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Performance Optimization in Body Sensor Network using Self Calibration TDMA Algorithm

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Abstract: The paper focuses on variation in performance characteristics, such as the packet delivery ratio, throughput, jitter, and the delay, varies when the queue length has been changed. The results proved that there is no impact on the jitter when the queue length was varied. The packet delivery ratio and the throughput are increased when the queue length are increased by 10. Hence, the self-calibrating TDMA algorithm can be used to implement the body sensor network and queue length can be kept at 20 to be optimized for good throughput and packet delivery ratio.

Keywords: TDMA, Queue Length, Self Calibration, Performance, Queuing theory

1 Introduction

The body sensor network imposes an algorithm for performance improvement based on the manipulation of the queue length. The queue length plays an important role in the performance variations of the network. The main consideration is the performance optimization and the reliability of the network. The self-calibration TDMA (Time Division Multiple Access) algorithm gave a reliability of 97 percent. When the queue length is manipulated, the performance was increased.A central entity is placed in a human body, participants organize themselves into a network. The job can be done locally and efficiently because it is environment friendly and involves, very smooth temporal variety of measures, very large scale variability and very long sensor range[1]. The movement and physiological data of the participant at various location sources or nodes are sent to the sink[9].
The sink processes and transmits to the remote computer or mobile application. The accelerometer measures the accelerated data from the human body and produces an analog voltage which is converted into digital using Analog to Digital Converter (ADC). Wireless Body Area Network (WBAN) devices are used because they are low power embedded processors with memory, radio transceivers are used to transmit and receive the signals,and sensors are used for the accelerations and a power source. Power is one of the most important considerations for the nodes to operate. It operates with the help of battery devices attached to the nodes. A composite power control algorithm is used in the algorithm, which increases the transmission energy of the sensor nodes until the tables are formed with transit level, equal to the tables using maximum power. The battery operates device or energy efficient Operation, in which, the participants draw energy from batteries and use multihop routing with low energy consumption[12]. Energy efficient routing is used for better link quality, link distance, residual energy, location information and mobility information[13].
Sinks are used to receive the data that are the devices which receive the data from the Wireless Sensor Network (WSN) and send to the system for processing. It may be part of the WSN. Deployment of sensor nodes plays the major role in which the nodes over the network are arranged in the form of a star topology. Single hop star topology can be used[10]. Location of the nodes is very important in the body sensor network where the sink is placed in the chest, and all other nodes are placed another part such as limbs, wrist, knee, thigh, and foot[14]. Mostly in all the WBAN, the star topology is designed.In other words the sensor nodes are deployed in the

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arrangements of a star. The sink is in the chest and surrounded by the sources in the star manner. Wireless accelerometer module is a module used to define the link performance between the sensor nodes by recording the data from different sources. Synchronization of time is important since in TDMA, the timing must be matched with the entire node's transmission for timestamp measurements, localization,cooperative communication between a sink and sources,and for sleep scheduling such that energy can be reduced.

2 Related Works

In TDMA, the sensor nodes transmit the data to sink on a time slot with a respective communication channel. In this paper, the message queue lengths are geometrically distributed. The end to end delay and traffic are calculated using this model. The fixed assignment category of MAC (Medium Access protocol) as time division multiple access transmits the data packets using the time slots allotted to them.The delay occurs due to the inter-arrival time of the traffic. In this paper, performance is analysed using the mean and variance of the queue size [1].

Low power MAC protocols provide fewer throughputs due to low duty cycle, which leads to poor performance. This paper focuses on a combination of CSMA/TDMA MAC protocol (Carrier Sense Multiple Access), or queue MAC. It outperforms the other protocols and low power duty cycle and high throughput is obtained [2]. A discrete multiserver system is used in which packets arrive in a fashion of correlated process. The arrival process is not required for calculating the delays[3].

A Self-organizing TDMA in which the QOS is improved. It has benefited the high load environment and the heterogeneous environment [4]. A TDMA scheme can improve the performance of the network, whereas TDMA scheduling is difficult in the dynamic environment. A cluster-based TDMA is used and NS3 (Network Simulator) simulator is used to determine the performance characteristics[5]. A dynamic code assignment with a time slot,in which the network is divided into multiple clusters and then the nodes are appointed to transmit the data.

Here, the simulation results indicate an increase in the performance[6]. A discrete-time queuing theory for determining end to end delay is used for the multi hop network. A queuing model is developed such that the traffic flow determines the correlation that exists between the nodes[7].

3 Analytical Models

Analytical models also have calculated models that produce a good resolution, which is the resolution of equations that defines variables in a network which can be expressed as a mathematical systematic function. Analytical technique delivers an exact solution. When an experimental model of the network is developed, a mathematical model also have to be developed.

3.1 Queuing Model

Queuing technique can be used to examine the network collision. It to understand the network characteristics. Most wireless networks are implemented on the base of single sink node queuing model[3]. An implementation of single sink node queuing prototype is conducted. The network queuing technique is a specific method in a networks validating that the nodes are characterized by a network with queue size that can be calculated analytically.

The network involving queues is a pool of sensor nodes, which denotes the sink, source nodes and the data packets. The evaluation is conducted with the help of a set of equations and some conditions among them. The queuing technique is regarded as a tiny subgroup of the methods among the statistical techniques designated for demonstrating computer networks. All queuing techniques are devoted to demonstrating multifaceted nodes using the sink node with certain characteristics. The mathematical methods are engaged to study these models. The algorithms necessitate time as to develop prohibitively rapidly depending upon the size of network. The algorithms are useful in defining situations, but they are not suitable for the direct analysis of the network.

3.2 Networks End to End delay

The data packet delay consists of various delays in queuing, processing, transmission, and propagation delay[8]. In most of the network, arrival rate is not enough to determine the network parameters, the delay also plays an important role. The delay is a summation of the delays from each node traversed. Delays involves four types as follows.

3.2.1 Queuing delay

It is the duration in which the data packet is waiting in the queue for communication and the time in which it starts the transmission. During this period, the data packet pauses when the other packets in the queue are being transmitted.

3.2.2 Processing delay

It is the duration in which the data packet is properly received at sink node and the time in which the data packet is allocated to an outward-bound queue for communication.

3.2.3 Transmission delay

It is the time between the first bit and last bits of the packet that are communicated.

3.2.4 Propagation delay

It is defined as the period between communication of last bit at the sink node of the link and time when the last bit is received at the other nodes.

3.3 Queuing Network

The necessary characteristics of a queuing network consists of the Input source, Queuing process, Queue discipline and the service process. Queuing system is the arrival time of a packet with distributions and is represented by a Poisson distribution. The Poisson distribution is a discrete probability distribution of the sum of data packets that arrive in the particular time interval. Considering a Poisson process containing the number of data packets (arrivals) n in a respective time duration 0 to it. The average number of arriving packets in a time interval is λ, as the number of arriving packets will be product of λ and t. Then, in interval from 0 to t, the probability that, number of data packets arrive is given by t.

$$P(x = 0/P_n = \lambda t) = (\lambda t)0 = e - \lambda t/0! = e - \lambda t \quad (1)$$

From equation (1) λt can be defined as an arbitrary variable, as the duration among two arrivals. As data can arrive at any time, the continuous random variable will be the time t. Based on equation 2, the probability of number of data packets arriving in the time interval 0 and t would be greater than t,

$$P(T > t) = P(x = 0/P_n = \lambda t) = e - \lambda t \quad (2)$$

3.4 Queue Discipline

It represents the direction in which the data packets from the queue are accepted by the sink node. There are multiple ways in which the nodes are being served.[11] A static queue is available and based on data packets in the queue, which denotes that the data packets are served in the order of the entry, which is defined as first come first serve (FCFS). In the static itself, another discipline is used as last come first serve (LCFS). The second category of queue discipline is dynamic one based on which the data packets are being served. From the present work, the dynamic method which comprises four classes cn be chosen.(i) the Random manner in which the data packets are being accepted in any order when they enter the sink node.(ii) the Priority service in which Data are assembled in priority on the aspect of position based.(iii) is a pre-emptive priority where higher priorities nodes rather than the lower priority nodes and (iv) the Non-pre-emptive priority, in this situation, highest priority node data goes fast to the sink node, but acceptance is made only when all other packets in process are received. Accordingly, the first come, first serve mechanism is used in the research.

4 Queuing model for network Collision

Data communication with sink and nodes with a single line, a single node queuing model is analysed. In this paper, the model recommended is a single node queuing model on the network. It emphasis is with long tenure normal performance to the point that complications of a transient collision through the packet arrival and communication of data.
The performance analysis of an individual node queuing model is proposed to reduce the network collision. In this technique, the packets are managed on a first come first service order. Different techniques in queuing theory are categorized through applying a standard notation which is represented by x/y/z. Also, d and e are added to the research.
The standard notations used to describe the main features are (x/y/z): (d/e), where x : Approach to data dissemination y : Acceptance of data dissemination z : Number of nodes d : Maximum storage of data allowed in the system e : Queue service Single node model generally represented as (x/y/1): (FCFS). The performance characteristics of a single queue, single node model of network collision are as follows: n represents a number of data packets in the system. Pn probability of n data in the system. λ: average number of data packets that arrives in the sink. μ average number of data received per unit of time in the sink. Traffic Intensity

$$\rho = \lambda/\mu \quad (3)$$

5 Self Calibrating TDMA (SC-TDMA) Algorithms

$Starttheprocess$
$Initializetheparameters$
$Createmnumberofnodeswithbuffer$
$Initialize\ the\ parameters\ values\ for\ buffer\ Initialize\ the\ window\ size\ to\ be\ zero;$
$buff[n] = accel[data];$
$save;$
$else\ Node\ equals\ the\ number\ of\ nodes\ from\ 1\ to\ m\ then;$
$SwitchtoTransmitMode$

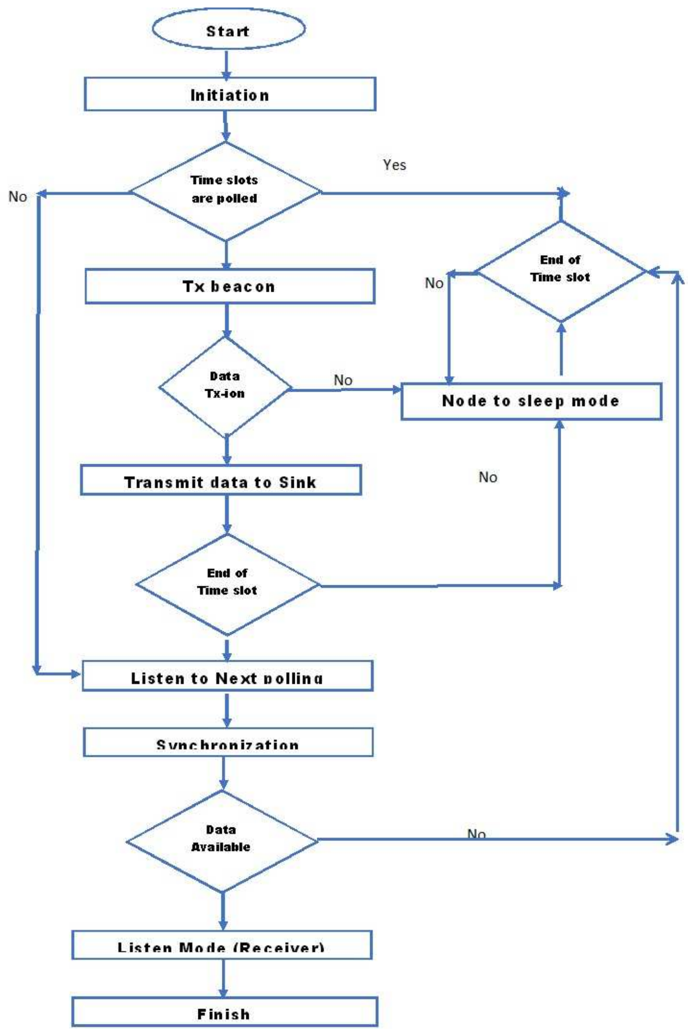


Fig. 1: Flowchart representing the SC-TDMA

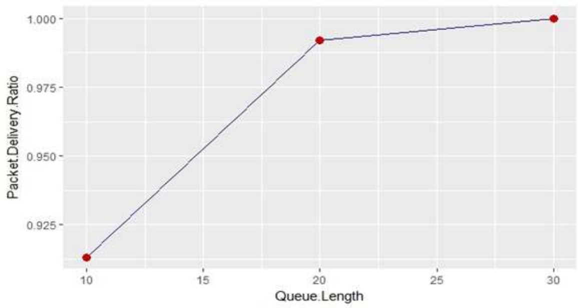
$node[m] < --reqdata = TRUE$
$Incrementthewindowsize;$
$send < --accel[data];$
$ifbuff[n] = 1;$
$stoptheprocess$
$else$
$node[m] < --reqdata$
$Stop$

6 Modelling and Simulation

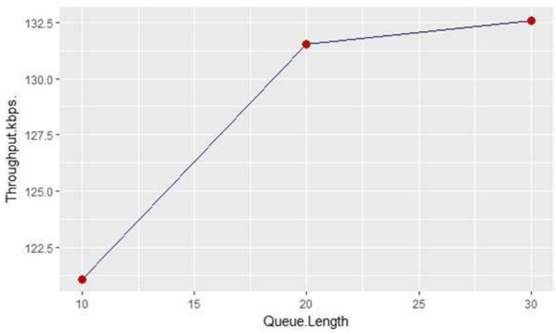
The SC-TDMA was modelled in the famous network simulator NS2 that used various network scenarios. The parameter description is given below and the simulation consists of mobile nodes and the sink with topology ranging from 200m to 1200m and used the protocol of AODV enhanced with the TDMA concepts. The transmitting node range was 1m and the initial energy of nodes for the simulation was 1000 Joules.A bit rate of

Table 1: Probability data sets A and B.

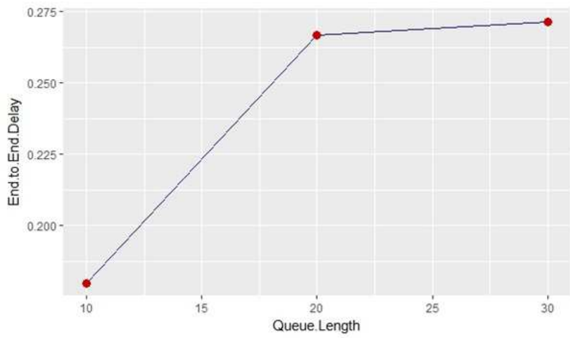
Parameters	Value
Channel	Wireless
Number of nodes	5-100
Topology size	200m*200m : 1200m *1200m
Protocol Type	AODV TDMA and P- TDMA
Transmitting node range	1m
Initial Energy	1000J
Bandwidth	2M bit
Interface queue length	10,20 and 30
Simulation time	50sec
Traffic type	CBR
Packet rate	250kb
Packet size	500 : 2500



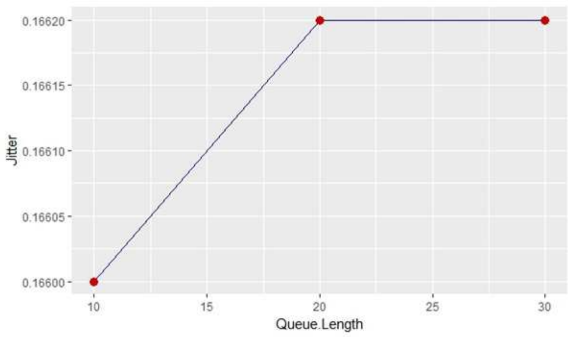
(a)



(b)



(c)



(d)

Fig. 2: (a) Depicts the comparison between Queue length & Packet Deliver Ratio, (b) Depicts the comparison between Queue Length & Throughput, (c) Depicts the comparison between Queue Length & End to End Delay, (d) Depicts the comparison between Queue length & Jitter

CBR was used. The packet size of 500 to 2500 was used and various simulation tests were conducted. The queue length ranging from 10 to 50 was considered for simulation with different scenarios and the output was recorded.

7 Flowchart

At the present hub is ready to accept the accelerated value now without any collision, it polls request gain, the next node sends the ack, then transmission occurs and then the process continues.

Step1: The nodes send the packet to the hub, the auto acknowledgment protocol switches the nodes mode to receive mode to receive ack from the hub.
Step2: If the packet is received by the hub, the auto acknowledgment protocol assembles and sends the ACK packet to the nodes before turning to receive mode.
Step3: If the nodes do not receive the ACK then the auto acknowledgment protocol retransmits the data to the hub after a delay and sets to receive mode to accept the packet.
Step4: The process continues until a successful delivery of packets is reached.
Step5: Even after retransmission if the nodes do not

receive the ACK, then the data is discarded and new node data transmission starts.

8 Analysis of Results

Fig.1 depicts the variation of performance parameters when the queue length is varied. First, length is set to 10,the parameters are recorded the length, set to 20, to 30 and is recorded. A peak increase in the parameters occurs when it increases by 10 then moderate increase. We can infer that when the Queue length is set to 20 there is optimality in the network parameters. Fig.2 depicts the variation in parameters compared to the different queue lengths. The PDR is optimal when the queue length is 20 and the delay is optimal when the length is 20 and the jitter is same when the queue length is varied.

9 Perspective

The results presented an SC-TDMA protocol for BSN which gave high-performance characteristics in different scenarios. The protocol forwards the packet to sink in time division manner and in a round-robin fashion. The reliability is achieved when the queue length is set to 20. This SC-TDMA can be used in various applications such as, sports and health-care applications. The protocol showed good performance in time-critical applications. The results were also compared with other TDMA protocols. Analytical expressions were also given to calculate the queue length and the queue discipline on the first come, first serve basis. This protocol is scalable and the future work will involve diversity of the packet size and estimate the network parameters.

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