DUAL SINK BASED ROUTING SCHEME FOR RELIABLE DATA DELIVERY AND LOS COMMUNICATION IN WBANS

1Ilyas Khan, 2Majid Ashraf, 3Asif Nawaz, 4Rehan Ali Khan, 5M.Habib Ullah, 6Wisal Khan, 7Sheeraz Ahmed

1,2,6University of Engineering and Technology, Peshawar, Pakistan
3Faculty of Engineering (ETS), Dubai Women College, HCT, Dubai, U.A.E.
4Deptment of Electrical Engg, University of Science and Tech,Bannu, Pakistan
1,4,5,6,7 Career Dynamics Research Centre, Peshawar, Pakistan
7Department of Computer Science, Iqra National University, Peshawar, Pakistan

Corresponding Author: Dr. Sheeraz Ahmed
E-mail: sheeraz.ahmad@inu.edu.pk

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Abstract

The architecture of WBANs consists of small nodes which are fitted on the body of human or it may be implanted inside body to investigate and analyze and sense data like monitoring body temperature, blood pressure, heart rate and glucose level checking etc. For efficient design and development of WBANs, which ensure reliability and efficiency the knowledge of system and its components are necessary. WBANs must be capable to support lower energy, high data rate, reliability, Quality of Service (QoS) and minimum interference for the consideration of vast applications of WBANs. In WBANs there is a need of proactive management because it is related to more reliable communication. In this research work we are trying to provide a comprehensive review of state of the art routing protocols for WBANs. After the thorough analysis and investigation of different routing protocols, we conclude that there are many good schemes to overcome and resolve the issues of routing in WBANs. But still some of the issues need to be resolved. A new routing protocol for WBANs is developed called DSBAN. In this scheme we considered the performance metrics in terms of the already available schemes SIMPLE, and LAEEBA and see the effects in terms of energy efficiency, Networks lifetime and path-loss. The results show that the scheme DSBAN is significantly showing improved performance than the other two schemes under consideration. The reason is that the scheme considers those positive features of SIMPLE and LAEEBA which help us in the design of the new scheme.

Keywords: WBAN, LoS communication, Routing protocol, Quality of Service
I. Introduction

The wireless sensor networks (WSNs) works in a different and unique type of wireless communication. The development was started since 1995 for several low energy devices [1]. A huge amount of smart devices are adopted in the desired area for sensing vital sign and usually depends over the nature of target and strength of the adopted network. WSNs work in different circumstances for example a targeted building or possibly underwater in rare cases. The WSNs is wireless network and all the devices in the network communicate wirelessly. WSNs sense and analyze different changes in target areas and deliver the collected data to the controlling station.

WBAN is the sub area of Wireless Sensor Networks (WSN). It can be defined as the low energy, self-organizing, cost effective, light weight sensor objects located on the body or implanted in the body that communicate with each other with the help of radio link, to collect the useful parameters from the body, which might use it locally or may send it to the server for remote processing. The data gathered from the nodes is transferred to the sink located nearer to the nodes. The sink then aggregates the data and sends it to the remote server for further analysis. The data available on the server can be easily accessible to the concerned person or authorities for useful decision making [II].

The WBANs has various uses although they commonly perform healthiness observations. In these networks structural design comprises of small nodes which may be fitted inside or outside body to collect and examine the data like observing human body temperature, and heart related functions such as intensity or pressure of blood in human body, pulse speed and diabetic blood intensity etc. These technologies are used in observing healthiness which has considerably decreased the expenses which were spent on many hospitals admitted patients. We are now able with the help of WBANS to monitor and perform long term treatment and patient observation without any limitation. In WBANs the sensor are constantly gathering the data and forward the gathered data to the dedicated medical servers which will perform further analysis [III].

The effective structural planning and improvement of WBANs provides the required reliability of the system and its components. As we know about the radio broadcasting along with communication and other necessary requirements. From a number of years huge amount of researches are performed to find out the characteristics, extreme wide-ranging bands and modeling interior as well as exterior broadcast. In WBANS the broadcasting specifically, within the human body or nearby devices are extremely complicated in comparison to the existing terrestrial systems because there is an extreme complications in an individual body, and it consists of various tissues [IV].
Table 1: Differences between WBAN and WSN

| Parameters       | WBAN                                                                 | WSN                                                                 |
|------------------|-----------------------------------------------------------------------|----------------------------------------------------------------------|
| Nodes            | The deployed nodes are limited in numbers and depend upon the application. | The deployed nodes are in large numbers and are deployed in places where it is difficult for someone to operate it. |
| Reliability      | The WBAN are much reliable                                              | Reliability is Low as compare to WBAN.                              |
| Data Rate        | Heterogeneous                                                         | Homogeneous                                                           |
| Wireless Technology | Low energized technology is needed to be utilized effectively.       | Bluetooth, ZigBee, Wireless Local Area Network, GPRS.               |
| Range            | It is limited in range.                                                | Range is large.                                                      |
| Data Rate        | Heterogeneous                                                         | Homogeneous                                                           |
| Latency          | Replacement of batteries in WBAN is easier when energy preservation is favorable. | Nodes once deployed are physically unreachable, so it is necessary to have long lasting energy mechanism at the expense of higher latency. |
| Mobility         | Event based monitoring                                                | Stationary                                                           |
| Area of interest | Small                                                                 | High                                                                 |
| Density          | It is not node dense.                                                 | Node dense                                                           |
| Scale            | In centimeters or meters                                              | In meters or Kilo meters                                             |

The WBANs should be capable for delivering optimized energy consumption, extreme transmission speed of data, consistency, improved service Quality (QoS) with lowest intervention. To provide this, IEEE 802.15 [IV, V] tried to set up a group to develop IEEE 802.15.6. The Table.1 below shows a similarity of WSNs and WBANs.

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A good application of WBAN is the ECG system. Most Commonly used ECG system is 12 lead ECG systems. There are other types of ECG systems are also available. The figure 2 shows ECG of a patient with 12 lead ECG machine. In this system, patient has to lie on a bed to place these gel-based electrodes on chest, arms and legs. After placement of electrodes, ECG machine started taking ECG signals and trace them on a graph paper. It takes few minutes to complete the whole process [V].

In medical, time and accuracy are important characteristics for any medical tests. A minute delay in treating any heart disease may damage heart muscle [I]. Current ECG systems are not user friendly and time consuming. Due to which systems are now moving towards automation, less time consumption and permanently save users information systems.
II. Challenges of WBAN Technology Implementation

With the recent advancement in the field of nodes, the size, cost, weight have been reduced to some extent. And the focus is on increase the intelligence of the nodes to be successfully deployed in real world applications. The key objectives are to have a reliable, fault-tolerant network with maximum throughput and minimum delay whereas keeping in view that energy consumption is minimized specially in case of no communication the energy is conserve. Privacy, safety, ease of use, security and compatibility are also of great importance [III]. Some of the challenges faced by the research community to fully deploy such technology are given below.

II.i. Sensitivity of the Nodes

The sensitivity of the nodes especially in case of wearable nodes becomes very important when deployed in harsh environments e.g. in the Military operations, fire situations, etc. Sweat can influence the transducers of the sensor contrarily, bringing on the decline in the affectability of the body-worn nodes [IV]. The self-calibration and sensitivity improvement processes are needed for sensor devices to be effectively used in various domains.

II.ii. Energy of the Nodes

Nodes are equipped with low energized batteries which is crucial problem of the sensor technology. It becomes really difficult to recharge or replace the batteries. Energy or energy required by the sensor node depends upon the type of the application. It has been an attractive area for researchers to enhance the life time of the nodes batteries from days to decades especially for devices implanted in the body. Plenty of work has been done and still needs improvement to be used in sensitive application areas like remote health monitoring. The life span of the WBAN depends vigorously on sensor’s battery life cycle and actuator. To acquire smaller than expected size of nodes, battery sizes must be kept little since, their size influence the overall size of the sensor node [VI]. Energy searching is a standout amongst the most proficient methods for guaranteeing that the BAN organize runs a very long time with no communications. So as to accomplish energy effective BAN, control utilization level must be confined and correspondence should just be done intermittently or as at when required.

II.iii. Effective Methods of Data Collection

Data collection is another challenge in the field of nodes technology as collection of useful data for processing needs more improvement. In some of the cases like collection of useful parameters by electrocardiograms is not possible by fixed number of nodes, so the number of nodes need to increase. Gathering data in real time for the psychophysiological assessment is very essential [VII]. Effective methods are needed to be addressed by the research community to be used in critical applications like health care, battle field etc.

II.iv. Heterogeneity in Devices

Since nodes in WBAN catch various types of data, quality of data is a key issue. For occurrence, sensed data may vary depending upon the type of application.
and data to be sent. Inalienably, a few nodes sense more basic data than others. Also, a similar sensor may be in various states that shift in their criticality. Henceforth, the dependability review may change energy fully at runtime.

II.v. Security

One of the significant test looked by the sensor systems is the security. Nodes networks being applicable in crucial areas like medical field, battlefield etc., it is necessary to protect it from security threats. For guaranteeing the safety, unwavering quality, data trustworthiness and data privacy, encryption and verification is required. The validation and encryption ought not to present excessively overhead on the energy utilization of BAN [VIII].

II.vi. Data Privacy

A system may require the data confidentiality to protect it from getting exposed, as during communication there are probabilities of eavesdropping. Particularly in image processing applications which are increasingly accessible from every day, the security protecting strategies ought to be created for the solace of the observed individuals. On-sensor handling of pictures can be an arrangement in which no pictures are exchanged, just the data about the picture is sent over the network. To overcome this issue some useful encryption methods are being used while transmitting data over the network [IX]. The private key is shared through a secure network at the destination to decrypt the data in its original form.

II.vii. Integrity of Data

Data integrity means that data is transmitted to the destination point in its original form and no one has alter the data. Absence of such technique clears a route to the enemy to change the data before it comes to the destination point [I]. It can be useful in medical application where the patient data is quiet sensitive and need not to be altered by any one for the assessment of the physician. Moreover, in critical applications like in battlefield while transmitting some sensitive or critical data to the base station.

II.viii. Authentication of Data

Authentication of data is necessary for sensitive applications like in military and medical field. While receiving data from the source it is very important for the Body Nodes (BN’s) and BAN Network Controllers to verify whether the data is coming from the trusted nodes [II]. Symmetric technique can be used for attaining the authentication of the data. Secret Key can be served for this purpose.

II.ix. Usability

BANs ought to be effortlessly setup by restorative work force and BAN clients who may not have any technical knowledge. This infers BANs ought to be fit for self-configurable. BAN sensors ought to have the capacity to set up at whatever point they are set in a network and turned on with no intercession. Positions of nodes are application based; for instance, a peacemaker could be embedded into the mind to invigorate diverse area of the mind with electrical signs. The security solutions for BSN have to be operational. The serviceable security solutions are defined which are

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activated on employment in plug-n-play manner with minimal initialization procedures [X].

III. Literature Review

Developing utilization of nodes came about in WBANs. In this kind of systems number of estimating gadget are situated over a body or situated in the body to recover basic parameters. Because of its tendency and assortment of nodes WBAN have numerous helpful presentations like remote observing of patients. Researchers talked about a few issues with respect to the situation of the Body Networks and how they influence the presentation of the system. Some most recent research problems were additionally featured, for example, security, enhanced life time of the network, more data rate, less energy consumption of nodes [VIII]. Researchers in [X] displayed a solid, energy productive protocol with high throughput. A cost capacity was displayed based and a sensor chosen closer to sink and has high leftover energy. The introduced model had a superior system life, extended security period and high parcel conveyance to sink when contrasted with different schemes.

In [I] researchers introduced Link-Aware and Energy Efficient plan for WBAN (LAEEBA) scheme, an effective one for WBAN results high packet delivery ratio. In past research a lot of spotlight was on energy preservation in any case, no thought was given on way energy. To diminish the way energy single-bounce and multi-jump directing methods were used to elevate the system life-time. With the help of a cost capacity, forwarder sensor of high lingering energy is picked to transfer data to sink. Simulations results exhibited that displayed scheme broadened the framework execution of high throughput along with a minimum data energy.

In paper [XII], researchers displayed DARE (Distance Aware Relaying Energy effective) protocol for e-medicinal services in the clinic with multi-bounce system. Here scheme nodes embedded on body impart by on body transfer with base station. Hand-off has more energy than of sensors. Nodes speak on the body transfers in range with more energy assets and smaller separation. Body hand-off accomplish accumulation and moving of data to base station. This heterogeneous procedure of nodes and body hand-off transfers’ data through multi-hops resulting in enhanced network lifetime with minimum energy utilization and more throughput. [XIII] Introduced a LAEEBA and Cooperative scheme Co-LAEEBA steering procedures. As opposed to prevailing schemes, they introduced work factors in symbiotic learning and way disaster. Cost capacity was familiar to learn and choose the most conceivable way from an offered sensor to sink while sharing each other’s division and leftover energy data.

Author in [IX] introduced artful plan to abuse development of body parts for example during strolling to expand the framework life-time. In this scheme, sink situated at the human wrist and sensor sensors on chest. Plan to locate sink at wrist was to effortlessly return the battery as it is easy over wrist as contrast with different sensors. Sink should be arranged where it perseveres through insignificant proportion of following from body. Analysts in [XIV], introduced a plan to improve the energy effectiveness alongside the issue of postponement in correspondence channels. The issues talked about in going before lines additionally bring about more throughput of
system. Researcher utilized a need plan so as to spare energy. For ordinary data stream rest and dynamic system was utilized. During the correspondence sensor stayed dynamic while gathering the helpful parameters. On the off chance that no transmission is seen, at that point sensors become dormant. Simulations were done by the researcher to get to the order of scheme.

Critical data is viewed as increasingly significant in human services and combat zone applications. WBAN ought to be able to support snappy and solid data transmission. Paper [XV] proposes another plan that can deal with critical and typical data correspondence at the hour of crisis in a defer edge. The outcomes demonstrated that the displayed plan has reduced delay than the traditional. Data assembled or transmitted in WBAN is amazingly fragile in war circumstances. Moreover, security is in like manner a basic problem from the war circumstances as officer's data is extremely ordered and should be dealt with, transmitted, and set away with consideration to neutralize data leakage to unauthorized people. Thusly, data approval, protection, data respectability, non-denial, and security should be guaranteed in the midst of all exchanges inside WBAN.

Authors in paper [XVI] presented a protocol for cattle health monitoring. The authors use devices arduino UNO, Arduino NAHO, Xbee module and different types of nodes for taking data of different disease in cattle health. The authors compare the healthy data and present data for disease detections. In paper [XVII] authors presented a scheme which is energy efficient on the basis of routing. First of all it select the shortest path, second is the energy level of node check for data relay and the third to avoid the path which may already been followed by huge number of packets. In paper [36], the authors presented a protocol to be run at application layer that permits the host node to forward the packet in revolution, using this method it the pass up the packet loss. The protocol will also collect physiological data and public policy for promoting physical activity.

In paper [XVIII], the authors presented cattle monitoring with Bio-nodes in wide area. The authors apply the Bio-nodes on the cattle and cattle health data collect through cloud server on smart phone application. On smart phone various types of data regarding cattle health data system of different diseases, which may be numerical, text and graphical are collected. This data provides better help to veterinary doctor and farmer. The presented system provides the cattle health data in long wide area. In paper [XIX], the authors presented animal’s health care tracking system. In this research the data provide animal location to former using GPS, on each animal GPS tracker is preset. The authors used Rapid Development Application system. In presented work the animal disease data is provided to web database server through cloud computing system and from the data base the server data is provided through SMS to veterinary doctor, farm owner, nutritionist and livestock guard.

In paper [XX], the author presented a protocol for Body Area Link Aware energy efficient approach which consist network data and initialization processes and it also calculate path lost calculation for energy reduction. The results show that the protocol improves residual energy, link organization, throughput and network lifetime. At the last the authors compared its protocol with M-Attempt and iM-SIMPLE which perform better performance these two protocols. In paper [XXI], the

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authors presented a scheme on cattle monitoring by wireless nodes network the animals various diseases such as mastitis, lameness, milk fever, diarrhea etc. data are stored in database by using nodes on animal body and from that data is forwarded to veterinary doctor and farmer for further consideration.

In paper [XXII] the authors presented the scheme that collects the sheep temperature and heart beat rate outside the laboratory. The system is made to produce a good quality of mutton from sheep to improve the economy of the country. The system performs a good and accurate transportation of data. In this research the authors describe in detail the temperature and heart beat nodes and its various units. In paper [XXIII] the authors introduced a system for animal monitoring, which collect the data from 500 km for flung from their laboratory. The system collect the data regarding animal existence that animal is present in the unit area or not. It also informs the owner and doctor regarding health status of the animal.

IV. Motivation

There are several routing problems in WBANs. In this research study we try to deliver a complete and detailed analysis of revolutionary routing protocols used for WBANs. These protocols are further categorized as thermal;QoS, clustering based, and cross level and lastly postural protocols. Progressive as well as encouraging thoughts are recognized by various revolutionary routing protocols after significant analysis of the routing protocols by associating several functioning parameters. There are several routing challenges are discussed and considered although some of the objectives still needs to be resolved. After the complete and detailed study of various routing protocols we conclude that the QoS must be considered along with critical signs associated with the hospitalized people. Similarly, postural activities of the human body are not considered along with the thermal properties of fixed sensor nodes are not taken into consideration in the majority of the researches. The most common routing protocols such as THE-FAME, LAEEBA and DARE discuss one issue and leave all the residual issue. Similarly when the routing protocols discusses the thermal issues of humans so than they don’t discuss the posterior movement or issues relating to QoS. In the same way several protocols discusses the thermic issues in WBANs, and the analyzed energy is absorbed due to antenna radiation, however inappropriately they don’t discuss residual problems. Consequently, we investigated seriously challenging problems of routing protocols moreover we have done effort to combine encouraging factors for further enhancement in WBANs. This will help us in designing novel WBANs protocol for mainly medical field. We have taken into consideration several parameters for our research like latency, consistency and mobile QoS.
V. Methodology

Fig. 3: Topology for Nodes Deployment on a Human Body

In DSBAN, there are two methods of correspondence. Direct method of correspondence happens for those nodes which are in straight contact to both of the sinks 1 or 2. Multihop method of correspondence for those sensors will be conceivable which will not be in direct contact. The Energy utilization in direct link mode is more as in multi-hop. More energy is required to moving information bundles over longer separations if there should be an occurrence of direct move; because of which, we go for the choice of multi-hop move. With the assistance of sending sensors, data parcels from different sensors are routed to any of the accessible sink.

V.i. Network Topology

Legitimate arrangement of sink and different sensors is very testing on a human body if there should be an occurrence of body territory systems. Inappropriate making arrangements for the organization will genuinely influence the system execution in WBANs. Figure 3 demonstrates the arrangement procedure for nodes just as 2 sinks S1 and S2 for DSBAN. Such positions for sinks are picked with regards to NLOS correspondence for situations of body developments.

8 sensor sensors are conveyed on the human body other than the 2 sinks. Scarcely any nodes move their detected data direct to sink S1 in light of LOS correspondence. Lingering nodes move their data in a roundabout way to both of the sink utilizing multi-jump correspondence picking a sending sensor. Both the sinks gather every one of the data produced by every one of the sensors and afterward forward it to a base station for assistant handling.

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V.ii. Initializing Network

In this phase, the 2 deployed sinks broadcast the “Hello” message to all of the nodes located on the human body. The message consists of Sinks IDs with their locations. All the sensors will save this data in their routing tables. Sensors will then broadcast their own data packets which will contain the data of their IDs, residual energy and deployment locations. All nodes whether sinks or normal will now be aware of their neighboring ones.

V.iii. Next-Hop Selection

Energy saving of nodes is the primary concern for body area networks. Nodes that are distant from other nodes need more energy for data amplification. As the energy level of nodes gets depleted, it loses its capability of transferring much data, hence the network stability goes down and critical data which must reach the sink may not be able to reach their destination. Because of these factors, the concept of forwarding node is employed in our routing strategy which will act as a relay in our presented scheme. This relay will be an intermediary node which will be elected depending on more residual energy (RE) and shorter distance from sink. DSBAN protocol uses a fixed threshold value for RE of 0.2 J. Threshold value is quite small compared to the initial assigned energy of 0.9 J; and is the least required energy which is able to transmit data packets. Various energy parameters used in our simulation with their respective values are mentioned in table 2.

Table 2: Energy Parameters with assigned Values

| Energy Parameters      | Values         |
|------------------------|----------------|
| DC current (RX)        | 18 mA          |
| DC current (TX)        | 10.5 mA        |
| Minimum supply voltage | 1.9 V          |
| ERcr–recv              | 36.1nJ/bit     |
| ERcr – send            | 16.7nJ/bit     |
| ERamp                  | 1.97nJ/bit     |
| Wavelength (λ)         | 0.135 m        |
| Frequency (f)          | 2.5 GHz        |
| Initial Energy (Ei)    | 0.7 J          |
| Do                     | 0.15           |

If in the selection of forwarding nodes, there is a tie in RE of 2 nodes, then the forwarding node will be elected on the basis of Received Signal Strength Identification (RSSI) value. RSSI is a measurement of the energy strength present in a received radio signal. DSBAN follows the model of RSSI of [XXXIV], as given in the equation (1).

\[ Pr = P_t \left( \frac{1}{d} \right)^n \]  

(1)

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Pr is the received energy of wireless signal and Pt represents the energy transmitted. D is the distance between two sending and receiving nodes. n is the transmission factor for sensor nodes; whose value depends on the environment. Such a node will be capable of being a forwarding sensor whose Pr is more.

**V.iv. Routing and Energy Consumption**

2 sinks are presented in this scheme which makes the best performance of overall BAN. Another benefit taken is the use of direct mode of communication in case of LOS and multi-hop in the case of NLOS to S1 or S2. Nodes that are in lesser distance from S1 or S2 transfer data packets by direct link mode and those which are not directly in contact to either of the sink, needs extra energy to transfer their data by the use of relays. Forwarding or relay nodes behave as intermediate nodes which forward their own data as well as coming from rest of the sensors. Such type of data transfer in which relays employed is called multi-hop communication. The flow chart for data transfer strategies in DSBAN scheme is shown in figure 4.

![Flowchart for the working of DSBAN Protocol](image)

**Fig. 4:** Flowchart for the working of DSBAN Protocol

In multi-hop communication, the energy consumption is expressed in equations (2), (3) and (4) while for direct communication is given in equations (5) and (6) [18]:

\[
ER_{t-M}(k,d) = n \times (ER_{cr} + ER_{amp}) \times b \times d^2
\]

\[
ER_{r-M}(k) = (n-1) \times (ER_{cr} + ER_{amp}) \times b
\]

\[
ER_{Total-M} = ER_{t-M} + ER_{r-M}
\]

\[
ER_{t-D}(b, d) = (ER_{cr} + ER_{amp}) \times b \times d^2
\]

\[
ER_{Total-D} = ER_{t-D}
\]
ERt is the energy required for transmission while ERr is the one needed for gathering of bundles. b communicates the complete bits moved while d is separation among sensors and sinks. ERcr is the energy expected to help execute electronic hardware. ERamp is the energy required for intensifying b bits to remove d. n is number of nodes conveyed on body and d2 is the energy during moving data parcels.

VI. Experimental Results and Discussion

Depending on the basic parameters for the purpose of measuring the DSBAN performance, we have performed some sort of simulations in our research. Two well-known protocols which are LAEEBA and SIMPLE are used for performing analysis of our presented protocols. Since these protocols have been evaluated for identical performance parameters and such parameters is Network Life span, PDR, residual energy, and The Delay.

VI.i. Residual Energy Graphs Time (secs)

![Residual Energy Graph vs Time](image)

**Fig.5:** Energy Consumption vs Time in Seconds

**Table 3: Residual Energy per 2000 seconds**

| Protocols | Performance | 2000s | 4000s | 6000s | 8000s | 10000s | 12000s |
|-----------|-------------|-------|-------|-------|-------|--------|--------|
| LAEEBA    | 0.888       | 1.92  | 1.13  | 0.458 | 0     | 0      | 0      |
| SIMPLE    | 1.989       | 4.16  | 2.74  | 1.315 | 0.327 | 0.193  | 0.0591 |
| DSBAN     | 0.969       | 2.56  | 1.14  | 0.195 | 0     | 0      | 0      |
We considered initial energy 0.7 joules to similarly assess for all thought about plans. The degree of energy in DSBAN scheme is impressively superior to LAEEBA as appeared in the figure 5 alongside Table 3, while SIMPLE isn't in that capacity proficient. Pollute energy use of DSBAN is in offset with dauntlessness period, all the way deferrals and throughput. Our noteworthy target for DSBAN was to enhance the throughput and security period with constraining the deferral.

For energy usage SIMPLE showed much better just as improved execution because of the explanation that such scheme essentially underlined on this parameter though the exhibited DSBAN scheme depended on the strength time frame improvement. Another motivation behind reduced additional energy usage is the consideration of RSSI. To pick a forwarder sensor center if when various center’s having lingering energy that is more conspicuous than the cutoff expands, DSBAN play out some additional counts. These figuring’s also need energy which prompts make DSBAN energy hung when contrasted with SIMPLE. In decision of forwarder sensor center, the tie case is furthermore a key focusing figured which isn't tended in existing plans by analysts.

VI.ii. Packet Delivery Ratio vs. Time (secs)

![Packet Delivery Ratio vs. Time (secs)](image)

Fig. 6: Packet Delivery Ratio vs. Time (secs)

Table 4: Successful PDR per 2000 seconds

| Protocols | Improvements | Average | %Age | 2000s | 4000s | 6000s | 8000s | 10000s | 12000s |
|-----------|--------------|---------|------|-------|-------|-------|-------|--------|--------|
| LAEEBA    |              | 12479.80| 100% | 6297  | 1.057e+4| 1.465e+4| 1.744e+4| 1.744e+4| 1.744e+4|
| SIMPLE    |              | 17246.30| 138% | 5778  | 1.199e+4| 1.861e+4| 2.719e+4| 2.859e+4| 2.999e+4|
| DSBAN     |              | 18790   | 151% | 5783  | 1.289e+4| 2.6e+4  | 2.805e+4| 2.805e+4| 2.805e+4|
Throughput can be characterized as the fruitful conveyance of data bundle from sensors to sink in per unit time. We considered second as unit that starts from 1000 secs to 12000 secs. 2types of connections are being used in DSBAN. From center point to forwarder is the primary connection, while second one is from forwarder center to sink center points. Forwarder center point to sink center point association move more data than center point to forwarder association. Hence as demonstrated by DSBAN various centers approach sink center points that direct transmit data groups and it prompts raise throughput. The differentiation of execution of three plans clearly is exhibited in the figure 6. The DSBAN is immeasurably improved than LAEEBA and SIMPLE. A normal throughput of our scheme portrays in table 4 which is 18790 and it is 51% and 13% better than LAEEBA and SIMPLE independently.

### VI.iii. End-to-End Delay

![Image of End-to-End Delay](image)

**Fig.7: End-to-End Delay (secs) vs. Time (secs)**

| Protocols | Improvements | 2000s | 4000s | 6000s | 8000s | 10000s | 12000s |
|-----------|--------------|-------|-------|-------|-------|--------|--------|
| LAEEBA    | Average      | %Age  |       |       |       |        |        |
| 167.970   | 75 %         | 380.70| 268.90| 106.70| 105.80| 105    | -      |
| SIMPLE    | 221.520      | 100%  | 433.30| 270.70| 269.30| 265    | 260    |
| DSBAN     | 162.340      | 73 %  | 173.50| 173.50| 174.60| 115.60 | 115.60 | 115.60 |
The time which is slack between a sender sensor and a goal sensor is named as start to finish delay. Wellbeing authorities assess the sensor detected data; consequently, accepting such data on time is considerably more significant and this must be conceivable when gotten data bundles on time at sink sensors. From figure 7, plainly as far as start to finish delay, the presentation of the exhibited scheme is significantly better than SIMPLE and LAEEBA. While table 5 demonstrates a normal delay realizes quantitative structure which depicts that DSBAN is 27% gainful than the SIMPLE scheme. In like manner, the displayed scheme is moreover 2% capable than the LAEEBA show. The DSBAN improved execution is required to anycast scheme for the assurance either of the two sinks to transfer data group and the center points has two options to forward their package. Both the earlier schemes used only 1 sink that is responsible of assembling of data packs from various nodes. Option of 2 sinks in DSBAN shows better execution as appears differently in relation to SIMPLE and LAEEBA as sinks accumulate data packets at 2 center points. Most of sensors in DSBAN come in direct contact of S1 or S2 and link between centers and the sink centers advances toward getting to be constrained. The investigation exhibits that all the way deferment diminishes by direct trades than by multi-bounce as the partitions ends up being less with direct correspondence.

VI.iv. Stability Period

![Graph showing Stability Period vs. Time (secs)](image)

**Table 6: Sum Total of Dead Nodes per 2000 seconds**

| Protocols | 2000s | 4000s | 6000s | 8000s | 10000s | 12000s |
|-----------|-------|-------|-------|-------|--------|--------|
| LAEEBA    | -     | 3     | 3     | 3     | 4      | 8      |
| SIMPLE    | -     | -     | 1     | 4     | 6      | 8      |
| DSBAN     | -     | -     | -     | 1     | 6      | 8      |
Stability period can be characterized as the time period lapsed from the start of the network till the first node dies. From figure 8, clearly the DSBAN is showing improved execution as diverge from SIMPLE and LAEEBA. A quantitative assessment of DSBAN with LAEEBA and SIMPLE to the extent kicking the bucket sensors beginning from 1000 seconds to 10000 seconds is referenced in the table 6. Such table show that the essential center of DSBAN ends following 7200 seconds while LAEEBA and SIMPLE lose their first center after 2100 and 4250 seconds. DSBAN accomplishes this better presentation by two sinks accessibility. Either sinks approaches center points which help them to move their data packs to near accessible sink. In that circumstance sink center points have moreover remarkably result and helpers for the healthier execution of WBAN. The wrist nodes distinguished the data packets through direct correspondence with either S1 and S2 sinks (without NLoS issue) move data packet groups. This factor enhances the establishment of DSBAN too high to the level of 10000 seconds. All of sensor center points of SIMPLE and LAEEBA ended reaching 8000 seconds anyway the very last sensor center of DSBAN passed at 10000 seconds.

VI. Conclusion

A new routing protocol for WBANS is developed called DSBAN. In this scheme we considered the performance metrics in terms of the already available schemes THE-FAME, LAEEBA and DARE and saw the effects in terms of energy efficiency, Networks lifetime and path-loss. The scheme was contrasted existing schemes with check the exhibition of DSBAN. Effective decision of forwarder sensor is made on the base jump check procedure. More prominent separation in between sensors makes much of energy be devoured, so least removed sensor is chosen for data sending. Next presentation variable which was upgraded is throughput; and oversaw directing alongside energy collecting gave us an effective answer for these issues in WBANs. In DSBAN, there are two methods of correspondence. Direct method of correspondence happens for those nodes which are in straight contact to both of the sinks 1 or 2. Multihop method of correspondence for those sensors will be conceivable which are not directly in range. Energy utilization in direct mode is excessive than in multihop. More energy is required for moving data bundles over longer separations if there should arise an occurrence of direct move; because of which, we go for the alternative of multihop move. With the assistance of sending sensors, data parcels from different sensors are AnyCasted to both of the accessible sink.

References

Ahmed, S., et al. "LAEEBA: Link aware and energy efficient scheme for body area networks." 2014 IEEE 28th International Conference on Advanced Information Networking and Applications. IEEE, 2014.
II Akram, S., et al. "The-fame: Threshold based energy-efficient fatigue measurement for wireless body area sensor networks using multiple sinks." Broadband and Wireless Computing, Communication and Applications (BWCCA), 2013 Eighth International Conference on. IEEE, 2013.

III Ansari, Hannan, Sachin Kumar Patel, and Sachida Nanda Barik. "Survey on Wireless Sensor Networks." (2014).

IV Ari, Ado Adamou Abba, et al. "Concepts and evolution of research in the field of wireless sensor networks." arXiv preprint arXiv:1502.03561 (2015).

V Bahanfar, Saeid, et al. "Reliable communication in wireless body area sensor network for health monitoring." arXiv preprint arXiv: 1112.0393 (2011).

VI Braem, Bart, et al. "The need for cooperation and relaying in short-range high path loss sensor networks." Sensor Technologies and Applications, 2007.SensorComm 2007.International Conference on.IEEE, 2007.

VII Braem, Bart, et al. "Improving reliability in multi-hop body sensor networks." Sensor Technologies and Applications, 2008.SENSORCOMM'08.Second International Conference on.IEEE, 2008.

VIII Crosby, Garth V., et al. "Wireless body area networks for healthcare: a survey." International Journal of Ad Hoc, Sensor & Ubiquitous Computing 3.3 (2012): 1.

IX Ehyaie, Aida, Massoud Hashemi, and Pejman Khadivi. "Using relay network to increase life time in wireless body area sensor networks." World of Wireless, Mobile and Multimedia Networks & Workshops, 2009.WoWMoM 2009.IEEE International Symposium on a. IEEE, 2009.

X Elias, Jocelyne, and Ahmed Mehaoua. "Energy-aware topology design for wireless body area networks." 2012 IEEE international conference on communications (ICC). IEEE, 2012.

XI Heinzelman, Wendi Rabiner, Anantha Chandrakasan, and Hari Balakrishnan. "Energy-efficient communication protocol for wireless microsensor networks." System sciences, 2000.Proceedings of the 33rd annual Hawaii international conference on.IEEE, 2000.

Yick, Jennifer, Biswanath Mukherjee, and Dipak Ghosal. "Wireless sensor network survey." Computer networks 52, no. 12 (2008): 2292-2330.

XII Javaid, Nadeem, et al. "Measuring fatigue of soldiers in wireless body area sensor networks." Broadband and Wireless Computing, Communication and Applications (BWCCA), 2013 Eighth International Conference on. IEEE, 2013.

XIII Khan, Z. A., et al. "Effect of packet inter-arrival time on the energy consumption of beacon enabled MAC protocol for body area networks." Procedia Computer Science 32 (2014): 579-586.
XIV Monsef, Ehsan, et al. "Managing Quality of Service in Wireless Body Area Networks using CoAP." 2016 IEEE International Conference on Electro Information Technology (EIT). IEEE, 2016.

XV Nadeem, Adnan, et al. "Application specific study, analysis and classification of body area wireless sensor network applications." Computer Networks 83 (2015): 363-380.

XVI Nadeem, Q., et al. "Simple: Stable increased-throughput multi-hop protocol for link efficiency in wireless body area networks." Broadband and Wireless Computing, Communication and Applications (BWCCA), 2013 Eighth International Conference on. IEEE, 2013.

XVII Ruprecht, David J. "Body Area Networks and Body Sensor Networks." Wireless Network 17 (2011): 1-18.

XVIII Tauqir, Anum, et al. "Distance aware relaying energy-efficient: Dare to monitor patients in multi-hop body area sensor networks." Broadband and Wireless Computing, Communication and Applications (BWCCA), 2013 Eighth International Conference on. IEEE, 2013.

XIX Tavli, Bulent, et al. "A survey of visual sensor network platforms." Multimedia Tools and Applications 60.3 (2012): 689-726.

XX Wang, Pengyu, et al. "Survey on application of wireless sensor network in smart grid." Procedia Computer Science 52 (2015): 1212-1217. Ansari, Hannan, Sachin Kumar Patel, and Sachida Nanda Barik. "Survey on Wireless Sensor Networks." (2014).

XXI Yick, Jennifer, Biswanath Mukherjee, and Dipak Ghosal. "Wireless sensor network survey." Computer networks 52.12 (2008): 2292-2330.

XXII Zhang, Mi, and Alexander A. Sawchuk. "Human daily activity recognition with sparse representation using wearable sensors." IEEE journal of Biomedical and Health Informatics 17.3 (2013): 553-560.

XXIII Zhou, Gang, et al. "Bodyqos: Adaptive and radio-agnostic qos for body sensor networks." INFOCOM 2008. The 27th Conference on Computer Communications. IEEE, 2008.