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A Review of Energy Sink-Hole Problem Occurred in k-Coverage Area in Wireless Sensor Network

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Abstract* — Data gathering is a fundamental task of WSN. It aims to collect sensor readings from sensory field at pre-defined sinks for analysis and processing. In wireless sensor network for a constant data reporting of the sensors which are nearer to the sink which are responsible for forwarding data to it on behalf of all other sensors in the network. These sensors suffer from a server battery power depletion problem, also known as the Energy Sink –Hole Problem. To overcome the problem of energy sink hole there occurs a system which provides the solution in k-coverage wireless network, where each point in a field of interest is covered by atleast k sensor. In that a use of Mobile Proxy Sinks that collects data from sources sensor and drop them off at the nearest immobile sink will be used. In this a mobility model moves the sinks node only upon the occurrence of an event according to the evolution of current events, so as to minimize the energy consumption incurs by the multihop transmission of the event- data

***Keywords* — Wireless sensor networks, k-coverage, data collection, energy sink-hole problem, mobility.**

I. INTRODUCTION

The design and development of large-scale wireless sensor networks (WSNs) for a variety of real-world applications, such as health and environmental monitoring, seism monitoring, industrial process automation, and battlefields surveillance, has become possible thanks to the advances in wireless communications and sensor technology. A WSN consists of low-powered sensors, which are physically small devices that have the capability of sensing the physical environment, collecting and processing data, and communicating with each other to accomplish certain tasks. Also, WSNs are commonly characterized by the presence of a central gathering point, called the sink, where all the data collected by the sensors reside. All the decision making process is run by the sink based on the collected data. The major challenge in the design of WSNs is mainly due to the inherent constraints imposed on the storage, processing, sensing, and communication capabilities of the sensors. In particular, the sensors have severely constrained power supplies, making them unreliable. In fact, they become faulty due to improper hardware functioning as well as low battery power (or energy).

There are two fundamental concepts in the design of WSNs, namely coverage and connectivity. In fact, data collection and routing suggest that a deployment field be covered and that the network be connected. The latter depends on the quality of coverage provided by the network. To enhance network reliability, k-coverage is an appealing solution, where each point in a deployment field is covered by at least k sensors at the same time, where k is a natural number such that $k \geq 1$. As it can be seen, k-coverage helps improve sensed data availability, which would enable the sink to make the best decision using data redundancy. To this end, k-coverage requires connectivity so sensed data can reach the sink. This fundamental problem in WSNs is referred to as connected k-coverage with $k \geq 1$. The challenge is to select a minimum subset of sensors to remain active in order to k-cover a field and ensure connectivity between all active sensors. In this type of duty-cycled WSN, connectivity is time-varying due to the fact that sensors may be on or off. Also, some sensors may deplete their energy and die. Thus, routing on duty-cycled sensors is challenging as those ones that are selected as next forwarders may not be on or have depleted all of their energy when data reached them. Sensors' power depletion may have a serious problem that affects the network performance. In particular, this problem gets aggravated in the case of immobile WSNs when some specific sensors deplete their energy. Indeed, the sensors nearer the sink are very critical to this problem as they act as the points of contact between the sink and the rest of the sensors in the network. It is easy to check that the sensors around the sink severely suffer from a battery power depletion problem. Those sensors are responsible for forwarding data on behalf of all other sensors in the network to the immobile sink. Thus, the death of those sensors may yield a coverage hole around the immobile sink, which prohibits the data from reaching it. This phenomenon is known as the energy sink-hole problem.

II. LITERATURE REVIEW

A. *Connected k-Coverage*

The problem of Energy Sink Hole Problem was also explained by Habib M. Ammari [1] and make use of *Mobile Proxy Sinks* to collect data from source sensors and drop them off at a central sink. The proposed architecture was three-tier that has immobile source sensors, immobile central sinks, and Mobile Proxy Sinks, the best mobility strategy of

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Mobile Proxy Sinks for the minimization of the total energy consumption for data collection was investigated. Then a joint mobility and routing schemes based on the number of immobile sinks and Mobile Proxy Sinks were proposed.

Habib M. Ammari , Sajal K. Das [2] address the problem of k-coverage in WSNs such that in each round, every location in a monitored field is covered by at least k active sensors while all active sensors are being connected. Firstly sufficient condition of the sensor in spatial density for complete k-coverage of a field was derived. Then relationship between the communication and sensing ranges of sensors to maintain both k-coverage of a field and connectivity among all active sensors was shown. Lastly, four configuration protocols to solve the problem of k-coverage in WSNs were proposed.

Habib M. Ammari, and Sajal K. Das [3] has focused on the connectivity and k-coverage issues in 3D WSNs. They had also proved that a 3D field is guaranteed to be k-covered if any Reuleaux tetrahedron region of the field contains at least k sensors and also computed the connectivity of 3D k-covered WSNs.

Habib M. Ammari [4] has consider the problem of k-coverage in mission-oriented mobile WSNs which is divide into two subproblems, namely sensor placement and sensor selection Th centralized and distributed approaches to solve the k-coverage problem in mission oriented mobile WSNs were specifically proposed. Also the solution to the sensor placement problem which is based on Helly's Theorem and the geometric analysis of the Reuleaux triangle was provided. In this a deterministic (or disk) sensing model, where the sensing range is modeled as a disk was provided.

Hung-Lung Wang Wei-Ho Chung [5] has investigated the coverage problem under a realistic model, the probabilistic sensing model, in which the probability of detection by a sensor decays with the distances. They generalize the coverage problem to the probabilistic sensing model and propose an algorithm to calculate the minimum degree of coverage. The generalized k-coverage problem is formulated, and the generalized k-coverage is physically interpreted as the minimum expected number of covering sensors among all points in the region of interest.

B. Energy Sink-Hole Problem

Haibo Zhang, Hong Shen, and Yasuo Tan [6] have investigated the problem of balancing energy consumption for data gathering sensor networks. There idea was to exploit the trade-off between hop-by-hop transmission and direct transmission to balance energy dissipation among sensor nodes. They used the concept by assigning each node a transmission probability which controls the ratio between hop-by-hop transmission and direct transmission, after that the energy consumption balancing problem as an optimal transmission probability allocation problem was formulated.

Guoliang Xing, Xiaorui Wang, Yuanfang Zhang, Chenyang Lu, Robert Pless, And Christopher Gill[7] has provided a design and analysis of novel protocols that dynamically configures a network to achieve guaranteed degrees of coverage and connectivity. Firstly a Coverage Configuration Protocol (CCP) which provides different degrees of coverage requested by applications was presented. Then the integration of CCP with SPAN was provided on both coverage and connectivity. And lastly a probabilistic coverage model and extend CCP to provide probabilistic coverage guarantees was proposed.

Weijia Jia, Tian Wang, Guojun Wang, Minyi Guo [9] has proposed a novel Hole Avoiding In advance Routing protocol (HAIR) to address energy consumption issue. In the proposed protocol, a data packet was design that can avoid meeting a "hole" by passing a hole when it meets the hole as existing Hole Avoiding Re-Routing protocols (HARR) do. They had proved that the proposed protocol will always find a routing path between a given source node and the sink if such a routing path does exist in the network. In this the proposed HAIR protocol will construct routing paths with shorter routing distance and less energy consumption.

Weihua Guo Zhaoyu Liu Guangbin Wu [8] has identified the drawbacks of two conventional data transmission protocols, in terms of balance of energy consumption. An approach to balance energy consumption, and present theoretical analysis and approximate methods of the pervious proposed approach were specifically proposed. The approach to balances the rate of energy consumption across the whole network well and increases the overall lifetime of the network was resulted.

III. RESEARCH METHODOLOGY

The research methodology is based on the four different modules which include the event driven module, coordinate sink head module, and central respiratory module. The working of each of the module will be explained in detail below.

A. Event Driven Mechanism

In an event-based strategy, a sink always moves toward the event region, i.e. the region with maximum data flow, in network. The objective is to shorten data transmission path, reduce sensors' overhead of relaying messages, eventually increase network lifetime. However, after the sink reaches the event node, it will stop there. In this case, the set of relaying nodes will remain unchanged and further energy balancing is prevented. A sink first moves toward event node then toward central node where data is gathered. When a sink moves away from an event node, while another moves close to it, the sensors sensing the event will report to the sink that yields larger energy gain. Each sensor node reactively initiates the data collection process after an event is sensed by the sensor node. It proposes controlled mobility for the mobile sink to improve the energy-efficiency of the mobile sinks in an event-driven sensor network.

B. Coordinate Sink Head Approach

In this module we provide two sinks. Moving Sink (MS) in Wireless Sensor Networks (WSNs) has appeared as a blessing because it collects data directly from the nodes where the concept of relay nodes is becomes obsolete. In our

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proposed scheme, we divide the circular field in small concentric circles. Middle point of the partitioned area is the location of the central gathering sink where the data is centrally gathered, and nodes around MPS (Mobile Proxy Sinks) are in its transmission range, which send directly the sensed data. Introduction of the joint mobility enhances network life and ultimately throughput. Two sinks are moving respectively (one after another). These two sinks start their journey for the data collection from the respective regions. One sink is collecting data at where the event has been occurred. In every circle sink will stop at the point of event occurrence and it will receive data from the nodes directly. When sink moves forward from the current location the nodes lying in that coverage area will observe sleep mode and the nodes which come under the new stop region will be awake and start transmission. Only those nodes will be active.

C. Central Respiratory Approach

Repository commonly refers to a location for storage, often for safety or preservation. The sensor networks have tendency to generate huge amount of data. The main aim of storing data locally is to get quick response for any query. In the Central Respiratory model, data will be transmitted by different sensors in WSN and would be received by nearest sink. In this module we mainly focused on the timing factor means the point at which the MPS (Mobile Proxy Sink) has to wait to a particular node to collect the data from that node is been stored centrally by the central sink .That means when a MPS (Mobile Proxy Sink) will be ready to travel and a go to the node where the event has been occurred the MPS (Mobile Proxy Sink) will know the time limit, upto what extend the data has to be collected, reducing the number of delays.

There occurs another concept of the authentication. Authentication of a node is an important part in any wireless network. Thus to make a MPS (Mobile Proxy Sink) authenticate we require the Certificate Authentication (CA). Again this module will be responsible to make the MPS (Mobile Proxy Sink) the authenticated so that the nodes which are in the coverage area are freely able to transfer their data to the MPS (Mobile Proxy Sink).

IV. CONCLUSION

Recent advances in inexpensive sensor technology and wireless communications have led to the design of cost – effective large – scale WSNs. Achieving k – coverage of a field of interest becomes a more challenging issue in WSNs. Thus a three-tier architecture that has immobile source sensors, immobile sinks, and Mobile Proxy Sinks were added in k-coverage area. An event driven mechanism proxy sink mobility strategy with a goal to minimize the total energy consumption due to data transmission by source sensors and its reception by a Mobile Proxy Sink is developed. To overcome the energy sink hole problem the event driven mechanism a with coordinate sink and central respiratory will be developed which will help in reducing the delays making the system more efficient as well as robust with an authenticated one as well as increasing the energy consumption.

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