Lifetime and Throughput Optimization in Wireless Body Area Network

Chinkee Kalra[1] Vikas Chauhan[2] Seema Singh[3]
[1,2,3]Department of Electronics & Communication Engineering
[1,2,3]ICL Group of Colleges

Abstract— Wireless body area network has now become a very efficient monitoring tool for patient's health parameters. Many approaches depending on routing, energy management, and data processing protocols have been designed for WBANs. Routing protocols in WBANs might differ from WSN depending on the application and network architecture. Research is going in this area to optimize the network parameters to meet specific applications of the WBAN. Due to recent technological developments, the availability of small and low-cost sensors has become practicable. In this paper a wireless sensor network protocol is implemented for body area network and then lifetime and throughput parameters are studied for optimization of the network.

Key words: WBAN, Wireless Body Area Network

I. INTRODUCTION

One of the major applications of WSN technology is monitoring of human health. In WBAN, only few sensors are used which are implanted in body or positioned on the body.

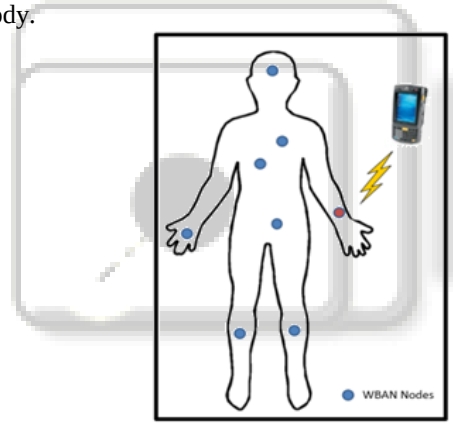

Fig 1: WBAN Nodes on Human Body

These tiny sensors placed on patient's body measure vital signs like blood pressure, Glucose level, pulse rate etc. These measured values are then forwarded to the medical server or doctor to monitor the patient's condition. Wireless sensors provide continuous monitoring of patient at a remote place. With advancement in wireless technology, there comes a new generation of WSN which is suitable for networking on the human body or in the human body. The wireless connection between the devices of a WBAN can occur at different frequencies. Often the ISM (Industrial, Scientific and Medical) frequency bands or UWB (Ultra Wideband)are used. For data transfer among sensor nodes a point to point topology or multi-hop topology is used in these networks. Use of topology depends on the application. Due to limited battery life of wireless sensor nodes, generally power aware protocols are designed for such networks. As far as the medial applications are concerned, the network should be optimized for lifetime and throughput. Most of the wireless sensor networks utilize various energy efficient protocols for communication among the nodes and base station. In this paper we have implemented WBAN using standard WSN protocol and adjusted the parameters to optimize the throughput and reliability of the network.

II. METHODOLOGY

The energy used for data transmission and receiving in the air intuitively has direct effect on the lifetime in sensor networks. In general, low energy radios are used in data transmission and reception. To model energy consumption, different conventions about the radio features, including energy dissipation in transmission and reception methods, will affect the performance of a protocol. To implement a WBAN in our case, we have used standard WSN leach protocol. The transmitter dissipates energy to run the radio electronics and the power amplifier, the receiver dissipates energy to run the electronics, as show in Fig.2.

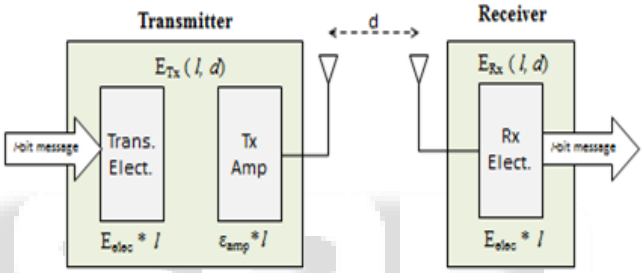

Fig. 2: General radio transmitter and receiver model

The electronics energy consumption E_{elec}, depends on reasons such as the digital coding method, modulation, filters used and also on spreading of the signal. The amplifier energy $\varepsilon_{amp} * d^2$, depends on the distance to the receiver and the acceptable bit error ratio(BER) and also a d^2 energy loss involved due to channel transmission losses. Thus to transmit a*l*-bit message through a distance d using decided radio model, the radio spends energy to transmit given by:

$$E_{TX}(l, d) = E_{TX-elec}(l) + E_{TX-amp}(l, d)$$
$$= l * E_{elec} + l * \varepsilon_{amp} * d^2 \quad (1)$$

and to receive this l-bit message, the radio expends:

$$E_{RX}(l) = E_{RX-elec}(l) = l * E_{elec} \quad (2)$$

For the simulation of network following parameters are used in MATLAB simulation.

Parameter	Value
Number of nodes (n)	8
Number of cluster	K
Rounds (r)	2000
Network size M*M	1.5m*m
Node Deploy Region	x (0,1.5, y (0,1.5)
Base station location	x = 50, y = 175
Length of data message(*l*)	4000 bit
Radio electronics energy E_{elec}	50 nJ/bit
Radio amplifier energy ε_{amp}	100 pJ/bit/m^2
Data aggregation energy E_{DA}	5 nJ/bit/signal
Initial power of node	2 nJ

Table 1: Network Simulation Paramenters

The network is then examined on the basis of different parameters

- Network lifetime
- Throughput
- Residual Energy

To evaluate the performance of throughput, the numbers of packets received by BS are compared with the number of packets sent by the nodes in each round. It is the time interval from the start of the network operation till the last node die. The residual battery energy of network is considered in order to analyze the energy consumption of nodes in each round. Residual energy presents the data related to degradation of network life.

III. RESULTS

Simulation results presents considerable improvement in the network lifetime and other parameters. The graph fig-3 of number of nodes show that in modified network, the alive node count is more as compared to the standard one.

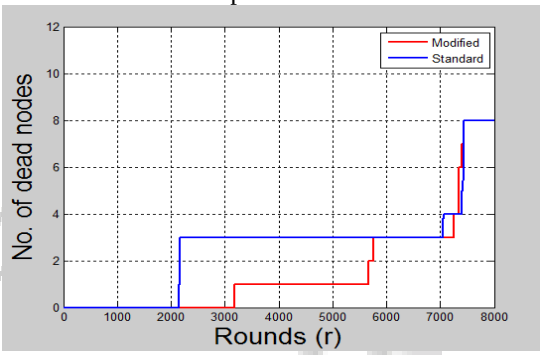

Fig. 3: number of dead nodes per round

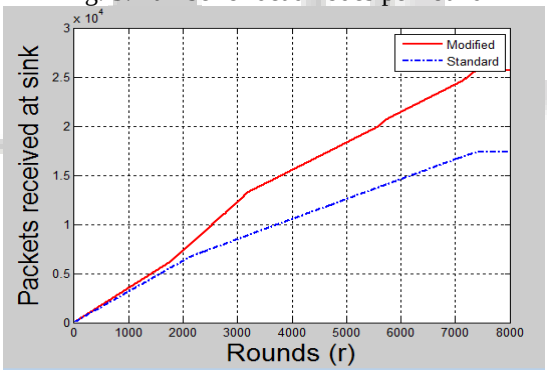

Fig. 4: number of packets received per round

Graph in figure-4 reveals that the number of packets received at the sink is also increased by adjusting the network parameters.

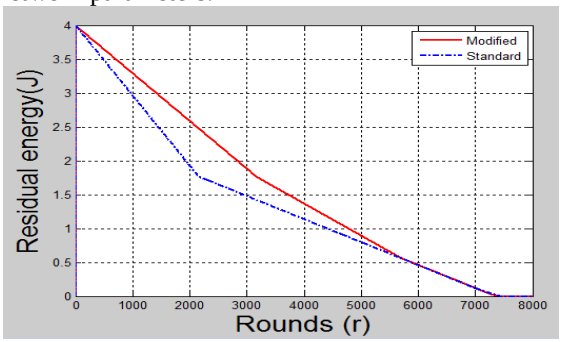

Fig. 5: residual energy of nodes per round

Residual energy of the nodes is also higher in modified protocol as shown in graph figure-5. This residual energy can assure reliable operation of the network.

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