A Survey of Data Dissemination Protocols

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Abstract — A wireless sensor network is typically a large collection of densely distributed sensor nodes which have been organised into a cooperative network. The growing need for efficient communication is posing constrains on wireless sensor networks. Data Dissemination has been put forward as a process, which allows the information to be distributed in the network efficiently. As energy is consumed largely during the distribution of data in the network, data dissemination is crucial in wireless sensor networks. Energy efficiency and network lifetime are the two important issues that need to be considered during data dissemination. In this paper we are going to summaries different data dissemination protocols that prolong the network lifetime as well as consider the constrained energy resources so, as to efficiently utilize the energy of the source nodes

Keywords— Wireless sensor networks, Static sink, Mobile sink, Data dissemination, Virtual Infrastructure.

I. INTRODUCTION

With the advancement in the micro-electromechanical systems (MEMS) technology, wireless communication have made sensor nodes possible which have a large no of functionalities and are cheap and consume less energy as compared to the earlier ones, along with the miniaturization of their size [1]. A single sensor node has a limited ability to sense and not able to collect all the information from a specified area, therefor we use a large no of sensor nodes to perform the task of sensing, collecting and processing the information collectively. Thus a wireless sensor network (WSN) is defined as a collection of large no of sensor nodes, which are distributed over the sensing field randomly [2] [3]. Each sensor node consists of data processing unit, sensing unit, power units, memories and communication units [4] and can be equipped with different components depending on the application.

Wireless sensor networks (WSN) find applications in areas such as monitoring the physical and environmental conditions, target tracking, military surveillance [5]. As compared to the traditional wireless networks, WSNs are limited in power, computation and memory capacities. Also the sensor nodes which are generally deployed in areas, where human intervention is not possible or restricted, the node batteries which are non-rechargeable poses a constraint on the design of WSN. So, efficient energy consumption among the nodes is an important issue. The nodes that are near to the base station or sink are generally burdened and get exhausted in their energy and the nodes die, creating 'energy-holes' in the network. The 'holes' in the network causes the network lifetime to be reduced. So, our main issues to deal with in this paper are the efficient energy consumption and to prolonged the network lifetime.

In order to achieve these objectives we introduced the concept of Mobile sink. The mobility of the sink improves the network lifetime as well as the network connectivity by balancing the consumption of energy among the nodes. Data Dissemination has been put forward as a process which allows the information to be distributed in the network efficiently. It has been observed that maximum energy is consumed during the distribution of data in the network and hence, data dissemination is crucial in WSN design.

Data dissemination is the process by which queries or information is distributed in the sensor network. The node which is interested in the data, collects it from the sensor nodes [6]. The node that generates data is called 'source node' and the information to be reported is called an 'event'. A node which is interested in an event is called 'sink. The sink can be static or mobile sink. The measured and monitored events are then forwarded for data post-analysis toward a more resource-rich device called a base station or sink. This procedure of gathering the data and sending it to the base station or sink called 'Data Dissemination' and is generally performed from the sensors generating the data toward a base station or a sink using an n-to-1 communication [7].

In this paper we are going to broadly classify the Data Dissemination protocols that efficiently utilize the energy of the sensor nodes and hence prolong the network lifetime of the WSN with Mobile Sink. The rest of the paper is organized as follows. Section-II presents the advantages of using Mobile Sink over Static Sink and the challenges related to the design of data dissemination protocols using Mobile Sink. Section-III presents all the classifications of Data Dissemination protocols along with their pros and cons. Section-IV conclusion.

II. STATIC SINK VS MOBILE SINK

In Wireless sensor network with a static sink the node nearer to the Base station or the sink is deleted in its energy the most, as a bottleneck is created around it, due to which it gives rise to a problem called 'Energy-Hole' or 'Hot-Spot' problem. To overcome this problem of 'energy-hole' the concept of Mobile-Sink has been introduced, where a Mobile

sink proactively move around and collect the data in the sensing field [8] [9]. In this section we are going to discuss the advantages of Mobile sink over the Static sink and what are the design issues of Data Dissemination protocols with Mobile sink.

A. *Advantages of Mobile Sink:* The advantages of mobility of the sink are multi-fold. The mobility of the sink has overcome the problem of energy-hole, the network lifetime has been prolonged, the lifetime of the node has been prolonged, the energy is consumed efficiently among the nodes, improvement of the connectivity, reduced network delay and reduced overhead, improved throughput.

B. *Design Issues:* Despite having so many advantages over the static sink, the mobile sink present some design issues that need to be considered while designing the data dissemination protocols. These issues are discussed as below.
1. Position of Sink- The sensor nodes measure and monitor the events depending on the application and forward the information to the sink. Now in order to forward the information to the sink or the Base station the node must know the position of the sink .In case of static sink the position of the sink is known, hence the data if forwarded but mobility of the sink generates a design issues, how to find the exact position of the sink in the sensing field. In order to overcome this issue the concept of virtual infrastructure has been introduced. In this concept the structure is considered as a rendezvous region that stores the generated information in it and the sink can directly collect the data from that region, using a query-based data reporting method. By the use of this virtual infrastructure the energy-efficiency can be improved.
2. Throughput of network- The mobility of the sink generates another issues related to the throughput of the network. The sensor nodes that are in direct connection with the sink can transmit their data to the sink. But the sensor nodes that are ready to send their data to the sink but are not able to do so, because of the absence of the sink in their vicinity have the chance of dropping the packet. Also the sensor nodes which have the sink in their vicinity have the chance of collision between the packets sent simultaneously by the different sensor. Such a problem is overcome by introducing Rendezvous nodes next to the Mobile sink, which act as buffers to store the data received from the sensor nodes and also avoid the chances of collision in the network, as sensor nodes will select the RN nodes close to them and will send their data to them.
3. Mobility Support- The last issue is the management of mobility of the sink. In order to overcome this issue the concept of progressive footprint –chaining have been used, where the sink selects a sink manager which performs all the function of receiving and transmitting the data to and from the sensor nodes.

III. CLASSIFICATION OF DATA DISSEMINATION PROTOCOLS

The classification of Data Dissemination protocols can be done based on a one of criteria. The Data Dissemination protocols have been classified as below:

A. *Nature of Information to Disseminated*: The protocols are classified based on the nature of information that is to be disseminated into the network [7].
1. Data Dissemination: Here the sensors disseminate the data that is measured and monitored by the sensors deployed in the sensor field i.e. the task of the sensor nodes is to monitor the temperature of the specified area, then the data that is disseminated by the nodes is the temperature of the area to the base station or the Mobile sink. Directed-Diffusion, TTDD [10], GHT [11], protocols disseminate the data to the sink.
2. Meta Data Dissemination: Meta Data is the data about the data measured. Here the meta data is disseminated to the sink while the actual data remains stored in the sensor i.e. the meta data about the temperature sensed by the sensor node is that, if the temperature is above a give threshold then it need to be announced to the mobile sink otherwise there is no need to announce it. SPIN, Railroad [112] are protocols that uses this approach.
3. Sink-Position Dissemination: Here the sink needs to disseminate the information about its position to the sensor nodes, when a mobile sink is being used. Locators [13] are examples of protocols using this approach.

B. *Where to Disseminate the Data:* The protocols can be classified based upon, where to Disseminate the information.
1. one-to-one dissemination: Here the sink individually visits every sensor node which stores the data in its local buffers. Whenever the sensor node receives the beacon message transmitted by the sink, they transmit their monitored data to the sink.
2. many-to- one dissemination: Here all the sensor nodes send their monitored data to the single sink, which enables the sink to collect the network wide information.
3. one-to- many dissemination: Here every sensor node send its monitored data to a subset of nodes. The sink collects the data from this subset of nodes, which enables the sink to collect the network wide information.

C. *Data Dissemination Structure Creating Entities:* The data Dissemination protocols can be classified based on the dissemination structure creating entities [14].
1. Source-Oriented Structure: Here the source node that detect the events create a structure and announces its presence to the sink. The sink then uses this source oriented path for data queries as well as for collecting the monitored information from the source nodes. TTDD and SEAD are the source oriented protocols.

2. Sink-Oriented Structure: Here the sink creates a structure and announces to the sensor nodes about its position by broadcasting beacon message periodically. Here the tree structure is rooted at the sink. ART is a sink-oriented protocol.

D. *Virtual Infrastructure Based Approach:* Here the virtual infrastructure acts as a rendezvous region that stores the generated information in it and the sink can directly collect the data from that region, using a query-based data reporting method. There are many advantages of this virtual infrastructure based approach, like the sink can collect all the information from the rendezvous area and also certain data optimization processes can be applied to the data in the rendezvous area. The virtual infrastructure based approach can be divided into two categories as Rendezvous – based approach and Backbone-based approach [7].

1. Rendezvous-Based Approach: In this approach, the sensor nodes are aware of their positions using GPS or some virtual coordinate system. In this approach a virtual infrastructure is drawn over the physical network and this overlay is used during the dissemination of the data using some geographical routing algorithms. The data disseminations protocols using this approach of Rendezvous-based virtual infrastructure are TTDD, GHT, LBDD and QDD. This approach allows the nodes to balance the energy consumption among the nodes, hence prolonging the network lifetime of the network, increasing the connectivity of the wireless sensor networks, reducing the delays and hence increasing the throughput of the network. But along with these added advantages, the rendezvous nodes sometimes get overloaded and results in the hot-spot problems.

2. Backbone-Based Approach: In this approach the sensor nodes use the concept of self-organization to build the virtual infrastructure over the physical network. HDD, HCDD are the data dissemination protocols using this approach. The main drawback of this approach is the energy-hole problem encountered due to the overloading of the leaders and need to maintain the structure.

E. *Cluster- Based Approach*: In this approach the sensor nodes are grouped togather into clusters, where they select a cluster head among them and all the communication in the cluster is done through the cluster-head. The inter-cluster communication is performed between the cluster-heads and the sink. Here the organization of the sensor nodes is done in a hierarchical manner. The protocols used under this approach are HCDD, QCCA. But along with this added advantage there is the problem of increased overhead of maintaining the hierarchical structure. The cluster based approach helps in efficient utilization of the energy in the network, as all the communication in the cluster is done through the cluster head and the inter-cluster communication is done between the cluster heads of different clusters.

F. *Flat- Based Approach:* This is a non-hierarchical approach of data dissemination, where the entire sensor node has same role and equal role to play and there is no need for the virtual infrastructure. The periodic location update by the sink to the sensor nodes is done only to some of the nodes that are nearby to the mobile sink and not to all nodes, which in turn reduces the overhead of location updates. The data dissemination protocols using this approach are ART, DST. This approach is used in applications were the exact location of the nodes is not required and hence the overload of updating the location is reduced and hence the energy consumption is reduced, resulting in the enhanced network lifetime of the nodes.

IV.   CONCLUSION

In this paper we have discussed the data dissemination techniques along with a mobile sink. These mechanisms of data disseminations have been based on certain criterions such as where to disseminate the data, what information need to be disseminated, structure creating entities, and different approaches for data dissemination. In this paper we have discussed the pros and cons of these data dissemination techniques and how they affect the energy consumption and the network lifetime of the wireless sensor networks.

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