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Review on a Proactive Data Reporting SinkTrail Protocol for Wireless Sensor Network

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Abstract: In Wireless Sensor Networks (WSNs), trailing data sinks' mobility for data gathering has drawn popular in recent years. Recent researches will 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. In many application scenarios, however, a mobile sink cannot move freely in the deployed area. We propose energy efficient proactive data reporting protocols, SinkTrail for mobile sink-based data collection to avoid constant sink location update traffics when a sink's future locations cannot be scheduled in advance. SinkTrail distinguish our approach from previous ones: 1) allow sufficient flexibility in the movement of mobile sinks to dynamically adapt to various terrestrial changes; and 2) without requirements of GPS devices or predefined landmarks, SinkTrail establishes a logical coordinate system for routing and forwarding data packets, making it suitable for diverse application scenarios. We systematically analyse the impact of several design factors in the proposed algorithms. Both theoretical analysis and simulation results demonstrate that the proposed algorithms reduce control overheads and yield satisfactory performance in finding shorter routing paths.

Keywords: Wireless sensor network, Sink, Routing, GPS, Mobile sink.

I. INTRODUCTION

Wireless Sensor Network (WSN) is a type of wireless network, consists of a collection of *sensor nodes*. Sensor node performs following tasks; (i) sample a physical quantity from the surrounding environment, (ii) process (and possibly store) the acquire data, and (iii) transfer them through wireless communications to a data collection point called *sink node* or *base station*. Wireless sensor network with sensor nodes work together to detect a region to collect data about environment. Typical WSNs are composed of a large number of sensor nodes which transmit the sensed information to the sink. Since a sensor node is constrained by a device with limited power supply, recharging sensor nodes is often infeasible. One of the most important challenges in large-scale WSNs is energy efficient algorithms, since sensor nodes have restricted energy. For example, if some sensor nodes fail due to insufficient power, then WSNs may not fulfill their functions properly. Therefore, less energy consumption of sensor nodes and maximize the lifetime of the entire network have significant importance in the design of sensor network protocols. So focus on data collection concludes that allowing and leveraging sink mobility is more challenge full for energy efficient data gathering rather than reporting data through long, multihop count routes to a static sink. So using mobile sinks data gathering becomes new challenges to sensor network applications. Studying or scheduling movement patterns of a mobile sink to visit some special places in a deployed area in order to minimize data gathering time. In such cases a mobile sink moves to predetermined trail points and ask about data report to each sensor node individually. One more Mobile Elements Scheduling (MES) protocols have been proposed to achieve efficient data collection via controlled sink mobility [8], [10], [14], determining an optimal moving trajectory for a mobile sink is itself an NP-hard problem [8], and may not be able to adapt to constrained access areas and changing field situations. In this review paper, we introduce SinkTrail protocol which is self-predictable and proactive data reporting protocol for various application areas. In this protocol mobile sinks move in the deployed area continuously with low speed, and gather data. From existing data gathering protocols we introduced some Control messages that are broadcasted in much lower frequency.

II. RELATED WORK

A. Data sinks mobility is the most challenging part in sensor data collection which is to be effectively handling the control overheads introduced by a sink's movement. At the first look, multicasting is the most natural solution to track the moving mobile sink. This approach is sink oriented and in previous research efforts, e.g., [1], [4], [13], have demonstrated its effectiveness in collecting a small amount of data from the network [17]. The TTDD protocol, proposed in [12], constructed a two-tier data dissemination structure in advance to enable fast data forwarding [17]. In [3], a spatial-temporal multicast protocol is proposed to establish a delivery zone ahead of mobile sink's arrival [17]. Similarly, Park et al. [9] proposed DRMOS that divides sensors into "wake-up" zones to save energy [17]. Luo and Hubaux [7] proposed that a mobile sink should move following a circle trail in deployed sensor field to maximize data gathering efficiency [17].Disadvantage of the multicasting method is its flooding nature. Let us consider that mobile sinks move at a fixed velocity and fixed direction, or follow a fixed moving pattern, which largely confines their application. Another category of methods, called Mobile Element Scheduling (MES) algorithms [2], [8], [10], [11], [14], [15], [16], considered controlled mobile sink mobility and advanced planning of mobile sink's moving path [17]. Ma and Yang [8] focused on minimizing the length of each data gathering tour by intentionally controlling the mobile sink's movement to query every sensor node in the network [17].

B. Whenever data sampling rates in the network are heterogeneous, scheduling mobile sinks to visit hot-spots of the sensor network becomes helpful. Example algorithms can be found in [2], [11].MES algorithm is useful to reduce data transmission costs and in the sensor field they need a mobile sink to cover every node. Even worse, finding an optimal data gathering tour in general is itself an NP-hard problem [6], [8], and constrained access areas or obstacles in the deployed field pose more complexity [17]. For sink location prediction and selects data reporting routes SinkTrail uses greedy algorithm. In [5], keally et al. used sequential Monte Carlo theory to predict sink locations to enhance data reporting [17]. SinkTrail deploys a different prediction technique that has much lower complexity.

III. PROPOSED WORK

Once the data gathering process has been started, the mobile sink moves around in IN keeps listening for data report. Sensor are connected and achieved by deploying deeply. Sensor nodes are awaked by synchronization or wake up massage and then the actual data gathering process starts. To gather data from predetermined IN network, we periodically send out a number of mobile sinks into the field.Follwing Fig.1 shows overall module structure of SinkTrail protocol.

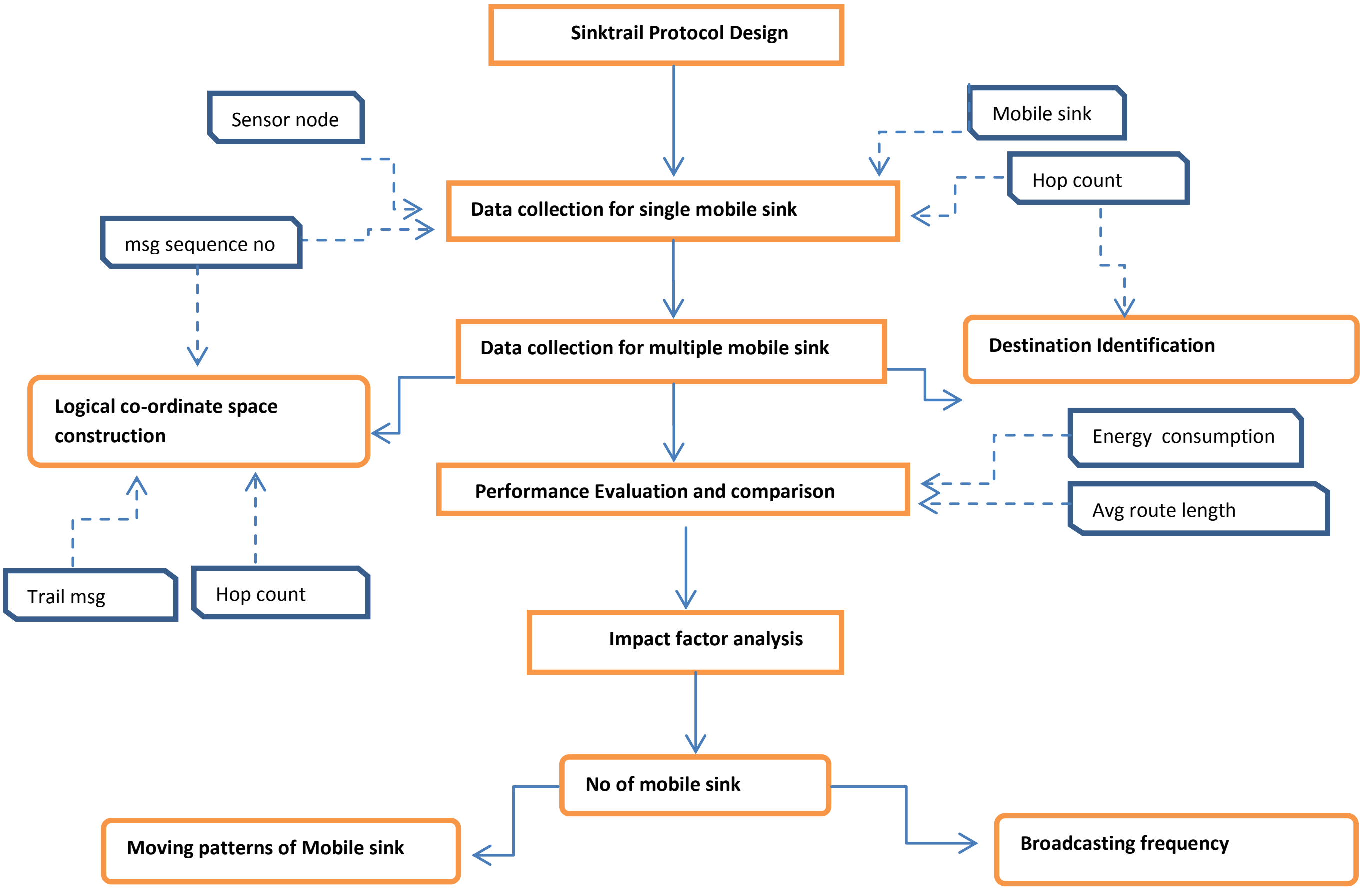

Fig 1.Abstract model diagram of SinkTrail.

SinkTrail protocol has been designed mainly into three modules:

1. *SinkTrail Protocol with One Mobile Sink*

The mobile sink moves around in IN keeps listening for data report packets when the data gathering process starts. Let us consider that $\bar{\tau}$ be the average transmission range. In network two adjacent trail points must be separated by a distance longer than$\bar{\tau}$, because the hop counts information will be significantly same. The distances between any two consecutive trail points are same (or similar), denoted as K$\bar{\tau}$, K>1. A mobile sink contains a trail message which contains sequence number (msg.seqN) and a hop count (msg.hopC) to the sink. In this protocol one "move" means the time interval between a mobile sink stops at one trail point and arrives at the next trail point. There may be multiple moves during a data gathering process. In the SinkTrail algorithm, another parameter use called as vectors i.e. "Trail References" to represent logical coordinates in a network. The trail reference maintained by each node is used for packet forwarding by indicating its location. All trail references should be of the same size.

In this protocol the data reporting procedure consists mainly three phases as follows.

1.1 *Logical Coordinate Space Construction*

The first phase is called logical coordinate space construction. During this phase, sensor nodes update their trail references corresponding to the mobile sink's trail messages. Initially all sensor nodes' trail references are initialized to [-1,-1,-1] of sized_v. To track the latest message sequence number a special variable λ that is used which is set to -1. After the mobile sink S enters the field, it moves to its first trail pointπ_1, and broadcasts a trail message to all the sensor nodes in IN [17]. The trail message, <msg.seqN, msg:hopC>, is set to <1, 0>, indicating that this is the first trail message from trail point one, and the hop count to S is zero. The adjacent node to S will be the first ones to listen this message. Then λ will be updated by the new sequence number by comparing with if this is a new message,. And noden_i's trail reference v_i is updated as follows: first, every element in v_i is shifted to left by one position. Then, the hop count in the received trail message is increased by one, and replaces the right-most element e_i^{dv} in v_i . After n_i updated its trail reference, this trail message is rebroadcasted with the same sequence number and an incremented hop count [17].

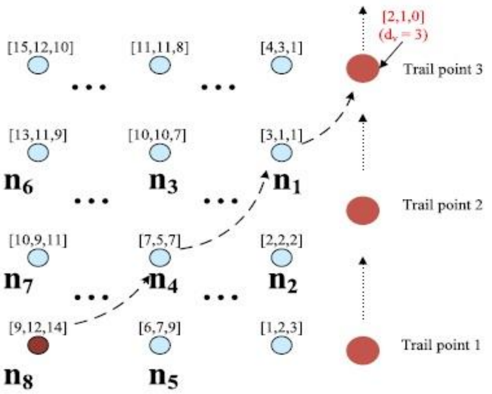

Fig 2 Example execution snapshot of SinkTrail: large solid dots indicate trail points and its moving path [17].

The same procedure repeats at all the other nodes in IN. The last hop count field in its trail reference is updated if a node receives a trail message with a sequence number equals toλ, but has a smaller hop count than it has already recorded, then, and this trail message is rebroadcasted with the same sequence number and an incremented hop count [17].Trail message that has sequence number less than λ will be discarded to eliminate flooding messages in the network.

1.2 *Destination Identification*

The mobile sink will stop at convenient locations according to current field situations. These sojourn places of a mobile sink, named trail points in SinkTrail, are footprints left by a mobile sink, and they provide valuable information for tracing the current location of a mobile sink [1]. One advantage of SinkTrail is that the logical coordinate of a mobile sink keeps invariant at each trail point, given the continuous update of trail references. This is because the mobile sink's hop count distance to its previous d_v-1 footprints are always K (d_v-1), K (d_v-2), K, and 0 to its current location. Therefore, the logical coordinate [K (d_v-1), K (d_v-2), 0] represents the current logical location of the mobile sink. We call this coordinate "Destination Reference." This destination reference does not necessarily require a mobile sink to have linear moving trajectory. Although arbitrary movement of a mobile sink may deteriorate the accuracy of destination reference, it can still serve as a guideline for data reporting [17]. Here, we set K = 1 and d_v=3 to ease our presentation. A large value of K means even less broadcast frequency.

In Fig.2, assume S is at the trail Point 3 now, and then its destination reference should be [2, 1, 0]. When S moves to the trail Point 4, the coordinate space is updated based on trail Points 2, 3, and 4, and destination reference of the mobile sink is still [2, 1, 0] [17].

1.3 *Greedy Forwarding*

Once a node has updated the three elements in its trail reference (we use d_v=3 for easy understanding and clear presentation), it starts a timer that is inverse proportional to the right-most element in its trail reference. For example, node n_5's trail reference is [6, 7, 9] in Fig. 3.2, then the duration of its timer is set to T_5=T_{init} $-\mu$ *9.Here, T_{init} and μ are predefined constants. The choice of timer function,T_{init}, and μ may vary. However, we assume the timer durations are significantly longer than the propagation time of a trail message, so that timers on all nodes are viewed as starting at the same time [17]. When a node's timer expires, it initiates the data reporting process. Every sensor node in the network maintains a routing table of size O (b) consisting of all neighbors' trail references. This routing table is built up by exchanging trail references with neighbors.

2 *SinkTrail Protocol with Multiple Mobile Sinks*

Our proposed SinkTrail protocol can be readily extended to multilink scenario with small modifications. When there is more than one sink in a network, each mobile sink broadcasts trail messages. A sender ID field, msg.sID, is added to each trail message to distinguish them from different senders. Algorithms executed on the sensor node side should be modified to accommodate multisink scenario as well. A sensor node maintains multiple trail references that each corresponds to a different mobile sink at the same time. Fig.3 shows an example of two mobile sinks. Two trail references, colored in black and red, existed in the same sensor node. In this way, multiple logical coordinate spaces are constructed concurrently, one for each mobile sink. When a trail message arrives, a sensor node checks the mobile sink's ID in the message to determine if it is necessary to create a new trail reference. In SinkTrail trail references of each node represent node locations in different logical coordinate spaces, when it comes to data forwarding, because reporting to any mobile sink is valid, the node can choose the neighbor closest to a mobile sink in any coordinate space.

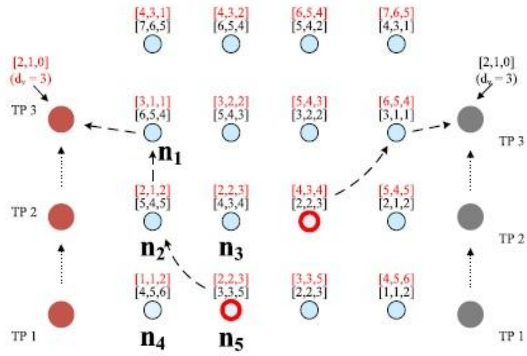

Fig.3 Example execution snapshot of SinkTrail of multiple mobile sinks scenario *[17]*.

Sink location in each logical coordinate space is still [2, 1, 0], as we use K = 1; d_v =3. If each mobile sink has a different K value, sensor nodes will calculate neighbors 'distances to multiple destination references and select route accordingly [1].

3. *Performance Analysis*

In NS2 message suppression can be implemented by using cluster based topology in personal computer running in fedora 13.Performance analysis can be measured based on the graph .Graph can be plotted based on

- Throughput=Amount of bytes received /Interval
- Packet Delivery Ratio=Total number of packets received/Total number of packet sent.
- Average Energy= The energy consumption can be reduced by controlling the message overheads.

IV. ADVANTAGES

1. SinkTrail uses logical coordinates to infer distances, and establishes data reporting routes by greedily selecting the shortest path to the destination reference.
2. SinkTrail is capable of adapting to various sensor field shapes and different moving patterns of mobile sinks

V. CONCLUSION

I have presented all the theoretical literature, SinkTrail, low-complexity, proactive data reporting protocols for energy-efficient data gathering. SinkTrail uses logical coordinates to infer distances, and establishes data reporting routes by greedily selecting the shortest path to the destination reference. SinkTrail is capable of tracking multiple mobile sinks simultaneously through multiple logical coordinate spaces. It possesses desired features of geographical routing without requiring GPS devices or extra landmarks installed. SinkTrail is capable of adapting to various sensor field shapes and different moving patterns of mobile sinks.

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