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# A Novel Algorithm for Mobility of Wireless Sensor Network

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**Abstract:**

WSNs-Wireless Sensor Networks comprises of small nodes with computation, sensing and wireless communications capabilities. Energy awareness is an essential design for WSNs and hence data broadcasting protocols, routing and power management isspecially designed to meet this requirement. However, the focus is mainly on the routing protocols which differ depending on the network design and application. A three-layer framework is being proposed in this paperwork for mobile data collection in wireless sensor networks. This includes cluster head layer, mobile collector (SenCar) layer, and sensor layer. These sencars are movable hence it can be any mobile object, robot or moving vehicle that works as a robust energy recharger for the mobile nodes which really need energy in the sensor networks. The sencar whose battery is below the threshold level will start to move towards the sensor node. Based on the data transmissions and the purpose of the network, the threshold for all the sensor nodes are set in advance. Sencars move from its base station and move from cluster to cluster in its defined path in a WSN (wireless sensor network). WSN (wireless sensor network) communicates with a large number of sensor nodes. The sensor identifies the memory limit, accessibility and mobility of storage. Data is circulated to all nodes in a geographic area (geocast) from a service area. Then the content based inquires all sensors that detected some specific activity in the past hour. This wireless sensor network uses AODV (Ad-hoc On Demand Distance Vector) routing algorithm and MIMO (Multi

Input Multi Output) Sencar is a mobile node that is set in the base station to detect the data status from source to destination. The sencars also measure the fixed threshold and detects the nodes whose limit of information transmission is below the limit.

**Keywords:** Wireless sensor networks (WSNs), data collection, multiple inputs and multiple outputs (MIMO), Ad-hoc On Demand Distance Vector (AODV), mobility control, Ns-2

## 1. Introduction

Rise of the need of low-power, low cost, multi-functional sensors are the reasons for wireless sensor networks to be a major data collection model. Sensors are deployed in huge numbers and distributed in a random base in the sensing field and left unattended. This makes it difficult to recharge or replace the batteries. As these sensors form self-governing organizations, the sensors near the data run out of battery due to the heavy traffic. When the battery of the sensor sinks, the whole network connectivity and coverage will get affected and cannot be guaranteed. As in some case data collection has to done in a specific time frame and hence data sensor plays a crucial part in the network. Therefore it is highly important to have a large-scale and efficient data collection scheme with scalability, low data latency and long network lifetime. In the literature part there are numerous approaches to efficiently perform the data collection. The first category to be considered is the relay that happens among the sensors. Some other factors to be considered are data redundancy, load balance and schedule pattern. The second category to be is considered is the cluster formed by these sensors and the cluster head performing the responsibility of forwarding data to the data sink. Cluster is specifically used where scalability is of high priority and highly effective in local data aggregation as it can reduce collision and load balance can be maintained among sensors. The third category is to consider the maximum utilisation of mobile collectors to work on the data routing from sensors. Just minimising the energy consumption will get the job done since some of the critical sensors may really run out of energy very fast that others. On the other hand in a cluster based model, the cluster head will consume more energy than the sensors as it has to handle intra-cluster aggregation and inter-cluster data transmission. Though mobile collectors can ease the job of energy consumption but it can result in poor data collection in terms of latency. This paper is actually based on this observation that a three-layer mobile data collection framework is proposed called as Load Balanced Clustering and Dual Data Uploading (LBC-DDU). In this model the sensors are organised in the cluster and each cluster has multiple cluster heads. Algorithm helps in load balancing of intra-cluster aggregation and dual data upload among multiple cluster heads and mobile collector are enabled. Secondly, these multiple cluster heads collaborate with each other for efficient energy utilisation inter-cluster transmissions. MU-MIMO communication is used to allow simultaneous upload of data from two cluster heads. The mobile collector with two head (sencar) collects data from cluster head by visiting all the clusters. The sencar decides the stop location in each cluster and decides the path to visit them so that data collection is done in minimum amount of time.

## 2. Sencar Layer

The basic and the bottom layer are called the Sencar layer. There are no assumptions in this layer on sensor distribution or node capability such as location awareness. Each sensor can communicate only to its neighbours that are the node within the transmission range. While implementing the sensors they are self-organised to form a cluster. Each individual sensor decides by itself to be a cluster head or member of the cluster. The sensor with high residual energy becomes the cluster head and each cluster has at most Mb cluster heads called as cluster head group (CHG). The entire cluster heads act as peers to each other. The algorithm places these sensors in such a way that they are one hop away from at least one cluster head. The FT designed to static WSNs, no predefined topology exists to transfer data from sensors to sink. All the sensor nodes directly communicate with the data collector or the one hop neighbour cluster head and finally reach the sink.

The limitations in the previous existing models is data redundancy, delay, node failure and high energy utilization as it uses gossiping, direct communication, flooding, etc. to communicate between nodes. This is the main drawback and not recommended for mobile wsns. After the appearance of Sencar, each CHG uploads data through MU-MIMO communications and synchronizes. IT seeks the shortest route to visit all the polling points only once and then return to the data sink, MU-MIMO is highly helpful in reducing the data latency and speed up the data collection time. Another utilization area is the disaster recovery. Let’s consider the forest fire, as we know sensors are deployed densely to monitor the situation. As we know that it is highly risky for human beings to collect data in such tedious situations and this application read hundreds and hundreds of data in a very short period. These applications are of high utilization in such scenarios. As mobile collectors are made up of multiple antennas, data collection is very fast and in such situations where human begins cannot access, these mobile collectors do the job in an efficient way. Although the mobility can cause delay but data collection is incomparable for its speed. In addition to this mobile data collector can work miracles even in a disconnected area and guarantee you for all the required data.

## 3. Related Works

Clustering Schemes Relay routing and Relay Routing is an effective and simple way to approach the concept of routing messages to the data sink in multi-hop fashion. Cheng et al discovered the alternate route method to avoid congestions and transfer data. Wu et al. studied to maximize the life time of data storage by designing an algorithm that started with a random design and ideally ended with load reduction on the bottleneck nodes. Xu et al. studied on the relay approach towards nodes to extend the lifetime of the network. Gnewali et al. assessed the collection tree protocol (CTP) via testbeds in [6]. CTP is mainly used to work on robustness, reliability, efficiency and hardware independent. Whatever maybe, but when it comes to nodes in the critical data path, if energy depletion occurs then data collection performance will decline. Heinzelman et al. [10] provided another applicable approach using the concept of clusters called LEACH. LEACH leads to less number of relays and instead forms the cluster groups. However the performance of the cluster depends on the cluster head. Younis and Fahmy [11] proposed the concept of HEED, which helps in the cluster head selection. This is a combination of residual energy and off course cost is also considered in this approach. HEED can deliver well-distributed cluster heads and compact clusters. Gong et al [12] discovered energy efficient clustering in wireless sensor networks through quality links. Amis et al [13] contributed towards another interesting concept of d-hop cluster where each node is at d hop away from the cluster head. Among all the cluster based models, clusters not only act as a local data collector, a cluster head also acts as a controller and a scheduler for in-network process. Zhang et al [15] worked on the scheduling characteristic of cluster head to ease the collision among transmissions. Gedik et al. [17] and Liu et al [18] discovered the concept of sensing the data and vigorously partitioning the sensor nodes into clusters. Cluster heads use the spatio-temporal concept to minimise the reading process to maximize the energy saving. Single head clustering schemes are not compatible with MU-MIMO;hence we propose a load balanced, multi-head clustering algorithm for general compatibility.

## 4. Status Details

In this section each node updates its status up-do-date from the nearest information node which contains the information and then it claims itself to be a cluster head control. The sensor which claims it to be cluster head is marked as the priority node.
The node refers the $r_h$ and $r_m$. This contains two support rules. This satisfies the rule of $r_h > r_m$.

1. $S_i$is creating a final cluster heads
2. $S_i$is not get the cluster head if the searching process is not completed the loop of iteration process increased by lter+1

### 4.1 Cluster forming

Cluster forming is the third phase where the decision is taken to announce the cluster head to which the sensor should be associated with. The criteria to decide this is that the sensor which is a member of a cluster group or being in a tentative status will associate itself with the cluster head among its peers for load balance. Considering the rare case where there is no cluster head in the group, then the sensor with tentative status, would consider itself and current candidate peers as cluster heads. Cluster members receive this message and perform the initial phase of forming a new round of clustering.

**Algorithm 3. Phase III: Cluster forming**

```
1: if My. status ¼ cluster_head then My. cluster_head _My. id;
2: else
3: recv_pkt ();
4: My:B _Fnl_NðMy:BÞ;
5: if My. B 6¼ F then
6: My. status _ cluster_member;
7: My. cluster_head _Rand_oneðMy:BÞ. id;
8: send_pkt (3, My. id, My. cluster_head, cluster_member, My. init_prio);
9: else
10: My. status _ cluster_head;
11: My. cluster_head _ My. id;
12: send_pkt (2, My. id, ID_ListðMy:AÞ, cluster_head, My. prio);
```

**4.2 MU-MIMO Uploading**

We are considering selected polling points for the corresponding scheduling pairs for the selection of schedule pattern, aiming to achieve the maximum sum of MIMO uplink capacity in a cluster. We also assume that the Sencar utilizes minimum mean square error receiver with successive interference cancellation (MMSE-SIC) as the receiving structure for each MIMO data uploading. Based on this receiver, the capacity of a 2 _ 2 MIMO uplink between a scheduling pair ða; bÞ and SenCar located at a selected polling point can be expressed as follows.

$$C^{\triangle}_{(a,b)} = \log\left(1 + \frac{P_t\|\mathbf{h}_a\|^2}{N_0\mathbf{I}_2 + P_t\|\mathbf{h}_b\|^2}\right) + \log\left(1 + \frac{P_t\|\mathbf{h}_b\|^2}{N_0}\right)$$

$h_a$ and $h_b$ are two 2 _ 1 channel vectors between the cluster heads a and b and sencar at ~, respectively. Pt represents the output power of a sensor for transmission range Rs, and N0 is the variance of the back-ground Gaussian noise. First the MMSE-SIC receives information from a and decodes the information while treating the signals from b as interference. Later it cancels the signals from a and the remaining signals from b only has to contend with the background Gaussian noise. After the selection of polling points for each cluster is chosen, sencar finally concludes its path. The travelling time in the path can be reduced if the visiting sequence of selected pooling points is set proper. As sencar leaves the data sink and also needs to return the collected data to it, the path of the sencar is a route that visits each selected polling point once. This is the common travelling salesman problem (TSP). As sencar knows all the locations of polling points, it is easy for it to decide the shortest moving path among the selected polling points for the TSP problem.

**4.3 Load Balanced Clustering**

The crucial part of clustering is the selection process for the cluster heads. Cluster heads with higher residual energy are preferred to demonstrate long network lifetime. We use the percentage of residual energy of each sensor to represent as initial clustering priority. Let's consider a set of sensors say S={s1; s2;…. ; sn}, this set is homogeneous and they are independent to make decision on their status based on local information. After executing the LBC algorithm, all the clusters will have at most M (>1) cluster heads. This means that the size of CHG of each cluster is not more than M. Each sensor will have at least one cluster head in each cluster group.

The LBC algorithm has four phases:

(1) Initialization;
(2) Status claim;
(3) Cluster forming and
(4) Cluster head synchronization.

**4.1 Initialization phase**

Once $s_i$ successfully becomes the cluster head, its peer candidates also update themselves automatically as cluster heads and all of them together form the cluster head group-CHG. Now $s_i$ sets its priority as a summation of its initial priority with those of its candidate peers.

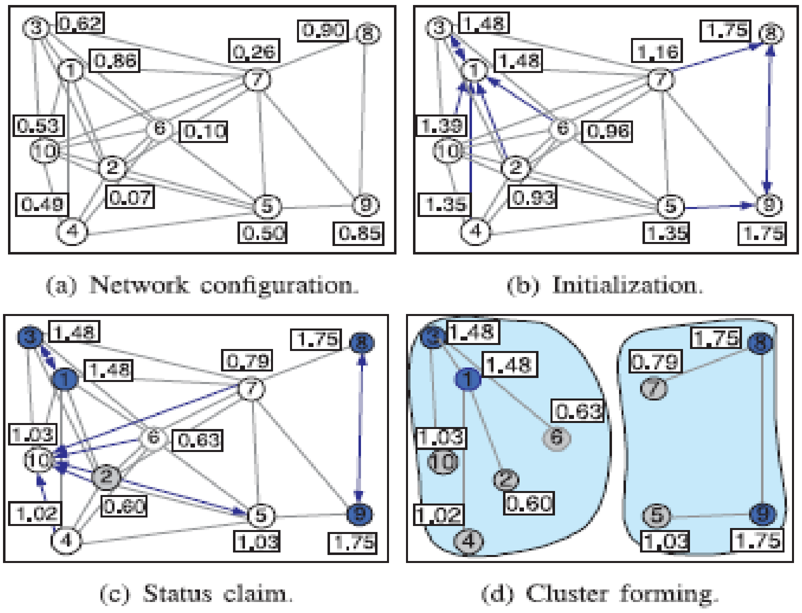


**Figure 1:** Initialization Phase

Thus, sensor can choose the peers suitable to it along with its status decision. fig. 3b demonstrates the initialization phase of the example, in this sample M is set to 2. This means that all the sensors choose its neighbour with the highest initial priority.

## 5. Performance Evaluations

The main objective of this framework is to compare and analyze the other schemes. Exploring different data collection schemes to reveal the best results. We assume all the schemes are implemented under same duty-cycling MAC strategy. The first scheme to be compared and studied is the relay routing where relay messages to a static data sink using multi-hops. This method delivers robustness and error resistance environment. The sensors select the hop neighbour with the highest residual energy for forwarding messages to the sink. If some of the nodes consume heavy energy, an alternative path is chosen to deliver the data to the sink. In this manner, relay routing can provide load balancing and provide a traffic free routing path. The second method to be considered is the Collection Tree Protocol [6]. ETX (Expected number of transmission) is the base concept in CTP. The route with lower ETX takes preference when compared with the higher ETX. In simple terms ETX is proportional to transmission distance between nodes. This proportion is logical, if fixed power is used for longer transmission distance would cause declination in receiving power and in turn increases error probability and expected number of transmissions. Based on this concept, collection tree is created in the static data sink at the origin (0, 0) [14]. All the nodes forward messages to the sink in the path which has lowest ETX. The existence of broken links will cause depletion in battery energy and will lead to large ETX.

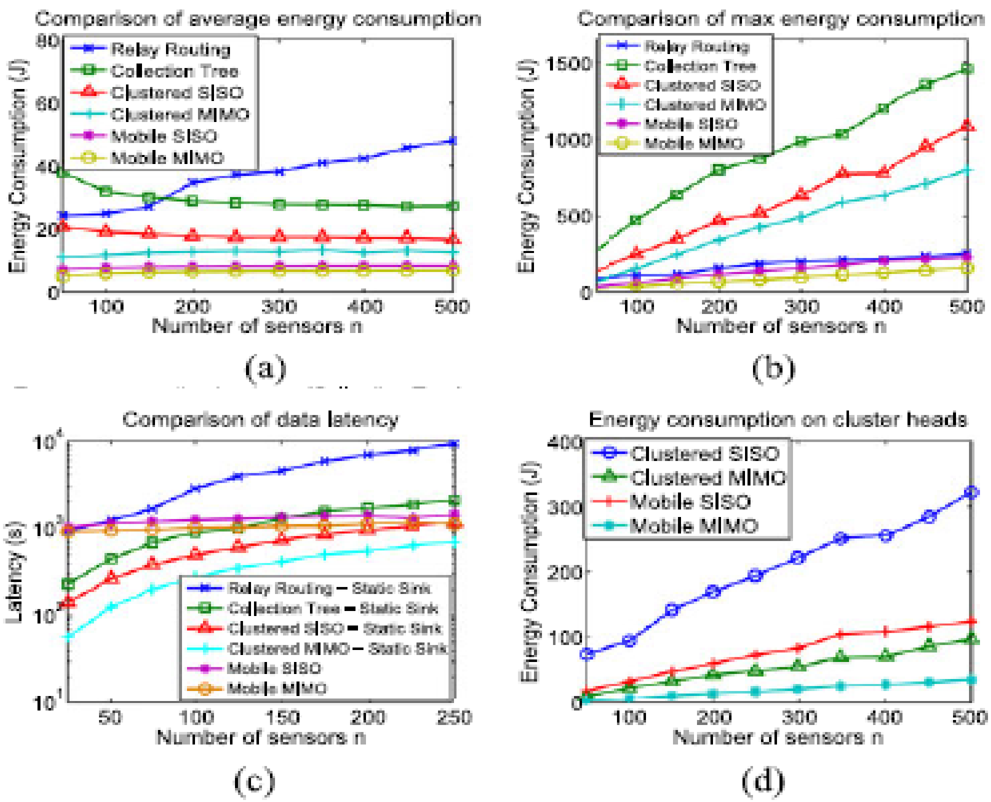


**Figure 2:** Performance evaluation

Geographical energy distribution between the collection Tree and mobile MIMO is considered to justify our choice of mobile data collections. To simplify the graphical demonstration let's set n ¼ 200 and draw the heat map of energy consumption. The diagram above showcases high energy consumption in Collection Tree method. It is high on the nodes near the data sink which is represented by bright spots in the diagram. These nodes create the bottle neck points and risk the network operation. Though the mechanism in collection Tree with ETX metrics is better in routing the path but congestion is unavoidable due to the physical locations of these nodes. On the other hand, mobile MIMO method results in less energy consumption and even distribution across the sensing field.

## Conclusions and Future Works

The LBC DDU framework proposed in this paper is for mobile data collection in WSN. The three layers that contribute to this framework are sensor layer, cluster head layer and Sencar layer. Distributed load balanced clustering character helps in self organisation for the sensors. It adopts the inter-cluster communication for energy efficient transmissions among CHG's, dual data uploading for fast data collection, and optimizes SenCar's mobility to fully enjoy the benefits of MU-MIMO. The performance study initiated in this paper work demonstrates the effective framework model. The results broadcast that energy consumption can be reduced with LBC-DDU by easing the routing burdens on nodes and balancing workload among cluster heads, this helps in achieving 20 percent less data collection time compared to SISO mobile data gathering. Over 60 percent energy saving on cluster heads is also achieved in this model. We have also tested these results by working with different number of cluster heads in the framework. We would also like to convey that there are some demanding problems that will be studied our future works.

The first problem is to find the best possible way to find the polling points and compatible pairs for each cluster. A discrete scheme to be developed to partition the continuous space and locate the optimal polling point for all the clusters. Finding the compatible pairs comes hand in hand with the above problem to achieve optimisation. The second problem is with the scheduling of MIMO uploading from multiple clusters. An algorithm will be proposed in the future that adapts to the current MIMO-based transmission scheduling.

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