

Protocol Analysis of Ubiquitous Sensor Networks with Health Care Monitoring and Surveillance

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Abstract—As the population grows and the lifespan of people is prolonging, the demand of health care will rise. A lot of visits to the hospital are exhausting and time consuming, especially for patients that have long term diseases. The long term disease patients and elderly withhold the largest part of the hospital resources and when the knowledge of sensor networks is getting better and the communication channels are getting more reliable, the need for going to the hospital in order to do a simple measurement can be decreased. Many measurements and even some monitoring activities can therefore be done at home instead of taking time and resources from the hospitals. Not only can this prove to be beneficial in terms of cost, but also when it comes to produce new services and business models.

I. INTRODUCTION

A research project named itACiH, IT support for Advanced Cancer care in the Home, recently started in the Skane region. It involves both the industry, hospitals as well as the university. It is funded by Vinnova which sponsored the project with 10 million SEK to speed up the phase of new health care techniques that work in a palliative manner at home. In other words, the need for the patients to transport themselves to clinics, health centers and hospitals that have medical equipment will decrease since many of these measurements can be done at home or more locally if the equipment is easy to use, has high reliability and is secure enough for transmitting and receiving potentially sensitive data. This might be possible with a Sensor Network, as seen in Figure I.

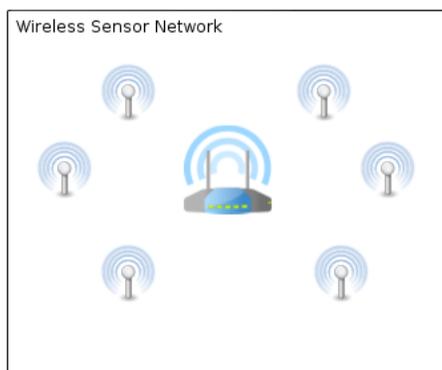


Fig. 1. A typical Sensor Network

II. SENSOR NETWORKS

There are several standards under development and a range of different standardization bodies are under way when it comes to the field of Wireless Sensor Networks, WSN. For instance the professional association IEEE 802.15 is mainly focusing on the standardization of the physical and MAC layer. In addition to this there are a number non-standard proprietary protocols being developed focusing on higher layers for special end-need purposes. ZigBee is an example of this.

A. Securitas Direct Safety Radio Protocol

In the beginning of the project research was laid on seeing if it was possible to use the existing protocol of Verisure in order to get the medical data to and from the node in a reliable way. This was shown not to be sufficient. Using the architecture of the security company today gave a model seen in Figure II-A. This model describes how 3 bytes is being sent to the node, while you can retrieve a lot more from the node to the database.

The RF protocol used was not sufficient to do the implementations we wanted.

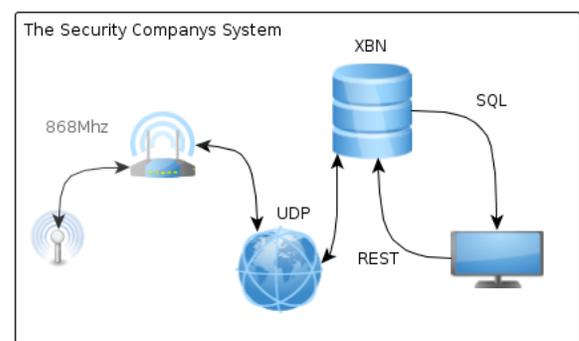


Fig. 2. The System architecture of the Security Company

B. ZigBee®

ZigBee is a high level communication suite specification that allows for communication over low power, small digital based radio. It is often applied to mesh networks for transmission of data over a long range, accomplished by sending data

between intermediate connected devices. While a single node have a range of about 50 meters,

1) *ZigBee Health Care*: One of the research objectives by the ZigBee alliance has been to look into the possibilities that involves standards promoting and supporting data exchange between medical and non medical devices. This has resulted in the so called ZigBee Health care public application profile which has been developed with the purpose to support medical attention in non-invasive contexts.

III. MEDICAL INTEROPERABILITY STANDARDS

There have been numerous projects in the recent years focusing on getting medical equipment operating in homes of patients. Most of the projects had focused on the optimization of the sensor networks. In 2007, the International Organization for Standardization joined the IEEE 11073 standard and ISO/IEEE 11073 was created. This focuses on the interoperability between health devices making it possible for different vendors and manufacturers to co-exist in the homes of patients. It can also prove to be beneficial for the manufacturer when changing market to another country or even municipality.

A. ISO/IEEE 11073 PHD

In 2004 the standard ISO/IEEE 11073 was released and described criteria for how medical equipment should communicate with each other. This standard was mainly focused to the hospitals, rather than into homes of patients. Therefore, the standard was developed further to take into account to the growing population, which will require home care.

Concern was raised that the roll-out of such home systems will take a lot of time because the systems available would be incompatible with each other, which is why the ISO/IEEE 11073 Personal Home Data (PHD) was developed. This is meant to be for individuals to keep track of their current health status through different services and even to have professional care takers to monitor their status.

1) *Continua Health Alliance*: The Continua Health Alliance (CHA) is an alliance created to realize the standard ISO/IEEE 11073 standard. CHA is a non-profit, open industry alliance with members from the leading health care and technology companies. The alliance was created in order to improve the interoperability between products in order to establish a health system that will improve the health and wellness of patients. The Alliance have a set of guidelines and principles that companies should follow in order to get certified. The terminology of the guidelines differ a bit from the ISO/IEEE 11073 standard, the Guidelines look very much like Figure III-A.

IV. RESULTS

There have been two different approaches on the goals, firstly a protocol analysis have been made and then we looked into medical interoperability standards.

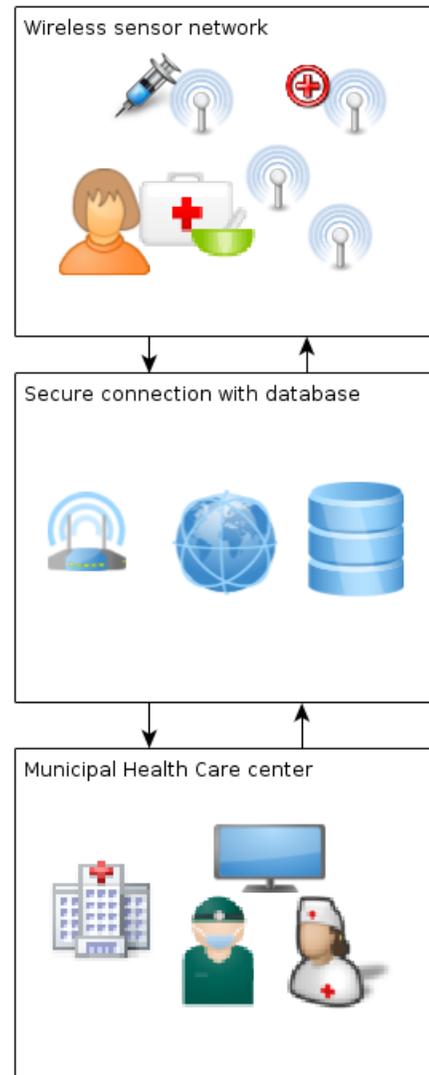


Fig. 3. A ZigBee based system with an ISO/IEEE 11073 PHD Implementation

A. Protocol Analysis

A way to implement the system in order to be a member of the Continua Health Alliance and to meet the specifications of IEEE 11073 PHD is to implement a ZigBee or BT-LE device into the gateway that would have the responsibility to communicate with agents that do not use SimpliciTI™ protocol. Hence, that the gateway should be the manager and the security companies backend handles the data transmission to the health centers and hospitals or other remote services.

B. Proposed ISO/IEEE 11073 PHD System

The whole implementation would look more like the Continua Alliance guidelines if ZigBee was used in the security companies sensor network. However, changing into using only ZigBee would be impossible in terms of development cost and interoperability with legacy products. Since the gateway of the

system handles all the communication, even with old nodes, changing the protocol of the sensor network would be costly and it would result in that one can not communicate with old nodes.

V. CONCLUSION

As previously mentioned numerous attempts have been made to accomplish medical specific transmission by using wireless protocols and back end solutions. However this task has not been easy, as for the number of different approaches is similar to the number of different solutions to this type of application. Nevertheless, a strive searching for a common standard has arisen propelling the need for a common goal.

The problem consists in short thinking when developing where the medical technical device serves its purpose for the moment, but in reality lacks great support or compatibility for future products of same type. The surge for a shared goal has been realised the past years under the name ISO/IEEE 11073 PHD to accommodate the requirements given. It is however up to the manufacturer or developer to decide whether they wish to comply these standards in order to reach levels of certification of these devices.

By adding an extra module into the gateway that handles the ZigBee nodes and keep the old SimpliciTI™ protocol for the security mechanism would be the best way to implement this feature. This could also be the the best way to be interoperable with other health devices and also be the most cost effective and reliable way to get a Continua Health certification.

The conclusion in this case is somewhat ambiguous. Since the proprietary nodes are all manufactured and developed by the same manufacturer, no actual requirements regarding interoperability with other vendors are required other than to choose to manufacture and supply the medical equipment themselves.

Low power wireless networks hold great promise for improving lives and increasing functionality. By focusing first on high-level application considerations and then moving to more specific criteria such as robustness and reliability, ease of use, and hardware criteria, a designer can apply a framework for selecting the proper protocol for his or her application and join the increasing number of products with low power wireless capability.