Load Balanced Data Delivery Using Mobile Sink in Wireless Sensor Network

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Abstract
Energy efficiency and load balancing is the main issue in wireless sensor network, because the batteries of the nodes near the sink deplete quicker than other nodes due to the data traffic like request and transfer of data towards the sink. To overcome this problem of efficiency many approaches where used and to overcome both problem like efficiency and load balancing mobile sink was introduced. Along with load balancing the data delivery should be fast and efficient. In this paper, we propose the routing protocol called ring routing with mobile sink which is distributed, energy-efficient mobile sink routing protocol, suitable for time-sensitive applications, which aims to minimize this overhead. Furthermore, we evaluate the performance of Routing via simulations.

Keywords
Mobile sinks, distributed routing, data dissemination, energy efficiency, mobility, wireless sensor networks.

I. Introduction

In wireless sensor networks (WSNs), energy efficiency[2] is considered to be a crucial issue due to the limited battery capacity of the sensor nodes. This problem generally affects the trustworthy nodes in the network. It may also deplete the whole wireless sensor network within a short time, the battery should work for long time without any interruption of human, since replacing the batteries of the sensor nodes requires significant effort. WSN packet forwarding approaches resulting in the concentration of data traffic towards the sinks, the nodes in the vicinity of the static sinks are more likely to deplete their batteries before other nodes, leading to the energy hole problem [1, 2], disruptions in the topology and reduction in the sensing coverage. Moreover, this problem could lead to the isolation of the sinks, hindering the delivery of the sensor data traffic. Mobile sinks are proposed and explored as a possible solution to this problem.

Load-balancing is implicitly provided by the sink mobility, shifting the hotspots around the sinks and spreading the increased energy drainage around the sink, which helps achieving uniform energy consumption that extends the network lifetime [5]. Sink mobility also has security benefits where the mobility makes the sinks more difficult to compromise than static sinks. An attack to the mobile sinks, e.g., sink destruction and sensitive information retrieval, would require an adversary to locate and chase down a mobile sink carrier. In addition, mobile sinks enhances the network connectivity by accessing the isolated portions of the network to retrieve data that might otherwise be inaccessible in a static sink case [6, 7].

Other than its advantages, the sink mobility brings about the problem of sink localization, requiring frequent advertisement of the changing sink position across the network. This operation may result in a significant overhead, which should be minimized to benefit from the energy savings introduced by the mobile sinks. An effective mobile sink routing protocol should also avoid an extreme increase in the sensor data delivery latencies. Especially for the time sensitive WSN applications, the validity of the sensor data depends on its freshness.

The WSN-based fire detection systems [8] deployed into a forest, habitat monitoring, smart houses and hospitals, pollution control, traffic monitoring, similarly in a battlefield surveillance scenario.

To further strengthen the advantages of mobile sinks, protocols employing controlled sink mobility, that guide the sinks to prioritize the areas with less residual energy, have been proposed [9], [10], [11]. Even though these approaches exhibit superior performance, their applicability is reduced since a controllable mobile sink might not always be available.

The advertisement of the mobile sink position to the network is a core problem for any routing protocol. The simplest mechanism to address this problem is flooding. However, flooding type mechanisms are known to introduce a high overhead due to frequent broadcast communications.

To minimize this overhead, hierarchical routing protocols have been proposed that determine a multi-tier hierarchy of roles among the nodes. The high-tier nodes acquire and store the fresh sink position. Low-tier nodes query them to retrieve the sink position whenever needed. Such an approach eliminates the need for network-wide sink advertisement and significantly decreases the advertisement overhead. In addition, by minimizing the need for broadcasts, the energy-efficiency of the network is enhanced, since every node in the transmitter's neighbour have to remain awake less often, decreasing the expenditure in the reception and the processing of the transmitted data.

Although the hierarchical architecture decreases the overall energy consumption in the network significantly, due to likeliness of increased traffic through the high-tier nodes, they may be subject to hotspot problems. Replacement of the high-tier nodes with the regular nodes during the WSN operation or adjusting the number of high-tier nodes to be relatively greater, results in the reduction of the extra load on each high-tier node by distributing it over a number of nodes. In this paper, we propose a novel hierarchical routing protocol for WSNs with a mobile sink, named Ring Routing.

II. System Model

In this section we consider the existing system design and the proposed system.

A. Existing System

WSN is that the network should be able to operate without human intervention for an adequately long time, since replacing the batteries of the sensor nodes requires significant effort. Due to the converge cast nature of traditional WSN packet forwarding approaches resulting in the concentration of data traffic towards the sinks, the nodes in the vicinity of the static (immobile) sinks are more likely to deplete their batteries before other nodes, leading to the energy hole problem, disruptions in the topology and reduction in the sensing coverage. Moreover, this problem could lead to the isolation of the sinks, hindering the delivery of the sensor data traffic. Sink mobility also has security benefits where the mobility makes the sinks more difficult to compromise than static sinks. The advertisement of the mobile sink position to the network is a core problem for any routing protocol. Network is increased traffic through the high-tier node, they may be subject to hotspot problems.

B. Proposed System

In this project, we propose a novel hierarchical routing protocol for WSNs with a mobile sink, named Ring Routing. We highlight some key features and the contributions of

- Ring Routing as follows:
- Ring Routing is a routing protocol targeted for large scale WSNs deployed outdoors with stationary sensor nodes and a mobile sink.
- Ring Routing establishes a virtual ring structure that allows the fresh sink position to be easily delivered to the ring and regular nodes to acquire the sink position from the ring with minimal overhead whenever needed.
- The ring structure can be easily changed. The ring nodes are able to switch roles with regular nodes by a straightforward and efficient mechanism, thus mitigating the hotspot problem.
- The mobile sink selects anchor nodes along its path and the anchor nodes relay sensor data to the sink.
- Ring Routing relies on minimal amount of broadcasts designed for WSNs [19].
- Ring Routing does not have any MAC layer requirements except the support for broadcasts.
- Ring Routing is suitable for both event-driven and periodic data reporting applications. It is not query based so that data are disseminated reliably as they are generated.
- Ring Routing provides fast data delivery due to the quick accessibility of the proposed ring structure, which allows the protocol to be used for time sensitive applications.
- No information about the motion of the sink is required for Ring Routing to operate. It does not rely on predicting the sink's trajectory, and is suitable for the random sink mobility scenarios.

III. Litertuare Survey

The lifetime of wireless sensor network is important, so to maximize the lifetime of the wireless sensor networks (WSNs) by using a mobile sink when the underlying applications tolerate delayed information delivery to the sink. Within a prescribed delay tolerance level, each node does not need to send the data immediately as it becomes available. Instead, the node can store the data temporarily and transmit it when the mobile sink is at the most favourable location for achieving the longest WSN lifetime. To find the best solution within the proposed framework, we formulate optimization problems that maximize the lifetime of the WSN subject to the delay bound constraints, node energy constraints, and flow conservation constraints. We conduct extensive computational experiments on the optimization problems and find that the lifetime can be increased significantly as compared to not only the stationary sink model but also more traditional mobile sink models. We also show that the delay tolerance level does not affect the maximum lifetime of the WSN[3].

Data gathering is a fundamental task of wireless sensor network (WSN). Recently, mobile sink has been exploited for data gathering in WSN to reduce and balance energy expenditure among sensors. How to energy-efficiently collect and transmit the data in case of multiple mobile sinks is a hot research topic. In this paper, we propose a multiple mobile sinks energy-efficient data collection (MSE^2DC) scheme for query-driven data delivery in tree-topology WSN and mobile cellular network (MCN) convergence system. In the system, user equipments (UEs) are equipped with WSN air-interface and act as mobile gateways to supervisory control the WSN data gathering and provide backhaul data links for the WSN. The WSN sensors are purposely activated for data delivery. By implementing the MSE^2DC, only necessary sensors should be activated for data delivery while the other sensors could keep sleeping to save energy consumption. Simulation results demonstrate that the significant energy saving of MSE^2DC[4].

Wireless sensor networks (WSN) have found their way into a wide variety of applications, like animal monitoring, Vehicle monitoring, Machine monitoring and Medical monitoring systems. In this paper we proposed a novel approach in handling the Hot Spot Problem with better connectivity and lifetime for a wireless sensor networks. We used variety of strategies in our experiments and came up with optimal solutions. Our smart Environment includes Sensor Area, Sensor Nodes, Base Station and Enemy Nodes.

Uneven energy depletion phenomenon noticed in sink-based wireless sensor networks. So we consider uniformly distributed sensors, each sending roughly the same number of reports toward the closest sink. We assume an energy consumption model governed by the relation E = dα +c where d, (d ≤ tx), is the transmission distance, α ≥ 2 is the power attenuation, c is a technology-dependent positive constant, and tx is the maximum transmission range of sensors. Our results are multifold. First, we show that for α> 2, all sensors whose distance to the sink is min{tx, (2c 1 α−2) α} should transmit directly to the sink. Interestingly, this limit does not depend on the size of the network, expressed as the largest distance R from a sensor to the closest sink. Next, we prove that in order to minimize the total amount of energy spent on routing along a path originating at a sensor in a corona and ending at the sink, all the coronas must have the same width, equal to the above expression. This choice, however, leads to uneven energy depletion and to the creation of energy holes. We show that for α>2 the uneven energy depletion can be prevented by judicious system design, resulting in balanced energy expenditure across the network. We describe an iterative process for determining the sizes of coronas. Their optimal sizes (and corresponding transmission radii) and the number of coronas depend on R. As expected, the width of coronas in energy-balanced sensor network increases. Finally, we show that for α =2, the uneven energy depletion phenomenon is intrinsic to the system and no routing strategy can avoid the creation of an energy hole around the sink.

IV. Design Construction

This Section consists of the following module design to form the ring routing protocol.

A. Ring Consruction

Ring Composition is dependent on the location information of the nodes, which is known to contain some incorrectness based on the developed technology. Monte- Carlo analysis to determine the successful ring construction likelihood under varying degrees of localization error. Network Center set the Radius for forming the closed loop containing several nodes. These nodes are called "Ring Nodes". Ring nodes are selected based on the distance of the node from the network authority. Monte-Carlo analysis is used for successful ring construction.

B. Advertisement of Sink Position

Initially, the sink selects the contiguous node as it's AN, and advertises an AN Selection (ANS) packet. Before the sink leaves the consultation range of the AN, it selects a new AN and informs the old AN of the position. Since now the old AN knows about the new AN, it can relay any data which is designed for it to the new AN. The current AN relays data packets directly to the sink. After a ring node receives an ANPI packet, it shares this information by sending an AN Position Information Share (ANPIS) packet to its clockwise and counter-clockwise ring neighbour.

C. Obtaining Sink Position From The Ring

Upon selection of a new AN, it sends an AN Position Information (ANPI) packet in the direction of the ring. If the AN is exterior to the ring, it sends the ANPI packet to the network center, and if it is internal to the ring, it sends it data towards a point which be inherent in the opposite direction of the network center. The source node sends an AN Position Information Request (ANPIREQ) packet in the direction of the ring. The ring node receiving the ANPIREQ packet generates an AN Position Information Response (ANPIRESP) packet which include the current AN's position and sends the data to the source node.

D. Data Delivery

In this module source node receives the response from the ANPIREQ. If the source node get the response from the anchor node it knows the position of the AN and can now send its message directly to it by geographic forwarding. If data reaches an old AN, that means that the AN has already changed by the time data has arrived at the destined AN, the follow-up mechanism is used to transmit data to the current AN.

V. Conclusions

In this paper, we proposed a novel mobile sink routing protocol, Ring Routing, by both considering the benefits and the drawbacks of the existing protocols. Ring Routing relies on minimal amount of broadcasts. Ring Routing is suitable for both event-driven and periodic data reporting applications. It is not query based so that data are disseminated reliably as they are generated. Ring Routing provides fast data delivery due to the quick accessibility of the proposed ring structure, which allows the protocol to be used for time sensitive applications. No information about the motion of the sink is required for Ring Routing to operate. Ring Routing is a hierarchical routing protocol based on a virtual ring structure which is designed to be easily accessible and easily reconfigurable. The design requirement of our protocol is to mitigate the anticipated hotspot problem observed in the hierarchical routing approaches and minimize the data reporting delays considering the various mobility parameters of the mobile sink.

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