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RESEARCH ARTICLE

Overview on Load Balanced Data Aggregation Tree in Wireless Sensor Network

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Abstract- In Wireless Sensor Networks (WSN), the sensor nodes sense the same kind of data and forward it to the sink node. This redundant information sustains the reliability; but at the same time, sink node wastes its energy in processing the redundant data. So there is a need to eliminate the redundancy in sensed data up to adequate level in order to maintain the tradeoff between energy conservation and reliability. Data Gathering is a crucial technique in Wireless Sensor Networks (WSNs). Data gathering trees capable of performing aggregation operations are also referred to as Data Aggregation Trees (DATs). Most of the current literatures investigate the construction problem under Deterministic Network Model (DNM), whereas the proposed work is suitable for Probabilistic Network Model (PNM) due to any lossy links in WSN's). Moreover, the load-balance factor is neglected when constructing DATs in current literatures. Therefore, this paper focuses on constructing a Load-Balanced Data Aggregation Tree (LBDAT) under the PNM considering balancing the traffic load among all the nodes in a DAT. For continuous monitoring applications with a periodical traffic pattern, a tree-based topology is adopted to gather and aggregate sensing data because of its simplicity.

Keywords- "Data aggregation Tree, Wireless sensor networks, Probabilistic network Model, Load Balanced data aggregation tree".

I. Introduction

A WSN consists of nodes with sensing, computing and communication capability connected according to some topology and a sink to communicate with the outside world. A common scenario of sensor networks involves deployment of hundreds or thousands of low-cost, low-power sensor nodes to a region from where information will be collected periodically. Hence, sensor nodes will periodically sense their nearby environment and send the information to a sink which is not energy limited. The collected information can be further processed at the sink for end-user queries. In order to reduce the communication overhead and energy consumption of sensors while gathering, the received data can be combined to reduce message size. A simple way of doing that is aggregating the data. A different way is data fusion which can be defined as producing a more accurate signal by combining several unreliable data measurements. the load-balance factor when they construct a DAT. Without considering balancing the traffic load among the nodes in a DAT, some heavy-loaded nodes may quickly exhaust their energy, which might cause network partitions or malfunctions. For instance, for aggregating the sensing data from v8 different nodes to the sink node v0, a shortest-path-based DAT for the probabilistic WSN. The intermediate node v4 aggregates the sensing data from four different nodes, whereas, v7 only aggregates one sensing data from v8. For simplicity, if every link is always there and every node has the same amount of data to be transferred through the intermediate nodes with a fixed data rate, heavy-loaded v4 must deplete its energy much faster than v7.

II. Related Work

Shouling Ji [1] proposed Load-Balanced Data Aggregation Tree (LBDAT) under the PNM. More specifically, three problems are investigated, namely, the Load-Balanced Maximal Independent Set (LBMIS) problem, the Connected Maximal Independent Set (CMIS) problem, and the LBDAT construction problem. LBMIS and CMIS are well-known NP-hard problems and LBDAT is an NP-complete problem. Consequently, approximation algorithms and comprehensive theoretical analysis of the approximation factors are presented in the paper. Simulation results show that the proposed algorithms outperform the existing state-of-the-art approaches significantly. Miss.Vrishali [2] presented the fundamental problems of constructing a load balanced DAT in probabilistic WSNs were studied. LBDAT construction problem and an approximation algorithm by using the linear relaxing and random rounding techniques is discussed. After an LBPNA is decided, by assigning a direction to each link, an LBDAT is obtained. The simulation results show that the proposed algorithms can extend network lifetime significantly. Mr. Samarth Anavatti, Sumedha and Sirsikar [3] gave brief overview to eliminate the redundancy in sensed data up to adequate level in order to maintain the tradeoff between energy conservation and reliability. There exist many data aggregation techniques that perform data redundancy removal in order to improve life time of sensor nodes. Data aggregation is a technique in which each intermediate node in the routing path receives multiple input packets, process them and transmits a single packet. In this paper we have studied different data aggregation strategies and focused on some data aggregation techniques based on these strategies. Further, advantages and limitations of these techniques are discussed**.** S. Uma Devi and P. Dhamodharan [4] dynamically adjusted the tree structure to avoid breaking tree link because of energy drain of the sensor node. The tree adjustment only needs localized information and operations are performed on the sensors side and the tree adjustment is controlled by a sensor's grandparent to avoid loop problem. This adjustment can effectively increase throughput of Probabilistic network model in Wireless sensor network. The adjustment phase reduces the consumption of aging node's energy to prolong network lifetime**.** Amandeep Kaurand and Rupinder Kaur [5] presented a data aggregation approach that has been explored and an in- network data aggregation strategy has been proposed that is showing better results in term of energy consumption. A comprehensive overview of secure data aggregation concept in wireless sensor networks has been presented. The paper presents that wireless sensor network consists of huge number of sensor node having sensing, processing and communication capabilities. These nodes are resource constraint. That's why lifetime of the network is limited so the various approaches or protocol has been proposed for increasing the lifetime of the wireless sensor network.

III. Load Balanced Data Aggregation Tree (LBDAT)

In the tree-based approach aggregation is done by constructing an aggregation tree. The tree has branches (nodes) on both sides, rooted at sink and source nodes are considered as leaves. Each node has a parent node to forward its data. Flow of data starts from leaves nodes up to the sink and the aggregation done by parent nodes. Load-Balanced Parent Node Assignment (LBPNA) is produced, which comprises LBPNA for non-leaf nodes and leaf nodes. By assigning a direction of each link in the constructed tree from the children node to the parent node, an LBDAT is achieved. First, LBPNA for leaf nodes is formulated and then, an algorithm is applied and an LBDAT is build.

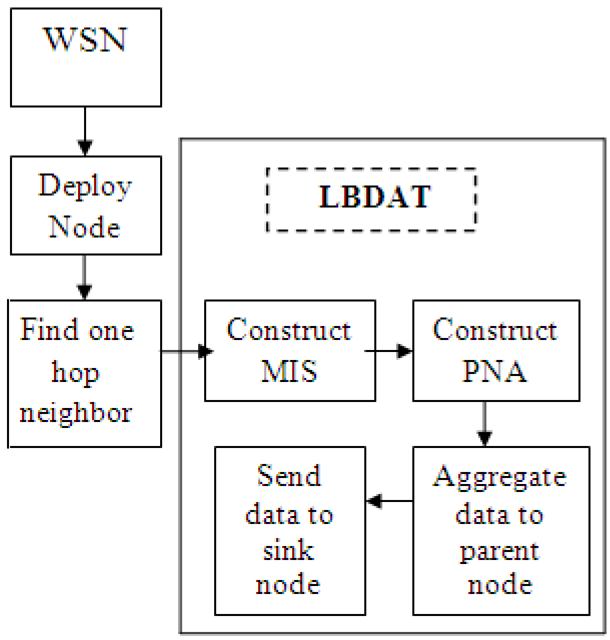

Fig 1. System Architecture

Identify and highlight the use of lossy links when constructing a DAT, moreover, in order to measure the load-balance of the nodes in a DAT under the PNM, two new metrics potential load, and actual load are defined. The "load" associated with a given sensor node represents the amount of data periodically generated by that sensor node. Load balanced trees can be classified into different categories. We define the "level" to be the distance from a node to the base station. A load-balanced tree could be fully balanced, top-level balanced or hierarchy-balanced. A fully balanced tree is a tree in which the branches on the same level carry the same total amount of load. A top level balanced tree is a tree such that each branch at the top level closest to the base station carries the same amount of load. Both fully balanced trees and top-balanced trees are extreme cases of hierarchy-balanced trees, i.e. a tree in which the branches in certain levels carry the same total amount of load.

Start

↓

Network Configuration (Topology Creation)

↓

Node Network Creation

↓

Routing and scheduling and path selection based
on shortest distance algorithm

↓

LBDAT

↓

Display network Topology animation

↓

Display graph, Energy Consumption, Analyze Traffic, hop count and end to end delay

Fig2. Proposed Flow

Constructing data aggregation consists of two steps. The first step is to construct the data aggregation tree distributive and the second step is to reduce the data traffic by adjusting the routing path locally. In this section, we will introduce the two options to construct the data aggregation tree and the local minimization to reduce the data traffic. If we consider nodes in a WSN as vertices and each wireless link between two neighboring nodes as an edge, the WSN can be naturally regarded as a graph. Its Shortest Path Tree (SPT) is composed of shortest paths from the sink to all nodes in a WSN.

After the shortest path distance of all nodes is found, we can assign a parent to each non sink vertex such that parent node is connected to sink vertex. In the case that multiple choices for parent node exist, choose the node for which there exists a shortest path from the sink to parent node with the smallest number of edges. After the parent of all non- sink nodes is determined, the short path tree consists of edges between all nodes and their parent.

Load-Balanced Maximal Independent Set (LBMIS)

All aggregated data are reported to the sink node, hence the sink node is deliberately set to be an independent node. Since an MIS is also a DS, we should formulate the DS constraint for the LBMIS problem first. The DS property states that each non independent node must reside within the 1-hop neighborhood of at least one independent node. Taking the load-balance factor into consideration, we are seeking an MIS in which the minimum potential load of the nodes in the constructed LBMIS is maximized. In other words, the potential traffic load on each node in the LBMIS is as balance as possible.

Step 1: Sort sensor nodes by the wi value (where 1 <= i <=n) in the decreasing order.
Step 2: Set the sink node to be the independent node, i.e., w0=1.
Step 3: Set all wi to be 0.
Step 4: Start from the first node in the sorted node array A.If there is no node been selected as an independent node in vi’s 1-hop neighborhood, then let wi=1 with probability p=wi.
Step 5: Repeat step 4) till reach the end of array A.
Step 6: Repeat step 4) and 5) for v, wi>0 times

Conclusion

There are various aggregation techniques. Based on the nature of the network, data aggregation can be done in two ways i) data aggregation tree or by ii) a clustering approach for hierarchical networks. A very frequent architecture used for data aggregation in flat networks is data aggregation trees (DAT). Data aggregation has been put forward as an essential paradigm for wireless routing in sensor networks. This paper proposes a node-centric load balancing strategy considering the cumulative load of data traffic from child nodes in a routing tree on their parent candidate nodes. The WSN routing tree is linked to the sink. The load of child sensor nodes includes to the load of each top parent in the data aggregation tree. Hence, the sensor nodes near to the sink or base station will be the most heavily loaded. The goal of node-centric load balancing is to evenly distribute packet traffic generated by sensor nodes across the different branches of the routing tree.

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