Aggregation Protocols in Wireless Sensor Network- A Survey

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Abstract--In this paper we provide a review of existing approaches, techniques and protocols for aggregation in wireless sensor networks. Throughout this paper we discuss some of the various types of aggregation in Wireless Sensor Networking field. Various protocols have been proposed to routing packets for facilitating data aggregation. Generally the users require only efficient aggregate functions. A sensor network may consist of hundreds or thousands of low-cost sensors. Each acts as an information source, sensing and collecting data from the environment for a given task.

Index Terms — Aggregation tree, Clusters, Data Aggregation, Wireless Sensor Network.

1. INTRODUCTIONS

WSNs are broad and emerging field of research which combines many challenges in distributed computing and embedded systems [1]. Now-a-days Sensor networks are most commonly used for applications such as Wild life Habitat monitoring, forest fire prevention and military surveillance etc [2][3][4]. A WSN has little and has no infrastructure. WSN consists of number of sensor nodes which was working together to monitor a region to obtain a data about that filed or area. There are two types of WSNs are categorized, i) Structured WSN and ii) Unstructured WSN. Sensor networks are mostly an event based systems that are different from traditional communication network in several ways: Wireless sensor networks have very severe energy constraints, redundant rate of data and many-to-one relationship form.

Data aggregation is the combination of information from the various sources. The information from the various sources can be collected in a number of different ways. The very simplest data aggregation function is to remove or omit the duplicate data from the source. Duplicate suppression is made, if sources A and B both sends the same data, node C will accept only one of these data. This is a simplest form of Data Aggregation.

2. PROBLEMS AND ISSUES

The main problem with all the wireless devices is the battery management. The battery power consumption, the more data are being transmitted it will cause the larger battery consumption. One way to solve this problem is to reduce the bit transmission. The bit transmission rate can be reduced by aggregating the sensor data [5]. This approach may not be applied for all the WSNs, but it can be applied for sensing some sensor properties like Min (or) Max, Temperature etc.

3. DATA AGGREGATION AS A SOLUTION

In WSN the sensed data must be gathered and transmitted to a Base Station (BS). Then the sensed data further processed for end user queries. By using the aggregation and data fusion technique the total energy, power consumption per node can be balanced. Sensor nodes are the collection of sensor nodes which are co-operatively collect and send data to base station.

The main aspect of data aggregation is to collect and aggregate data in an energy efficient manner. So, that the network lifetime is increases quietly. Aggregating data is a technique of compressing the transmitted packet, in the sense the packet is has only the necessary information. Aggregation of data was initially used in DSP (Digital Signal Processing) applications [6]. In detail, an error free and scalable aggregation framework is

called *Synopsis Diffusion.* It has been proposed for computing aggregation values such as COUNT, AVERAGE,UNIFORM SAMPLE and MOST FREQUENT ITEMS [7][8].

Good aggregation functions for Wireless Sensor networks need to have some additional requirements such as, they should take care of energy capabilities of the sensor devices, energy resources and computational capabilities. Based on the topology of the network the aggregation function can be constructed and used by the sensors.

In wireless sensor networks, a possibility to reduce the amount of data to be transmitted, and therefore to conserve energy, is to combine several sensor readings in intermediate nodes along the way towards the requester. This process is known as Data Aggregation [9].

Spatial convergence and temporal convergence during transmission are the two
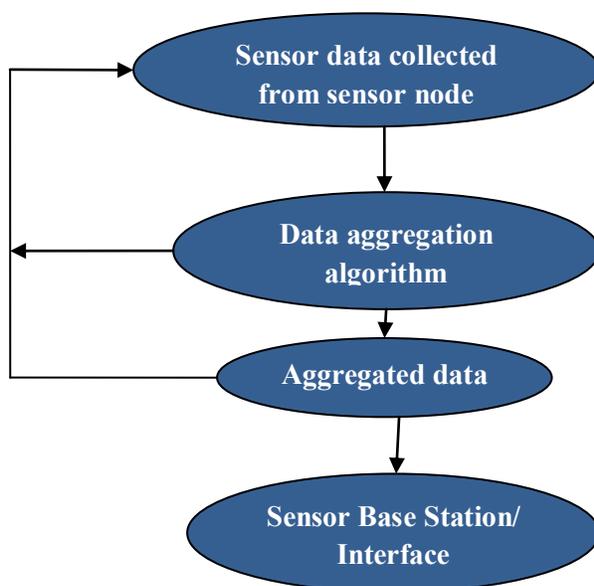

Figure1. General architecture of the data aggregation

4.1 Clustering in WSN

Grouping of similar data are known as *Clusters.* The Process of collecting similar data are known as *Clustering* [10]. In cluster based approach the whole network is divided into several clusters. Some of the issues involving in clustering in wireless sensor networks are, how many sensor nodes are used in a

necessary conditions for aggregation in Wireless Sensor Networks Kai-Wei-Fan et al. proposes two mechanisms for improving spatial and temporal convergence are Data-Aware-Anycast (DAA) is for improving the Spatial convergence and Randomized Waiting is for improving the Temporal convergence during the data transmission [19].

4. TYPES OF AGGREGATION APPROACHES

Data aggregation protocols are used to reduce the communication cost and extending the lifetime of sensor networks. There are four basic types of aggregation approaches are categorized. i) Cluster based approach ii) Tree-based approach iii) Centralized approach and iv) In - network aggregation approach. Figure 1 illustrates the General architecture of the Data Aggregation.

single cluster, which sensor node act as a cluster head in the network and selection of procedure.

4.1.1. Cluster based protocols

In [11], Heinzelman et al. proposes the LEACH protocol. Low-energy adaptive clustering hierarchy (LEACH) protocol is used to group sensor nodes and works with cluster heads to aggregate data. This protocol work and communicate with the base station directly using high transmission power in LEACH the cluster –heads are randomly selected in each round of the node operation. LEACH is a routing algorithm used to collect the data and deliver it into the sink or base station. Mainly it is used to reduce the lifetime of the communication and reduce energy consumption of the each node in the network. In LEACH each cluster in the network was operated by the cluster head.

In [12], Lindsey and Raghavendra propose the PEGASIS protocol. Power- Efficient gathering in Sensor information Systems (PEGASIS) is a Chain based routing protocol used in the Sensor Networks. This protocol organizes all the nodes in a chain and let them play the role of head in turn to save more energy. In this protocol structure nodes are only communicate with their closest node. The chain starts with the farthest node in the sink or base station. After that network nodes are added progressively within the chain.

Based on LEACH and PEGASIS Culpepper et al. propose HIT [13] protocol. Hybrid Indirect Transmission (HIT) protocol is still uses LEACH like clustering operations. But LEACH allows multi-hop routes between cluster heads and non cluster head nodes. HIT protocol can have high energy transmission aspects. HIT protocol is highly used to reduce delay in the process of collecting and aggregate the information from the sensor nodes.

O. Younis and S.Fahmy proposes a protocol HEED [14]. A Hybrid, Energy-Efficient, Distributed Clustering approach (HEED) is a distributed clustering protocol that considers a hybrid of energy and communication cost when selecting Cluster heads. Only sensors that have a high residual energy can become Cluster heads. In HEED each node is mapped to exactly one cluster and can directly communicate with its Cluster head.

4.2 Tree based protocols

By constructing an aggregation tree, which could be a minimum spanning tree rooted at sink or base station and source nodes are considered as leaves.

In [15] [16] C. Intanagonwiwat et al. propose GIT protocol. Greedy Incremental Tree (GIT) is a tree based protocol that is used to establish an energy efficient path based on Directed Diffusion [17] [18]. An extremely popular aggregation scheme for sensor network is Directed Diffusion (DD) [17] [20] is a data centric architecture. DD aggregates data from the paths of the network to reduce the quantity of data transmitted across the network. GIT protocol builds an aggregation tree sequentially to merge path and give many aggregation opportunities. At the first step the aggregation tree consists of only the shortest path network and the nearest source. Then the next source node closest to the current tree is connected to the aggregation tree [21].

In [22] [23] Madden et al. propose Tiny Aggregation Service (TAG) protocol. It is also a tree based protocol used in the Wireless Sensor Networks. It uses shortest path tree method and improves snooping based and hypothesis testing based optimization. Zhang and Cao propose Dynamic Convey Tree based Collaboration (DCTC) [25] protocol.

Power Efficient Data Gathering and Aggregation Protocol (PEDAP) [24] is quite better than LEACH and PEGASIS protocols. This protocol improves the lifetime of the system. Basic scheme of data aggregation include Center of the nearest Source (CNS) [15] in this protocol the data are aggregated at the source node which is nearest to the destination. In Shortest Path Tree the data are sent through the shortest path from the source to the destination.

4.3 Centralized approach

This is an address centric approach in this approach each node sends the data to the central node through the convenient shortest path using multi-hop environment. Central node acts as header and the header aggregates the information from the various nodes.

4.4 In-network approach

In–network approach [25] is the global process of gathering and aggregating the information. There are two approaches are used i) with size reduction ii) without size reduction. Adaptive Application Independent Data Aggregation in Wireless Sensor Networks (AIDA) utilizes feedback control based on network traffic condition when making aggregation decisions to adaptively optimize bandwidth while minimizing system energy consumption which is under exploited in the traditional schemes [16] [26] [22] [27] [28].

5. CONCLUSION

We surveyed Wireless Sensor Networks and its Aggregation techniques and protocols. We have summarized different algorithms, protocols and techniques in Data aggregation in Wireless Sensor networking area. There are still many issues to be resolved around WSN applications such as communication architectures, security, and management. By solving these issues, we can close the gap between technology and application.

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