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Performance of Medium Access Control Protocol in WBAN for Energy Conservation

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Abstract- Wireless Communication and Wireless Networking is the popular research in this era. The combination of this is useful method for one step ahead to increase the life of human being who are part of different lifecycle are senior citizen, teen rage and the youth on this world. The issue is to increase the growth of all this living mankind from different serious diseases so the technology and communication is BAN (Body Area Network) through wireless is Wireless Body Area Network. We do the research on the Data link layer of the stack protocol used in WBAN, so to increase the life of battery having the energy with some constraint because one's the energy is utilized we cannot extend its energy only by replacing the battery so the main innovation for the research will to create the proposed protocol using existing MAC protocol performance so the total energy used for the data transmission should be minimized to increase the battery life. Transmission of data is in different condition may be in Normal, On-demand and Traffic which leads to consume more energy to overcome this there are different MAC protocol for performance in WBAN like S-MAC, Wise-MAC with IEEE 802.15.6 standard.

Keywords—*Wireless Body Area Network, CSMA-CA, TDMA, S-MAC, Wise-MAC, Frame format, Contention-window Synchronization, Prposed MAC, Back-off and Periodic CSMA-CA based Algorithm.*

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I. INTRODUCTION

Wireless Body Area Network it is one of the subset of Wireless Personal Area Network, Wireless Sensor Network and Wireless Local Area Network. WBAN is having the one module, layered architecture, protocol stack for WBAN and as the motto of the research is to implement the protocol on Data-Link Layer which is the WBAN stack protocol layer architecture use to increase the life time of battery by energy saving. We can see the following table the Protocol Layer Working in OSI-ISO layer, WSN and WBAN Layer architecture is purposely working for number of applications there is a difference between the OSI, WSN and WBAN architecture. All the layers are working for the communication between the packets in case of OSI and Sensor nodes in case of WSN or WBAN. The purpose is to Increase the overall energy- efficiency protocol stack.

The different layer of protocol stack as shown in the figure 1 can be explaining as follows:

A. PHYSICAL LAYER

In WBAN, the range of the transmission of data depends upon the type of sensor nodes. Inter-Body communication and Intra-Body communication. The distance in layer is taking into consideration, as the work for physical layer is Narrow Band (NB) PHY Ultra-Wide Band (UWB) PHY and Human Body Communication (HBC) PHY.
The parameters which are fixed on this layer, to measure the physical parameters of the patient such as Blood Pressure (BP), SPO_2, ECG (Electro Cardio Graph), EEG (Electroencephalogram),Body Temperature, EMG (Electro-my gram) and respiratory rate[1].

B. DATA-LINK LAYER

MAC (Medium Access Control) protocol plays the important role in maintaining the QOS of the WBAN. MAC is group into the two parts for transmission of data and increase the Scalability. Contention Based Protocol or Random Access Protocol (CSMA/CA) and Contention Free Protocol or Scheduled Based Protocol (TDMA).

C. NETWORK LAYER

It Depends upon the QOS issue like path latency, will improve the Routing method, the traffic on the network at each sensor node which transmit the data for communication and will increase the network lifetime for maintain the energy efficiency.

D. TRANSPORT LAYER

It decides the range of bandwidth, to improve reliability, latency and cost.

E. APPLICATION LAYER

The communication range in meters is 1-tier, 2-tier and 3-tier architecture.

Intra-BAN communications:
About two meters range around the human-body it can further categorized into the communication between BSN (Body Sensor Nodes) and Communication between BSN and CCU (Body Sensor Nodes and Central Control Unit)

Inter-BAN communications
It is the communication between CCU and one or more AP (Access Points) as the APs can be working in to the BNC (Body Network Controller).

F. PROTOCOL STACK

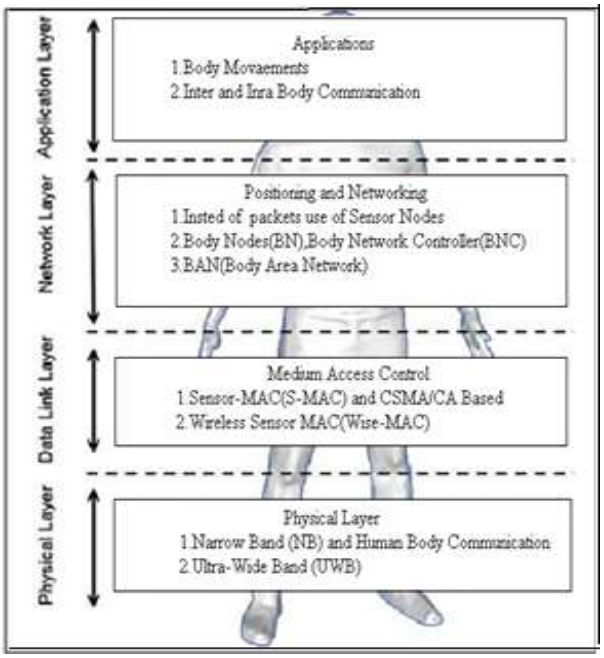

Figure 1: Protocol Stack for WBAN

II. RELATED WORK

Medium Access protocol work for the Data-Link layer and we have to minimize the consumption of power from each sensor nodes, which are use in WBAN.

The Proposed WBAN 5 Layer model is working for the data transmission, as the number of the sensor nodes with the fixed parameters and we will take into consideration the IEEE standard 802.15.6 for body area network use the MAC format.

The following table 1: Gives the number of layers is define for each model.

OSI LAYER	WSN	WBAN
Application layer	Upper Layer (Communications)	Application layer (Data reliability and resolution)
Presentation Layer	Middleware	-
Session Layer	-	-
Transport Layer	Transport protocol	Latency and Cost
Network Layer	Routing protocol	Network layer (localization, routing, maintenance and positioning)
Data-Link Layer	Error control MAC protocol	Sensor-MAC, Wise-MAC and Energy efficiency
Physical Layer	Transceiver	short-range and long – range, uplink-downlink

Table 1: Layer Architecture

A. MOTIVATION

MAC protocol for WBAN will consider the following design issues [2]

1. To increase the lifetime of nodes we have to minimize the power consumption of each node.
2. The sleep mode of each sensor node should be maximum
3. The unnecessary wake-up period of node should be minimized to save the energy
4. To save the energy we have to maintain the overhead, idle listening time, collision, retransmission of packet and delay.
5. The data transmission is efficient in Normal, On-demand and Emergency traffic immediately.

Therefore, we will overcome these issues by studying the existing MAC protocol in WBAN.

The following table 2: Gives the suitable method to maintain the energy efficiency from MAC protocol.

CSMA/CA	TDMA
Energy efficiency is high	It is low
Periodic and Non-periodic traffic is handle efficiently	Efficiently handle periodic but non-periodic is not due to delay.
Packet delay and loss is dynamic, changeable and non-deterministic	It is static, fixed and deterministic
Scalability is poor	Scalability is good

Table 2: Compare CSMA/CA and TDMA

B. EXISTING MAC PROTOCOL FOR WBAN

1. Low power listening :

Protocol use is Wise-MAC (Wireless Sensor Medium Access Control) operation is base on random access protocol.

Advantage: It supports the scalability and mobility.

Disadvantage: Low-high power consumption depends upon traffic load.

Adaptability: Good for Normal, On-demand and Emergency traffic and not suitable for Low duty cycle.

2. Schedule Contention:

Protocol use is S-MAC (Sensor-Medium Access Control) operation is base on schedules.

Advantage: High transmission latency.

Disadvantage: Low throughout.

Adaptability: Throughput is not concern in medical applications.

3. TDMA (Time Division Multiple Access)

Protocol use is LEACH and HEED operation base on cluster scheme.

Advantage: Prolonged network lifetime and load balancing.

Disadvantage: Require extra overhead for dynamic clustering.

Adaptability: Mesh size is frequently determined.

C. IEEE 802.15.6

It is use for medical and non-medical applications [3].

Requirements are:

1. Energy-efficiency
2. Network structure i.e. star topology for short distance is use.

3. Scalability like data rate is varying from kbps to mbps and duty cycle.
4. Must have reliability, security, handle heterogeneous traffic and interoperability.

The MAC layer in IEEE 802.15.6 is intense to define short range and wireless communication inter and intra body communication.

- Super frame IEEE 802.15.6 having two modes of communication
- Beacon enabled mode and Non-Beacon mode.
- MAC having following parts
  1. Beacon
  2. Exclusive Access Period (EAP)
  3. Random Access Period (RAP)
  4. Contention Access Period (CAP)

The following figure 3: Gives frame for MAC is use for energy efficiency of sensor node.

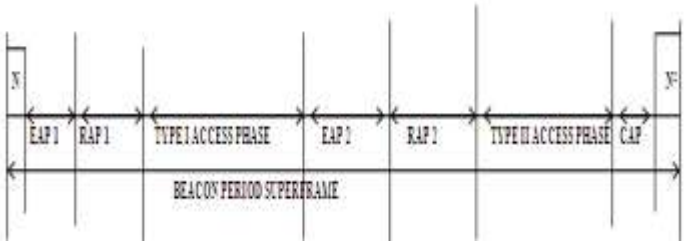

Figure 2: frame structure for MAC IEEE 802.15.6

D. PROPOSED S-MAC IEEE 802.15.6

Sensor-MAC having following merits and demerits, which will take into consideration:

Merits:

- Simple
- High latency
- Time synchronization using periodic CSMA/CA takes into consideration.

Demerits:

- Low throughput
- Overhearing and collision- If packet is not destined to destination mode

To make energy efficiency mechanism and high throughput we will use the Priority organized CSMA/CA or Scheduled Based Slots.

S-MAC will use the Beacon period Type I/II Access for 'N' number of sensor nodes.

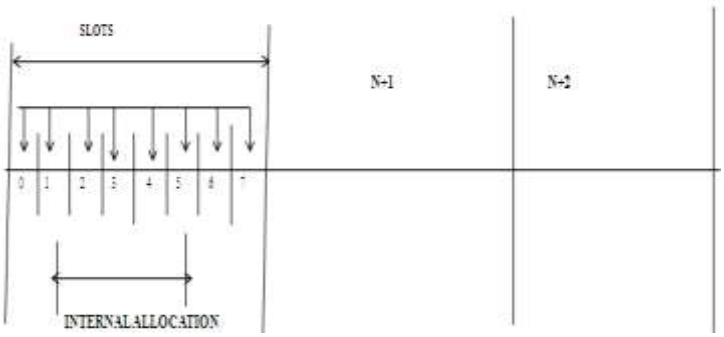

Figure 3: frame structure for S-MAC (CSMA/CA) IEEE 802.15.6

E. DEFINED TOPOLOGY FOR IEEE 802.15.6

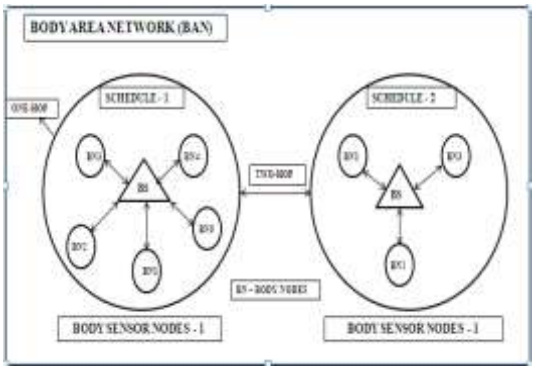

Figure 4: Defined Topology for IEEE 802.15.6

The medium access and the power management coordinated by all the sensor nodes and their respective base station (BS) in Body sensor Network (BSN). IEEE 802.15.6 standard supports the single-hop and two-hop network. In single-hop network all the sensor nodes communicate with the base station (BS) so the defined topology is star-topology for BSN. The following figure 5: Gives star topology for periodic CSMA/CA schedules based BSN [5].

III. WORKING MODEL

We will implement the following model as shown in the figure 6: Gives the proper method to reach at our goal, as will take the parameters that are fixe to calculate the parameters from table 3: Gives the on-body and in-body sensor nodes [4].

In our proposed model will take the two measure units for BNC (Body Network Controller) i.e. CCU (Central Control Unit) and MMU (Memory Management Unit). The distance in meters will take seriously for instant data transmission for normal, on-demand and emergency traffic.

AP is the Access point for short and long distance range that will use the star topology and tree structure in multi-hop.

For wireless communication, we will use the simulation results for new technology JAVA using the independent platform, dynamic and flexible structure.

Results for parameters are generating at the database server that will be the back-end of JAVA technologies [6].

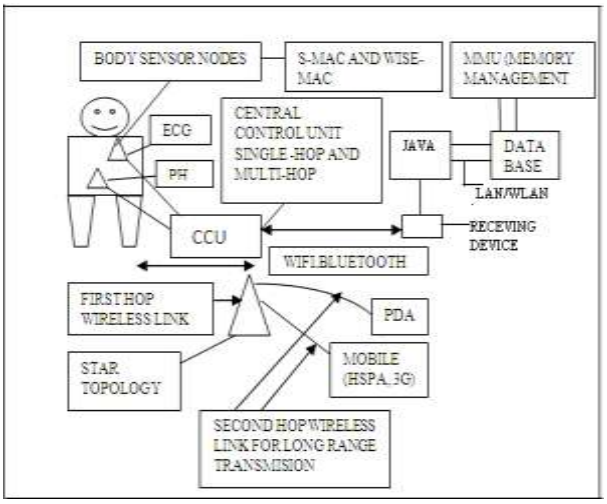

Figure 5: Proposed Model for WBAN

Parameters	Range of Parameters	Signal Frequency
ECG signal	0.5-4 mV	0.01-250 Hz
Respiratory rate	2-50 breaths/min	0.1-2 Hz
Blood Pressure (BP)	10-400 mm Hg	0-50 Hz
EEG	3 µV-300 µV	0.5-60 Hz
Body temperature	32-40^{0}C	0-0.1 Hz

Table 3: Parameters for WBAN

A. PERIODIC CSMA/CA BASED ALGORITHM USING S-MAC

IEEE 802.15.6 has the performance evaluation of periodic CSMA/CA mechanism, we will consider in our algorithm that the body nodes (BN) in WBAN operates with beacon mode and all the BN synchronized to support the contention based mechanism of S-MAC protocol.

STEP 1:

The BN keep at the access phases that includes EAP1, RAP1, Type I/II and EAP2, RAP2, and CAP (Contention Access Period)

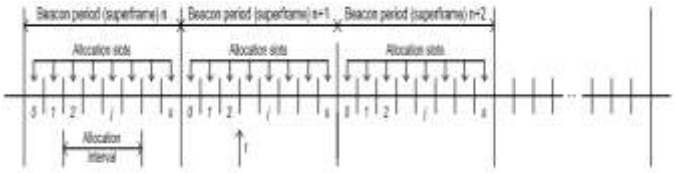

Figure 6: IEEE 802.15.6 Time reference model

STEP 2:

There are eight different priorities indicate UP (user priority) for accessing the medium for patient body nodes in emergency condition.

STEP 3:

The UP's are prioritized by value of contention window i.e. CW_{max} and CW_{min}.

STEP 4:

Only the UP7 nodes give the opportunity to decrease their backup counter or access the Medium during EAP periods, while all nodes can periodic in the medium access during RAPs and CAP. Hence, nodes are prioritized by a combination of assigning different medium access contention parameters and medium access time constraints.

STEP 5:

If BN did not have an allocation then the CW (Contention Window) set to CW_{min} else, if CW gets the data transmission acknowledgement then it remains unchanged.

If nodes not received expected acknowledgement, then in last allocation.

B. MATHEMATICL MODULE

For above proposed model as shown in figure 6. will take the Number of sensor nodes are five, the Sensor-MAC protocol will use for data transmission for IEEE standard 802.15.6.

1. PROBLEM DESCRIPTION

Let A be a protocol (S-MAC) that transfer data such that.

Where A= [E, C, M, S, W, P]

Where, A Represents data transmission protocol; A= {a1, a2},

E Represents ECG sensor for '1'.

$E= \{e_0 \mid \varphi\ e\}$,

C Represents CCU (Central Control Unit).

$C= \{c_0 \mid \varphi\ c\}$,

M Represents Mobile Unit number of

$M= \{m_0, m1, m2, m3 \ldots m_n \mid \varphi\ m\}$,

S Represents Central Server '1'.

$S= \{s_0 \mid \varphi\ s\}$,

W Represents W_{ban} no. of

$W= \{w_0, w1, w2, w3 \ldots w_n \mid \varphi\ w\}$,

P Represents Priority CSMA/CA based

$P= \{p_0, p1, p2, p3 \ldots p_n \mid \varphi\ p\}$

IV. CONCLUSION

In this paper, we proposed a WBAN infrastructure that supports on-demand, emergency, and normal traffic using wakeup and main radios. This infrastructure proves to be adequate for unobtrusive health monitoring. Existing low-power MAC protocols have several limitations to accommodate the heterogeneous traffic in a reliable manner and hence require new power-efficient solutions. We finally outlined the potential of a WBAN for ubiquitous healthcare, entertainment, and military applications.

V. REFERENCES

[1] Jamil.Y.Khan and Mehmet R.Yuce, "*New Developments in Biomedical Engineering*" In Tech 1 January 2010.

[2] IEEE Computer Society for Local and Metropolitan Area Network IEEE 3 Park Avenue New York, NY 10016-5997 USA 29 February 2012

[3] Byoung Hoon Jung, Raja Usman Akbar, and Dan Keun Sung, 2012, "Throughput, Energy Consumption, and Energy Efficiency of IEEE 802.15.6

[4] Body Area Network (BAN) MAC Protocol" IEEE 23rd International Symposium on Personal, Indoor and Mobile Radio Communications - (PIMRC) 584-589.

[5] S. Hayat, N. Javaid, Z. A. Khan§, A. Shareef, A. Mahmood, S. H. Bouk, 2012, "Energy Efficient MAC Protocols" IEEE 14th International Conference on High Performance Computing and Communications, 1185-1192.

[6] Shajahan Kutty and Laxminarayan J.A, 2010, "Towards energy efficient protocols for wireless body area network"5th International Conference on Industrial and Information Systems, 31-34.

[7] Xin Feng, 2011, "Study of MAC protocol fairness of WBANS" International Conference on Computer Science and Network Technology,795-799.