iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** VI **Month of publication:** June 2018

DOI: http://doi.org/10.22214/ijraset.2018.6075

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue VI, June 2018- Available at www.ijraset.com

Load Balancing in Mobile Sink Path Strategy for Wireless Sensor Network

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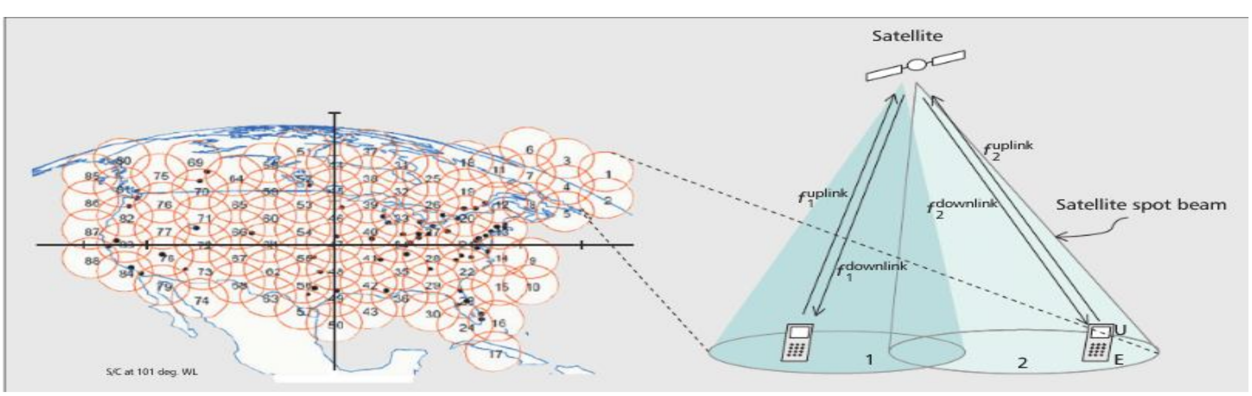
Abstract: According to mobile data collection in wireless sensor communication regulatory bodies have recently granted distributed load balanced clustering and dual data uploading, which is referred to as LBC-DDU. In this paper we study the problem of detecting and eliminating redundancy in a sensor network with a view to improving energy efficiency, while preserving the network's coverage. Multiple cluster heads within a cluster cooperate to perform energy saving inter cluster communications. Through intercluster transmissions, cluster head information is forwarded to Satellite for its moving trajectory planning. We reduce both problems to the computation of lower bounds on and present efficient distributed algorithms for computing and maintaining solutions in cases of sensor failures or insertion of new sensors. Nodes can be sleep to extend the lifespan of the network without compromising neither area coverage nor network connectivity. This paper addresses the area coverage problem with equal sensing and communication. The goal is to minimize the number of active sensors involved in coverage task, while computing a connected set able to report to monitoring stations. Our solution is fully localized, and each sensor is able to make decision on whether to sleep or to be active based on two messages sent by each sensor.
Key words: Wireless sensor networks (WSNs), data collection, load balanced clustering, dual data uploading, Sensor networks, area coverage, network connectivity, localized algorithms.

I. INTRODUCTION

Recent advances in micro-electro-mechanical systems (MEMS), digital electronics, and wireless communications have enabled the development of low cost, low power, multifunctional

Sensor devices. These devices can operate autonomously to gather process and communicate information about their environments. A sensor network is a set of nodes in which a battery, a sensoring and a wireless communication device are embedded ([1]). Sensor networks are a special case of ad hoc networks with objects generally densely deployed either very close or inside a studied phenomenon. Sensor nodes are deployed over hostile or remote environments to monitor a target area. Therefore, their irreplaceable batteries imply energy to be the most important system resource. These objects are expected to work and collaborate as long as possible in order to send their collected data to one or more sink stations. These sinks, also called monitoring stations, are considered to have no limited battery and aim to collect information from sensor nodes in multi-hop manner. The lifetime of the network is the time during which the surface coverage is maintained. A point of the target surface is said to be covered if it is in the sensing range of an active sensor which can report to a sink. It means that the sensor network can accomplish its surveillance task while the set of connected components which contain monitoring stations covers the target area. To extend the network lifespan, some nodes are placed into sleep mode to save their energy. The issue consists in these nodes deciding themselves whether to turn off or not so that the whole area remains covered and the subset of active nodes connected.



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II. BRIEF OVERVIEW OF MOBILE SATELLITE SYSTEMS (MSS)

Satellite communication services can be classi-fied as fixed satellite services (FSS) and mobile satellite services (MSS). In this article, we focus on MSS, which represents the future of global satellite communication. The implementation of mobile satellite-based phone services goes back to the late 1970s. However, from a penetration point of view, satellite-based phone service has greatly suffered due to competition from cellular technology, which offers a reliable and affordable alternative that achieves near global cover-age.

A. Low Cost

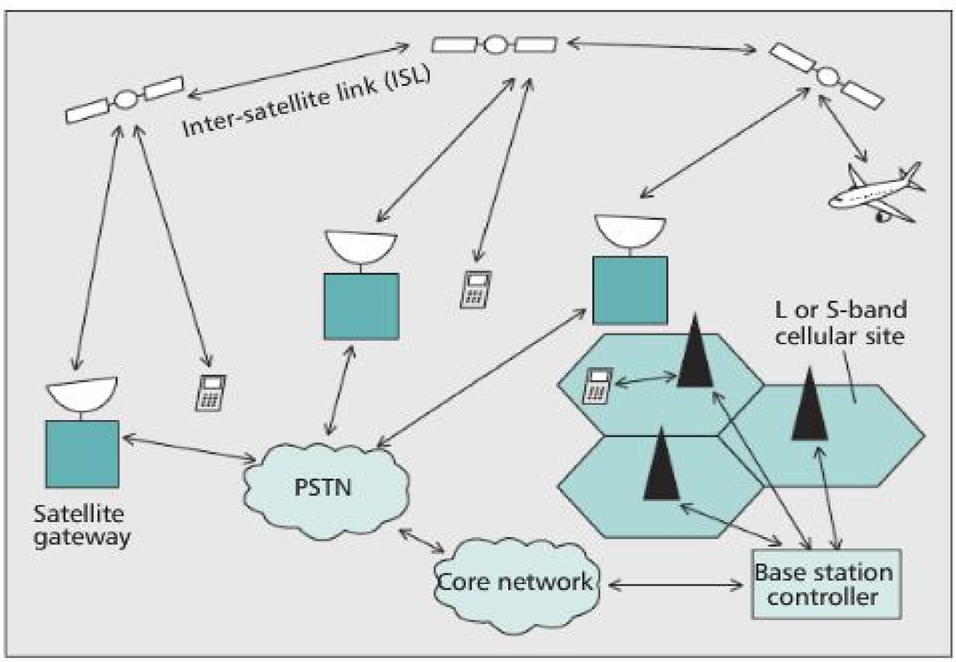
Cellular networks provide low-cost coverage for high-density populations in urban areas. Typically, voice calls from a satellite phone to a landline or a mobile phone varies from around 0.15 to 2 per minute. Spectral efficiency: This is a result of efficient frequency reuse in cellular networks.

B. Transparency

One of the main features of a truly integrated hybrid network is transparency. It is also one of the main requirements of the FCC for an MSS/ATC network. This means that moving from the satellite component to the ground com-ponent or vice versa should be transparent to the user (i.e., there should be no interruption in the service or any sudden change of any sort,including change in the level of power consump-tion of the user equipment). Although the defi-nition of transparency is quite simple and clear,achieving it is a challenging task.

C. Frequency Planning

One factor that can contribute significantly to interference between the satellite and terrestrial components is frequency reuse. Thus, an optimum frequency planning strategy should be used for frequency reuse among the satellite and ground components. In addition to mitigating interference, a good frequency reuse plan can help maximize the system capacity through optimum allocation of the spectral resources.



III. EFFICIENT COVERAGE

If each sensor knows the position of its node generators, it can easily detect its redundancy. Under specific assumptions on the network (bounded degree nodes), the expected number of nodes generators is constant, and the computation of the associated distributed detection takes constant time. The sensor then checks in constant time if its distributed detection are covered by the node neighbor that generated them. This verification takes constant time since the number of distributed detection nodes of a sensor is O(g), where g is the number of nodes generators of the sensor.

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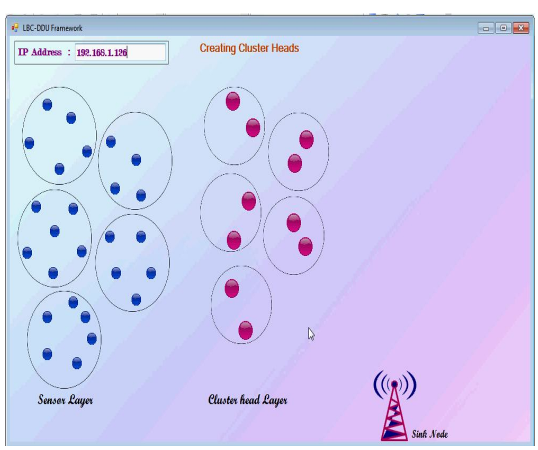
A. Network Load
We investigate the traffic generated in the network by insertions of new sensors and failure of existing ones. The messages generated are necessary to recompute the local Voronoi diagrams, and with it, the coverage-boundary and the redundant sensor information. As before, we assume that all the sensors have similar capabilities, which in this section is expressed by identical radio transmission ranges.

B. Lbc-Ddu Algorithm
The distributed load balanced clustering dual data uploading algorithm (LBC-DDU) at the sensor layer. The essential operation of clustering is the selection of cluster heads. To prolong network lifetime, we naturally expect the selected cluster heads are the ones with higher residual energy. Hence, we use the percentage of residual energy of each sensor as the initial clustering priority. Assume that a set of sensors, denoted by S = {sn}, are homogeneous and each of them independently makes the decision on its status based on local information. After running the LBC algorithm, each cluster will have at most M (>1) cluster heads, which means that the size of SYNCHRONIZE of each cluster is no more than M. Each sensor is covered by at least one cluster head inside a cluster. The LBC algorithm is comprised of four phases: (1) Initialization (2) Status claim (3) Cluster forming and (4)Cluster head synchronization.4.1Initialization Phase In the initialization phase, each sensor acquaints itself with all the neighbors in its proximity. If a sensor is an isolated node it claims itself to be a cluster head and the cluster only contains itself. Otherwise, a sensor si, first sets its status as “tentative” and its initial priority by the percentage of residual energy. Then, si sorts its neighbors by their initial priorities and picks M − 1 neighbors with the highest initial priorities, which are temporarily treated as its candidate peers.

C. Status Claim
In the second phase, each sensor determines its status by iteratively updating its local information, refraining from prompt claim 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.

D. Cluster Forming
The third phase 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 case a cluster head is running low on battery energy, re-clustering is needed. This process can be done by sending out a re-clustering message to all the cluster members. Cluster members that receive this message switch to the initialization phase to perform a new round of clustering.

E. Cluster Head Synchronization
The fourth phase is to synchronize local clocks by beacon messages. First, each cluster head will send out a beacon message with its initial priority and local clock information to other nodes synchronization. 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.



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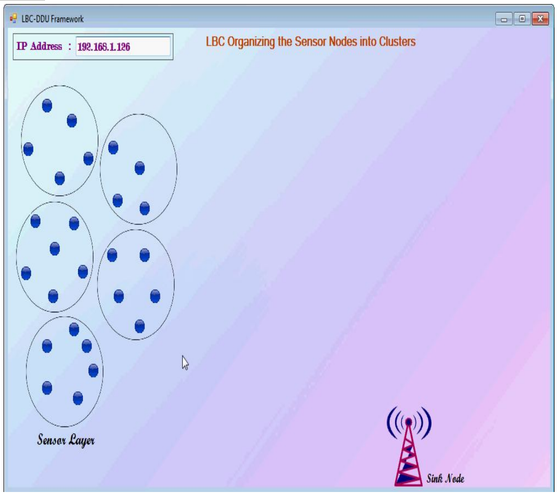

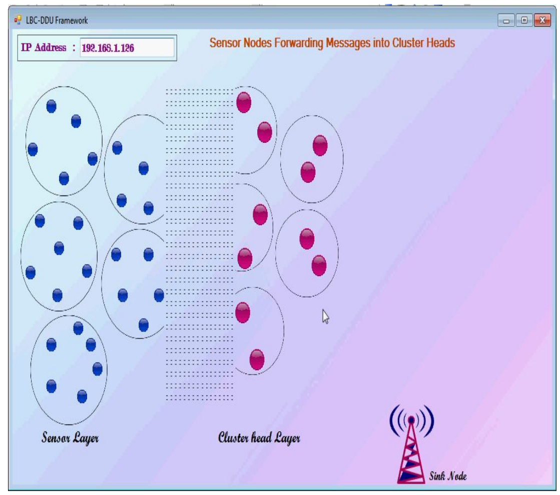

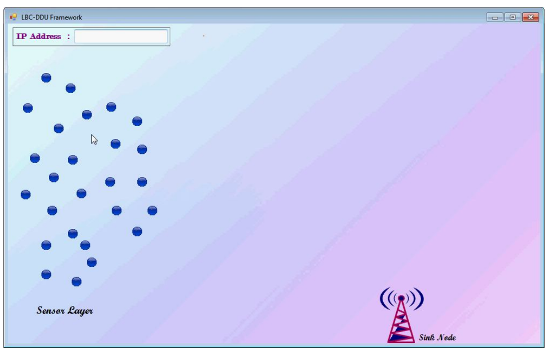

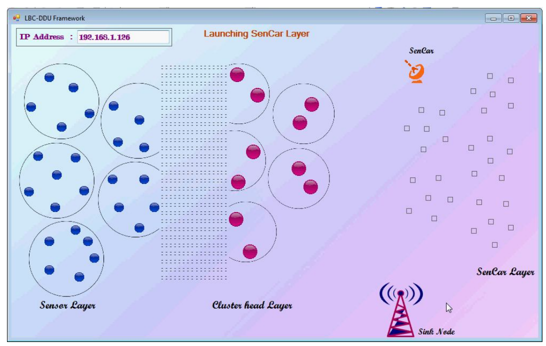

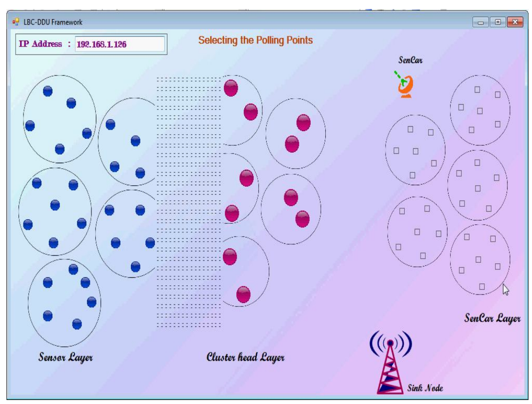

F. Sencar Layer

The sensor is equipped with two antennas, as it is not difficult to mount two antennas on Sencar, while it likely becomes difficult even infeasible to mount more antennas due to the constraint on the distances between antennas to ensure independent fading. Note that each cluster head has only one antenna. The multiple antennas of SenCar, which act as the receiving antennas in data uploading, make it possible for multiple cluster heads in a synchronize to transmit distinct data simultaneously. In other words, since SenCar is equipped with two receiving antennas, at most two cluster heads in a synchronize can simultaneously send data to SenCar. Once the selected polling points for each cluster are chosen, SenCar can finally determine its trajectory. The moving time on the trajectory can be reduced by a proper visiting sequence of selected polling points. it checks to see whether collecting data from the next polling point would cause any violations of deadline in its buffer. If yes, it immediately moves back to the data sink to upload buffered data and resumes data collection in the same way. By prioritizing messages with earlier deadlines, SenCar would do its best to avoid missing deadlines.

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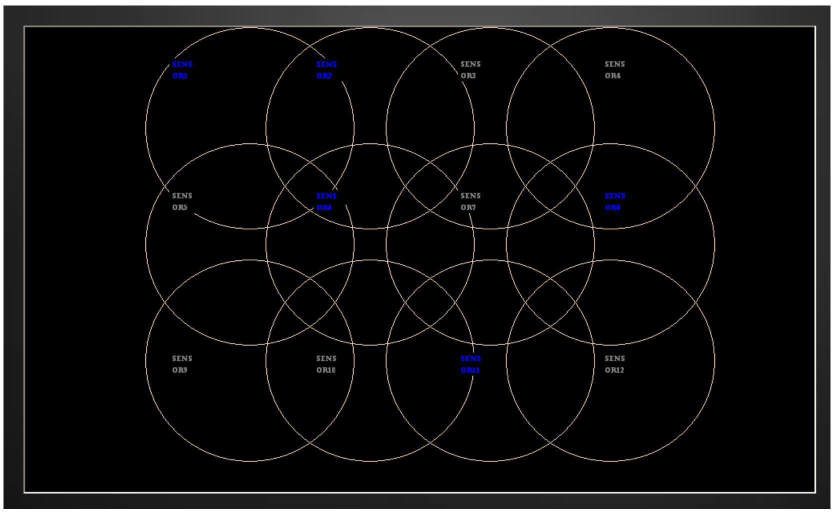
G. Performance Evaluations

In this section, we evaluate the performance of relay messages to a static data sink in multi-hops and we call it Relay Routing. Since nodes with higher battery energy provide more robustness and error immunity, sensors select the next hop neighbor with the forwarding messages to the sink. Once some nodes on a routing path consume too much energy, an alternative route will be chosen to circumvent these nodes. In this way, the relay routing method can provide load balance among nodes along the routing path.

IV. CONCLUSIONS

The LBC-DDU framework for mobile data collection in a WSN. It consists of three layers such as sensor, cluster head and SenCar layers. It employs distributed load balanced clustering for sensor self organization, And adopts collaborative intercluster communication for energy-efficient transmissions among synchronizes, and uses dual data uploading for fast data collection, can greatly reduce energy consumptions. It is done by all aviating routing burdens on nodes , balancing workload among cluster heads, which achieves 20% less data collection time compared to mobile data gathering and over 60% energy saving on cluster heads.



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