

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 7, Issue 5, May 2018

## A Survey on Conserving Energy in Wireless Body Area Networks for Health Monitoring

Rekha R. Kamath<sup>1</sup>, Dr. Bindu M.S.<sup>2</sup>, Dr. Anuj Mohamed<sup>3</sup>, Rajendran R.<sup>4</sup>

M.Tech Student, School of Computer Sciences, Mahatma Gandhi University, Kottayam, Kerala, India<sup>1</sup>

Associate Professor, Department of Computer Science, School of Technology & Applied Sciences, Kottayam,  
Kerala, India<sup>2</sup>.

Associate Professor, School of Computer Sciences, Mahatma Gandhi University, Kottayam, Kerala, India<sup>3</sup>

Associate Professor, Department of Computer Science, School of Technology & Applied Sciences, Kottayam,  
Kerala, India<sup>4</sup>

**ABSTRACT :** The recent advances in the field of wireless networking technologies and the advent of integrated electronic circuits offering very small and intelligent sensor nodes able to be used on or implanted in the human body has led to the development of Wireless Body Area Networks (WBANs). Currently, WBAN constitute an active field of research and development as it offers the potential of great improvement in the monitoring of healthcare remotely. However, there exist some challenges to the application of WBAN in this area, one of which is the power consumption. In this paper, we survey the various techniques employed to reduce the power consumption in WBANs for e-healthcare.

**KEYWORDS:** Wireless Body Area Network, energy efficiency, wireless transmission, IEEE802.15.6, 6LoWPAN

### I. INTRODUCTION

Recently, there is a great demand in the field of WBAN as it allows real-time and continuous monitoring in different fields including medical and non-medical applications. WBANs consist of a number of heterogeneous biological sensor nodes which are placed in different parts of the body and can be wearable or implanted under the user skin[1]. The rapid growth of wireless technologies and personal area networks enables the continuous healthcare monitoring of patients using these heterogeneous biological sensor nodes that collect and evaluate body parameters. Equipped with WBAN, the physiological attributes, such as heart beat, body temperature and blood pressure, could be continuously monitored by sensor devices. Admittedly, taken good care of by WBAN, elderly people and patients who are always at home or hospitals could get mobility support, freely roaming in the coverage of a telemedicine system[1].

In a WBAN based health monitoring system, the medical information of the patient is collected automatically by various biomedical sensor nodes. These data are then transmitted via a coordinator to a local medical server directly or a remote medical server through Internet. The medical personnel can then retrieve these data from the medical server, processes them and provide necessary assistance to the patients.

#### A. Architecture

Based on[1], the architecture of a WBAN communication system for e-healthcare is shown in Figure 1. The architecture can be divided into three tiers as follows:

- Tier1: Internal-WBAN communication

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 7, Issue 5, May 2018

- Tier2: WBAN communication with the sink node
- Tier3: Medical servers and communication from the sink node to the medical server.

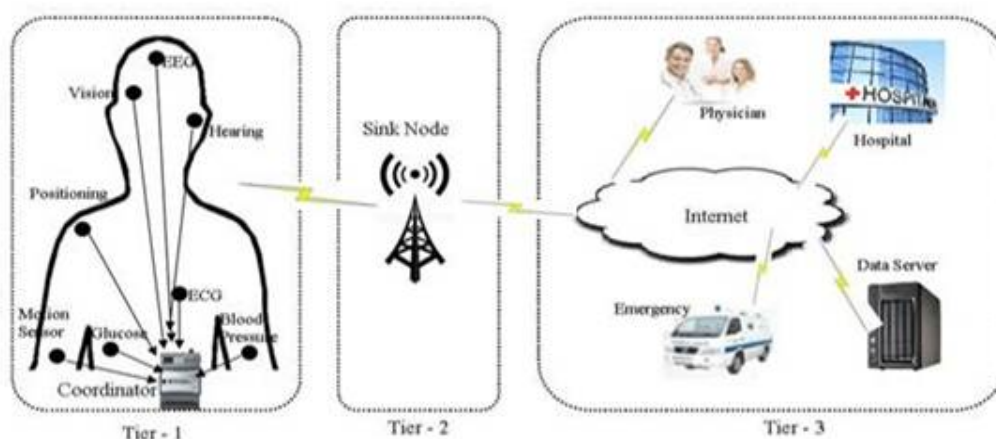


Figure 1. General Communication Tiers in a WBAN-based e-healthcare System

The three tiers are explained below,

## Tier1

It shows the interaction of various sensor nodes which are used to collect biological data from the human body and forward them to a coordinator. Communications between sensor nodes and coordinator is supported by several technologies, such as Bluetooth, Bluetooth Low Energy, IEEE 802.15.4, Zigbee, IEEE 802.15.6, 6LoWPAN etc.

## Tier2

This communication tier is between the coordinator and the sink node. The processed biological data from Tier1 is further transmitted to a sink node in Tier2.

## Tier3

This tier provides connectivity to the local/remote medical servers directly /through Internet/GPRS/3G/4G.

## B. Applications

WBAN applications cover numerous fields in order to improve the user's quality of life. These applications can be categorized mainly according to whether they are used in medical field or in non-medical field. Non-medical applications include motion and gestures detection for interactive gaming and fitness monitoring applications. Medical applications mainly comprise healthcare solutions for aging and diseased populations[3]. Typical examples include the early detection, prevention and monitoring of diseases, elderly assistance at home, rehabilitation after surgeries, biofeedback applications which controls emotional states and assisted living applications which improve the quality of life for people with disabilities. Generally, body sensors used in health monitoring can be either: (a) Physiological sensors used to measure human body vital signals internally or externally, like body temperature, blood pressure or Electrocardiography (ECG); or (b) Biokinetic sensors able to collect human body movement based signals as acceleration or angular rate of rotation[3].

## C. Energy Wastage Resources in a Sensor Node

A sensor node in WBAN system mainly consists of five components. They are biological sensors, microcontroller, memory, wireless transceiver, and battery. The sensor nodes usually consume power during sensing, computing and

## International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 7, Issue 5, May 2018

transmitting data(wireless communication) to the coordinator. However, wireless communication consumes a large amount of power compared to sensing biological data and data computation[4]. The wastage of energy of the sensor nodes can be due to collision of packets, overhearing, over emitting, idle listening and fluctuations in the traffic. In such cases, again the source has to retransmit the data. Collision of packets in the network means two or more nodes transmits the data simultaneously and collision between packets happen and again source has to retransmit the data, because of this energy can be wasted. Overhearing incur when source node transmit data to one node that is destined to another node in the same transmission range. Idle listening incurs when an node is in idle state and waiting for some possible events to occur, wasting energy by keeping idle all the time [4].

Many techniques have been proposed in the past to lower the power consumption of sensor nodes by making use of various energy conserving techniques and energy efficient Medium Access Control (MAC) protocols. In order to minimize power consumption, it is also important that the upper layer, the application layer, must use better strategies such as sampling and transmitting, reducing the size of the data packets by compression or transmitting only the necessary data packets and dropping the unwanted ones.

### D. Popular Low Power WBAN Wireless Transmission Technologies

In health monitoring applications based on WBAN, energy efficiency of the sensor nodes depends highly on the wireless communication protocols selected, because a large amount of power is consumed during wireless transmissions. Thus, a suitable energy efficient communication technology can substantially reduce the power consumption. WBAN may involve different transmission technologies at different levels, as exposed in Figure.1. Based on[3] a comprehensive study of the main proposed wireless communication technologies for WBAN is shown in Table 1.

**Table 1. Popular Low Power WBAN Wireless Transmission Technologies**

Parameters	Bluetooth	Bluetooth Low Energy	ZigBee and IEEE 802.15.4	6LoWPAN	IEEE 802.15.6
Frequency	2.4 GHz	2.4 GHz	800 and 900 MHz, 2.4 GHz	868 and 915 MHz, 2.4 GHz	400,800,900 MHz,2.3,2.4GHz, 3.111.2 GHz
Maximum data rate	3 Mbps	Upto 1 Mbps	250 Kbps	250 Kbps	10 Mbps
Maximum range	1-100 m	200 m	100 m	Less than 10 m	2-5 m
Power consumption	Moderate	Very Low	Very Low	Ultra Low	Extremely Low
Battery life	Hours	Several months to years	Several months to years	Several months to years	Several years

WBAN-based medical applications with high criticality especially e-healthcare systems using implanted or wearable sensors should rely on mechanisms to minimize the power consumption in order to extend the battery life, while

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 7, Issue 5, May 2018

achieving maximum throughput and minimum delay. Battery replacement in WBAN-based non-medical applications is easy and so there is less focus on reducing power consumption, for such scenarios.

This paper mainly focuses on surveying of various techniques implemented for reducing the power consumption in WBAN-based e-healthcare applications.

The rest of the paper is organized as follows. Section 2 describes the Related Works. Section 3 presents the Comparative Study of various techniques employed to reduce the power consumption in WBAN sensor nodes. Conclusion is provided in Section 4.

## II. RELATED WORKS

Dapeng Wu *et al.*[5] uses an energy-efficient data forwarding strategy that balances the sensor node energy consumption and improves the network lifetime. Here the original physiological data are compressed to reduce the data size in order to improve the energy efficiency of the body sensor nodes and transmitted by multi-hop tree based routing protocols.

B. Chen *et al.* [6] provides a cognitive radio capability to the sensor node in order to avoid Electro Magnetic Interference (EMI) which reduces the sensor power consumption. In a cognitive radio system, the cognitive process typically starts with spectrum sensing, followed by channel identification and spectrum management. Spectrum sensing is achieved by probing and sensing the quality of the channels. A channel with the best quality, i.e., the channel experiencing the least interference or fading, is then chosen for packet forwarding.

Byoungseon Kim *et al.*[7] have proposed an automatic segment repeat request scheme for the IEEE 802.15.4-based WBANs. This proposed scheme fragments the data payload when the channel condition is bad, and retransmits only the corrupted fragments. This reduces the size of the retransmitted frames, which improves frame reception rate and decreases the amount of transmitted traffic, and thus energy consumption.

Akande Sheriff Abiodun *et al.*[8] have introduced a novel data segregation and classification scheme that separates the sensor's readings into urgent, semi-urgent and non-urgent packets. The urgent packet is sent to the gateway immediately. The semi-urgent packet is buffered temporarily inside the sensor, and the buffered packet waits for the next transmission. If the next transmission is also semi-urgent, the sensor forwards the buffered packet to the gateway or drops the packet if it cannot be forwarded. The non-urgent packet is dropped immediately without being transmitted to the gateway. Since the number of packet transmissions are reduced the sensor node power consumption is reduced. Moreover, WBAN systems are highly dependent on gateway devices. This paper offers an architectural routing approach for a medical sensor that enables transmitting packets during gateway failure. The WBAN wireless transmission technology used here is 6LoWPAN.

Stevan Marinkovic *et al.*[9] focuses on the Wake Up Radio (WUR), which allows power efficient listening of wireless channel which could be used to reduce power consumption of implantable WBAN systems. WURs are the basic circuits for the on-demand communication scheme. They handle the sending and receiving of wake up messages that switch on the main processing unit or the main radio of the required sensor node. It consists of two functional groups namely wake up circuits and wake up receivers. The wake up circuits only detects the activity on a channel, and hence has very low power consumption (even zero power). Wake up receivers on the other hand demodulate and decode some information packets following the signal, which can be used for addressing to reduce the number of activations.

De-Thu Huynh *et al.*[10] proposes an energy efficient solution for WBAN based on ZigBee applying Healthcare Monitoring System. Particularly, they have utilized the ZigBee standard working in beacon enable mode to obtain the adaptive duty cycle. Consequently, the energy consumption in idle-mode is avoided, as well as the total energy consumption of sensors is also decreased and extended network lifetime.

## International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 7, Issue 5, May 2018

### III. COMPARATIVE STUDY

A comparison of various Energy conserving technologies used in WBANs based on wireless transmission technologies and other upper layer strategies used, is shown in Table 2.

**Table 2. Comparison of different Energy Conserving Techniques in WBAN**

Energy Conserving Techniques	WBAN Wireless Transmission Technologies	Average Power Consumption	Remarks
Energy efficient data forwarding strategy[5]	Bluetooth	Very Low	The volume of data transmitted is reduced by compression and multi-hop tree based routing is used. Wireless communication protocol used here is Bluetooth which is less efficient
Cognitive radio system[6]	ZigBee	Low	It avoids EMI which avoids the packet loss and retransmission. Here a more efficient wireless communication protocol such as ZigBee is used. But the actual number of data packets transmitted is not reduced.
Automatic segment repeat request scheme[7]	IEEE 802.15.4	Moderate	This technique fragments the data payload when the channel condition is bad, and retransmits only the corrupted fragments(s). IEEE 802.15.4 is the wireless communication protocol used here. But the actual number of data packets transmitted is not reduced.
Novel data segregation and classification technique[8]	6LoWPAN	Extremely Low	This technique reduces the number of data packets transmitted. The wireless communication protocol used here is 6LoWPAN which is much more efficient.
Wake Up Radio Concept[9]	ZigBee	Moderate	Enables power efficient listening of the transceivers and ZigBee is the wireless communication protocol used. But the actual number of data packets transmitted is not reduced.
Adaptive duty cycle[10]	ZigBee	Low	It avoids the idle listening mode of the transceiver and the wireless communication protocol used is ZigBee. But the actual number of data packets transmitted is not reduced.

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 7, Issue 5, May 2018

## IV. CONCLUSION

In WBAN systems for health monitoring low-power consumption is one of the most challenging requirements. Many techniques have been proposed to lower the power consumption of sensor nodes. The wastage of energy of the sensor nodes due to collision of packets, overhearing, over emitting, idle listening, fluctuations in the traffic can be reduced by using various energy conserving techniques and energy efficient MAC protocols. It is also very important, that the upper layer protocols, must use better strategies such as sampling and transmitting, reducing the size of the data packets by compression or transmitting only the necessary data packets and dropping the unwanted ones. Comparative study of the various energy conserving methods have been done and we have found that the classification of data into urgent, semi-urgent and non-urgent data using the novel data segregation and classification technique implemented inside the sensor node is the best one as it reduces the number of packets transmitted by transmitting only the necessary data packets(urgent and some semi-urgent packets) and dropping the unwanted ones(non-urgent packets), there by reducing the energy consumption. Moreover, they have implemented a novel routing architecture in case of gateway failure which reduces the packet loss and increases the system reliability and have used 6LoWPAN as the wireless communication protocol. We truly believe that this survey would be a source of inspiration towards future developments in techniques to conserve the energy in Wireless Body Area Networks for e-healthcare.

## REFERENCES

- [1] S. Movassaghi, M. Abolhasan, J. Lipman, D. Smith, and A. Jamalipour, "Wireless body area networks: A survey," IEEE Commun. Surveys Tuts., vol. 16, no. 3, pp. 1658-1686, Jan. 2014.
- [2] J. Xing and Y. Zhu, "A survey on body area network," in Proc. 2009 5th Int. Conf. Wireless Communications, Networking and Mobile Computing, pp. 1-4.
- [3] Rim Negra, Imen Jemili and Abdelfettah Belghith, "Wireless Body Area Networks: Applications and Technologies", Conference Paper in Procedia Computer Science · May 2016.
- [4] Mohammad Ghamari, Balazs Janko, R. Simon Sherratt, William Harwin, Robert Piechockic and Cinna Soltanpur, "A Survey on Wireless Body Area Networks for eHealthcare Systems in Residential Environments", Journal, , 2016 JunPMC4934257.
- [5] Dapeng Wu<sup>1,2</sup>, Boran Yang<sup>1</sup>, Honggang Wang<sup>2</sup>, Dalei Wu<sup>3</sup>, and Ruyan Wang<sup>1</sup>, "An Energy-Efficient Data Forwarding Strategy for Heterogeneous WBANs", IEEE Access, 2016, 2611820, vol:4, pp 7251-7261, September 2016.
- [6] B. Chen and D. Pompili, "Transmission of patient vital signs using wireless body area networks," pp. 663-682, 2011.
- [7] Byoungseon Kim, Student Member, IEEE, Ben Lee, and Jinsung Cho, Member, IEEE, "ASRQ: Automatic Segment Repeat Request for IEEE 802.15.4-Based WBAN", IEEE SENSORS JOURNAL, VOL. 17, NO. 9, MAY 1, 2017.
- [8] Akande Sheriff Abiodun, Mohammad Hossein Anisi, Ihsan Ali, Adnan Akhuzada, and Muhammad Khurram Khan, "Reducing Power Consumption In Wireless Body Area Networks (A novel data segregation and classification technique)", IEEE Access, October 2017.
- [9] Stevan Marinkovic, Emanuel Popovici, and Emil Jovanov, "Improving Power Efficiency in WBAN Communication Using Wake Up Methods", MobiHealth in 2012.
- [10] De-Thu Huynh, Min Chen, "An Energy Efficiency Solution for WBAN in Healthcare Monitoring System", The 2016 3rd International Conference on Systems and Informatics (ICSAI 2016).