

# Review on Wireless Sensor Networks in Human Health Monitoring

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## ABSTRACT

Wireless sensor Network (WSN) is changing into a big facultative technology for a large type of applications. Recent advances in WSN have facilitated the conclusion of pervasive health observation for each homecare and hospital environments. Current technological advances in sensors, power-efficient integrated circuits, and wireless communication have allowed the event of miniature, light-weight, low-cost, And sensible physiological device nodes. These nodes are capable of sensing, processing, and human activity one or additional very important signs. Moreover, they'll be utilized in wireless personal area networks (WPANs) or wireless body device networks (WBSNs) for health observation. Several studies were performed and/or are underneath approach so as to develop versatile, reliable, secure, real-time, and power-efficient WBSNs appropriate for Healthcare applications. To efficiently management and monitor a patient's standing additionally on cut back the value of power and maintenance, IEEE 802.15.4/ZigBee, a communication commonplace for low-power wireless communication, is developed as a brand new economical technology in health watching systems.

**Keywords** - Wireless device Networks (WSNs), Sensor Nodes, Health observation.

## I. INTRODUCTION

Wireless device Network (WSN) may be a set of little, autonomous devices, operating along to resolve different issues. It's a new technology, experiencing true growth for the past decade. research within the field of nanostructures and sensors has brought real opportunities for development of WSNs. individuals have complete that integration of little and low-cost microcontrollers with sensors may end up in production of very helpful devices, which may be

used as an integral a part of the device nets. These devices are referred to as device nodes.

Nodes are ready to communicate each other over different protocols. Studies, within the field of communication protocols for wireless device networks, are significantly fascinating, and accept numerous network topologies. Issues, addressed by communication among nodes, include power management, knowledge transfer, quality patterns, etc. am fond of it was mentioned before, and WSNs gift new technology. History of this idea begins at University of California (UC), Berkley, with sensible mud project that was funded by Defense Advanced research projects Agency (DARPA) [1]. The aim of this project was to develop self-organized, millimeter-scale hardware platform for distributed WSNs. Primary, this was a military application that resulted in development of comparatively large detector nodes. Later shrinking method brought abundant smaller devices, with solid sensing and communication capabilities. One in all the key points within the history of wireless device networks was the implementation of energy-efficient software package platform, Tiny OS, software, additionally developed at UC. more development result in implementation of various software package platforms for WSNs. device nets are employed in agriculture, ecology, tourism, however medication is that the area wherever they definitely meet the best potential.

## II. REVIEW OF WIRELESS device NETWORKS IN HEALTH MONITORING:

In this section some specific applications that are developed or being researched for the health watching purpose are mentioned.

In MobiCare a Wireless Physiological measuring System as a MobiCare shopper and health care servers employs short-range Bluetooth between Body device

Network(BSN) and a BSN manager, and GPRS/UMTS (General Packet Radio Service/ Universal Mobile Telecommunications System) cellular networks between the BSN manager and health care suppliers. Bluetooth is applied during this system, permitting rate up to 1Mbps. However, it consumes high power and has restricted network size (up to seven slave nodes). Thus, it doesn't suit for LR-WPAN (Low-rate WPAN) PRN in several care applications. Firefly may be a device network-based rescue device employed in mine as developed at Carnegie Mellon University. Voice streaming over WSN is enforced during this system. A TDMA primarily based network planning is investigated to fulfill audio timing needs. The developed hardware contains a twin radio design for electronic communication and hardware primarily based international time synchronization. This technique is meant for the rescue in mine and contains a little network size. It uses the codec chip and South Dakota card for extra memory for sound transmission. It's high power consumption, high value of a sensor node, and bulky size.

The CodeBlue projected from Harvard University explores WSN for a spread of medical applications. It employs WSN in emergency treatment, hospitals And country as an emergency message delivery system. With transparent substance notes, CodeBlue uses pulse oximetry and ECG (ECG) sensors to observe and record blood range and cardiac data from an oversized number of patients. Lee et al. [2006] introduced an important sign watching system with life emergency event detection using WSN. Very important signs like electrocardiogram and blood heat of patient's are transmitted wirelessly to the bottom station connected to a server or PDA (Personnel Digital Assistant). Dagtas given a framework for a wireless health watching system among a wise home atmosphere using ZigBee. They designed some basic process platform that enables the center rate and fatal failure detection. They're presently building an example of the projected system using in-home electrocardiogram probes and ZigBee radio modules. In a wireless physiological device system, meant to develop wireless device technology for ambulant and implantable human psychophysiological applications. They need developed the devices for watching the center, prosthetic joints for an extended amount of your time and alternative organs.

They projected the reliable knowledge transmission of physiological health knowledge during a ZigBee primarily based health watching system. They developed an articulation, chest belt, shoulder, and necklace kind physiological signal devices. They use

a CC2430 microcontroller because the central unit and 2 PDMS (Polydimethylsiloxane) electrodes for electrocardiogram, a ribbon kind temperature device, and SpO2 device for sensing the physiological signals. Their wrist kind physiological signal device's (W-PSD) size is of 60x65x15 millimeter and total system weight is 160g together with one Lithium-polymer battery. A reliable knowledge mechanism is additionally provided by employing a retransmission. They acknowledge the ability downside for a network device. It wants little battery as its power supply. It will work for six hours while not replacement or recharging. It's little, light-weight weight, and straightforward to bring, however its life time from little battery ought to be improved. Chien and Tai [2006] projected an example moveable system to live phonocardiography (PCG), ECG, and blood heat. They insert a capacitor-type electro-acoustic transducer into the stethoscope's tube for PCG and develop a 3-wired lead electrocardiogram. Bluetooth transceiver and receiver modules are used with a microcontroller and PDA for wireless link between a sensing module and personal digital assistant. This technique has some weak points as a health watching system. First, users ought to initiate the PDA whenever they require to live health conditions. Therefore this technique isn't operated mechanically or in an incident driven or schedulable approach. Second, this technique has several sizable external circuits, wired leads for electrocardiogram, and memory unit. It's not appropriate as a wearable device and therefore tough to hold, due to its serious weight and hulking size. Third, due to their difficult and lots of external devices, power consumption is high. Hence, it's limitation from the viewpoints of wireless health watching. Microsoft declared the Health Gear, a wearable period health watching system. It consists of many physiological sensors for watching and analyzing the blood O level (SpO2), heart rate, signal. Developed an internal organ watching system, Human++, for ambulant health watching of multi-parameters like electrocardiogram, electroencephalography (EEG), and diagnostic procedure (EMG). This technique consists of 3 device nodes in body space networks and a base station. They sample the bio-signal at 1024 Hertz with a 12-bit ADC in AN MSP430F149 microcontroller. The bottom station collects the information from every device node and transfers to computer or personal digital assistant through a USB interface. This technique is meant to run autonomously for three months on 2 AA batteries. A small, light-weight and low-power WPMS platform is developed for ambulant and continuous watching for involuntary responses in real world applications. The Human++

UniNode uses AN MSP 430 MCU, Nordic nRF24L01 a pair of 4 gigacycle per second radio, fifty Ohm antenna, and an a hundred sixty five mAh lithium-ion battery. The scale of a node together with battery is 20x29x9 mm<sup>3</sup>. Their topology may be a star network employing a static TDMA protocol. Their wearable medical sensors are developed into the chest-belt and wrist-band varieties. The electrocardiogram and respiration sensors (20x22x4 mm<sup>3</sup>) are connected to at least one Human++ UniNode and integrated into a chest belt, whereas the skin electrical phenomenon and skin temperature sensors (20x25x5 mm<sup>3</sup>) are connected to a second Human++ UniNode and integrated into an articulation radiocarpea band. The chest node consumes a pair of 6 mA fully active operation, whereas the articulation radiocarpea node consumes four mA, leading to a roughly battery life of sixty three hours and forty one hours, severally. Given a wearable electrocardiogram device for continuous watching. The hand-held device, that may be a common personal digital assistant, collects the amplified electrocardiogram signal from a wearable device. The device senses electrocardiogram signals with five hundred Hertz frequency, and this signal is digitized with ten bit resolution. Once digitizing the signal, it endlessly transmits to a hand-held device by employing a modulated RF link at 869.700 MHz. this technique has targeted its application on the emergency scenario. Given WPMS-based patient watching. This BSN follows a star network technology, and consists of 2 forms of modules. A little device (34x48mm<sup>2</sup>), referred to as device communication module (SCM) is connected to at least one or many sensors for sensing the health signals. SCMs transmit signals to a central process unit (73x110x25mm<sup>3</sup>), referred to as personal processing unit (PDPU) via ZigBee. PDPU is meant to attach to native external systems through: 1) UWB to attach individual devices like PCs or PDA, 2) Wi-Fi to attach with local area network, or 3) GPRS for WAN.

The development of a belt-type wearable wireless body space network is delineate in [Wang, et al., 2009]. A photoplethysmograph (PPG) device and a metastasis inductive measuring instrument (RIP) device for heart rate and O saturation measurements are used for dynamic respiration watching. A WPMS node includes AN MSP430F149 microcontroller as its main management unit, nRF905 as RF transceiver (915MHz), and sixty four unit of measurement AT25DF641 as external memory. They follow a straightforward communication protocol. Its overall method is incredibly easy, i.e., one device to at least one base station at a time. Milankovic et al. [2006] projected a single-hop WSN topology. Every device

for health watching is directly connected to a personal personal digital assistant that provides the property to a central server. They principally concentrate on the synchronization and energy potency problems on the single-hop communication network between network devices and personal digital assistant. A wireless mobile care application is developed to control along with IEEE 802.15.4 enabled devices and adopted the CDMA cellular network for hospital and residential environments [Yan and Chung, 2007]. Research Issues a number of aspects ought to be thought of once developing a miniature wireless device and network for a true life health observance system.

#### A. Reliability

Reliability in a very wireless health observance system is that the foremost vital issue. Wireless health observance systems got to be compelled to accurately transmit measured info in a very timely manner to a medical doctor or folks for observance and analyzing the data from patients.

The reliability issue is also thought of in three main stages:

- 1) Reliable information measure,
- 2) Reliable info communications, and
- 3) Reliable info analysis.

Stages one and three area unit mainly regarding hardware and package for sensing and analyzing the knowledge whereas not errors. Stage a try of wishes extra thought than the alternative stages as a results of it's regarding communication between a tool node and organizer or central observance server. For reliable communication, planned combined wireless networks that embody WSN, ad-hoc wireless networks, cellular networks, WLAN, and satellite networks created a reliable info transmission by using a retransmission protocol. A tool device sends the knowledge with ACK (Acknowledgement) request. If the device node doesn't receive associate ACK from a mobile device or organizer at intervals AckWaitDuration, it transmits an analogous info frame another time till it receives the ACK from the mobile device. This continuation methodology is restricted by predefined MaxFrame-Retries.

#### B. Power

The power issue is researched for all types of WSN applications. Since most WSN devices area unit battery-operated, one in all the foremost challenges for his or her style is to optimize their power usage. Some WSN applications like passive RFID (Radio Frequency Identification) [RFID book of facts, 2003], don't need battery. Instead they use power from their reader, i.e., backscattering. However, they need restricted communication vary and might carry



terribly little size information solely. Alternative applications adopt energy harvest systems for WSNs like cell, vibration using electricity devices [Roundy and Wright, 2004], temperature distinction [Stark, 2006], and shoes insert. However these energy harvest systems have some issues for real WSN applications, e.g., their power earning depends on their setting and that they tend to be over-sized. Conferred energy economical protocols for WSN by coming up with energy-efficient mack protocols. Planned to manage standby or sleep mode periods of device nodes to cut back energy consumption. They propose Mack protocol operations supported 3 main communication processes. A link institution method is to associate a method to a network. A wakeup service method is to come to life a slave and master once an allotted sleep interval. Associate alarm method operates only a slave node desperately needs to send information to the master. These processes may be initiated by the master node solely.

*C. portability*

Integration of sensing parts into a wireless device node ought to be conducted in a very useful, robust, small, light-weight, and inexpensive means. For this reason, most PANs use a tiny low chip system, i.e., SOC, which incorporates a microcontroller associated RF transceiver or single MCU with an external transceiver. Currently, there are some medicine systems that suit the wants of easy-to-wear or attach on the body for observance physiological signals [Barth, et al., 2009; Jung. et al., 2008]. So they exhibit sensible movability.

*D. Network Interference*

In general, a wireless link is additional sensitive to interference than a wired one. In WSN environments, typically 2 or additional completely different communication techniques area unit used along in a very same network. Usually, WPANs and WLANs exist using a similar Industrial, Science and Medical (ISM) band. Therefore, they'll cause a network interference drawback. Network interference or information collision issues cause intermittent network property, packet loss and ultimately end in lower network output and raised energy expenditures. The interference and existence issues between Bluetooth and WiFi are conferred in. Interference issues between IEEE 802.15.4/ZigBee and {wlan|wireless local area network|WLAN|wireless fidelity|WiFi|local area network|LAN} are delineate in. BER (Bit Error Rate), PER (Packet Error Rate), RSSI (Radio Signal Strength Indicator), or SINR (Signal Interference Noise Ratio) for interference rejection area unit measured and analyzed. Planned

interference prediction algorithms to explore the impacts of wireless local area network and microwave oven on ZigBee communications supported observations of the packet error rate.

*E. Real Time and Continuous observation*

Some physiological information, like heart beat sound, lung sound, ECG, and RIP, ought to be monitored endlessly and in real time. Also, a biomedical device is speculated to operate for days, sometimes, weeks while not a user's intervention. A decent example may be a heartbeat observance system for a patient who has cardiovascular disease. Since the guts rate is according sporadically, a heartbeat sensing device ought to be forever on and transmit endlessly with low transmit delay and latency for real time observance. If a sensing device may transmit periodic information discontinuously or transmit continuous information with abundant delay time, it's onerous for doctors to watch and prepare a patient's attack. Therefore, period and continuous observance is essential in handling an essential patient.

**III. SUMMARY OF WIRELESS SENSOR NETWORKS**

*A. Basic parts in Wireless device Nodes:*

A WSN is outlined as a network of wireless devices, known as nodes that sense given objects or entities and communicate the detected information through wireless links. The information is transmitted via one hop or multi-hops, to a base station or PDA/cell phone, which may be connected to alternative networks, e.g., Internet. A wireless device node consists of 1 or additional sensors for sensing physical variables, main process unit (a microcontroller or low-power overwhelming processor), analog-digital converter (ADC), non-volatile storage, and RF transceiver. It typically has restricted power supply.

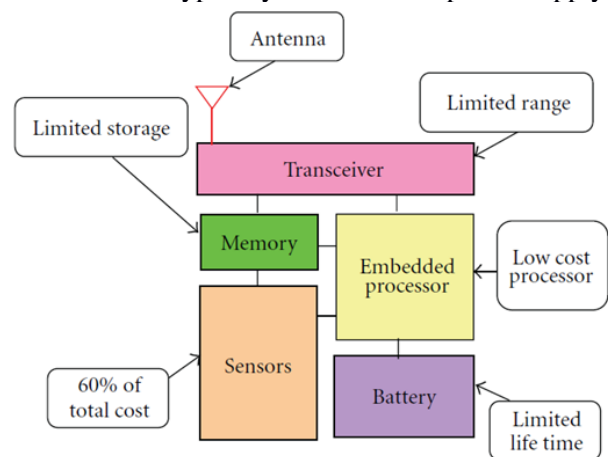


Figure 1: A basic setup of a sensor node [4]

Figure 1 presents basic components of a typical wireless sensor node. Most WSN nodes use an 8051 microcontroller as their main processing unit because of its low cost and low-power consumption as well as their limited size [7]. Some systems use the SOC (system-on-chip) such as CC2430 that includes ADC, flash memory, and RF transceiver. Because of the small size of SOC, one can develop a small and low power-consuming sensor node. But its limitations are the low quality of ADC and small memory size. Also, some sensor nodes are developed by using a micro controller unit (MCU) such as MSP430F1611 or Atmel with external RF transceiver. Other developers use MCU with external ADC or external extra flash memory to achieve higher quality of service.

*Wireless Sensor Network in Health Monitoring*

A wireless physiological information monitoring system uses a radio channel to send period of time vital sign information from wearable medicine sensing element devices to a coordinator. Patients will wear wireless devices that sense physiological conditions and send the perceived information to their doctors in real-time.

Wireless health monitoring systems have many benefits compared to wired healthcare instrumentation. First, patients no longer waste waiting time to satisfy their doctor. Moreover, the use of wireless attention systems outside the hospital helps to avoid wasting the healthcare price for care providers. Also, it permits several patients to figure whereas they're still under their doctor's care. Second, such systems will alert any medical emergency if specific very important signs amendment drastically, e.g., rate is on the far side the norm. A heart attack is the death of cardiac muscle from the sudden blockage of a coronary artery by a blood. If blood flow isn't renovated to the heart muscle within 20 million Americans suffer a heart attack annually. Four-hundredth of them die as a results of their coronary failure. As a result of coronary failure suddenly happens to old people or patients, their continuous and period of time observation of heart rates will definitely facilitate save their lives. Currently, most heart beat monitors, e.g., electrocardiography (ECG), are out there at certain locations solely, e.g., hospitals and doctor's offices. They need many wired electrodes on the skin of a patient. Medical professionals usually use stethoscopes to ascertain the guts beat sound of a patient. Sadly, these have essential limitation in heart beat observation. As mentioned before, it's extremely desired to watch heart beat unendingly for sudden coronary failure. However, it's nearly not possible with the present

wired medical instrumentality. Clearly, wireless health observation systems carry several blessings compared to the present wired attention instrumentality. Figure 2. Shows a typical wireless sensing element network for attention applications. during this network, the information collected by the sensing element nodes square measure transmitted mistreatment an RF channel to the bottom station, organizer or PDA/cell phone, that is connected to alternative networks via wired or wireless affiliation. The complete network is controlled and monitored by a server in real-time. Depending on an application, varied transmission techniques are used for wireless communication like Wi-Fi, Bluetooth, ZigBee, UWB, and cellular networks.

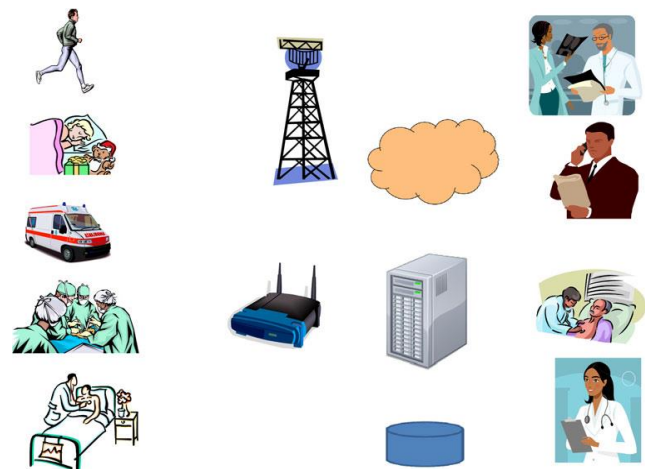


Fig. 2 Typical architecture of wireless sensor networks in healthcare applications [6]

*1. Technologies for WSN in Health Monitoring*

In this section 3 wireless customary technologies, i.e., IEEE 802.15.1 (Bluetooth), IEEE 802.15.4 (ZigBee), and IEEE 802.15.3a (UWB) for PAN, and one IEEE 802.11 a/b/g (Wi-Fi) as wlana network|WLAN|wireless fidelity|WiFi|local area network|LAN} are shortly reviewed for his or her applications in wireless health observance systems. WSN have interaction tiny, low-power overwhelming devices for aggregation medical knowledge. Their nodes sense and collect information then communicate to an arranger or a far off observance device, i.e., PDA, cell phone, or PAN arranger directly using wireless information transfer technology. The PAN coordinator has large-size memory and quick processors to research and present given information. The physical radio layer defines the operational frequency, modulation theme, network rate, and hardware interface among nodes and between a node and also the central server. Counting on different medical objectives. ZigBee IEEE 802.15.4 and ZigBee are standard-based

protocols that give the network infrastructure needed for WSN applications. 802.15.4 itself defines the physical and mackintosh layers, whereas ZigBee defines the network and application layers. They'll be wont to develop low rate, low complexness, low power consumption, and low price WSNs. The physical layer (PHY) supports 3 radio bands, 2.4GHz ism band (global) with sixteen channels, 915MHz belief band (Americas) with ten channels, and 868MHz band (Europe) with one channel. The info rates are 250kbps at 2.4GHz, 40kbps at 915MHz, and 20kbps at 868MHz. The mackintosh layer controls the access to the radio channel by exploitation the Carrier Sense Multiple Access with Collision turning away (CSMA/CA) mechanism. The IEEE 802.15.4 PHY uses direct sequence unfold spectrum cryptography to reduce packet loss because of noise and interference. Also, it supports 2 PHY layer modulation choices. The 868/915 MHz PHY adopts binary section shift keying modulation, whereas the 2.4 GHz PHY uses offset quadrature phase shift keying. A ZigBee defines 3 varieties of devices: coordinator (MAC Full perform Device-FFD), Router (MAC FFD), and end device (MAC Reduced perform Device- RFD). An FFD will function a network organizer or regular device. It will communicate with the other devices. AN RFD is meant for applications that are easy, such as a Light switch or easy device. It will communicate solely with FFD. A ZigBee organizer could be a base station node that mechanically initiates the composition of the network and controls the network method. It desires an outsized memory and high process power. A ZigBee Router is additionally AN FFD that links teams along and supports multi-hopping for packet transmission. It will connect with al-ternative routers and end-devices. ZigBee finish devices will solely communicate with an FFD. It's restricted practicality. In theory, ZigBee will support up to sixty five, 536 nodes. For security, it uses 128-bit advanced coding commonplace (AES) coding and authentication. The transmission vary is from 10m to 75m, counting on an application's power output and environmental options. Some, ZigBee devices area unit expected to possess electric battery life starting from many months to years.

## 2. Bluetooth

Bluetooth, additionally known as IEEE 802.15.1, may be a low value, low power wireless radio frequency commonplace for short-distance communication. The Bluetooth protocol stack is somewhat sophisticated compared with alternative IEEE networking stacks. It defines several parts above the PHY and mac layers. Some are nonmandatory, thereby complicating its

overall protocol. Bluetooth operates within the unlicensed 2.4 GHz ism band, occupying seventy nine channels. The PHY layer uses frequency hopping unfold spectrum writing to reduce interference and attenuation. The most rate is up to 3Mbps within the enhanced rate mode.

However, the particular knowledge payload is sometimes reduced thanks to completely different units' address and alternative header info to ensure the compatibility among all Bluetooth sensing element nodes. Bluetooth's basic property technology is that the piconet supported a star topology. It consists of 1 master device that communicates directly with up to seven Active slave network devices. In a given piconet, all devices are synchronal using the clock and frequency hopping pattern of the master, and slave devices communicate solely with their master within the matched method. Bluetooth has 3 power saving modes. At the hold mode, devices simply method reserved slots for synchronous links. At the moment they enter the sleep standing. At the sniff mode, a tool is within the sleep mode for many of the time. It wakes up periodically in a given time for communication. At the put mode, the device simply holds the put slave broadcast (PSB) link and turns off the other links to the master device. If the latter would really like to awaken put devices, it sends beacons to them over the PSB link A slave device at the active mode will reduce the power consumption by coming into the higher than power saving modes.

## 3. Ultra Wide Band (UWB)

UWB (IEEE 802.15.3a) could be a wireless radio technology for short-range, high-bandwidth communication at terribly low energy levels by using a larger portion of the radio-frequency spectrum. UWB May be a latent challenger to the IEEE 802.11 standards. One of its most eminent properties is its large bandwidth. Wireless USB presently delivers an information measure of up to 480 Mbps at three meters and 110Mbps at ten meters. It will support transmission applications like audio and video transmission in home networks. It may also be used as a wireless cable replacement of high speed serial bus like USB a pair of.0 and IEEE. However, IEEE 802.11 is more intended for information networking like WLAN and to replace LAN cables. Currently, Bluetooth is common for tiny PAN-covering space applications, like wireless mouse and cellular phone set. However UWB supports a lot of higher information measure than Bluetooth. It uses terribly powerless, short-pulse radio signals to transfer information over a good spectrum of frequencies.



#### 4. LAN (WIFI)

Wi-Fi (wireless fidelity) is that the general term for any variety of IEEE 802.11 network. Samples of 802.11 networks are the 802.11a (up to fifty four Mbps), 802.11b (up to eleven Mbps), and 802.11g (up to 54 Mbps). These networks are used as WLANs. Three 802.11 standards dissent in their offered information measure, coverage, security support and, therefore, applications. 802.11a is best fitted to transmission voice, video and large-image applications in densely inhabited user environments. However, it provides comparatively shorter vary than 802.11b does, that consequently needs fewer access points for the coverage of huge areas. The 802.11g customary is compatible with and will replace 802.11b, partially because of its higher information measure and improved security.

Even if they'll monitor the health conditions, they can't be without delay accessible for real world applications. They use differ wireless technologies for his or her different health parameters, situation, and areas. As an example, some little information like body temperature and patient ID are communicated by IEEE 802.15.4/ZigBee, even if this normal has low rate. Also, these styles of information aren't a lot of tormented by time synchronization in real time. However some physiological information like EKG, EEG, and EMG, would like continuous and time period transmission. Also, they need high rate for reliable transmission. As such, every application on a health watching system has got to contemplate or improve their weak points for real-life use.

#### IV. CONCLUSION AND FUTURE SCOPE

The WSN research community has done an admirable job of addressing some of the limitations that currently exist for health care related applications. Proposals have mostly focused on the deployment of tiny wearable medical sensors, while others have developed infrastructures for monitoring individual patients during daily activity, at home, or at a hospital. In this paper, we review the state-of-the-art in wireless sensor network research and highlight the gaps between the existing technologies and the needs of a Health Care Wireless Sensor Network. In future scope we can continue with WMSN (Wireless Medical Sensor Networks) and we can collect any medical data or signal from the remote patient and preprocess it and transmit it to the remote medical center.

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