



# A Revolution in Health Sector using Wireless Body Area Networks

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**Abstract**— Our world has been changed a lot over the past few years. Only a few decades back and you will see that communication among people was not an easy task at all. Thanks to the advancement in technologies especially the networking techniques that have made the lives of the people so comfortable. Now due to these computer networks, communication with your family, friends, and colleagues is so easy all across the globe. This communication is not only limited to the entertainment or information anymore. Wireless Body Area Networks has made it possible for the doctors to keep in touch with their patients and check their health conditions while staying miles away from them physically. This application of Computer Networks is impacting so many lives in the world in a very positive way. This technology is helping people in getting better health services without taking the time to go to their doctor or changing their daily routine. This application has so many benefits but at the same time it is also facing challenges and secure transfer of the data is one of the challenges and researchers are working to make sure to keep data of the patients secure.

**Keywords**—Wireless Body Area Networks, Wireless Sensor Networks, Quality of Service, Security.

## I. INTRODUCTION

Recent developments in technologies have made computer networks so complex. We just need to look at the basics first in order to get the idea that how smaller and simple networks have now become so large and how useful they are in connecting people with one another. The application of computer networks has tremendously expanded and now almost every person living on the planet earth is somehow connected to the world and is a part of the computer network. The computer networks were initially used for very low-level communications. People in the sitting in the same room were connected using computer networks. This was considered to be a huge success as people sitting nearby were been able to send and receive files from their computers. Then a point came when people started connecting different rooms and different floors of the building and they were able to communicate with each other through these networks. Besides this, the connections among different buildings were made to communicate and share the data. This was the time when people started thinking that different cities

and even countries can be connected by using the concept of Computer Networks. Gradually networking among different cities was made possible and a time came when all the countries of the world were connected through the computer networks [1]. Now not only people living on the globe are connected to each other but these networks have made people connected in the space and under the water in the oceans. Computer Networks are benefitting mankind through its applications and Wireless Body Area Networks has also brought a revolution in the healthcare as its services are expanding and helping both the patients and doctors while not affecting their daily lives. We will start with the basics of computer networks and their geographical scaling.

## II. GEOGRAPHIC SCALING OF A COMPUTER NETWORK

### A. Nano-Scale Network

Communication at the minor scale is taken place at the Nanoscale network. It is clear from its name that very small actuators and sensors are used at the Nanoscale Network. The category of body area networks also falls under the category of nanoscale networks as these sensors and actuators are the backbones of biological systems.

### B. Personal Area Network

This type of network is used for the transfer of data among the computers and devices placed around a human being. The maximum area that can be covered under Personal Area Network is around 10 meters. The devices used in this type of network are printers, scanners, fax machines, personal computers and mobile phones. The network can be in the form of a wired network or it can be a wireless network.

### C. Local Area Network

The most common and popular network that we have listened to so far is the Local Area Network. Computers and other devices within a range of less than 1 kilometer can be connected through this type of Network. This type of network is used to connect the offices or any other place which falls in the area of fewer than 1000 meters. These networks can be experienced mostly inside the buildings connecting different rooms or floors of a building. These sorts of networks are largely based on Ethernet technology. Wireless Local Area Network or commonly known as WLAN is the wireless form of this network.

#### D. Wide Area Network

These types of networks were previously known as Metropolitan Area Network or MAN. These are the networks which in those days was thought to be a network which can cover the whole town or a big locality. The population of the cities increased, this leads to the expansion of cities with the passage of time. The communication between the different cities started and that is why it is now known as Wide Area Network [2]. Three layers known as the Physical layer, Data link layer and Network Layer of the OSI model are used in these Wide Area Networks.

#### E. Global Area Network

The scope of communication becomes vast and now the whole world is a Global Village. Satellite communication is one of the most important factors for this type of network. Mobile or portable devices are used in the areas where there is an availability of satellite signals. Broadband Global Area Network is a well-known example of such a network. Both telephone and internet services fall under such type of network. Moreover, line of sight communication to the satellite signals is an important factor for the communication as the data cannot be transfer without the line of sight communication.

### III. WIRELESS SENSOR NETWORK

Before Wireless Sensor Networks (WSNs) are the key factors in bringing the upcoming technological revolution in the world. WSNs are easing the ways for human beings and machines to link with their surrounding environment and to understand and react to the real-world problems that we face on a daily basis. WSNs are made up of nodes and these nodes are actually formed by the combination of micro-electronic mechanical systems, wireless communications, and digital electronics. These nodes are smart enough and have the ability to sense their environment, not only they sense their environment but they can also perform computations and communicate [3].

The WSN network is made up of a few nodes to as many as hundreds or thousands of nodes. These nodes are connected to the sensors. The complexity of the environment is the reason due to which the size of the sensor may vary. Sensors are found from a very small size to a large size. A sensor can be as small as a dust particle and can be as big as the size of the shoebox or even bigger. The price of the sensor nodes also varies. They can be very expensive as much as hundreds of dollars and can be cheap as a few dollars only depending upon the size and complexity of the sensor. Every node consists of some essential parts i.e.

- Radio transceiver
- An internal or an external antenna
- A battery
- Microcontroller
- Electronic circuit

WSNs have seen very fast and rapid growth over the past few years. It is assumed that in the coming 10-15 years the world

will be full of WSNs and all these networks will be reached via the Internet. WSN is a very big field, it is also expanding at a high rate and it has too many applications covering different fields. A few of the applications are given below.

### IV. APPLICATIONS OF WSNs

#### A. Military Purposes

The major application of WSNs development is military utilization. It was used mainly for surveillance purposes during battlefield activities. WSNs technology is helpful in intelligence as well as in commutations activities whereas WSNs detect the existence of military forces and war vehicles and in the tracking of their movements. The WSNs are also utilized for applications such as geo-fencing of oil as well as of the gas pipelines.

#### B. Domestic Uses

Wireless Sensor Networks are also utilized to facilitate household residents. It can be very helpful in making people's life easy and smooth. The Application mechanism of WSNs utilization is to install WSNs nodes at various locations at home and get control of various devices [4].

#### C. Industrial Uses

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#### D. Agricultural Uses

The WSNs have wide usage in the agriculture field where the statistics of the water used in the fields are communicated through WSNs wireless systems to the control center where their billing amounts are calculated. These systems are providing a wide help inefficient utilization of water and avoid its wastage.

#### E. Environmental Uses

WSNs are utilized for the monitoring of harmful and poisonous gases present in the atmosphere. WSNs have been deployed in most of the advanced cities to monitor air pollution e.g. Brisbane, Stockholm, London. Landslides can be detected by using WSNs systems which will help to detect the movements going on in the soil by installing WSNs units in rocky and mountainous locations. Thus by timely detection of landslides through WSNs utilization, the severe damage caused by it can be avoided [6]. A comprehensive analysis should be carried out while designing the security protocols of WBANs with the following three features to be highly prioritized.

- Security Attacks
- Security Requirements
- Existing Security Mechanisms

WSNs can be very helpful in flood prevention. The WSNs units can wirelessly communicate the water level information to the central location, thereby preventing the flood by advanced

detection. This advance detection will help the officials to relocate the inhabitants and goods to a safe place in time. In the current era, the most useful application of WSNs is in the underwater. There are various underwater parameters that can be detected by the installation of WSNs units, such as the water temperature and pressure, the salinity, turbidity and oxygen density can be measured.

During the past decade, the applications of WSNs in the health area has been increased many folds and is gaining more popularity amongst scientists and engineers. Various new techniques and inventions have been developed in the research field of WSNs that enables the patients to cope with the diseases effectively. Wireless Body Area Network is one of the applications of WSNs which is discussed in detail below.

## V. WIRELESS BODY AREA NETWORKS

Wireless Body Area Network (WBAN) or Wireless Body Sensor Network (WBSN) is one of the major applications of WSNs in the field of healthcare. This technique has proved to be a revolution in this field as it provides efficient methods for healthcare and related issues. By using WSNs wireless devices a patient has the freedom to wander freely without being bound to stay at the bed at the hospital. WSNs help records the data and saves/wirelessly transmit the data of various parameters in a continuous way. This data is available to the concerned physician as well as for the consideration of the patient to monitor the patient's health regularly. WBAN is composed of various tiny devices implanted along with the human body. Various tasks are performed by these WBAN devices [7]. These devices help to establish the wireless link and perform uninterrupted health supervision. The most significant feature of WBANs is that they can perform continuously for 24 hours every day and perform the recording and storage of data in a periodic way. In general, the two significant types of WBANs devices used in general practice are sensors as well as actuators. The major task of the sensors is to measure various parameters. Contrarily, the function of the actuators is to carry out important steps as a response to the recorded data of the sensors. As an example, in case a sensor records a high level of diabetes, then the function of the actuator is to find out the proper dose of insulin. One requirement of WBANs is that it has to be very efficient in terms of energy consumption. Also, it should have good Quality of Service (QoS) [8]. Furthermore, the patient's privacy, as well as security, must be ensured. A wide range of work is carried out by the scientists as well as the engineers across the world, on various aspects of WBANs in order to improve the standard of services towards the patients. WBANs are categorized in a number of research areas, including energy efficiency, improving QoS as well as the routing of various WBANs nodes etc. Since the WBANs sensors are utilized such as they are embedded inside the body of the humans, and thereby replacing the sensors frequently is not easy. Therefore, the shortest possible time of these sensors is around 5 years nowadays [9]. Because of this necessity, most of the research is going on increasing the lifetime of these devices. Another most challenging factor is the Security of WBANs. The data transfer towards the destination from sensors is carried out in various ways. Our research is based on this issue and has proposed various optimal solutions for the secure transfer of finalized

results towards the related receiver. One of the most important parameters of WBANs is to take care of the privacy as well as the security of the patients. Because in the case of tampered reading or malfunctioned measurement will result in a false dosage regarding medicine. All this will put the patient's life in extreme danger [10]. The major WBANs security factors are Confidentiality, Integrity and Availability of recorded data. In addition to these, the various other factors are also important while working on the security of the WBANs, like authentication as well as the fresh updates of the received results. The management is also important in terms of security because it serves as the keys distributor to the various nodes for the purpose of encryption as well as decryption. Similarly, the technique of secure localization helps in the estimation of the accurate localization of the target patient. This counts as an essential factor in terms of the security of the patient. Contrarily, scalability, as well as the flexibility, should also be considered vital in securing the WBANs. The data that is recorded may travel along a short route of a long route in order to be received by the doctor or a physician. Thus various people as diversified distances might attempt to tamper data thereby breaching the WBANs security. Mainly the internal and external sources are involved in the threats as well as attacks on the data. The classification is based on the type of attack carried out. For instance, if an attempt is carried out to attach the data for the purpose to illegally hack the data for changing it, then this type of attack is usually carried out through internal sources. Such sources are normally in the close proximity of the patient and thus can access the WBANs nodes of the patients physically. Contrarily, an outsider attacker breaches the WBANs security through passive eavesdropping, refusal of the demanded service as well as the replay attack to ignore the process of authentication. Such attackers don't have physical access to the patients and thus use such techniques for breaching WBANs security [11].

## CONCLUSION

We discussed the geographical scaling of a network in detail and then we also discussed the applications of the computer networks in detail. While discussing all the other applications of the computer networks, we focused on one of the very important applications and it was the Wireless Body Area Networks. We discussed how this application is useful for the patients but besides other challenges one very important challenge that this application is the security, confidentiality and integrity of the data. We just need to carry out our research work in order to make the communication among stakeholders more secure and must not leave any loophole while designing the protocols from which the life of the patient could be at risk.

## REFERENCES

- [1] Queiroz-Sousa, Paulo Orlando, and Ana Carolina Salgado. "A Review on OLAP Technologies Applied to Information Networks." *ACM Transactions on Knowledge Discovery from Data (TKDD)* 14, no. 1 (2019): 1-25.
- [2] Qin, Zhijin, Frank Y. Li, Geoffrey Ye Li, Julie A. McCann, and Qiang Ni. "Low-power wide-area networks for sustainable IoT." *IEEE Wireless Communications* 26, no. 3 (2019): 140-145.
- [3] Gilbert, Edwin Prem Kumar, K. Baskaran, Elijah Blessing Rajsingh, M. Lydia, and A. Immanuel Selvakumar. "Trust aware nature-inspired

optimised routing in clustered wireless sensor networks." *International Journal of Bio-Inspired Computation* 14, no. 2 (2019): 103-113.

- [4] Kashyap, Ramgopal. "Applications of Wireless Sensor Networks in Healthcare." In *IoT and WSN Applications for Modern Agricultural Advancements: Emerging Research and Opportunities*, pp. 8-40. IGI Global, 2020.
- [5] Gope, Prosanta, Ashok Kumar Das, Neeraj Kumar, and Yongqiang Cheng. "Lightweight and physically secure anonymous mutual authentication protocol for real-time data access in industrial wireless sensor networks." *IEEE transactions on industrial informatics* 15, no. 9 (2019): 4957-4968.
- [6] Shu, Tongxin, Jiahong Chen, Vijay K. Bhargava, and Clarence W. de Silva. "An energy-efficient dual prediction scheme using LMS filter and LSTM in wireless sensor networks for environment monitoring." *IEEE Internet of Things Journal* 6, no. 4 (2019): 6736-6747.
- [7] Ohri, Kriti, R. Vijaya Saraswathi, and L. Jai Vinita. "Performance analysis of wireless body area sensor analytics using clustering technique." In *2019 International Conference on Communication and Signal Processing (ICCSP)*, pp. 0278-0281. IEEE, 2019.
- [8] Tseng, Hsueh-Wen, Yu-Bin Wang, Yi Yang, and Ru-Xin Wang. "An Adaptive Channel Hopping and Dynamic Superframe Selection Scheme with QoS Considerations for Emergency Traffic Transmission in IEEE 802.15. 6-Based Wireless Body Area Networks." *IEEE Sensors Journal* (2019).
- [9] Bai, Tong, Jinzhao Lin, Guoquan Li, Huiqian Wang, Peng Ran, Zhangyong Li, Yu Pang, Wei Wu, and Gwanggil Jeon. "An optimized protocol for QoS and energy efficiency on wireless body area networks." *Peer-to-Peer Networking and Applications* 12, no. 2 (2019): 326-336.
- [10] Shim, Kyung-Ah. "Universal Forgery Attacks on Remote Authentication Schemes for Wireless Body Area Networks Based on Internet of Things." *IEEE Internet of Things Journal* 6, no. 5 (2019): 9211-9212.
- [11] Paul, Pangkaj Chandra, John Loane, Gilbert Regan, and Fergal McCaffery. "Analysis of Attacks and Security Requirements for Wireless Body Area Networks-A Systematic Literature Review." In *European Conference on Software Process Improvement*, pp. 439-452. Springer, Cham, 2019.