

# A Study on Networking Techniques of WBAN System

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**Abstract** - *Wireless Body Area Networks (WBANs) used in many fields such as medical, entertainment, sports, electronics etc. WBAN should be efficient and accurate. It is basically a short range communication. Wireless body area network (WBANs) provide tremendous opportunity for remote health monitoring. However, engineering WBAN health monitoring systems encounters a number of challenges including efficient WBAN monitoring information extraction, dynamically fine tuning the monitoring process to suit the quality of data, and to allow the translation of high-level requirements of medical officers to low-level sensor reconfiguration. Group formation and modification is performed with respect to patient's conditions and medical officer's requirements, which could be easily adjusted through high level policies. We also propose a new metric called the Quality of Health Monitoring, which allows medical officers to provide feedback on the quality of WBAN data received. The WBAN data gathered are transmitted to the virtual group members through an underlying environmental sensor network. Energy efficiency is a key concern for wireless sensor nodes, especially for wireless body area network (WBAN) in which sensors operate in close vicinity to, on or even inside a human body. In this paper we will discuss various sensing, monitoring, routing and security techniques for WBAN system.*

**Key Words:** *wireless body area networks, energy aware routing protocols, sensor networks, security of WBANs*

## 1. Introduction

Nowadays, Wireless body sensor networks are playing an emergence role in various wireless applications. It is very useful in medical field. Wireless body area network deals with the wireless health monitoring of a patient. WBANs consist of many small but smart devices that are easily available to sense, process and communicate. The sensor that is used for WBAN is implanted in or on the body of the patient. There is a centralized node which controls the other nodes. The centralized node is the master node and controls the work of all other nodes that are attached in the human body.

The body networks have to make all the data transfer between the sensor nodes. As these nodes operate under the limited energy, the nodes that implant in the body has the limited availability of power over the time period of that node. Here to avoid this limitation energy efficient routing protocols are used. Routing and controlling should be highly energy aware to achieve longevity of these sensor nodes. There are three types of sensors are used i.e. physiological sensor, ambient sensors, Biokinetic sensors. These sensors are capable of sampling, processing, and communicating various vital signs and it provides the real time feedback to the network. But WBANs also faces number of security issues as loss of data, authentication and access control.

This paper gives a review on previous researches that emphasis on sensor networks, routing and security issues in WBANs. This Paper is organized into four different sections such as characteristics of WBANs, types of protocols, sensor networks and security of WBAN systems.

## 2. CHARACTERISTICS OF WBANS

Basically, WBANs are communication networks that exist between the humans and the computers or internet through a wearable device that implants in or on the body of the patient. To realize this communication ad hoc and wireless network could be used. A node is an independent device that is used to communicate. These different nodes can be classified on the bases of their functionality, implementation and their role in the network.

Nodes on the basis of functionality: PDA (Personal Device Assistant) is a personalized server that is used for transmitting the data which was sent by the sensor network and actuators and it controls the interaction with other users. This PDA can also named as body gateway, sink, body control unit etc. The data that received from the sensor is interacted by the actuators. These actuators provides the feedback in the network by the data that received by the sensor. In WBAN network sensor node should be much accurate and reliable to sense the body and carry out the low-level processing of the signal and transmits it to the other processing unit [1]. Here Table 1 shows a basic difference between the Wireless body area network and the sensor networks [2].

**TABLE- 1:** Difference between WBAN AND WSN.

	WBAN	WSN
Data Rate	WBAN has stable data rate and data is in well periodic manner.	WSN is an occurrence based monitoring. In WSN outcomes happen at non-uniform intervals.
Density	WBAN systems are not node dense	WSNs are node dense
Mobility	The users of WBANs may move around easily. Nodes share the same mobility pattern.	WSN nodes are stationary.
Latency	Battery replacement can be easily done in WBANs when energy conservation is not an big issue.	It is difficult to replace the battery as nodes are physically unreachable. So in WSNs we have to increase the lifetime of the battery
Security	Data is more secure in WBANs	In WSNs the data is not much secure.

WBAN is a small scale networks than the WPAN, it is a short range communication and more reliable.

Data that are detected collected and transmitted in the WBANs is more sensitive; more secure and have high privacy than the WPANs.

In WBANs the devices implanted in the body are limited in their computational capability, energy and power.

WBANs follows star topology method as the communication is centrally organized by a master node and every sensor node is directly linked it.

### 2.1 Classification of nodes

#### 1) Nodes on the basis of implementation

The nodes implant in the body either in the skin or in the tissue of the body. Body surface nodes are implanted on the surface of the body.

#### 2) Nodes on the basis of their role in networks

a) Gateway nodes-Gateway nodes are used to coordinate with the other networks. PDA acts as a coordinate for the WBAN as all other nodes communicate through the PDA.

b) Back end nodes:-These nodes are very limited to performing their applications. These nodes are not very much capable of relaying messages from other nodes.

These back end nodes delivers the information of the sensor nodes.

c) Intermediate nodes:- They have a master node, that controls the other server nodes and transmit messages for e.g. if there is a node at the extreme end of the body then data is to be relayed by the intermediate nodes before reaching the PDA. These nodes are capable also to sense the data.

### 3. Power Efficient Protocols used In WBANs

When a node is implanted in the human body, the nodes that are used to operate for a long period of time. It is a difficult to change or remove the battery of the node from the body. So we should increase the power and energy of the efficiency of the system. For this energy efficiency Routing protocols are used .So they are also called as Energy aware routing protocol. Routing protocol selects the route or the participation of the node in the packet routing.

#### 3.1 Cross layered Protocol:

There is another cross layer based routing protocol i.e. Time zone coordinated sleep scheduling. Its main aim is to increase the efficiency of the system. As it supports the star topology network.TICOSS provides the shortest path for routing for data from the node to the nearest coordinate node.TICOSS main feature is the time zoning .These nodes are divided into different time zones, where the each and every node that has the same distance to the coordinate node that falls in the same time zone. There is a transmit and receive zone in the pair of time zone. The upper time zone starts transmitting the data into one slot and during the other slot, lower time zone turn on to transmit the data. Nodes keep active only during the scheduling of its time zone. Otherwise it remains into sleep state. This mechanism saves the energy consumption [3].

#### 3.2 Hybrid Indirect Transmission

It is a protocol that uses the clustering technology. Basically, it is the combination of LEACH [4] & PEGASIS protocols. HIT combines these two protocols and two major features introduces.i.e it decreases the number of transmission sensor from nodes to other base stations. And the parallel transmission can be done without disturbing the adjacent clusters. As each and every node gets the same information of the network. TDMA scheduling can be calculated independently, as during transmission no other node interfered. Therefore without

the disturbance of the other adjacent clusters parallel transmission is possible in the network. In HIT's nodes transmitting data for long state. When TDMA's schedule is calculated, the node transmits the data without interference of other adjacent nodes. In a cluster transmitted data is fused by the other nodes before transmitted to the next hop node by this the data become smaller and it saves the energy and the uses efficient network bandwidth.

### 3.2 DQBAN

DQBAN is termed as Distributed Queuing Body Area network [5]. It is also an energy saving protocol. To improve the energy efficiency DQBAN uses cross layer fuzzy scheduling algorithm. To avoid collision it use a QoS scheduler with this fuzzy logic in body sensors. But due to this fuzzy logic system the implementation of sensor in body is b more complex which is unsuitable for the WBANs [6].

### 4. Monitoring and Sensing

Wireless sensor networks play a valuable role in today's technology as in medical field, sports, entertainment etc. In biomedical sensor networks for measuring the different body signals to monitor the body parameters and movements.

Wireless body sensor networks consists of intelligent sensors with light weight, less power and very small in size that can be easily placed in or on the human body. A general structural design of WBSN shown in fig 1. WBAN is used to communicate with sensor nodes. WBANs are capable of sampling; monitoring, processing and communicating with different signs and it provide real time output to the user to measure the body parameters. These sensors can be differentiable as wearable and implanted sensors. Three types of sensors are used here 1) Physiological sensors that measures the blood oxygen, blood pressure, monitoring of glucose in the body, body temperature, electrocardiography (ECG), electroencephalography (EEG) and electromyography (EMG). 2) Ambient sensors that measures the humidity, light and temperature and other environmental factors. 3) Sensors that measures acceleration and the rate of rotation of the patient's body movement.

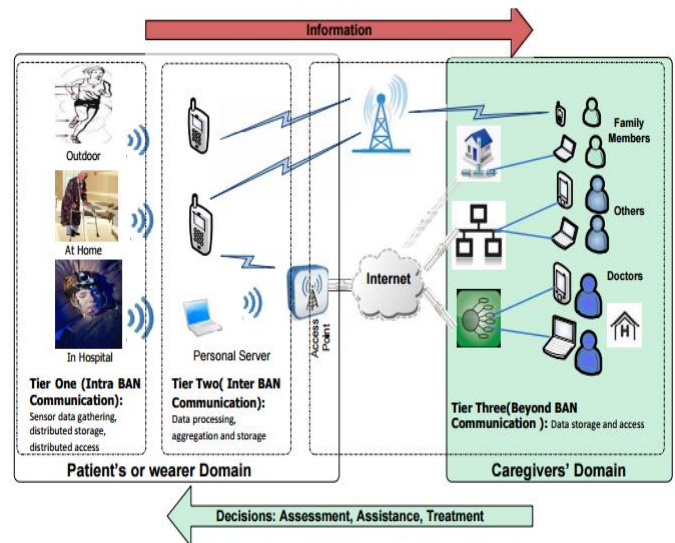


Fig -1: Structural design of wearable health monitoring system architecture

### 4.1 Wearable Sensors

Pulse Oximetry is a medical device that measures the saturation levels of the oxygen in the blood indirectly of individual as well as amount of change in the volume of blood in the skin that coincide with the cardiac cycle. This type of sensors are attached to a finger or embedded in any other part, and it consists of red and infra-red light that is transmitted or reflected back, which depends on the light that absorbed by the blood. The absorption of light varies according to the change in the volume of blood. To determine the heart rate quasi-periodic signal named as Photoplethysmograph (PPG) can be used.

A PPG biosensor fig 2 is a wearable sensor that can be worn as a ring [7], it is easy to worn for suitable monitoring. These type of devices help to reduce the power consumption with a high frequency, low duty cycle modulation scheme. It is a light based technology which is used to sense the blood flow rate which is controlled by the pumping action of heart.

Electrocardiography (ECG) is a waveform that represents the propagation of electric potentials through the heart muscle with respect to time. ECG provides a non-invasive means for detecting the heart function. ECG measurement using wireless sensors are generally for ambulatory applications and will typical utilize a subset of these leads. The ECG signal can also be used to monitor cardio irregularities by using WBAN [8].

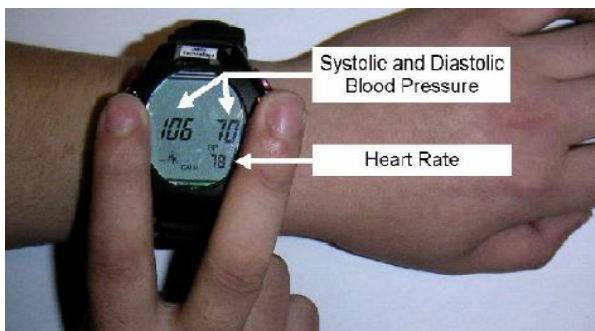
Blood pressure (BP) is a measure of the force that exerted by the blood that is circulating on the walls of blood vessels. It has been noticed that measurement of BP at regular intervals is related to target organ damage and cardiovascular events that the readings of the BP taken clinically [9]. For this cuff-less BP watch sensor is used fig3.



**Fig -2:** PPG Ring biosensor type

Electromyography (EMG) in this we can monitor the electrical signals that emitted by the muscle of the body to study the functioning of the muscles [10]. A surface electrode is placed on the skin of the muscle and while it contracts it receives electrical signal from muscle fibers that associates with different motor units [11].

Electroencephalography (EEG) represents the activities of the brain. Ambulatory EEG (AEEG) recordings have been shown to have great value in the diagnosis of epilepsy and monitor the response of patient to the therapy [12].



**Fig -3:** Cuff-less Blood pressure watch prototype

But it is difficult to obtain the information readings of AEEG from a 20-min EEG test. To avoid this a wireless EEG sensor can be used that will help to make the recordings of AEEG from the daily activities that is less complex, have minimum obstructions and can be easily managed [13].

#### 4.2 Implantable Sensors

The sensor that implant in the skin or in the tissue of the body to measure the body parameters as Glucose

monitoring it has been observed that continuous blood glucose data in the body will reducing the risk of type1 diabetes [14] and also reduce the chances of low blood sugar or hypoglycemia that is caused by the medications used to treat diabetes as level of insulin become very high. It can be monitored by implanting a sensor under the skin.

Implantable Neural Stimulators sends the electrical signals into the brain or spinal cord, this sensor improve the quality of life of those who are suffering from many diseases such as paralysis, chronic pain etc for this some devices are used such as[15].

### 5. Security of WBAN Systems

#### 5.1 Security

The data of the patient should be secure and private. It should not be disclosed to the everyone. Security of the WBAN is very important. Security concern with WBAN technology is increasing day by day. It is very important to secure the network architecture of WBAN system. WBAN system should be user friendly and it should be operate on low powered system, this is again a challenge for the security of the WBANs [16]. For WBAN the security of the system is asses by the practical assessment (PIA). This PIA based on the C.I.A [17] concept which represents the confidentiality, integrity and availability of the network system. By using the inputs from the PIA, we develop an architecture that will help to prevent threats and also to find the cause of an attack if occur in the network. For the security of the WBAN network it is necessary to have authenticated nodes. Authentication prevents our network to compromise and to impersonation of the nodes.

As we know WBAN network carries the data which is very sensitive and important and which has the information of life saving. So, the availability of the network resources in all circumstances is mandatory.

#### 5.2 Security solutions

Tiny sec is a proposed security solution in the sensor network that is used to achieve the high level authentication [18]. It encrypts the information of data Packets with a particular set of key which is common to all other nodes. Its security architecture is based on software [19]. Unsecured mode and secured mode are the two different classifications of security suites. In unsecured mode there is no as such security. There is full depiction of the security suites in [20]. There is number of different standard suite based on the properties of the security they provide as given in the table below:

**TABLE- 2** Security Suites

Name	Description
Null	It has no security.
AES-CTR	Data Encryption only.
AES-CBC-MAC-128 AES-CBC-MAC-64 AES-CBC-MAC-32	Authentication only
AES-CCM-128 AES-CCM-64 AES-CCM-32	It provides encryption and authentication.

**6. Conclusion and Future Work**

WBAN is an promising technique for medical supervision. It is a wireless network that is used to measure the different body parameters of the patient to cure the disease. There is a vast future scope of WBANs in the medical field, entertainment and education. WBANs has the capability for breakthrough in the study of medical field, military applications, entertainment, education etc. It also need evolving standards for coexistence and transfer of the data with the other mobile network, internet and ad-hoc network.

Sensor networks consists of number of nodes and these sensors are used to gather some body parameters of the patient and it transfer the data and use only the valid data. But there should be some changes in this prototype system to form a real medical supervision system. We should make the system more portable and comfortable. Optimization of network schedule mechanism for compounding medical data transmission. The data transmitted in our system varies in size, transmission time, priority & property of signal used in the network. Some systems have to be compressed before transmitting in the network.

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