

Multihead Node Selection Technique for Improving Lifetime and Energy Efficiency of WSN

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Abstract: In this paper, a three-layer framework is proposed for mobile data collection in wireless sensor networks, which includes the sensor layer, cluster head layer, and mobile collector (called SenCar) layer. The framework employs distributed load balanced clustering and dual data uploading, which is referred to as LBC-DDU. The objective is to achieve good scalability, long network lifetime and low data collection latency. At the sensor layer, a distributed load balanced clustering (LBC) algorithm is proposed for sensors to self-organize themselves into clusters. In contrast to existing clustering methods, our scheme generates multiple cluster heads in each cluster to balance the work load and facilitate dual data uploading. At the cluster head layer, the inter-cluster transmission range is carefully chosen to guarantee the connectivity among the clusters. Multiple cluster heads within a cluster cooperate with each other to perform energy-saving inter-cluster communications. Through inter-cluster transmissions, cluster head information is forwarded to SenCar for its moving trajectory planning. At the mobile collector layer, SenCar is equipped with two antennas, which enables two cluster heads to simultaneously upload data to SenCar in each time by utilizing multi-user multiple-input and multiple-output (MU-MIMO) technique. The results show that when each cluster has at most two cluster heads, LBC-DDU achieves over 50 percent energy saving per node and 60 percent energy saving on cluster heads comparing with data collection through multi-hop relay to the static data sink, and 20 percent shorter data collection time compared to traditional mobile data gathering. This system provides much better efficiency as compared to SISO system.

Key words: *Wireless Sensor Networks Clustering Cluster head LEACH*

Introduction

A wireless sensor network is a collection of sensor nodes, linked together via some form of wireless communication network. These sensor nodes are autonomous devices using a variety of sensors (e.g., temperature, sound, vibration, pressure, motion, or pollutant) to monitor the environment in which they are deployed.

The WSN is built of "nodes" – from a few to several hundreds or even thousands, where each node is connected to one (or sometimes several) sensors. Each such sensor network node has typically several parts: a radio transceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery or an embedded form of energy harvesting. A sensor node might vary in size from that of a shoebox down to the size of a grain of dust, although functioning "motes" of genuine microscopic dimensions have yet to be created. The cost of sensor nodes is similarly variable, ranging from a few to hundreds of dollars, depending on the complexity of the individual sensor nodes. Size and cost constraints on sensor nodes result in corresponding constraints on resources such as energy, memory, computational speed and communications bandwidth. The topology of the WSNs can vary from a simple star network to an advanced multi-hop wireless mesh network. The propagation technique between the hops of the network can be routing or flooding.

The applications for wireless sensor networks are broad. Commercial and industrial applications include monitoring equipment to which it is difficult to attach wired sensors, or in older buildings where it is difficult to retrofit a wired network. Environmental monitoring (e.g., coastal monitoring) applications abound due to the ease of deployment, and the minimal impact on the environment. Sensor networks not only eliminate the need for wires, but also do not typically require large power supplies. Common applications for sensor networks include: environmental monitoring, habitat monitoring, acoustic detection, seismic detection, military surveillance, inventory tracking, medical monitoring, smart space, etc

Literature Survey

[1] Author consider the problem of collecting a large amount of data from several different hosts to a single destination in a wide-area network. This problem is important since improvements in data collection times in many applications such as wide-area upload applications, high-performance computing applications, and data mining applications are crucial to performance of those

applications. Often, due to congestion conditions, the paths chosen by the network may have poor throughput. By choosing an alternate route at the application level, we may be able to obtain substantially faster completion time. This data collection problem is a nontrivial one because the issue is not only to avoid congested link(s), but to devise a coordinated transfer schedule which would afford maximum possible utilization of available network resources. Our approach for computing coordinated data collection schedules makes no assumptions about knowledge of the topology of the network or the capacity available on individual links of the network. This approach provides significant performance improvements under various degrees and types of network congestions. To show this, we give a comprehensive comparison study of the various approaches to the data collection problem which considers performance, robustness, and adaptation characteristics of the different data collection methods. The adaptation to network conditions characteristics are important as the above applications are long lasting, i.e., it is likely changes in network conditions will occur during the data transfer process. In general, our approach can be used for solving arbitrary data movement problems over the Internet. We use the Bistro platform to illustrate one application of our techniques.

[2] In a heterogeneous wireless sensor network (WSN), relay nodes (RNs) are adopted to relay data packets from sensor nodes (SNs) to the base station (BS). The deployment of the RNs can have a significant impact on connectivity and lifetime of a WSN system. This paper studies the effects of random deployment strategies. We first discuss the biased energy consumption rate problem associated with uniform random deployment. This problem leads to insufficient energy utilization and shortened network lifetime. To overcome this problem, we propose two new random deployment strategies, namely, the lifetime-oriented deployment and hybrid deployment. The former solely aims at balancing the energy consumption rates of RNs across the network, thus extending the system lifetime. However, this deployment scheme may not provide sufficient connectivity to SNs when the given number of RNs is relatively small. The latter reconciles the concerns of connectivity and lifetime extension. Both single-hop and multihop communication models are considered in this paper. With a combination of theoretical analysis and simulated evaluation, this study explores the trade-off between connectivity and lifetime extension in the problem of RN deployment. It also provides a guideline for efficient deployment of RNs in a large-scale heterogeneous WSN.

[3] Most sensor networks are used to collect information from the physical world. Examples include sensor networks deployed to monitor micro-climates in agriculture farms and deployments that measure energy consumption in office or residential buildings. The nodes in these networks collect information about the physical world using their sensors and relay the sensor readings to a central base station or server using multi-hop wireless communication.

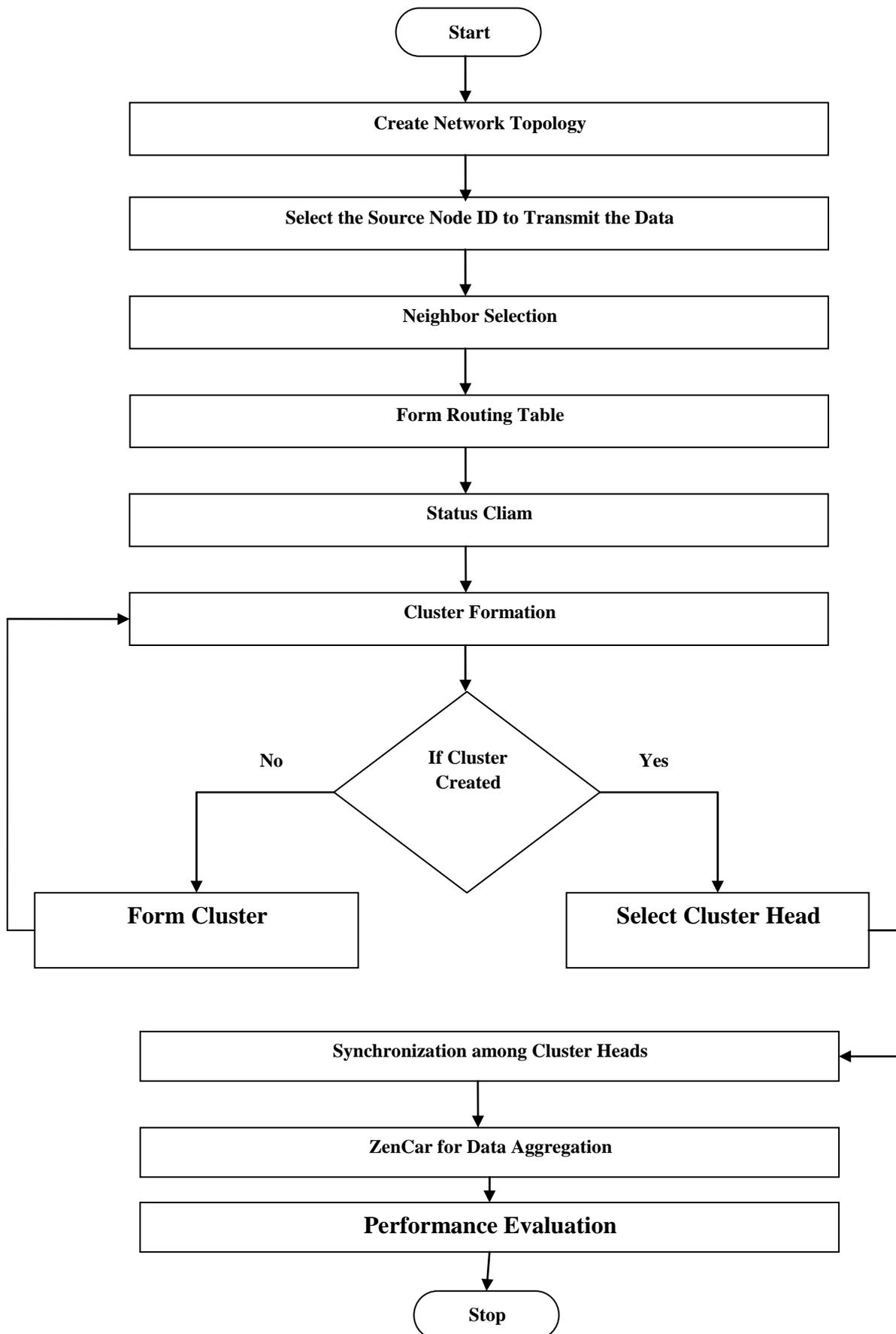
Collecting information reliably and efficiently from the nodes in a sensor network is a challenging problem, particularly due to the wireless dynamics. Multihop routing in a dynamic wireless environment requires that a protocol can adapt quickly to the changes in the network (agility) while the energy-constraints of sensor networks dictate that such mechanisms not require too much communication among the nodes (efficiency). CTP is a collection routing protocol, that achieves both agility and efficiency, while offering highly reliable data delivery in sensor networks.

CTP has been used in research, teaching, and in commercial products. Experiences with CTP has also informed the design of the IPv6 Routing Protocol for Low power and Lossy Networks (RPL).

Proposed System

We propose a three-layer mobile data collection framework, named Load Balanced Clustering and Dual Data Uploading (LBC-DDU). The main motivation is to utilize distributed clustering for scalability, to employ mobility for energy saving and uniform energy consumption, and to exploit Multi-User Multiple-Input and Multiple-Output (MU-MIMO) technique for concurrent data uploading to shorten latency. The main contributions of this work can be summarized as follows. First, we propose a distributed algorithm to organize sensors into clusters, where each cluster has multiple cluster heads. Second, multiple cluster heads within a cluster can collaborate with each other to perform energy efficient inter-cluster transmissions. Third, we deploy a mobile collector with two antennas (called SenCar in this paper) to allow concurrent uploading from two cluster heads by using MU-MIMO communication. The SenCar collects data from the cluster heads by visiting each cluster. It chooses the stop locations inside each cluster and determines the sequence to visit them, such that data collection can be done in minimum time.

Flow of System



Initialization Phase

In the initialization phase, each sensor acquaints itself with all the neighbors in its proximity. If a sensor is an isolated node (i.e., no neighbor exists), it claims itself to be a cluster head and the cluster only contains itself. Otherwise, a sensor, say, s_i , first sets its status as “tentative” and its initial priority by the percentage of residual energy. Then, s_i sorts its neighbors by their initial priorities and picks neighbors with the highest initial priorities, which are temporarily treated as its candidate peers. We denote the set of all the candidate peers of a sensor by A . It implies that once s_i successfully claims to be a cluster head, its up-to-date candidate peers would also automatically become the cluster heads, and all of them form the CHG of their cluster. s_i sets its priority by summing up its initial priority with those of its candidate peers. In this way, a sensor can choose its favorable peers along with its status decision.

Status Claim

In the second module, each sensor determines its status by iteratively updating its local information, refraining from promptly claiming to be a cluster head. We use the node degree to control the maximum number of iterations for each sensor. Whether a sensor can finally become a cluster head primarily depends on its priority. Specifically, we partition the priority into three zones by two thresholds, th and tm ($th > tm$), which enable a sensor to declare itself to be a cluster head or member, respectively, before reaching its maximum number of iterations. During the iterations, in some cases, if the priority of a sensor is greater than th or less than tm compared with its neighbors, it can immediately decide its final status and quit from the iteration.

We denote the potential cluster heads in the neighborhood of a sensor by a set B . In each iteration, a sensor, say, s_i , first tries to probabilistically include itself into $s_i:B$ as a tentative cluster head if it is not in already. Once successful, a packet includes its node ID and priority will be sent out and the sensors in the proximity will add s_i as their potential cluster heads upon receiving the packet. Then, s_i checks its current potential cluster heads. If they do exist, there are two cases for s_i to make the final status decision, otherwise, s_i would stay in the tentative status for the next round of iteration.

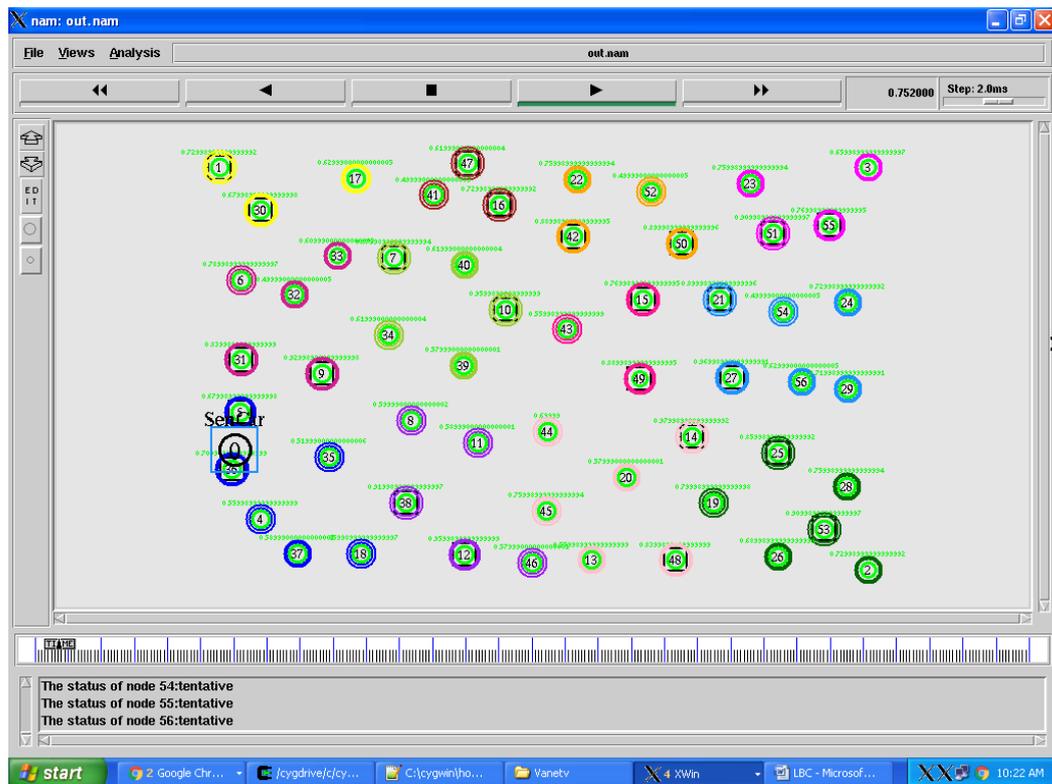
Cluster Forming

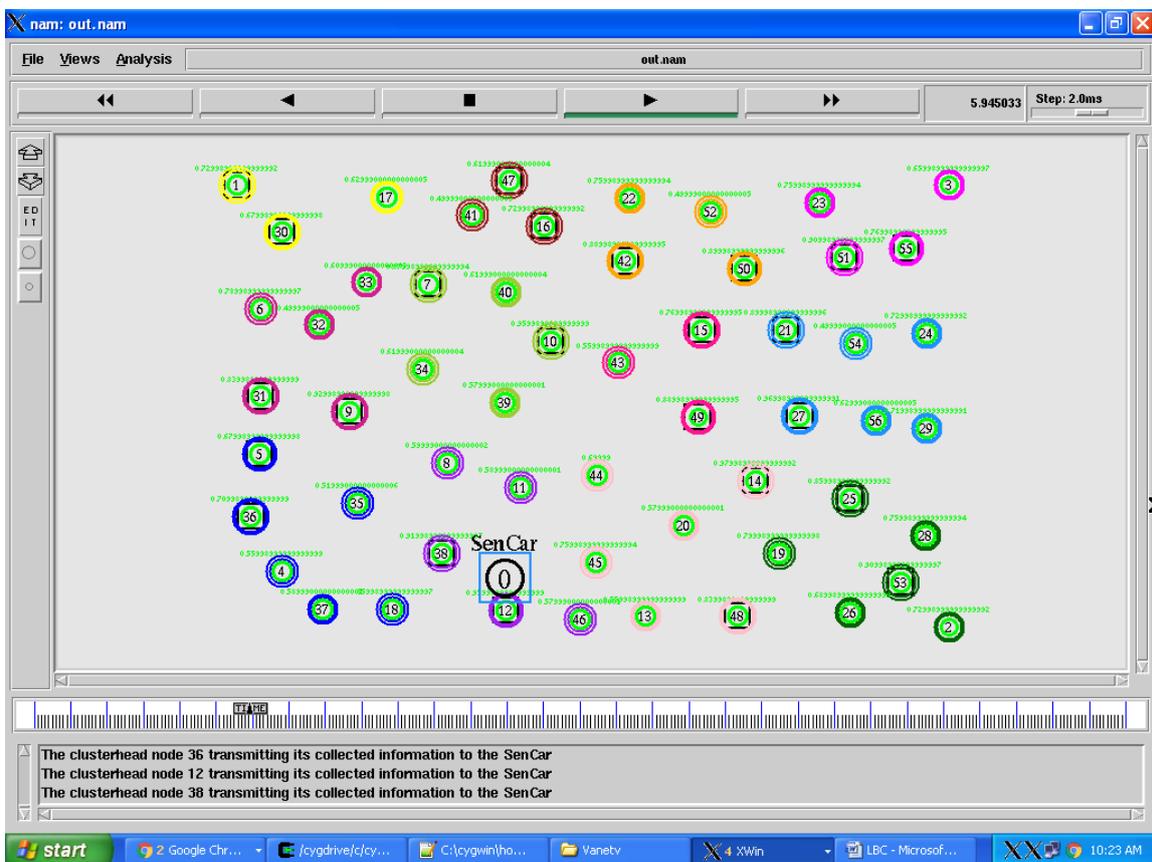
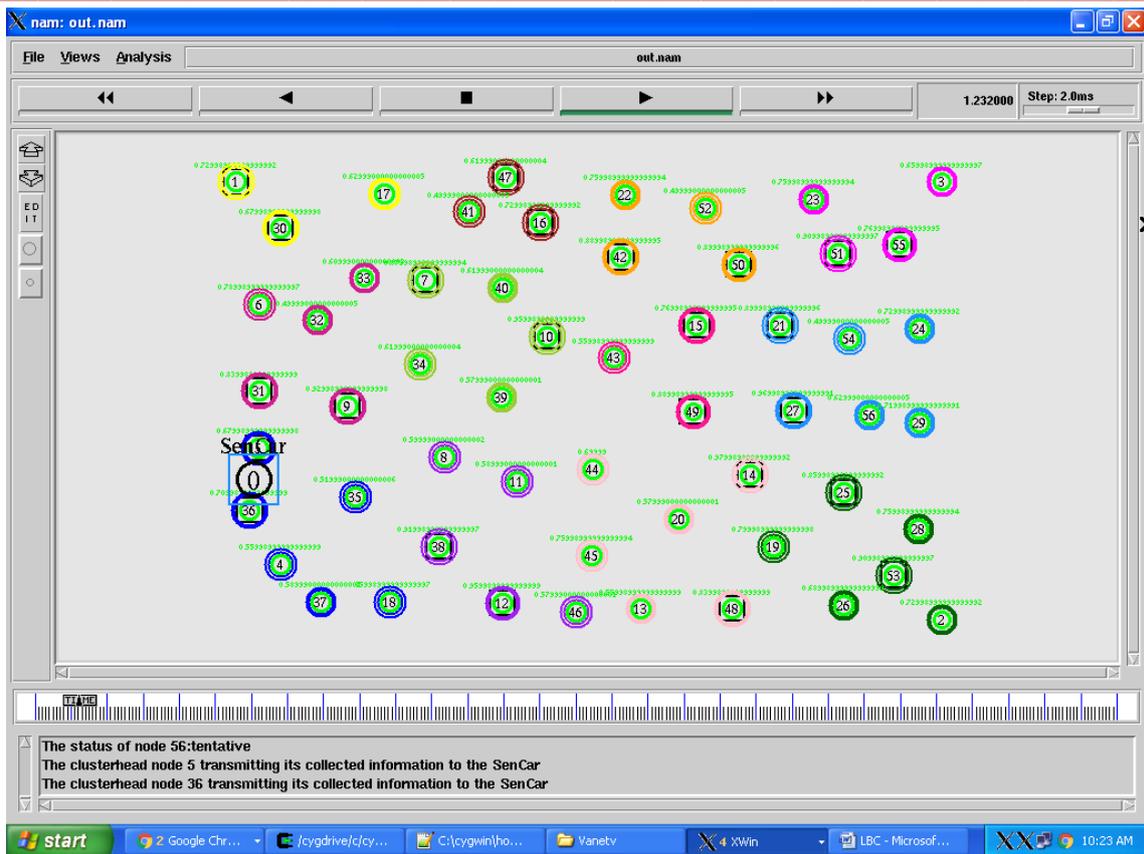
The third module is cluster forming that decides which cluster head a sensor should be associated with. The criteria can be described as follows: for a sensor with tentative status or being a cluster member, it would randomly affiliate itself with a cluster head among its candidate peers for load balance purpose. In the rare case that there is no cluster head among the candidate peers of a sensor with tentative status, the sensor would claim itself and its current candidate peers as the cluster heads.

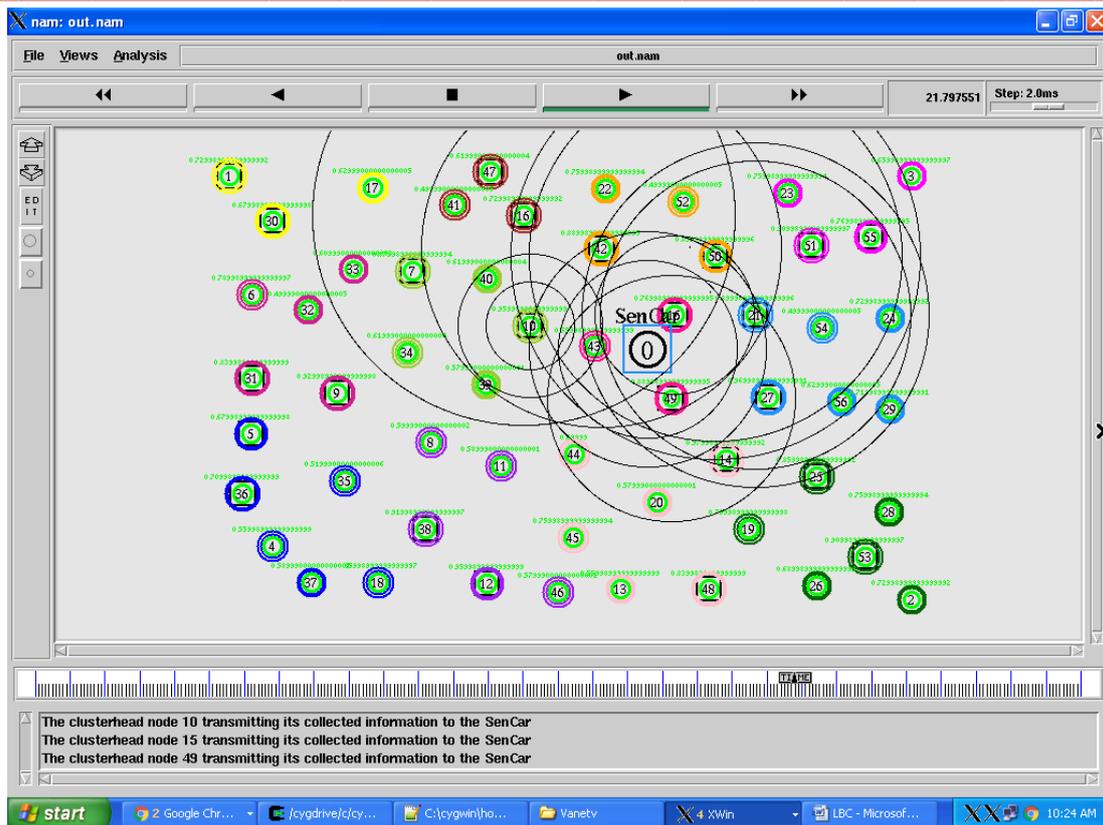
Synchronization among Cluster Heads

To perform data collection by TDMA techniques, intracluster time synchronization among established cluster heads should be considered. The fourth phase is to synchronize local clocks among cluster heads in a CHG by beacon messages. First, each cluster head will send out a beacon message with its initial priority and local clock information to other nodes in the CHG. Then it examines the received beacon messages to see if the priority of a beacon message is higher. If yes, it adjusts its local clock according to the timestamp of the beacon message. In our framework, such synchronization among cluster heads is only performed while SenCar is collecting data. Because data collection is not very frequent in most mobile data gathering applications, message overhead is certainly manageable within a cluster.

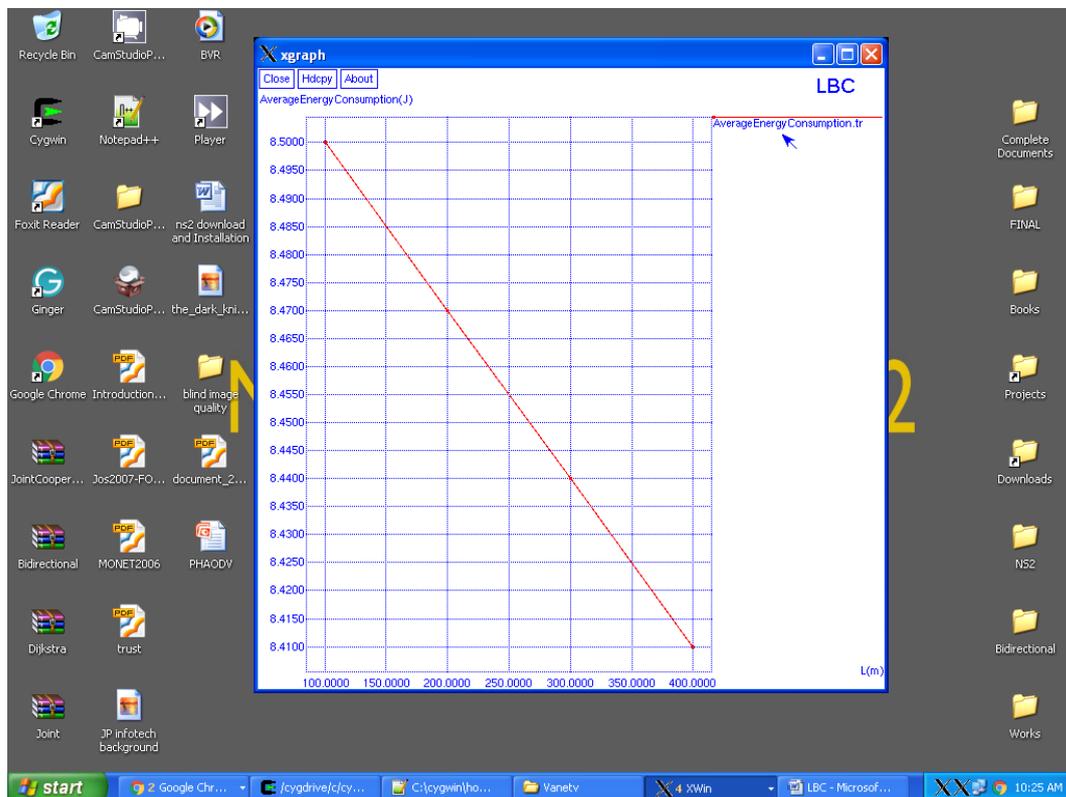
Simulation

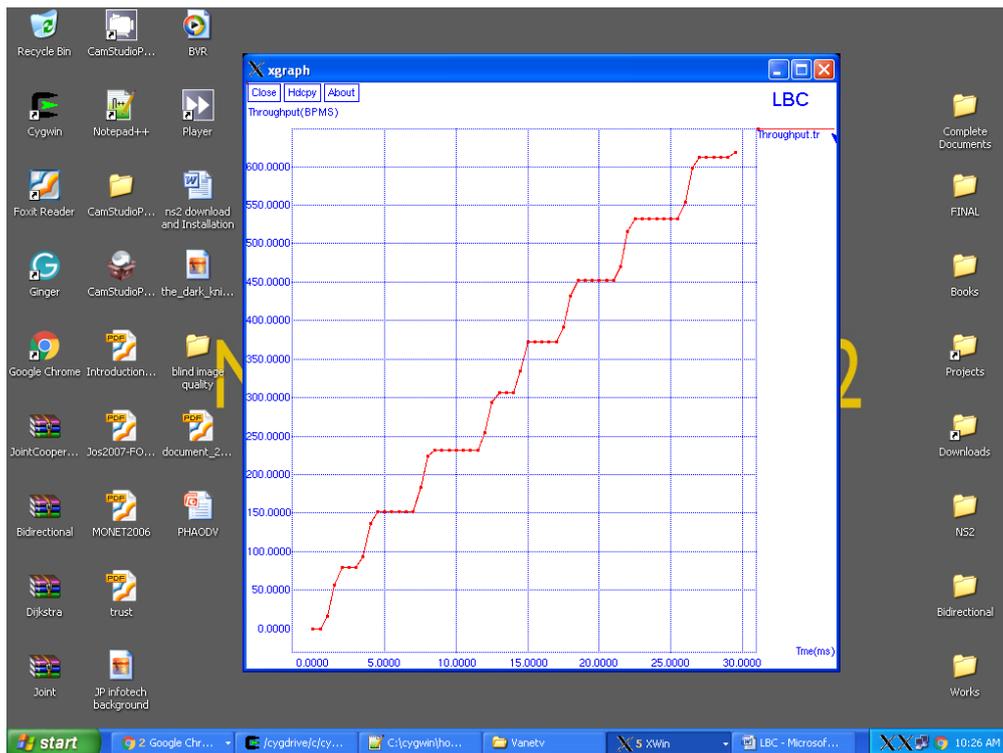
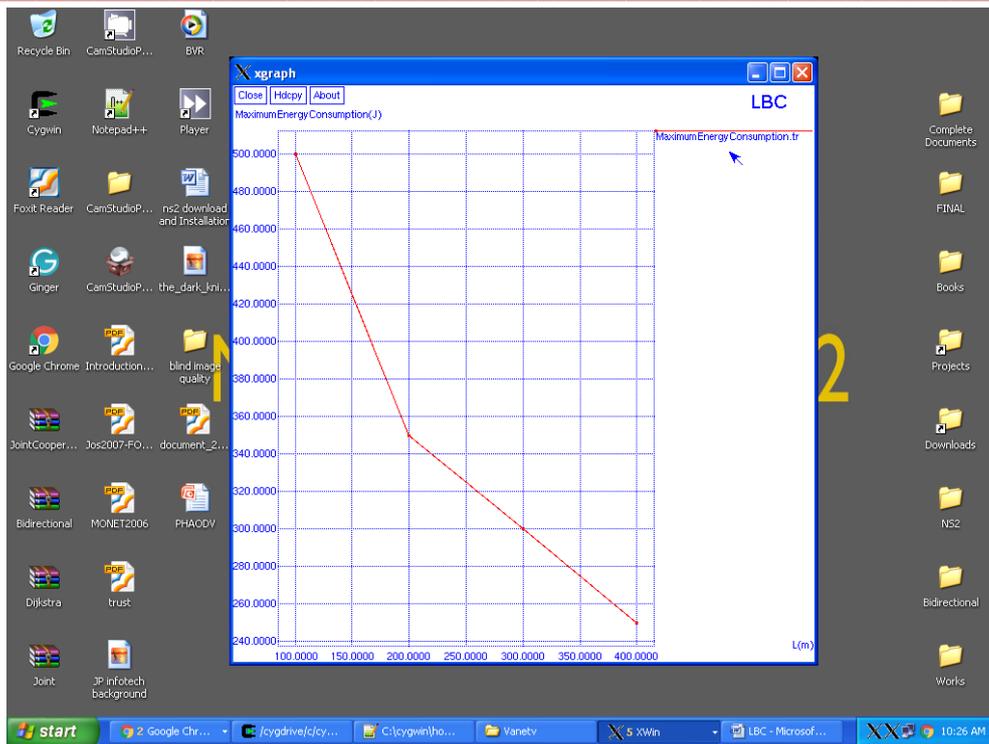


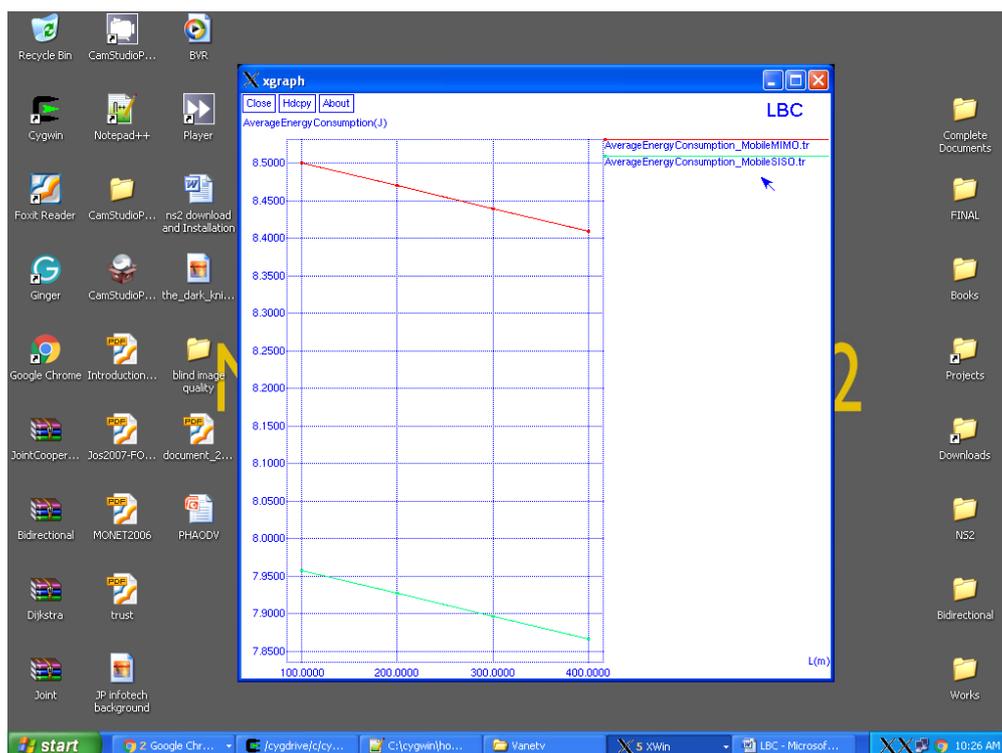
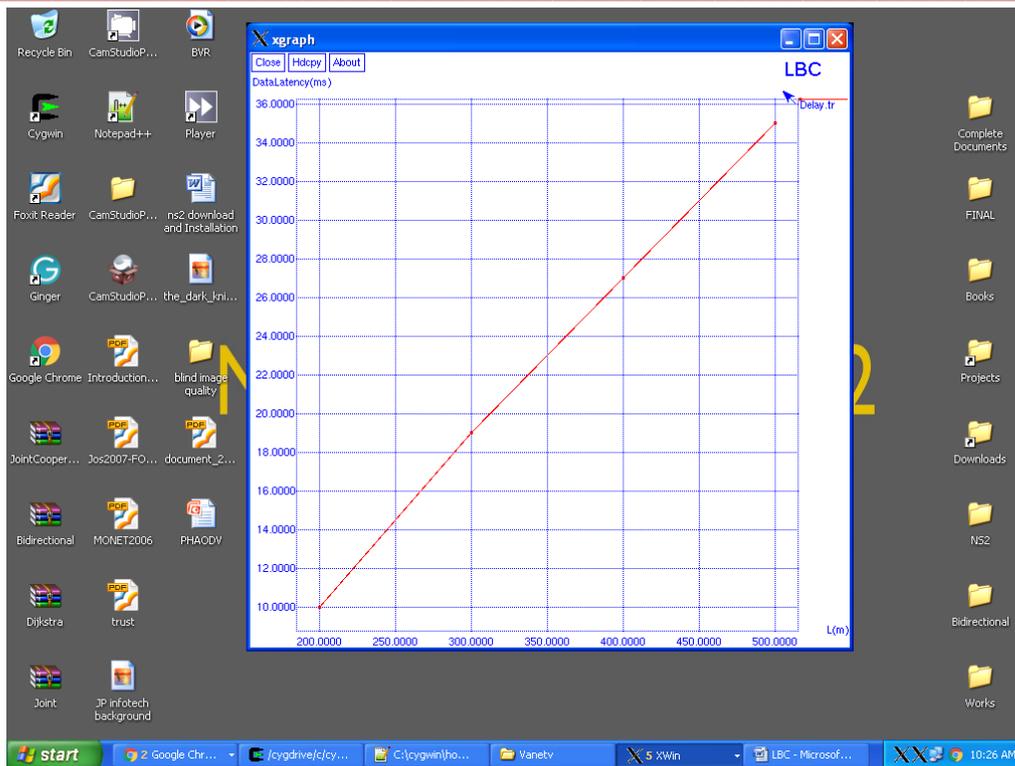




Experimental Results







Conclusion

In this paper, we have proposed the LBC-DDU framework for mobile data collection in a WSN. It consists of sensor layer, cluster head layer and SenCar layer. It employs distributed load balanced clustering for sensor self-organization, adopts collaborative inter-cluster communication for energy-efficient transmissions among CHGs, uses dual data uploading for fast data collection, and optimizes SenCar's mobility to fully enjoy the benefits of MU-MIMO. Our performance study demonstrates the effectiveness of the proposed framework. The results show that LBC-DDU can greatly reduce energy consumptions by alleviating routing burdens on nodes and balancing workload among cluster heads, which achieves 20 percent less data collection time compared to

SISO mobile data gathering and over 60 percent energy saving on cluster heads. We have also justified the energy overhead and explored the results with different numbers of cluster heads in the framework. Finally, we would like to point out that there are some interesting problems that may be studied in our future work. The first problem is how to find polling points and compatible pairs for each cluster. A discretization scheme should be developed to partition the continuous space to locate the optimal polling point for each cluster. Then finding the compatible pairs becomes a matching problem to achieve optimal overall spatial diversity. The second problem is how to schedule MIMO uploading from multiple clusters. An algorithm that adapts to the current MIMO-based transmission scheduling algorithms should be studied in future.

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