Body Area Network for Cattle Monitoring

[1]Anwarullah, [2]Sheeraz Ahmed, [3]Azhar Khan, [4]M.Saqib, [5]Nadeem Ahmed

[1, 2, 3] Institute of Social Policy and Research, Peshawar, Pakistan
[1, 2, 4] Career Dynamics Research Centre, Peshawar, Pakistan
[4] Iqra National University, Peshawar, Pakistan
[2,5] University of Engineering and Technology, Peshawar, Pakistan

***Abstract*— Agriculture is a major source of income in our country. Animals like cow, buffalo, sheep, goat etc play an important role in life of rural. They are used as a source of income. Hence animal husbandry becomes a most important concern. One of the major applications of WBAN is for cattle health care for the purpose to provide a best quality of milk and meat to human. In this research we focus on a scheme using WBAN for cattle monitoring to improve energy efficiency and increase network life time. In the presented scenario the nodes are half time active and half time passive when the nodes are on the check the cattle if current result is normal it not forward the data to sink for further processing and when the cattle position is not normal it forward the collected data to sink and the sink than forward it to cattle medical server for cattle treatment.**

***Keywords*— WBAN, Energy Efficiency, traffic load, network lifetime**

I. INTRODUCTION

A Body Area Network (BAN) is a well-dress biomedical sensors stand, which measure the signal of human body such as ECG, EMG and temperature etc. Its inventive uses are in the form of WBAN (Wireless Body Area Network) for checking psychological signal. WBAN is a wireless sensor network which operates on, in or around Human body in order to monitor human body consideration. The monitoring signals of the human body are collect by sink from sensors nodes and forward to medical server for health care monitoring [1]. In early days the main idea behind WBAN was the provision of remote monitoring of patients suffering from chronic diseases such as asthma, heart attack and diabetes. Nowadays WBAN may also be utilized in sports, military or security applications and also these networks are used with huge application such as to identify human body position, action monitoring and support for other health disaster [2]. The IEEE 802.15 define the BAN in such a way that it is a communication slandered optimize for sensors nodes and perform operation on, in or around human body or animal to provide a variety of applications including medical, consumer electronic (personal entertainment and other). In simple words a BAN is a network of sensors nodes which are very nearly attached to human body and cooperates for human assistance [4].

A WBAN typically consist of central node (known as sink) and several sensor nodes. The sink also functions as a gateway to public network through WLAN or cellular network. A sink can also provide interface for the wearer to check the health indicator when needed [5]. WBAN consist of sensors nodes which wirelessly monitor the remote patient and thus the patient can take benefits from wireless technologies. WBAN is a talented technology from which it is expected to improve health care monitoring and medical treatment procedure of human body. WBAN operate in fields like fitness, entertainment, etc [6]. From last decade, sensors are used in the field of human society in two major areas, medical & non medical. These sensors behave interactively but in distributed manner. Due to invention of wireless technology, these sensors network also develop. As human are able to move everywhere along with its all natural sensors (eyes, nose, ears etc) in different environment condition similarly WSNS are also evolved to behave [7].

A WBAN consist low power, light weight sensors nodes which measure the functionality of human body and also measure its environment. The three level structural design of WBAN consist sensors nodes, sink and Medical Server (MS). The MS stores patient information received at the data base. The MS also contains medical documents of patients and contacted them when some emergencies occur [9].

II. RELATED WORK

In paper [1], the authors proposed a biometric based security system within a BAN for data authentication. In order to collect trustworthy and reliable patient health information, it is necessary to provide node authentication serving a BAN, which prevent an attacker from impersonation and false data/command injection. In paper [2], the authors proposed multi hop and three cooperative routing schemes for reliability and energy efficiency. The protocol Critical data transmission in Emergency with Mobility support in WBAN (CEMob) operated on both single hop and multi hop communication modes and keep away from continuous data transmission for the purpose to save the energy of the sensors nodes. CEMob protocol is compared with both protocols i.e. Adaptive Threshold-based Thermal aware Energy efficient Multi hop Protocol (ATTEMPT) and Reliability Enhanced-Adaptive Threshold based thermal protocol (RE-ATTEMPT), the result show that CEMob is more energy efficient than ATTEMPT and RE-ATTEMPT.

In paper [3], the authors proposed that LEACH (Low Energy Adaptive Clustering Hierarchy) is more efficient energy saving protocol as compare to direct communication sensor network protocol, MTE (Minimum Transmitting Energy) protocol and conventional based static cluster protocol. When the base station is far from the node then the greater power energy will require, communicating with base station. It is best when the base station is near to the nodes or the more power energy to transmit the data is large. LEACH (Low Energy Adaptive Clustering Hierarchy) a clustering based protocol that minimizes energy dissipation. In paper [4], the authors proposed energy efficient mechanism for WBAN which showed better efficiency than LEACH and Energy efficient based protocol. In this mechanism all nodes were scattered homogeneously over the wireless field, in which cluster based and stable routing mechanism was used. In this protocol heads were decided through ratio of energy and random head selection probability was decided through integer linear programming platform.

In paper [5], the authors proposed WBAN routing algorithm for balance energy utilization in order to extend the overall lifetime of the network called Dynamic Routing Algorithm (DRA) and its advance version based on multi path choice mechanism. This routing algorithm suitably organizes the forward route in the network to balance energy consumption of each sensor with the consideration about the network topology structure. The algorithm is different from traditional routing algorithm for sensors network to archive the minimum hops, the algorithm is build according to Dijkstra algorithm to determine the route matching the restrictions of minimization of the maximum energy where the optimization is processed to archive the utmost life time of the overall network.

In paper [6], the authors proposed Reliable and Energy Efficient incremental cooperative communication for WBAN use different route for data communication, which provide Energy Efficiency and less Packet Error Rate. The algorithm use three different stages for data communication and provide batter performance for EE and PER. Later the algorithm also used for network layer, enhanced incremental cooperative critical data transmission in emergencies for Static WBANs.

In paper [8], the authors proposed that WHSN (Wireless Hospital Sensor Network) consists of different sensors nodes and Smartphone powered by batteries. The author tried to extend the battery lifetime of each sensor node and smart phone. A mechanism MST (Minimum spanning tree) has been used for battery power utilization. WBAN facilitated the moment of patient in ICU and other regular wards, as the patient body is attached by various cables to monitoring device.

In paper [9], the authors compared three MAC protocols 802.15.6, 802.15.4 and TMAC. Here WBAN architecture was divided into three layers. 1. WBAN 2. Personal Server 3. Central Server (Medical Server) and also the Requirements were classified into three categories a. Event Driven b. Query Driven c. Continuous delivery model. WBAN should support data ranging from 1kbs to 10mbps. Data gathered from sensor node were sensitive to latency and end to end delay. The IEEE 802.15.6 algorithm is suitable for WBAN communication especially for latency, end to end delay in worst case and is better for real time application for WBAN network communication.

In paper [10], the authors proposed QoS-aware Peering Routing Protocol for Reliable data (QPRR) the mobility of patient in hospital may require a change of dedicated display unit that display patient data. QPRR for reliable BAN communication is required that display critical patient data reliably in real time. QPRR is deployed in the BAN peering framework use both centralized and distributed approach. In centralized approach the information of BAN and display unit are stored in central computer, which help to improve data security and batter control of BAN communication. In paper [11], the authors proposed an energy efficient routing algorithm for WBAN that was taken into consideration for two additional attributes (node critical and communication count) along with coverage distance and residual energy of sensors nodes. These four parameters will result in improvement of working lifetime of the network via less energy consumption in comparison to existing routing protocols.

In paper [12], the authors illustrated WSN technology for the farmers. They proposed that a sensor network should be installed on farms to gather ecological. This will facilitate farmers not only in monitoring their cattle through web from outside the farm, but also help control of farm environmental in remote locations. In addition, facilities can be mechanically controlled based on breeding parameters and a SMS notice service to report of deviations shall provide users with ease.

III. MOTIVATION

Most of the researchers focus on energy efficiency of WBAN for patient monitoring. But they did not consider that for animal monitoring.

In this research, we want to focus on cattle because the quality of meat and milk which is achieved from cattle is very essential for human life. If we are getting infected meat and milk, then this can be a great harm to human health. Cattle normally suffer from diseases and their viral disease transfer from one cattle to other, often these cattle die in bulks and are source of loss for the farmers as well. If we are aware of some cattle who is suffering from viral disease, then that can be identified and diagnosed on proper stage. It may then be shifted to some other location. This may save us from a severe loss both in monetary terms as well as health issues for humans.

Inspired from [12], here, in this study we propose a scheme in terms of the features of WBAN for cattle monitoring which proves to be energy efficient than [12] as well as having better stability period. In this the node will not be alive full time; half time it will be active and half time it will be in passive mode. And these node will also compare the current data with previous result. If the case is same then it will not forward any message to medical server, due to this qualitative data will be forwarded.

In WBAN, sensors nodes are operated with limited energy source and to recharge the batteries frequently is a big problem. To extend the life time of the network, it is required to use minimum power for data transmission to sink and minimum power required to forward the data from sink to base station.

IV. PERFORMANCE METRICS

Key performance metrics are appraise for our scheme and they are defined as:

A. Network life time:

It is define as it is the total network operation time till the last node die.

B. Energy saving:

As the nodes are half time active and half time passive as a whole energy will be saved; as only meaningful data are forwards to sink therefore transmission energy will be saved of each node.

C. Stability Period:

The time taken by the first node to die after initialization of the network is called the stability period.

V. PROPOSED SCHEME

WBAN is an emerging technology in the field of environment monitoring where the issue for cattle health monitoring is one of the major applications. In this network many sensors are scattered around the animal body to monitor different parameters like temperature, ECG, pulse rate, heart beat etc. The important data from these parameters are aggregated by sink and forwarded to external medical caretaker shown in figure 1.

In our scheme, these sensors nodes are operated with limited energy source and to recharge the batteries frequently is big obstacle. To prolong the life time of the network, it is necessary to use minimum power for transmitting data from sensors to sink, therefore such protocol required which may be energy efficient, reduce traffic load and enhance network life time.

In this research we present a scheme which uses ten sensors nodes on the animal body and one sink. The sink collects the data from these sensors nodes and forward to base station.

The second main theme of this research is to implement a such protocol in which the sensors nodes are half time in active mode and half time in passive mode. When nodes are active they read the data and match the current data with stored data which are in Normal Data Limt Table (NDLT). If animal health is normal, it will keep silent otherwise it will send the data to sink for further consideration to medical care taker of animal through base station. In this as a whole energy, transmission energy and traffic load will be reduced; and network life time will increase. flowchart is shown in figure 2.

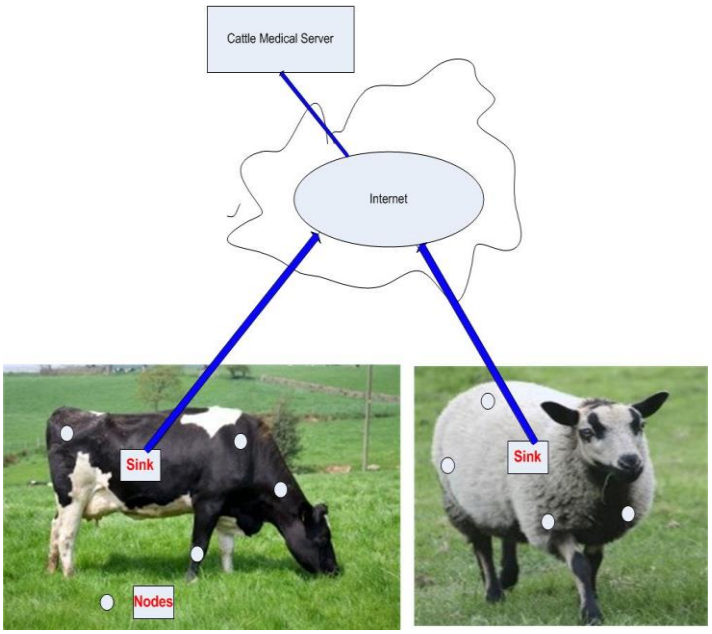

Figure 1: A WBAN environment for cattle

Flow chart of the schemef is shown in figure 2.

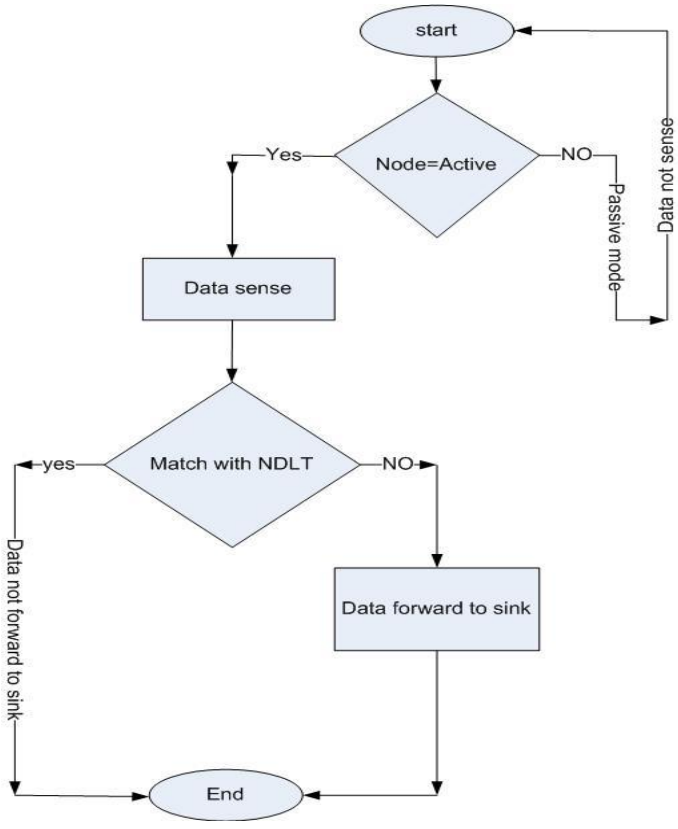

Figure 2: Flow-chart for BAN scheme

The following table 1 indicates the various parameters set for the purpose of simulation.

Table 1: *Simulation parameters*

Parameters	Values
Numbers of nodes	10
Sink position	At the center of Animal body
Initial Energy	Advance node 0.3J Normal node 0.1J
Packet size	1000 bits
Data generation rate	400 bits E_{elec} 50nj/bit
E_{fs}	10 pj/bit//m^2
E_{amp}	0.0013 PJ/bit/m^4

VI. ENERGY MODEL

According to radio energy model [3] that was proposed for WBASN and WSN, transmission energy of sensors node at distance d>d0 is given by

$$E_{tx}(k,d)=E_{elcc}*k + k*(e_{amp}*d^n) \quad \ldots\ldots\ldots\ldots\ldots (1)$$

and for d<d0 is

$$E_{tx}(k,d)=E_{elec}*k+k*(e_{fs}*d^n) \quad \ldots\ldots\ldots\ldots\ldots (2)$$

where transmission energy for intermediate node is

$$E_{tx}(k,d)=((E_{elcc}+E_{DA})*k)+(e_{amp}*k*d^n) \quad \ldots\ldots\ldots (3)$$

Equation for reception energy of all sensors nodes is

$$E_{rx}(k)= E_{elec}*k \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Here E_{rx} and E_{tx} are transmitting and receiving energies of each node, which transmits or receive k bits a distance d.

E_{elex} is energy which dissipate to run the circuitry of transmitter and receiver. n is the path loss exponent and d0 is the reference distance. E_{emp} and e_{fs} are characteristics of transmitter amplifier, where E_{DA} is the energy cosnumed in data aggregation by forwarder nodes. Figure 3 shows the 1st order radio model used.

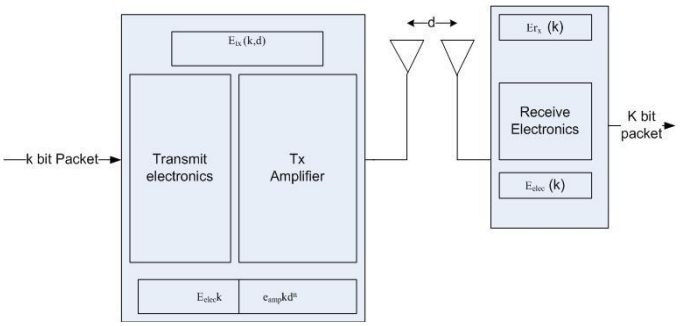

Figure 3: First Order Energy Model

VI. RESULTS AND DISCUSSIONS

A. Stability Period

The time duration from the establishment of network till the first node died is called Stability period. Once the first node is dead the remaining period is referred as unstable period. From figure it is clear that stability period of our proposed scheme BAN with cattle monitoring is better than Smart cattle monitoring with WSN.

Due to the fact of non-continuous data transmission in our scheme, we have increased stability period as compared to that of Smart scheme for WSN. Data is forward to sink node only if any change occurs between the current value and previously recorded value.

It can be noted from above plot that after completing 1500 rounds, node 1 of our scheme dies after 520 rounds while in case of Smart scheme, node 1 dies after round 480. As more computation is done in case of Smart scheme, which results in higher amount of energy consumption. Therefore nodes in Smart scheme die quickly as compared to our scheme.

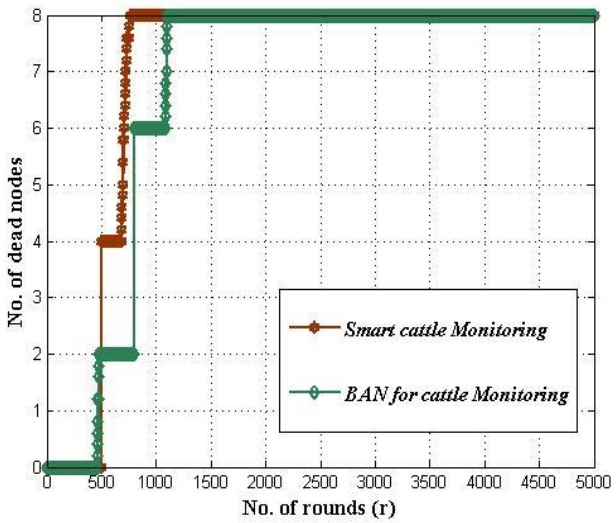

Figure 4: Stability period vs Rounds

B. Residual Energy

In order to have a fair comparison of energy consumption of both protocols, initial total energy was kept 5.5 joules for both of them. The simulation result justifies the performance of our proposed scheme. From above plot it is observed that our scheme has greater network lifetime as compared to that of Smart scheme and the reason behind is non-continuous data transmission. Smart scheme using WSN features performance is worse than our BAN scheme for cattle monitoring because improper load balancing and static network topology is used.

From the figure, the percentage efficiency is calculated and it clearly shows that BAN scheme performance is much better than WSN scheme in terms of Residual Energy i.e. it is 18% more efficient than Smart scheme.

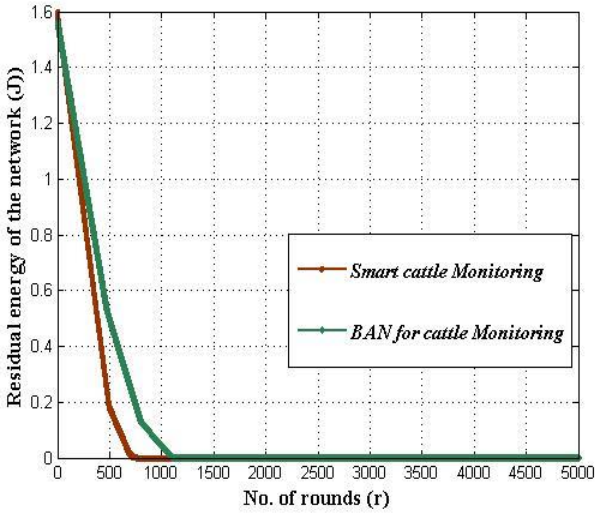

Figure 5: Residual Energy vs. Rounds

VII. CONCLUSION

This paper propose a protocol for cattle body area network. The purpose of this research is to save the energy of nodes and enhance the network life-time. The proposed scheme is compared with Smart scheme using WSN for the same scenario of cattle monitoring. The performance show that the proposed scheme is better than Smart scheme in term of energy efficiency and network life time.

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