operational mode of the components. For example, putting the radio in the sleep mode reduces significantly the node power consumption. Therefore, node components, and specifically, the radio subsystem, should be put in sleep mode whenever possible.

Based on the above general remarks, several approaches can be exploited, even simultaneously, to reduce power consumption in wireless sensor networks. The most effective way is putting the radio transceiver in the (low-power) sleep mode whenever communication is not required. Ideally, the radio should be switched off as soon as there is no more data to send/receive, and should be resumed as soon as a new data packet becomes ready. This way nodes alternate between active and sleep periods depending on network activity. This behavior is usually referred to as duty cycling, and duty cycle is defined as the fraction of time nodes are active during their lifetime. Obviously, from the power saving standpoint, the duty cycle should be as low as possible. However, as sensor nodes perform a cooperative task, they need to coordinate their sleep/wakeup times. A sleep/wakeup scheduling algorithm is required to this end. The sleep/wakeup scheduling algorithm is typically a distributed algorithm based on which sensor nodes decide when to transition from active to sleep, and back. It allows neighboring nodes to be active at the same time, thus making packet exchange feasible even when nodes operate with a low duty cycle (i.e., they sleep for most of the time) Duty cycling reduces significantly the energy consumption of sensor nodes as, ideally, it keeps nodes active only when there is network activity. Actually, it is the most effective approach to energy conservation. However, additional energy savings can be achieved through an energy-efficient design of applications and networking protocols. The goal is to develop applications and networking protocols that perform their specific task by minimizing network activity.

Cluster Analysis, also called data segmentation, has a variety of goals. All relate to grouping or segmenting a collection of objects (also called observations, individuals, cases, or data rows) into subsets or "clusters", such that those within each cluster are more closely related to one another than objects assigned to different clusters. Central to all of the goals of cluster analysis is the notion of degree of similarity (or dissimilarity) between the individual objects being clustered. There are two major methods of clustering -- hierarchical clustering and k-means clustering.

In hierarchical clustering the data are not partitioned into a particular cluster in a single step. Instead, a series of partitions takes place, which may run from a single cluster containing all objects to n clusters each containing a single object. Hierarchical Clustering is subdivided into agglomerative methods, which proceed by series of fusions of the n objects into groups, and divisive methods, which separate n objects successively into finer groupings. Agglomerative techniques are more commonly used, and this is the method implemented in XLMiner. Hierarchical clustering may be represented by a two dimensional diagram known as dendrogram which illustrates the fusions or divisions made at each successive stage of analysis. An example of such a dendrogram is given in fig2. An agglomerative hierarchical clustering procedure produces a series of partitions of the data, $P_n$, $P_{n-1}$, ....... , $P_1$. The first $P_n$ consists of n single object 'clusters', the last $P_1$, consists of single group containing all n cases.

At each particular stage the method joins together the two clusters which are closest together (most similar). At the first stage, of course, this amounts to joining together the two objects that are closest together, since at the initial stage each cluster has one object. Clustering is a nonlinear activity that generates ideas, images and feelings around a stimulus word. As students cluster, their thoughts tumble out, enlarging their word bank for writing and often enabling them to see patterns in their ideas. Clustering may be a class or an individual activity.

Cluster techniques have two basic concerns: firstly, the measurement of similarity between individual profiles; and secondly, the use of that measure to form the groups or clusters. Brennan described Iterative Relocation as the most important cluster technique in behavioral and educational research. It has been adopted at Lancaster to create typologies of pupils based on personality and behavioral items to identify types of students and to isolate the skills considered to be important for certain grades of technologist in industry. Other similarity coefficients are available and the one chosen will depend upon the type of data gained.

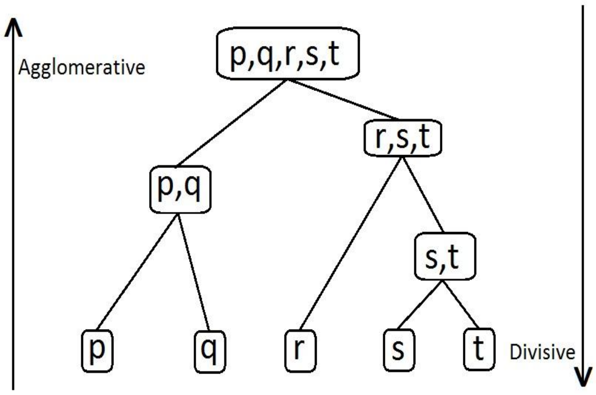


**Fig 2. Dendrogram**

## 5. Recent Scenario

In 2007, Yu Gu et al. [14] proposed the problem of lifetime optimization under storage constraint for wireless sensor networks with a mobile sink node. The problem is particularly challenging since they need to consider both mobility scheme and storage constraint. Hence, they try a different way. First we analyze this problem and give a lifetime upper bound, so whether this upper bound is tight. Thus, we first construct a 2-approximation $O(n2)$ algorithm to solve the TSP problem, then a novel data diffusion mechanism is built to achieve this upper bound. They prove that under some reasonable assumptions, our algorithm can output this optimal lifetime.

In 2009, Huan Li et al. [15] proposed and investigate the theoretical aspects of the unequal clustering strategy for minimizing and balancing the energy consumption of cluster heads in large uniform distributed sensor networks. Based on the proposed optimal clustering architecture, they design simple energy-aware head rotation and routing protocols to further balance the energy consumption among all nodes. Extensive simulations show that the proposed architecture can maximize the network lifetime defined from different aspects, and therefore, are suitable for the design and deployment of large scale sensor networks.

In 2010, YoungSang Yun et al. [16] proposed a framework to maximize the lifetime of the wireless sensor networks (WSNs) by using a mobile sink when the underlying applications tolerate delayed information delivery to the sink. Within a prescribed delay tolerance level, each node does not need to send the data immediately as it becomes available. Instead, the node can store the data temporarily and transmit it when the mobile sink is at the most favorable location for achieving the longest WSN lifetime. To find the best solution within the proposed framework, we formulate optimization problems that maximize the lifetime of the WSN subject to the delay bound constraints, node energy constraints, and flow conservation constraints. They conduct extensive computational experiments on the optimization problems and find that the lifetime can be increased significantly as compared to not only the stationary sink model but also more traditional mobile sink models.

In 2010, Saeed Rasouli Heikalabad et al. [17] proposed the new cluster head selection protocol namely HEECH. This protocol selects a best sensor node in terms of energy and distance as a cluster head. They produce the Simulation Results which show that the HEECH increases the network lifetime about 56% and 9% compared to the LEACH and HEED, respectively. In 2010, Babar Nazir et al. [18] proposed and address hotspot problem and Mobile Sink based Routing Protocol (MSRP) for Prolonging Network Lifetime in Clustered Wireless Sensor Network. In MSRP, mobile sink moves in the clustered WSN to collect sensed data from the CHs within its vicinity. During data gathering mobile sink also maintains information about the residual energy of the CHs. Mobile sink based on the residual energy of CHs move to the CHs having higher energy. Consequently, the hotspot problem is minimized as the immediate neighbor of the sink is high energy node and it changes because of regular sink movement. It results in a balanced use of WSN energy and improves network life time.

## 6. Conclusion and Outlook

We consider the joint effect of mobility and routing algorithms to alleviate” funneling effect” of multi-hop routing in wireless sensor networks. . However, the existing methods decrease Quality of Service (QoS) and lead the routing hotspot in the vicinity of the mobile sink. In large scale wireless sensor networks, clustering is an effective technique for the purpose of improving the utilization of limited energy and prolonging the network lifetime. However, the problem of unbalanced energy dissipation exists in the multi-hop clustering model, where the cluster heads closer to the sink have to relay heavier traffic and consume more energy than farther nodes. In this paper we analyze several aspects based on the optimal clustering architecture for maximizing lifetime for large scale wireless sensor network.

We provide some detail and analytical behavior base on the some survey. In future we propose the simulation result with the real time application.

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