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BUFFER TRAFFIC-AWAR WIRELESS BODY AREA NETWORK FOR EFFECTIVE PACKETS TRANSMISSION

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KeyWords: Buffer Traffic, Cluster, Hop-distance, Routing protocol, Sink node, Transceiver sensor node, Wireless Body Area Network

Abstract

Wireless Body Area Network is an integral part of Wireless Sensor Network, designed to provide healthcare services to the patient, where sensor nodes are strategically deployed in the human body and communicate the body condition to assigned medical personnel via the internet. In WBANs, one of its challenges is limited energy due to its finite nature, hence, well-efficient and effective management of the network energy must be deployed to have a continuous operation of the network activities. In this study, we adopt the Buffer traffic scenario and Time-division multiple access to enhance the network energy efficiency. The simulation result shows that the improved algorithm outperforms the existing algorithm with a percentage improvement of 6.59% in terms of throughput.

1. INTRODUCTION

Wireless Body Area Network (WBAN) has played its part in the WSN environment in the past decades to produce a remote healthcare monitoring scheme [1]. The most important role in delivering medical services is due to the scarcity of clinical applications [2] due to the high increment in the old age population [3] that is associated with longstanding ailments. When these physiological signs are been discovered in the human body, the sensor nodes convey these data via sink node to the medical personnel [4]. Early detection of this ailment and proper deployment of the WBAN save the life of the patient on time from deterioration. One of the limitations of WBANs is energy efficiency and a proper systematic approach is highly required to manage the energy system in the network during data transmission in order to continue in the network operation [5]. WBANs comprise sensor nodes, the entirety of power utilization in the network is derivable from the transmission energy and circuit energy [6][7]. Although, utilization of circuit power in the network is lower with the help of microelectronics which is characterized by low power. A well manage strategy is will be deployed in the network during packet transmission: is to minimize energy consumption and maximization of network lifetime. Buffer traffic scheme will be introduced to specify the individual nodal capacity in the network, thereby minimizing the number of dead nodes in the network system, and improves network throughput.

RESEARCH WORK

In [8], the authors proposed an efficiency in energy communication for WBAN. In this work, the authors evaluate the energy utilization approach with respect to communication to distance, and communication data rate in wearable WBAN. A trade-off was carried out between the communication packet and circuit power, which culminates in power saving in WBAN. The network Simulation shows that the improved algorithm outperforms the existing algorithm. However, non-consideration of Buffer traffic condition amongst the individual nodes during transmission in the network reduces the level of energy it would have got.

In [9]. The authors proposed a scheme that is executing wireless transmission delay-constrained scheduling in IoT-Based Healthcare servicing. In their work, different physiological data were randomly aggregated at their individual gateway and their respective delay- constrain. Also, in their work, the uplink WBAN communication is scheduled by the base station, by creating a queuing system that addresses medical-grade QoS needed by considering the intelligence in the devices of the smart gateway that are embedded in the IoT system. However, if they were to consider Buffer traffic of the individual nodes in the network, more energy would have been gotten than the one they got.

In [10] proposed, an adaptive congestion aware scheme, that is employing fuzzy logic controller for WBAN, in their work, they employ ACK that registers for congestion traffic status. They create two avenues by which energy minimization is utilized in the network via radio chips, then the outcome optimizes the energy utilization. However, if they were to look into the direction of individual nodes' buffer traffic status to determine their respective current capacity during the transmission, more energy would have been recovered than what they got in their work.

In [11] proposed IEEE 802.15.6 performance evaluation in WBAN with heterogeneous congestion. In their work, they evaluate the general performances in IEEE.802.15.6 effectively in terms of the CSMA/CA back-off approach, and the other is M/G/I queuing approach. However, more energy would have been seen in the network, if they could have considered the buffer traffic state of the individual nodes in the network.

For a network to continue its operational activities, a well-organized management system must be deployed to optimize its energy efficiency. Buffer traffic state of individual nodes in the network must be expressed to ascertain the level of the current capacity of nodes before a packet is been transmitted during transmission operation, and also, Time Division multiple access will allow the nodes that have a packet to transmit to be in active state, whereas, those without packet to transmit to be in sleep mode, thereby conserving the individual node in the network, which will culminate in an improve throughput of the system.

Wireless Body Area Network (WBAN)

WBAN came into the limelight decades back, it a new technology designed to provide medical healthcare services remotely, whereby physiological signs are been collected from the human body using sensor nodes and transmitted to the cluster head, and the cluster head collects, aggregates and sent to medical personnel via the internet for further analysis. It is Rf based technology.

2. METHODOLOGY

2.1.Evaluating Node Buffer Traffic Scenario Threshold

For effective communication amongst the nodes in the network system, there is a need to develop an algorithm that evaluates the Buffer Traffic scenario (BTs) of the individual nodes in the WBAN. This BTs is employed as a cost function during the route search. Its function is to specify the current capacity of all the individual nodes in the WBAN. In the course of the initiation of transmission, every sensor node in the network incorporates its current buffer capacity in its reply packets (Swhwertzer& Lam, 1976). An average of the buffer capacity value is employed as a threshold for the forwarding process, an average value of buffer capacity was considered because, since the outcome of the packets is a physiological sign, one cannot determine the future outcome of that physiological sign from the present, that is an adaptive system, and the best way to evaluates such capacity must be in average. The model equation for determining the threshold of BTs in the network is given as:

$$BTs = \frac{Size\ of\ the\ packet\ in\ the\ Buffer}{Size\ of\ the\ Buffer} \quad (1)$$

The evolve BTs threshold value is obtained, by considering the BTs value of an individual node's in the network as follows:

$$BTs_{th} = \frac{bts\,1 + bts\,2 \ldots\ldots btsn}{N} \quad (2)$$

Where:

bts_1 is the buffer traffic scenario value of the nth node.

N is the total number of nodes in the network.

By the application of this model equation (2) in a transmitting network, where each of the sensor nodes is made to specify their current buffer status during transmission of packets by the buffer traffic scenario, whenever a transmitting node transmits the packet to its intermediate nodes, the first thing the BTS_{th} will look out for, is to determine its current capacity because, when there is an operational activity in the network, the initial energy of the sensor nodes before transmission are not the same with the current energy during operation, that is residual energy, then, when BTs_{th} sees the receiving intermediate sensor nodes current capacity is lesser than what it can accommodate with the packets, it will look out for the sensor nodes within the neighborhood that has the capacity to handles such incoming packet, by so doing conserving the individual nodes energy in the network, which will accumulate to the total network energy. If there is no BTs_{th} in the network, the receiving packet within the neighborhood whose current capacity is smaller than the incoming packet will experience a dead node, and such information cannot reach its destination, with the proper application of this equation (2) saves all from such a bad situation.

2.1.1. Dynamic Sleep – Mode Time Division Multiple Access MAC

Dynamic sleep-mode Time Division Multiple Access (TDMA) MAC following the connection between the Sink node/ controller/cluster head, a request frame is sent by sensor nodes, whereby they request the sink node to allocate them a number of Time Division Multiple Access slots due to its configuration. When the sink node receives the request, an acknowledgement is sent to the sensor nodes by the sink node and provides it with the number of time slots that is commensurate to the number of requested time slots. Sensor nodes are programmed to access the wireless channel when the sink node gets the Time Division Multiple Access time slot time request. Any sensor nodes that have been requested and been accepted first by the sink node, will employ the wireless channel before any other ones. Due to the programming, a sensor node will only wake-up, when it is in the assigned time slots period to transmit its data, otherwise sleep. These programming of sensor nodes to sleep, when there is no packet to transmit and be in active mode when there is data to transmit, help to minimize the energy consumption in the network, hence improving throughput and network lifetime maximization, and the number of the connectable wireless channel is given [13].

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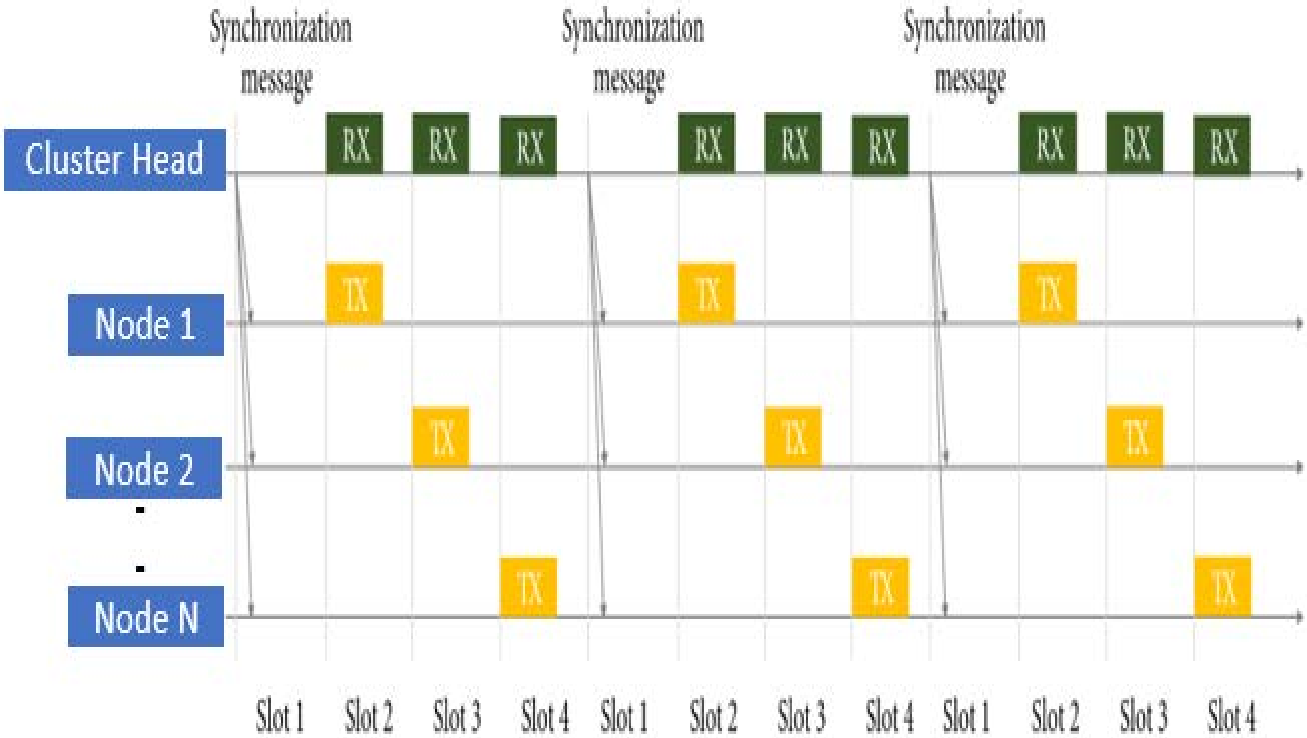

Figure 1. Time slot allocation by Sink node/ Cluster head/ Controller

$$X_C = \frac{L}{T} - 1 \quad (3)$$

Where:

X_c is the allocated number of the wireless channel

T is the length of time slot

L is the length of a cycle time.

Table .1: The Simulation Parameters

Parameter	**Value**
Simulator	MATLAB 2017
Initial Energy	0.6 J
Minimum supply voltage	1.8 V
Frequency (f)	2.4GHz
$E_{Tx\text{-}amp}$	1.98nJ/bit

$E_{Tx\text{-}CCT}$	16.7nJ/bit
$ER_{x\text{-}CCT}$	36.3nJ/bit
DC current (TX)	10.6 mA
DC current (RX)	17mA
Wavelength (λ)	0.138m
Γ_{max}	7

The percentage improvement of the developed improved DSCB routing algorithm over the existing DSCBof the work of Ullah *et al.,* (2017) is given by equation (4).

$$Percentage\ \text{Improvement} = \frac{\text{iDSCB - DSCB}}{DSCB} \times 100 \quad (5)$$

3.0 **RESULT AND DISCUSSION**

3.1. THROUGHPUT AGAINST NETWORK PROCESSING TIME

In this work, the successful delivery of data packets from the source node to its destination node per unit time is referred to as throughput. Figure 2 shows the throughput performance of the developed algorithm against the existing DSCB algorithm.

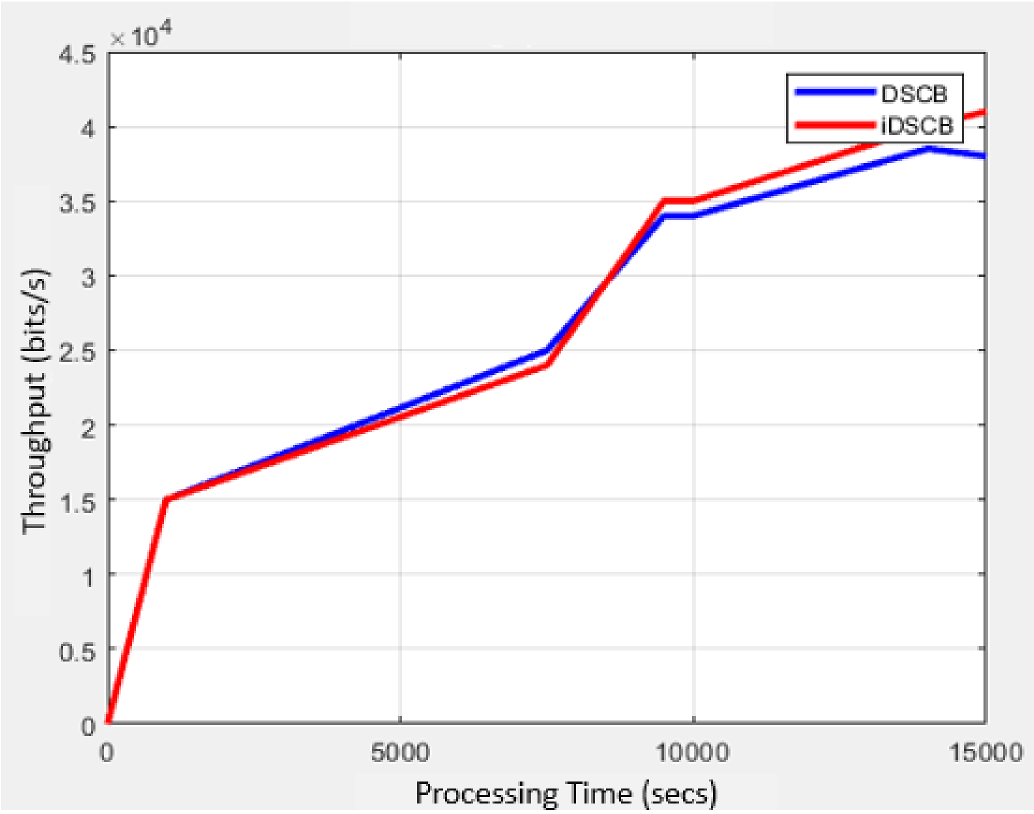

Figure.2: Plot of Throughput against Network Processing Time

It is observed from Figure 2 that the throughput increases as the network processing time increase for both algorithms. This is due to the use of dual sink nodes that enable more transmission of packets to the CH at a given time. Equation (5) was used to generate the plot. However, the iDSCB algorithm shows better throughput than the DSCB algorithm. This is because the developed algorithm considered other parameters such as the node BTs in the selection of neighbour node for data transmission, whose effect reduces the drop of packet due to high traffic in the node. The iDSCB algorithm shows an improvement of 6.59% when compared with the existing DSCB algorithm. Table 2 shows the percentage improvement evaluation of the iDSCB algorithm over the existing DSCB algorithm.

Table 2: Throughput Performance Analysis of DSCB and iDSCB

S/N	Algorithm	Average Throughput	Percentage Improvement Using Equation (5)
1	DSCB	2.28	6.59%

2	iDSCB	2.43

4.0. CONCLUSION

Because of the packet communication instability of the wireless body area network, this work developed a buffer traffic-aware wireless body area network for effective packet transmission. Buffer traffic state of each node was estimated, and the time division multiple access was used to reduce the end-to-end delay of a packet in the transmission process. Also, the improved algorithm intensified the performance of the existing algorithm when developed along with BTs and TDMA schemes. Simulation results show that the improved algorithm performs better than the existing algorithm in terms of throughput.

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