Power Optimization using Intermediate Virtual Backbone Scheduling in Wireless Sensor Networks

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Abstract

Wireless Sensor Networks (WSNs) are keys for various applications that involve long-term and low-cost monitoring and actuating. In these applications, sensor nodes use batteries as the sole energy source. Therefore, energy efficiency becomes critical. Many WSN applications require redundant sensor nodes to achieve fault tolerance and Quality of Service (QoS) of sensing. However, the same redundancy may not be necessary for multihop communication because of the light traffic load and the stable wireless links. VBS is designed for WSNs that have redundant sensor nodes. VBS (Virtual Backbone Scheduling) forms multiple overlapped backbones which work alternatively to connect the nodes and prolong the network lifetime. In VBS, traffic is only forwarded by backbone sensor nodes, and the rest of the sensor nodes turn off their radios to save energy. This paper elucidates the time delay in forming VBS source to destination and the effective application of Intermediate Virtual Backbone Scheduling (IVBS) Router in transmitting the data when the VBS nodes fail to transmit data. It has been observed from the research that if there is failure in nodes, the data can be passed through Intermediate Router to the next nearby VBS node by avoiding the failure node. The application of Intermediate Router increases the efficiency and reduces the time consumption in transmitting data.

Keyword: Power optimization, WSN, VBS, IVBS

1. Introduction

The past two decades have witnessed the boom of Wireless Sensor Networks (WSNs), a key technology for various applications that involve long-term and low-cost monitoring, such as battlefield reconnaissance, building inspection, security surveillance, etc. In most WSNs, the battery is the sole energy source of the sensor node. Sensor nodes are expected to work on batteries for several months to a few years without replenishing. Thus, energy efficiency becomes a critical issue in WSNs.

Among the functional components of a sensor node, the radio consumes a major portion of the energy .Various techniques are proposed to minimize its energy consumption.

This Paper describes the implementation of the Intermediate Virtual Backbone Scheduling in WSN. VBS Intermediate Routing Technique is used to save energy. In this technique VBS forms a virtual backbone to pass data from source to destination by choosing a nearby next VBS node. In this context, the effective application of Intermediate Router transmits the data when the VBS nodes fail to transmit data. It has been observed from the research that if there is failure in nodes, the data can be passed through Intermediate Router to the next VBS node by avoiding the failure node. The application of Intermediate Router increases the efficiency and reduces the time consumption in transmitting data.

This technique does not affect communication quality because WSNs that have redundancy. By redundancy, it is meant that the turning off the radio of some sensor nodes in a WSN do not affect the connectivity of the network. This redundancy results in more effective wireless links.

2. Key Contribution

In this project the new type of Intermediate VBS Router technique is implemented in wireless sensor network and the effect of this routing is analyzed in the wireless sensor networks. Then the result of this Intermediate VBS Routing technique is compared with the other routing technique like virtual backbone scheduling.

The energy efficiency of Intermediate Virtual Backbone Scheduling technique has been compared with other existing technique and found effective.

2.1 Problems in Existing Routing Schemes

- In the existing wireless sensor networks many routing algorithms are applied. These routing algorithms use more time to determine the route from source to destination.

- The sensor nodes in the networks worked in the batteries only. So the time delay uses more battery power. So the lifetime of the sensor nodes is also reduced.

- And the routing is also affected by deadlock and overload problems. Load balancing is such a difficult task in shortest path routing. The transmission of the real time data requires quality of service such as less delay, high throughput and more efficiency.

- In VBS technique, one node has been failure time WSN forms another VBS and transmit the data.

2.2 Proposed Solution

It is proposed to implement this new protocol for following objectives.

- To improve the network life time by reducing the battery usage of the network.
- To ensure reliability and throughput in wireless sensor network by using the Intermediate VBS Routing Technique.
- To balance the load in the network and increase the efficiency in the network.
- Analyze and compare the Intermediate VBS routing technique with ordinary VBS to reduce energy consumption.

These Intermediate VBS routing protocol reduce time of routing from source to destination. So the battery life increases. And the cost of routing process also decreases.

3. Network Assumption

In this study sensor nodes are deployed in a 500 x 500 area. The transmission range is fixed to 250 so that all of the networks generated are fully connected. The number of nodes in the network ranges from 10 to 100. Then the area of the network is fixed, these settings vary the density of the sensor nodes. Lifetime is determined by the node with the minimum energy and the achieved lifetime when all nodes works are nearly halved. The lifetime increases with network density because networks are smaller and tended to be disjoint.

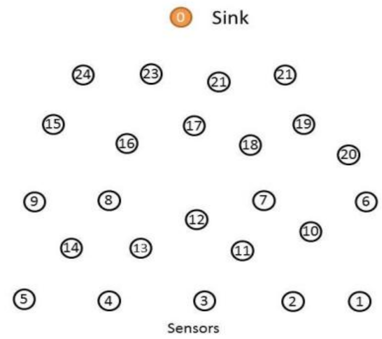

Fig 1: Network Assumption of WSN

The above figure represented as Network Structure of the Wireless sensor Networks.

4. Problem Definition

4.1 The Maximum Lifetime Backbone Scheduling Problem and its NP-Hardness

In order to find the optimal schedule, the Maximum Lifetime Backbone Scheduling is formulated. It is defined as follows.

A schedule in VBS is a set of backbones working sequentially in each round. Formally, we need to find a set of backbones, $B = \{B_1, B_2 \ldots., B_p\}$, and each backbone Bi works for Ti rounds. A schedule is, therefore, represented by a set of tuples, $\{(B_1,T_1),\ldots(B_p,T_p)\}$, that satisfy the following constraints:

- Connectivity: All $B_i \sum B$ is a connected subgraph of the network, and all other nodes are, at most, 1 hop away from a node in B_i. In other words, they are CDSs of the network.
- Energy constraints: The amount of energy consumed by any sensor node in the network at the end of the lifetime does not exceed its initial value.

The lifetime of a schedule is the lifetime of the network using this schedule to turn on and off the radio of the sensor nodes. The objective of the MLBS problem is to find that schedule that achieves the maximal network lifetime. Note that the backbones can be overlapped.

5. Background

5.1 Centralized Approximation Algorithms for MBLS Problem

Because the MLBS problem, NP-hard, it has been focus on designing approximation algorithms. In this section, there are two centralized approximation algorithms are presented. A scheduling Transition Graph Based Approximation

Algorithm and Intermediate Virtual Backbone Scheduling Algorithms are used

5.1.1 A Scheduling Transition Graph-Based Approximation Algorithm

First centralized approximation algorithm is based on a new concept called Schedule Transition Graph (STG). A STG is used to model a schedule in a WSN. Fig. 1 gives an example. As shown in the figure, the horizontal axis represents the time scale, counted in rounds. In each round, possible states are listed vertically, which are represented by ellipses. The number of possible states for each round is equal to the number of backbones. Each state contains a backbone and the corresponding energy levels. The state and the backbone have a one-to-one mapping. An initial state is placed at round 0 and is connected with all states in the first round to represent a starting point. Unidirected transition edges connect states in one round to those in the next round. No backward edges is allowed. Each edge represents the time elapse of 1 round. Since energy is used in each round, each edge also represents the consumption of energy. We assume that the sensor nodes in the backbone consume a fixed amount of energy in each round; all edges represent the same amount of energy consumption. The residual energy of all nodes is obtained by subtracting this value from the starting state of each transition edge. No transition is allowed if the energy of any sensor node of a state is depleted. It is clear that a directed path from the initial state corresponds to a schedule. Thus, the MLBS problem is thus to find the longest path in the STG.

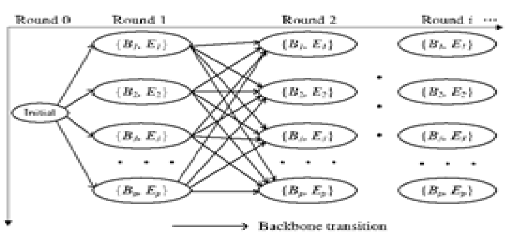

Fig 2: The illustration of a STG. The initial state is attached as a common starting point for the scheduling.

5.1.2 Intermediate Virtual Backbone Scheduling Graph Based Approximation Algorithms

The new technique of VBS Intermediate routing technique is used to increase the life time of the network by reducing the battery usage of the system. Hence the Intermediate Router transmits the data when the VBS nodes fail to transmit data. It has been observed from the research that if there is failure in nodes, the data can be passed through Intermediate Router to the next VBS node by avoiding the failure node. The application of Intermediate Router increases the efficiency and reduces the time consumption in transmitting data. So less amount of energy is consumed by the wireless sensor network which increases the life of the battery.

5.1.2.1 Intermediate VBS Routing

In multi-hop wireless networks, packets are transferred through routes that can be composed of multiple relay nodes between sources and destinations. In many multi-hop wireless networks, Intermediate VBS routing is often used for its simplicity and scalability, and this is closely approximated by routing for large multi-hop wireless networks. Fig 3 Represents the passage of passing the data through the Source 3 (Sensor) to Destination 0 (Sink). Each source node knows the details of VBS node.

The 3rd Sensor senses the data and passes the signal to the sensor 3 to sink 0. Normally Primary path of 3rd sensor is 3->8->17->->21->0. In previous VBS technique, if any one of the node energy is low, it disconnects the primary path and chooses the secondary VBS path then transfers the data. The Proposed Intermediate VBS Technique chooses another VBS path node using the node before the failure node and transfers data without loss. The Path is 3->8->18->21->0.

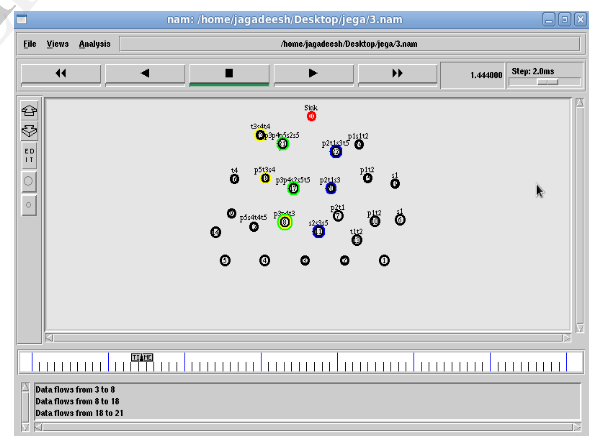

Fig 3: Intermediate VBS Routing for WSN.

6. Performance Evaluation

Simulations are used to evaluate the performance of Intermediate VBS. The proposed algorithms are implemented in a customized simulator. We present the results of the network lifetime and the energy balance.

The networks are modelled as unit disk graphs. Sensor nodes are randomly placed in a square area. The sink is placed at the top of the area. All sensor nodes have the same transmission range. The number of sensor nodes is varied to model different network densities and scales. It is assumed that the sensor nodes in the backbone consume 1 unit of energy per round.

Intermediate VBS have been compared with the VBS. The exhaustive search for the optimal network lifetime is less time- consuming, even for small networks of 10 to 20 nodes; therefore, the optimal values have been identified.

In below the Graph represents the Proposed and Existing WSN Network Lifetime.

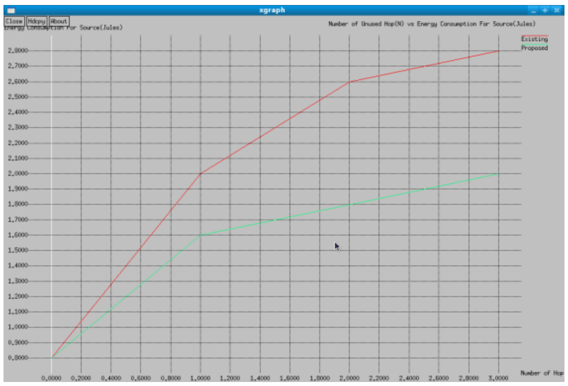

Fig 4 : No of Unused hop(N) Vs Energy Consumption for Sources(Jules).

VBS have been compared with the Intermediate VBS technique for number of unused node Vs Energy consumption for sources. It has been observed that Intermediate VBS technique is effective than the existing system as proved in the graph.

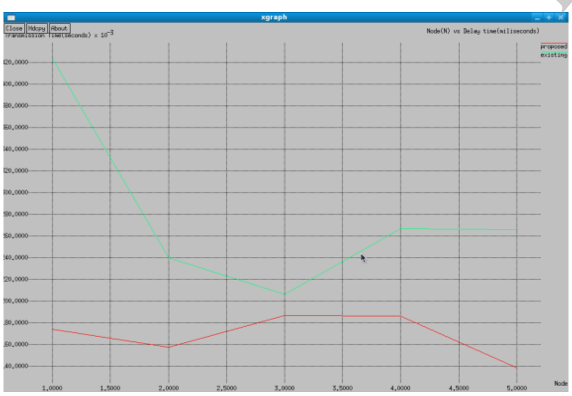

Fig 5: Node(N) Vs Delay Time (Milliseconds)

Further VBS have been compared to Intermediate VBS technique for Node V/s Delay time and found Intermediate VBS technique proved to be better than the existing system as shown in the graph.

7. Conclusions

Intermediate Virtual Backbone Scheduling (IVBS) routing technique is a new protocol to save energy in WSN. Forwarding technique has been proposed in this paper. This protocol aims to reduce the energy in sensor nodes and increase the lifetime of battery usage.

The simulation shows that the Intermediate Virtual Scheduling path can enhance the successful ratio of routing, lower the energy consumption at minimum time delay.

7.References

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