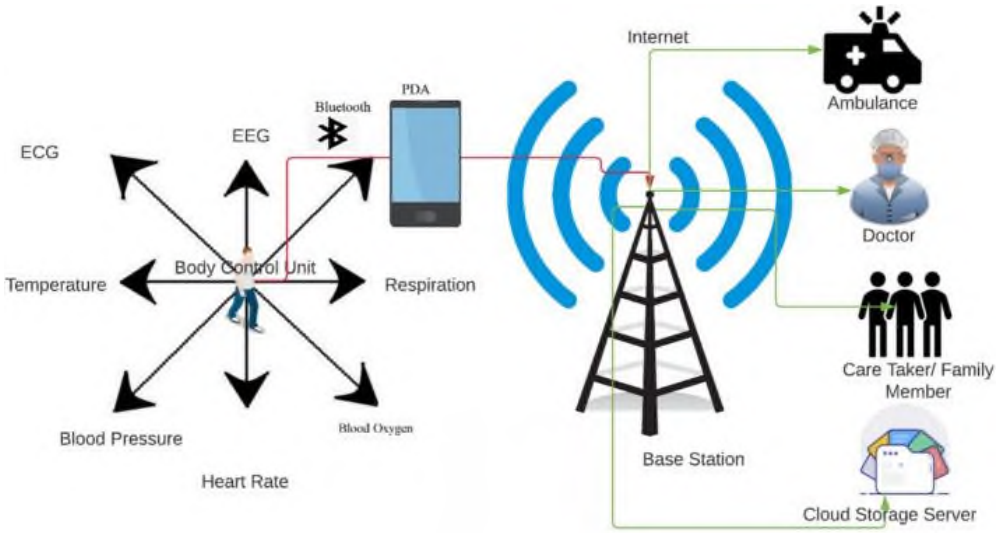
3.5 System security and reliability



Sensor nodes/actuators represent essentially the wireless sensor network, and the sensor node senses acoustic factors including temperature, pressure, sound, pulse rate, ECG, blood pressure, and heart rate of the human body. In healthcare, this form of sensor network is known as a wireless body area network (WBAN)

Wireless body area networks consist of sensors, biological parameters, body control unit, personal device assistant, transmission factor, and user access. Figure shows that the wireless body area network along with the sensor senses the biological factors continuously in order to obtain the human health information from the body control unit. The electrocardiogram (ECG) sensor records the patient's electric impulse as it passes through the heart muscle. This assists in monitoring the patient's heartbeat, which is used to track various movements such as resting and moving. The temperature of the human body's ears, skin, and forehead are detected by the body temperature sensor.

The pressure of blood as it travels through the arteries is measured by blood pressure and the pulse wave is measured by the heart rate sensor as it pumps blood through the patient's body. The saturation level of oxygen in the blood is measured with a pulse oximeter. The airflow sensor can be positioned near the human body's nasal to assess the body's respiration. The collected information will be transferred and stored in the personal device assistants (PDA) and later transmitted to the base station. From the base station, the data will be transferred to

the respective user applications such as cloud databases, ambulances, family members, and doctors via the Internet.

A cloud database's purpose is to store the patient's data on a server so that the doctor can access it and then send the patient's information to the user via the internet. Star topology is used in the body area network. The body control unit acts as a central node and then each sensor will sense and communicate to the center node. The center node interfaces the human body by using Bluetooth or ZigBee or Personal Device Assistants (PDA), and then the patient's information can be accessed by the doctors using the Internet.

Security Issues in WBAN

The purpose of network security is to protect data from threats during data transmission. There are two forms of attacks in network security: active and passive attacks, both of which contribute to the detection of malicious data. An active attack is primarily focused on data and has a significant impact on the system's operation. A passive attack damages or modifies data but does not degrade information resources. The security flaws are applied at various levels. Each layer of the TCP/IP layered architecture generates attacks. IP attacks are introduced in the second layer (logic link control), resulting in address spoofing for incorrect communication. Internet Control Message Protocol (ICMP) attacks is generated in the media access control layer, which results in sniffing and man-in-the-middle attacks. In the third network layer, routing attacks such as blackhole and eavesdropping attacks are created. TCP attacks are originated in the transport layer, resulting in high synchronization flooding in data communication. Application layer attacks are generated in the OSI model's application layer, resulting in authentication issues such as accessing the user's username and password

A denial of service (DoS) attack will restrict data from authorized users and prevent them from accessing their resources. Because of the week password, distributed denial of service (DDoS) attacks is generated. The main difference between a DOS and a DDOS attack is that a DOS attack targets a single host at a time, but a DDoS attack targets numerous hosts simultaneously. These types of attacks will degrade network performance.

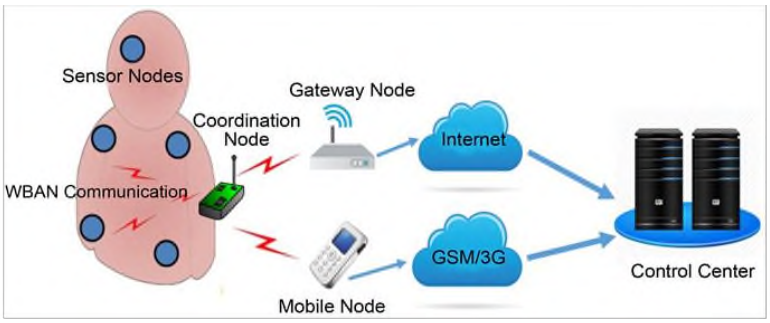
The term "reliability" refers to the fact that health-care practitioners receive monitoring data in a timely and accurate manner. WBAN sensors must be capable of viewing and detecting essential active signs of human health; therefore, reliability is critical. WBAN sensors must be capable of viewing and detecting essential active signs of human health; therefore, reliability is critical

3.6 BAN Architecture

WBAN is designed with special purpose sensor which can autonomously connect with various sensors and appliances, located inside and outside of a human body.

Below Figure demonstrates a simple WBAN architecture where the architecture is divided into several sections. Here we have classified the network architecture into four sections. The first section is the WBAN part which consists of several numbers of sensor nodes. These nodes are cheap and low-power nodes with inertial and physiological sensors, strategically placed on the human body. All the sensors can be used for continuous monitoring of movement, vital parameters like heart rate, ECG, Blood pressure etc. and the surrounding environment. There are vast monitoring systems are being used already based on wired connections. Any wired connection in a monitoring system can be problematic and awkward worn by a person and could restrict his mobility. So, WBAN can be a very effective solution in this area especially in a healthcare system where a patient needs to be monitored continuously and requires mobility.

The next section is the coordination node where the entire sensor nodes will directly connected with a coordination node known as Central Control Unit (CCU). CCU takes the responsibility to collect information from the sensor nodes and to deliver to the next section. For monitoring human body activities



there is no such wireless technology is fixed for targeting WBAN. Most popular wireless technologies used for medical monitoring system are WLAN, WiFi, GSM, 3G, 4G,WPAN (Bluetooth, ZigBee) etc. . Except Cellular network standard all of these technologies are commonly available for short distance communication. WMTS (Wireless

Medical Telemetry Service) and Ultra-Wide Band are another technology that could be used for body monitoring system as they operate in low transmission power.

The third section is the WBAN communication which will act as a gateway to transfer the information to the destination. A mobile node can be a gateway to a remote station to send Mobile Message to a cellular network using GSM/3G/4G. A router or a PC can be a remote node to communicate via email or other service using Ethernet which is shown in Figure.

The last section will be a control center consists of end node devices such as Mobile phone for message, PC for monitoring and email and server for storing the information in the database.

WBAN Requirements and Workflow

Before you begin to format your paper, first write and save the content as a separate text file. Keep your text and graphic files separate until after the text has been formatted and styled. Do not use hard tabs, and limit use of hard returns to only one return at the end of a paragraph. Do not add any kind of pagination anywhere in the paper. Do not number text heads—the template will do that for you.

Requirements for Wireless Medical Sensors in WBAN

Wireless medical sensors should satisfy the following main requirements such as

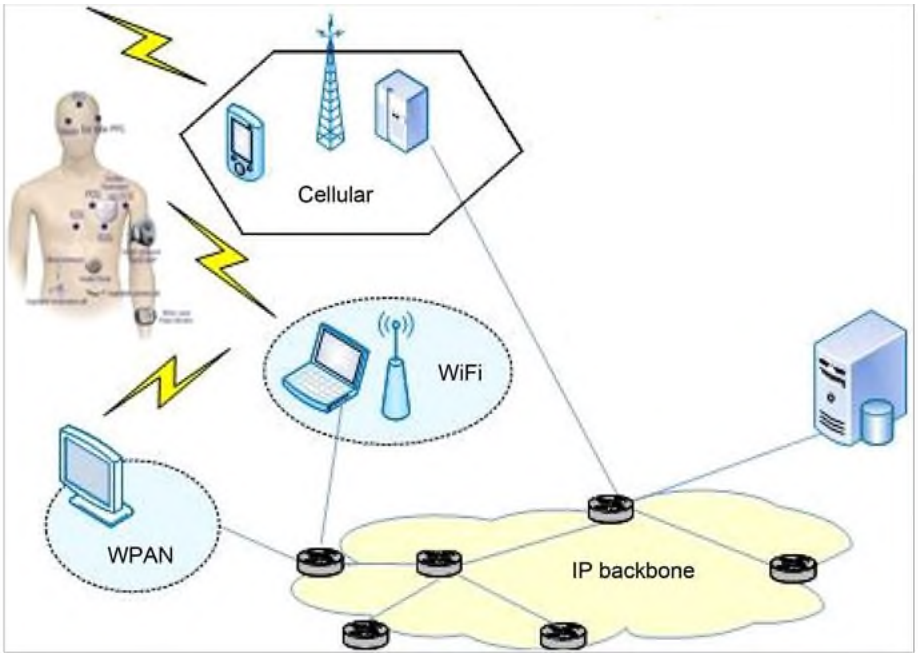


Figure . A Typical WBAN communication.

wearability, reliability, security, and interoperability :

Wearibility: To achieve non-invasive and unobtrusive continuous monitoring Wearibility is a very important issue. These sensors must be lightweight and small. Size and

weight of sensors are mainly determined by the size and weight of batteries . But, a battery's capacity is directly proportional to its size.

Reliability: Reliable communication in WBANs is of paramount importance for any WBAN application. So the designer should target a reliable communication technique which will ensure uninterrupted communication and optimal throughput. A careful trade-off between communication and computation is very crucial for a reliable system design.

Security: Another important issue is the security of the network. All the wireless medical sensors must meet the requirements of privacy and should ensure data integrity and authentication.

Interoperability: Wireless medical sensors should allow users to easily build a robust WBAN. Standards governing that interaction of wireless medical sensors will help vendor competition and eventually lead to more accessible systems .

Monitoring Sensors

Wireless body area network is a system which can continuously monitor a person's activities. Based on the operating environments the monitoring sensors can be classified into two types.

v Wearable sensor devices worked on the human body surface.

v Implantable devices operated inside human body

Wearable sensor devices allow the individual to follow closely the changes in her or his functions and in the surrounding environment and provide feedback for maintaining optimal and instant status. For example ECG, EEG, Blood pressure sensor can be used to monitor a critical patient, GPS sensor can be used to locate an area and different types of sensor that can be used to measure the distance, temperature, movement etc.

To measure heath parameters, implantable sensors are planted in close contact with the skin, and sometimes even inside the human body. Implantable biosensors are an important class of biosensors based on their ability to continuously measure metabolite levels, without the need for person interference and regardless of the person's physiological state (sleep, rest, etc.) . the implantable biosensors have great impact to diabetes and trauma care patients, as well as soldiers in action (military). Figure focuses on the sensor nodes with wireless capabilities.

Traffic Types

In a WBAN traffic can be divided into three categories such as:

v Normal traffic

v Emergency traffic

v On-demand traffic

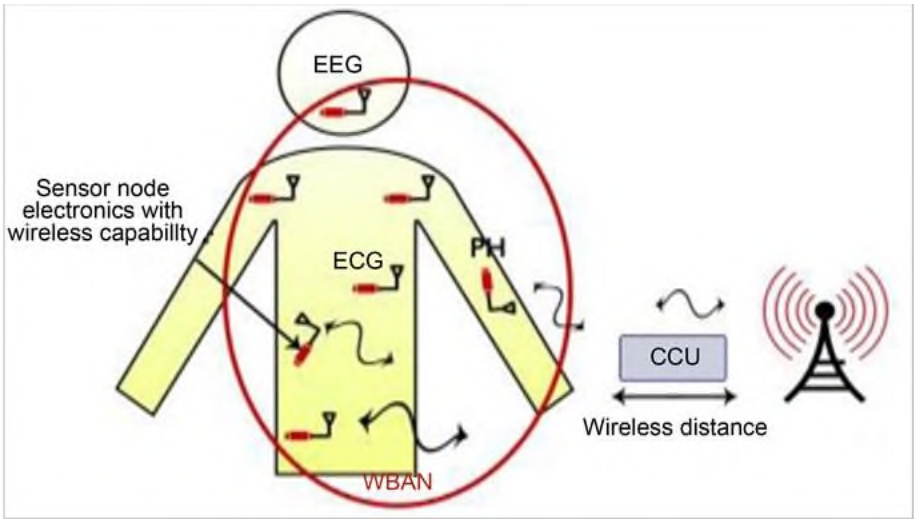


Figure . Sensor nodes in WBAN.

Normal traffic is the data traffic which is used to monitor the normal condition of a person without any criticality and on demand events. Emergency traffic is initiated by nodes when they exceed a predefined threshold or in any emergency situation. Such type of traffic is totally unpredictable.

On-demand traffic is initiated by the authorized personnel like doctor or consultant to acquire certain information for diagnostic purpose .

Work Flow

Figure shows the work flow chart of WBAN. In the flowchart workflow is divided into two sections. First section is the WBAN where all the sensors devices will collect data and process them to the control center. While processing if any error occurs then it will read data again from the sensor and will forward for processing.

The control center will send the data to the desired location. If any problem occurs then it will generate an error where resend option should be needed again.

WBAN Standards and Technologies

As WBAN is a short range wireless networks so different types of wireless short range technologies can be involved in different stages. In this segment we will describe most common technologies such as Bluetooth, ZigBee, WiFi, IEEE 802.15.6 etc. that can be used to deploy WBAN.

Bluetooth

Bluetooth is an IEEE 802.15.1 standard commonly known as WPAN (Wireless Personal Area Network). Bluetooth technology was designed as a short range wireless communication standard, anticipated to form a network with security and low power

consumption. A typical Bluetooth network forms a Piconet where a Bluetooth device works as a master and another seven Bluetooth devices

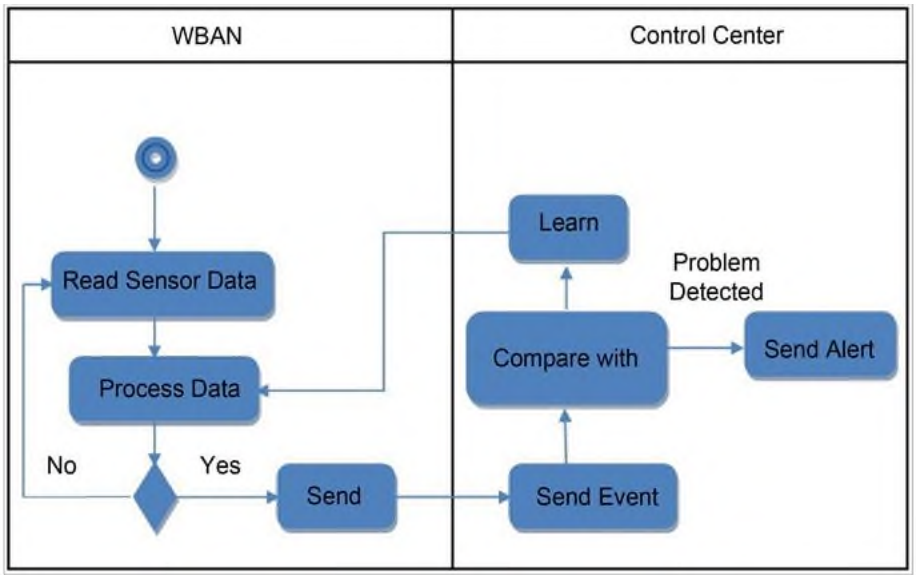


Figure Working flowchart of WBAN.

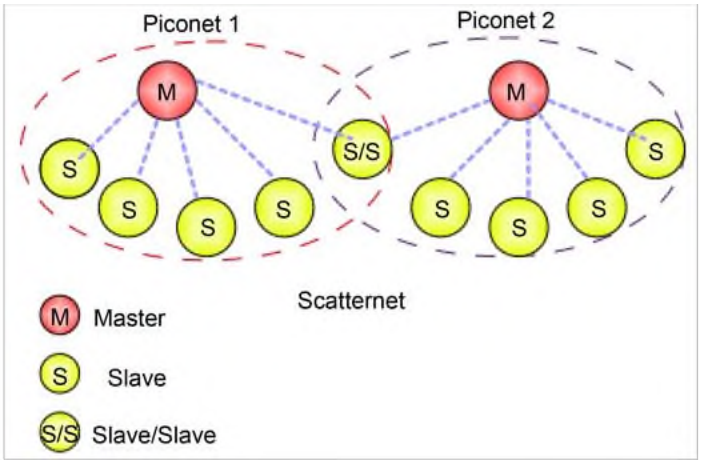
work as slaves which gives each device to communicate with each other simultaneously. Another type of Bluetooth network can be formed with more than one Piconet known as Scatternet. In Scatternet a node of a Piconet (can be a master or a slave) joins as a slave in another Piconet. Figure shows how a Piconet and Scatternet are formed using Bluetooth nodes. Though, the basic Bluetooth protocol does not support relaying but it is possible to join together numerous Piconet into a large Scatternet, and to expand the physical size of the network beyond Bluetooth's limited range using this method.

Bluetooth devices operate in the 2.4 GHz ISM band (Industrial, Scientific and Medical band), utilizing frequency hopping among 79 1 MHz channels at a nominal rate of 1600 hops/sec to avoid interference. It is classified with three classes of devices with coverage ranging from 1 to 100 m and different transmission powers ranging from 1 mW to 100 mW with 3 Mbps data rate. A very key feature of Bluetooth is that all the Bluetooth devices can communication with each other in NLOS condition. Bluetooth is suitable for short distance data transmission applications such as between servers of WBANs or between a WBAN and a personal computer.

ZigBee

ZigBee is an IEEE 802.15.4 standardized solutions for wireless telecommunications designed for sensors and controls, and suitable for use in harsh or isolated conditions. One of the biggest advantages of ZigBee network is its low power consumption. Figure shows a

typical ZigBee network topology which consist of three kinds of devices or nodes such as coordinator, router and end device. One coordinator exists in every ZigBee network. It starts the network and handles management functions as well as data routing functions. End devices are devices that are battery-powered due to their low-power consumption. They are in standby mode most of the time and become active to collect and transmit data.



Bluetooth network.

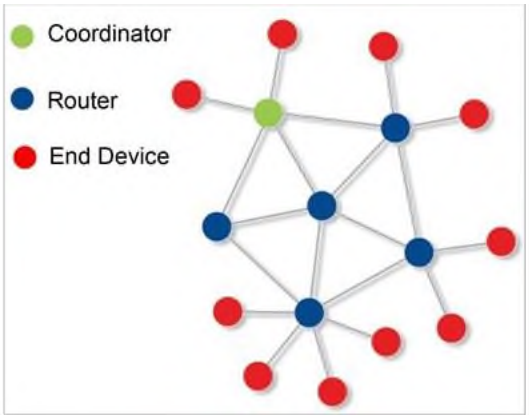


Figure ZigBee network.

Devices such as sensors are configured as end devices. They are connected to the network through the routers. Routers help to carry data across multi-hop ZigBee networks. In some cases ZigBee network topology are formed without routers when the network is point to point and point to multipoint.

ZigBee is aimed at RF applications that require low data rate, long battery lifespan and secure networking. Through the standby mode, ZigBee enabled devices can be operational for several years. ZigBee-based wireless devices operate in three different frequency bands such as 868 MHz, 915 MHz, and 2.4 GHz. Therefore, one substantial drawback of using ZigBee network for WBAN applications is due to interference with wireless local area network (WLAN) transmission, especially at 2.4 GHz. As ZigBee devices operate at low data rate so it

can be unsuitable for large-scale and real time WBAN applications. But, it can be very much suitable for personal use like assisted living, health monitoring, sports, environment etc. within a modest range between 50 - 70 meters

WiFi

WiFi is an IEEE 802.11 standard for wireless local area network (WLAN). Generally WiFi technology comes with four standards (802.11 a/b/g/n) that runs in ISM band 2.4 and 5 GHz with a modest coverage of 100 meter. Wi-Fi permits users to transfer data at broadband speed when connected to an access point (AP) or in ad hoc mode. Fig shows a WiFi network where WiFi sensor nodes and users can transfer data using internet by standard WiFi router. In some modified version, WiFi devices can be used in data acquisition applications that allow a direct communications between the sensors and the smart phones/ PC even without an intermediate router.

WiFi is preferably suitable for large amount of data transfers with high-speed wireless connectivity that allows videoconferencing, voice calls and video streaming. An important advantage is that all smart phones, tablets and laptops have Wi-Fi integrated; however the main disadvantage of this technology is high energy consumption.

IEEE 802.15.6 WBAN

IEEE 802.15.6 is the latest addition in WPAN which is known as WBAN standard that provides various medical and non medical applications and supports communications inside and around the human body. This standard supports communication inside and outside of human body which can be used for different medical and non medical applications such as e-Healthcare monitoring, sports, environment etc.

IEEE 802.15.6 standard is classified by three physical layer standards. Each standard uses different frequency bands for data transmission with data rate 10 Mbps maximum. First one is Narrowband (NB) which operates within the range of 400, 800, 900 MHz and 2.3, 2.4 GHz bands. The Human Body Communication (HBC) is another standard which operates at range of 50 MHz. The Ultra Wideband (UWB) technology operates between 3.1 GHz to 10.6 GHz which supports high bandwidth in short range communication.