

# **A Survey on Emerging Research Trends Towards Congestion Control Issues of Wireless Body Area Networks (WBANs)**

**Srinidhi.C**

M. Tech student, Dept. of CSE  
East West Institute of Technology  
Bangalore-91, India

**Mangala.C.N**

Asst Prof: Dept. of CSE  
East West Institute of Technology  
Bangalore-91, India

## **ABSTRACT**

In the era of Internet of Things (IoT), the recent advancements of information and communication technologies enables deployment of sensor nodes on our human body. Therefore the present health care scenario enables the dynamic and continuous patient health monitoring by configuring small sensors into patients body. Wireless Body Area Networks (WBAN) are one of the special kinds of networks which have been visualized to be a reality in future for remote healthcare diagnosis and patient health monitoring referring the concept of Wireless Sensor Network (WSN). The concept of implementing the pervasive and ubiquitous networks needs proper synchronization in between various heterogeneous networks such as internet, cellular network along with WBAN. The Heterogeneous WBAN networks require a heterogeneous communication system to ensure quality of services with respect to the reliable data transmission and delivery ratio. This proposed study provides an overview of the state of art techniques towards congestion avoidance strategies in WBAN. The study also highlights various congestion control strategies over heterogeneous communication system to ensure the quality of services. The significant contribution if the proposed study is highlighted over research gap which illustrates the existing research issues associated with the WBAN communication systems.

## **Keywords**

Wireless Body Area Networks, HealthCare Monitoring, Congestion Avoidance, Quality of Services.

## **1. INTRODUCTION**

A sensor node is an electronic and battery driven device which can be utilized to measure the dynamic changes associated with the environmental parameters e.g. measuring the amount of rainfall, humidity in a particular area etc. There are lot of existing research trends which talks about the cost optimization and ensuring quality of service by minimizing the size of it. Therefore very smaller and cheaper sensor unlike dust sizes is available in the market places. A typical sensor device has basically five major components such as 1) A sensory device 2) A real-Time operating system, 3) A

processing unit 4) Analog to Digital Converter and 5) Wireless Communication Unit. The sensed data is further converted into electrical signals using ADC and pre-processed by its micro controller chips. A typical wireless communication using Radio Frequency waves is established in order to initiate a communication in between the sensor nodes. A battery with limited electric power constantly supplies power to maintain the above stated operations [1] [2]. A WBAN is considered and integrated as a special purpose wireless sensor network which has been conceptualized to

operate and accessible in human body area. The network collaborates various medical sensor nodes and appliances which are located inside and outside of a human body. Presentation of a WBAN for restorative checking and different applications will offer adaptabilities and cost optimization choices to both social insurance experts and patients. A WBAN framework can offer two huge favorable circumstances contrasted with current electronic patient observing frameworks. The main point of interest is the portability of patients because of utilization of compact mobile gadgets. Second point will be the preference towards area autonomous monitoring facility [3].

A WBAN communication unit/node is a self-governing gadget can seek and locate a suitable correspondence system to transmit information to a remote database server for capacity. It is likewise conceivable that a WBAN node will associate itself to the web to transmit information in a non-obtrusive way. The utilization of WBAN in medical healthcare systems might comprise of sensor nodes can be joined to or embedded into a human body [4] [5]. These sensor nodes have remote transmission capabilities thus they can sense biological data from human body to transmit over a short route to a control gadget worn on the body or put at an available area. At first for considering very small region within the communication range, an immediate correspondence from individual node to the sink node has been established and configured as the correspondence scope of nodes falls inside of the area of sink. As the power from the battery enabled on a sensor node used for transmission is specifically propositional to the square of distance between the two respective transmitter-receiver nodes, in this way the node at more remote distance will be exhausted and died sooner [6].

Therefore, in case of large deployment over an extensive scale WSN Direct Transmission is not suitable. Further to avoid this kind of situation hop to hop data transmission within a particular wireless network has been introduced. Where the information goes from neighbor node to neighbor node, where the transmit-receiving cycle increments and thus adjacent node nearest to sink node will be exhausted soon. Further, to defeat this issue an idea of collection or clustering has been presented, where a few sensors get to be individual from one gathering and one is chosen as cluster-head, who gathers the information from every nodes belongs to that particular cluster, however here the participation is static, as a result the chosen cluster-head energy will exhaust faster and die soon, which was broken by W. Heinzelman by introducing dynamic clustering concept called a Low Energy Adaptive Clustering Hierarchy (LEACH), which became a bench mark. This paper introduces various existing studies towards congestion

control and avoidance in wireless body area networks where the paper also discusses about the existing congestion control mechanisms and associated issues. The proposed study also analyzes the various congestion control mechanisms in WBANs and highlights how congestion control will have impact on provisioning the quality of services of the whole system.

The paper is organized as follows section 2 summarize the background of existing prior techniques. Section 3 and 4 illustrates an overview of problem description and the existing techniques respectively whereas section 5 discusses about the research issues associated with the existing state of art studies towards congestion control in WBAN technology. In the end Section 5 summarize the whole paper.

## 2. BACKGROUND

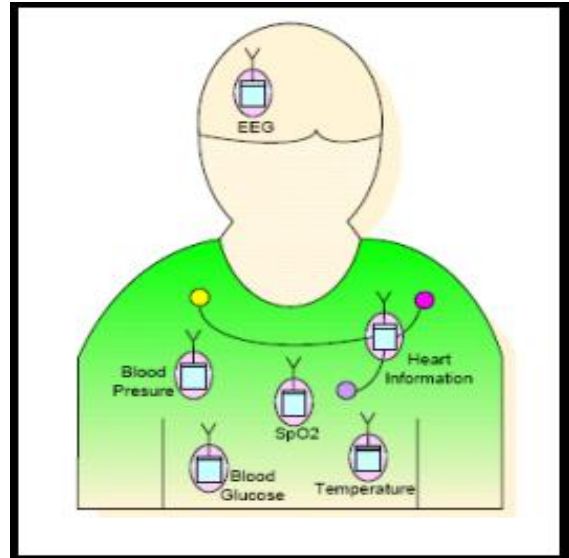
### 2.1 Wireless sensor Network

The potential of the WSN to enable applications which connects physical world to virtual world as gained lot of importance for designing and implementing WSN in Healthcare industry. Potential application of wireless sensor network is seen in applications such as medical monitoring. Here the WSN is used for monitoring patients in hospitals by using wireless sensor in order to remove the limitations of restraining the patients to wire monitoring devices and to monitor patients in mass situation as well as in their day to day activity so as to provide early detection and interpretation of different kinds of diseases. The sensors used in such case are different size varying from miniature sensors like body worn sensors to external sensors like positioning devices or video cameras. The application of WSN for medical healthcare is challenging since the sensor data input must be used dependable so as to be used in interpretation or analysis. Since most of the sensors used for monitoring are battery dependent it also calls for the need of networking protocol which provide efficient, reliable and scale response [7].

### 2.2 Wireless Body Area Network

Wireless Body Area Network is a form of special purpose sensor network that is designed to operate autonomously to connect different medical sensors and appliances which are located within or outside the human body. The use of WBAN in medical monitoring will offer flexibilities and economic benefits to both the patient as well as healthcare professionals. WBAN node which is autonomous device searches and finds an appropriate communication network to transmit the data to the remotely located server or system. WBAN also as the ability to autonomously connect to internet in order to transmit data in non-invasive manner [8]. Wireless Body is network is very popular for patient's data monitoring. Earlier when patient used to enter the hospital he used to undergo medical examination and doctors as well as the paramedic staff would question the patients about the symptoms in order to identify the actual symptoms of the diseases. In certain case the patient is made to stay for long time in the hospitals to undergo certain rests in order to obtain more clarity of the symptoms. Where the patients are connected to various wired sensors which makes the patients feel uncomfortable. The core idea of WBAN is to eliminate all the wired sensors on the patient's body and to develop wireless network of the sensors. All the constituent devices are connected using wireless medium and thereby increasing patients comfort and also provide the opportunity of remotely monitoring the patient. The different information related to patients such as cardiogram, blood pressure, sugar level, oxygen saturation and so on which are used by the doctors for the diagnostic can be easily measured through attaching sensor nodes to patients. Two types of hardware device are used in WBAN. They are: 1) Wearable devices which are used on the body surface of the patient. 2)

Implanted medical device inserted within the patient body as shown in Figure 1. In wireless body area network, wearable systems are used as a prime technology for the continuous health monitoring of the patient. As well assisting in patient in having a affordable healthcare service. WBAN's permit to monitor the diagnostic state of the patient and allow feedbacks to be preserved in order to maintain reliable health information related to the patient. With advancement in technology over the years we are able to use wearable health monitoring devices of different functionalities and sizes such as simple pulse monitors, holter monitor, and activity monitor to the highly sophisticated and highly expensive implantable sensors. The application of implantable sensors or the wearable monitoring system as are referred as smart sensors in body area network.



**Figure 1: Example of Wearable Body Sensor**

The prime aim of the wearable system is to perform the continuous monitoring of biomedical and physiological data in the patient's activity. The patient's sensor device is connected to cluster head (CH) and the CH is connected to internet device or any other medium of wireless communication which connects it to the healthcare system or doctors. The WBAN system acts as a resident doctor for critically ill patients by timely monitoring their health status [9]. The figure 2 shows typical WBAN dataflow in medical application. The advantages of using WBAN are it allows the mobility of the patient due to the portability of monitoring devices. It is also offers the location independent monitoring facility. WBAN assists in continuously monitoring and logging the crucial parameters of patients suffering from chronic diseases like diabetes, asthma and heart attacks. By using the WBAN in patient's vicinity it is possible to alert the hospital prior to the heart attack by measuring changes in the vital parameters of the patient. WBAN at a diabetic patient's vicinity will assist in auto injecting insulin through pump in case of the insulin level declining.

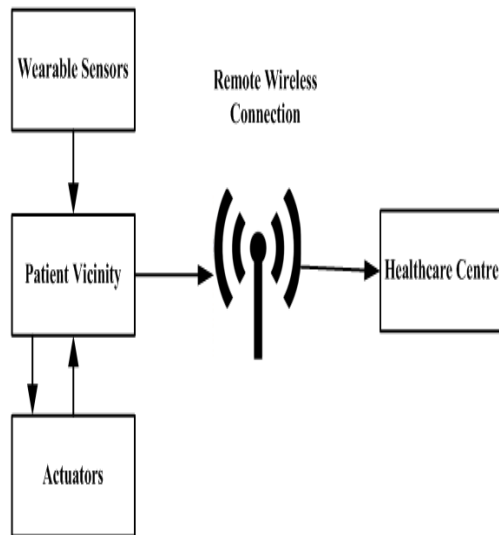


Figure 2: General WBAN Dataflow in Medical Application.

### 3. RELATED WORK

A concept of wireless body area network is brought in by Khan et al.[10] which is a special purpose network that is used to function independently but connect different medical appliances and sensors, that are placed inside and around the human body. The paper also talked about medical monitoring and cost saving options to both patients and a new technology oriented era of pervasive supervision.

Eleftherakis et al. [11] discussed about the advanced uses of the sensor network in different domains like healthcare, environment study and protection. They also demonstrated the live scenarios of the application of the about said system and usefulness of the technology in to different areas with examples.

Khan et al.[12] presented WBAN design techniques for medical applications and also experimented various WBAN design constraints especially they have emphasized on design of MAC protocols and the power consumption issues associated WBAN. A comparative analysis of the existing conventional WBAN technologies ensures point out existing research issues associated with the WBAN design specifications.

In their study, Darwish et al.[13] highlighted the upcoming trends about wearable body area networks. They discussed the benefits of WBAN systems applying to the healthcare industry and especially when used for independent and elderly people and the patients. They also pointed out the benefits of the scalability, availability, pervasiveness and cheaper uninterrupted protection available to the people.

Khan et al [14] focused on the evaluation of the performance for different patient monitoring systems that use Zigbee MAC based WBAN/ IEEE802.15.4. Especially they talked about simulation models based on OPNET.

Ullah et al [15] reviewed the core technologies related issues and underlying mechanism of the WBAN its routing protocols and low-power MAC, design, structure, and other low level issues. Different threats, challenges that are posed to the network, physical and other layers were presented along with some of the possible solutions. To complete the discussion they also listed the different application areas.

Manfredi et al.[16] aimed to develop a realistic simulation model for the patient health care based system including various essential wireless sensor network protocol implementations. A comparative analysis has been performed in a real time based scenario which ensures the effectiveness of the proposed system.

### 4. ISSUES OF WSN TOWARDS QUALITY ENABLE WBAN

Wireless sensor network is an intelligent, agile, low-cost, and ultra-low power technology developed by using sensors that can collect data and help to transmit when necessary. For healthcare monitoring system, WSN, wearable and implantable wireless body area network emphasis on some significant components such as Tele-monitoring, tracing and monitoring doctors and patients, and drug administration. Almost similar technologies used and applications of WSN are gradually moving into WBAN. The key goal of WSN system is patients' physiological signals monitoring, where the main goal of WBAN is providing real time feedback of patients biological data, and uninterruptedly observing health parameters like heartbeat rate, blood pressure level in an efficient way and also some other parameters of patients' on-body, around body and in-body. Depending on the level of usages of WSN and WBAN technologies information or facts acquirement through sensor devices can be point-to-point or multipoint-to-point.

WBANs have some own characteristics which are different from conventional wireless sensor networks and also characterized into some categories such as architecture, network density, data rate, latency, mobility, and many more. It may include many devices and applications and has the characteristics of general wireless sensor networks. In our research paper we have studied and analyzed the major challenges while developing a QoS based WBAN.

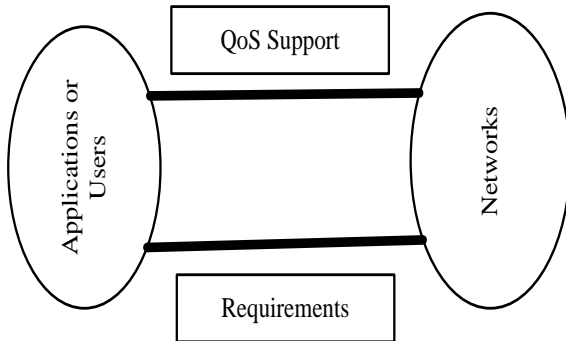
#### 4.1 Qos Techniques, Mechanisms, And Metrics Necessary To Build Efficient Wban

For overseeing dangers in therapeutic applications it is essential to appropriately taking care of Quality of Services (QoS) issues. Unwavering quality is the key variable towards ensured conveyance of information in sensible time. It straightforwardly influences the nature of patient checking; in other hand it can be unfortunate when an existence undermining result has gone imperceptibly and undetected.

#### 4.2 Qos Observations And Main Objectives

It is extremely hard to discover and give meaning of QoS identified with remote sensor systems. Among a large number of definitions we can choose the accompanying as illustrations. The quantity of helpful sensors used to send information at any given timeframe. QoS can likewise decide by system qualities like information transmission, and blunder rates. QoS additionally relies on upon the system quality sorts, for example, transmission capacity, dormancy, and jitter. In a large portion of the cases the execution or quality administration shift from application to application and these applications can be delegated unwavering quality, convenience, heartiness, reliability, and versatility. QoS issues towards growing high caliber and very much sorted out WSN and WBAN is an incredible examination region. In any case, it needs more consideration because of the basic level of operations for instance basic data with zero postponement, constant information transmission with no blunder or drop, organization, unwavering quality, a few components identified

with force or vitality. There are two viewpoints in conventional QoS perspective, they are applications and framework. In the main case, QoS ordinarily insinuates the quality as clear by the customer/application, yet in frameworks organization perspective, QoS is recognized as a measure of the organization quality that the framework offers to the applications/customers. The two QoS perspectives can be displayed using a direct structure as showed up in Figure 3.



**Figure 3: QoS perspectives: a general view**

The attempts of QoS are masterminded as best effort (no QoS), guaranteed organizations (hard QoS) or isolated organizations (sensitive QoS). Any application must satisfy any of the above three orders to finish its QoS objective. QoS targets for any application should fuse the support of organizations by the framework by immaterial utilization of (essentialness usage) and capable transmission limit use. So the advancements like WBAN, WSN we ought to be extremely cautious that in both cases we have lacking computational assets, confined memory and restricted time (due dates) for an occasion. Major QoS of remote WBANs are dormancy and unwavering quality.

#### Challenges in WBAN:

- The WBAN has a very less resources like memory, processing power and energy. It also has a very less capability.
- It has a multi-source and multi base station system. This network has a service level system architecture.
- In WBAN, the sensor nodes will changes randomly, so its service of quality will not affect the network.
- In WBAN system, Variety of traffic methods are used to improve the QoS techniques at different periods.
- The data redundancy and variety of applications are developed in large number of get better quality of Services.

## 5. CONCLUSION

QoS has come forward as a foremost apprehension and research vicinity in the field of ad-hoc, sensor network, and body sensor network applications such as WBAN. But at a standstill much work has to be done. We believe that there should be further and more QoS definite WBAN research. To handle QoS challenges and issues in WBAN predominantly to advance the general functionality there is also need more research on energy efficient MAC and routing protocols. It's also very important to monitor the QoS in body area sensor networks itself and we desire to take account of it in our upcoming research work. It's a huge research domain for us especially for academicians and researchers to work for improving the performance level as well as QoS level in sense of in-body and out body WBAN. The traffic control and

avoidance has been proposed to improve the dynamic and other differentiated scenarios of healthcare applications.

## 6. ACKNOWLEDGEMENT

My deepest gratitude and sincere thanks to our beloved guide Mrs. Mangala .C.N. Assistant Professor and our Hod Dr. Arun Biradar, Dept Of Cse East West Institute Of Technology, Bangalore, for their valuable guidance's during making of this paper and continuous suggestion in making the paper successful.

## 7. REFERENCES

- [1] Khan, Jamil Y., and Mehmet R. Yuce. "Wireless body area network (WBAN) for medical applications." *New Developments in Biomedical Engineering. INTECH* (2010).
- [2] Thomas D. Lagkas and George Eleftherakis, "An Overview of Wireless Sensor Networks: Towards the Realization of Cooperative Healthcare and Environmental Monitoring", Copyright © 2014. 23 page.
- [3] Khan J Y, Yuce MR, Bulger G and Harding B, "Wireless Body Area Netowrk (WBAN) design techniques and performance evaluation", *Journal of Med. System* 2012, Vol. 6, Pg. no.1441-57.
- [4] Darwish A, Hassanien A E, "Wearable and implatable wireless sensor network solutions for healthcare monitoring", *Sensors (Basel)*-2011, Vol.11, Pg.no.5561-95.
- [5] Khan, J.Y.; Yuce, M.R.; Karami, Farbood, "Performance evaluation of a Wireless Body Area sensor network for remote patient monitoring," in *Engineering in Medicine and Biology Society*, 2008. EMBS 2008. 30th Annual International Conference of the IEEE, vol., no., pp.1266-1269, 20-25 Aug. 2008.
- [6] Sana Ullah , Henry Higgins , Bart Braem , Benoit Latre , Chris Blondia , Ingrid Moerman, Shahnaz Saleem , Ziaur Rahman , Kyung Sup Kwak, "A Comprehensive Survey of Wireless Body Area Networks", *Journal of Medical Systems*, v.36 n.3, p.1065-1094, June 2012
- [7] Perillo, Mark A., and Wendi B. Heinzelman. "Wireless sensor network protocols." *Algorithms and Protocols for Wireless and Mobile Networks*, Eds. A. Boukerche et al., *CRC Hall Publishers* (2004).
- [8] J.Y.Khan and M.R.Yuce, "Wireless Body Area Network (WBAN) for Medical Applications", *New Developments in Biomedical Engineering*, Domenico Campolo(Ed), InTech.
- [9] J.Ahmad and fareeha Zafar, "Review of Body Area Network Technology & Wireless Medical Monitoring" *International Journal of Information and communication Technology Research*, 2012.
- [10] Khan, Jamil Y., and Mehmet R. Yuce. "Wireless body area network (WBAN) for medical applications." *New Developments in Biomedical Engineering. INTECH* (2010).
- [11] Thomas D. Lagkas and George Eleftherakis, "An Overview of Wireless Sensor Networks: Towards the Realization of Cooperative Healthcare and Environmental Monitoring", Copyright © 2014. 23 page.
- [12] Khan J Y, Yuce MR, Bulger G and Harding B, "Wireless Body Area Netowrk (WBAN) design techniques and

- performance evaluation", *Journal of Med. System* 2012, Vol. 6, Pg. no.1441-57.
- [13] Darwish A, Hassanien A E, "Wearable and implatable wireless sensor network solutions for healthcare monitoring", *Sensors (Basel)*-2011, Vol.11, Pg.no.5561-95.
- [14] Khan, J.Y.; Yuce, M.R.; Karami, Farbood, "Performance evaluation of a Wireless Body Area sensor network for remote patient monitoring," in *Engineering in Medicine and Biology Society, 2008. EMBS 2008. 30th Annual International Conference of the IEEE*, vol., no., pp.1266-1269, 20-25 Aug. 2008.
- [15] Sana Ullah , Henry Higgins , Bart Braem , Benoit Latre , Chris Blondia , Ingrid Moerman, Shahnaz Saleem , Ziaur Rahman , Kyung Sup Kwak, "A Comprehensive Survey of Wireless Body Area Networks", *Journal of Medical Systems*, v.36 n.3, p.1065-1094, June 2012.
- [16] Manfredi, Sabato. "Performance Evaluation of Healthcare Monitoring System over Heterogeneous Wireless Networks", *E-Health Telecommunication Systems and Networks* 1.03 (2012): 27.
- [17] S. Brendard, M. Tabassum and HongSiang Chua, "Wireless Body Area Networks channel decongestion algorithm," *IT in Asia (CITA), 2015 9th International Conference on*, Kota Samarahan, 2015, pp. 1-6.
- [18] S. Ghanavati, J. Abawaji and D. Izadi, "A Congestion Control Scheme Based on Fuzzy Logic in Wireless Body Area Networks," *Network Computing and Applications (NCA), 2015 IEEE 14th International Symposium on*, Cambridge, MA, 2015, pp. 235-242.
- [19] M. T. I. ul Huque, K. S. Munasinghe and A. Jamalipour, "A Probabilistic Energy-Aware Routing Protocol for Wireless Body Area Networks," *2014 IEEE 80th Vehicular Technology Conference (VTC2014-Fall)*, Vancouver, BC, 2014, pp. 1-5.
- [20] Y. m. Baek, B. h. Lee, J. Li, Q. Shu, J. h. Han and K. j. Han, "An adaptive rate control for congestion avoidance in wireless body area networks," *Cyber-Enabled Distributed Computing and Knowledge Discovery, 2009. CyberC '09. International Conference on*, Zhangjiajie, 2009, pp. 1-4.
- [21] F. Chiti, R. Fantacci and S. Lappoli, "Contention Delay Minimization in Wireless Body Sensor Networks: A Game Theoretic Perspective," *Global Telecommunications Conference (GLOBECOM 2010), 2010 IEEE*, Miami, FL, 2010, pp. 1-6.