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Individual Case Study - Scholarship

Wireless Body Area Network

A review of *wireless body area network*

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Abstract — **The acceleration of development of information and communication technologies in the past few year has simplify the daily life of human in all aspect. Most of all, the technologies of information and communication also have involved in the healthcare services. For instance, one of the vital services provide by the technologies is doctor can observe the situation of patient remotely and giving advance to him without meeting physically. As the technology able smaller the size of body sensor, the advantage of it give the flexibility of install body sensor whether in a way of in, on or off the body of patients. These body sensors able to send the physiological data to the serve. This is called as Wireless Body Area Network (WBAN) technology. This article will elaborate the current engineering of WBAN, the application and limitation of current WBAN technology. Finally, this article also pointing out the direction for the future research about WBAN which the new technologies such as Software Defined Networking (SDN) and Blockchain.**

Keywords : Wireless Body Area Network, Machine-to-Machine communication system, Software Defined Networking, Blockchain.

I. INTRODUCTION

The gigantic evolution of wireless communication technologies has made impact in our society in all aspects. It is unavoidable for the health sector to get in touch with the benefit bring by this advancement since now is the generation of Big data and Internet of Things (IoT). There is some health service become available by utilizing various type of communication technologies such as fitness monitoring, measurement of calorie and electronic health monitoring although these health services are not available in the past. To enable monitoring the health data of human dan post processing of it, WBAN is considered as the first choice among the most potential communication technologies application and this leads to the increasing demand of the WBAN [1]. By mean of internet, WBAN connects the services such as medical center and hospital etc. In health sector, the characteristic of WBAN which exchange the various sensory data among all the participating nodes, this type of communication is classified as machine-to-machine (M2M) communication system. M2M communication system has applied in different fields like smart metering, health, security, automotive, transportation, and energy etc.M2M communication system is predicted to be the future major market driver. With the advance development in healthcare service, patient with physical mobility difficulty such as patient with chronic diseases, they are no longer forced to stay at hospital with continuously monitoring. There is a significantly reduce of the necessary of hospitalization because of the advance development in health sector [2]. Now the electronic processes and communication able to support the healthcare system, which is knowns as eHealth. Other than that, there is another term, mobile health (mHealth) which indicate the healthcare service with the ability of being mobile. In the model of the mHealth and telemedicine, it uses the WBAN technology. In WBAN, body sensors are embedded into the patient's body or installed on the body. Example of wireless technologies in short-range which is Bluetooth, WiFi and ZigBee are used to connect those health-related sensors. Data from the sensors can be collected by electronic device such as Personal Digital Assistant (PDA) or mobile phone and the information will be forward to the remote online server. With the help of medical software applications, the processing and analysis of the data will be takes place at the remote online server.

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II. FINDINGS OF WBAN

A. M2M communication

This section of article will be more emphasize on explanation of how does M2M communication system work. As a new coming technology, M2M communication formed by two devices which is self-organizing of interconnecting device and autonomous device. With this technology, we able to control the device remotely while we are monitoring the device [3]. The characteristic of M2M that being able to be remote monitoring that make M2M communication system can be used in various fields such as transportation, security and surveillance, energy management, smart metering, health care and industrial automation. Within of these fields, the future major of M2M market driver will be the healthcare field.

Figure 1 shows a simple structure application of healthcare in M2M communication system. There are three main domains of M2M communication architecture has been proposed by the European Telecommunications Standards Institute (ETSI).
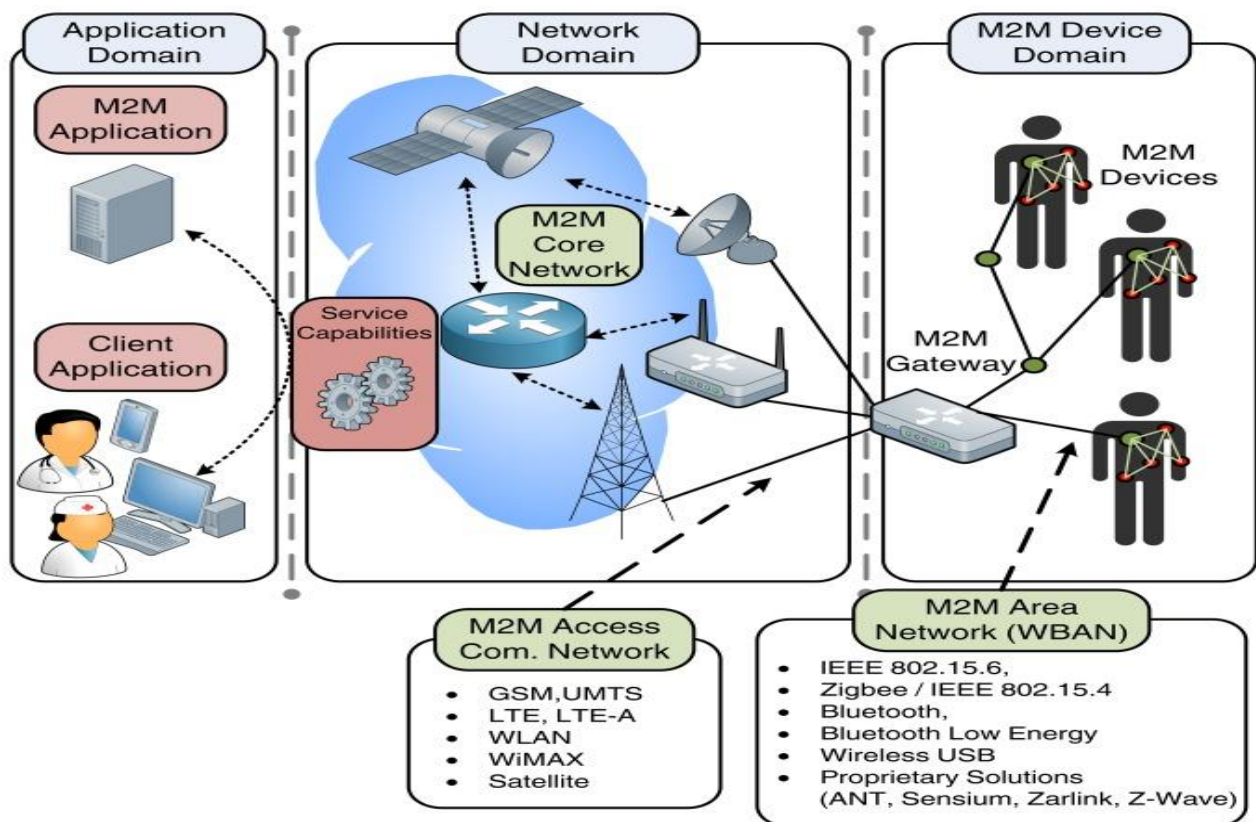
Figure 1: A simple M2M structure of mHealth with wireless connectivity

- The domain of device of M2M where the communication of M2M device take place in a gateway with a short-range network.

- The domain of network that provide the gateway connect to the application by core communication networks and long-range access.

- The domain of application that every application service can be specified and provide the certain service to the user based on the user's situation.

The sensor of WBAN or M2M device are installed into the patient's body or the device in a shape that wearable and wore by the patient or implanted in the patient's body. When the data of patient body is requested from the device, the WBAN sensor will send the data to the device autonomously. Each device can be connected to a short-range communication network by the function of wireless communication that embedded in the device. To set up a M2M area network, it needs different technologies such as IEEE 802.15.6, Bluetooth and Bluetooth Low energy, ZigBee. The M2M area network give a connection to the M2M gateway from the WBAN sensors. M2M gateway act as a proxy between the network domain and M2M device. To be a gateway in the system, the device must be portable and has the radio communication technology interfaces. PDA or the everywhere common device mobile phone and smart watches can meet with the criteria so this make the M2M system easy to

be operating. The M2M gateway will be connected to Internet and then connect to the application server through the M2M communication part. Traditional wireless communication technologies such as Long-term Evolution (LTE), WiMAX and IEEE 802.11WLAN will be utilized by the M2M communication part. At the end, with the help of specific software the domain of application will receives the data and processes accordingly [4].

B. The application of WBAN

The application of WBAN can be classified into two section which is non-medical application or medical application but in this article we will discuss about the medical application only. For the medical application, it has three section further to be classified which is implant WBAN, wearable WBAN and remote monitoring.

- Implant WBAN - The type of implant WBAN devices are basically implanted or embedded inside the body. One of the application example of this type of device can be found in the treatment of cardiovascular. One of the major diseases causes of death is cardiovascular diseases. We can monitor it buy using WBAN technology. We can lower the risk to a more considerably level by periodically monitoring the
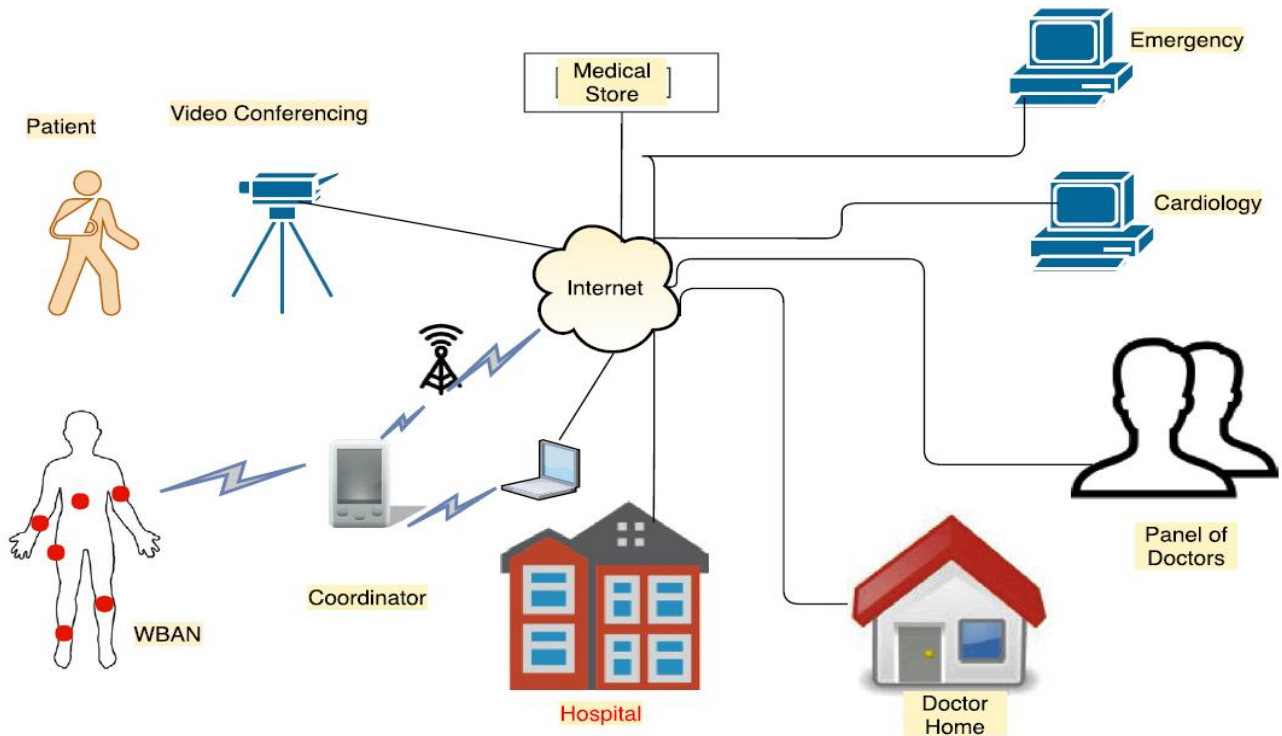
Figure 2: Monitoring device for real-time telemedicine

Myocardial Infraction (MI). To monitor different types of anomaly physical health, we can also apply WBAN technology in it [5]. With the WBAN health related sensor, the data that used for cancel can be extract out by monitoring the cancer cell. No need for taking biopsy, doctor can use those data to detect out the tumors inside the patient's body. This can also give more information to the doctor for analyzing the ideal treatment for the patient [5]

- Wearable WBAN – In this category, the device connect with the WBAN can be easily attached on human body surface. Figure 2 has shown a simple architecture that include wearable WBAN [6]. In this system, the WBAN framework can control and monitor the patient rehabilitation. Through WBAN framework, the real-time physiological data of patients will be sent to the cloud when the patient is under monitor. On the other side, the real-time database updates or the video conferencing can help the doctor to monitor the activities of the patient through the panel of doctors.

- Remote Monitoring – With the connectivity of Internet, WBAN allows the doctor to keep an eye on the condition of the patient's body and can give some advice to the patient in real-time when it is needed. The sensors of WBAN have the capability to detect the vital sign of the body such as blood pressure, respiratory rate, heartbeat, body temperature and other physiological parameters which is crucial of the patient's body [7].

These WBAN sensor will be monitoring the data or the condition of the patient's body from time to time and forward to the doctors. With the information that send by the sensor, doctors will be more easily and being able to provide any optimal support to the patient through the panel or video conference.

C. The limitation of WBAN

Although the system of WBAN look like a complete system that help doctor more easily to analysis and operate the treatment of patient but still there is remain some research gap because of the current WBAN architecture. One of the reasons causing this is the reliant of vendors. Only the platform that specified by the vendor can support the sensor that provide from the same vendor. Since the body sensor cannot interact with each other than come from different vendor, this make the operation and management of sensor from multi-vendor become more complex and difficulty [8]. If we just install the install the sensor from different vendors to cooperate, it will some obstruction in the internet and might be leading to inappropriate collection of data. One of the examples can be found in Nagao City University Hospital. For each clinical department, they construct an individual network respectively. At the end, the changing of each individual networks will make the whole network configuration become very complex. Any change of the individual networks required to stop the whole network to do fixing of the network. As a result, the various platform of sensor will lead to a complex management system and need a huge effort for the staff to manage it [9]

It is difficult and complex to incorporate current engineering of WBAN with the serve of cloud in both technically and financially. Furthermore, the changing of daily life or non-daily life event and its changing of body action will cause the data transmission rate changing vigorously. The unstable data transmission rate will make the back-end-server in a not balance in processing data and storing data situation [10]. Another limitation of current engineering of WBAN is the security and privacy of it. As WBAN has big amount of patient's personal private health data, when the system is processing the huge amount of data which is complex and need a lot of time, it make the system in defenseless and easy to be attack by hackers. A system when dealing with the data while still have the capability to protect privacy and have its security is still a considering issue of WBAN [11].

III. FUTURE DIRECTION

To find the ideal solution to solve the challenge of WBAN, researchers have incessantly doing research by make use of new technologies in WBAN or modified the current existing solution. There are two most attractive and potential technologies to dealing with the issues of WBAN which is Blockchain and SDN.

SDN is a new technology which can form the data plane by separates the authorized control plane. By separate the control plane, this will form a centralized control program that can offer to operator to work. This mean that now there is only a platform for the operator need to deal with instead of to use the numerous platforms or the network devices that specified by the vendor [12]. The control program is formed by software-based network device and software-based controller which make it become a simple forwarding device. By using open interface such as OpenFlow and ForCES, the user or operator can program the simple packet forwarding device. In SDN, for any changing in shift in traffic loads, connection initiated by end hosts, network topology or messages from other controllers must be follow the packet-forwarding rules that construct by the controller machine. Rules that created by the controller will also forward to the switches which are programmable and included functionalities that is compulsory. This characteristic of SDN make the user or operator more easily to add on new application or new protocols.

The concept of Blockchain started to be used in protect privacy and maintain security in healthcare services in the past few year ago only. Blockchain technology is more often being used to solve problem in cryptocurrency. The concept of solution based on Blockchain in cryptocurrency is every transaction that made by each participating organization will be collected and store in a database which is distributed and secured. The basic structure of Blockchain is when organization A decide to do a transaction with organization B, the Blockchain system will send the request to all the authorized members which under the network of Blockchain. Then, a set of transactions that need to be process will be gather by each node and the set of transactions will be grouped in a block. The block will be distributed by using consensus algorithm and the authorized members need to do the validation for each block. After validation process, the transaction between organization A and B is done [14]. Gem Health Network, and startup of US based, take the advantage of Blockchain technology and applied it into maintaining the security and privacy of WBAN [15]. They construct a platform for the users such as individuals, patients and doctors can access the information of the patient's treatment accompanying with allow the doctors can see the information of the past treatment of the patient while the other cannot. This make the WBAN system become more privacy and more secure.

IV. CONCLUSION

In this article, recent research of WBAN has been elaborated. This article also pointed out the limitation of current engineering of WBAN. In this section, it is necessary to understand the limitation of the structure so that the future research aiming can be more specified on resolve the current issue of WBAN. This article highlights the utilization of WBAN in medical fields. Last but not least, if the new technologies for instance Blockchain and SDN integrate with WBAN technology, it will bring a radical change to the health sector. It is envisaged that most of the current critical issues of WBAN can be soled by Blockchain and SDN.

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