Energy Efficient and Maximize Data Collection Rate in Wireless Sensor Network

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Abstract— Wireless sensor networking is an emerging technology that has a wide range of potential applications including environment monitoring, smart spaces, medical systems, and robotic exploration. Large numbers of distributed nodes that organize themselves into a multihop wireless network. Like in all shared-medium networks, medium access control (MAC) is an important technique that enables the successful operation of the network. One fundamental task of the MAC protocol is to avoid collisions from interfering nodes. There are many MAC protocols that have been developed for wireless voice and data communication networks. To design a good MAC protocol for the wireless sensor networks, we have considered the following attributes. The first is the energy efficiency. As stated above, sensor nodes are likely to be battery powered, and it is often very difficult to change or recharge batteries for these nodes. In fact, someday we expect some nodes to be cheap enough that they are discarded rather than recharged. Prolonging network lifetime for these nodes is a critical issue. Another important attribute is scalability and adaptivity to changes in network size, node density and topology. Some nodes may die over time; some new nodes may join later; some nodes may move to different locations. A good MAC protocol should gracefully accommodate such network changes. Other typically important attributes including fairness, latency, throughput, and bandwidth utilization may be secondary in sensor networks.

Key words: MAC, MAC protocol, nodes, Wireless Sensor networks

I. INTRODUCTION

A. Wireless Sensor Network

Sensor networks comprise a large number of low-cast miniaturized computers each acting autonomously and equipped with short-range wireless communication, limited processing and memory, and a physical sensing capability. Decisions in daily life are based on the accuracy and availability of information. Sensor networks can significantly improve the quality of the information as well as the ways of gathering it.

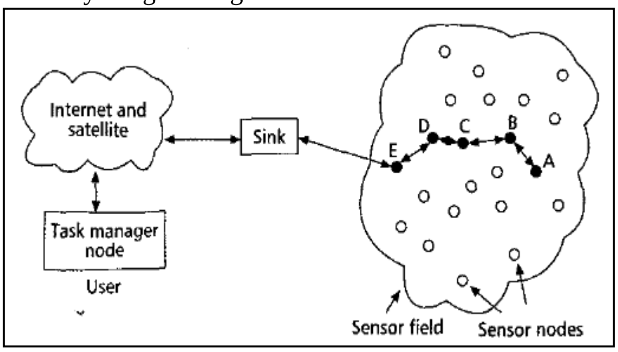


Fig. 1: Sensor Network

For example sensor networks can help to get higher fidelity information, get information in real time, get hard-to-obtain information and reduce the cost of getting information. Therefore it is assumed that sensor networks will be applied in many different areas in the future. Application areas might be production surveillance, traffic management, environmental supervision, medical care or military applications

One of the important parts of a wireless sensor networks is the communication between the nodes. The character of the communication used in a wireless sensor networks has a huge impact on the usability of a sensor network. For example, the lifetime of a sensor networks in which single nodes are battery-powered is essentially influenced by the used communication patterns.

Therefore a lot of research in wireless sensor networks is currently focused on the communication aspect. To be able to optimize communication in wireless sensor networks it is important to consider all communication layers. The goal of this special session is to present and discuss current problems on the various communication layers.

A given computing capacity becomes exponentially compute smaller and cheaper with each passing year. Researchers can use the semiconductor manufacturing technique that underlie this miniaturization to build radios and exceptionally small mechanical structures that sense fields and forces in the physical world. These inexpensive low-power communication devices can be deployed throughout a physical space, providing dense sensing close to physical phenomena, processing and communicating this information and coordinating actions with other nodes. Combining these capabilities with the system software technology that forms the internet makes it possible to instrument the world with increasing fidelity.

To realize this opportunity, information technology must address a new collection of challenges. The individual devices in a wireless sensor (WSN) are inherently resource constrained. They have limited processing speed, storage capacity, and communication bandwidth.

B. Sensor Network Applications

Although computer-based instrumentation has excited for a long time, the density of instrumentation made possible by a shift to mass-produced intelligent sensors and the use of pervasive networking technology gives WSNs a new kind of scope that can be applied to a wide range of uses

The first category includes environmental and habitat monitoring, precision agriculture, indoor climate control, surveillance, treaty verification, and intelligent alarms. The second includes structural monitoring, ecophysiology, condition-based equipment maintenance, medical diagnostics, and urban terrain mapping.

C. Environmental Monitoring

Many initial WSNs have been deployed for environmental monitoring which involves collecting readings over time across a volume of space large enough to exhibit significant internal variation.

Researchers are using WSNs to monitor nesting seabird habitats and microclimates chaparral transects and to conduct analogous studies of contaminant propagation, building comfort, and intrusion detection.

In an initial study, researchers will likely extracts all the environmental data front such a network and use it to identify biologically relevant features, such as a temperature front. Later , the network will likely perform the front-tracking algorithm within the tree itself, communicating only relevant statistical summaries, thereby increasing the network lifetime, As the ecophysiological model evolves, the researchers will likely refine the detection and tracking features.

D. Problem Statement

In rechargeable wireless sensor network a sensor cannot be always beneficial to conserve energy when a network can harvest excessive energy from the environment due to its energy replenished continually and limited energy storage capacity. Therefore, surplus energy of a node can be utilized for strengthening packet delivery efficiency and improving data collection rate.

Currently, Energy Harvesting or Rechargeable Wireless Sensor Networks (EHWSNs or R-WSNs) have attracted more and more attention benefiting from the lifetime extending of sensor nodes by equipping them with rechargeable technologies, which convert sources, such as body heat, foot strike, finger strokes, and solar into electricity. Harvesting energy from the environment is not new and has been in use for decades. It is particularly important that these power sources can be reused friendly and freely. A sensor can operate without disruption due to human intervention to change batteries and operate perpetually by using super capacitors (in the order of a million cycles) to store the harvested energy.

In the existing system a connectivity maintenance protocol is proposed to minimize the delay of single hop node message delivery to a base-station. The resulting sleep schedule achieves the lowest overall target surveillance delay given constraints on more energy consumption.

The goal of the maximum data collection rate is to deliver all the data packets generated by sensor nodes to base stations as soon as possible subject to node harvesting energy, node capacity and link capacity constraints such that with minimum data collection rate is maximized.

II. LITERATURE SURVEY

A. An Energy-Efficient MAC Protocol for Wireless Sensor Networks

S-MAC, a medium-access control (MAC) protocol designed for wireless sensor networks. Wireless sensor networks use battery-operated computing and sensing devices. A network of these devices will collaborate for a common application such as environmental monitoring. We expect sensor networks to be deployed in an ad hoc fashion, with individual nodes remaining largely inactive for long periods of time, but then becoming suddenly active when something is detected.

B. Sleep-based Topology Control for Wakeup Scheduling in Wireless Sensor Networks

Wireless sensor network applications require both energy-efficiency and low latency for reporting urgent but rare events. Various wakeup scheduling schemes have been proposed to save energy by employing duty cycles and to reduce end-to-end delay by synchronizing nodes' wakeup times and shortening setup latencies.

C. Enhancing The Lifetime Of Wireless Sensor Network By Using The Minimum Energy Scheduling Algorithms

MES(Minimum Energy Scheduling) algorithm is mainly favorable for dynamic link scheduling and network protocol designs in energy-constrained wireless sensor networks.

A novel scheduling method named Backbone Scheduling using Virtual nodes which schedules multiple overlapped backbones so that the network energy consumption is evenly distributed among all sensor nodes. In this way, the energy of all of the sensor nodes in the network is fully utilized, which in turn prolongs the network lifetime. Here the data is only forwarded by the backbone sensor nodes and other sensor nodes turn off the radios saves energy.

D. An Optimal Wake-Up Scheduling Algorithm for Minimizing Energy Consumption while Limiting Maximum Delay in a Mesh Sensor Network

An algorithm for maximizing the lifetime of a sensor network while guaranteeing an upperbound on the end-to-end delay. We prove that the proposed algorithm is optimal, and that it requires simple computing operations that can be implemented by simple devices. To the best of our knowledge.

The proposed algorithm significantly increases the lifetime of the network, while guaranteeing a maximum on the end-to-end delay.

E. Distributed data collection in large scale asynchronous wireless sensor networks under the generalized physical interference model

Wireless sensor networks (WSNs) are more likely to be d-pistributed asynchronous systems. In this paper, we investigate the achievable data collection capacity of realistic distributed asynchronous WSNs. Our main contributions include five aspects. First, to avoid data transmission interference, we derive an $\Re_0$-proper carrier-sensing range ($\Re_0$-PCR) under the generalized physical interference model, where $\Re_0$ is the satisfied threshold of data receiving rate. Taking $\Re_0$-PCR as its carrier-sensing range, any sensor node can initiate a data transmission with a guaranteed data receiving rate. Second, based on $\Re_0$-PCR, we propose a Distributed Data Collection (DDC) algorithm with fairness consideration. Theoretical analysis of DDC surprisingly shows that its achievable network capacity is order-optimal and independent of network size. Thus, DDC is scalable. Third, we discuss how to apply $\Re_0$-PCR to the distributed data aggregation problem and propose a Distributed Data Aggregation (DDA) algorithm. The delay performance of DDA is also analyzed. Fourth, to be more general, we study the delay and capacity of DDC and DDA under the Poisson node distribution model. The analysis demonstrates that DDC is also scalable and order-optimal under the Poisson distribution model. Finally, we conduct extensive simulations to validate the performance of DDC and DDA.

F. Multi-objective routing optimisation for battery-powered wireless sensor mesh networks

Mesh network topologies are becoming increasingly popular in battery powered wireless sensor networks, primarily due to the extension of network range and resilience against routing failures. However, multi-hop mesh networks suffer from higher energy costs, and the routing strategy directly affects the lifetime of nodes with limited energy sources. Hence while planning routes there are trade-offs to be considered between individual and system-wide battery lifetimes. We present a novel multi-objective routing optimisation approach using evolutionary algorithms to approximate the optimal trade-off between minimum lifetime and the average lifetime of nodes in the network. In order to accomplish this combinatorial optimisation rapidly and thus permit dynamic optimisation for self-healing networks, our approach uses novel k-shortest paths based search space pruning in conjunction with a new edge metric, which associates the energy cost at a pair of nodes with the link between them. We demonstrate our solution on a real network, deployed in the Victoria \& Albert Museum, London. We show that this approach provides better trade-off solutions in comparison to the minimum energy option, and how a combination of solutions over the lifetime of the network can enhance the overall minimum lifetime.

G. A Survey on Distributed Topology Control Techniques for Extending the Lifetime of Battery Powered Wireless Sensor Networks

Large-scale, self-organizing wireless sensor and mesh network deployments are being driven by recent technological developments such as The Internet of Things (IoT), Smart Grids and Smart Environment applications. Efficient use of the limited energy resources of wireless sensor network (WSN) nodes is critically important to support these advances, and application of topology control methods will have a profound impact on energy efficiency and hence battery lifetime. In this survey, we focus on the energy efficiency issue and present a comprehensive study of topology control techniques for extending the lifetime of battery powered WSNs. First, we review the significant topology control algorithms to provide insights into how energy efficiency is achieved by design. Further, these algorithms are classified according to the energy conservation approach they adopt, and evaluated by the trade-offs they offer to aid designers in selecting a technique that best suits their applications. Since the concept of "network lifetime" is widely used for assessing the algorithms' performance, we highlight various definitions of the term and discuss their merits and drawbacks. Recently, there has been growing interest in algorithms for non-planar topologies such as deployments in underwater environments or multi-level buildings. For this reason, we also include a detailed discussion of topology control algorithms that work efficiently in three dimensions. Based on the outcomes of our review, we identify a number of open research issues for achieving energy efficiency through topology control.

H. Energy-efficient routing protocols in wireless sensor network

In WSN, the sensor nodes have limited battery power, limited transmission range as well as their processing and storage capabilities are also limited. Routing protocols for wireless sensor networks are responsible for maintaining the routes in the network under above mentioned limitations. In this paper, I have given a survey of routing protocols for Wireless Sensor Network which works better in the limited resources of sensor nodes.

III. SYSTEM ANALYSIS

A. Existing System

A connectivity maintenance protocol is proposed to minimize the delay of single hop node message delivery to a base-station.

The resulting sleep schedule achieves the lowest overall target surveillance delay given constraints on more energy consumption.

B. Proposed System

The goal of the maximum data collection rate is to deliver all the data packets generated by sensor nodes to base stations as soon as possible subject to node harvesting energy, node capacity and link capacity constraints such that with minimum data collection rate is maximized.

IV. WORK DONE IN PHASE ONE

A. System Architecture Design

Rechargeable Wireless Network

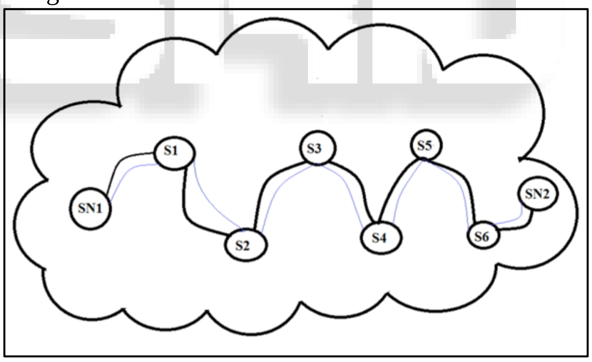
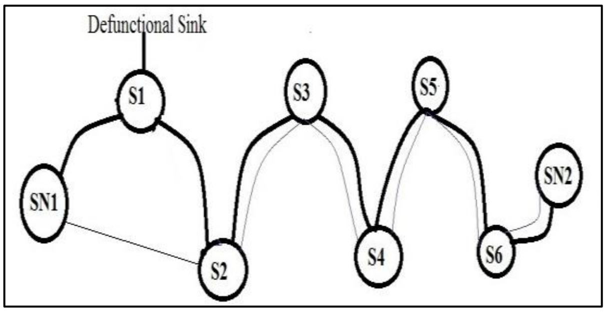


Fig. 1:

N- Node
S - Sink



-------------> Data flow

Fig. 2:

V. IMPLEMENTATION

Implementation is the state in the system where the theoretical design is turned into a working system. The most crucial stage in achieving a new successful system and in giving confidence on the new system for the users that will work efficiently and effectively. The system can be implemented only after thorough testing in done and if found to work according to the specification.

If involves careful planning, investigation of the current system and its constraints on implementation, design of methods to achieve the changeover, an evaluation of changeover methods apart from planning. Two major tasks of preparing the implementation are education, training of the users and testing the systems. System analysis and design efforts will be more for complex systems beings implemented. Based on policies of individuals organization an implementation coordinating committee has been appointed.

The implementation process begins with preparing a plan for the implementation system. According to this plan, the other activities are to be carried out. In this plan, discussion has been made regarding the equipment, resources and how to test the activities. Thus a clear plan is preparing for the activities.

A. *Performance Analysis*

Simulation of our algorithm for r-WSNs was done by c# software with up to 10-20 nodes and 1-5 sinks are randomly deployed in a 100m*1000m square field. The maximum communication range of each node is set to be 100m. Every two nodes can communicate with each other directly within their transmission range.

When multiple sinks were deployed in the monitoring field, the performance for all algorithms. Due to limited available energy, it is common to deploy multiple sinks for collecting information in realistic application, which brings at least two advantages comparing one sink. Firstly, in multiply sinks environment, since packets generated by sensors are only needed to be forwarded to anyone sinks, which is closest to it generally, the degree of routing path from source node to sink will be shorted due to higher sinks density. Secondly, a limited number of sensors is distributed around the sink and it often represents a bottleneck for data transmission because all packets from sources have to be forwarded to these sensors before reaching the sink, while it will relieve this pressure for data forwarding with more than one sink.

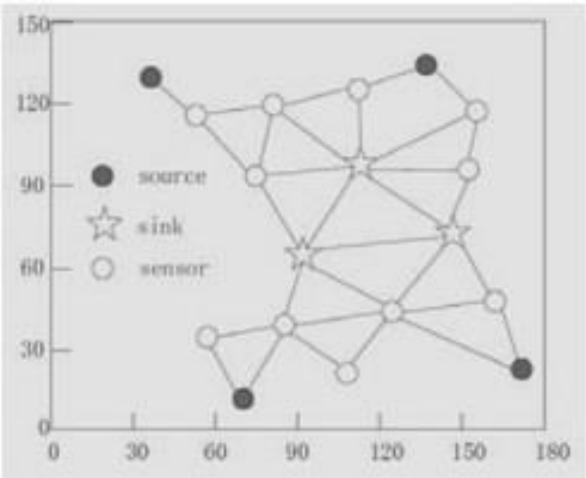


Fig. 1: The routing process using maximum data collection rate scheme

Figure (2) and Figure (3) shows the routing process using different communication models established when 15 sensors and 3 sinks deployed in experiment scenario, where contains 4 source nodes sensing signal and other sensors undertaking forwarding tasks. Figure (2) presents the routing paths for all sources to reach at least one sink based on maximum data collection rate of our algorithm.

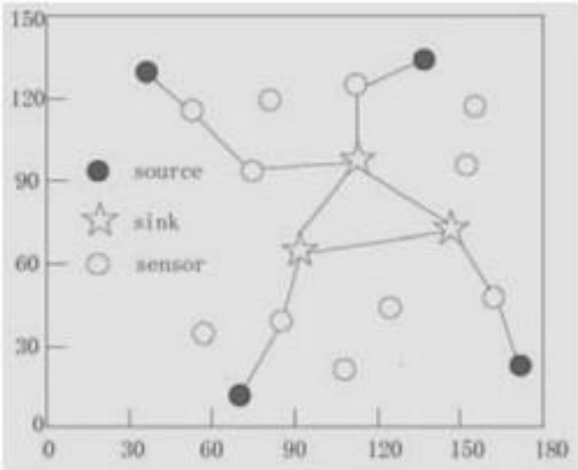


Fig. 2: The routing process using minimum energy consumption scheme

By considering the limited energy supplement, a source node still choose closer base station as its destination, however the packets from sources maybe through all common nodes in the network area and the communication energy consumption will be balanced to all nodes in order to improve From the Figure (3), we can see only some of nodes participate in the formation process of routes. The Figure (3) shows the routing process is based on the minimum energy consumption. A source node will create a route path to the nearest base station with smallest link distance between each two adjacent nodes in order to reduce energy consumption, such as, if the distance for two adjacent sensors is shorted to half of original length, the energy consumption will be reduced to quarter of original quantity, which is recognized and widely used in traditional WSNs. There are at least four advantages of this scheme, such as, high data delivery speed, high system stable, low data transmission delay and energy expenditure. However, it is designed for traditional WSNs which cannot be lied in R-WSNs.

VI. CONCLUSION & FUTURE WORK

In this work, for addressing the maximum data collection rate problem, considering the energy can be replenished continually for each sensor, which generally equipped with limited power storage device, we propose a distribute algorithm to compute an optimal data generation rate to improve sensor usage efficiency. We formulate a linear programming problem for maximum data generation rate with energy extracting rate and data flow constrained. Since it is NP-hard, the original linear programming is converted to a dual problem by introducing Lagrange is constructed and subgradient algorithms are used to solve it in a distributed manner. The resulting algorithms are guaranteed to converge to an optimal data generation rate.

Hereafter, the energy replenished and routing schemes are analyzed. Finally, the optimization techniques with linear programming for maximum data generation rate are illustrated by an example in which an optimal flow is computed for a network of randomly distributed nodes and minimizing the energy consumption is introduced as the secondary optimization problem.

In future we intend to create find out minimum distance routing path with secured data transmission approach.

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