Wireless Body Area Network Needs and Performance: A Survey

Arashpal Singh[1], Ranjeet Singh[2]
Student, Electronics and Communication, GIMET Amritsar, PTU, Punjab, India
Student, Electronics and Communication, GIMET Amritsar, PTU, Punjab, India
Email - arashpalchahal69@yahoo.com, itzranjeet@gmail.com

Abstract: WBAN is treated as one of the application of Wireless sensor network which provides inexpensive and continuous monitoring of the patient with real time update of medical records through internet. WBAN makes it possible to collect process and then transmit the data samples such as blood pressure, brain, heart, tissues and other vital information of the body to the medical server for further actions. WBAN contains a coordinator (smart phones, Personal digital Assistant) which receives data from other sensor nodes and distributes received data wirelessly to the medical centers. Now at the receiving end, Medical applications perform continuous sampling of biomedical signals and then monitor vital signal information. These applications also provide data collection, data processing, and data transmission and then provide feedback to the user. Due to the easiness of wireless network it has been empowering Wireless Body Area network.

Key Words: Wireless Wearable Body Area Network (WBAN), Medical Server, Energy Consumption.

Introduction:

Wireless body area network forwards the required information to the doctor at the time of requirement. The basic idea behind using the wireless body area network is to reduce the energy consumption of the individual nodes and exceeds the lifetime of the network so that monitoring of the health of the patient can be diagonse ubiquitously.[6]

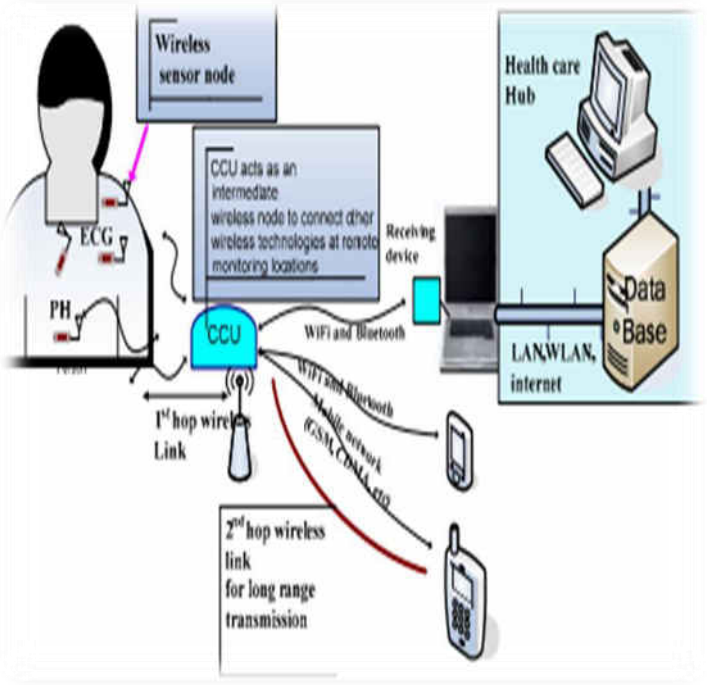

Figure 1 WBAN(Wireless Body Area Network)[6]

Wireless communication network has been increasing appreciably which provides several applications in the field of heathcare and medical systems. Wireless body area network provides special purpose

sensor network that allows number of sensors to be installed in or out of the human body. These sensors are implanted on the body of the patient and sensors communicate with each other concurrently. [6][7]Applications based on Wireless body area network provides flexibility and low cost options. WBAN has been used due to its advantages provided by the sensor nodes like mobility of the patient which means that patient can move freely or do their regular task without fixing on a prticular location. Another advantage of WBAN is location independent monitoring facility in which physician not need to go and check the health of the patient because attached sensor on the body of the patient regularly forward the samples to the physician devices. The basic requirement for WBAN is internet connectivity that allows sensor nodes to send the data at the remote side and provide storage of data.

WBAN System Architecture:

In WBAN (Wireless Body Area Network) various kind of devices are used. The devices like medical sensors, Special sensors, set up pens and other devices are shown in the figure below. All of these devices are linked to the health care system. This connection to the health care system makes a WBAN capable for generating the output and diagnosing the human body system. WBAN contains Sensor nodes which are deployed in human body. Out of all these sensor nodes there is a node known as Patient Identifier Node. This PI node is used to recognize a patient uniquely. All the sensors attached to the human system is linked with the Medical monitoring devices in the hospital. Hence the doctors are able to monitor the patient continuously. The working of these sensors is to sense the biomedical conditions of human body and to transfer this collected information to the server which is deployed at the hospital. The data transmission is done by using Bluetooth or ZigBee technologies. The data is forwarded to the health care system at the server side. [9,8]

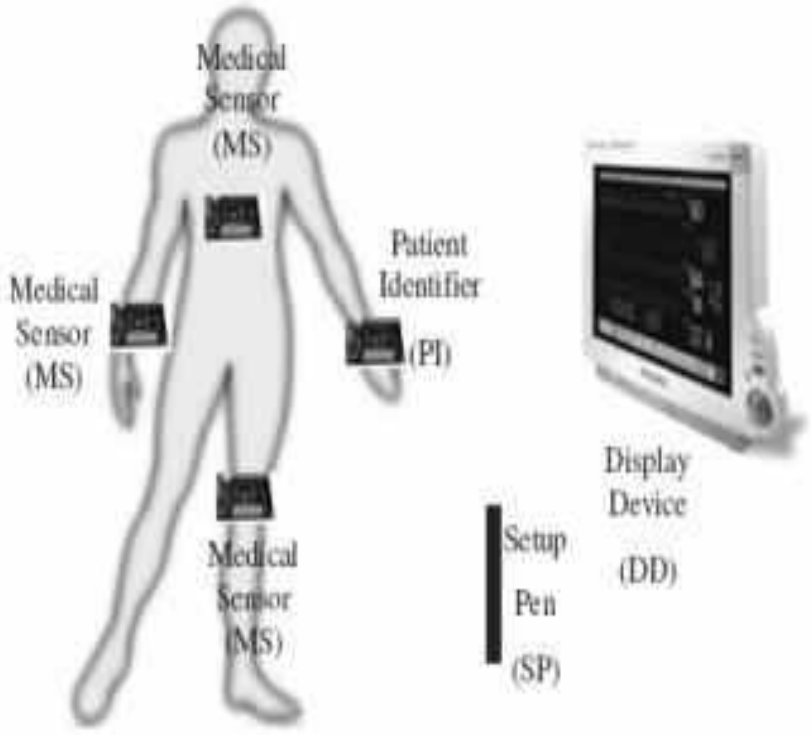

Fig.2 Architecture of WBAN (along with attached devices)

The health care system can be located anywhere such as on the display device at the hospital or on a PDA i.e. Personal Digital Assistant. It can also be deployed on personal computers. The purpose of the health care system is to control the WBAN. It is also used for providing a user interface to the client side. It also transfers the sensed data to the server by using internet. The data can be transferred by using mobile telephony network or wimax [10].

Applications of WBAN:

WBAN is applied in various fields for sensing the internal moments of human body. List of applications of WBAN includes interactive interface games, defense Area, medical field. It can be applicable in two ways in-body and On-body respectively. In case of in-body the sensor is placed inside the human system such as pacemaker and implantable defibrillators etc. On-body WBAN includes the devices like monitoring BP of patient; body temperature etc. Following is the list of applications of WBAN:[13]

a) Cardiovascular Disease
b) Cancer Detection
c) Asthma
d) Telemedicine System
e) Artificial retina
f) Battlefield

A. Cardiovascular Disease

Special purpose screens are used for gathering the data. In cardiovascular, the data is collected in the form of rhythms such as cardio rhythms. It is a kind of offline processing. WBAN is used in this field[15]. After performing communication nodes change their status from awake to sleep in which ECG node goes sleeping after 150 seconds. Thus after the completion of the transmission of ECG node at 300 seconds coordinator consumes less energy.

B. Cancer Detection

Cancer is one of the biggest causes of death which puts human life in danger. According to survey it about 9 million people are suffering from the cancer disease in late 1999. WBAN can be savior in such case. A set of sensors can be helpful in detecting or monitoring cancer cells and provides physician to diagnose tumours without biopsy.

C. Asthma

Asthma is also a problem suffering by several people. WBAN can help millions of patients by monitoring allergic agents which are present in the air. As a result real time feedback can be provided to the physician.

D. Telemedicine Systems

Traditional systems use two types of systems for the transmission of information from the source to the medical servers such as dedicated wireless channels and power demanding protocols namely Bluetooth. But in these systems, interference can occur from other devices working in same frequency band. [16][17]Due to which it cannot used for health monitoring. As a result telemedicine systems can collaborate with WBAN which will be able to support unobtrusive ambulatory health monitoring

E. Artificial Retina

Another application of WBAN is aid for the visually inspired people. In such case a matrix of micro wireless sensors implanted into the eye under the surface of the retina. This matrix has been collaborated as an artificial retina which converts electrical signals into the form of neurological signals.

F. Battlefield

WBAN can also be helpful in the field of battle where soldier's information can be send to the commander. Information of a soldier can be like running, firing and digging. Due to which a soldier must have a secure communication channel with the purpose of preventing surprise attack.

RELATED WORK:

i. **Jamil Yusuf Khan et al, "Wireless Body Area Network (WBAN) Design Techniques and Performance Evaluation" [1]**Application of wireless body area network has been becoming the widest area in montioring of patients health. Thus WBAN has grown appreciably in the field of medical. With the advancement in the application area of WBAN, it allows patient to be move freely and provides flexibility to medical staff. In the process of monitoring of patient invloves several activities like collection of data from several attached sensors for storage as well as diagnosis, transmission of data to remote medical databases and at last control of medical devices. Basically WBAN works in an interconnected mode which provides monitoring of patients health remotely with the help of telehealth/e-health applications. It includes various applications like monitoring of athletes' performance and provides them tranining activities. Therefore, it is necessary for WBAN to be reliable enough so that it can transmit data in time to the monitoring entity. This paper focuses on designing issues of WBAN in medical applications as well as design of MAC protocols. It also includes power consumption of WBAN. Results are evaluated on the basis of simulations and concludes performance of several WBAN design techniques.

ii. **Kenichi Takizawa et al, Performance evaluation of wearable wireless body area networks during walking motions in 444.5 MHz and 2450 MHz,[2]** This paper decribes performance of WBAN at the time of walking motion. For the calculation of performance, different parameters are considered named as Received signal strength i.e. RSS, Bit error rate and packet error rate. These parameters are evaluated in an anechoic chamber and an office room for better calculation. Frequency band of 444.5 and 2450 MHz has been used in order to measure parameters performance by using GFSK signal with symbol rate of 1 MHz. Concluded results shows that WBAN works on 444.5 MHz for error free communication and 2450 MHz for faces packet errors in an anechoic chamber. On the other hand, results obtained from office room five comparable performance between these given frequencies. Thus after observing these facts, use of 2450 MHz requires reflection waves so that it can able to compensate shadowing effect of the human body in Wireless Body Area Network.

iii. **Xiyu Lu et al, "UWB-based Wireless Body Area Networks channel modeling and performance evaluation",[3]** WBAN is most trending technology of nowadays including several designing issues. Wireless channel in WBAN is very complex and unique in nature due to the irregular shape of the human body. As compared to traditional narrow band communication environment, this paper focuses on ultra wide band frequency ranges from 3 to 9 GHz which has been used for modelling of channels. Channels are modelled in terms of statics and their parameters are derived through actual measured data. It concludes that each people have different shapes due to which difference lies between multipath parameters. On the basis of the characteristics of body shape, three kind of channel model are classified as sparse, medium and dense multipath channel models. These channel model can be applicable in different scenario which helps in enhancing the system design. Evaluations has been performed under delays of models and average number of multipaths and results shows effectiveness of proposed models.

iv. **Venki Balasubramanian et al, "Performance evaluation of the dependable properties of a Body Area Wireless Sensor Network",[4]** Highlighted part of this paper is Body area wireless sensor network which has been used to monitor health essential data of the patient. It has been used in various applications like healthcare applications where patients data monitors remotely. Thus accuracy is primary factor which allows correctely receiving of data from Body area wireless sensor network. However, errors may enter into the data at the time of acquisition or during transmission on the wireless network. Thus it is required to measure the health of the patient accurately as well as specifically. This paper focuses on the performance parameter of Bosy area wireless sensor network in remote healthcare monitoring applications. Paper concluded with the evaluations that has been performed in real time test bed and find out results of Body area wireless sensor network accordingly.

v. **Chao Chen et al, "Design and Evaluation of a Wireless Body Sensor System for Smart Home Health Monitoring",[5]**Due to the advancements in the wireless sensor networks it make it possible for smart health care at a low cost without specify a particular location. It allows a patient to move freely everywhere while its health status will be send to the medical server regularly. This

paper focuses on monitoring of signs or data captures from sensor nodes embedded on the body of the patient. Waist-mounted triaxial accelerometer has been specified in this paper that helps in capturing the human movements. After capturing of sample it has been forwarded to the IEEE 802.15.4 wireless transceiver to a data logger unit. In this paper acceleration measurement has been used which tests the sample and classified different human motion accordingly with the help of acceleration reading. On the other hand, while using IEEE 802.15.4 devices at home, interference has been occurs from IEEE 802.11 signals and microwave ovens. Thus, these factors has to be considered while deploying of wireless body area sensor network.

Conclusion:

Wireless body area network plays an important part in capturing the medical information about the sensor nodes and forwards that information to the medical server. The main idea of using this technique is to provide reliability or flexibility in diagnoses the medical parameters based on the information acquired from the nodes. WBAN uses limited energy resources to monitor the human health.This paper provides brief introduction to the concept of WBAN and other concepts related to it.

References:

1. Jamil Y. Khan, "Performance evaluation of a Wireless Body Area sensor network for remote patient monitoring", IEEE Engineering in Medicine and Biology Society, Pp. 1266 – 1269
2. Kenichi Takizawa et al, "Performance evaluation of wearable wireless body area networks during walking motions in 444.5 MHz and 2450 MHz", IEEE, Pp. 370 – 373
3. Xiyu Lu et al, "UWB-based Wireless Body Area Networks channel modeling and performance evaluation", International Wireless Communications and Mobile Computing Conference, Pp. 1929 - 1934
4. Venki Balasubramanian et al, "Performance evaluation of the dependable properties of a Body Area Wireless Sensor Network", Optimization, Reliabilty, and Information Technology (ICROIT), Page(s):229 – 234, Feb. 2014.
5. Chao Chen et al, "Design and Evaluation of a Wireless Body Sensor System for Smart Home Health Monitoring", IEEE, Page(s):1 – 6, Dec. 2009.
6. Hadda Ben Elhadj et al, "A Survey of Routing Protocols in Wireless Body Area Networks for Healthcare Applications", International Journal of E-Health and Medical Communications (IJEHMC), Vol. 3, No. 2, 2012.
7. C. Li et al, "Performance Evaluation of IEEE 802.15.4 for Wireless Body Area Network (WBAN)" IEEE, Pp.1 – 5, 2009.
8. Jamil Yusuf Khan et al, "Wireless Body Area Network (WBAN) Design Techniques and Performance Evaluation" Journal of Medical Systems, Volume 36, Issue 3, pp 1441-1457, June 2012.
9. Chris A. Otto et al, "A WBAN-based System for Health monitoring at Home" IEEE, Pp. 20 – 23.
10. Aung Aung Phyo Wai et al, "Development of visualization and performance evaluation testbed for Wireless Body Area Network, IEEE, Pp. 205 – 208
11. Obaid ur Rehman et al, "Performance Study of Localization Techniques in Wireless Body Area Sensor Networks", International Conference on Trust, Security and Privacy in Computing and Communications, Pp. 1968 – 1975,June 2012
12. Venki Balasubramanian, "Critical time parameters for evaluation of body area Wireless Sensor Networks in a Healthcare Monitoring Application", Intelligent Sensors, Sensor Networks and Information Processing (ISSNIP), Page(s):1 – 7, April 2014.
13. Punyawi Jamjareegulgarn, "Performance evaluation for cooperative diversity-based wireless body area network", IEEE International Conference on Networks (ICON), Page(s):1 – 6, Dec 2013.

14. S.Ahmed et al.,"LAEEBA: Link Aware and Energy Efficient Scheme for Body Area Networks", IEEE, Page(s): 435-440, May 2014.
15. Jae Myeong Choi et al, "A Study on the Wireless Body Area Network Applications and Channel Models" International Conference on Future Generation Communication and Networking, Vol. 2, Page(s): 263 – 266, Dec. 2008.
16. Nhat-Quang Nhan et al, "Asynchronous MAC protocol for spectrum agility in Wireless Body Area Sensor Networks", International Conference on Cognitive Radio Oriented Wireless Networks and Communications (CROWNCOM), Page(s):203 – 208, June 2014
17. Norman A. Benjamin et al, "Failure Performance Study of Hierarchical Agent Based Patient Health Monitoring in Wireless Body Sensor Mesh Network", Advances in Computing, Control, & Telecommunication Technologies, Page(s): 85 – 87, Dec. 2009.
18. Ilkyu Ha, "Technologies and Research Trends in Wireless Body Area Networks for Healthcare: A Systematic Literature Review", International Journal of Distributed Sensor Networks, Vol. 2015, Pp. 14, February 2015.
19. S. Ullah et al., "A comprehensive survey of wireless body area networks on PHY, MAC, and network layers solutions," Journal of Medical Systems, vol. 36, no. 3, pp. 1065– 1094, 2012.
20. H. Cao et al, "Enabling technologies for wireless body area networks: a survey and outlook," IEEE Communications Magazine, vol. 47, no. 12, pp. 84–93, 2009
21. M. Chen et al, "Body area networks: a survey," Mobile Networks and Applications, vol. 16, no. 2, pp. 171–193, 2011
22. M. A. Hanson et al., "Body area sensor networks: challenges and opportunities," Computer, vol. 42, no. 1, pp. 58–65, 2009.
23. B. Antonescu and S. Basagni, "Wireless body area networks: challenges, trends and emerging technologies," in Proceedings of the 8th International Conference on Body Area Networks, pp. 1–7, Boston, Mass, USA, September 2013.
24. Karthiga I. et al, "A study on routing protocols in wireless body area networks and its suitability for m-Health applications", Communications and Signal Processing (ICCSP), Page(s):1064 – 1069, April 2015
25. Feng Jingling et al, "Performance Enhancement of Wireless Body Area Network System Combined with Cognitive Radio", Communications and Mobile Computing (CMC) Vol. 3 , Page(s):313 – 317, April 2010.
26. Jun Wang et al, "An all dynamic MAC protocol for Wireless Body Area Network", 11th International Conference on Wireless Communications, Page(s):1 – 6, Sept. 2015.
27. Masahiro Kuroda et al, "Secure and usable monitoring in body area network for ubiquitous healthcare and medical system", Communications and Information Technologies (ISCIT),Page(s): 453 – 457, Oct. 2010.
28. Sana ULLAH (November,2009) ,"A Review of Wireless Body Area Networks for Medical Applications" IJCNS,Vol.2 No.8
29. Robert T. Morris: High-Throughput Routing For Multi-Hop Wireless Networks " 2004.
30. Kalyani divi:"Modeling of WBAN and cloud integration for secure and reliable healthcare" Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering, Pp 128-131, 2013.