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IMPROVISING THE LONGEVITY OF WIRELESS NETWORKS

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ABSTRACT:

The longevity of wireless sensor networks (WSNs) is a major issue that impacts the application of networks. When communication protocols are striving to save energy by acting on can be prolonged by further involving sink mobility. The most proposals give their evidence of lifetime improvement through either (small-scale) field tests or numerical simulations on rather cases, theoretical understanding of the reason for this improvement and the tractability of the joint optimization problem is still missing. In our project, we are attempting to build a framework for investigating the joint sink mobility and routing problem by constraining the sink to a finite number of locations. We also investigate the induced sub-problems. In particular, we are using an efficient primal-dual algorithm to solve the sub-problem involving a single sink, and then we generalize this algorithm to approximate the original problem involving more sinks. Last we apply the algorithm to a set of typical topological graphs; the results demonstrate the benefit of involving sink mobility.

1. INTRODUCTION

Wireless sensor networks (WSNs) are fast emerging as a new networking and sensing paradigm based on a large number of tiny sensor nodes. These networks can be deployed close to or inside the phenomenon under surveillance and, thus, have the potential of providing diverse information to numerous applications. However, the small size of the sensor nodes (hence their capacity-limited power sources) is posing a great challenge: The longevity of WSNs under energy constraints should be addressed before we can benefit from advantages. Communication protocols that is strive to save energy in WSNs mainly focus on the sensor nodes, whereas a recent trend indicates a focus shift to the behaviour of sinks, which can be exploited to further improve the lifetime of WSNs. There are two approaches, fast mobility and slow mobility, for exploiting sink mobility to improve network lifetime. They are distinguished by the relationship between the moving speed of a sink and the tolerable delay of the data delivery. On one hand, a sink can “transport” data with its movements if its speed is high enough to produce a tolerable data delivery delay and hence, spare nodes from the traffic-forwarding load. This is the fast mobility action, as the sink should move sufficiently fast. On the other hand, moving the sink, even very infrequently (say once a week), may still benefit the network lifetime because it can lead to a global load balancing in the entire network. This is the slow mobility approach because the mobility cannot be used to transport data within a tolerable delay (but it barely affects the delay due to the way it is used). The main reason for the improvement brought by the slow mobility approach is the typical many-to-one traffic pattern in WSNs.

Such a pattern imposes a heavy forwarding load on the nodes close to sinks. While no energy-conserving protocol alleviates such a load, moving sinks can distribute the role of bottleneck nodes over time and thus even out the load. The general reason that sink mobility, no matter if fast or slow, can improve network lifetime lies in the fact that mobility increases the dimension (thus the degree of freedom) of the problem. This follows the principle that optimizing an objective in a high-dimension space always leads to a result no worse than what can be achieved in a subspace of reduced dimension. However, solving problems in high-dimension space incurs a higher complexity. Existing approaches either directly consider the practical implementation issues before developing a theoretical understanding or solve simplified sub problems using contemporary software without paying attention to the tractability of the problem. This prevents us from getting deeper insight on how and why sink mobility brings lifetime improvement. Our main contributions are the following:

- We identify the sub problem that has a potential to guide routing protocol designs in practice.

- We develop an efficient primal dual algorithm for the sub problem involving a single sink; it is the generalized to approximate the general MNL problem.

- We prove the superiority of moving the sinks over keeping them static in the case that the sinks are constrained to where the nodes are.

2. EXISTING SYSTEM

Existing approaches either directly consider the practical implementation issues before developing a theoretical understanding or solve simplified sub-problems using contemporary software without paying attention to the tractability of the problem in general. This prevents us from getting deeper insight on how and why sink mobility brings lifetime improvement. Existing energy-conserving routing protocol, aim at balancing the energy consumption instead of minimizing the absolute consumed power.

3. PROPOSED SYSTEM

In our proposed system, we build a framework for investigating the joint sink mobility and routing problem by constraining the sink to a finite number of locations. We also investigate the induced sub-problems. Specially we develop an efficient primal-dual algorithm to solve the sub-problem involving a single sink, and then we generalize this algorithm to approximate the original problem involving of typical topological graphs; the results demonstrate the benefit of involving sink mobility.

4. RELATED WORK

We first present the recent work consisting of improving network lifetime with mobile sinks. We then briefly discuss a few topics related to energy conservation in WSNs. but we will not discuss them because these proposals are either about coping with sink mobility (rather than exploiting it) or about preventing buffer overflow (rather than extending lifetime).We are aware that there have been significant efforts in designing online mobility control algorithms but our offline approach does serve as a benchmark. Our offline solution is applicable and more efficient provided that the data rates can be accurately estimated. Last but not least, we refer to for a theoretical investigation on load-balancing (including using mobile sinks) in WSNs detecting bursty events.

5. MODULES IN OUR WORK

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NETWORK MODULE Client-server computing or networking is a distributed application architecture that partitions tasks or workloads between service providers (servers) and service requesters, That means clients. Often clients and servers operate over a computer network on hardware. A server machine is a high-performance host that is running one or more server programs which share its resources with clients.

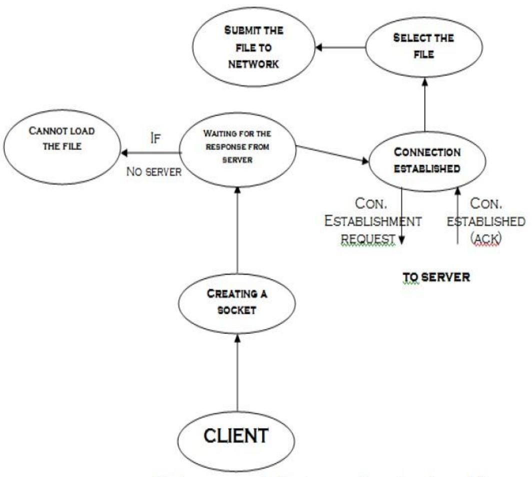

Fig.1. server and client request in network module

WIRELESS MOVING SINKING MODULE Sink moves fast enough to deliver data with a tolerable delay; WSNs may take advantage of mobility capacity. In this mobile relay approach, the mobile sink “picks up” data from nodes (through one-hop transmissions) and transports the data with for the reduction of The problem is to find an energy-efficient route for the new service from source to destination that does not violate the resource constraints. That end, the problem becomes finding a route that minimizes the total energy increment needed to serve the new arrival over the entire network.

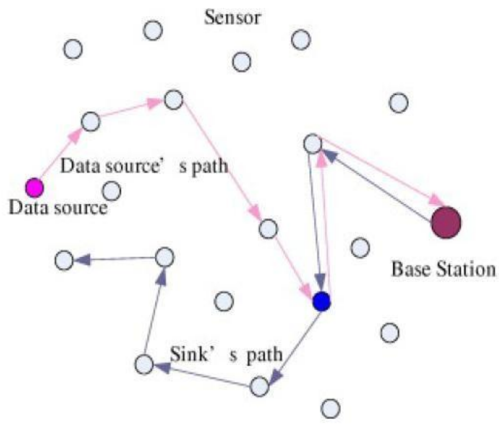

Fig.2. wireless sensors and sink in the path

An energy-efficient based routing algorithm for given minimum data rates on individual service flows. We explicitly impact of routing a new flow on the energy consumption of the network for a certain class of scheduling schemes. Our approach is to transform the error defined with the minimum bandwidth requirements into a corresponding problem with the constraints. 5.3 POWER MODULE We study the performance of our algorithm for the case when flows randomly arrive at the network and the source-destination pairs are randomly chosen. We consider a time-slotted system, we use two our environment, we divide each time slot into eight sub-time slots and assign them to each link at each node as follows: We assume that reception and transmission do not occur simultaneously at every node. In the first scheduling scheme, we use fixed and periodic link scheduling as proposed. Each node periodically transmits (or receives) data to its neighbours at fixed sub-time slots.

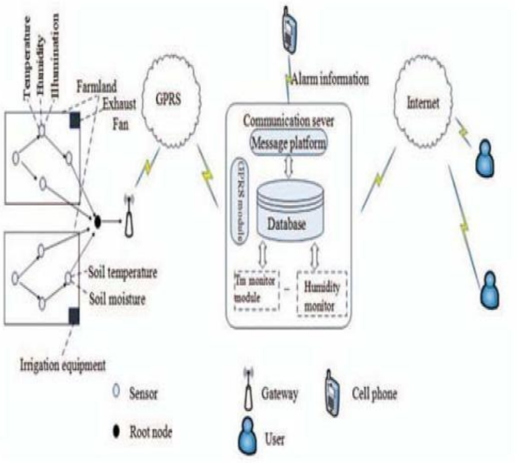

Fig.3. sensors and sink in a square grid

The following simplifying assumptions in building the system model:

□ Sensors remain stationary at the nodes of a bi-dimensional square grid composed of same-size cells.

□ The sink can move freely on the grid from one node to another. During its sojourn time at a node, sensors can communicate with the sink. For analytical simplicity, the travelling time of the sink between two nodes is considered negligible.

□ Sensor nodes are homogeneous and wireless channels are bi-directional, symmetric and error-free

□ Sensor nodes communicate with the sink by sending data via multiple hops along the shortest path; a hop is of one cell side length, The sensor network is modeled as a graph G(N,E) where N is the set of all the nodes in the square grid and E is the set of all links (i, j) where i and j are neighbouring nodes. A node i can communicate directly with its (at most) four neighbouring nodes. Let Si be the set of i's neighbours. Each sensor generates data packets at a fixed data rate.

If a sensor node i is neither co-located with sink k nor directly connected with it (i.e., if k is not co-located with any of the nodes in Si), After data packets generated at node i have to be relayed through multiple hops to reach the sink. The sink can only be located at one node position in the grid (the sensor locations and the possible sink locations are the same). The sink keeps moving among grid positions until the maximum network lifetime is reached, which occurs when one sensor node's residual energy drops below a predefined threshold required for it to operate (when this happens the sensor "dies"). In our model the network lifetime is calculated as the sum of sojourn times of the sink at all visited nodes. The sojourn times are constrained by the fact that the total energy spent by each node when the sink is co-located with different nodes cannot exceed the sensor node initial energy.

When a sensor node lies on the same horizontal or vertical line of the current position of the sink, a unique shortest path exists between the two nodes. Otherwise, many shortest paths exist. For example, six shortest paths exist between sensor i and sink k (Figure 1), each four hops long. Three of those paths are shown, path 1 and 2 along the perimeter of the rectangle defined by nodes i and k, and path 3, one of the four interior paths. In our routing protocol we consider only the two paths along the perimeter of the rectangle, i.e., paths 1 and 2 in Figure 1. These two routes are taken at equal frequencies, or equivalently, the route alternates between the two paths. When calculating power consumption, the first order radio model is frequently used. For receiving k1 bits/sec, the power consumption (pr) at a sensor node is pr = $k1\beta$ where β is a factor indicating the energy consumption per bit at the receiver circuit.

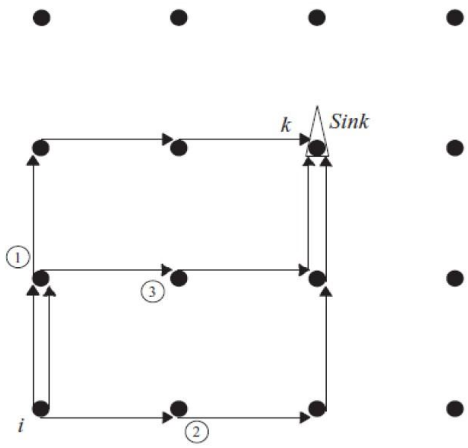

Fig.4. shortest paths from a sensor to the sink

The power pt needed for transmitting k2 bits/sec is pt = k2(α1 + α2dp) where α1 is the energy consumption factor indicating the power consumed per bit by the transmitter circuit and α2dp indicates the energy consumption on the amplifier (per bit), d being the physical distance between the transmitting and the receiving node and p the path loss exponent (usually between 2 and 4, depending on the environment).

The transmission radius of a sensor node is usually very limited (of the order of a few tens of meters) so that the energy spent for the transceiver circuitry exceeds the energy consumption due to the emitted power. According to the energy model of real-life sensor nodes prototypes we adopted an energy model in which the energy consumed when transmitting is basically constant, and in which the energy consumed for receiving a bit is the same as the energy consumed for transmitting a bit, here denoted by e: β ≈ α1 + α2dp = e Therefore the total energy consumption at a node per time unit is: pr + pt = k1β + k2(α1 + α2dp) ≈ e(k1 + k2).

5.4 RANDOMNESS OF FLOW

We study the performance of our algorithm for the case when flows randomly arrive at the network and the source-destination pairs are randomly chosen. We consider a time-slotted system, we use two scheduling schemes. Since every node has four adjacent nodes in our environment, we divide each time slot into eight sub-time slots and assign them to each link at each node as follows: We assume that reception and transmission do not occur simultaneously at each node. In the first as proposed. Each node periodically transmits (or receives) data to its neighbours at fixed sub-time slots. Finally, we illustrate the benefit of using a mobile sink by applying our algorithm to a set of typical topological graphs.

- We provide a constructive proof of the NP hardness of the MNL problem involving multiple mobile sinks.

- We identify the sub problem that has a potential to guide routing protocol designs in practice.

- We develop an efficient primal-dual algorithm for the sub problem involving a single sink; it is then generalized to approximate general MNL problem.

We prove the superiority of moving the sinks over keeping them static in the case that the sinks are constrained to where the nodes are.

6. CONCLUSION AND FUTURE SCOPE

In our project, we have built a unified framework to analyze the maximizing network lifetime (MNL) problem in WSNs. Our investigation, based on a graph model, jointly considers sink mobility and routing for lifetime maximization. We have formally proved the NP-hardness of the MNL involving multiple mobile sinks. Then identified the sub-problem that has a potential to guide routing protocol designs in practice. In particular, we have developed an efficient algorithm to solve the MNL problem. In addition, using the duality theory, we have proved that for on-graph mobility, moving the sink is always better than keeping them static. Finally, we have illustrated the benefit of using a mobile sink by applying our algorithm to a set of typical topological graphs. As for future directions, we are in the process of engineering the routing protocol that we proposed to support sink mobility in order to approach the upper bound characterized in this project. We are also working on an online algorithm, derived from the approximation algorithm, to guide sink mobility in the face of the network dynamics.

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