

Secure Data Aggregation for Energy Efficient Wireless Sensor Networks

Jyoti Kaurav, Kaushik Ghosh

Abstract— *Wireless Adhoc and Sensor Networks (WASNs) provide easy, effective and cheaper solutions for real life multidisciplinary problems as in military, robotics, weather forecasting and medical sciences. The energy constraint and security issue comes directly in mind while talking of WASN. As the areas of WASNs are increasing, security and energy needs special attention so that the network does not results in a failure. While talking about energy there are three major areas of WASN which can be worked upon to improve their efficiency. They are: battery, circuitry & topology and routing protocols used. Here we are working only on the protocols with certain assumptions for the node hardware. In order to ensure energy efficiency by reducing number of transmissions, data aggregation is a widely used technique. We thus, implement a secure data aggregation scheme which ensures reduced total energy consumption of the network as well.*

Index Terms— *Data Aggregation, Energy efficiency, lifetime, security, WSN*

I. INTRODUCTION

Wireless Ad-hoc and Sensor Networks are one of the fastest emerging technologies showing its applications to almost all areas of life. For WASN to be the future technology so many factors are to be worked upon. So what are wireless Ad-hoc and sensor networks?

Sensor networks are large sets of small, inexpensive devices with hardware for sensing and a radio for communication with the other sensors. Sensor networks are being enabled by the convergence of several technologies at once. The advent of cheap, low-power microprocessors, sensor technology, and low-power RF design has made it possible to conceive of large networks which can together do what might be impossible (or too costly) to do with fewer, more expensive nodes. Wireless sensor networks are “ad-hoc” networks, which mean that the topology of the network is not planned, but must be decided by the network nodes themselves.

Many fundamental questions about wireless ad hoc networks remain unanswered. Among the questions considered in this dissertation are: what extent and How energy consumption can be minimized in WASN? How does energy minimization techniques affect the lifetime of the network? Is the data being transmitted securely? With what power should nodes in the network transmit? Will nodes determine their neighbors, and

if so, how? What routing protocols to be used for energy efficient WASN?

Giving an attempt to find out the answers of the few such questions, we here propose an energy efficient data aggregation algorithm for WSN using Fermat point concept as described in the papers [1]-[3].

II. LITERATURE SURVEY

Sensor nodes of a typical wireless sensor networks, are usually resource-constrained and battery-limited. In order to save resources and energy, data must be aggregated to avoid overwhelming amounts of traffic in the network [4]. The authors of papers [4-2] show the impact of data aggregation in WSN.

The aim of data aggregation is that eliminates redundant data transmission and enhances the lifetime of energy in wireless sensor network. In which reduce energy consumption of the sensor nodes and also reduce the number of transmissions or length of the data packet. In WSN, data aggregation is the process of one or several sensors then collects the detection result from other sensor. The collected data must be processed by sensor to reduce transmission burden before they are transmitted to the base station or sink. The wireless sensor network has consisted three types of nodes: the source node, the aggregator node and the sink node.

Paper [5] describes the In-network aggregation as the exclusive process of collecting and routing information through a multi hop network with processing of data packet with the help of intermediate sensor nodes. The objective of this approach is increasing the life time of the network and reducing the resource consumption. Mohamed Wafaa in [5] gives an energy efficient approach to query processing by implementing new optimization techniques applied to in-network aggregation. He focuses on the two major drawbacks with general data aggregation protocols. The preprogrammed behavior which cannot be modified and increased energy wastage due to the communication overhead which results in decrease of overall system lifetime. In-network aggregation means computing and transmitting partially aggregated data rather than transmitting raw data in networks to reduce the energy consumption [7].

Paper [8], [9] tells about the various security issues related to data aggregation in WSN. There are two type of securities are require for data aggregation in wireless sensor network, confidentiality and integrity. As per my knowledge, [10], [11], [12] were the first few works to discuss techniques for secure data aggregation in Wireless Sensor Networks.

III. PROBLEM STATEMENT

Especially from an industry perspective, the major barrier to the wide adoption of wireless sensor networks technology

Manuscript received April 2013

Jyoti Kaurav, Computer Science and Engineering, Mody Institute of Technology and Science, Laxmangarh, India

Kaushik Ghosh, Computer Science and Engineering, Faculty of Engineering and Technology, Mody Institute of Technology and Science, Laxmangarh, India).

are the lack of easiness in WSN programming, the lack of installation ease, and the big concern about the reliability, interference, and the robustness to the dynamicity of the environment and also the battery lifetime. For this, data aggregation is also to be embedded in the protocol on which security is to be applied. This will serve both the purposes i.e. to minimize energy consumption and to secure the transmission.

IV. PROPOSED DATA AGGREGATION SCHEME IN WSN

Data aggregation is being used to minimize the energy consumption in transmitting data multiple times. Fermat point is the median of polygon having shortest distance from all the vertices of polygon [3]. So, obviously if the data is being travelled from the Fermat point, it will cover the shortest distance. Fermat point is an imaginary point and data cannot be transmitted to it so the Fermat node i.e. the node nearest to the Fermat point is obtained and then the data is send to the Fermat node and aggregation takes place.

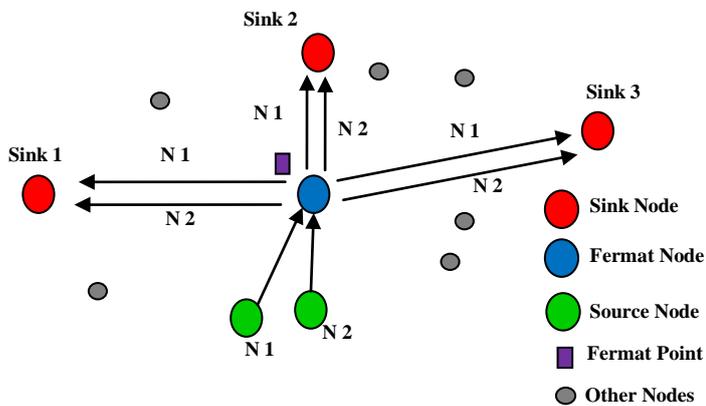


Fig.1 Data Transmission with Data Aggregation

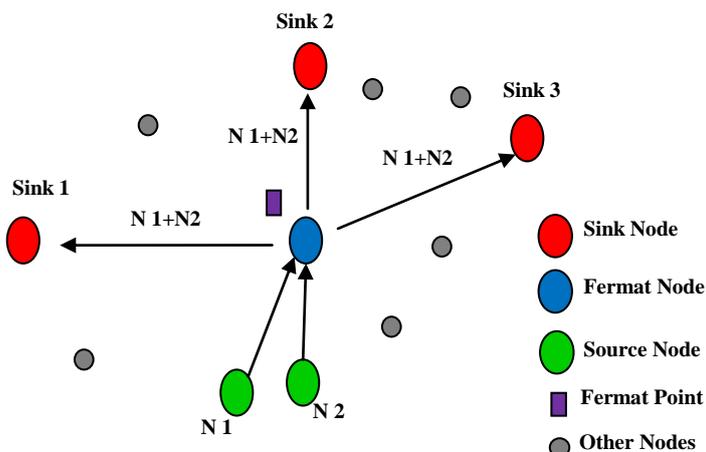


Fig.2 Data Transmission without Data Aggregation

Fig. 1 and fig. 2 show the number of transmissions with and without data aggregation. As we are using here the Fermat point concept for data aggregation so the number of transmissions are almost reduces by half. The ratio by which

the no. of transmissions are reduces depends upon for how many sources the node acts as the Fermat node.

A. Data Aggregation in WSN: Our Approach Algorithm

1. Source Node-> Plaint Text to Fermat Node
2. Fermat Node->Data Aggregation and Encryption on Aggregated data
3. Sink node-> Decrypt
4. Keep a check when data reaches NF_ID; wait for 1 second before transmitting it to sinks.
 - If**
 - Within that time other data reaches from nodes for which it is also acting as NF_ID then Aggregate, Encrypt and transmit
 - Else**
 - Encrypt and transmit
5. Exit

The algorithm described above is also embedded with simple data security using simple encryption and decryption. We are trying to enhance the security aspects in our future works.

V. EXPERIMENTAL RESULTS

This is with reference to the paper “Effect of Transmitting Radius, Coverage Area and Node Density on the Lifetime of a Wireless Sensor Network”. The lifetime is going to increase with Data Aggregation.

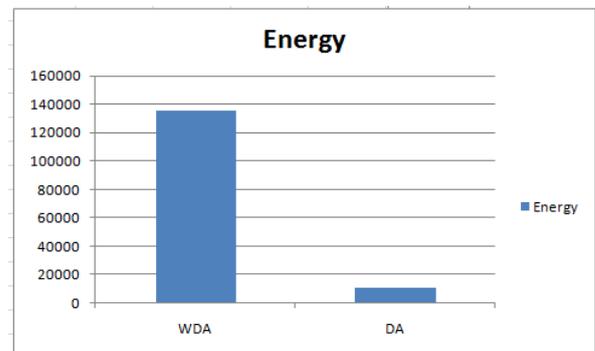


Fig.3 Effect of Data Aggregation on the total Energy consumption in WSN

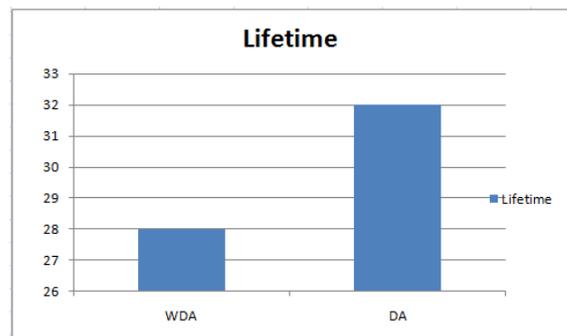


Fig.4 Effect of Data Aggregation on the lifetime of WSN

Fig. 3 and fig.4 shows the effect of data aggregation algorithm we proposed on the lifetime and total energy consumption of a WSN. As the number of transmissions decreases so very less energy is consumed and the lifetime is increased comparatively.

VI. CONCLUSION

It is shown how the Data aggregation can help in minimizing the computational energy and maximizing the lifetime improving the energy efficiency of a WSN, reducing the number of packets needed, and enabling a high increase in energy efficiency. As the Current model assumes homogeneous nodes but data aggregator nodes consume more energy as compared to other nodes and aggregators nodes may die out soon.

VII. FUTURE WORK

Data security is a matter of concern when it comes to applications implemented using WSN. For which, we are trying to implement low energy security algorithm along with data aggregation in order to make WSN data aggregation more secure and more energy efficient. For preventing the aggregator nodes from dying out we may assign them higher energy as compared to other nodes in the network calling them the advanced nodes, resulting into a heterogeneous network.

ACKNOWLEDGMENT

We are grateful to the management of Mody Institute of Technology and Science for the facilities provided to the authors for carrying out this work.

REFERENCES

- [1] Kaushik Ghosh, Sarbani Roy and Pradip K. Das "An Alternative Approach to find the Fermat Point of a Polygonal Geographic Region for Energy Efficient Geocast Routing Protocols:Global Minima Scheme" First International Conference on Networks & Communications 2009.
- [2] Kaushik Ghosh and Pradip K Das "Effect of Forwarding Strategy on the Life Time of Multi-hop Multi-sink Sensor Networks" Proceeding of the 3rd International conference on trends in Information, telecommunication and computing ITC 2013, LNEE, Vol 150, part 3, pp 54-64 2012.
- [3] Kaushik Ghosh, Sarbani Roy and Pradip K. Das, "I-Min: An Intelligent Fermat Point Based Energy Efficient Geographic Packet Forwarding Technique for Wireless Sensor and Adhoc Networks"; International journal on applications of graph theory in wireless ad hoc networks and sensor networks, 2010.
- [4] Kiran Maraiya, Kamal Kant, Nitin Gupta "Wireless Sensor Network: A Review on Data Aggregation" International Journal of Scientific & Engineering Research Volume 2, Issue 4, April -2011 1; ISSN 2229-5518; IJSER © 2011
- [5] Mohamed Watfa , William Daher and Hisham Al Azar "A Sensor Network Data Aggregation Technique" International Journal of Computer Theory and Engineering, Vol. 1, No. 1, April 2009
- [6] E. Fasolo, M. Rossi, J. Widmer, and M. Zorzi, "In-Network Aggregation Techniques for Wireless Sensor Networks: A Survey", IEEE Wireless communication 2007.
- [7] Bo Yu, Jianzhong Li, Yingshu Li "Distributed Data Aggregation Scheduling in Wireless Sensor Networks" IEEE Communications Society, IEEE INFOCOM 2009 proceedings
- [8] Sanjeev SETIA, Sankardas ROY and Sushil JAJODIA "Secure Data Aggregation in Wireless Sensor Networks" IEEE TRANSACTIONS ON INFORMATION FORENSICS AND SECURITY, VOL. 7, NO. 3, JUNE 2012
- [9] Mukesh Kumar Jha, T.P. Sharma "Secure Data aggregation in Wireless Sensor Network: A Survey" International Journal of Engineering Science and Technology (IJEST) Vol. 3 No. 3 March 2011

[10] Cam, H; Ozdemir, S Nair, P Muthuavinashiappan, D (October 2003). "ESPDA: Energy-efficient and Secure Pattern-based Data Aggregation for wireless sensor networks". *Sensors* 2: 732–736.

[11] Hu, Lingxuan; David Evans "Secure aggregation for wireless networks", Workshop on Security and Assurance in Ad hoc Networks, (January 2003).

[12] Przydatek, Bartosz; Dawn Song; Adrian Perrig, "SIA: secure information aggregation in sensor networks". *SenSys*: 255–265. 2003.

Jyoti Kaurav. The author is an M.Tech final student in Computer Science Department at MITS, Laxmangarh. Her researches are in the various fields of Wireless sensor Networks (WSN), especially on Energy Efficient WSN.

Kaushik Ghosh. The author is faculty in in Computer science Department at MITS, Laxmangarh. His researches follow the works on different schemes of minimizing energy of a WSN.