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"Biomedical Signal Monitoring"

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Abstract— There is a critical need for more cost efficient solutions for supervision/monitoring patients during and after surgery, as well as when the patient is at home. Advanced sensors combined with wireless communication will give reduced costs, improved monitoring, and better life quality for the patient. This project developed, implemented and tested a first version of a biomedical sensor network for the future wireless hospital and home care. The sensor network comprised four different sensors, and was tested in a hospital environment.

Keywords— Biomedical sensors, wireless communication

INTRODUCTION

The continuous search for people welfare through various mechanisms, has led medicine to seek synergy with other disciplines, especially engineering, among many other developments allowing the application of new techniques to monitor patients through their own body signals. The application of new developments in areas such as electronics, informatics and communications, aims to facilitate significantly the process of acquisition of biomedical signals, in order to achieve a correct approach when developing diagnostic or medical monitoring, to optimize the required care process and sometimes to reduce the cost of such processes. In some specific situations it is desirable that the patient under monitoring does not lose his mobility by the wire connection to the device that captures any particular signal, since this state may interfere with the study. For example, in case you need to measure the heart effort of a person taking a walk or a sprint. It is in this type of environment where new ICT technologies such as Wireless Sensor Networks (WSN) can support the development of biomedical devices allowing the acquisition of various signals for subsequent monitoring and analysis in real time. Telemedicine also called e-health is everything related to electronic health data for monitoring, diagnosis or analysis for the treatment of patients in remote locations. Usually this includes the use of medical supplies, advanced communications technology, including videoconferencing systems (Engineering in Medicine & Biology, 2003).

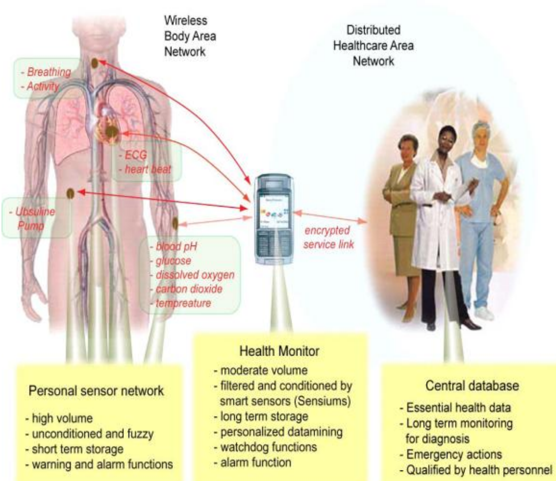
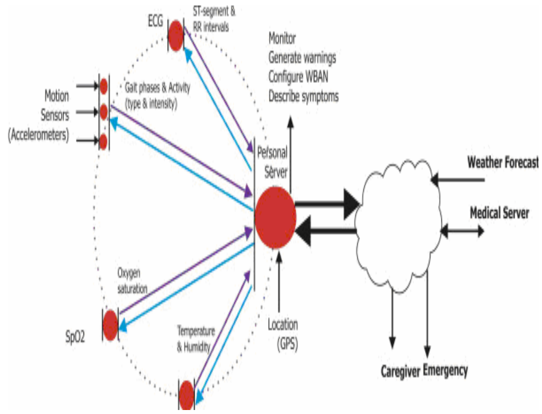


Figure 1: Continuous vital monitoring for trauma triage using Wireless Sensor Networks (WSNs).

Telemedicine systems can establish good and emerging technologies such as IEEE standards 802.11, 802.15 and 802.16, which these bases are characterized by the distribution networks for medical information, and provision for life-saving services. These systems have certain restrictions in the sense that when these wireless communications may be affected by a storm, or in conditions where the signal to transmit is not the most appropriate spots, then due to these problems, which solutions were sought resulted in great advances in wireless networking technologies providing vital routes for the restoration of services in telemedicine. The efficiency of telemedicine systems are widely affected by the design of systems, such as standardization, which in this case would not only rapid deployment, but also easy access for maintenance and renewal future systems that support care services. The constant study and monitoring of biomedical signals, has been an important tool in the development of new medical technology products. However, these over time begin to see that they are useful and important in industries that formerly had not been implemented but that scientific advances are essential. Over the years, monitoring of such signals have been putting more importance and trust in the medical corps, allowing them to exploit technological advances to benefit human care. Within each wireless sensor network, sensors are one of the most important components of the network. There are several sensors based on the applications we want to use. An example is the temperature sensor, which is a component that is mostly composed of semiconductor materials that vary with temperature change. In the case of biomedical environments, it senses the temperature of the skin or skin temperature, which enables us to monitor it in the patient, allowing for immediate assistance. We are not too far from the meaning stated above, to make a comparison, we found that both conditions vary only in the ability to sense, as this requires certain conditions of the system or agency is analyzing nevertheless remains a fundamental part at the time to learn about processes that is "easy" observe or with our senses is impossible to understand. However, biomedical sensors, should be chosen under certain parameters that are vital to the development and smooth operation of the same, they should be able to measure the signal in particular, but also to maintain a single precision and replacement capacity fast enough to monitor living organisms. Additionally, these sensors must be able to adapt to variations in the surface bioelectric be implemented (Bronzino, 1999).

WIRELESS BODY AREA AND SENSOR NETWORKS:-

A Wireless Body Area Network (WBAN) consists of several small devices close to, attached to or implanted into the human body. These devices communicate by means of a wireless network. Interaction with the user or other persons is generally handled by a central device.



The WBAN system is divided into three levels. The lowest level consists a set of intelligent sensors or nodes. These are the reduced function devise. These can only communicate with there parent device and cannot act as parent. The second level is the personal server (Internet enabled PDA, cell-phone, or home computer). These are full function devices. And they can communicate with there children as well as with the external network. The third level encompasses a network of remote server which is the remote application to which data or information is transferred.

WIRELESS COMMUNICATION SOLUTIONS:

Today a number of wireless communication solutions are available. Typical short ranges solutions are Bluetooth, ZigBee and several other more or less proprietary solutions. Several of these solutions are intended for short range, in-room (10m) range and are reasonably power efficient. Moving wireless solutions in to body-area networks (BAN) or personal area networks (PAN) for carrying important health information is adding another
level of quality of service mostly unavailable in current wireless solutions. In critical applications loss of communication cannot be tolerated. Based on input from the sensor vendors, the communication solution requirements have been specified. The requirements have been organized as common requirements for all sensors and two cases, where Case 1 is related to the Novo sense ECG sensor and Case 2 is valid for the rest of the sensor providers.

COMMON REQUIREMENTS:

- Global synchronization
- Retransmission of lost data
- Two-way communication
- Encryption
- Identification
- Authentication
- Power consumption: <0.4 mW/Kbit
- Error detection/correction
- On-board or On-chip 12-bit A/D converter
- On-board or On-chip microcontroller

CASE 1:

- Data rate < 100 Kbit
- Global synchronization 250 us resolution

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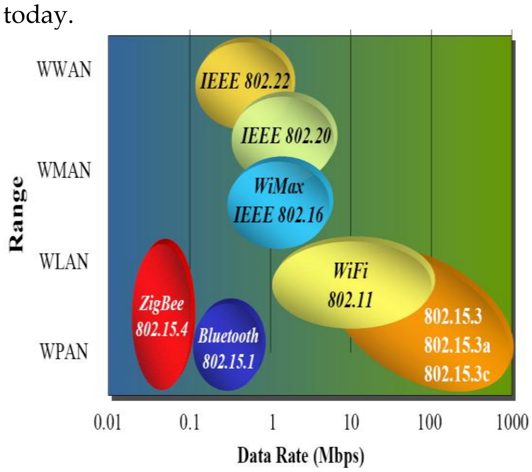
• Range: 70m
• Number of units per piconet: > 120
• Number of A/D channels: >10
• Handover across base stations

CASE 2

• Data rate < 50 Kbit
• Global synchronization relaxed resolution
• Range: 10-15m
• Number of units per piconet: 20-40
• Number of A/D channels: 3-5

As shown in the figure below, the trade -off between different network functionality may vary significantly. Both history and available technology is setting the scene of today.



Although most of these network solutions are aiming at mobile functionality, they all consume significant power. In the context of BWSN several applications are only requiring low bandwidth (<10kb/s) and it is important to trade the reduced speed requirements in for increased battery life and improved security/robustness. In the current project phase it is important to sort our state-of-the-art technology and consciously select available technology when adequate. More important is to pinpoint the deficiencies of available technology and develop improved solutions within the BWSN project.

Bluetooth Solutions:

Bluetooth is a low cost, low power, short range technology, originally developed as a cable replacement solution to connect various devices such as mobile phone handsets, headsets and portable computers. Bluetooth is often described as a Personal Area Network (PAN) technology, and has also been used to connect to various sensor devices.

The Bluetooth specifications are managed by the Bluetooth SIG (Special Interest Group). In addition to the core specifications, The Bluetooth SIG has specified a number of profiles. Each profile describes how a particular application can be implemented including which parts of the Bluetooth protocol should be use to support the profile. Most of the basic BWSN requirements seem to be supported by the Bluetooth technology with some important exceptions. The exceptions are related to the network topology with a high number of units, global synchronization and for Case 1: Handover across base stations.

BLUETOOTH AND THE BWSN REQUIREMENTS:

• Global Synchronization – Basic Bluetooth topology supports clock

Synchronization within a pioneer consisting of one master device and up to 7 slave devices. A basic timeslot is 625 microseconds, and all devices within a pioneer share the same clock. If more than 8 active network members are required, it is needed to link pioneer into scatter nets, where some device members are members of more than one pioneer (timeshared).

• Retransmission of lost data – this is supported using an appropriate communication link

• **TWO-WAY COMMUNICATION** - Supported

• **ENCRYPTION** - Supported

• **IDENTIFICATION** – Supported through SDP (Service Discovery Profile)

• **AUTHENTICATION** - Supported

• **POWER CONSUMPTION: <0.4 MW/KBIT** - Supported with careful selection of Sensor communication scenario, appropriate Bluetooth profile and Bluetooth low power options. Might be a problem for Class 1 version.

• **ERROR DETECTION/CORRECTION** – Supported

• **DATA RATES OF 50 OR 100 KBIT/S** – Supported

•**RANGE 10-15 OR 70M** – Supported by selecting appropriate radio transceiver. (Class 1 or Class 2)

• **NUMBER OF UNITS PER PICONET** – Basic Bluetooth piconet topology consists of one master and up to 7 slave devices. More devices can be supported by utilizing scatternets, where some devices are members of more than one piconet or by parking and unparking inactive members. An alternative solution could be to add more parallel piconets.

CASE 1

The main limiting factors in using Bluetooth for Case 1 are:
• Global synchronization 250 us resolution
• High number of simultaneously active units
• Handover between base stations.

CASE 2

The main limiting factor in using Bluetooth for Case 2 is the high number of simultaneous active units in the system. There is a possibility to utilize the low power parking mode to park and unpark devices in a piconet and thus increase the number of slaves to 255, but this would result in a rather high latency.

IEEE 802.15.4

One of the hottest emerging candidates for WSN communication is the Zig Bee Technology. Building on the IEEE 802.15.4 standard the proposed aims of ZigBee is certainly approaching demands of the BWSN project. Some key features are:

Operation range - 10m (30m)
Channels - 16 (2.4GHz ISM band)
Data rate - 20kb and 250kb

Nodes - 255

Standards are nice, but in real life we have to use some available silicon system implementing ZigBee. Apparently most available motes for WSN systems seem to use the Chipcon developed CC2420 (or derivative of this chip) for wireless communication. In order to be as realistic as possible we find it appropriate to use specifications for the CC2420 chip in our assessment.

CHIPCON CC2420:

The CC2420 is a fully integrated transceiver (just a few external components) designed for the 2.4 GHz band. In the BWSN project we should probably evaluate the fitness of the 2.4GHz band due to crowding of several other quite common functions like WI-FI and microwave ovens. For sure significant interference exists, degrading performance. However, for now we will use the maximum specifications and keep in mind we need significant headroom to alleviate for disturbance in real life environments. The available band is split in 16 channels each with 5MHz bandwidth.

The maximum speed is 250kb/s for each channel. Although 255 nodes (motes) are addressable, we believe the limited number of channels is most important in BWSN networks.

• **GLOBAL SYNCHRONIZATION** – The ZigBee protocol supports synchronization through "beacon" signals transmitted over the network. Some sort of reference clock is assumed. One report indicates feasible synchronization in the order of 100µs, but results are inconclusive.

• Bit Error Loss is low compared to other protocols due to robust modulation scheme (DSSS) and initial measurements indicate high tolerance to noise interference.

• **TWO-WAY COMMUNICATION** - Supported

• **ENCRYPTION** - The CC2420 is using AES-128 encryption and dedicated hardware is provided for efficient encoding/decoding with two embedded keys.

• **AUTHENTICATION** - Supported

• **POWER CONSUMPTION: <0.1 MW/KBIT** – Power is less with shorter distance and can be set in hardware.

• **ERROR DETECTION/CORRECTION** – Supported

• **DATA RATES UP TO 250 KBIT/S** – Supported

• Range 10m nominally with high sensitivity CC2420 30m feasible.

• Number of units is nominally 255, but channel limitations are limiting number of nodes to 16 simultaneous nodes. CSMA-CA may be explored to increase node count.

CONCLUSION

The main conclusion is that the BWSN shows the future opportunities for supporting mobility while monitoring vital body functions in hospital and home care. The BWSN is a first version

solution where important technical barriers have been solved. The BWSN needs to be further developed in order to cover security handling, improved signal integration and visualization, achieve extended mobility outside the surgery room, monitoring of several patients/persons at the same time, and further adaptations to medical experts needs for information included integration with other patient systems. The BWSN and the collaboration form an important platform for further technical development and business development in order to penetrate a market expected to increase a lot in the future.

REFERENCES:

[1].Emil Jovanov, Aleksandar Milenkovic, Chris Otto Piet C de Groen, "A wireless body area network of intelligent motion sensors for computer assisted physical rehabilitation", Journal of Neuro Engineering and Rehabilitation, University of Alabama in Huntsville, March 2005.

[2].M.Ishjima, Monitoring Electrocardiogram in bed without body surface electrode, IEEE Transactions on Biomedical Engineering, 1993;

[3].CAS Co.Ltd http://www.cas.co.kr

[4].Intium Co.Ltd. http://www.initium.co.kr

[5]. Gordon Bell, "The Body Electric, "Commun, ACM, Vol 40/2, Feb. 1997.

[6]. G.-Z. Yang. Ed., Body Sensor Networks, Springer, 2006.

[7]. M.A Hanson et al., 'Body Area Sensor Networks: Challenges and Opportunities," IEEE Computer, vol.42/1 Jan.2009.

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