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A Review: Wireless Body Area Networks for Health Care

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ABSTRACT: In wireless body area networks various sensors are attached on clothing or on the body or even implanted under the skin. The wireless nature of the network and the wide variety of sensors offer numerous new, practical and innovative applications to improve health care and the Quality of Life. Using a WBAN, the patient experiences a greater physical mobility and is no longer compelled to stay in the hospital. In this paper, we present an overview of wireless body area network and we also provide the differences between Wireless Body Area Network and Wireless Sensor Network (WSN) that is inadequate to apply in WBAN. We also present an idea to improve healthcare systems in India with the help of telecommunication and information technology by using wearable and implantable body sensor nodes which does not affect the mobility of the patients. We discuss how the wireless body area networks are used for healthcare monitoring by using multiple sensor nodes. In this paper we present various innovations and discuss promising new trends of wireless body area networks for ubiquitous health monitoring applications.

KEYWORDS: Wireless Body Area Network (WBAN); Architecture; Requirements; MAC protocols;

I. INTRODUCTION

Wireless body area network is a system which can continuously monitor the health conditions of patients to prevent and early risk detection by sharing the information with care takers and physicians. Based on the operating environments this can be classified into two types one is called wearable body area network which is operated on the surface of body and another is implantable body area network which is operated inside the human body.

Wireless Body Area Networks (WBAN) is a forthcoming technology which utilizes wireless sensor nodes to implement real-time wearable health monitoring of patients. These sensor nodes can be worn externally or implanted inside the body to monitor multiple bio-parameters (such as blood oxygen saturation, blood pressure and heart activity) of multiple patients at a central location in the hospital. It is a radio frequency based wireless networking technology. Here patients' health status can be monitored anytime and anywhere without restricting his/her mobility. Thus patient can live his/her normal daily life activities. A WBAN can be used to offer assistance to the disabled. For example, a paraplegic can be equipped with sensors determining the position of the legs or with sensors attached to the nerves [1]. Another area of application can be found in the domain of public safety where the WBAN can be used by firefighters, policemen or in a military environment [2]. The WBAN monitors for example the level of toxics in the air and warns the firefighters or soldiers if a life threatening level is detected.

1.1 Architecture:

The WBAN technology is the consequence of the existing WSN technology. A number of tiny wireless sensors, strategically placed on the human body, create a wireless body area network that can monitor various vital signs, providing real-time feedback to the user and medical personnel. In a WBAN, each medical sensor monitors different vital signs such as temperature, blood pressure, or ECG. The system consists of multiple sensor nodes that monitor body motion and heart activity, a network coordinator, and a personal server running on a personal digital assistant or a personal computer.

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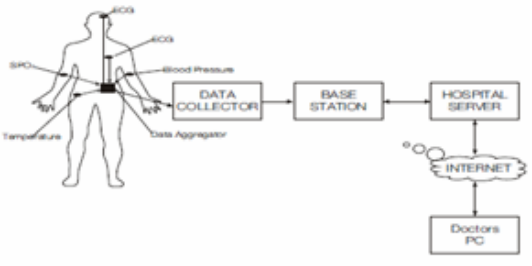

Figure 1: WBAN Architecture

Data collected by the medical sensors is transmitted to the coordinator. The sensors are always activated and continuously transmit data to the coordinator. This configuration causes high energy consumption in all medical sensors and reduces their operational time. The WBAN architecture presented in figure 1, shows several key components. Different types of medical sensors can be used for monitoring various vital parameters. Figure 2, represents the other form of WBAN in which data from the multiple nodes transmitted through the internet to multiple clients.

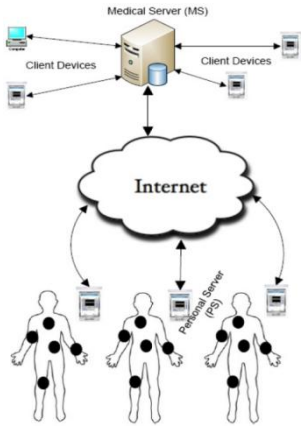

Figure 2: Another form of WBAN Architecture

1.2 MAC protocols for WBAN:

MAC protocols [3] used in WBAN must be low power consuming, accurate and with less latency. The most important thing is the protocol should give good performance on varying traffic load. Some popular protocols for WBAN are TMAC, SMAC, ZigBee MAC and Baseline MAC.

TMAC: It is a duty-cycling protocol. In this protocol the node is awaken for a particular period that is called active time. Duty cycle changes according to the information traffic load of the network. When traffic load is high than the duty cycle becomes large so that nodes can handle high traffic load. When traffic load is low then duty cycle is adjusted to small value so that nodes can save their power reducing the problem of idle listening. TMAC protocol is able to handle varying load with low power consumption.

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SMAC: SMAC protocol is similar to TMAC but only difference is its fixed duty cycle. This protocol is the previous version. This protocol is not efficient in handling continuously varying data rates in WBAN.

ZigBee MAC: ZigBee MAC protocol can use two schemes- CSMA/CA or TDMA. While using CSMA/CA mechanism this protocol gives average performance but using TDMA mechanism (applying Guaranteed Time Slot or GTS) it reduces the power consumption up to a great extent. At high rates the data loss becomes high in TDMA mechanism so it is best when there is less no of nodes or low traffic load.

Baseline MAC: This MAC protocol uses CSMA/CA scheme. The performance of Baseline MAC in terms of energy consumption is not average but throughput is average.

1.3 Characteristics of WBAN:

Basically, WBAN is a communication network between the humans and computers through wearable devices. In order to realize communication between these devices, techniques from Wireless Sensor Network and ad hoc networks could be used. A typical sensor node in WBAN should ensure the accurate sensing of the signal from the body, carry out low-level processing of the sensor signal and wirelessly transmit the processed signal to a local processing unit [4]. However, because of the typical properties of a WBAN, current protocols designed for these networks are not always well suited to support a WBAN. To support this point, TABLE 1 simplifies the general differences between a Wireless Sensor Network and a Wireless Body Area Network as discussed elsewhere in [5] and [6]:

	WBAN	WSN
Deployment	The number of sensor nodes deployed by the user are equally important and only added when they are needed for application.	WSN is often deployed in places that may not be easily accessible by operators which require more nodes to be placed to compensate for node failures.
Mobility	WBAN users may move around. WBAN nodes share the same mobility pattern.	WSN nodes are usually considered stationary.
Data Rate	WBAN may occur in a more periodic manner and stable data rate.	WSN is employed for event-based monitoring where events can happen at irregular intervals.

TABLE 1: DIFFERENCES BETWEEN WBAN AND WSN

1.4 Requirements of WBAN:

We categorized requirement of WBAN into two categories i.e. systems and security. Further detail is described in the following subsection.

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A. System Requirements

This sub-section provides brief description of system requirements that viewed in three different aspects such as type of devices, data rate and energy.

a) Types of devices:

Sensor node: A device that responds to and gathers data on physical stimuli processes the data if necessary and reports this information wirelessly

Gateway (Personal Device): It gathers all the information acquired by the sensor nodes and informs the users. This device is also called a Body Control Unit (BCU), body gateway or a sink.

Monitoring Server: It is consists of database for data storage and processing and analyzing software for delivering system intended services.

b) Data rates

The reliability of the data transmission is provided in terms of the necessary bit error rate (BER) which is used as a measure for the number of packets lost. For a medical device, the reliability depends on the data rate. Low data rate devices can cope with a high BER while devices with a higher data rate require a lower BER. The required BER is also dependent on the criticalness of the data.

c) Energy

Energy consumption can be divided into three domains: sensing, communication and data processing [7]. However, the energy consumption for communication is more than computation in WBAN. Further, higher security requirements usually correspond to more energy consumption for cryptographic operations.

B. Security Requirements

The security and privacy of patient-related data are two indispensable components for the system security of the WBAN. By data security, it means the protection of information from unauthorized users while data being stored and transferred and data privacy means right of individuals to control the collection and use of personal information about themselves. Security and privacy issues are raised automatically when the data is created, transferred, stored and processed in information systems. Thus the system needs to comply with the following major security requirements:

a) Data storage security requirements:
Confidentiality, Integrity assurance, Dependability.

b) Data access security requirements:
Access control, Accountability, Revocability, Non-repudiation.

c) Other security requirements:
Authentication and Availability.

1.5. Innovations and Latest trends:

The latest advancement in medical technologies, there are mainly three terms being used in the medical industry. The three terms are “Telehealth”, “Telecare”, and “Telemedicine”. Most of the people think the above three terms are interchangeable, when in fact they are not.

- Telehealth [8] is the broad term used to refer to providing health care services, health care education and health information services at a distance. Telehealth allows things like remote doctor-patient consultation, remote monitoring of vital parameters and health education services. This technology helps medical practitioners to evaluate and diagnose patients remotely, prescribe treatment, e-prescription and monitor fluctuations in the patient’s condition at distance.

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- Telecare [9] refers to technology that helps the patients at home to stay safe and healthy with the help of telecommunication technology. Telecare involves continuous remote monitoring of patients for real time alerts and emergencies and to track the change over a time period. In this way, telecare helps manage a wide range of risks associated with a patient's independent living.

- Telemedicine [10] refers specifically to the provision of health care services and education over a distance with the help of electronic communication and information technologies. Telemedicine allows functions like video consultation with specialists, remote medical evaluations and diagnoses and the digital transmission of medical imaging.

The latest trends in the area of telemedicine and body area networks are

1) On-body implants
2) In-body implants
3) Health carts

On-body implants are the sensors that are placed on the body or that are sewed into the fabric (wearable sensors) that can be worn. These on-body and wearable sensors are capable of monitoring the vital parameters like body temperature, blood pressure, and ECG etc [11] [12].

The in-body sensors are the sensors that are implanted in the body to measure vital parameters from the implants. These include monitoring of the activity of the transplanted organs or activity of the affected organs in order to monitor and provide the better services in advance.

II. RELATED WORK

Supriya O. Rajankar et al. [13] study the architecture for healthcare monitoring applications in Wireless Body Area Network. The technology used in their study utilizes wireless sensor nodes to implement real-time wearable health monitoring of patients. Primary motivation of their study is to provide steady, timely, comfortable and proper monitoring of physical and biomedical parameters of patient continuously. They study that Long term monitoring may provide detection of early signs of deterioration of patient's health and support for computer assisted rehabilitation. They demonstrate from their study that the main two challenges in this system are there should be continues power supply to the body sensor nodes and system should Guarantee for delivery of data stream to the destination means Quality of service.
Sofia Najwa Ramli et al. [14] review the current development on Wireless Body Area Network and the security issues faced by Wireless Body Area Network. They also study the differences between Wireless Body Area Network and Wireless Sensor Network (WSN). WBAN brings out a new set of challenges in terms of scalability, sensor deployment and density, energy efficiency, security and privacy and wireless technology so WBAN requires a strong security system and part of it is authentication. So there is need to discover hybrid authentication protocol in providing a strong security system for WBAN.
In [15] Sujeethnanda M et al. present an overview of wireless body area networks and present ideas to improve healthcare systems in India with the help of telecommunication and information technology. Web-based medical advices system, called e-vaidyam is proposed for effective and affordable healthcare. They study that Body Area Networks effectively enable monitoring patient health and communicate with the doctor. Various paradigms of Mobile WSN's for healthcare are documented in this paper.
Emil Jovanov et al. [16] study that WBAN based m-Health technologies demonstrated great potential for ubiquitous health monitoring during activities of daily living. WBAN can provide patients with increased confidence and a better quality of life, and promote healthy behaviour and health awareness. They present state of technology, discuss promising new trends. They review the opportunities and challenges of wearable ubiquitous health systems that can increase acceptance of WBAN technology and lower the cost by shifting the focus to prevention and early detection of

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health conditions. A new generation of personalized monitoring systems will allow users to configure their systems and user interface, interact with their social network and improve their quality of living.
Narendra Kumar et al. [17] provide a snapshot of current developments and future direction of research on wearable and implantable body area network systems for continuous monitoring of patients. In this paper, medical sensors were used to collect physiological data from patients and transmit it to Intelligent Personal digital Assistant (IPDA). They explain the important role of body sensor networks in medicine to minimize the need for caregivers and help the chronically ill and elderly people live an independent life, besides providing people with quality care. They have discussed the benefits of using wireless networks for medical applications. They have discussed about how the new wireless technologies can be utilized in potential manner to get benefits for the human well being.

III. PROPOSED WORK

In order to review the overall system performance of our systems such as reliability, robustness, scalability and wearability of patient monitoring system, we have proposed high level system architectures and prototype for WBAN. A WBAN for patient monitoring system requires the multiple sensor nodes. Each node is typically capable of sensing one or more physiological signals. We reviewed the architecture of wearable sensors for remote healthcare monitoring system which composed of three tiers. This new generation of personalized monitoring systems will allow users to configure their systems and user interface, interact with their social network and improve their quality of living.

IV. CONCLUSION AND FUTURE SCOPE

WBAN is an emerging and promising technology that will change people's healthcare experiences revolutionarily. In this paper, we have reviewed the current development on Wireless Body Area Network and we focused on the requirements for this technology. We have discussed various MAC protocols used in WBAN. We have discussed about how Wireless Body Area Networks can be utilized in potential manner to get benefits for the human well being. We are planning to perform comparative analysis of different models for better health monitoring in WBAN. Also there is need to simulate the best model by taking conventional parameters in physical, electrical and mechanical environments.

REFRENCES

[1] Li, H.-B., Takizawa, K.-I., Zhen, B., & Kohno, R. (2007). Body area network and its standardization at IEEE 802.15.MBAN. In 16th IST on mobile and wireless communications summit, Budapest, Hungary, Jul 2007, pp. 1–5.
[2] Hoyt, R., Reifman, J., Coster, T., & Buller, M. (2002). Combat medical informatics: Present and future. In Proceedings of the AMIA 2002 annual symposium, San Antonio, TX, Nov 2002, pp. 335–339.
[3] Vinay Singh and Rahul Sharma. Article: Performanance Analysis of Mac Protocols for WBAN on Varying Transmitted Output Power of Nodes. International Journal of Computer Applications, 67(7):32-34, April 2013.
[4] Selimis, Georgios et al. "A Lightweight Security Scheme for Wireless Body Area Networks: Design, Energy Evaluation and Proposed Microprocessor Design," Journal of Medical Systems, 2011, pp. 1-10-10, doi: 10.1007/s10916-011-9669-2.
[5] Latré, Benoît, Bart Braem, Ingrid Moerman, Chris Blondia, and Piet Demeester. "A survey on wireless body area networks," Wireless Networks, vol. 17, 2010, pp. 1-18, doi: 10.1007/s11276-010-0252-4.
[6] Chen, M., Gonzalez, S., Vasilakos, A., Cao, H., & Leung, V. C. M. "Body Area Networks: A survey," Mobile Networks and Applications, vol. 16, 2011, pp. 171-193, doi:10.1007/s11036-010-0260-8.
[7] Latré, Benoît, Bart Braem, Ingrid Moerman, Chris Blondia, and Piet Demeester. "A survey on wireless body area networks," Wireless Networks, vol. 17, 2010, pp. 1-18, doi: 10.1007/s11276-010-0252-4.
[8] Adam Darkins, Patricia Ryan, Rita Kobb, Linda Foster, Ellen Edmonson, Bonnie Wakefield, and Anne E. Lancaster. "Telemedicine and e-Health," December 2008, 14(10): 1118-1126. doi:10.1089/tmj.2008.0021
[9] Anne Rogers, Sue Kirk, Claire Gately, Carl R. May, Tracy Finch, "Established users and the making of telecare work in long term condition management: Implications for health policy, Social Science & amp; Medicine," Volume 72, Issue 7, April 2011, Pages 1077-1084, ISSN 0277-9536,10.1016/j.socscimed.2011.01.031. (http://www.sciencedirect.com/science/article/pii/S0277953611000748)
[10] Thomas EJ, Lucke JF, Wueste L, Weavind L, Patel B. "Association of Telemedicine for Remote Monitoring of Intensive Care Patients With Mortality, Complications, and Length of Stay," JAMA.2009;302(24):2671-2678. doi:10.1001/jama.2009.1902.
[11] Chen, W., Bouwstra, S., Bambang Oetomo, S. & Feijs, L.M.G. (2011). Sensor integration for perinatology research. International Journal of Sensor Networks, 9(1), 38-49.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 2, Issue 4, April 2014

[12] Patel S, Park H, Bonato P, Chan L, Rodgers M. A review of wearable sensors and systems with application in rehabilitation. J Neuroeng Rehabil 2012; 9: 21. DOI:10.1186/1743-0003-9-21

[13] Kalyani P Wagh and Supriya O Rajankar. Article: Wireless Body Area Network : Real-Time Health Monitoring System. IJCA Proceedings on National Conference on Advancement in Electronics and Telecommunication Engineering NCAETE(1):7-11, May 2012.

[14] Ramli, S.N.; Ahmad, R., "Surveying the Wireless Body Area Network in the realm of wireless communication," Information Assurance and Security (IAS), 2011 7th International Conference on , vol., no., pp.58,61, 5-8 Dec. 2011 doi: 10.1109/ISIAS.2011.6122845

[15] Sujeethnanda M et.al "Mobile Wireless Sensor Networks: Healthcare in Hospitals" in ifth International Conference on eHealth, Telemedicine, and Social Medicine (eTELEMED), 2013.

[16] Emil Jovanov et al. "Body Area Networks for Ubiquitous Healthcare Applications: Opportunities and Challenges," Journal of Medical Systems, 2011, pp. 11245-1254, doi: 10.1007/s10916-011-9661-x.

[17] Narendra Kumar et.al. "Wearable Sensors for Remote Healthcare Monitoring System," International Journal of Engineering Trends and Technology, 2012, vol 3, issue 1.