Optimal Aggregator Node Selection in Wireless Sensor Networks

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Abstract. In order to reduce number of data transmissions and improve the bandwidth and energy utilization in wireless sensor networks (WSNs), *data aggregation* or *in-network processing* techniques are needed. The simplest way to achieve data aggregation is to select data aggregator nodes. In this paper, we investigate optimal aggregator node selection in WSNs. The main idea of our approach is to perform a skyline query on the sensor nodes in WSNs in order to extract sensor nodes that are potential candidates for the leading role, and those that cannot possibly become an aggregator node.

Keywords: Wireless sensor networks, data aggregation, top-*k*.

1 Introduction

Recently, wireless sensor networks (WSNs) have been used in many applications, such as military target tracking and surveillance, environmental monitoring and healthcare. Communication is a dominant source of energy consumption in such resource constrained networks [1]. In order to reduce number of data transmissions and improve the bandwidth and energy utilization in WSNs, *data aggregation* or *in-network processing* techniques are needed. Data aggregation involves processing, combining, and filtering sensor data that belong to the common phenomena.

The simplest way to achieve distributed data aggregation is to select data aggregator nodes. Aggregator nodes are regular nodes that receive data from neighboring nodes, perform some kind of processing, and then forward the filtered data to the next hop and finally to the base station [2]. In this paper, we investigate optimal aggregator node selection in WSNs. The selection process is formulated as a top-*k* query problem. The main idea in our approach is to perform a skyline query on the sensor nodes in WSNs in order to extract sensor that are potential candidates for the leading role, and those that cannot possibly become an aggregator node. The remainder of this paper is organized as follows. Section 2 discusses related work. Section 3 describes our proposed approach. Section 6 highlights conclusions.

2 Related Work

Traditionally, data aggregation protocols can be categorized into two types: tree-based data aggregation protocols and cluster-based data aggregation protocols. In this section, we briefly describe representative data aggregation protocols.

Madden et al. [2] proposed the Tiny AGgregation (TAG) service for aggregation in low-power, distributed, wireless environments. Routing tree at the base station, and aggregates collected data along the way to the base station through the implemented routing tree. However, TAG-based approach wastes the energy for unnecessary updating data. Heinzelman et al. [1] proposed a low-energy adaptive clustering hierarchy, called LEACH (Low-Energy Adaptive Clustering Hierarchy), a protocol architecture for micro-sensor networks. LEACH consists of a distributed cluster formation technique that enables self-organization of large numbers of nodes, algorithms for adapting clusters and rotating cluster head positions to evenly distribute the energy load among all the nodes, and techniques to enable distributed signal processing to save communication resources.

3 Proposed Method

The main idea in our approach is to perform a skyline query on the sensor nodes in WSNs in order to extract among those sensor nodes that are potential candidates for the leading role, and those that cannot possibly become an aggregator node.

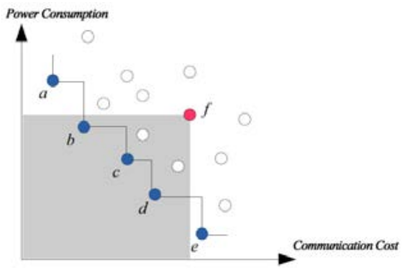

Figure 1. An example of skyline sensor nodes.

Figure 1 shows an example of skyline sensor nodes of a certain cluster. Each sensor node is described by two attributes, namely power consumption and communication cost. Hence, the sensor nodes are represented as points in the 2-dimensional space, with the coordinates of each point corresponding to the values of the attributes of sensor node. We can see that the sensor node *a* belongs to the skyline, because it is not dominated by any other nodes, i.e. there is no other service that offers both shorter power consumption and communication cost than *a*. The same holds for the services *b, c, d* and *e*, which are also on the skyline. On the other hand, service *f* is not contained in the skyline, because it is dominated by the services *b, c* and *d*.

Notice that the skyline sensor nodes provide different trade-offs between the attributes, and hence is incomparable to each other, as long as there is no pre-specified preference scheme regarding the relative importance of these attributes. For instance, for a specific base station, sensor node *a* may be the most suitable choice for a leading aggregator node, due to its very low power consumption and despite its high communication cost, while for a different base station, where execution time is not the primary concern, the sensor node *e* may be the most preferred leading aggregator node due to its low communication cost.

4 Conclusions

In this paper, we investigate optimal aggregator node selection in WSNs. The main idea in our approach is to perform a skyline query on the sensor nodes in WSNs in order to extract among those sensor nodes that are potential candidates for the leading role, and those that cannot possibly become an aggregator node. Thus, the amount of communication can be significantly reduced by sending only aggregated data through selected leading aggregator nodes, instead of individual sensor data, to the base station.

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References

1. Heinzelman, W. R., Chandrakasan, A., Balakrishnan, H.: Energy-Efficient Communication Protocol for Wireless Microsensor Networks. In: Proceedings of the International Conference on System Sciences, pp. 1 – 10 (2010).
2. Madden, S., Franklin, M., Hellerstain, J., Hong, W.: TAG: a Tiny AGgregation service for ad-hoc sensor networks. In: Proceedings of the 5th symposium on Operating systems design and implementation, pp. 131-146 (2002).
3. Ozdemir, S., Xiao, Y.: FTDA: outlier detection-based fault-tolerant data aggregation for wireless sensor networks. In: Security and Communication Networks, Vol. 6, No. 6, pp. 702-710 (2012).
4. Pottie, G. J., Kaiser, W. J.: Wireless intergrated network sensors. In: Communications of the ACM, Vol. 43, No. 5, pp. 51-58 (2000).