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Low Cost Disposable Mobile Relays to Reduce the Total Energy Consumption of Data - Intensive WSN

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Abstract: ***Wireless Sensor Networks (WSNs) are increasingly used in data-intensive applications such as microclimate monitoring, precision agriculture, and audio/video surveillance. A key challenge faced by data-intensive WSNs is to transmit all the data generated within an application's lifetime to the base station despite the fact that sensor nodes have limited power supplies. We propose using low cost disposable mobile relays to reduce the energy consumption of data-intensive WSNs. Our approach differs from previous work in two main aspects. First, it does not require complex motion planning of mobile nodes, so it can be implemented on a number of low-cost mobile sensor platforms. Second, we integrate the energy consumption due to both mobility and wireless transmissions into a holistic optimization framework. So we proposed an energy efficient data gathering process through clustering method.***

Keywords: Wireless sensor networks, energy optimization, mobile nodes, wireless routing, data aggregation

1. Introduction

Wireless Sensor Networks (WSN) is a hybrid type of network where data sensed by the sensors is not collected continuously by the sink. Data has to be secured by every node until the next visit of the mobile sink. This inability to communicate with sink might be for reasons such as: limited transmission ranges, power constraints or signal propagation problems. The concept of WSNs with a mobile sink looks realistic if we consider the environments where the sensing field is too far from the base station and sending data through intermediate nodes may result in weakening the security (e.g., intermediate nodes may modify the data) or increase the energy consumption of the nodes close to the base station. In normal multi-hop Wireless Sensor Networks, power of the nodes placed near the sink will be depleted earlier than the other nodes. This is because all the nodes have to transmit the data to the sink through the nodes placed near the sink.

A WSN can be used to save the battery of these nodes and as a result increase the lifetime of the network Unattended environments as mentioned in include sensor networks for monitoring sound and vibration produced by troop movement, airborne sensor networks for tracking enemy aircrafts, LAN droids which retain information until soldiers move close to the network, sensor networks for monitoring nuclear emissions, national parks for discharge and illicit cultivation, etc. In many real world applications, critical data is collected and stored in the unattended nodes in hostile environments. The data should be accumulated until the next visit of the sink. The unattended nature of the network and the lack of tamper resistant hardware increase the susceptibility of attacks over the data collected by the sensors. Since the WSN scenario is different from the traditional WSN's, defense solutions from WSN security literature are not suitable for coping with a mobile adversary in WSN's. The sensors battery power is more limited compared to the battery power of the nodes in MANET's and hence the security protocols for MANETs are not effective for WSNs.

Data Aggregation Process

Data aggregation needs should be taken into account to ensure data protection (also called data survivability) in these sensors at the time of design. Distributed data collection schemes are preferable over centralized schemes, because centralized schemes are prone to single point failure. Data gathering is defined as the systematic collection of sensed data from multiple sensors to be eventually transmitted to the base station for processing. Since sensor nodes are energy constrained, it is inefficient for all the sensors to transmit the data directly to the base station. Data generated from neighboring sensors is often redundant and highly correlated. In addition, the amount of data generated in large sensor networks is usually enormous for the base station to process. Hence, need methods for combining data into high quality information at the sensors or intermediate nodes which can reduce the number of packets transmitted to the base station resulting in conservation of energy and bandwidth. This can be accomplished by data aggregation.

2. Literature Survey

We review different approaches, mobile base stations, data mules, and mobile relays that use mobility to reduce energy consumption in wireless sensor networks. We have also review cluster based routing scheme,data transmission method on clustering.Analyzing the three different approaches: Mobile base stations, data mules and mobile relays. All the three approaches use mobility to reduce energy consumption in wireless sensor networks.

2.1 Mobile Base Station

A mobile base station is a sensor node collects the data by moving around the network from the nodes [4]. In some work, in order to balance the transmission load, all nodes are performing multiple hop transmissions to the base station. The goal is to rotate the nodes which are close to the base station. Before the nodes suffer buffer overflows, the base station computes the mobility path to collect data from the visited nodes. Several rendezvous based data collection algorithms are proposed, where the mobile base station only visits a selected set of nodes referred to as rendezvous points within a deadline and the rendezvous points buffer the data from sources. High data traffic towards the base station is always a threat to the networks life time. [5]. The battery life of the base station gets depleted very quickly due to the sensor nodes which are located near to the base station relay data for large part of the network. The proposed solution includes the mobility of the base station such that nodes located near base station changes over time. All the above approaches incur high latency due to the low to moderate speed of mobile base stations.

2.2 DATA MULES

Data mules are another form of base stations. They gather data from the sensors and carry it to the sink. The data mule collects the data by visiting all the sources and then transmits it to the static base station through the network. In order to minimize the communication and mobility energy consumption the mobility paths are determined. In paper [6] the author analyses an architecture based on mobility to address the energy efficient data collection problem in a sensor network. This approach utilizes the mobile nodes as forwarding agents. As a mobile node moves in close propinquity to sensors, data is transmitted to the mobile node for later dumps at the destination.

In the MULE architecture sensors transmit data only over a short range that requires less transmission power. However, latency is increased because a sensor has to wait for a mule before its data can be delivered.

The Mule architecture has high latency and this limits its applicability to real time applications (although this can be mitigated by collapsing the MULE and access point tiers). The system requires sufficient mobility. For example, mules may not arrive at a sensor or after picking the data may not reach near an access-point to deliver it. Also, data may be lost because of radio-communication errors or mules crashing. To improve data delivery, higher-level protocols need to be incorporated in the MULE architecture. Data mules also introduce large delays like base stations since sensors have to wait for a mule to pass by before initiating their transmission.

2.3 Mobile Relay

In this approach, the network consists of three nodes such as mobile relay nodes along with static base station and data sources. To reduce the transmission cost relay nodes do not transport data rather it will move to different locations. We use the mobile relay approach in this work. .our approach reduces the energy consumption of both mobility and transmission. Our approach also relocates each mobile relay only once immediately after deployment. The paper study the energy optimization problem that accounts for energy costs associated with both communication and physical node movement. Unlike previous mobile relay schemes the proposed solution consider all possible locations as possible target locations for a mobile node instead of just the midpoint of its neighbors.

3. Proposed Work

In this paper, we use low-cost disposable mobile relays to reduce the total energy consumption of data-intensive WSNs. Different from mobile base station or data mules, mobile relays do not transport data; instead, they move to different locations and then remain stationary to forward data along the paths from the sources to the base station. Thus, the communication delays can be significantly reduced compared with using mobile sinks or data mules. Moreover, each mobile node performs a single relocation unlike other approaches which require repeated relocations.

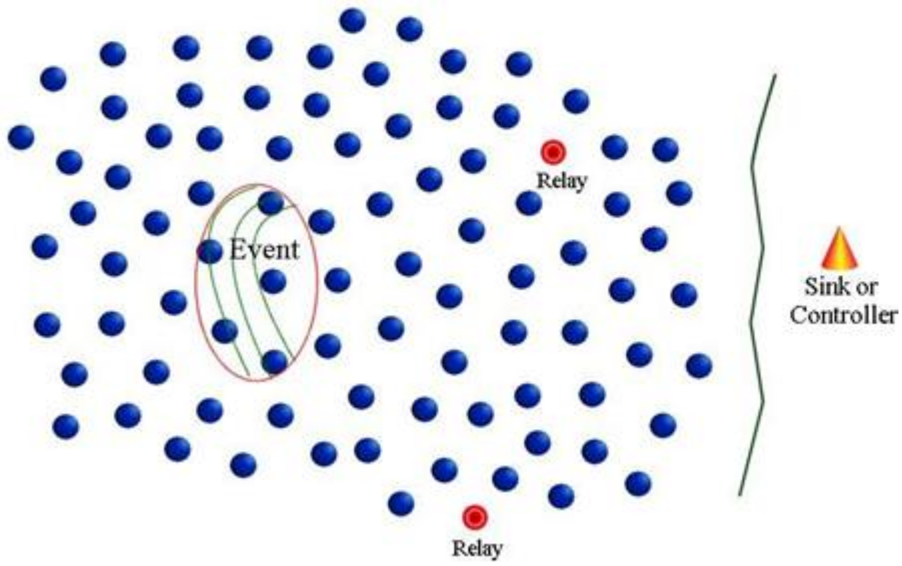
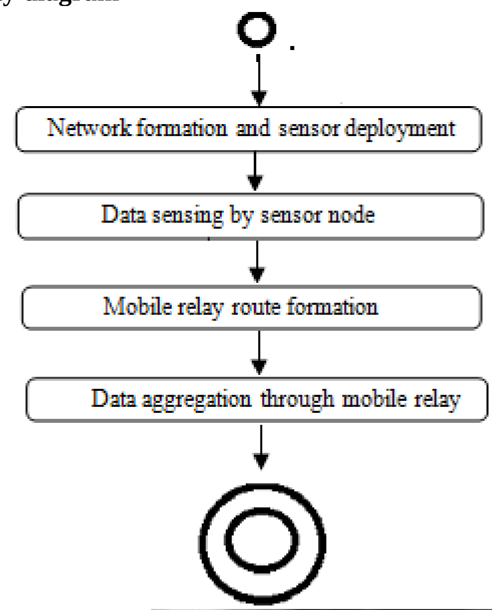


Figure 1: System Architecture

In, mobile relay, the mobile access point (Mobile relay) traverses the network and collects the sensing information from the individual sensor nodes. The major advantage of the SENMA architecture is that it ensures a line of sight path to the access point within the power range of the sensor nodes, allowing the information to be conveyed without routing. This feature makes it a resilient, scalable and energy efficient architecture for wireless sensor networks. In many cases, due to bandwidth and energy limitations, the sensors quantize their sensing result into a single bit. The mobile relay collects data from sensor node and delivers to base station. we use low-cost disposable mobile relays to reduce the total energy consumption of data-intensive WSNs. Different from mobile base station or data mules, mobile relays do not transport data; instead, they move to different locations and then remain stationary to forward data along the paths from the sources to the base station. Thus, the communication delays can be significantly reduced compared with using mobile sinks or data mules. Moreover, each mobile node performs a single relocation unlike other approaches which require repeated relocations.

The data aggregation is a technique used to solve the implosion and overlap problems in data centric routing. Data coming from multiple sensor nodes are aggregated as if they are about the same attribute of the phenomenon when they reach the same routing node on the way back to the sink. Data aggregation is a widely used technique in wireless sensor networks. The security issues, data confidentiality and integrity, in data aggregation become vital when the sensor network is deployed in a hostile environment. Data aggregation is a process of aggregating the sensor data using aggregation approaches.

Activity diagram



Architecture diagram

The figure of architecture diagram states that each sensor node will transmits the data to the sink through mobile relay nodes

4. Implementation

We consider a large scale, uniformly distributed sensor network. Nodes in the network communicate with each other via radio links. We assume the whole sensor network is connected, which is achieved by deploying sensors densely. We also assume sensor nodes are awake when data gathering process initiates .The moving pattern of a mobile sink can affect the energy consumption for data collection, as directional change in a mobile sink's movement is unavoidable due to occasional obstacles depicted. To numerically model the moves conducted by a mobile sink, we trace the moving trail of a mobile sink on a plain and measure the directional change at each trail point. Specifically, suppose at some time the mobile sink arrives at trail point the sensor relay node transmits data from source to sink node with minimum number of hop nodes. The mobile sinks visit each cluster and collect the data and it makes an energy efficient routing. The sensor nodes data in the cluster are collected directly by the mobile sink visiting each cluster on time synchronization TDMA.

We use NS2 is an open-source event-driven simulator designed specifically for research in computer communication networks. NS2 has continuously gained tremendous interest from industry, academia, and government. Having been under constant investigation and enhancement for years, NS2 now contains modules for numerous network components such as routing, transport layer protocol, application, etc. To investigate network performance, researchers can simply use an easy-touse scripting language to configure a network, and observe results generated by NS2. Undoubtedly, NS2 has become the most widely used open source network simulator, and one of the most widely used network simulators.

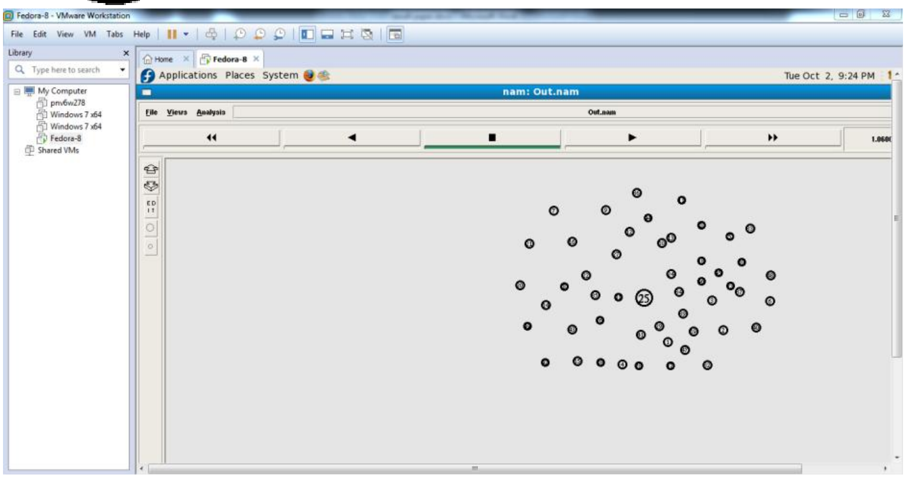


Figure 4.1: Random Network deployment

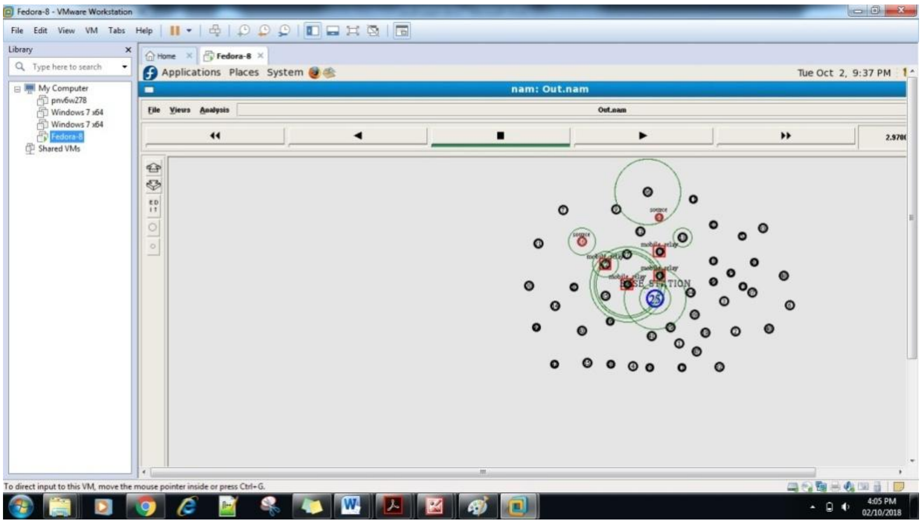


Figure 4.2: Creation of mobile relays and data collection by mobile sink

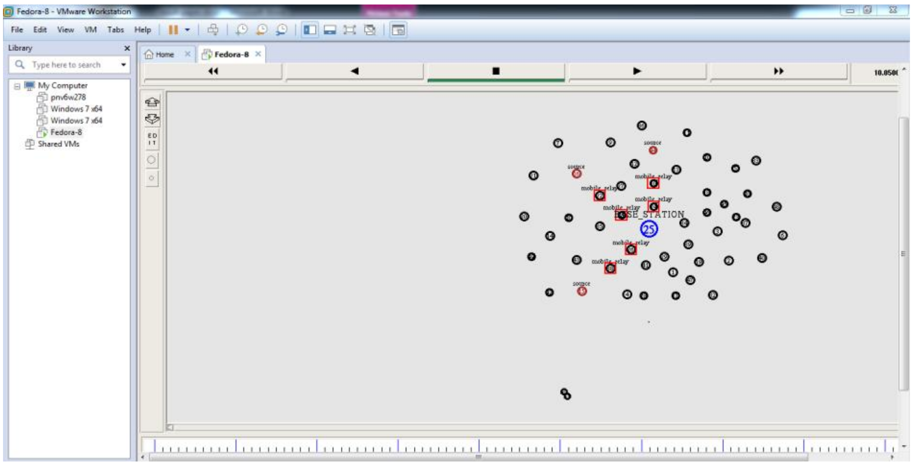


Figure 4.3: Source nodes 44, 16 and 15 transmitted all the stored data to the sink (25)

5. Conclusion

In this paper , we proposed a holistic approach to minimize the total energy consumed by both mobility of relays and wireless transmissions. Most previous work ignored the energy consumed by moving mobile relays. When we model both sources of energy consumption, the optimal position of a node that receives data from one or multiple neighbors and transmits it to a single parent is not the midpoint of its neighbors; instead, it converges to this position as the amount of data transmitted goes to infinity. Ideally, we start with the optimal initial routing tree in a static environment where no nodes can move. However, our approach can work with less optimal initial configurations including one generated using only local information such as greedy geographic routing. Our approach improves the initial configuration using two iterative schemes. The first inserts new nodes into the tree. The second computes the optimal positions of relay nodes in the tree given a fixed topology. This algorithm is appropriate for a variety of data-intensive wireless sensor networks. It allows some nodes to move while others do not because any local improvement for a given mobile relay is a global improvement. This allows us to potentially extend our approach to handle additional constraints on individual nodes such as low energy levels or mobility restrictions due to application requirements

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