J. Basic. Appl. Sci. Res., **4(7)169-178, 2014**

ISSN 2090-4304
Journal of Basic and Applied Scientific Research
www.textroad.com

A Novel QoS Algorithm for Health Care Applications of Body Area Sensor Networks

Abdul Salam, Adnan Nadeem, Kamran Ahsan, Muhammad Sarim, Kashif Rizwan

Department of Computer Science, Federal Urdu University of Arts, Science and Technology, Karachi, Pakistan

Received: March 17, 2014
Accepted: June 14, 2014

ABSTRACT

Wireless Body Area Sensor Networks (WBASNs) applications have emerged as major type of Wireless Sensor Networks (WSN). It has a wide range of applications and plays a vital role in a society, particularly in health care system. Healthcare applications using WBASN required uninterrupted and reliable communication. In healthcare applications particularly in the monitoring of chronicle diseases patients data from critical sensors such as ECG needs to be delivered timely. Considering the requirement of QoS support in healthcare application of WBASN, this paper proposes a QoS algorithm for the provision of QoS support in WBASN on multi-hop topology; it increases the critical traffic data rate by ensuring a minimum delay of the data from critical sensors. The proposed algorithm provides QoS provisioning by defining three classes of services (i.e. guaranteed service, real time service, and best effort services). Data categorized into three classes using classifier and scheduled according to their priority with the help of priority queue. The proposed model is implemented using Castalia simulator and evaluated using a WBASN simulation scenario. Simulation results show the analysis of path latency, data rate and overhead of the proposed model and its impact on network performance.

KEYWORD: Quality of service, Wireless Body Area Sensor Networks, Wireless Sensor Networks, Classifier, Priority Queue

1. INTRODUCTION

Provision of quality healthcare services in the developing countries is of prime importance especially with the scarcity of medical experts. Wireless Body Area Sensor Networks (WBASNs) have recently emerged as a small scale short range sensor network, which comprises of a sink node (a mobile phone, PDA or laptop) and compact sensors, communicate with each other; these sensors are either wearable or implanted in the human body that continuously monitored vital body parameters. These sensors are used to record different parameters of the human body. The few examples of these sensors are accelerometer, ECG, EMG, temperature sensors, hearing aid sensors, and visual aid sensors.

WBASN could play a vital role in healthcare sector especially in the monitoring of chronic disease patient. This technology might help the patient where the access of clinical staff is difficult. The bio-sensors are continuously gathering data about the health of the patient gathers at the sink node. It can provide the real time feedback or treatment to the patient. It could also assist in emergency situations and inform emergency services for immediate help.

According to the report of the American Heart Association, the survival chances of the patient who is experiencing ventricular fibrillation is 48% to 75% within first 12 minutes. The decrement in the survival rate has been seen after 12 minutes 2% to 4% [1].

A chronic disease is an abiding condition which can be controlled but not alleviated; its illness effects the population worldwide. According to the Centre for Disease Control, chronic disease is a major cause of death and disability in the United States. In U.S., 70% deaths account by chronic disease which is 1.7 million each year [2]. Chronic diseases are the common and costly health problem and a routine visit is required for the chronic disease patient to monitor the progress and development of complications of the disease. The treatment plan will be effected by the choice what to monitor, when to monitor and how to adjust. Poor choices can have a sever effect on the patients' health.

Heart disease is a very common chronic condition which affects the people worldwide. It is the leading cause of death in the world and also a major cause of disability. According to WHO (World Health Organization) 17.3 million people died from heart disease in 2008 which is representing the 30% of all the global deaths, out of these deaths an estimated 7.3 million were died due to coronary heart disease while the rest of 6.2 million were died due to stroke. In the monitoring of heart disease patient minimum delay is required to transfer the critical data to health

***Corresponding Author:** Abdul Salam, Department of Computer Science, Federal Urdu, University of Arts, Science and Technology, Karachi, Pakistan. E-mail: a.salam@fuuast.edu.pk

care specialist. The most common heart disease is coronary which can lead to heart attack. Mostly elder people suffer from heart disease; they need a lot of care when they are admitted in the hospital.

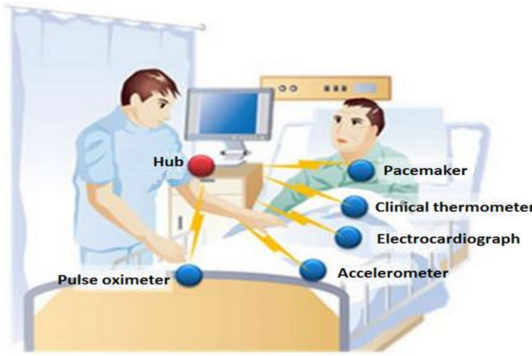

Figure.1. Architecture of Body Sensor Network

Implanted and wearable sensors are used to monitor the physiological and biochemical parameter of the patients. The data which is collected with the help of these sensors is transferred to the healthcare professionals to monitor the patient's vital signs. In the hospital environment an automated requirement of BAN address the new challenges which are faced by the health professionals during the process of collecting and managing delay sensitive medical information.

In monitoring patients especially for chronic disease patients, further efforts are required to improve the quality of services in health care applications. The Quality-of-Service (QoS) provisioning is a challenging task in the WBASN mainly due to energy and wide variations in data generation rate. The QoS in WBASN depends on three parameters; packet error rate, latency and energy. From the literature review we had seen that most of the work has been done on the MAC layer considering one of the QoS either on energy, timeliness or reliability, some also done work on the network layer.

According to [3],[4] numerous routing protocols have been proposed for the traditional Wireless Networks. However, these routing protocols cannot be employed on the WBASN system due to their different nature of applications environment. Despite a lot of work has done in the advancement of wireless technology, QoS in WBASN is still a complex job. The requirement of data criticality and condition dependent for the QoS in WBASN demands a new QoS solution in WBASN.

Due to heterogeneous working requirement, WBASN defines different QoS issues, which are specific to that particular application only. QoS requirements may vary based on context. WBASN applications are very sensitive hence require more attention and focus on QoS issues. However, QoS issues in sensor networks did not get lots of attention [5] as compared to other aspects such as architecture and protocol design, energy conservation, security, location and positioning of nodes.

The rest of the paper is organized as follows. Section 2 review the existing work from the literature. Section 3 presents the proposed QoS algorithm with technical details. Section 4 then evaluate the performance of the proposed algorithm. In section 5, we analyze the overhead of the algorithm and compare it with some related work. Finally, we conclude our work.

2. RELATED WORK

QoS aware routing in WSN divided into two classes Integrated and Differentiated. The integrated service involves the prior reservation of resources before sending it onto the network while no prior reservation is required in differentiated services. In differentiated services, you just mark the packets and send it onto the network. The QoS in WBASN is varying from application to applications. In [6] QoS differentiation schemes proposed for the IEEE 802.15.4 CSMA-CA which improve the latency and packet rates of the prioritized nodes. The [7] presented multi-stage low complexity QoS layer which improve the QoS in ambulatory conditions. The retransmission protocol which is define by QoS layer, consists of a interconnected set of linked lists in such a way that different types of defined services could be guaranteed.

Some researchers have suggested QoS at MAC layer [8, 9, 10]. In[8] an urgency based MAC (U- MAC) protocol is proposed, which based on the IEEE 802.15.4a standard at 2.4 GHz.In U-MAC protocol sensor nodes contend for the medium at the beginning of the MAC frame by using slotted aloha mechanism which further helps to divide the network traffic divided into two broad categories critical and non-critical. Critical node transmission prioritized over non-critical node transmission by cutting-off retransmission node packet. In [9] presents a QoS system for body sensor networks, called Body QoS which addresses the three unique challenges (asymmetric architecture, virtual MAC and adaptive resource scheduling strategy) to provide statistical bandwidth and reliable data communication in WBASN. In [10] present a novel mechanism which provides QoS for IEEE 802.15.4- based Wireless Body Sensor Networks. It is used for the pervasive healthcare applications and shows the improvement in terms of reliability and delay for inter node and intra node scenarios while keeping the backward compatibility to improve interoperability.

Wireless Body Area Sensor Networks (WBASNs) provide continuous health monitoring and analysis of physiological parameters. A high degree of QoS for WBASN is extremely required. In [11] authors proposed a decentralized inter-user interference suppression algorithm for WBASN, namely DISG.

WBASN deals with the variety of health care services. In [12], authors propose a packet scheduling schemes for real time transmission in WBASN. This proposed method is designed considering security and privacy e-health application. In [13] QoS-based MAC protocol is proposed to improve the QoS of medical wireless body area sensor networks. The sensor nodes are classified into two categories life-critical health information and non-critical health information. The proposed model prioritized the access of transmission medium for the critical packets by reducing the number of retransmission of the non-critical packets which increases the through put of the critical nodes. In[14], authors proposed a WBASN QoS provisioning framework based on the super frame structure of IEEE 802.15.4 beacon-enabled mode to provide a reliable communication services to the prioritized data in health care applications.

CICADA [15] or Cascading Information retrieval by Controlling Access with Distributed slot Assignment is a cross-layer communication protocol is present for WBASN which is based on tree structure. It setup a network tree in a distributed manner and use the tree structure for the guarantee collision free access to the medium and to route the data towards the sink. It provides a minimum delay while preserving network flexibility.

Prolonging network lifetime is a critical issue in WBASN, so energy constrained sensor nodes must carefully optimized. In [16], a novel QoS cross layer-scheduling mechanism proposed, which based on fuzzy logic rules. The main objective of this is to optimized MAC layer performance in terms of QoS and energy consumption by applying fuzzy-logic rules into the Distributor Queuing Body Area Networks (DQBAN). In [17] discrete-time Markov chain based analytical model is developed to evaluate the performance of the IEEE 802.15.6 WBAN MAC protocol in terms of throughput, power consumption, and energy efficiency. In [18] a heuristic adaptive routing algorithm is proposed to reduce the power consumption and to lower the delay for the emergency data in the wireless body area networks. In [19] QoS-driven scheduling approach is presented which used optimal slot allocation to overcome the technical challenges arrive in WBASN due to the energy consumption, channel variation and time varying traffic. The performance of BAN is often decreases in ambulatory condition due to the radio waves interference from the surrounding field.

LOCALMOR [20] is the localized multi objective routing protocol for Bio-medical applications. It is used flexible delay sensitive model approach to calculate delay .The delay sensitive module is responsible to select a path to route the delay sensitive packets. Neighbor's table updated the information of neighbors by receiving Hello packets. Neighbor manager module is responsible to send/receive the Hello packets and updated information of the neighbors. The LOCALMOR have been used separated routing functions for multiple packet types. All the packets are blindly duplicated toward both sinks (primary and secondary). This protocol is un-scalable and also increases the network overhead by sending too many duplicate packets.

DMQoS [21] is a data centric multi-objective QoS aware routing protocol for Wireless Body Area Sensor Networks. The network assumption for the protocol is that several nodes attached to the human body. All these attached sensors send their data to the central node which has high energy as compared to the other nodes. Several sink nodes are used in the implementation of the network. The DMQoS protocol is designed to communicate between the central nodes. The central node is also called coordinator. The disadvantage of the DMQoS hop-by-hop routing is that the source node depends only on the neighbor's node's reliability or delay information. If the neighbor node does not find any upstream next hop node with the required reliability or delay, the data packets are dropped. In this case source node assumes that packets are reached successfully to the destination node but in actual packets does not reach to the destination. Due to the heavy traffic load the required end-to-end latency may not be guaranteed.

The Quality-of-Service (QoS) provisioning is a challenging task in the WBASN due to the dynamic network topology and second the wide variations in data generation rate. The QoS in WBASN depends on three parameters; packet error rate, latency and energy. Most of the work has been done on the physical and MAC layer considering one of the QoS either on energy[7],[16] timeliness[8],[11],[12] or reliability[6],[8],[9].However there is a limited work done on network layer. The functionality of the WBASN has been developed by considering the MAC layer and physical layer due to the development of low power sensors. Most of the sensors for BASN in health care are simple functional sensors (i.e. they can sense and transmit). Now with the development of fully functional sensors in near future will allow multi hop communication in BASN. This introduces research challenges in routing and provision of QoS. Therefore, unlike most of research on physical and MAC layer, this paper proposed a QoS algorithm which works on network layer considering multi-hop path. The propose model provides QoS support for health care applications of WBASN. It provides a low delay and high data rate for the critical sensor node.

3. CLASS BASED QoS MODEL

3.1FUNTIONALITY OF THE PROPOSED QoS MODEL

This study now proposes the functionality and technical details of the proposed QoS algorithm. This study assumes that the fully functional sensors nodes placed on the body sense physiological parameters and are capable of performing some basic computation, storage and can transmit wirelessly to the sink node. The sink node assumed to have more processing power, battery and data storage capacity. The sink node is responsible for aggregating data and transmits it to the central base station as shown in Fig 2.

Sink broad cast the HELLO packet to every node after a certain interval of time where the time is divided into smaller units (time intervals *Ti*) such as *T1, T2,... ,Tn.* On receiving a packet from the sink each node generates a reply for the sink.

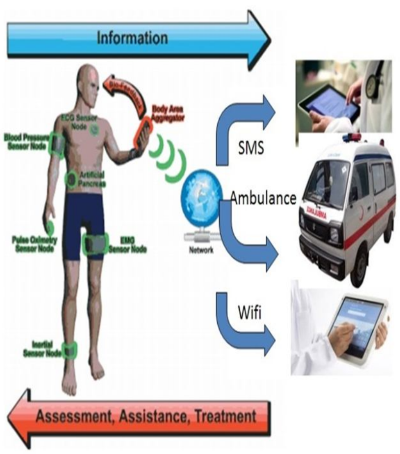

Figure.2.Model for remote monitoring and assistance of patients

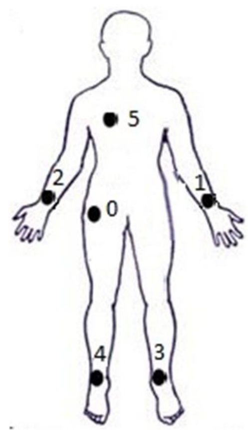

Figure.3. WBASN with sensor model.

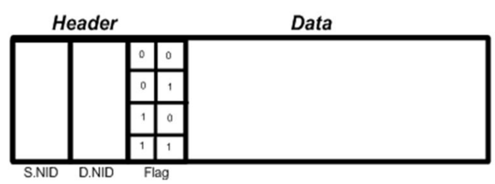

Figure 4.Format of Data Packets with flag bits

The sink maintains a table of nodes on the basis of their reply. It counts the number of nodes currently present in the network and writes their information in the table. Sink node uses the HELLO packets to update existing entries, add new entries when any node enter in the network and delete the entries when any node move away from the network or breakdown, which can be detected in case of not receiving the HELLO packet after a certain interval of time.

The QoS is required when different type of healthcare sensors competes for the resources.

The sensors in health care applications of WBASN can be divided into either critical or non-critical sensor based on their transmission delay requirements.

The proposed QoS model divides the sensor data traffic into three classes:

- Class A for guaranteed services.
- Class B for real time service.
- Class C for best effort service.

These three classes based on critical sensor with very minimum delay, non-critical sensor with minimum delay and non-critical sensor with high delay respectively.

We consider the WBASN shown in Figure3. We classify the traffic between sensors and sink into three classes. The traffic, which is going, and coming towards the critical sensor with least transmission delay requirement consider as class A. The sensor data with slightly higher transmission delay is considered as Class B traffic. Finally, the sensor data with high delay requirement is classifies as class C traffic. For example, in case of medical application monitoring ECG, EEG of the patients will fall in the class A. In another example, the video transmission sensor is included in class B, the objective of these category sensors is to provide real-time monitoring; the rest of the applications fall in category C where the transmission delay requirement is high.

In the proposed QoS model each node maintains the information of classifying data into classes and its corresponding scheduling technique. We add two bits flag inside the header of each packet to define the class of data with respect to the type of sensor. With the help of these two bits, we can distinguish between the data of different classes, i.e.

Flag value (01) represents the data of Class A
Flag value (10) represents the data of Class B
Flag value (11) represents the data of Class C

Figure 4 shows the format of data packets, which consist of two main parts header and payload. The header of the packet further divided into three parts S.NID (source node ID), D.NID (destination node ID) and Flag, the flag value define the type of data traffic. The classifier is used to categorize the individual sensor node data into one of the above-mentioned classes. The classifier has a predefined information table in which they have the information about the different types of sensor. Each class based on one of the above mentioned parameters. After receiving a data packet, the classifier first read the flag value from the header of the packet and then searches it in the table.

If the value matches in the table then it identifies the class of the packet (i.e. class A, class B or class C) otherwise assign it to the class D. After identifying the class of the packet, the second thing is to calculate the priority queue value of the packet, which depends on two factors that are sensor priority value and delay tolerance. The packets are en-queue in the priority queue according to their priority queue value.

3.2 SYSTEM MODEL

In our system model, we classify the data packets into three classes based on the type of sensor and its delay requirement. Fig 5 shows two basic module of our proposed QoS algorithm. The incoming packets are classifies with the help of classifier. The classifier is also calculating the priority queue value for the packets based on the sensor priority value and delay tolerance. After identifying the class and the priority queue value of the packet, the packets are en-queue into priority queue according to their assigned priority level and they are de-queue with the same priority level.

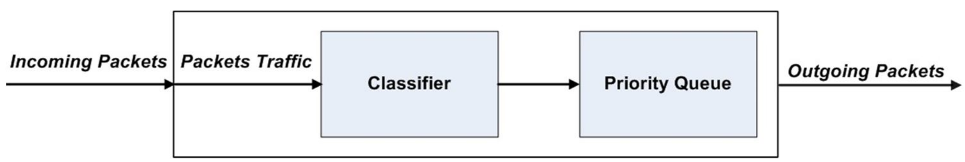

Figure .5. Basic Architecture of Proposed QoS Algorithm

3.3CLASSIFIER

The classifier contains a table in which it has the information about the class of the packet, type of sensor and delay tolerance. The classifier performs two very important task as shown in Fig 6, first it identify the class of the packet and second it calculate the priority queue value of the packet. After calculating the priority queue value it forwards the packet with the defined priority. The packets are en-queue in the priority queue according to their priority queue value and extract from here also in the same manner. For example, if the packet carries the critical data then class A will assign to it which means that this packet will move towards the destination with very minimum delay.

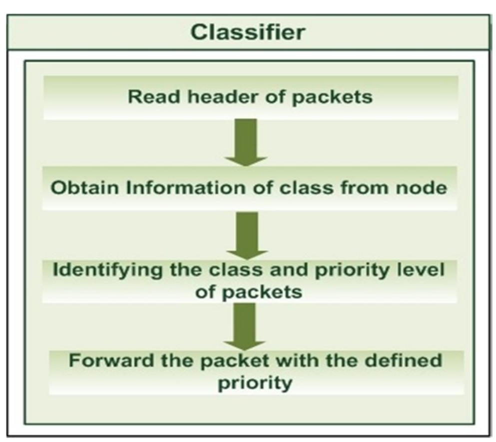

Figure.6. Proposed QoS model classifier

3.3.1 IDENTIFYING THE CLASS OF PACKET

On receiving the packet classifier first read the header of the packet; the header contains a two bits flag value, on the basis of flag value it decides that the packet belongs to which type of class. After reading the value of the flag from the header of the packet, it searches it in the table.

If the value of the flag is matched with the table value then assign it to one of the known class i.e. class A, class B and class C, and if the value of the flag does not match inside the table then it assign it to the unknown class i.e. Class D.

3.3.2 IDENTIFYING THE PRIORITY LEVEL OF PACKET

When classifier identifies the class of the packet, the second important task is to set the priority queue value of the packet. If the delay requirement is small then priority value is high and if the delay requirement is larger than the priority value is smaller.

The packets are en-queue and de-queue in the priority queue based on its priority queue value. The priority queue value calculated with the help of sensor priority value and delay tolerance. Priority of the packet determines the degree of importance and the types of data. Generally, the emergency alarm has the highest priority and the medical data has next highest priority. The priority classification summarizes in the Table 1.We have used the priority sensor values and the delay ranges in Table 1 as an example to implement the QoS algorithm. However, the algorithm in general can be applied any other configuration of sensors and delay requirements.

In the initial stage, we set the sensor priority value and range of the delay tolerance in millisecond. We assign the priority sensor value 1 for emergency alarm, 2 for medical continuous, 3 for medical routine, 4 for non-medical continuous and 5 for other data types. The delay requirement defines the range of maximum delay tolerance of packet in milliseconds.

The priority queue value for the prioritized queue calculated using equation 1:

$$P = \mathrm{frac}(x) = \begin{cases} x - \lfloor x \rfloor, & x \geq 0 \\ x - \lceil x \rceil, & x < 0 \end{cases} \qquad (1)$$

Here $x = PSV - DT$, PSV refers to the Priority Sensor Value and DT refers to the Delay Tolerance. After calculating the priority queue value, the packets are stored in the priority queue with their defined priority level.

Table.1: Priority Classification

Class	Priority sensor value	Data Types	Examples	Delay Requirement	Delay Range in millisecond
Class A	1	Emergency Alarm	emergency signs, battery depletion	very minimum	0.1
	2	Medical Continuous	EEG/ECG/EMG	minimum	0.1 - 0.2
	3	Medical Routine	temperature, Blood pressure	minimum	0.1 - 0.3
Class B	4	Non-medical continuous	real time audio ,video	minimum	0.4
Class C	5	others	file transfer	high	0.4 - 0.5

3.4PRIORITY QUEUE

Priority queue is maintained once the traffic is classified by the classifier. For this the algorithm uses the weighted queue and fairness of the queue is ensured by making each sensor to send their data periodically. The packets are coming in the priority queue according to the calculated priority value using equation 1. Packets are en-queue in the priority queue at their exact position. They served from the queue through their position. If the priority value is less than 0.4 then the data packet will be en-queue at the last position in the queue.

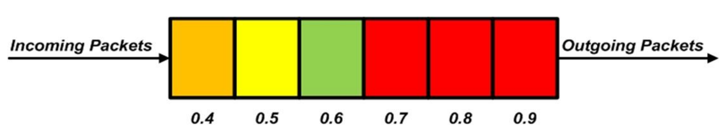

Figure .7. Priority Queue

3.5PSEUDO CODE OF QoS MODEL

Our algorithm works in three phases as shown in Fig 8 i.e., Node collection, Flag bit and Classifier. In node collection the sink broad cast the hello packet (*hpkt*) to every node (*Ni*) in the network after a certain period of time.

Periodic updates exchanged by Hello packet is used by sink to update the node table. The only disadvantage of sending the Hello packets after some interval of time (*Ti*) is that it causes of node energy depletion. In second phase the flag value (*flg_val*) of two bits are added in the header of the packet. After inserting the *flg_val* in the header of the packet forward it to sink or intermediate node. In third phase on receiving the packet at intermediate node the classifier first read the header of the packet. Extract the *flg_val* from it and search it in their own table.

```
Pseudo code of class based QoS Model

a) Node Collection
  .Sink(snk) Monitors the network for Time Interval (TI)
   .Do after each TI
         . snk broad cast the packet(pkt) to every node(Ni)
         .  Ni reply to the snk
         . snk collects  the reply from Ni
        . Update the node tabel
  . End do

b) Flag Bit
   .Select the node randomly
  .Create a pkt for it
  . Insert two bits flg_val in the header of the pkt
  . Send the packet to the sink/intermediate node

c) Classifier
  .Read the header of the packet
 .Extract the flg-val
 .Search it in the table
 .If the flag_val is matched within  table
        Assign the class A,class B or class C to pkt
 .else
        Assign the class D to pkt
 .end if
 .Calculates the priority queue value using equation 1
 . Forward the pkt with the defined priority vlaue.
```

Figure. 8. Pseudo code of Proposed QoS model

On behalf of *flag_val* it assign class to the packet (*pkt*).For example if the *flg_val*=00 then it assign the class A to the pkt, if *flg_val*=01 then it assign the class B to *pkt* and if the *flg_val*=10 then it assigns the class C to the pkt. However if the *flg_val* is not present inside the table then it assign the class D to the pkt. After assigning a class to the packet it calculates its priority queue value by using equation 1.All the packets are en-queue and de-queue from the priority queue according to their priority value.

Results show a significant improvement in the delay and data rate of the critical nodes after the implementation of our proposed QoS algorithm.

4. EVALUATION OF PROPOSED QoS MODEL

In this section we evaluate the proposed QoS model. We have implemented the QoS model using the Castalia a module of OMNET++.

Table.2: Configuration of parameters

Parameter	Value
No. of nodes	6 nodes
Transmit power	-15dB
Simulation time limit	500 sec
Start-up delay	1 sec
Packet rate	5 pkt/sec

Table.3: Position of the nodes

Node	Position
Node # 0	R-hip
Node # 1	L-wrist
Node # 2	R-wrist
Node # 3	L-ankle
Node # 4	R-ankle
Node # 5	chest

The parameter of the simulated environment shown in Table 2,the position of the nodes describe in Table 3 while Figure 3 shows the WBASN scenario consider, where a sink node and five sensors node are placed on the body for monitoring and assisting of the patients. The source node sent data to the sink by multi-hop routing. In the simulation of 51 seconds each node sends 250 packets to the sink node. The size of each data packet is 105 bytes. To assess the performance of the proposed algorithm we have analyze the path delay, data rate and overhead produced by the proposed algorithm.

4.1ANALYSIS OF PATH DELAY

To analyze the performance of proposed QoS model, we analyze the WBASN with and without QoS provision. We simulate both scenarios using Castalia. The first scenario runs with the no-provision of QoS while in the second scenario we run the simulation by applying the QoS model.

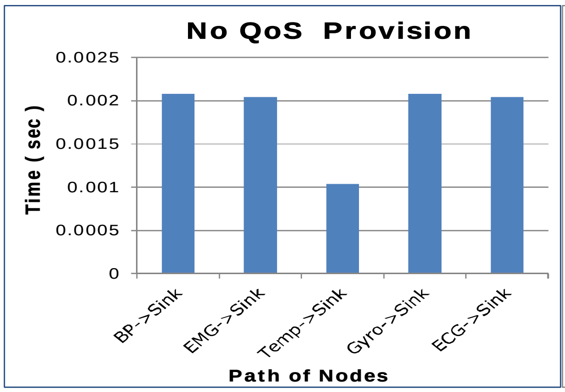

Figure. 9. End-to-end delay of paths with QoS Provision.

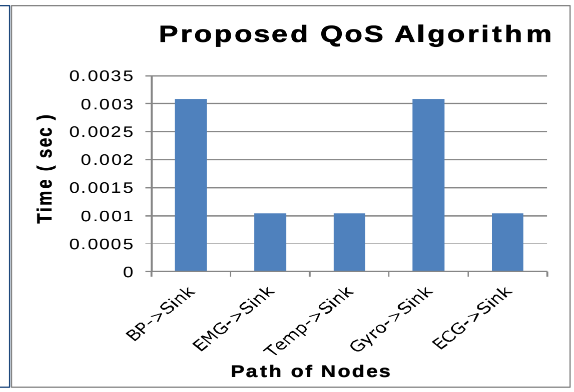

Figure. 10. End-to-end delay of paths with proposed QoS Algorithm.

We observe the end-to-end delay of critical nodes. The graph in Fig.9 shows the end-to-end delay of all paths from each sensor to the sink, when there is no QoS available in the network. The graph shows that the critical nodes such as ECG and EMG sensors was more than it tolerance limits define by the healthcare application. We then repeat the same scenario of WBASN with proposed QoS algorithm. Graph in Fig.10 shows the end-to-end delay of all the paths with proposed QoS algorithm. The graph indicates that the end-to-end delay of critical nodes paths has approximately decreased by 33%. However, it increases the end-to-end delay of non-critical nodes but their delay values are still within the desired limit. This ensures that the critical nodes get guaranteed services in terms of transmission delay.

4.2ANALYSIS OF DATA RATES OF THE PATHS

We evaluate and compare the data rate of all paths with and without QoS provision. In first scenarios we run the simulation without any provision of QoS and the second scenario by applying the proposed QoS algorithm using the same scenario of WBASN in Fig.3.

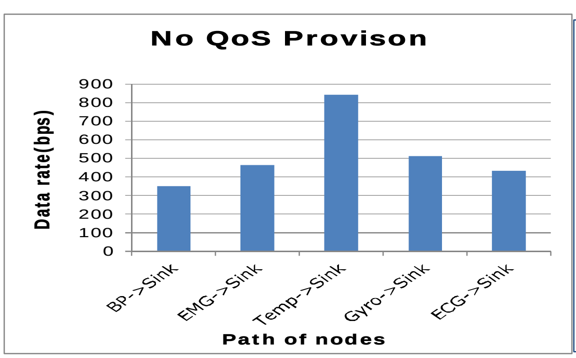

Figure.11. Data rate of all paths with no QoS.

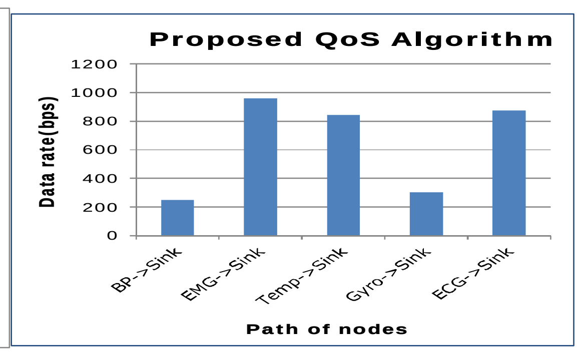

Figure .12. Data rate of different paths with proposed QoS Algorithm.

The Fig 11 and Fig 12 show the data rate in bits per second of all the paths in WBANS without QoS and with proposed QoS algorithm respectively. We can observe from the graphs that the data rate of critical nodes has increased when we applied the proposed QoS algorithm. We can relate these data rate analysis with the results in Fig.9 and Fig.10. The end-to-end delay of critical node decreases with proposed QoS algorithm. This results in increasing the number of data packets transfer per second. Although there is no significant difference in total number of packets transfer, but it still increases the data rates of critical nodes ensuring guaranteed service for critical sensors. Number of packets transfer, but it still increases the data rates of critical nodes ensuring guaranteed service for critical sensors.

4.3OVERHEAD OF QoS MODEL

In the simulation of 51 seconds the total no. of packets send by each node is 250 while the packet size with no QoS model is 105 bytes. Moreover, 131250 bytes are the size of all packets that are generated during simulation. However the size of the packet is increased by four bytes with proposed QoS algorithm mainly due to the additional information of the flag inside the packet. After applying the QoS model the total number of packets sent by each node is same i.e., 250 in the simulation of 51 seconds. The size of all the generated packets during the simulation is 525000 bytes. To estimate the overhead of our QoS algorithm, we calculate the number and size of the additional traffic generated by our QoS algorithm packet which is approximately 5 % of the overall traffic in the network, which is a very low sum.

5. COMPARISON

A Wireless body area sensor networks is used for patient monitoring in hospital and residential environments. On this basis we can categorized the WBASN in two types: inter- WBASN and intra-WBASN. The former provides the WBASN to WBASN communication or the communication between the WBASNS's while the second aggregates the vital signs of the patients inside each WBASN or it is the communication between entities within a WBASN.

We now compare the proposed QoS algorithm with the four existing models LOCALMOR[20], DMQoS[21], CICADA[15] and QoS for IEEE 802.15.4-based WBSN[10]. The comparison is shown in Table 4.

The proposed QoS algorithm is used for remote patient monitoring by using the intra WBASN communication while the LOCALMOR[20] and DMQoS[21] is used for general patient monitoring in the hospital environment. All of related QoS model are either works on MAC layer such as [20][10] or cross layer model such as [15][21], but our proposed QoS algorithm considering the development & availability of fully functional sensor devices works on the network layer. Unlike existing literature, we have implemented and evaluate our algorithm using Castalia which is a module of OMNET ++ specifically designed for WBASN.

Table.4: Comparison of proposed QoS algorithm with some of related algorithm in literature.

Comparing Parameter	LOCALMOR[20]	DMQoS[21]	CICADA[15]	QoS for IEEE 802.15.4-based WBSN[10]	Proposed QoS Algorithm
Environment Contemplate	Hospital Environment	Hospital Environment	Remote health monitoring.	pervasive healthcare applications	Chronic disease patient monitoring
QoSMatrics	Reliability , Energy, Delay	Reliability , Energy, Delay	Delay and Energy	Delay, Reliability	Minimum delay with high data rate
Layer Consider	MAC Layer	Cross Layer	Cross Layer	MAC Layer	Network Layer
Type of WBASN communication	Intra WBASN	Intra WBASN	Inter WBASN	Inter/Intra WBASN	Inter WBASN
Implementation method	GloMosim	NS2	Nsclick	Philips AquisGrain platform	Castalia

6. CONCLUSION

This paper first addresses the need of the provision of QoS in healthcare application of WBASN. We then propose algorithm that ensures three types of QoS considering the type of sensors and their desired requirement. The proposed QoS algorithm ensures three types of services in the network according to the severity and importance of type of sensor devices. Simulations results suggest that it ensures minimum tolerable delay for critical node communication (guaranteed services), real-time services for less critical nodes and best effort services for the other sensors nodes in the network. We believe the proposed QoS algorithm will assist in the efficient monitoring and assistance of chronic disease patients. The proposed QoS algorithm can be integrated with any routing protocol.

REFERENCES

1. Shih, E., Bychkovsky, V., Curtis, D., &Guttag, J. "Demo Abstract: Continuous Medical Monitoring Using Wireless Microsensors", *SenSys'04, November 3–5, 2004, Baltimore, Maryland, USA*
2. "What is Chronic Disease?", 2011 University of Michigan [Online]. Available: http://cmcd.sph.umich.edu/what-is-chronic-disease.html. [Accessed 20 March 2014]
3. N. Javaid, et al. "Wireless Proactive Routing Protocols under Mobility and Scalability Constraints"J. Basic. Appl. Sci. Res., 3(1)1187-1200, 2013
4. S. Ahmed, et al. "Comparative Analysis of Routing Protocols for Under Water Wireless Sensor Networks" J. Basic. Appl. Sci. Res., 3(6)130-147, 2013
5. Lotf.J; and Ghazani.N, "Overview on Wireless Sensor Networks"J. Basic. Appl. Sci. Res., 1(12)2811-2816, 2011
6. Feng Shu, "Performance evaluation of the IEEE 802.15.4 CSMA-CA protocol with QoS differentiation," *Intelligent Sensors, Sensor Networks and Information Processing, 2008. ISSNIP 2008. International Conference on* , vol., no., pp.475,480, 15-18 Dec. 2008
7. Massé, F.; Penders, J., "Quality-of-Service in BAN: PER Reduction and its Trade-Offs," *Body Sensor Networks (BSN), 2010 International Conference on* , vol., no., pp.261,266, 7-9 June 2010
8. Ali, K.A.; Sarker, J.H.; Mouftah, H.T., "Urgency-Based MAC Protocol for Wireless Sensor Body Area Networks," *Communications Workshops (ICC), 2010 IEEE International Conference on* , vol., no., pp.1,6, 23-27 May 2010
9. Gang Zhou; Jian Lu; Chieh-Yih Wan; Yarvis, M.D.; Stankovic, J.A., "BodyQoS: Adaptive and Radio-Agnostic QoS for Body Sensor Networks," *INFOCOM 2008. The 27th Conference on Computer Communications. IEEE* , vol., no., pp.565,573, 13-18 April 2008
10. Garcia, Jose Javier, and Thomas Falck. "Quality of service for IEEE 802.15. 4-based wireless body sensor networks." In Pervasive Computing Technologies for Healthcare, PervasiveHealth 3rd International Conference on, pp. 1-6. IEEE, 2009
11. Guowei Wu; JiankangRen; Feng Xia; Lin Yao; ZichuanXu, "DISG: Decentralized Inter-user Interference Suppression in Body Sensor Networks with Non-cooperative Game," *Ubiquitous Intelligence & Computing and 7th International Conference on Autonomic & Trusted Computing (UIC/ATC), 2010 7th International Conference on* , vol., no., pp.256,261, 26-29 Oct. 2010
12. Barua, M.; Alam, M.S.; Xiaohui Liang; XueminShen, "Secure and quality of service assurance scheduling scheme for WBAN with application to eHealth," *Wireless Communications and Networking Conference (WCNC), 2011 IEEE* , vol., no., pp.1102,1106, 28-31 March 2011
13. Ali, K. A., Sarker, J. H. &Mouftah, H. T., 2010. QoS-based MAC protocol for medical wireless body area sensor networks. s.l., s.n., pp. 216-221.
14. Cao, H., Gonz.V.S. & Leung, V. C., 2010. Employing IEEE 802.15. 4 for quality of service provisioning in wireless body area sensor networks. s.l., s.n., pp. 902-909.
15. Latre, Benoit, Bart Braem, Ingrid Moerman, Chris Blondia, Elisabeth Reusens, Wout Joseph, and Piet Demeester. "A low-delay protocol for multihop wireless body area networks." In Mobile and Ubiquitous Systems: Networking & Services, Mobi Quitous Fourth Annual International Conference on, pp. 1-8. IEEE, 2007.
16. BegonyaOtal et al., Novel QoS scheduling and energy-saving MAC protocol for body sensor networks optimization, in Proceedings of the ICST 3rd international conference on Body area networks 27 (ICST (Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering) 2008).
17. Jung, B. H., Akbar, R. U. & Sung, D. K., 2012. Throughput, energy consumption, and energy efficiency of IEEE 802.15. 6 body area network (BAN) MAC protocol. s.l., s.n., pp. 584-589.
18. Seo, S.-H.et al., 2010. An energy-efficient configuration management for multi-hop wireless body area networks. s.l., s.n., pp. 1235-1239.
19. Yan, Z., Liu, B. & Chen, C. W., 2012. QoS-driven scheduling approach using optimal slot allocation for Wireless Body Area Networks. s.l., s.n., pp. 267-272.
20. DjamelDjenouri and IlangkoBalasingham. New qos and geographical routing in wireless biomedical sensor networks. In Broadband Communications, Networks, and Systems, 2009. BROADNETS 2009. Sixth International Conference on, pages1-8. IEEE, 2009.
21. MdAbdurRazzaque, ChoongSeon Hong, and Sungwon Lee. Data-centric multiobjectiveqos-aware routing protocol for body sensor networks. Sensors, 11(1):917-937, 2011.