

WIRELESS COMMUNICATION STANDARDS FOR INTELLIGENT BUILDINGS

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Abstract: For our main research project we had to design and develop a monitoring and control system which, using a wireless sensor network (WSN), to make a building to become 'smart' (automated). One of the goals of this development is to choose the best available solution for wireless communication. In this paper it is presented a comparison between different possibilities of implementing the wireless communication inside the WSN network and in final it is decided which is the best solution which should be implemented (considering the advantages offered and the requirements of our system: low energy consumption, low latency, large signal range, low data rate, cost, easy implementing, etc.).

Key words: DASH7, ISO 18000-7, ZigBee, wireless communication, smart building

1. INTRODUCTION

The main idea of our project is to design and develop a system which to realize the automation of a building (which to point at the end the concept of smart building) using wireless sensor networks (WSN). There is a building with many offices where the people will do research activities. It is necessary to optimize the working conditions (temperature, humidity, light, quality of the air, etc.) into the offices and in this way to increase the comfort of people, which develop activities in that space. In the same time the cost will also be reduced by increasing the energy consumption efficiency (using the natural energy sources will be also taken into consideration: photovoltaic panels, heat pumps, etc.).

A system of this kind contains many elements which need to communicate between them and ensure that the entire system works well. For communicating there are 2 possibilities: with wires, which link the components as it is necessary, or wireless (radio waves). In the first case the wires need to be installed into the walls of the building; process which is quite difficult and expensive if the construction of the building is already finished. In this case the system should be installed, preferably, during the construction of the building. The second solution, which could be a little bit more expensive (depending on the technology used), offer the possibility to link the elements by wireless connections, which could be modified when it is necessary and it is ensured a very easy maintenance of the entire system. Also, the system structure could be very easy modified; usually it is necessary only a personal computer, which to be connected to the system, and using a dedicated software application the configuration of the system could be changed according to the needs. Even if nowadays many commercial building automation equipments use wires for realize the communication and supply the devices with electrical power, the wireless solution should be more considered since it represents the future, offering a lot of advantages. On the other side, as a disadvantage, it is considered that the wireless communication produces electromagnetic fields which could be dangerous to the human body. But, the studies on this problem do not conclude that this risk exists, neither the opposite.

A long period of time the single wireless protocol used inside the WSN was ZigBee, which reach today a certain level of maturity. But there have been also other wireless solutions, not dedicated to WSN, and the recent research activities proved that new wireless solutions are still defined and developed.

The most part of wireless communication comparisons have been made by the companies which sustain a wireless standard, presenting its advantages, and less the disadvantages. The best way of determine the real advantages and disadvantages for different wireless communication protocols/standards is to make an advanced analyze from a neutral point of view and corresponding to our system needs. Also, there have been studied which commercial components exist for implementing of each standard, hardware and software.

2. WIRELESS COMMUNICATION

In the area of wireless communication there have been developed different protocols and defined multiple standards. The main goal of researchers was to increase the data rate transfer into a stable 'stack' of functionalities. But a high value of data rate is not necessary in all situations. In case of WSN it is more important to ensure low energy consumption for increasing the life time of the network. And for most of monitoring systems a low data rate value is enough for transmitting the essential information.

Always it is necessary to design a WSN having the idea of minimizing the energy consumption in mind. The most part of energy is consumed at wireless data transmitting or receiving. For this reason it is important to analyze and decide which information is essential to be transmitted, the interval of time at which the transmission is done and if some archiving algorithms are necessary. Also, the technology used for wireless communication is important; this is the reason for which we have done the following comparison.

2.1 Short presentation and comparison

Into the first step it was analyzed the most part of wireless communication standards and then there were analyzed in more details the solutions which have been considered to be more affordable for our system.

It is quite difficult to decide if a solution is better than another. It depends on the type of the system in which it should be implemented. For this reason there have been defined a set of parameters which to be considered: the implementing possibility, the energy consumption, the latency, the range of transmitting the information, the total cost and the necessary maintenance (they have been listed here in order of importance). The next wireless communication standards were analyzed:

- *WI-FI (IEEE 802.11)* represents a trademark of the WI-FI Alliance and it is used for a variety of products, which need to communicate wirelessly and which require having a big data rate transfer. It is not dedicated for WSN.
- *Bluetooth (IEEE 802.15.1)* represents a set of specifications for using the radio waves into the Personal

Area Networks (PAN). The energy consumption for data transmitting is high and it's dedicated only for communicating on short distances. It is not dedicated for WSN.

- IRDA (infrared) represents a set of specifications for using the infrared radiation for communicating on very short distances. It is dedicated especially for Personal Area Networks and not for WSN.
- ZigBee (IEEE 802.15.4) have been defined in 2004 and it was especially designed for being used with the WSN. It was based on the IEEE 802.15.4 standard and implemented on the OSI model (Varchola M., 2007). The main advantages of it were the reduced energy consumption comparing with the other standards existent on that time and the fact that it was defined especially for WSN (<http://www.zigbee.org>, 2010). In present ZigBee have reached a high level of maturity, offering a large set of functionalities. There are a lot of commercial equipments (network nodes) implementing this protocol.
- Z-Wave is a protocol dedicated for home automation. This technology uses low power radio devices which could be integrated in home electronics and in systems for light control, access control, etc. It is dedicated especially for controlling the equipments and less for monitoring the space of the building (<http://www.z-wave.com>, 2010).
- DASH7 (ISO/IEC 18000-7) is a very new wireless sensor networking standard used for the low power sensor networks (the batteries used for these devices are usually coin size). It was initially defined for being use into the military area and today it is trying to integrate it also in commercial applications. It allows communication over a distance until 2 km, life battery till 10 years, possibility to connect the nodes into a mesh network and another main aspect, which is very important, is the possibility of the radio signal to penetrate concrete and water (in this way the signal could reach easily the destination even there are obstacles in it's way). It's a free standard which operates on free license frequency of 433 MHz. The big advantage of this under-GHz frequency is the fact that the interferences are much lower, comparing to the 2.4GHz frequency (representative for ZigBee). It offer support for sensors, data crypting and other useful functionalities (Norair, 2009; Liard, 2009; <http://dash7.org>, 2010). The major disadvantage is that there are just a few equipments which support this standard, and the software is not completely defined (it is still under developing).
- Wiebree (Bluetooth ultra low power, Bluetooth low energy) is a technology of wireless communication with a very low consume of energy and which operates on short distances.

2.2 Choosed solution – DASH7 (but in the next future)

Considering the possibilities offered and the requests of our system (low energy consumption, low latency, low data rate transfer, long distances communication etc.) it was considered that the best solution which should be implemented to be the DASH7. But, it should be considered as a future solution, 1-2 years have to pass, since the equipments which support it are just a few and the software platform, which to support this standard, is not completely developed – some of the WSN functionalities are just proposed for being integrated into the ISO 18000-7 standard. Its characteristics offer us many advantages comparing with the other technologies.

Until now, in different other projects, we have used the ZigBee, and we will continue to use it and in this project. We have to wait for DASH7 to reach a higher level of maturity before starting to use it.

In the next table and paragraph we will made a more detailed description of the DASH7 standard and compare it with the most used wireless standard ZigBee.

Technology	DASH7	ZigBee
Global standard used	ISO/IEC 18000-7	IEEE 802.15.4
Frequency	433MHz	2.4GHz, 915MHz, 868MHz
Global frequency available	YES	2.4GHz - YES, 915MHz - NO, 868MHz - NO
Penetrate water	YES	NO
Penetrate concrete	YES	NO
Covery area	1000m	30 - 500m
Medium required power	30 - 60 μ W	125 - 400 μ W
Medium latency	2.5 – 5 sec	From seconds to minutes
Device cost	> 10\$	> 10\$
Multi-hop capability	YES	YES
Sensors support	YES	YES
Security support	YES	YES
Max. data rate transfer	28 kbps	250kbps

Tab. 1. Comparison between DASH7 and ZigBee

The DASH7 was designed having in mind the following ideas:

- the data transfer is sporadic and doesn't include video, audio or stream information;
- for most of the applications the maximum dimension of a data packet is 256 bytes;
- the main communication method is answer-response type and it is not required the synchronization between device (Norair, 2009; Liard, 2009; <http://dash7.org>, 2010).

3. CONCLUSION

This article has described shortly the features offered by different wireless communication standards. At final a single solution of wireless communication was choose as offering the best advantages for our system. The features offered by the DASH7 were very convincing to choose it as the best solution for implementing, but the lack of support (equipments and software functionalities) make this solution impossible to be implemented. The ZigBee still remain the preferred version of wireless communication which to be used.

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