

# Challenges and Applications of Wireless Body Area Networks

Rajeev Sharma, Sandeep singh kang

*Abstract-Modified low-power, ultra-slim, light in weight, intelligent devices are the result of recent advances in technology. Wireless Body Area Network (WBAN) is a replacement technology that can be used to incorporate these devices & thereby provide health monitoring applications in healthcare. Further development of wireless communications in recent years has led to the use of sensing element networks, which are low priced. These networks have a wide variety of applications. Various technical problems in these application areas are being resolved by researchers across the world. These sensing component networks play a significant role in healthcare. These networks have deep roots in various sectors viz; engineering, medicine & science & can show good performance even in harsh climatic conditions. Therefore, this paper provides an associated degree of exposure for the analysis and applications of wireless body area networks (WBAN's), and body sensor networks (BSN's). Apart from it, it addresses a wide variety of challenges in these technologies.*

**KEYWORDS:** *Wireless body area networks (WBANs), body sensor networks (BSNs), ultra-wideband (IEEE 802.15.3) & ZigBee (IEEE 802.15.3), Sensor, personal digital assistant (PDA)*

## I. INTRODUCTION

Realization of Wireless Body Area Networks (BANs) is now possible due to the advent of radio frequency technology & sensors. A typical WBAN comprises three types of devices: sensors, actuators and personal digital assistant (PDA) [13]. These networks can serve as the building blocks to build networks in the future & can further help in providing better approach toward health monitoring.

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These networks have the ability to pass on information of respiration, blood heat, sound, vibration and other important signs. In a WBAN, biomedical sensors, deployed on a patient's body, report their measurements to a data sink, which often links to a healthcare institution through wide area networks, by wireless transmission in a single-hop or multi-hop fashion [14]. Non-invasive sensors fail to detect & analyze functional reading, which can be intercepted by the nearest devices, with a mobile phone as an entrance. ZigBee is meant to produce a protocol, which is durable & cost-efficient, thereby providing high stability & performance. This paper provides a summary of wireless body area networks (WBANs), their practical applications, challenges and issues related to their security. This paper provides a comparison with OSI Model and with TG6 (ask Cluster Half Dozen) security issues. A large number of open-problems & challenges that are needed to be self-addressed to create wireless BAN's & ZigBee have been addressed in the paper.

An organizer or doctor starts traffic on-demand in order to get exact data, largely for the aim of diagnosis of the patient's health. After nodes go higher than a predefined threshold, they start sending emergency traffic which may be contained within one second. Moreover, this kind of traffic is amenable to change & non-periodic. Usually the traffic is the normal one with no time criticality. Normal traffic includes treatment of the patient for diseases like cancer, disorders related to heart, neural systems etc. The conventional knowledge is processed by the arranger. The organizer holds a wakeup route, a main radio, and a bridge perform, all of them connected to a knowledge interface. The wakeup circuit is employed to produce on- demand and imperative scenario passage. The organizer is connected to servers for communication.

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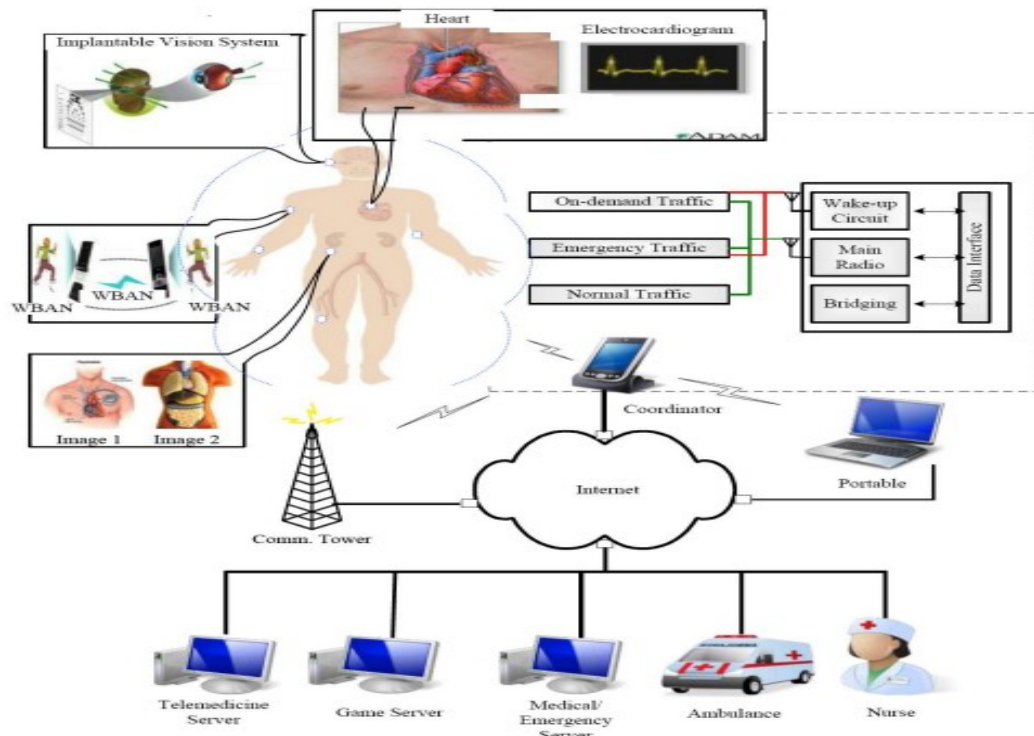


Figure 1 A WBAN design for application in the various areas of medical & non-medical science [6]

Figure 1 shows the WBAN traffic for medical & other applications. A number of challenges have been introduced in the fields of administration, healthcare monitoring due to the rise of population in the developed countries & the rise of diseases in old aged people. To provide customized services to patients, there is an immense need for the use of wireless instruments to enhance performance. WBANs provide an extremely reliable infrastructure for medical devices, particularly those ingrained inside the body. They consist of a variety of small sensors that may be fixed on the body as microchip, either beneath the skin or deeply

### A. E-Health Care

WBANs provide interface for medical specialty, remote monitoring of human physiological knowledge. Patients will be treated remotely in near future. WBAN Provides healthcare application that offers immense contribution in improving patients healthcare and diagnosing and

embedded within the body tissues. This increases the capability of doctors to monitor the health of patients in a secure manner, thereby increasing the quality of life [1]. Three communication protocols are applied by wireless BAN's [2], Bluetooth [3], ultra-wideband [4] & ZigBee [5]. A wireless BAN is used to connect nodes that are implanted on the surface of the body for applications in healthcare, recreation, defense, or other areas. Following are the application of body area networks.

monitoring. Moreover, it provides medical rehabilitation and supervising of patients. Patients can now be examined at their homes while performing daily activities.

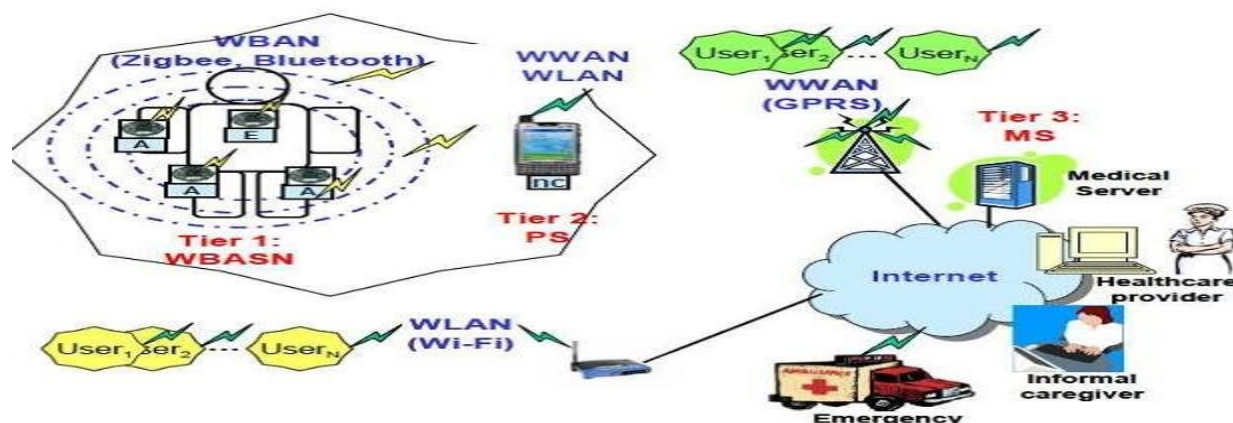


Figure 2 E-health care system designs [7]

## B. Lifestyle and Sports

In [8], Wireless BAN has its utility in golf as well, wherein it resolves the problem of proper direction of the golf club. In addition to this supplying period response as per the limb of participant in terms of hip movement is also resolved. Conserving energy & ability to perform at maximum altitude by the golf player corresponds to body sensory knowledge of player's movement. Not only does BAN provide better performance observation & nipper observation in sports but

it also extends its area to new functions for wireless body area networks.

## C. Military Applications

Accomplished experiments are using auditory sensing elements to detect and limit short signals from mortars, weapon systems has been successfully carried out by ARL, the Army Research laboratory which will have a powerful consequence on deadline & survivability in battlefields [9].

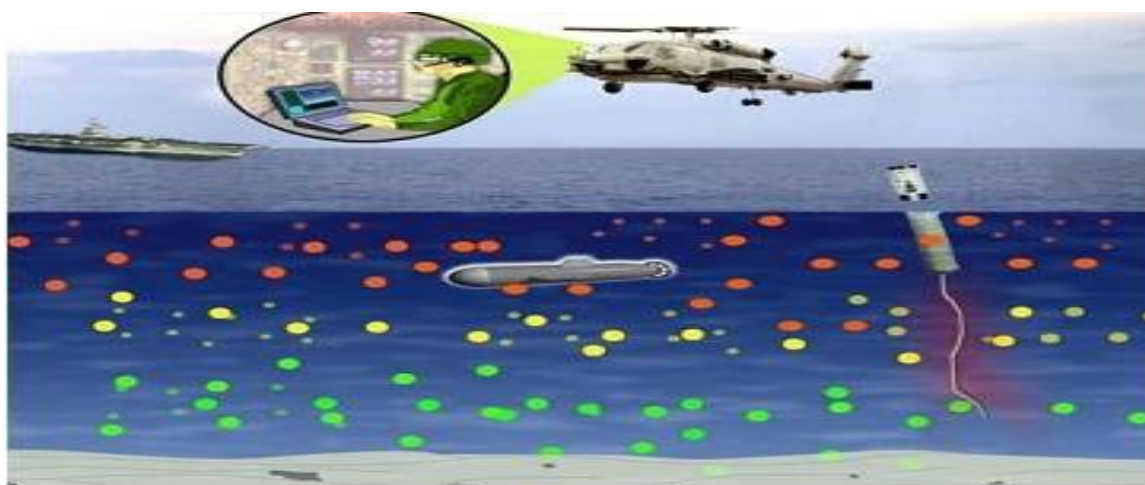


Figure 3 WBAN actions in Military Operations [9]

Among the battlefield BAN's applicability is immense, which includes health monitoring, location based services & detection of hot temperature. BAN combined with military uniform forms a wearable network connecting devices like PDA's, cameras, life support sensors, health monitoring which then proceeds to transfer knowledge to & from the soldier's wearable laptop. Chemical recognition, prevention

of victims from fire & observation of a soldier's state are some other functions provided by the networks.

## D. WBAN for Animals

Wireless BAN serves as an important tool for diagnosis of various infectious diseases in animals. Published By: Blue Eyes Intelligence Engineering & Sciences Publication

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individuals & animals. This is quite important because both animals & humans share a symbiotic interdependent relationship.

### E. Preventing Cable and Conductor Theft

Reports of cable stealing including both power cables and telecommunication lines have been reported. Different types of wires are being stolen due to increasing price of metal. Business against Crime (BAC) African country declares that the knock-on effects to the economy is, conventionally, 10 times superior to the expenses needed for substituting stolen wire.

### F. Networking and communications

These technologies decrease the prices of different resources which accordingly facilitate integration with the internet.

## II. TECHNIQUES USED

Various latest radio communication technologies are discussed in this paper.

### A. ZigBee and IEEE 802.15.4

In order to implement BAN in various application areas, two interrelated technologies named ZigBee [10] and IEEE 802.15.4 provide a strong foundation. The previous standard enhances the IEEE 802.15.4 standard by adding networking related security layers and an application framework to provide complete wireless sensing element network (WSN) systems whereas the latter standard covers the physical (PHY) and medium access control (MAC) layers targeting low-rate short-range radio-communications, most suitable for BAN nodes. The ZigBee supports technologies that enable systems with practical multi-vendor devices & low-power consumption, for instance, the ZigBee good Energy and Building Automation Profiles target applications within the realm of good energy use involving numerous forms of appliances within the home atmosphere, and building and industrial automation within the industrial atmosphere. In order to fulfill Continuous Health Alliance necessities within the realm of health and fitness observation, ZigBee has proposed a ZigBee Healthcare Profile Technology. Whenever radio transmissions are done over ZigBee band, transmissions suffer considerably from extremely variable path loss around the body [11]. This hinders data-rate, thereby hindering the support ZigBee offers for BAN applications.

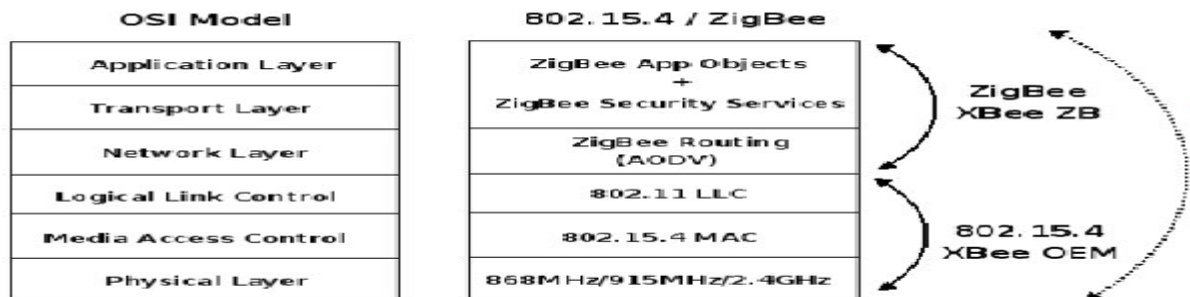


Figure 4 802.15.4/ZigBee comparisons with OSI Model [10]

### B. Bluetooth Low Energy

Bluetooth is widely used for connecting a large number of private devices. This technology helped modify knowledge and voice communications. By forming a star like topology referred to as a piconet, these devices operate within the pair of 4 gigacycle functional system band and have the capability to access seventy nine channels [12]. This technology has a data rate of up to one Mbps & utilizes fewer channels for pairing thereby increasing the performance.

### C. Comparison of Techniques

ZigBee and Bluetooth technologies have a lot in common, like each of them operates within the same waveband of 2.4 gigacycle and belong to a wireless personal area network (IEEE 802.15). There are a large number of variations between these two technologies.

Whereas Bluetooth eliminates cabling between short-distanced devices, ZigBee is



additionally home-bound towards high technology. Bluetooth eliminates the need of cables between nodes that are in the close vicinity. The users of this technology are always ready to exchange documents, files, images etc.

ZigBee is anticipated to be ready to eradicate the need of electrical cables in homes thereby permitting the liberty of wireless lightweight switches.

#### D. Technical Parameters

Bluetooth features a network range of one to one hundred meter, whereas for ZigBee it is up to seventy meters.

Bluetooth batteries are rechargeable; however this is not the case for ZigBee, although ZigBee batteries are long lasting.

- 1) ZigBee focuses on automation whereas Bluetooth focuses on connecting cell phones in close vicinity.
- 2) ZigBee networks support longer range devices whereas Bluetooth networks support short range devices.
- 3) ZigBee is suitable for critical applications (join time=30 milliseconds) whereas Bluetooth's longer join time is harmful (3 seconds).

### III. ROUTING PROTOCOLS IN WBAN

Routing protocols in WBANs are classified into following five categories discussed as under:

#### A. Cluster-based Algorithms

The first category of routing protocols in WBANs is Cluster-based routing algorithms that divide nodes in WBANs into completely different clusters and assign a cluster-head for every cluster. Data is routed through the cluster-heads to the sink. These routing protocols decrease the amount of direct transmissions from the sensors to the bottom station but large delay & overhead related to cluster choice are the disadvantages of these protocols.

#### B. Probabilistic Algorithms

Probabilistic routing protocols sporadically update their cost function based on link state data, and establish their path among routes with minimum cost.

#### C. Cross-Layer Algorithms

Cross layer routing protocols are low energy consuming protocols which provide high output, but in terms of performance they lag behind.

#### D. Temperature-based Algorithms

Radio signals generated via wireless communication generate electric and magnetic fields which leads to the rise in the temperature of the body. If the temperature inside the body continues to rise body tissues might be damaged & this may further lead to blood flow reduction in some organs.

#### E. QoS-based Routing Algorithms

The last class is QoS routing protocols, which provide a standard approach by presenting separate modules for various QoS metrics that, operate in coordination with one another. The modules employed in this methodology are the reliability-sensitive module, the delay-sensitive module and also the neighbor manager.

### IV. WBAN CHALLENGES

Wireless BAN is an emerging technology with plenty of issues to be addressed. WBAN has to face a number of challenges like confidentiality which is the most important issue. Some important technical challenges are discussed below:

- 1) Number of nodes: The number of nodes should neither be too many in number nor too less in number depending on the specific applicability.
- 2) Size of the node. This is an important challenge in WBANs.
- 3) Security of data: Various security provisions should be provided in WBANs to prevent the sensitive information.
- 4) Wireless tools: There is an increasing demand for supply of low power wireless tools in WBANs.
- 5) Compatibility: The various types of equipment's like sensors etc. used in WBANs should be compatible with each other, otherwise sensors supplied externally might increase cost.

### V. SECURITY IN WBAN

Before instigating encoding, the protection strategy should

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be considered. Wireless Body area Networks (WBAN) are used to diagnose various diseases in patients .WBAN provides three levels of security viz level 1, level2 & level 3. Level 1 has no inbuilt mechanism for security. Level2 provides a mechanism for authentication only whereas level 3 provides a mechanism for encryption as well as authentication of data.

### A. Data Confidentiality & Integrity

Data confidentiality in WBAN's is the most important issue that needs to be addressed. It avoids information leakage. Knowledge integrity is equally important. Import information of the patient could be lost & this could be detrimental from a privacy perspective.

### B. Data Authentication

Authentication helps establish proof of identities. MAC (Message Authentication Code) computed using secret key can ensure data authentication.

TABLE I  
Security methods in communication protocols

Protocols	Bluetooth	ZigBee	TG6
Confidentiality	Yes	Yes	Yes
Integrity	No	No	Yes
Non repudiation	No	No	No
Authentication	Yes	Yes	Yes
Authorization	No	No	No

### C. Data Freshness and Secure Localization

Data needs to be refreshed time & again. Old data is stale & useless. Data freshness has two type's viz strong freshness wherein data is sent quickly with less delay & weak freshness wherein only partial data is sent with some delay.

### D. Availability and Secure Management

In healthcare, it is very important to respond to a patient quickly, supply him the medicines etc. Thus there should be systems that are available 24/7 for a fast response .If any node of the network is attacked, to ensure response to the patient; the compromised node should be changed to ensure secure management & high availability.

## VI. CONCLUSION

The aim of this paper is to study an emerging technology called Wireless Body Area Networks (WBANs). This paper also studies technologies like ultra-band, ZigBee, and Bluetooth. In addition to it, an insight into the challenges, applications & security issues associated with WBANs & different ways to tackle the various security issues are discussed.

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