

Sensor Environment and Internet of Things (IoT) with Patterns on Medical Domain and Health Sector

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Abstract

The concept of the Internet of things has developed due to the integration of various innovations, real-time analytics, artificial intelligence, product sensors, and embedded devices. Traditional areas of embedded devices, wireless sensor networks, control systems, robotics (including home and building automation), and others all lead to enabling the Internet of things. In the consumer industry, IoT technology is more popular with items pertaining to the idea of the "smart home", including devices and appliances (such as lighting fixtures, thermostats, home monitoring systems and cameras, and other home appliances) that support one or more typical ecosystems, and can be regulated by devices associated with that ecosystem, such as smartphones and smart speakers. IoT may also be found in hospital systems. There are a range of serious concerns about dangers in the growth of IoT, particularly in the areas of privacy and

protection, and subsequently industry and governmental moves to resolve these concerns have begun including the establishment of international standards.

Keywords : Wireless Technologies, Quantum Computing, IoT, Internet of Things, Medical Domain and IoT

Introduction

The modern age is surrounded by immense computers and gadgets connected with each other utilising high performance technology. Such form of technology loaded entity communication is viewed under the aegis of Internet of Things (IoT) (IoT). A variety of applications are utilising IoT focused networking as it is linked to protection equipments, smart towns, smart workplaces, highway patrolling, smart toll collections, company communications, satellite televisions, traffic networks or interconnected web cams for social security. IoT is often recognised and synonymous with other concepts as Universal Computing (UbiComp), Widespread Computing or Ambient Computing in which number of computers and artefacts are digitally linked for remote control and decision making [1, 2].

I.T connected to almost all factors of human life directly and indirectly. Along with the development of Human life it also contributes in life saving medical sector. In health sector, it electronically records all medical data which is easily accessible and transferable. This transferred data is easily available to all concerns. Thus Medical solutions become more convenient, perfect and easy. It reduces medical error and workload. It also provides quick decision making and cost saving [3, 4].

The 21st century has seen a drastic change and improvement in the health care industry with the involvement of wireless medical sensor networks in health care applications.

Before a few decades, wireless sensors were just some kind of prototypes and were seen in movies. With the advancement of technology, it has become a reality now (Rajasekaran, Kumaran, Premnath&Karthik, 2013).The ageing population of the world is ever increasing and therefore, there is a need of system which could monitor the health of such population. Although the ageing population signifies, a human success story of increased longevity, the steady and sustained growth of older population poses some health challenges.

As the number of people entering the older age increases, there also increases a risk of developing certain chronic and debilitating diseases. For instance, Alzheimer disease symptoms typically appear after age 60, heart diseases and stroke rate rises after age 65 etc. for this reason, it is very important to monitor the status of the health of such ageing population(Wijesekera, 2011).There is a desperate need of independent life and good quality of care without disturbing the comforts. Thus, there is a need of wireless sensor technology that could provide highly useful tools for such people in order to monitor their health [5, 6].

Health care using wireless technology or wireless sensor networks is an exciting and growing field for scientific investigation. In fact, the future of modern healthcare will demand the continuous and ubiquitous monitoring of health. This will lead to minimum or least interaction of doctors and patients. The wireless sensor networks can be wearable, implantable or portable, and integrated on different kinds of wireless communication notes. Generic wireless sensor networks are automatic and standalone which are deployed at a large scale. It is deployed either in a fixed or distributed manner. The data rates of such sensor networks depend specifically on the applications [7, 8, 9].

The health care monitoring system with the help of wireless sensors or wireless technology will ensure better and smooth monitoring of the patient as the status of health is updated earlier than any other means. Everything in the human body and status of the critical organs can be checked in no time even from a remote location. The advancement of Wireless medical sensor networks in health care applications have made patient monitoring more feasible. Several wireless healthcare researches and projects have been proposed (Tague, 2009). These researches aim to provide continuous patient monitoring, in-ambulatory, in-clinic, and open environment monitoring [10].

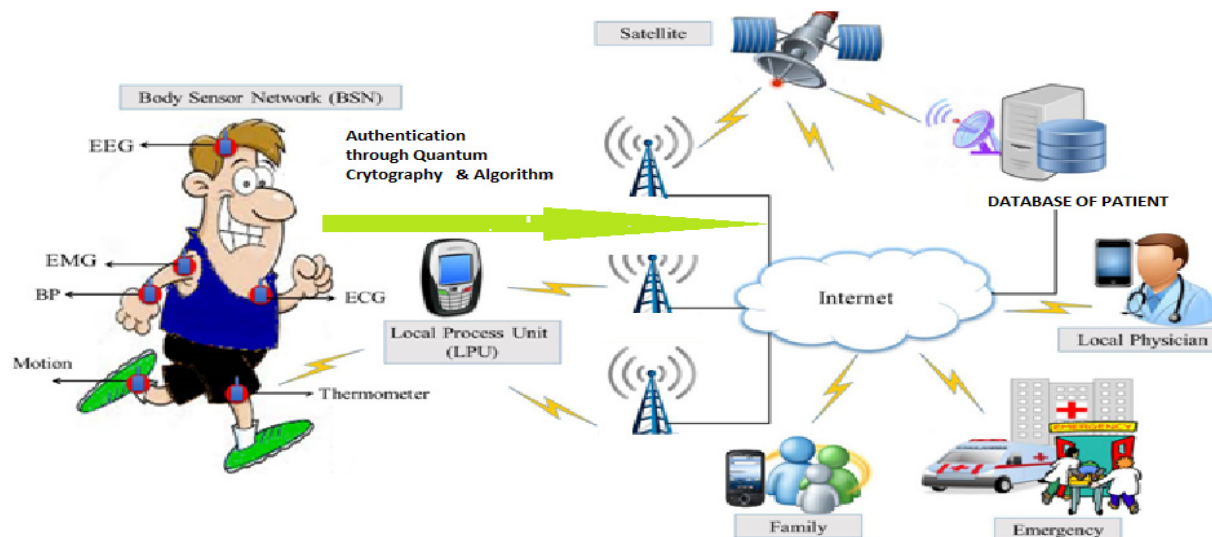


Figure 1: Body Sensor Networks and Medical Perspectives

In today digital revolutionary epoch, Wireless Networks are increasing widespread like coffee shops, offices, hospitals, airports, hotels, universities and other public places. Today, It is the prime mean of communication. Its high speed information exchange quality and portability is the basic reason behind its popularity and fame. Generally, when someone is connected to Wireless Network and sends information through internet application than it is easy for someone to intrude in the network and access the information. Wireless Network generates a large amount of data, which often is more sensitive and vulnerable than wired networks. This may increase the probability of data loss. There are many ways to keep data secure and safe. Encryption technique is very famous technique to keep the integrity and safety of data in the wireless network. In this the data is converted in code form which is not understandable by people. This data is sent to source to destination in coded form. The destination end convert this encoded data again into its original form and access it according to its requirement. In this research proposal, the advance data encryption technique is used to make the data secure and safe. The Quantum key distribution by using quantum cryptography is a new and advance approach which is used in this research proposal to achieve the absolute confidentiality of data at every node. In this research proposal, data is converted into its quantum form and sent to source to destination at specific angle, speed and time. All properties of a photon is noted and send to its destination end which will help to decoded it [11]. A secure quantum channel is also used in this data communication to make data safe from vulnerable attacks.

In the olden time communication is done through Ethernet cable. It covers a long area and used to connect the several people placed at different places. Along with the changing of time, new inventions in technology are made the human life more convenient. Wireless network are very similar with Ethernet communication but in this

no physical means such as Ethernet cable are used. It provides the user with great mobility, convenience and inexpensive. Wireless network is a broadcast service where the data is sent to all possible directions within a limited range in air here but not by cables. Wireless networks consist of four basic components: Transmission of data using air waves, Access points (AP) to establish a connection to the public or private (organization) network and the wireless client operated by the user [12].

Body sensors are placed on the human body from where the sensors send the data to the medical station for diagnosis and monitoring the health conditions. The Code Blue framework presented by V. Shnayder shows a decentralized integrated MWSN for use as body sensor which collect the body data and send all vital information data to the medical center.

This framework use to collect data with pulse oxi-meter, two-lead electrocardiogram, and a specialized motion-analysis sensor. It uses such routing protocol which is able to communicate with patient in very remote location with appropriate medical facility. But CodeBlue framework defeat in the field of security and data protection. After this to ensure the data confidentiality and integrity a new Ping-Pong encryption algorithm is introduced with MAC protocol.

Waluyo have innovated a centralized framework that has a personal digital assistant (PDA) with powerful computing sensor devices. It has additional feature of data collection and control which is developed on TinyOS on the sensors with a Java framework on the PDA. They have applied the SkipJack encryption algorithm to their communication to ensure confidentiality. There is no method of Authentication and Key Agreement (AKA) as they have a single pre-distributed key for all devices [13].

A new innovation in home network for human health monitoring is proposed by Singh which use a stationary camera, a PDA, body sensors, and home health controller system. It will send the patient's information over the internet to the medical unit. This technique uses an Encrypted Key Exchange (EKE) protocol for key distribution with a Key Distribution Center (KDC) to reduce the impact of losing the data in the network.

Diffie-Hellman based EKE (DH-EKE) use a session key. It uses few resources than Elliptic Curve Cryptography (ECC). User enters a password into the PDA. This password is encrypted and uses the DH-EKE to authenticate the PDA against the cameras. Every camera authenticates the data and PDA has sent the secure information and authenticates the body sensor.

Review of Classical Work and Associated Dimensions

Human life is considered most precious in the world. Innumerable efforts have been made to develop the existence of human life in various ways around the world. In the era of modern technology, due to various innovations in the medical sector, the average life cycle of humans has also increased. The medical sector and information technology have been added and as a result patient is kept under medical observation by 24 hours but without keeping the patient in the hospital. From time to time, different software, applications have been made using different types of protocols, techniques in Wireless Body Sensor Networks, which we will study in this chapter.

Health Care Monitoring System

Today, the health care application is struggling with various daily diseases. The situation becomes more painful due to unhealthy lifestyle, stress and non physical

activities. The World Health Organization depicts that old people, who are frequently suffer from chronic disease, require a highly effective and efficient provision of care. According to the National Broadband Plan (2015) by the Federal Communications Commission (FCC), the use of remote patient monitoring under IOT technology will save the healthcare industry \$700 billion over 15 to 20 years. In current's time, serious diseases like obesity, diabetes and heart disease in the youth have become common issue. Various applications have been developed for continuous monitoring of fitness for patient convenience and health but these applications should be inexpensive, simple and completely equipped. In these E-Health applications, doctor's consultation is done by recording the pulse rate, respiration rate, blood pressure etc. through sensors, connecting the patient monitoring health care application.

The current famous technologies like cell phones, laptops, Wi-Fi, Bluetooth, Personal digital assistants (PDAs) and radio frequency identification (RFID) are deployed the healthcare application. Along with these applications various sensors are also attached to the body for regular monitoring of the patient. This data is calculated by the health care professionals. The doctor is immediately informed when the reading of pulse rate etc. are improper/ change in order to get the immediate medical assistance. In the continuous development of these applications, slowly, different features were added to the same machine.

Health Monitoring has capability to continuous reduce lifecycle costs, safe useful life of a structure, reduce insurance costs, decrease the requirement for expensive maintenance, and rectify the complete failure of the monitored structure. It is very difficult to be used by poor people. Some portable real-time wireless health monitoring system also gives an automatic triggered accurate output which is used for remote

monitoring of patients' pulse rate and oxygen saturation in blood. All these applications were available only in hospitals. Providing medical facility to the patient in a comfortable environment of his home was still a major problem. Along with this, It is also very important that application should be simple, cheap, effective and secure from outer attacks. Leaking data related to the patient's health can prove to be a big loss for the patient. Due to all these reasons, the need for a secure home based health care monitoring system was felt.

Evolution of Wireless Body Sensor Network in Health Care

Wireless Technology is connecting with large number of people directly or indirectly throughout the world and playing a important role in their lives. This Wireless technology ensure to increase the speed and range of networks with also encourage wireless computing to large number of people and expanding the power of these networks to accommodate video and other bandwidth intensive applications. The wireless communication and telecommunication bring a fundamental change in integrated networks. Wireless sensor network is a inexpensive way to be connected to the internet via satellites. In this way, its range has reached many countries, regions. This has greatly increased average life span and health in many developed countries. The factors associated with the Wireless Body Area Network minimize the cost, battery, power consumption, security and communication [14].

The main concept behind the Wireless sensor Network is to remove all cables to the patients and to make patient comfortable. Wireless Sensors are designed in a way that they can wear and implanted easily in the body. Wireless sensors are very commonly used in health care monitoring systems and medical fields. These wireless sensors are become very popular in order to continuous monitoring of patient's physical condition on

predefined parameters. As we know that the population of world is continuously increasing and its need to increase the better life expectancy and mortality rate. Wireless Sensor Network specially help chronically ill people as providing continuous medical monitoring, memory enhancement, secure medical data transfer and immediate communication with the healthcare provider in emergency situations in homely environment. Wireless sensor networks provide remotely access the physical condition's signals without interrupting the patient normal life, as well it helps to increase freedom and the quality of life.

Wireless Body Area Network (WBAN) consists of several inexpensive, lightweight, miniature sensors which could be located on the different part of body as tiny smart patches, integrated in to clothing, beneath the skin or integrated deeply in to the body tissues. A WBAN consists of multiple sensor nodes, each capable of sampling, processing, and communicating one or more vital signs (heart rate, blood pressure, oxygen saturation, activity) or environmental parameters (location, temperature, humidity, light). WBAN monitor and analyses the physiological signals and transmit these signals to special medical servers without affecting the daily routine of the patient. Patients continuously transfer the observed data to personal server of health care system which is further use according to requirement like medical database or emergency service over the internet. Special types of algorithms are also used on the health care system to make it secure and add on patient specific recommendations. The main function of the WBAN is to real-time monitoring of patients, diagnosis, and timely drug delivery with asset tracking of goods on the move.

According to Elliott, Pearson & Troxel, (2003), Wireless Body Sensor Network is the technology which is used by to identify the health conditions of the individuals. It is a type of communication technology which is used to provide report for the health status

about an patient to the medical team. In the support of Elliott, Pearson & Troxel, (2003), Zeng, (2017) also clear the situation by explaining that WBSN is playing a vital role in the healthcare sectors. It provides several benefits to the patients and doctors. It is not necessary for the doctors that they have to intrude through the patient's body for the implantation of pacemakers and other medical devices. This can be easily done through by the wireless medical devices.

In contrast, Ouafaa, Mustapha, Salah-ddine & Said (2017) says that reliability and security risks should be on top priority in these medical devices. It is because there has many possibility of leaking the sensitive information through wireless network. Moreover, it also need many legal directives and security requirements. In addition to this, it is compulsion to trust on the existing proposed technologies and services. WBSN processed the information which mainly impacts the people's lives and privacy. After the analysing the views Ouafaa, Mustapha, Salah-ddine & Said (2017), Kamble & Jog (2017) has depicted three factors that need to be considered in WBSN such as authentication, integrity and confidentiality.

With this technology, Health Care Department can easily and effectively monitor the complete health status of the patient. Many other secure technologies have been included in WBSN to make it safe and effective like elliptic curve, Quantum Cryptography etc. Along with this, many latest and convenient protocols and algorithms have also been made to protect the data from external threats. It is identified that healthcare department is the field, where Wireless Sensor Network can be used to understand overall conditions of the patients in effective manner. According to Long and Lin, (2017), healthcare department has introduced multicast scheme in which, user can evaluate the authentic behaviour of each node.

Quality of Care has been given special attention by the help of the WBSN via wide range of health care application. WBSN is specially working on monitoring in hospitals as well monitoring of elderly ill people, Sportsman, Mass Casualty Disasters people in homely environment [15].

Code Blue

It is a sensor network which is based on medical research project and is being developed at Harvard Network Sensor Lab. It is used in deployment for disaster response and rehabilitation of stroke patient. Pulse Oxi-meter, EMG, SPO2 sensor board on the Mica 2 motes are placed on the patient's body. The nodes in these sensors collect Heart rate, ECG data and oxygen saturation. The data collected is relayed over a wireless network to a number of receiving devices or end user device. Medical professionals received the query and act in order to cure the problem. A Tiny ADMR (Adaptive Demand Driven Multicast Routing Protocol) is used as a routing protocol. RF based localization is used for the accurate location of a patient and medical professional position.

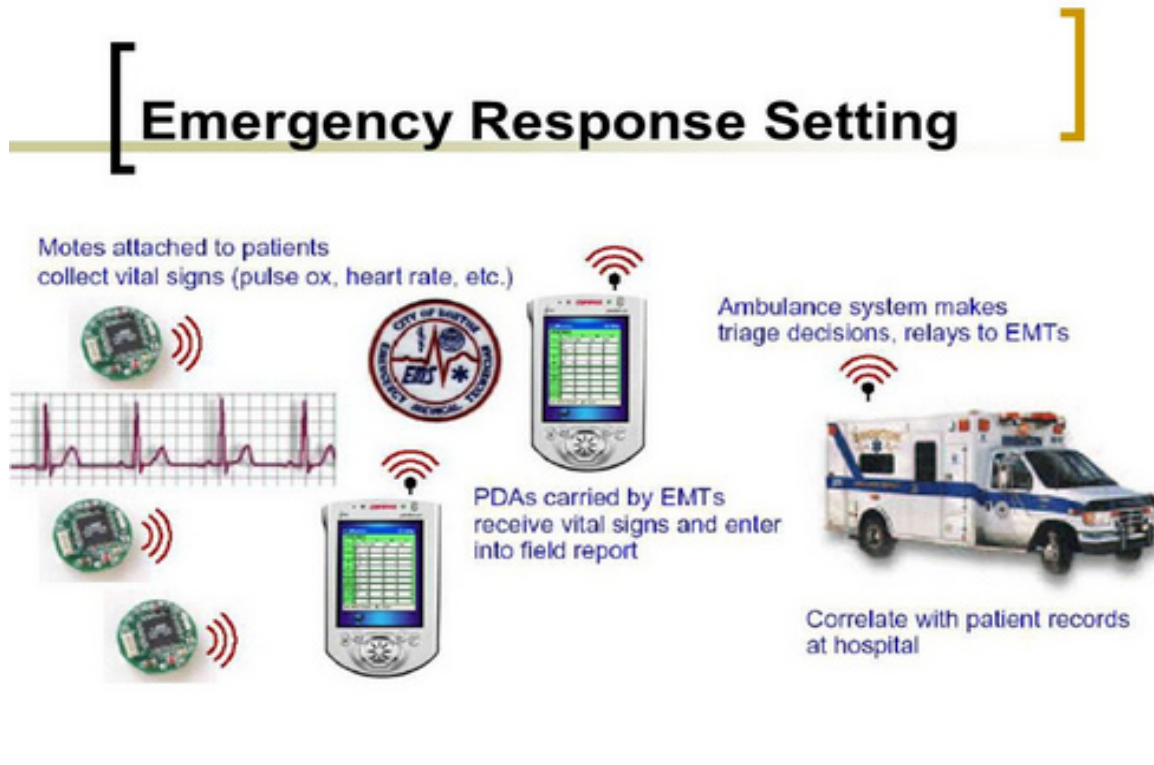


Figure 2: Emergency Response Setting

Code Blue also has some drawbacks. There is a strong possibility of security attacks like denial of service attack, snooping attack, Modification of data, Routing Loop Attack, Grey Hole attack etc. The data of the patient can be manipulated at the receiving devices by intruders or unauthorized users. The confidential information of the patient's health can also be leaked and such data can be used to manipulate things.

ALARM-NET

This technology is mainly designed by the University of Virginia and it is used for the monitoring of patient health in the medical assisted living and homely environment. Alarm Net consist of human wearable sensors. It is mainly based on the three tier

architecture. In the First tier, patient wears the sensor like ECG, Accelerometer, SpO2 etc. These sensors observed the data and send it to medical centre with the multi hop communication and shortest path routing protocol to the alarm gate. In the second Tier environmental sensors are deployed to sense the environmental conditions like dust, light, humidity, motion, temperature etc. of the patient. In the third tier Internet Protocol is used for authentication. This IP network is closely associated with star-gate gateway called Alarm Gate. For a real time single-shot query, the sensors sample the requested data and respond a single report to the query originator, and appropriate action should be taken accordingly. This technology is enabled with Link Layer for security as well it is also uses Advanced Encryption System (AES Algorithm) for cryptographic security features.

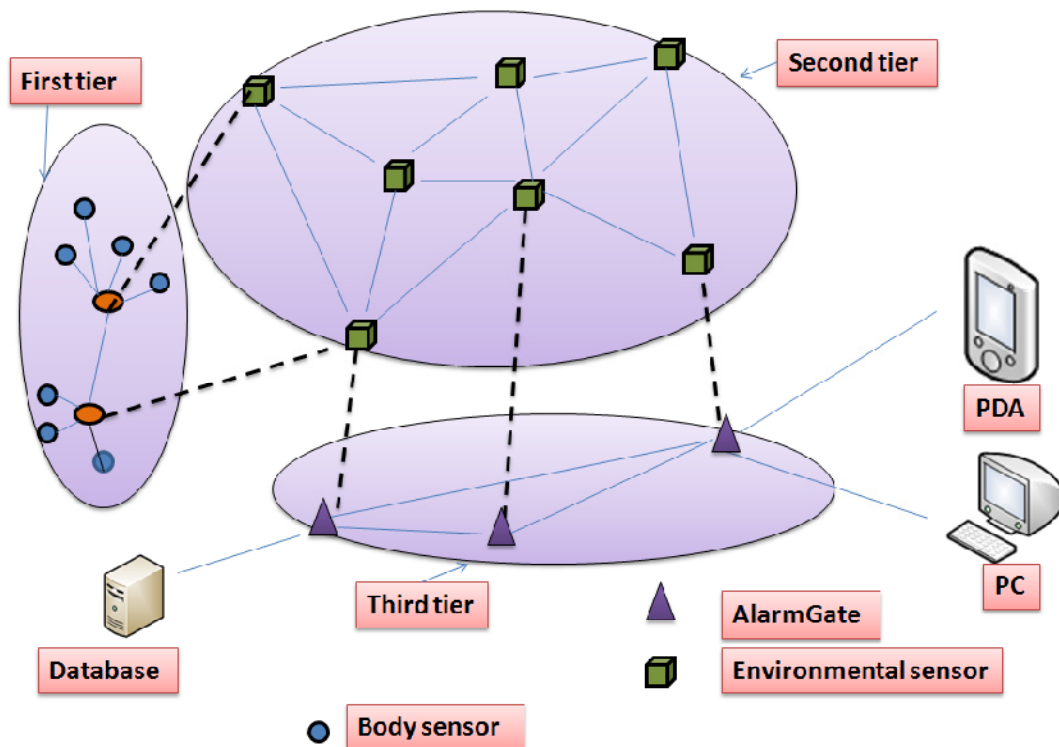


Figure 3 : Assorted Aspects with Sensor Environment

The main demerit of Alarm Net is that it does not offer AES based decryption by which means the encrypted data cannot be accessed by an intermediary node during communication. The hardware based built-in cryptosystem makes the application highly platform dependent. Alarm Net is susceptible to adversarial confidentiality attacks, which can leak resident's location.

UbiMon

UbiMon (Ubiquitous Monitoring Environment) . It is a Body Sensor Network made of wearable and implantable sensors using an ad-hoc network. It is mainly used to continuous monitoring of the patient's physical condition. It collects the physical state like normal condition as well as abnormal/ threat is detected of the patient and transmits it to medical center.

Obviously it is a good ubiquitous healthcare monitoring architecture, but still security is a major concern. It is widely accepted that without considering security for such applications they are often vulnerable to security attacks like denial of service attack, Modification of data etc.

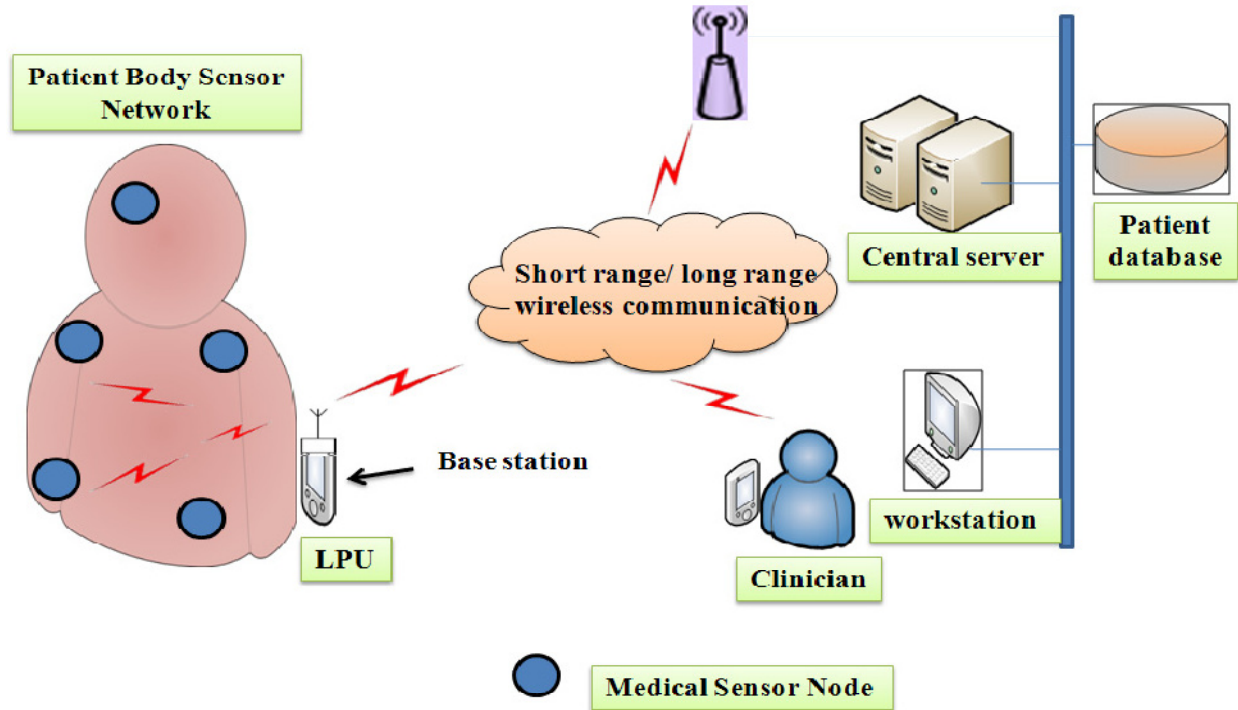


Figure 4 : UbiMon

MobiCare

It (MobiCare) potentially improves the quality-of-patient care and saving many lives. Mobicare consists of body sensor network (BSN) having wearable sensors like ECG, SpO2, and blood oxygen. A BSN manager called "MobiCare client that is MobiCare server. The medical sensors timely sense the patient's body data and broadcast it to the MobiCare client. The MobiCare client aggregates the body data and sends them using GPRS/UMTS or CDMA cellular link to the MobiCare server. MobiCare client uses application layer standard HTTP POST protocol for sending patient's data via BSN data to the MobiCare server.

Chakravorty addressing security issues are not sufficient for real-time healthcare applications. In fact author suggested that the wireless application protocol (WAP), which is based on wireless transport layer security (WTLS) protocol could be used to provide the patient privacy, data integrity and authentication. Thus, security and privacy is still not implemented in MobiCare healthcare monitoring system.

MEDiSN

MEDiSN is designed at Johns Hopkins University for monitoring of the patients during disaster. It monitors and collects the physiological data of patients by multiple monitors called PM's and sensors which are equipped with patient to collect the health information. These Monitors are battery powered motes. The PMs are mobile, temporarily storing sensed data and transmitting it (after encrypting and signing the sensed data) to the relay points (RPs). MEDiSN incorporates different stationary RPs that are self-organized into a bidirectional routing tree, and forwards PM data to the gateways and vice versa. The RPs uses a collection tree routing protocol (CTP) for reliable routing and forwarding their measurements to the gateway. MEDiSN uses back end database to stores the patient's data and present it to authenticated GUI clients.

Conclusion

A new and sought-after set of skills, distinct IT Architectures and newness of corporate strategies requires a different way of thinking. The technology also has immediate security implications. In the light of data privacy responsibilities and challenges, safety is a field of particular importance for the healthcare sector. In the field of health, as in other industries, it can be possible to combine quantum computers with conventional computers, which alone cannot provide substantial advantages. As a result, a race to

quantum applications has now taken place. The next three key potential cases of quantum use are central to the ongoing transformation of the healthcare industry:

1. Diagnostic assistance: early, accurate and effective diagnosis of patients
2. Medical accuracy: maintain the health of people based on personalised treatments
3. Pricing: Pricing and improved insurance premiums.

One of the most anticipated developments for the military is the introduction of quantum technologies, although it is impossible to foresee the extent of their influence. There is little dispute that if used on a big basis, they would be disruptive to the economy. During the month of May in 2018, Intel, the Chief Executive Officer of Quantum Computing, said that a universal quantum computer will completely revolutionise the world like a microprocessor did for the first time. Intel claims that. It is unknown, however, to what extent the conventional balance of power between states or between state and non-state actors would be changed by quantum technology.

Quantum sensing is a lever of quantic mechanics for improving basic precision and enabling novel sensor systems or modalities. The incorporation of these new capabilities would give military gains that would be readily apparent. The UK Committee of the Advocacy Science Experts recognised that submerged objects, like as submarines, might be detectable by gravimeters to increase sensor gravities (quantum gravitations). Magnetometers that utilise quantum technology may also be utilised to find sous-marines. Using the quantum radar, even planes with low observation ability may be found. Scientists predict fresh militarily disruptive technologies, such as advanced communications or radar modalities, to appear in the future. As miniatureaturization advancements are made for atomic clocks, quantum technology already plays a role in this process.

In the first stages of development, quantum computing will most likely result in a variety of additional applications, while it is impossible to foresee which specific innovations will be made or which types of friendly forces or opponents will be used at this time. Conventional computer techniques based on microchips and transistors will not be totally replaced by quantum computing. When seen as an alternative, complementary, and even synergistic technology, quantum computing should be seen as an equal, if not superior, solution to certain issues that contemporary computers are unable to address.

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