Review on Data Aggregation Techniques for Energy Efficiency in Wireless Sensor Networks

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Abstract— Wireless sensor network is most important building block for communications. Wireless sensor network faces some critical challenges like security, fault tolerance, scalability, heterogeneity, energy efficiency. Energy efficiency is one of the most studied challenges in wireless sensor network by researchers. Different protocols or algorithms are designed to improve the energy of wireless sensor network. In this paper we discuss about different data aggregation techniques to improve energy efficiency in WSN. Also we have suggested modified data in network aggregation technique to overcome the problem of existing DRINA.

Keywords— Wireless sensor network, energy efficiency, data aggregation.

I. INTRODUCTION

A Sensor Node is a device that sense environmental or physical conditions, such as sound, temperature, pressure, vibration, motion, or pollutants at different locations. Sensor nodes are energy-consumed devices and the energy consumption is generally related with the amount of gathered data, therefore for communication purpose it required more energy. Wireless sensor network uses sensor nodes and are used in applications like homeland security, environmental monitoring, communications, critical infrastructure systems, manufacturing. Different algorithm and protocols are designed to reduce the energy in wireless sensor network. Moreover, WSNs are data-driven networks that generally outcomes a large amount of data that needs to be routed efficiently, often in a multi-hop fashion, toward a sink node, which works as a gateway to a monitoring center. Towards this scenario, the data gathering process, routing plays an important role.

II. ENERGY EFFICIENCY

A wireless Sensor Network is a static ad hoc network consisting of many sensor nodes. Each sensor node is equipped with a sensing device, a low computational capacity processor, a short-range wireless transmitter-receiver and a limited battery-supplied energy. Sensor nodes monitors surrounding data and process the data obtained and forward this data towards a base station located on the sensor network. Sink node in WSN collect the data from the sensor nodes and transmit this data to some remote control station. Thus sensor nodes need more energy for its working and it need to be optimized for efficient performance of WSN. To improve energy efficiency in WSN, different techniques are available. They are categorized into different approaches like, topology control, data aggregation, routing protocols.

III. DATA AGGREGATION

The sensor nodes collect sensory information via monitoring geographical area. Sensory information in wireless sensor network is collected by sink node by wireless hop-by-hop transmissions. A suitable aggregation function is used at sink node for received data from intermediate sensors nodes.[7] And hence it conserves the energy. Aggregation helps to reduce the amount of network traffic and to reduce energy consumption on sensor nodes.

In data aggregation technique, data is gathered to sensor node using aggregation approaches. The data aggregation algorithm collects the sensor data from the sensor node and then aggregates at one particular node. Many authors used data aggregation technique for energy efficiency in WSN. Different protocols or algorithms are used for data aggregation concept. Following figure show the general data aggregation algorithm work.
**A. Tree Based Data Aggregation**

Tree-based data aggregation approach builds an aggregation tree. This tree is a minimum spanning tree, sink node as root node and leaves consider as source node. In this technique data is transferred from leaves node to sink node and aggregation is done by parent nodes.

Ex. TAG (Tiny AGgregation) performs the data aggregation process with the help of queries process. It provides service for aggregation in distributed, low-power, wireless environments. [3]

**B. Centralized Data Aggregation**

Data is gathering at centre node in centralized data aggregation technique. For this process it takes the help of shortest path using a multi-hop wireless protocol. The sensor nodes send the data packets to a centre node, which is the powerful node. The leader aggregates the data which can be queried. Each intermediate node has to send the data packets addressed to leader from the child nodes. So a large number of messages have to be transmitted for a query in the best case equal to the sum of external path lengths for each node. Ex. DD, SPIN.

i) **DD (Direct Diffusion)**

It is data-centric protocol which sense data with the help of attribute-value pairs such as duration, geographical area, and interval. [4]

ii) **SPIN (Sensor Protocol for Information via Negotiation)**

It uses meta-data or high level descriptors. Meta-data are exchanged among sensors via a data advertisement mechanism before transmission. [5]

**C. Cluster Based Data Aggregation**

This approach also consists of hierarchical organization of nodes where nodes are divided into clusters with some special nodes to treat as a cluster head are elected to aggregate data and forwards it to the sink node.

Ex. LEACH, HEED

i) **LEACH (Low Energy Adaptive Cluster Hierarchy)**

It is the first cluster based protocol. It runs into different rounds. Each round has two steps; first step is cluster setup which forms the cluster in self adaptive mode and second step is steady which used for data transfer. [2]

ii) **HEED (Hybrid Energy Efficient Distributed)**

In this primary parameter is remaining energy and secondary parameters are network topology features.
It is used to break tie between candidate cluster heads, as a metric for cluster selection to achieve load balancing. In this all nodes are considered as homogeneous. All sensor nodes are assumed to have equal initial energy. [8]

D. In-Network Aggregation

In the scenario of WSNs, in-network data aggregation uses different ways to transfer data packets from intermediate nodes to the sink node and this gathered from different source nodes. The design of a data aggregation aware routing protocol is a main component for in-network data aggregation. The idea of the INA is to aggregate the data required for the determination of the derivatives as close to the source as possible, instead of transmitting all sensed values through the entire network.

Ex. DRINA, M-DRINA

i) DRINA (Data Routing In-Network Aggregation)

DRINA algorithm is a cluster-based approach. It works in three phases. In Phase 1, the hop tree is built when sensor nodes communicate with the sink node and the sink node starts building the hop tree that get used by coordinators for data forwarding purposes. In phase 2 cluster formation and cluster-head election is done among the nodes that detect the occurrence of a new event in the network. Finally, Phase 3 is responsible for both setting up a new route for the reliable delivering of packets and updating the hop tree. [1]

ii) M-DRINA (Modified Data Routing In-Network Aggregation)

This is our proposed algorithm to optimize the energy efficiency in clustering nodes. For multi-hop communication cluster head required more energy. Using proposed system the energy for multi-hop communication can be reduced. In Existing DRINA cluster head selection is based on hops count where as in proposed system cluster head selection is based on remaining energy.

### Table I: Comparison of Various Data Aggregation Techniques

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Type</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAG</td>
<td>Tree based</td>
<td>Ability to tolerate disconnections and loss.</td>
<td>Network lifetime is limited.</td>
</tr>
<tr>
<td>SPIN</td>
<td>Centralized</td>
<td>Simple in nature, implosion avoidance and economic start up cost</td>
<td>No feedback mechanism for delivery of the data.</td>
</tr>
<tr>
<td>DD</td>
<td>Centralized</td>
<td>It extends the network lifetime</td>
<td>It cannot be used for continuous data delivery</td>
</tr>
<tr>
<td>LEACH</td>
<td>Cluster based</td>
<td>Low energy, increased lifetime of network</td>
<td>Not used for large network region.</td>
</tr>
<tr>
<td>HEED</td>
<td>Cluster based</td>
<td>Improved energy efficiency</td>
<td>No support for heterogeneous node, Lifetime of sensor node is limited.</td>
</tr>
<tr>
<td>DRINA</td>
<td>In-Network</td>
<td>Data security, Low energy</td>
<td>Cluster Head dynamically not changes</td>
</tr>
<tr>
<td>M-DRINA</td>
<td>In-Network</td>
<td>Achieves more energy efficiency than DRINA and increase the lifetime of network with dynamic selection of cluster head.</td>
<td>Not applicable for large network regions.</td>
</tr>
</tbody>
</table>

### IV. Conclusion

Different data aggregation algorithms or protocols are used for energy efficiency in wireless sensor network by various researchers. Cluster based and in-network algorithm is mostly used for low energy consumption and increase the life time of network.
REFERENCES


