A Review on Relevance and Technologies of WBAN

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Abstract

Recent advances in microelectronics, physiological sensors, low-power built-in circuits, and wireless communication has allowed the awareness of Wireless Body Area Networks (WBAN), which are used for health monitoring, athletic guidance, monitoring traffic, crops, infrastructure etc. The physique location networks (BAN) are low power, miniaturized, inexpensive, large-scale multifunctional network. It permits non-stop health monitoring of a individual with real-time updates of medical data thru the Internet. As a result, it decreases fee and ordinary visits to the medical doctor and also saving the human life's when unpredictable health situation occurs. This paper overview the key aspects of WBAN, its architecture, trendy technologies, challenging troubles and applications in medical and nonmedical fields.

**Keywords:** Wireless Body Area Network (WBAN), Zigbee, Bluetooth, Channel Models

1. INTRODUCTION

Nowadays the health conditions are unpredictable and also with the growing old of the population, present scientific sources cannot satisfy future healthcare demands of seniors and patients. Resources are constrained and it is not possible for many human beings to come up with the money for long-term health center stays due to economic restrictions, work, and different reasons. As a result, wi-fi monitoring scientific structures will become part of cell healthcare centers with real-time monitoring of fitness stipulations by way of the technological know-how of Wireless body Area community (Zhang et al., 2005). In WBAN, a number of shrewd physiological sensors can be integrated into a wearable wireless physique vicinity network, which can be used for detection of health prerequisites of the people. The implanted sensors in the human body will gather a variety of physiological changes in order to reveal the patient's fitness status irrespective of their location. The records will be transmitted to an external processing unit barring   any connection between them (Wireless). This machine will instantly transmit all data in real time to the doctors at some point of the world. If an emergency is detected, the doctors will at once inform the patient via the laptop gadget by using sending splendid messages or alarms (www.lifewire.com/introduction-to-body-areanetworks-817364).

Generally, there are two sorts of devices: sensors and actuators. The sensors are used to measure positive parameters of the human body, either externally or internally. Examples are measuring the heartbeat, physique temperature or recording a prolonged electrocardiogram (ECG) etc. The actuators (or actors) on the other hand do some precise moves according to the information they acquire from the sensors or through interaction with the user. E.g., an actuator equipped with a built-in reservoir and pump administers, injects the right dose of insulin to the diabetic people based totally on the glucose level measurements. Interaction with the consumer or other individuals is typically handled by way of a non-public system called PDA or a smartphone which acts as a mediator for records of wireless devices (Kiran Pooja Ahlawat, 2015).

2. WBAN ARCHITECTURE

Figure 1 suggests the invulnerable 3-level WBAN structure for medical and non-medical applications. Level1 incorporates in body and no one BAN Nodes or sensors (BNs) such as Electrocardiogram (ECG) – used to display electrical activity of heart, Oxygen saturation sensor (SpO2) –used to measure the degree of oxygen and Electromyography (EMG) – used to reveal muscle exercise (Chen et al., 2011).

Figure 1: Architecture of WBAN
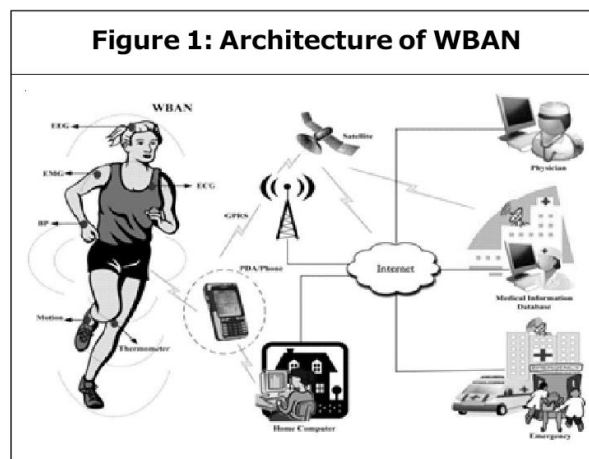
The wi-fi community nodes can be applied as tiny patches or integrated in clothes or shoes. These community nodes continually gather the uncooked data and manner it, save them regionally and ship them to the personal server (Emil Jovanov et al., 2005). The wireless sensor nodes are of minimal weight, miniature form-factor, low-power operation to permit extended continuous monitoring, seamless integration into a WBAN, standards-based interface protocols, and patient-specific calibration, tuning, and customization (Emil Jovanov et al., 2005). The statistics between gadgets propagates in the form of waves. The propagation frequency of exclusive nodes is specific and is divided into a range of channel models.

Channel Models for WBAN

In WBAN systems, statistics from devices which are close to or interior the human physique propagates as Electromagnetic waves. These waves trip some losses brought on by means of power absorption, reflection, diffraction, and shadowing by using physique tissues and body posture. So, the human physique will no longer become an best medium for the propagation of radio waves (Sai Sanath Kumar et al., 2016). The a range of channel models for WBAN are Implant node: This is the node positioned simply beneath the pores and skin of a human body to propagate further deeper into the body tissues.

Body Surface node: This is the node placed on the surface of the human skin or at most 2 centimeters away.

External node (Gateway Node): This is the node positioned away from the physique that is now not in contact with human skin. These are some eventualities for which the units are operating. These situations alongside with their description and frequency bands are listed in Table 1 and are decided based totally on the vicinity of the communicating nodes (i. e., implant, body surface and external). The scenarios are grouped into instructions that can be represented via the Channel Models (CM). Level 2 incorporates a BAN Network Coordinator (BNC) that gathers patient's fundamental facts in the shape of electromagnetic waves from the nodes which comprise a small transmitting antenna. The BNC switch the collected data to our private computers or to the nearest base station. The base station antenna transmits this data either to the medical doctor or to the database station the place the scientific facts is stored or alerting the ambulance thru a satellite tv for pc (Kiran, Pooja Ahlawat, 2015).

Level three includes a variety of remote base stations. When the information is obtained by means of the physician, he will take a look at the present prerequisites of the person. If the obtained information carries the quintessential situation of a individual then the details of the character are verified and his cutting-edge place is tracked. Then an practise is given to the ambulance by way of ringing an emergency alarm thereby admitting the person in the clinic and certain cure is supplied (Kiran, Pooja Ahlawat, 2015).

3. STANDARDS OF WBAN

There are sure requirements reachable for communicating the BANs. They are RFID, Zigbee, Bluetooth, wireless private region network, wireless nearby location networks, MICS, etc. Minute chips, which are commonly as a phase of wearable gadgets, depending on these standards. The description of some of the requirements is as follows:

Table1: List of Channel Models in WBAN [7]			
Scenario	**Description**	**Frequency Band**	**Channel Models**
S1	Implant to Implant	402-405 MHz	CM1
S2	Implant to Body surface	402-405 MHz	CM2
S3	Implant to external	402-405 MHz	CM2
S4	Body surface to Body surface (LOS)	13. 5, 50, 400, 600, 900 MHz 2. 4, 3. 1-10. 6GHz	CM3
S5	Body surface to Body surface (NLOS)	13. 5, 50, 400, 600, 900 MHz 2. 4, 3. 1-10. 6GHz	CM3
S6	Body surface to external (LOS)	900 MHz 2. 4, 3. 1-10.6 GHz	CM4
S7	Body surface to external (NLOS)	900 MHz 2. 4, 3. 1-10. 6 GHz	CM4

Bluetooth
Bluetooth technology has the biggest coverage on the market. Bluetooth doesn't focal point on the topic of low power consumption, which is most important in WBAN applications. Bluetooth transmitter has a transmit electricity of 1mW, the place WBAN solution can use much lower powers ~100uW than the Bluetooth. This innovation used to be considered as a short distance wireless verbal

exchange preferred commonly used for concerning a diversity of hand held devices to bear data and voice purposes (Luis Filipe et al., 2015). Bluetooth units operates in 2.4 Giga Hertz ISM band, making use of frequency hopping approach amongst 79 MHz channels at a supposed velocity of about 1600 hops/sec to trim down interference (Saarika et al., 2016). Z

igbee

Zigbee/IEEE 802.15.4 objectives low-data-rate and low-power-consumption applications. Basically, the Zigbee Alliance has been working on solutions for clever energy, and home, building, and industrial automation. The Zigbee Health Care public utility profile performed their lookup and submitted their flexible framework that meets Health Alliance requirements for remote fitness and health monitoring (Huasong Cao et al., 2009). It handles tricky verbal exchange in low power conversation gadgets such as nodes with collision avoidance schemes. It consumes a lesser quantity of electricity of about 60mW and gives a low information rate of 250 kbps (Saarika et al., 2016).

UWB

According to the Federal Communications Commission (FCC), UWB refers to any radio technology having a transmission bandwidth exceeding the lesser of 500 MHz or 20 percent of the arithmetic centre frequency. FCC additionally affords license-free use of UWB in the 3.1– 10.6 GHz band to have a highly low power spectral density emission. This leads to the suitability of UWB applications in short-range and indoor environments, and environments sensitive to RF emissions (e.g., in a hospital) (Huasong Cao et al., 2009).

MICS

MICS is a brief vary standard. It collects signals from exclusive sensors on the physique in a multi-hop arrangement. MICS has low electricity radiation and accordingly more suitable for the sensors in ubiquitous fitness care monitoring (http:// fiji.eecs.harvard.edu/CodeBlue). Bluetooth 3 + High Speed Bluetooth technological know-how was once designed as a replacement of RS232 cables, and later developed to end up a widely everyday wi-fi choice popular for connecting a range of non-public devices. It is unique from others in helping audio and information traffic streams. This is probable why Bluetooth headsets are considered everywhere. The newly adopted widespread was Bluetooth 3 + HS which introduces the 802.11 protocol adaptation layer (PAL) into the protocol stack, and will increase data rate guide from three Mb/s to 24 Mb/s, supporting functions like transferring bulk records files. Together with its Low Energy extension, Bluetooth comprises functions with exceptional statistics rate, energy consumption, and community insurance necessities (Saarika et al., 2016).

Sensium

It offers on-body health monitoring purposes that makes use of ultra-low power consumption. Sensium creates wi-fi hyperlinks to clever phones, for this reason presenting fitness monitoring functions at a practical fee (Wong et al., 2009).

4. Challenges of WBAN

BAN technological know-how is still rising and there are a lot of issues left to solve. Not considering moral troubles like privacy, there are nevertheless masses of technical challenges that we need to overcome before BAN will turn out to be an fine solution. The BAN draft submissions have described options for a lot of the simple wireless community protocols, but there is nevertheless a massive amount of ambiguities and researches need to be accomplished to successfully propagate a signal in and round the human body.

Security

There need to require a Considerable effort to make WBAN transmission impervious and accurate. The patient's database have to make tightly closed and need to no longer mingled with another person's database. The data need to be received from a committed WBAN system. Although

protection is a high priority in most networks, little study has been executed in this place for WBANs. As WBANs are aid restrained in terms of power, memory, conversation charge and computational capability, security solutions proposed for other networks may also not be relevant to WBANs (Mohsen et al., 2015). Signal and Path Performance The sign and direction loss interior the human body is drastically distinctive than the rules.

The rules governing signal and route loss stays the same. Researchers have been able to mannequin a gadget besides sign loss in the course of the human body; on the other hand the greater interesting lookup involves the usage of the human physique as a transmission medium for electrical signals. Marc Wegmueller et al. have attempted to mannequin the conductivity and permittivity of alerts despatched from one region of the body to another (Erik Karulf, 2008).

Interoperability
WBAN systems would have to ensure seamless facts transfer between devices throughout standards such as Bluetooth, Zigbee etc. to promote data exchange, plug and play gadget interaction. Further, the structures should be scalable, ensure environment friendly migration throughout networks and offer uninterrupted connectivity.

Sensor validation
Pervasive sensing units are challenge to inherent conversation and hardware constraints including unreliable wired/wireless community links, interference and limited power reserves. This may additionally result in inaccurate datasets being transmitted returned to the stop user. It is of the utmost importance particularly inside a healthcare domain that all sensor readings are validated. This helps to minimize false alarm technology and to identify viable weaknesses within the hardware and software design (Donoghue et al., 2006).

Usability
Given the close proximity of customers with the BAN technology, the needs on usability are pretty high. Zheng et al. referred to a usability hassle with structures such as Lifeguard and AMON; the technological know-how positioned artificial restrictions on the user, which made adoption extra difficult. Zheng's group decided to use advances in fabric manufacturing to sensing wearable shirts that would actively reveal the wearer (Erik Karulf).

System Devices
The sensors used in WBAN would have to be low on complexity, small in structure factor, light in weight, strength efficient, convenient to use and reconfigurable. Further, the storage units want to facilitate far off storage and viewing of affected person data as properly as access to exterior processing and evaluation equipment with the aid of the Internet.

Invasion of Privacy
People may consider the WBAN technology as a workable danger to freedom, if the functions go past "secure" clinical usage. Social acceptance would be key to this technological know-how discovering a wider application.

Data Consistency
Data residing on a couple of cell gadgets and wireless patient nodes want to be accumulated and analysed in a seamless fashion. Within body region networks, integral affected person datasets may additionally be fragmented over a range of nodes and across a range of networked PCs or Laptops. If a scientific practitioner2 s cell device does not incorporate all recognised statistics then it is unable to take care of affected person (Donoghue et al., 2006).

Interference

The wireless hyperlink used for physique sensors decrease the interference and make bigger the coexistence of sensor node devices with different community devices accessible in the environment. This is specially necessary for large-scale implementation of WBAN structures (Mehmet R Yuce, 2010).

Data Management As BANs generate large volumes of data, the want to manage and maintain these datasets is of utmost significance (John O' Donoghue and John Herbert, 2012). Besides, we additionally have some extra challenges like cost, steady monitoring, constrained deployment, steady performance. The remaining challenge that BAN technology faces is really a trouble of Human-Computer Interaction (HCI) and how to make this technology usable (Erik Karulf, 2015).

5. APPLICATIONS OF WBAN

WBAN functions can be divided into clinical and nonmedical applications. Medical Applications Cardiovascular Diseases: A WBAN is a key technology to prevent the prevalence of sudden coronary heart attacks, video display units episodic activities or any other abnormal condition and can be used for ambulatory health monitoring (Lo and Yang, 2005).

Cancer Detection:

Cancer stays one of the largest threats to the human life. According to National Centre for Health Statistics, about 9 million people had most cancers analysis in 1999 and this number will increase each and every year. A set of miniaturised sensors succesful of monitoring most cancers cells can be seamlessly integrated in WBAN. This approves health practitioner to diagnose tumours (http://www. cdc.gov/nchs/Default. htm).

Asthma:

A WBAN can help thousands and thousands of sufferers suffering from allergies by way of monitoring allergic retailers in the air and by offering real-time comments to the physician. Chu et al proposed a GPS-based device that video display units environmental factors and triggers an alarm in case of detecting information allergic to the patient (Chu et al., 2006)

Non-Medical Applications

Lifestyle and Sports: BANs allow new services and features for wireless body-centric networks along with wearable leisure gadget (e.g., tune entertainment), navigation assist in the auto or whilst walking, museum or metropolis guide, coronary heart charge and overall performance monitoring in sports, baby monitoring, wi-fi cash card (e.g., display of current transactions and checking of balance, etc) (Ragesh and Baskaran, 2012). Military Applications: The opportunities for the use of BANs in the navy are numerous. Some of the navy applications for BANs consist of monitoring health, location, temperature and hydration levels.

A struggle dress uniform integrated with a BAN may also come to be a wearable electronic community that connects devices such as life aid sensors, cameras, RF and non-public PDAs, health monitoring GPS, and transports statistics to and from the soldier's wearable computer. The network ought to perform functions such as chemical detection, identification to forestall casualties from friendly furnace and monitoring of a soldier's physiological condition. Calling for support, his radio sends and receives alerts with an antenna blended into his uniform. As a result, BANs grant new opportunities for battlefield lethality and survivability (Ragesh and Baskaran, 2012).

WBAN for animals: Wireless Body Area Network is an extraordinarily beneficial device. It is deployed for the analysis of a range of contagious diseases in human beings and animals. Initially, animals fitness is to be included which offers us meals in the shape of milk, eggs, meat, eggs etc. The

purpose behind this is that human and animals are interdependent on each some other which is a symbiotic connection. The purposes of WBAN are tabulated in Table1.

Table 2: WBAN Applications [23]

Application Type	Sensor Node	Date Rate	Duty Cycle (per device) %per time	Power Consumption	QOS (Sensitiveto Latency	Privacy
In-body	Glucose Sensor	Few kbps	<1%	Extremely Low	Yes	High
Applications	Pacemaker	Few kbps	<1%	Low	Yes	High
	Endoscope Capsule	>2Mbps	<50%	Low	Yes	Medium
On-body	ECG	3 Kbps	<10%	Low	Yes	High
Medical	SpO2	32 bps	<1%	Low	Yes	High
Applications	Blood Pressure	<10 bps <	<1%	High	Yes	High
On-body	Music for Headsets	1.4 Mbps	High	Relatively High	Yes	Low
Non-Medical	Forgotten Things Monitor	256 Kbps	Medium	Low	No	Low
Applications	Social Networking	<200 Kbps	<1%	Low	No	High

6. CONCLUSION

Wireless Body Area Networks are a very beneficial science which offers a extensive vary of makes use of not only to patients however also to the entire society by way of continuous monitoring. Thus WBANs make sure in enhancing the satisfactory of life. In this paper, we evaluate on wireless body location community architecture, its standards, challenges and applications.

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