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A Review on: Wireless Body Area Network

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Abstract: As the use of wireless networks has grown, so has the need for intrusive / semi-invasive electrical equipment, which has resulted in the growth of Wireless Body Area Networks (WBAN). Underlying health surveillance is provided by WBAN to a client without interfering with regular activities. Because of their ability to track subjects in real time and continuously in various fields, such as tele-health, culture, sports, or weapons training, wireless body area networks (WBANs) are currently gaining popularity. They have particular advantages for the detection and treatment of chronic illnesses. Wireless Body Area Network (WBAN) is a low-power, ultra-short-range wireless technology. There have been various developments that have been successful in satisfying the special needs of WBAN patients for high quality service while promoting WBAN programmes including remote access, biofeedback, and dialysis Choosing the latest technology for a healthcare application is a difficult task due to the large number of tools accessible. Wireless Body Area Network (WBAN) developments, challenges, and design are all covered in detail in this article, as are a variety of WBAN applications. In a WBAN, the sensors, for example, measure the heart rate, the body temperature, or take a lengthier ECG as proof of good cardiac health.. After employing a WBAN, the patient is more mobile and no longer requires hospitalization. In this paper, the theoretical basis of WBANs is addressed.\

Keywords: WSN, WSBN, Sensors Node, Wireless Networks.

1. INTRODUCTION

When people live longer and develop chronic ailments, health care providers and patients alike are looking for better ways to control their health care costs and improve the quality of care they provide. Wireless Body Area Networks (WBANs) are growing in popularity in healthcare because to recent advances in sensor technology, integrated circuits, and wireless communication. Small wireless sensor nodes worn or implanted by patients form the basis of wireless body area networks (WBANs). Using a wireless sensor network, a cluster head or gateway device may connect to one or more local servers to collect physiological signals from the patient, such as body temperature, blood pressure, oxygen levels and ECGs (ECGs). Local servers then aggregate, analyze, and disseminate the data on their own. Low-cost wireless body area networks (WBAN) varies significantly from normal wireless sensor networks in terms of transmission range, data speed, and so on. IEEE 802.15.6, a wireless body area network (WBAN) standard, was developed to solve the WBAN's reduced range and increased interference. For data aggregation and cluster coordination, the WBAN draught standard necessitates a cluster design with a powerful cluster head. WBAN system security, trustworthiness, and reliability issues frequently overshadow the advancements in WBAN technology as a whole. WBANs represent a serious security concern because to their poor processing capacity and computational limitations. Managing keys and performing cryptographic operations consumes a significant amount of computing and electricity. On the other hand, when a system's trusted nodes are compromised, all cryptography-based systems fall apart. These limitations have hampered the broad application of WBAN in healthcare systems due to the risk of compromising life-critical physiological data.

ARCHITECTURE:

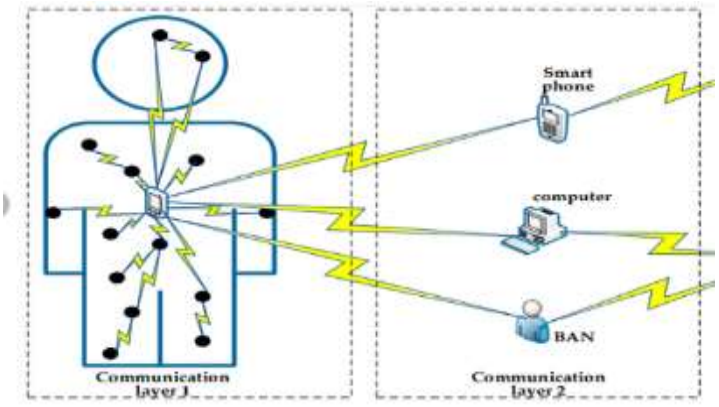

Figure 1: WBAN Architecture

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WBAN is a byproduct of WSN technology that was already in place. Small wireless sensors are carefully placed on the human body to build a wireless body area network. Using this wireless body area network, medical professionals and patients can get real-time input on a range of crucial indications. Different medical sensors in a WBAN keep track of different vital signs, such as temperature, blood pressure, or an ECG. Network coordinator, personal server running on a PDA or PC, and various sensor nodes for tracking body movement and heart activity are all part of the system.

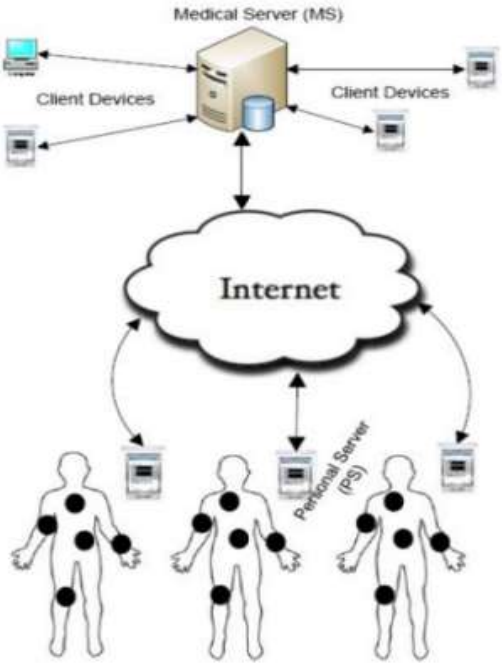

Figure 2: Another form of WBAN Architecture

Information gathered by the medical sensors is sent to the coordinator through cellular network. The sensors are always on and sending data to the coordinator in real time. As a result of this arrangement, all medical sensors require more energy and operate for shorter periods of time. Figure 1 depicts the WBAN architecture, which includes several important elements. Various medical sensors can be used to keep tabs on a variety of vital signs. Figure 2 shows a different implementation of WBAN, in which data is transferred from various nodes across the internet to various customers.

2. LITERATURE REVIEW

Aashima Arya et. All (2014) WBAN is a new and exciting technology that has the potential to transform the way people get healthcare in the future. This research focused on the requirements for a new type of body area network, which uses wireless body area network (WBAN) technology. The authors have discussed a number of the MAC protocols that are employed in WBAN. The use of Wireless Body Area Networks (WBANs) to promote human health and well-being was discussed earlier in the article. They intend to conduct a comparative analysis of several WBAN model models to improve health monitoring. In addition, the optimal model must be simulated using typical parameters in the physical, electrical, and mechanical contexts. [1]

Sana Ullah et. All (2014) WBAN's main components such as traffic classification, in-body antenna design, and MAC protocols were reviewed in this article. For in-body communication, we offered a technical debate on the antenna design and backed a patch antenna. MAC protocol for wireless body area networks was also discussed. Current low-power MAC protocols, we feel, are unable to handle heterogeneous traffic in a reliable manner due to many restrictions. New power-efficient methods are therefore required. Finally, researchers have described some of the potential uses for WBAN technology in the broader healthcare industry. [2]

Geethapriya Thamilarasu et. All (2016) Wireless body area networks (WBANs) present unique security difficulties and threats, which were examined in this paper. Several existing security solutions were examined by the authors, who then categorized them according to their level of security. Through an in-depth examination of these options, they identified both their advantages and disadvantages. During the implementation of a defence mechanism for WBANs, authors explored probable mitigations and design elements that needed to be considered, including viable security solutions for various attacks. The future of cryptography, intrusion detection, and trust-based security solutions research in these networks will be dependent on this combination. [3]

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Hoi-Jun Yoo et. All (2013) The emergence of the u-healthcare era has ushered in a new era of wireless body area networks (WBANs). The WBAN technology has three physical stages, which we summarise in this research (PHYs). The human body communication (HBC) serves as a communication pathway by transmitting an electric signal via the body. Six CMOS HBC transceivers built with a T-shaped body channel model and theoretical channel analysis are demonstrated by the authors, including the world's first WBAN transceiver that satisfies all IEEE 802.15.6 standards. Using the transceiver we developed, we were able to effectively demonstrate an MP3 player and a smart patch system for healthcare and entertainment, respectively. [4]

M. Udin Harun et. All (2015) There is no doubt, after examining all of the test results and previous discussions, the implementation and monitoring of Electromyogram sensors, which are built on top of the e-Health sensors platform with the Arduino Uno, is extremely beneficial for patients who can make use of the applications on their smart phones, is extremely beneficial. Data communication from sensors to mobile devices is quick and error-free with the Roving RN-171 wifi module. Men and women experience different levels of muscle strain to varying degrees. The amount of muscle tension a person experiences varies based on their level of activity. Despite the age difference, the amount of muscular strain observed is unaffected. [5]

Mehmet Rasit Yuce et. All (2013) This research demonstrated the most recent medical signal monitoring body sensor devices. Vital to a patient's life in a medical context is the tracking of physiological data. This means that prior to installing a wireless sensor network in healthcare, safety-related testing and evaluations should be carried out to assure reliable communication. Implementations of body sensor devices and low-power design methodologies have been discussed. A wireless body area network will require tiny and wearable sensor nodes to monitor physiological variables from human bodies. Energy harvesting techniques will be incorporated into the next generation of body sensor nodes to enable self-monitoring and long-term use. [6]

Rim Negraa et. All (2016) The writers of this article examine the most important WBAN applications and underline the QoS needs that go along with them. The goal is to develop wireless technologies that are appropriate for use in these kinds of networks. A list of communication technologies has been provided for this purpose. An suitable WBAN radio technology can be selected depending on a WBAN application's requirements and the level of the architecture at which the WBAN application will be deployed It's possible that energy, latency, and throughput issues will arise in a general WBAN architecture when body sensors talk to the master node. collisions and interferences can readily arise on a shared channel between the master node and one or more access points (APs). WLAN, Bluetooth, Zigbee, cellphone, and 3G are examples of wireless technologies that could be used for inter-BAN communication. [7]

Hiroki Katsuta et. All (2012) Using a UWB BAN system compliant with the proposed MAC standard draught IEEE802.l5.6, experiments were conducted for this article. The experiment was carried out in an anechoic environment with the system devices mounted to the body. When two nodes are connected to a single hub, packets are sent simultaneously. The experiment's findings confirm that data can be transmitted simultaneously across several nodes without latency. Four nodes connected to a single hub simultaneously send packets in the second scene. When the MAC values remained the same as in the previous experiment, no packets were sent. The communication was made possible, however, thanks to a change to the MAC protocol's settings. Since there's a trade-off between CAP slots and CFP slots as a result of this, it's essential to plan for optimal use of CAP slots when sending lots of different kinds of data. [8]

Arturo Fajardo Jaimes et. All (2016) The IEEE 802.15.6 standard for wireless body area networks attracted a lot of attention recently. Reading the literature, it is clear that different authors employ several terminologies to describe the same idea, or that one terminology is used for a number of different ideas. The result is misinformation and the inability to make accurate comparisons across different platforms. Wireless Body Area Networks (WBAN) with an emphasis on applications are presented in this study. We also suggest a comprehensive taxonomy to assist clear up any ambiguity in the current WBAN jargon. The suggested taxonomy allows discussion of WBAN technology to be unified and centralized while still using appropriate language. Additionally, it speeds up the process of searching and indexing the data linked with these technologies, allowing users to save time and grasp the gist of WBAN principles more quickly. [9]

Sang-Hun Han et. All (2011) The off-body WBAN channel was examined and a system model was provided in this paper. WBAN's CM4 varies depending on the angle at which the wireless access point is pointed towards the subject's body. As a result, when a person moves or turns, the channel changes, even though it remains in a degraded form. We recommend putting a receive antenna on the opposite side of the body from the current receive antenna to address this issue. MIMO and diversity systems provide better bit error performance as well as more diversity gain. [10]

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3. DIFFERENCES BETWEEN WBAN AND WSN

	WBAN	WSN
"Deployment"	"The number of sensor nodes deployed by the user are equally important and only added when they are needed for application."	"WSN is often deployed in places that may not be easily accessible by operators which require more nodes to be placed to compensate for node failures."
"Mobility"	"WBAN users may move around. WBAN nodes share the same mobility pattern."	"WSN nodes are usually considered stationary."
"Data Rate"	"WBAN may occur in a more periodic manner and stable data rate."	"WSN is employed for event-based monitoring where events can happen at irregular intervals."

Table: 1 Difference Between WBAN and WSN

4. SECURITY CHALLENGES AND TRADEOFFS IN WBAN

Various security assaults on wireless body area networks are discussed in this section, as well as security solutions that can be utilized to combat these threats.

4.1 Eavesdropping: An attacker in a wireless body area network for medical purposes can passively listen in on the connection between the cluster head (CH) and base station. Although this requires the adversary to be quite close to the victim, an attacker can intercept communication between sensors and the CH. Medical information about the victim is frequently traded in this kind of attack for financial gain. You should consider the possibility that the adversary's purpose is to harm the victim's reputation in public by revealing confidential information.

4.2 Spoofing and Sybil Attack: A spoofing attack, in which the attacker pretends to be someone else, such as a trusted member of the system, is used to disrupt the network. With this attack, several nodes' identities have been stolen and used for malicious purposes. Sybil attacks require the attacker to be within striking reach of the victim, yet isolating the assailant after they have begun can be extremely difficult. The detection rate to replication rate ratio is almost always weak, which makes it difficult to successfully fight this attack. Generally, this is done to make an attacker's presence felt on the network, making it more difficult to reverse an assault and offering platforms for more complex attacks in the future. One or more reliable sources (such feedback on treatment or diagnosis) may appear to be sharing information, but the attacker may be sending false information instead.

4.3 Replay Attacks: Information from a previously sent state is recorded and replayed into the system in order to get credentials or confuse and error in the system in this attack. A malfunctioning sensor node can elude detection by replaying its most recent measurement. Patient safety can be jeopardised in medical scenarios when an enemy sends out old readings within the normal range, making it difficult for medical equipment to identify when levels exceed the normal threshold.

4.4 Denial of Service: This attack's purpose is to prevent legitimate entities from accessing network resources. By sending packets at such a fast pace that it drains the batteries of both the sender and receiver, malicious nodes can restrict bandwidth available for legal data transfer all but to zero. As with sink-hole assaults, this has the same goal of preventing access to vital real-time physiological data. DoS attacks like jamming, in which the attacker transmits obnoxious frequencies on the radio channel, can cause radio communications to be disrupted. Unavailability of the radio channel can jeopardise patients' capacity to send or receive crucial medical information for treatment in a WBAN context.

5. WBAN TECHNOLOGIES

5.1 Bluetooth

Bluetooth12 was created as a short-range wireless communication standard with a focus on security. For as long as the piconet exists, it can serve as the hub for up to seven slave devices, creating an ad hoc network. In a piconet, each device can talk to up to seven other devices at once. Master clock synchronisation is required, as well as hopping in accordance with the master's instructions for slaves. Each device can also be a member of numerous piconets at the same time as they come into radio proximity with other master devices. With Bluetooth, you can connect and communicate with nearly any other Bluetooth-enabled device in the world. Being able to communicate with gadgets without direct line-of-sight contact is a significant feature. There for many different portable data and voice devices can be connected to it. Bluetooth devices reduce interference in the 2.4 GHz ISM band by using a notional hop rate of 1600 hops/sec (Industrial, Scientific, and Medical band).

5.2. Bluetooth Low Energy

Bluetooth Low Energy (BLE) 7 was introduced as a better option for WBAN applications where less power consumption is feasible with low duty cycle operation as a derived option of the Bluetooth standard. Bluetooth Low

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Energy (LE) is a wireless standard for connecting small devices to mobile phones and other portable electronic devices. They aren't the best devices for regular Bluetooth since they consume too much power and cost too much money, but they are perfect for health-monitoring applications. The data rate of Bluetooth Low Energy is projected to be up to 1 Mbps. As opposed to Bluetooth's seconds, synchronization takes only a few milliseconds when using fewer channels for pairing devices. This helps BAN applications that require fast response times, like as alert generating and emergency response, while also saving energy. Wearable sensor nodes and access points can communicate with BLE thanks to its nominal data rate, minimal latency, and low battery consumption (AP).

5.3 Zigbee and 802.15.4

The ZigBee specification describes a widely used wireless network technology called ZigBee 12. Its 128-bit security features, such as message integrity and privacy and authentication for low-data-rate radio-frequency applications, make ZigBee a good choice. Thanks to the sleep mode, ZigBee-enabled devices can run for years on a single set of batteries. ZigBee technology is divided into two components. Network, security, and the layer that executes applications are all defined by the ZigBee alliance. It's important to note that IEEE 802.15.4 has two standards for physical and medium access control layers: one is called CSMA/CA (Carrier Sense Multiple Access with Collision Avoidance), while the other is known as IEEE 802.15.4 ZigBee-based wireless devices make advantage of all three of the available ZigBee frequency bands. As a result, Zigbee's main issue for WBAN applications is interference with wireless local area network (WLAN) transmission, particularly in the 2.4 GHz band where many wireless systems operate.

5.6 Other radio technologies

Other radio technologies, outside those commonly utilized in WBAN application development, can be effective substitutes. Short-range communication systems benefit from the large bandwidth provided by Ultra Wideband (UWB) technology. Because indoor localization in assisted living institutions and hospitals is particularly critical for user localization, UWB is the only form of localization that can be relied upon. However, it is unsuited for wearable applications due to its complexity. Another new standard for wellness and health monitoring apps is the ANT protocol 10. Sensor manufacturers support the ANT protocol, which is a low-speed and low-power one. As a result of Zarlink's low data rate and low frequency, it is well-suited for medical implant applications. Active wireless protocol 12 of Rubee employs magnetic signals to send and receive small data packets (128 bytes) in the local network using long wave magnetic signals. No line-of-sight connectivity is required in order to operate the robot.

6. SIMPLIFIED ARCHITECTURE OF WBAN

6.1 Isolated WBAN:

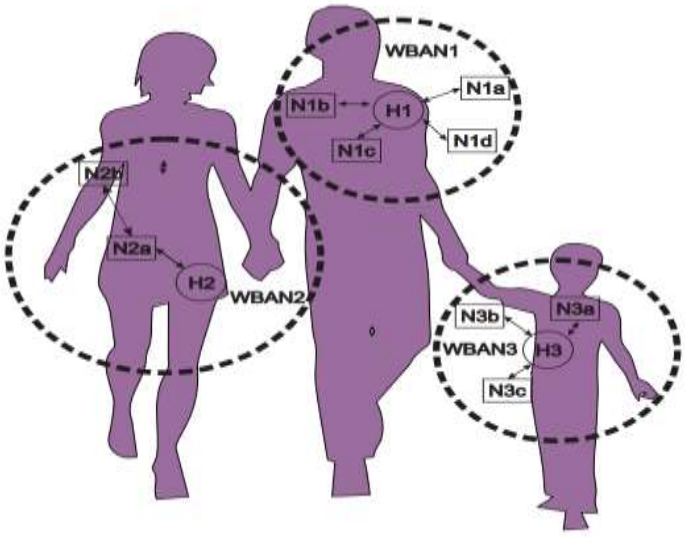

Figure: 3 Simplified architecture of a isolated WBAN

While most wireless sensor networks (WSNs) operate on their own, wireless body area networks (WBANs) rarely do. There are many distinct types of nodes in an isolated wireless mesh network. One-hop and two-hop star topologies with a central node each have their own considerations in the IEEE 802.15.6 standard. Nodes can be categorized as coordinators, end nodes, or relay nodes based on their functionality. To and from end nodes and relay nodes (sensors and actuators), and in dealing with interactions with other users, the coordinator transmits and receives information (i.e. a display or external gateway). It is important to note that end nodes cannot pass messages to coordinator, only relay nodes may. In terms of implementation, the nodes are divided into three categories: implant nodes (located inside the

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body), body surface nodes (0-2 cm out from the body), and exterior nodes (around 2-5 cm away from the body). Several different implementation scenarios for these topologies are presented in the figure above.

6.2 IT solution based in WBAN: As shown in Figure 1, a WBAN-based health monitoring system's overall design may be seen. The general communication process is typically divided into three stages: Tier-1: communication within the WBAN, Tier-2: communication across WBANs, and Tier-3: communication outside the WBAN (Tier-3). Internal WBAN communication occurs at tier-1 between nodes (IEEE 812.15.6). By communicating via these networks (such as the Internet and cell phone networks), WBANs can link to other types of networks that people use regularly. The WBAN coordinator node communicates with one or more WBAN access points. (APs). There are a variety of wireless technologies available for inter-WBAN communication, compared to the nascent technologies used for intra-WBAN communication. As a result, Tier-3 communications should be flexible enough to meet the needs of a wide range of users. An alarm can warn the patient or the doctor via email or short messaging service (SMS) if any irregularities are discovered based on the most recent body signal transmitted to the database. For this example, we require at least 3G.

7. CONCLUSION

WBAN is a new and exciting technology that has the potential to transform the way people get healthcare in the future. In this study, we looked at the current state of Wireless Body Area Network development, with a particular emphasis on the needs of this new technology. For the purposes of this study, wireless body area networks (WBANs) were examined for security problems and assaults. According to the results of our research, there are various types of security solutions now available. A patient's survival depends on the physiological data collected in a medical setting. This means that safety-related testing and evaluations should be performed in advance of implementing a wireless sensor network in healthcare to ensure reliable communication. In the medical industry, the Wireless Body Area Network has emerged as leading software that may give significantly better-time patient care surveillance ways in clinics and mental hospitals, even in their homes. The importance of Wireless Body Area Network in the medical field, as well as the breadth of its applications, have sparked recent attention and made it one of the most closely scrutinized systems in medical facilities. Sensors and actuators can be linked together using the Wireless Body Area Network, a radio frequency-dependent wireless networking software.

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