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ENERGY EFFICIENT MULTIHOP QUALITY PATH BASED DATA COLLECTION IN WIRELESS SENSOR NETWORK

DATA COLLECTION WITH MOBILE SINK

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Abstract - In recent years there has been an increased focus on the use of sensor networks to sense and measure the environment. This leads to a wide variety of theoretical and practical issues on appropriate protocols for data sensing and transfer. Recent work shows sink mobility can improve the energy efficiency in wireless sensor networks (WSNs). However, data delivery latency often increases due to the speed limit of mobile sink. Most of them exploit mobility to address the problem of data collection in WSNs. The WSNs with MS (mobile Sink) and provide a comprehensive taxonomy of their architectures, based on the role of the MS. An overview of the data collection process in such a scenario, and identify the corresponding issues and challenges. A protocol named weighted rendezvous planning (WRP) which is a heuristic method that finds a near-optimal traveling tour that minimizes the energy consumption of sensor nodes. Focus on the path selection problem in delay-guaranteed sensor networks with a path-constrained mobile sink. Concentrate an efficient data collection scheme, which simultaneously improves the total amount of data and reduces the energy consumption. The optimal path is chosen to meet the requirement on delay as well as minimize the energy consumption of entire network. Predictable sink mobility is exploited to improve energy efficiency of sensor networks.

Keywords- Data Aggregation, Energy Efficiency, Mobile Sink, Data Collection, Wireless Sensor Network

I. INTRODUCTION

Recent research shows that significant energy saving can be achieved in mobility-enabled wireless sensor networks (WSNs) that visit sensor nodes and collect data from them via short-range communications. However, a major performance bottleneck of such WSNs is the significantly increased latency in data collection due to the low movement speed of mobile base stations. To address this issue, a rendezvous-based data collection approach in which a subset of nodes serves as rendezvous points that buffer and aggregate data originated from sources and transfer to the base station when it arrives. This approach combines the advantages of controlled mobility and in-network data caching and can achieve a desirable balance between network energy saving and data collection delay. An efficient rendezvous design algorithms with provable performance bounds for mobile base stations with variable and fixed tracks, respectively. The problem of data collection in sparse sensor networks is encountered in many scenarios such as monitoring physical environments such as tracking animal migrations in remote-areas, weather conditions in national parks, habitat monitoring on remote islands, city traffic monitoring etc. The objective is to collect data from sensors and deliver it to an access point in the infrastructure. These systems are expected to run unattended for long periods of time (order of months). The principal constraint is the energy budget of the sensors which is limited due to their size and cost.

In large-scale Wireless Sensor Networks (WSNs), leveraging data sinks' mobility for data gathering has drawn substantial interests in recent years. Current researches either focus on planning a mobile sink's moving trajectory in advance to achieve optimized network performance, or target at collecting a small portion of sensed data in the network. A large class of Wireless Sensor Networks (WSN) applications involves a set of isolated urban areas (e.g., urban parks or building blocks) covered by sensor nodes (SNs) monitoring environmental parameters. Mobile sinks (MSs) mounted upon urban vehicles with fixed trajectories (e.g., buses) provide the ideal infrastructure to effectively retrieve sensory data from such isolated WSN fields. Existing approaches involve either single-hop transfer of data from SNs that lie within the MS's range or heavy involvement of network periphery nodes in data retrieval, processing, buffering, and delivering tasks. These nodes run the risk of rapid energy exhaustion resulting in loss of network connectivity and decreased network lifetime.

II. LITERATURE SURVEY

2.1. Architecture of Wireless Sensor Networks with Mobile Sinks: Sparsely Deployed Sensors

In this paper, scheduling problems in node to sink transmission. Specifically, the tradeoff between the probability of successful information retrieval and node energy consumption cost, is studied. The optimization is formulated in the framework of dynamic programming. Our investigation is focused on sparsely deployed networks, where the simplified model of single node to sink transmission is considered. This simplified model facilitates the analysis and helps us to understand the fundamental rules behind the above mentioned tradeoff. The model does have practical value. While it may not always be true that only one sensor is within the communication range to the sink, it may be reasonably assumed that only one sensor in that range has packets of interest to the sink. Or assuming there are multiple wireless channels available, only one node will transmit in a specific channel. The sparsely deployed network model is particularly useful for the previously mentioned traffic surveillance application. The results in the paper serve as the foundation for the study of more sophisticated multiple nodes to sink transmission scheduling problems that rise in densely deployed networks

2.2. Power Optimization in Sensor Networks with a Path-Constrained Mobile Observer

Our primary contribution is to address communication power optimization in a network of randomly distributed sensors with an observer (data collector) moving on a fixed path. The key challenge in using a mobile observer is that it remains within range of any sensor for a brief period, and inability to transfer data in this period leads to data loss. We establish that the process of data collection can be modeled by a queue with deadlines, where arrivals correspond to the observer entering the range of a sensor and a missed deadline means data loss. The queuing model is then used as a design tool to identify the combination of system parameters that ensures adequate data collection with minimum power. The results obtained from the queuing analogy take a particularly simple form in the asymptotic regime of dense sensor networks. Additionally, for sensor networks that cannot tolerate data loss, we derive a tight bound on minimum sensor separation that ensures that no data will be lost on account of mobility.

In a mobile observer WSN, data loss occurs when the observer passes through a region of high local node density, so that not all sensors succeed in sending data to the observer while within range. This loss is inevitable if sensors are independently distributed over the network. However, some WSN applications cannot tolerate data loss. To extend the advantages of mobile data collection to such applications, we discover a constraint on minimum sensor separation that guarantees zero data loss with a mobile observer. The condition we derive is a sufficient condition for zero data loss, and although it is not necessary, we show that it is tight.

2.3. Mobile Element Scheduling For Efficient Data Collection in Wireless Sensor Networks with Dynamic Deadlines

In recent years there has been an increased focus on the use of sensor networks to sense and measure the environment. This leads to a wide variety of theoretical and practical issues on appropriate protocols for data sensing and transfer. In most cases the sensors are battery constrained which makes the problem of energy-efficiency of paramount importance. Both these deployments focus mainly on the problem of habitat and environment monitoring. One can also envisage scenarios where a sensor network is used to sense pollution levels at strategic locations in a large city. Naturally, there will be regions in which variation in pollution level will be more, such as industrial areas as compared to residential areas. To capture this behavior, the sensing rates of sensors at different positions will typically need to be different. The sensor nodes in regions with higher variation in the phenomenon need to sample more frequently. Wireless networks have historically considered support for mobile elements as an extra overhead. However, recent research has provided means by which network can take advantage of mobile elements. Particularly, in the case of wireless sensor networks, mobile elements are deliberately built into the system to improve the lifetime of the network, and act as mechanical carriers of data. The mobile element, which is controlled, visits the nodes to collect their data before their buffers are full. It may happen that the sensor nodes are sampling at different rates, in which case some nodes need to be visited more frequently than others. We present this problem of scheduling the mobile element in the network, so that there is no data loss due to buffer overflow.

2.4. Efficient Data Collection and Selective Queries in Sensor Networks

Efficient data collection in wireless sensor networks (SNs) plays a key role in power conservation. It has spurred a number of research projects focusing on effective algorithms that reduce power consumption with effective in-network aggregation techniques. Up to now, most approaches are based on the assumption that data collection involves all nodes of a network. There is a large number of queries that in fact select only a subset of the nodes in a SN. Thus, we concentrate on selective queries, i.e., queries that request data from a subset of a SN. The task of optimal data collection in such queries is an instance of the NP-hard minimal Steiner tree problem. We argue that selective queries are an important class of queries that can benefit from algorithms that are tailored for partial node participation of a SN. We present an algorithm, called Pocket Driven Trajectories (PDT), that optimizes the data collection paths by approximating the global minimal Steiner tree using solely local spatial knowledge. We identify a number of spatial factors that play an important role for efficient data collection, such as the distribution of participating nodes over the network, the location and dispersion of the data clusters, the location of the sink issuing a query, as well as the location and size of communication holes. In a series of experiments, we compare performance of well-known algorithms for aggregate query processing against the PDT algorithm in partial node participation scenarios. To measure the efficiency of all algorithms, we also compute a near-optimal solution, the globally approximated minimal Steiner tree.

2.5. Scalable Data Collection Protocols for Wireless Sensor Networks With Multiple Mobile Sinks

In this work investigate sink mobility as a method for efficient, scalable and robust data delivery in wireless sensor networks. Our work is one of the first few attempts in the relevant state of the art that introduces multiple mobile sinks. We investigate several important performance properties of our protocols through a detailed, large scale simulation evaluation. We emphasize in examining the effect of having different degrees of mobility and on the scalability of increasing the number of sinks, mainly with respect to the delivery delay. Our findings demonstrate that by lightly increasing the number of mobile sinks we can greatly reduce the delivery delay, without introducing any additional energy overhead on the sensors. Even when having many static sinks, adding a number small of mobile sinks can significantly increase performance.

III. PROBLEM DESCRIPTION

Recently, sink mobility has become an important research topic in wireless sensor networks (WSNs). A wireless sensor network (WSN) is a large-scale ad hoc multi-hop network deployed (usually, at random) in a region of interest for surveillance purpose. One of its fundamental tasks is to gather sensor readings from the sensory field at data sinks. Research has shown that sensors near a sink deplete their battery power faster than those far apart due to the heavy overhead of relaying messages. Non-uniform energy consumption causes degraded network performance and shortened network lifetime. We address the problem of energy-efficient data collection by mobile sink in WSN.

Each sensor node has the capability to collect and process data, and to forward any sensed data back to one or more sink nodes via their wireless transceiver in a multihop manner. In addition, it is equipped with a battery, which may be difficult or impractical to replace, given the number of sensor nodes and deployed environment. These constraints have led to intensive research efforts on designing energy-efficient protocols. In multihop communications, nodes that are near a sink tend to become congested as they are responsible for forwarding data from nodes that are farther away. Thus, the closer a sensor node is to a sink, the faster its battery runs out, whereas those farther away may maintain more than 90% of their initial energy. This leads to non uniform depletion of energy, which results in network partition due to the formation of energy holes. As a result, the sink becomes disconnected from other nodes, thereby impairing the WSN. Hence, balancing the energy consumption of sensor nodes to prevent energy holes is a critical issue in WSNs.

A main reason of energy spending in WSNs relates with communicating the sensor readings from the sensor nodes (SNs) to remote sinks. These readings are typically relayed using ad hoc multihop routes in the WSN. A side effect of this approach is that the SNs located close to the sink are heavily used to relay data from all network nodes; hence, their energy is consumed faster, leading to a nonuniform depletion of energy in the WSN. This results in network disconnections and limited network lifetime. Network lifetime can be extended if the energy spent in relaying data can be saved.

The MS(s) may visit each SN and gather its data (single-hop communication) or may visit only some locations of the WSN and SNs send their data to MS through multihop communication. Apparently, since in the first solution only singlehop communication is required, energy consumption is minimized, however, at the expense of high data delivery delay. In the second solution, this delay is low but the energy consumption due to multihop communication is rather high. In addition, SNs should constantly be kept updated about the MS's current location thereby creating considerable routing overhead. A solution in between is to have SNs send first their data to a certain number of nodes (RPs) which buffer the received data and send them to MS when MS is within their transmission range or when they receive a query from MS asking for the buffered data. In the second approach, the MS does not necessarily pass near the RNs and the data stored at each RP are forwarded to MS by reversing the route of the received query packet. Note also that many of the previous works provide an on time delivery guarantee by bounding the length of MS trajectory.

The main trade-off that should be considered is between the delivery delay tolerated and the energy consumption due to multihop routing to the RNs. Another issue in all previous schemes is that there is no provision in case that RNs run out of energy. In that case, all SNs that send their data to these RNs cannot send their data to MS any longer. A local or even a global rebuilding of the routing structures may be required in order to by pass dead RPs.

3.1.Drawbacks

- Existing approaches involve either single-hop transfer of data from SNs that lie within the MS's range or heavy involvement of network periphery nodes in data retrieval, processing, buffering, and delivering tasks.
- These nodes run the risk of rapid energy exhaustion resulting in loss of network connectivity and decreased network lifetime.
- High broadcasting end to end delay.

IV.PROPOSED SYSTEM

Existing work has shown that sink mobility can improve the performance of WSNs. Mobile sinks are mounted on some people or animals moving randomly to collect information of interest sensed by the sensor nodes where the sink trajectories are random. In the scenarios where the trajectories of the mobile sinks are constrained or predetermined, efficient data collection problems are often concerned to improve the network performance. Path constrained sink mobility is used to improve the energy efficiency of single hop sensor networks which may be infeasible due to the limits of the path location and communication power. So, aiming at the data delivery problem in large-scale wireless sensor networks with mobile sinks which move along fixed paths with constant speed, we propose an efficient data collection scheme that simultaneously improves the total amount of data and reduces the energy consumption.

As a result, the problem, which is called rendezvous design, becomes selecting the most suitable RPs that minimize energy consumption in multihop communications while meeting a given packet delivery bound. A secondary problem here is to select the set of RPs that result in uniform energy expenditure among sensor nodes to maximize network lifetime. In this proposed system, we call this problem the delay-aware energy efficient path (DEETP). We show that the DEETP is an NP hard problem and propose a heuristic method, which is called weighted rendezvous planning (WRP), to determine the tour of a mobile-sink node. In WRP, the sensor nodes with more connections to other nodes and placed farther from the computed tour in terms of hop count are given a higher priority.

4.1. Weighted Rendezvous Planning (WRP) Technique

We propose a hybrid unconstrained movement pattern for a mobile sink with the aim of balancing the energy consumption of sensor nodes. Our approach makes the following contributions, as compared with the work reported in the literature.

• We prefer nodes that have a high degree. This is critical as sensor nodes in dense parts of a WSN generate the highest number of packets. Hence, giving priority to sensor nodes in these parts during tour computation will help to reduce congestion points, and in turn, reduces energy consumption and improves WSN lifetime. In addition, it helps to mitigate the energy-hole problem.

• We consider hop distance between sensor nodes and RPs as fewer hop counts reduce multihop transmissions. RP-UG minimizes network energy consumption by reducing the physical distance between sensor nodes and RPs. However, due to the existence of obstacles, physical distance is not a reliable indicator of energy consumption.

• Apart from node density and hop count, when using an SMT, we use virtual RPs in the final tour to increase performance, and we do not replace them with real sensor nodes. Replacing a virtual RP with a real sensor node in RD-VT and RP-UG effectively approximates an SMT with a shortest-path tree (SPT). We will show through simulation that, when SMT is used and virtual nodes are in the final tour, the energy consumption of nodes can be reduced considerably, as compared with using an SPT.

4.2. Optimized Delay Aware Path Selection Scheme (ODAPSS)

The excess data traffic may result in oversaturated which are not able to transmit all data to the mobile sink in the limited communication duration. We analyze an architecture based on mobility to address the problem of energy efficient and reduce data loss data collection in a sensor network. Recent research shows that significant energy saving can be achieved in mobility-enabled wireless sensor networks (WSNs) that visit sensor nodes and collect data from them via short-range communications. However, a major performance bottleneck of such WSNs is the significantly increased latency in data collection due to the low movement speed of mobile base stations.

A data collection scheme based on the multi-hop communication is designed to improve the amount of data and reduce energy consumption. Data collection at the sink node from the surrounding sensor nodes is an important step in most of the wireless sensor network (WSN) applications. Most of existing data gathering protocols work well only when the sensor nodes are relatively immobile. In this project, we propose an energy efficient data collection protocol, referred to as Optimized Delay Aware Path Selection Scheme (ODAPSS), for gathering data from mobile nodes. We introduce a dynamic cluster structure so that when a node has data to transmit for the sink, it is able to join the nearest cluster-head.

4.2.1. Network Assumption:

In the proposed model we assume that mobile sink node have enough energy, memory and processing power. During pause time mobile sink communicates with the sub sink or RP in two step process. In initial step it broadcasts a beacon frame to alert the sub sink nodes in the range to transmit data packet. Every node sets to send the packet to the mobile sink. In the second step every node that have set, they send their data packets to mobile sink with one hop or multi hop with clustering. Thus it continues until mobile sink reach certain position with constant direction path and speed.

Proposed protocol called ODAPSS aims at minimizing the overall network overhead and energy expenditure associated with the data retrieval process while also ensuring balanced energy consumption among SNs and prolonged network lifetime. This is achieved through building cluster structures consisted of member nodes that route their measured data to their assigned cluster head (CH). The CHs perform data filtering upon the raw data exploiting potential spatial-temporal data redundancy and forward the filtered information to their assigned RPs, typically located in proximity to the MS's trajectory.

4.3. ODAPSS Proposed Protocol Procedure

Step 1: Mobile Sink node issues data gathering request to a collection area A x B.
Step 2: A RP within the collection area is in charge for setting up an initial cluster network. Cluster length, defined as the transmission range between two RP nodes, of the initial group network is computed based on the total allowable communication time.
Step 3: The cluster length is dynamically adjusted to meet both the total allowable energy consumption and the packet loss ratio.
Step 4: MS node, RP Nodes, CH (Cluster head) nodes and CM (Cluster members) are aware of their physical locations.
Step 5: The maximum speed of MS is vm, which is much smaller than the speed that data travels in the network.
Step 6: Each member source si generates a chunk of data synchronously at a period of Di and the data chunks must be delivered to the RP through multihop CH on the basis of communication time within Di.
Step 7: A MS communicates with a node when it is at the location of the node. The time that takes a MS to receive all the data buffered by a RP is small compared to the deadline of data.
Step 8: The energy of MS is replenishable (e.g., by recharging batteries at the BS).

4.4. Advantages

- Proposed protocol mainly aims at maximizing connectivity, data throughput, and enabling penditure among SNs.
- Increased data throughput is ensured by regulating the number of RPs for allowing sufficient time to deliver their buffered data and preventing data losses.

Minimize inter cluster data overhead

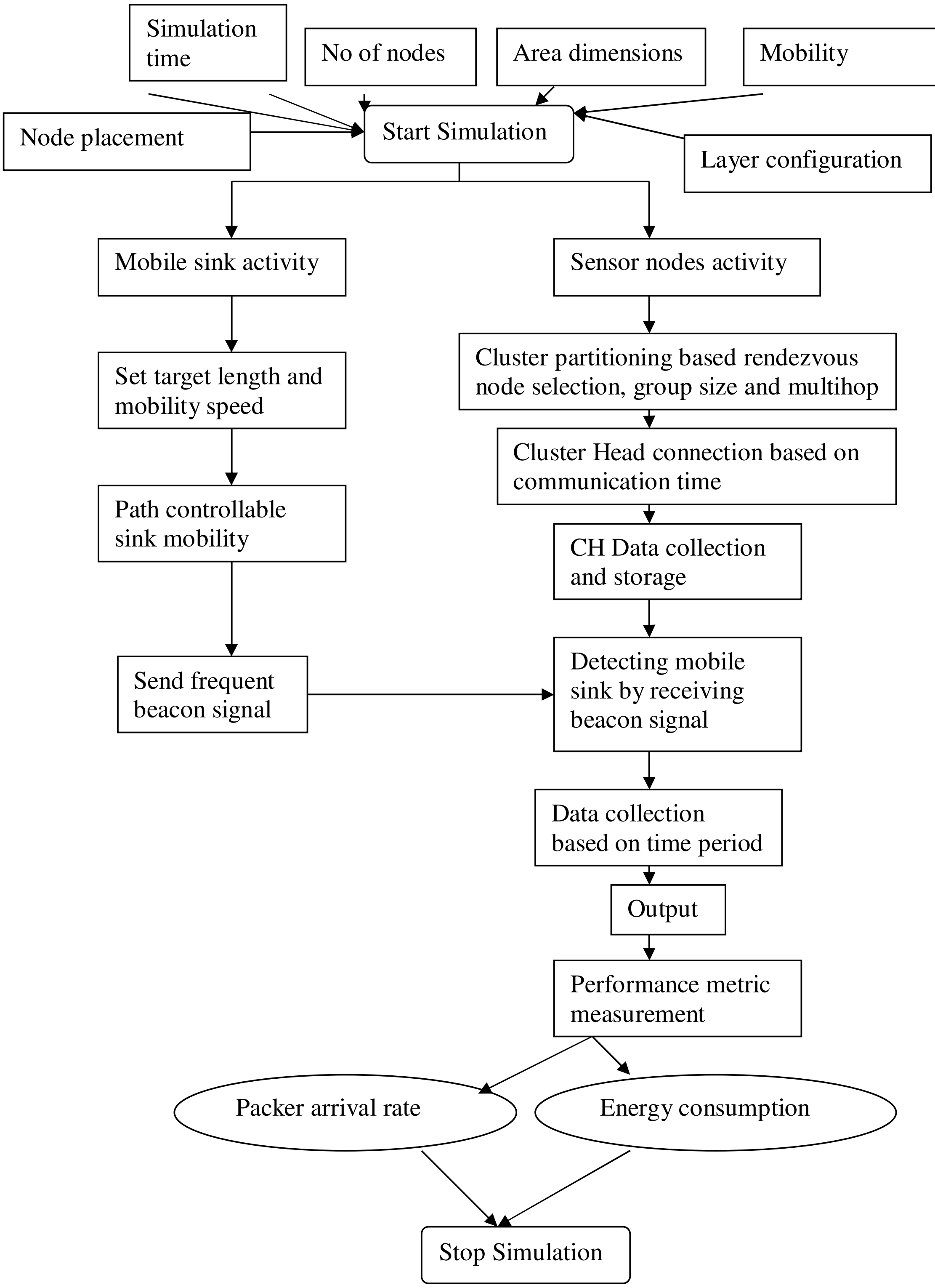

Figure 1.Architecture Diagram

V.CONCLUSION

In this paper, we have presented WRP, which is a novel algorithm for controlling the movement of a mobile sink in a WSN. WRP selects the set of RPs such that the energy expenditure of sensor nodes is minimized and uniform to prevent the formation of energy holes while ensuring sensed data are collected on time. In addition, we have also extended WRP to use an SPT and an SMT. Apart from that, we have also considered visiting virtual nodes to take advantage of wireless coverage. Our results, which are obtained via computer simulation, indicate that WRP-SMT reduces the energy consumption of tested WSNs by 22% in comparison to CB. We also benchmarked WRP against existing schemes in terms of the difference between sensor node energy consumption. As a future work, we plan to enhance our approach to include data with different delay requirements. This means a mobile sink is required to visit some sensor nodes or parts of a WSN more frequently than others while ensuring that energy usage is minimized, and all data are collected within a given deadline.

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