Sensor Network Discovery for Deep Mining

Ekenias Chigiga
Department of Electrical Engineering
University of Cape Town, Private Bag X3 Rondebosch, Cape Town 7701
Email: ekenias.chigiga@uct.ac.za

Abstract- AziSA is an architecture for open measurement defined by the CSIR. It makes use of Wireless Sensor Networks (WSN) to provide a mechanism of recording data from drill and blast mining environments. This research focuses on developing a sensor discovery method that is custom to the AziSA architecture. The method needs to cater for the limitations of WSNs and enhance the strengths of WSNs. The method can be used in a protocol specification for the AziSA architecture.

Index Terms—WSN, AziSA, CSIR

I. INTRODUCTION

WSNs have found many applications in the recent years. They are very versatile and can be used in numerous applications such as military applications, industrial control and monitoring and a few others. WSN have been regarded to as one of the most important technologies of the twenty-first century [1]. In environmental applications, sensor nodes can be deployed over an area to measure aspects such as temperature or water levels. The nodes can give warnings if the temperature is too high or if there is flooding. In military applications sensor nodes can be deployed to monitor the perimeter. They have the advantage of being cheap to deploy and they are a better solution compared to using landmines [6].

As the WSN grow in size, network discovery becomes an issue, especially in environments where the nodes occasionally lose contact with each other due to the harshness of the environment. During network discovery, the devices in the network will also advertise the services they offer [2]. This research is focused on using some of the existing service discovery architectures to create a network discovery method that is custom and optimized for the AziSA architecture.

This paper structure is organized as follows, Section I is an introduction to WSNs and sensor network discovery. Section II takes a brief look at the AziSA architecture. Section III discusses some of the work taking place in the WSN world with respect to network discovery. The key issues to be addressed in the research are covered in Section IV. Section V contains the conclusion and summarizes the purpose of the document.

II. AZISA ARCHITECTURE

The drill and blast mining is not tightly managed due to the lack of information about what is happening underground. The CSIR designed an architecture for underground measurement and control networks called AZISA [3]. AZISA defines four classes of devices/nodes that make up the network. The devices are divided into measurement and management nodes.

Class four devices are simple measurement devices. They are able to send information to class three devices and they are typically low power devices that are battery operated. Class three devices are more superior to the class four devices. They are able to take measurements as well as raise alerts based on their own data. They also continue to operate even if they lose contact with their class two parent devices. Class two devices each have the task of coordinating a subnet of the class three and class four devices as in figure 1. They make decisions based on the data available to them and they can also raise alerts. The class two devices aggregate the data from the class three and four devices and forward the data to the class one devices. Class one devices act as the data store for all the data in the network, they also act as an interface to the data from other interfaces such as the web interface. The class one devices are also responsible for raising alerts or forwarding important notifications to the parties responsible.

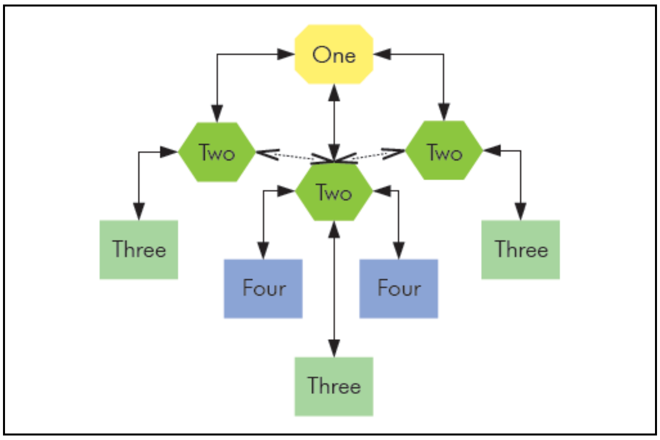

Figure 1: AziSA class diagram [3]

The class two devices acts as data sink, the difference between the AziSA class two and conventional data sinks is that the class two should be able to gather and communicate with several different sensor network technologies. This means that the class two network discovery mechanisms have to take this into account. The network discovery refers to when the network is starting up and the devices are finding out the network structure, and when a device joins an existing network. This research is limited to class two devices.

III. Wireless Sensing Network Discovery

In related work WSNs differ with respect to the application or purpose of the network. Different platforms and protocols are used depending on the type of application of the WSN.

In August 2001, researchers created a self organizing wireless sensor network with 800 nodes [4]. The project made use of the TinyOS operating system which ran on the motes. A network of similar size can be expected in the drill and blast mining environment. Some of the mines can run for a few kms underground.

The Vienna University of Technology has a project that has a data sink connected to multiple sensor nodes.

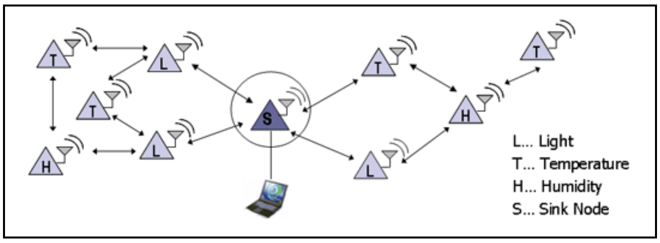

Figure 2: University of Vienna Sensor Network Project [5]

The structure of this project is similar to one of the subnets in the AziSA architecture. The sink in figure ii can be equated to the class two devices of the AziSA architecture.

One of the major issues with the sensor network discovery of the class two devices is that the less superior devices being managed by the class two devices will operate using different protocols. This means that during network discovery the class two devices need to account for such differences. The devices will also send data at different rates. This means that the class two devices should also handle this during network discovery.

It is important that the network discovery method should not use too many resources (bandwidth, power etc). The harshness of the drill and blast mining environment means that the network will constantly face situations where some nodes lose their connection and have to reconnect to the network. The discovery method should also handle such situations without straining other elements of the network.

IV. Advancing WSN Discovery

Energy minimization is crucial for the AziSA architecture. Thus the network discovery method should be critical of this. A lot of messaging and signaling occurs during network discovery. This means that energy conservation is one of the key issues affecting the network discovery method.

The class two devices have to perform node management on the nodes connected to their subnet. They also have to ensure that the routing in their subnets is efficient and uses resources wisely.

The sensor network discovery method for the AziSA architecture will be tested using a simulation tool that has the necessary tools. An example would be the TinyOS environment to simulate and test the network discovery.

A number of test cases will be applied to the simulation environment, the most important being network startup and adding elements to the network. These two will be monitored to see if they conform to the required standards. On success, the testing can be moved to hardware and simple tests run using actual hardware.

V. Conclusion

An efficient and sufficiently robust sensor network discovery method can be used to develop a protocol for the AziSA framework for the class two type-devices. It is a small cog in the complex AziSA machine and this research aims to add to AziSA. The literature review is still ongoing with respect to this research and a lot of work still needs to be done in terms of designing an efficient sensor network discovery method.

VI. References

[1] I. F. Akyildiz , W. Su , Y. Sankarasubramaniam , Y. , and E. Cayirci , " Wireless sensor networks: A survey " , *Computer Networks (Elsevier) Journal* , vol. 38 , no. 4 , ar. 2002 , pp. 393 – 422.

[2] Å. Östmark, P. Lindgren, A. van Halteren, L. Meppelink, "Service and Device Discovery of Nodes in a Wireless Sensor Network", *IEEE CCNC 2006 proceedings.*

[3] R Stewart, S.J. Donovan, J. Haarhoff, V. Brink, D Vogt, "AziSA: An architecture for underground measurement and control networks" http://www.csir.co.za/mineral_resources/pdfs/CPO-0005.pdf

[4] University of California, Berkeley, Largest Tiny Network Yet, http://webs.cs.berkeley.edu/800demo/

[5] University of Vienna Sensor Network Project, http://www.ict.tuwien.ac.at/wireless/

[6] J. Zheng, A. Jamalipour, "WIRELESS SENSOR NETWORKS, A networking perspective" , pp. 1-10.

Ekenias Chigiga received his undergraduate degree in 2009 from the University of Cape Town and is presently studying towards his Master of Science degree at the same institution. His research interests include Wireles Sensor Networks, Embedded Systems and Telecommunications.