DATA AGGREGATION ON WIRELESS SENSOR NETWORK PERFORMANCE WITH EFFECT

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ABSTRACT

Wireless Sensor Network has limited battery power and computational power, leads to increased complexity. A better data aggregation framework on wireless sensor networks gives anefficient battery power and improved lifetime.This paper brings out the various concepts associated with wireless sensor networking and various advantages of using WSN like knowledge repository, cost deduction, phishing filters, ERP applications, data privacy distinguish competencies through resources and capacity building. Here we investigate models and mechanisms for detection and recovery form faults and propose an adaptation framework to facilitate their deployment and maintenance.

This can be achieved by making the framework as middleware for aggregating data, measured by a number of nodes within a network. In this paper the performance of TAG in terms of energy efficiency in comparison with and without data aggregation in wireless sensor networks is presented.

Keywords: Aggregation; Sensor Network; Clustering.

I. INTRODUCTION

Sensor network is the collection of sensor nodes which cooperatively send sensed data to the base station. As sensor nodes are battery driven, an efficient utilization of power is essential in order to use network for longer duration. Hence it is needed to reduce data traffic inside sensor networks and reduce the amount of data that is to be sent to the base station. The main goal of data aggregation algorithms is to gather and aggregate data in an energy efficient manner so that network lifetime is enhanced. Wireless sensor network nodes need less power for processing than transmitting data. It is preferred to do network processing within the network and reduce packet size. One such approach is *data aggregation* which is an attractive method of data gathering in distributed system architectures and dynamic access via wireless connectivity [1]. With advance in technology, sensor network is composed of small and cost effective sensing devices equipped with wireless radio transceiver for environment monitoring. The key advantage of using these small devices to monitor the environment is that it does not require infrastructure such as electric mains for power supply and wired lines for Internet connections to collect data and does not need human interaction while deploying. These sensor nodes can monitor the environment by collecting information from their surroundings, and work cooperatively to send the data to a base station, or sink, for analysis [1-3].

The main goal of data aggregation algorithms [1] is to gather and aggregate data in an energy efficient manner so that network lifetime is enhanced. Wireless Sensor Network (WSN) offer an increasingly attractive method of data gathering in distributed system architectures and dynamic access via wireless connectivity based on the grouping of sensor nodes. The process of grouping the sensor nodes in a densely deployed large-scale sensor network is known as clustering.

The intelligent way is to combine and compress the data belonging to a single cluster which is known as data aggregation in cluster based environment.

There are some issues involved with the process of clustering in a wireless sensor network: *(1) Number of clusters to be formed to optimize the Performance (2) Number of nodes to be included in a single cluster. (3) Selection procedure of cluster head.*Apart from the above, making required cluster heads(CH) more powerful in terms of energy so that other nodes work as members of clusters is an important issue. As mentioned above, it is important to know and compare the performance of TAG in terms of energy efficiency with or without variation in data aggregation. In this paper we have presented these comparisons through simulation results.

II. METHODOLOGY

Data aggregation protocols aims at eliminating redundant data transmission and thus improve the lifetime of energy constrained wireless sensor network. In wireless sensor network, data transmission takes place in multi-hop fashion

where each node forwards its data to the neighboring node which is nearer to sink. Since closely placed nodes may sense same data, above approach cannot be considered as energy efficient. An improvement over the above approach would be clustering where each node sends data to cluster head and it performs aggregation on the received raw data and sends it to sink. Performing aggregation function over cluster head still causes significant energy wastage. In case of homogeneous sensor network cluster head will soon die out and re-clustering has to be done which again causes energy consumption.

III. WSN MANAGEMENT

The number of nodes in a sensor network makes management cumbersome or even impractical for administrators. Management frameworks have been pro-posed to support the proves of conjuration and control of nodes. In centralized approaches a global manager assumes the role of the leader and orchestrates nodes in the network. There are two monitoring models for such approaches -active, where queries where detected issues are reported to a leader, outside the network, which then performs network reconguration. The global state collected typically includes routing tables. The global state collected typically includes routing tables node connectivity and energy maps of nodes. MANNA is centralized with active models representing the state of the network, while functions are processes provided by the basic framework and operate on supported modes. A service is a complex operation dened as a composition of functions.

Sympathy is also a centralized system that performs passive monitoring by piggybacking monitoring information on regular network trac. Consequently, it does not fit well in event-driven networks, where messages may occur infrequently in response to events. Centralized solutions suffer on scaling; the sink is a single point of failure and can result in message concentration causing overload. In multi-hop deployments, nodes around the sink suer significantly increased traffic due to relaying messages from the rest of the network, resulting in uneven power consumption.

Furthermore, multi-hop routing to the sink adds significant, potentially unbounded, delays on message delivery which may prove problematic for applications where event propagation time is critical, such as health decision making closer to aected node and reduces trac towards the sink. Network re-conguration implies the existence of an adaption infrastructure in the network.

IV. DATA AGGREGATION

Data aggregation is a process of aggregating the sensor datausing aggregation approaches [3-].The general data aggregation algorithm works as hown in “Fig.1”. The algorithm uses the sensor data from the sensor node and then aggregates the data by using aggregation algorithms such as centralized approach, LEACH(low energy adaptive clustering hierarchy),TAG(Tiny Aggregation)[2] etc. This aggregated data is transfer to the sink node by selecting the efficient path.There are many types of aggregation techniques namely: (i) Centralized Approach (ii) Networked aggregation (iii) Tree based approach and (iv) Cluster based approach. In this approach, the simulation results are carried out using the cluster based approach along with aggregation without clustering.

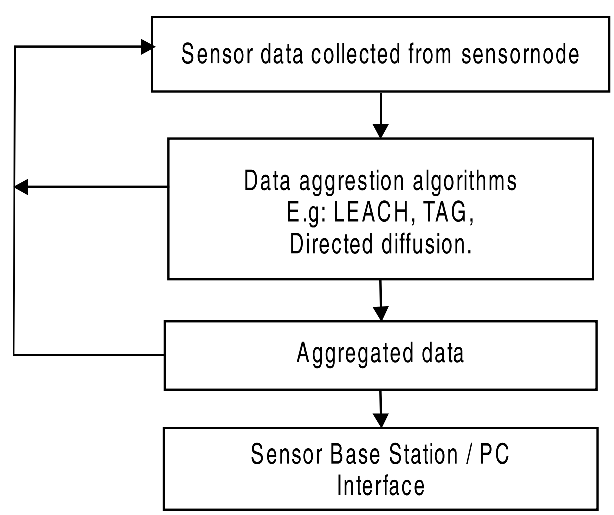

Fig. 1. General architecture of the data aggregation algorithm

V. QUERY PROCESSING

COUGAR approach [6] has been used to aggregate the data along with TAG based approach. This is possible because the TAG and COUGAR are tightly coupled with the underlying aggregation schemes [7]. TinyDB's query language based on SQL is used in this case. Query Language in TinySQL supports selection, projection, determining sampling rate, group aggregation, user defined aggregation, event trigger, lifetime query, and setting storing point and simple join [8]. Some of the sample queries used for aggregation and clustering are as below:

A. Simple Queries

These are non aggregate queries. And are generally mapped to broadcast or point to point queries.

Eg. "SELECT temperature FROM sensor WHERE node = z".

B. Complex Queries

These may contain sub queries.Eg. "SELECT temperature FROM sensor WHERE room =

(SELECT room WHERE floor = '3')".

C. Event Driven Queries

These are the continuous queries that return the values periodically at specified time intervals.

Eg: "SELECT AVG (temperature) FROM sensor where node = z".

The Grammar of TinySQL query language is as follows: SELECT select-list [FROM sensors] WHERE predicate 294

[GROUP BY gb-list] [TRIGGER ACTION commandname [(param)]] [EPOCH DURATION time]

Where, select-list is the attribute list of the unlimited virtual relational table, which can include an aggregation function, predicate, is the query condition, gb-list is an attribute list, command-name is a trigger operation, param is the parameter of trigger, time is the value of time. TRIGGER ACTION is the subordinate clause which defines the trigger. It determines the operations executed when WHERE clause is satisfied. EPOCH DURATION defines the query cycle. The meaning of the other clauses is same as SQL. Following is an example of a TinyDB query:

SELECT nodeid, AVG(light), AVG(temp) FROM sensors

WHERE AVG(light)=100 GROUP BY nodeid EPOCH

DURATION 5min

The meaning of the query is detecting nodeid for every five minutes in which the average light is 100 and returning the nodeid and its average light and temperature. Currently, the functions of TinyDB are very limited. Some functions which are supported by SQL are not supported by TinyDB.

VI. SIMULATION AND RESULT

The most popular WSN simulators are TOSSIM, NS-2,OPNET, OMNet++, J-Sim, GlomoSim, and Qualnet. TOSSIMis a discrete event simulator for TinyOS (TinyOS is a popularsensor network operating system) sensor network. Instead ofcompiling a TinyOS application for a mote, users can compileit into the TOSSIM framework, which runs on a PC. This allows users to debug, test, and analyze algorithms in acontrolled and repeatable environment. As TOSSIM [9] runson a PC, users can examine their TinyOS code using debuggers and other development tools. TOSSIM's primary goal is toprovide a high fidelity simulation of TinyOS applications. For this reason, it focuses on simulating TinyOS and its execution,rather than simulating the real time enivornment. Heretemperature and light are used as measurement parameters in simulating the results with raw data.

A. Simulation Run

The simulation experiments are conducted with threedifferent set of SQL queries i) Simple SQL query without AVG() aggregation function ii) SQL query with AVG()aggregation function without the cluster environment iii) SQLquery with AVG() aggregation function with two node percluster , with EPOCH DURATION of2048ms/sample usingTinySQL and the results are recorded.

QUERY-1: SELECT light FROM SENSORS SAMPLEPERIOD 2048.

A simple SQL query without AVG() function is executedon the WSN of 10 nodes for measuring the day light from each.This query is executed for 80 cycles. Figure 2 shows the plot ofdata generated by the simple SQL QUERY-1 during first 80cycles.

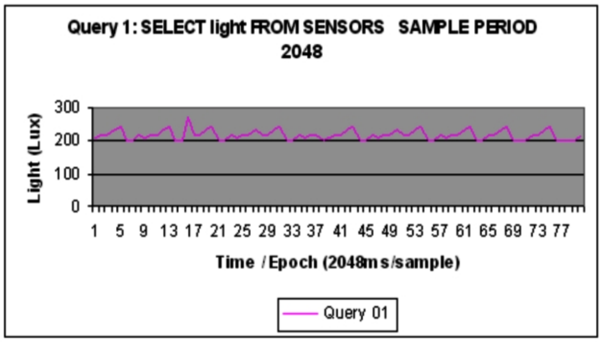

Fig. 2. Output of Query 1

QUERY-2: SELECT AVG(light) FROM SENSORS

SAMPLE PERIOD 2048.

A SQL with AVG() aggregation function is executed on the WSN of 10 nodes for measuring the day light from each. This query is executed for 80 cycles. Figure 3 shows the plot of data generated by the SQL QUERY-3 during first 80 cycles.

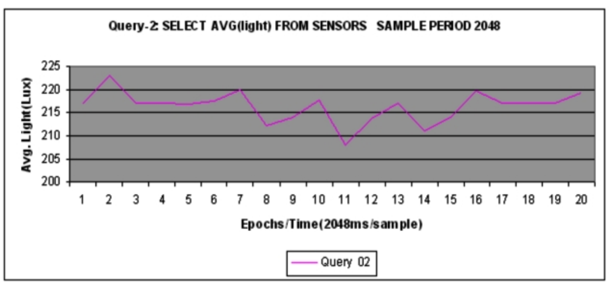

Fig. 3. Output of Query 02

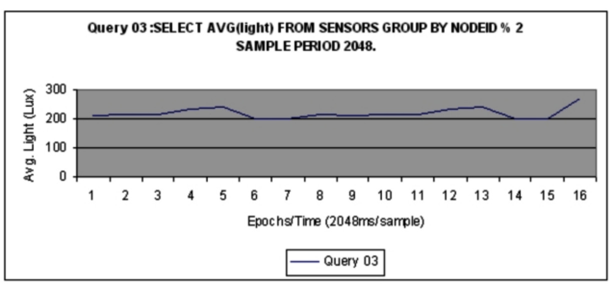

Fig. 4. Output of Query 03

QUERY-3: SELECT AVG(light) FROM SENSORS GROUP

BY NODEID % 2 SAMPLE PERIOD 2048.

The SQL QUERY-3 measures the average day light from the cluster (size 02) on the WSN of 10 nodes for a sampling rate of 2048ms for 80 cycles. "Fig. 4" shows the data captured from each cluster for 80 cycles.

"Fig. 5" and "Fig. 6." show the bar graph which compares the amount of data generated by the above mentioned three different SQL queries. The SQL QUERY-1 generates more number of readings compared to the other two. It is observed that amount of data generated by query with aggregation and without clustering

environment (i.e. Query-2) is found to be bare minimum, but the method is inefficient in terms of energy efficiency as each node has to communicate with a sink node with more numbers of hops. The data generated by SQL QUERY-3 is bit more than data generated by SQL QUERY-2. However, in some circumstances where the size of network is large and for non optimal number of clusters the QUERY-3 may not be efficient.

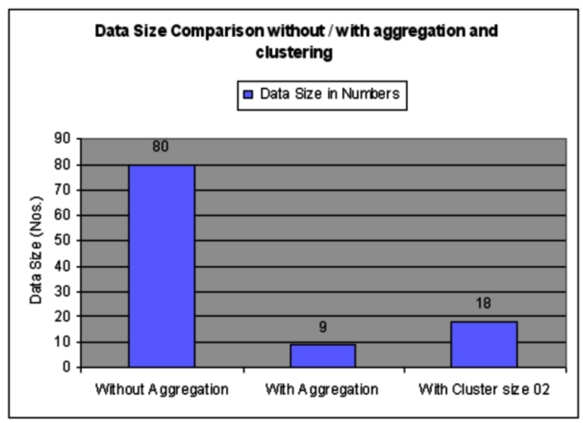

Fig. 5.Comparison of the data with different aggregation technique.

VII. FUTURE WORK

Here are some ideas for ways that this project could be extended in the future:

- More realistic physics should be employed in the simulation, including better modeling of how sound and vibrations work, etc.
- More than one object could be tracked at once, or three-dimensional tracking of flying objects such as planes.
- Battery life of non-wired nodes.
- Extensibility to allow for different routing algorithms.

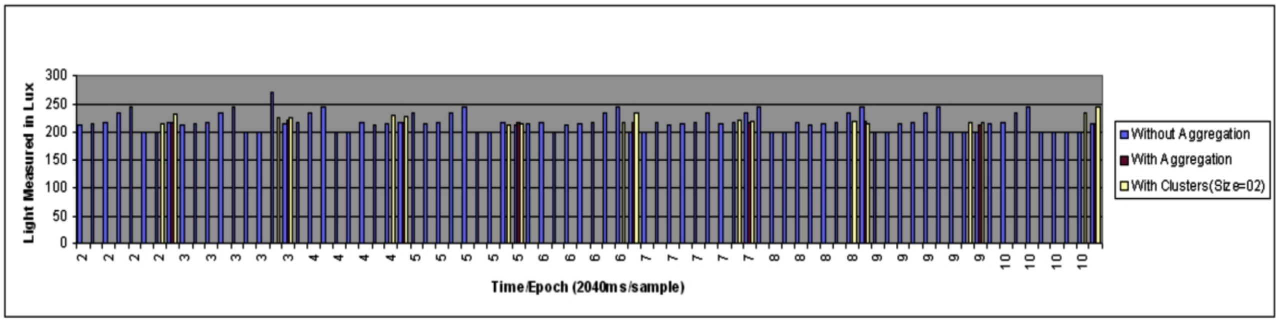

Fig.6

- Our simulation of the LEACH protocol made some attempt to model the fact that sensors have limited communication range; however, they are allowed to freely communicate with the Monitor from any location. A more thorough simulation of this or other protocols would have required a network path to a base station, rather than a disembodied monitor which all cluster-heads can reach directly.

VIII. RELATED WORKS

Key Management is one of the main challenges in securing wireless networks, and has been addressed by many authors. In this section, we present an overview of some approaches and protocols for keying management in both WSNs and WMNs respectively.

A. Key Management in WSNs

To date, the key Management protocols, each pair of communication nodes should establish a shared key. One attractive idea in the pair wise key management is key pre distribution, i.e.,.pre-installing a limited number of secrets in sensor nodes prior to actual deployment; after the deployment, if two neighboring nodes have some common keys, they can setup a secure link by the shared keys. While in the group key idea is to broadcast information that is useful only or trusted nodes. Combined with its pre-distributed secretes, this broadcast information enables a trusted sensor node to reconstrut a group key. Most pair wise key an group key management protocols in WSNs are based on symmetric key cryptography. These solutions are designed to sustain severe computation power, storage, mobility and energy constrains, and as a result have limited scalability and robustness. Although some research shows that the right selection of process and associated parameters along with code optimization can make public key cryptography feasible for sensor networks. For example, the ECC and RSA based key management protocols. The major shortcomings of them are the associated expensive computation and the high probability of likely penetration by malicious agents. Also all feasibility for WSNs. Unfortunately, as we know, none of current works propose complete key management infrastructure compatible public and private key cryptography.

B. Key Management in WMNs

Secure group communication is a mature research area and has a large body of research literature. The main objective of a secure group communication protocol is to ensure the data confidentiality against outsiders such that only legitimate group members can recover the group data. Existing solutions for wired networks are not well suited for WMNs as they fail to take into consideration the multihop communication paradigm featured by WMNs, as well as the communication security among mesh clients within the coverage of a mesh router.

These protocols also do not exploit unique features of WMNs, such as the broadcast nature of wireless communication. ARSA proposes attack-resilient security architecture for WMNs, which use ID-based cryptography (IBC). LSSS presents an ideal linear multi-secret sharing protocol, by using monotone span programs. Though, they achieve efficient and secure group communication in WMNs. They cannot be employed in the WSNs. pensive energy consumption and also they cannot offer modular security for WMSNs. In general, none of the existing protocols considered the unique features of WMSNs, such as coexistence of resources constrained sensor nodes and powerful mesh nodes, increasing scalability when remote cluster sensors get interconnected thanks to presence of WMN, all of which can be leveraged for designing more optimized protocols. We will take into account the diversity of nodes' ability and proposed a unified key management framework, which includes simple techniques that are able to provide basic functionalities on the simplest sensor devices and at the same time they can be extended to support advanced functionalities on high performance mesh nodes.

IX. CONCLUSION

In this work we have studied the two most important parts of data communication in sensor networks- query processing, data aggregation. And also realized how communication in sensor network is different from other wireless networks. Wireless sensor network are energy constrained network, since most of the energy is consumed for transmitting and receiving data, the process of data aggregation becomes an importantissue and optimization is needed. Efficient data aggregation not only provides energy conservation but also removes redundant data and hence provides useful data. The simulation results shows that when the data from source node is sent to sink through neighboring nodes in a multi-hop fashion by reducing transmission and receiving power. The energy consumption is low as compared to that of sending data directly to sink. Henceaggregation reduces the data transmission than without aggregation. We have shown how aggregate queries are efficiently executed in wireless sensor network.

REFERENCES

[1] Yingshu Li, My T. Thai, Weili Wu, "Wireless Sensor Networks and Applications", Springer Series on signals and communication technology, 2008, pp.331-347.

[2] S. Madden et al., "TAG: a Tiny Aggregation Service for Ad-hoc Sensor Networks," OSDI 2002, Boston, MA, Dec. 2002.

[3] E. Fasolo, M. Rossi, J. Widmer, and M. Zorzi, "In-Network Aggregation Techniques for Wireless Sensor Networks: A Survey", IEEE Wireless communication 2007.

[4] M. Ding, X. Cheng, and G. Xue, "Aggregation tree construction in sensor networks," in Proc. of IEEE VTC'03, Vol. 4, Orlando, FL, Oct. = 2003.

[5] K. Dasgupta, K. Kalpakis, and P. Namjoshi, "An Efficient Clusteringbased Heuristic for Data Gathering and Aggregation in Sensor Networks", IEEE 2003.

[6] "The Design Space of Wireless Sensor Networks" by Kay Romer and Friede mann Mattern http://www.vs.inf.ethz.ch/publ/papers/wsndesignspace. Pdf

[7] http://en.wikipedia.org/wiki/Wireless_Sensor_Networks

[8] S. Nath et al., "Synopsis Diffusion for Robust Aggregation in Sensor Networks," ACM SenSys 2004, Baltimore, MD, Nov. 2004.

[9] P. Levis, N. Lee, M. Welsh, and D. Culler. "TOSSIM: Accurate and Scalable Simulation of Entire TinyOS Applications". To appear in Proceedings of the First ACM Conference on Embedded Networked Sensor Systems (SenSys 2003).