International Journal of Future Generation Communication and Networking
Vol. 13, No. 4, (2020), pp. 4816–4827

An Enhanced Iot Security For New Born Baby Using Wban With Zigbee Techniques

S. Mahalakshmi[1], Dr.R.Latha[2]

[1]*Ph.D Research Scholar, Computer Applications*

[2]*Prof & Head, Department of Computer Applications*

[1&2] *St. Peter's Institute of Higher Education & Research, Chennai, Tamil Nadu, India.*

mahahindustan@gmail.com

Abstract

In Recent Decades, Medical Field has grown gradually with the digital information world. Today we can buy all types of medical tablets and surgical instruments online for the hospital. These proposed works consist of four phases. Initially focused on IoT Concept, a paired device with RFID are tagged with mother and baby, in order to monitor mother, baby heart rate, pressures which are connected with the internet. It also used to protect the child from the theft in the hospital. This research work used to transmit the information about the particular child, mother information for the particular hospital using the LEACH Algorithm to avoid the transmission delay in terms of Quality of Services. Finally used to determine the process posture based routing protocol used to compare the complexity, delay, and energy level in terms of cost minimization. This Proposed work will be effective and efficient in monitoring the child-mother physical health, avoid the theft of child from the hospital and also the network slicing of information transmitted to WBAN.

Keyword : *WBAN, Zigbee, Wireless Sensor Network, Sensor Band, IOT.*

1. Introduction

Wireless body area network (WBAN) is the core network component in IoT-based healthcare systems. Generally, a WBAN consists of a number of different biosensors that are deployed in, on or around a patient for continuously monitoring the health conditions. The sensedphysiological signals are first collected at a gateway for data aggregation via Intra-WBAN communications (i.e., from biosensors to the gateway) and then forwarded to remote medical centers for interpretation and analysis via beyond-WBAN communications (i.e., from gateways to remote medical centers). Gateways in IoT-based WBANs can be patients' smartphones or any other smart devices, each of which ordinarily stands for one patient.In recent years, numerous applications and prototypes for IoT-based healthcare systems have been developed. Research efforts in this area include the design of platforms, the coordination of interoperability and the protection of privacy and security. However, among all these, technical problems related to medical data transmissions in IoT-based healthcare networks, especially in the IoT-based beyond-WBAN, have not been well studied.

The Zigbee 3.0 protocol is designed to communicate data through noisy RF environments that are common in commercial and industrial applications. Version 3.0 builds on the existing ZigBee standard but unifies the market-specific application profiles to allow all devices to be wirelessly connected in the same network, irrespective of their market designation and function. Furthermore, a ZigBee 3.0 certification scheme ensures the interoperability of products from different manufacturers. Connecting ZigBee 3.0 networks to the IP domain opens up monitoring and control from devices such as smartphones and tablets on a LAN or WAN, including the Internet, and brings the true Internet of Things to be an effective.

ISSN: 2233-7857 IJFGCN

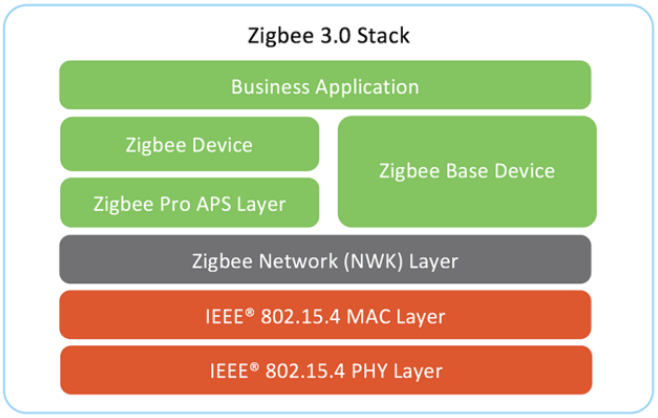

Fig.1 The architecture of ZigBee Technology

The above architecture includes the Zigbee 3.0 software stack incorporates a 'base device' that provides consistent behavior for commissioning nodes into a network. A common set of commissioning methods is provided, including the Touchlink, a method of proximity commissioning. Zigbee 3.0 provides enhanced network security. There are two methods of security that give rise to two types of network:

- **Centralized security**: This method employs a coordinator/trust center that forms the network and manages the allocation of network and link security keys to joining nodes.
- **Distributed security:** This method has no coordinator/trust center and is formed by a router. Any Zigbee router node can subsequently provide the network key to joining nodes.

2. Classification of WBAN

WBAN is a technology applied to the human body, so its network environment is very complex. Since the physiological information collected has an excellent impact on human life and health, it's important to style routing for the body space network. Supported the on top of analysis, the subsequent issues and challenges should be thought of in routing style:

Dynamic changes: Wireless transmission involves body surface transmission, body transmission, and free house transmission. Channel conditions square measure complicated. The Shadow impact caused by human motion ought to even be thought of. The gap and therefore the relative position between nodes also will modification with the movement of limbs. Considering the time-variationofthetopologyandthepossibleproblems, a reliable routing mechanism ought to be designed to adapt to the dynamic topology.

Energy efficiency: WBAN could be a technology applied within the figure, some sensors square measure planted within the body and should get replaced by surgery. it's not enough to produce power solely through micro-batteries. Now, though RF (Radio Frequency), EM (Electro-Magnetic) or energy harvest home is used for the ability offer, energy efficiency style ought to even be administered at the supply. Therefore, the energy efficiency of one node and energy balance of the entire network should be thought of within the routing style, thus on prolong the period of the network, as so much as doable.

Node temperature: Nodes generate heat once they work, which may cause injury to the key tissues and organs of the human body. Therefore, the temperature of nodes should be taken under consideration within the routing style.

QoS requirements*:* Nodes within the WBAN generate different kinds of knowledge, which should be processed otherwise, to ensure the QoS requirements of different types of data, like emergency information, delay-sensitive information, responsibility sensitive information, and general information. The Classification of Routing Protocol for WBAN is shown in Figure as follows

ISSN: 2233-7857 IJFGCN

Posture Based Routing: Posture-based routing is employed to research the constellation of the figure in varied dynamic postures to ascertain a quick and stable path. The analysis of varied postures is of nice significance. Several experiments have well-tried that everyone forms of figure movements have some regularity. This may greatly improve the event of the dynamic WBAN that's used. Within the dynamic atmosphere, the movement of limbs creates the constellation smart or dangerous and additionally turns out a shadow impact. the prevailing solutions will solely be additionally processed when the case happens, which was passive and had an outsized delay. If the following action is expected beforehand within the current time-slot, the judgment and process are created beforehand, which is incredibly useful to scale back the delay and improve the info transmission rate, with success. This Posture Routing protocol is further classified into two categories which discussed in detail below section are

i) **Mobility Handling Routing Protocol and**
ii) **Energy Efficient and Distributed Management Cost Minimization**.

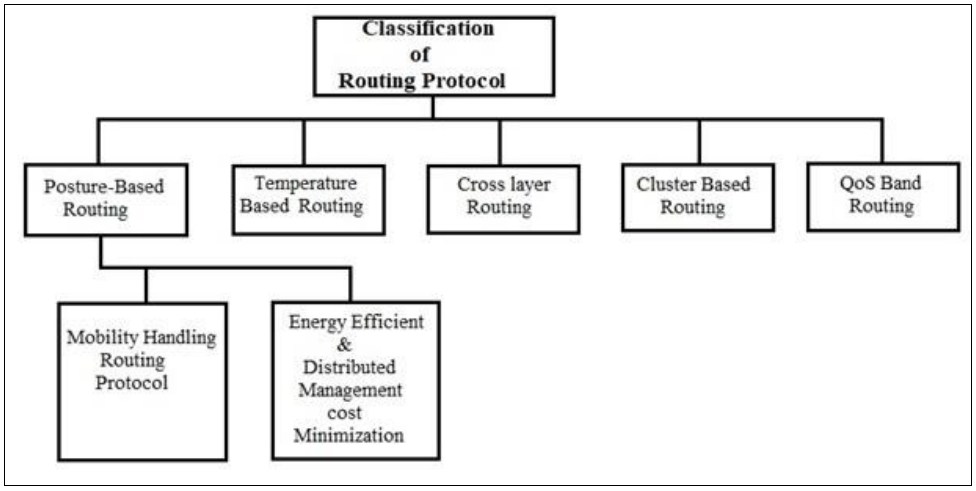

Fig.2 Classification of WBAN Routing Protocol

Temperature Based Routing: The Purpose of Temperature Based Routing Protocol used to determine and keep the node temperature below the safety level which may not affects the human body. This Temperature Routing Protocol mainly focused on the packets which send the details about the temperature in WBAN.

Cross-Layer Routing: The purpose of this Cross-Layer is used to share the information across the heterogeneous layer with high adaptability. Each Layer is consists of each attribute and its values.

Cluster-Based Routing: The Purpose of this layer is used to collect the data from all other nodes to the head node in the cluster and perform a certain aggregated function based on their requirement and send the result of the aggregated function to the base station in the wireless network.

QoS Band Routing: This QoS based Routing protocol which is used to determine the path for the flow of network based on the availability of network resources in the heterogeneous network. These are the classification of WBAN Protocol but this paper will propose only one routing protocol called Posture Routing Protocol.

3. System Model

The System Model of Wireless Body Area Network are classified into three-layer as shown in Figure 3 below,

ISSN: 2233-7857 IJFGCN

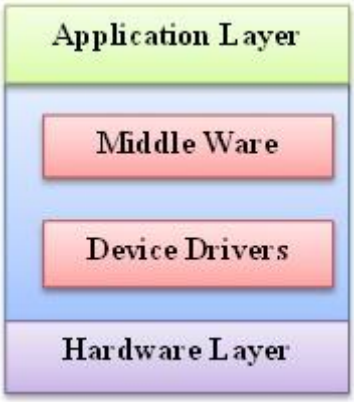

Fig.3 WBAN Layer

From the above figure 3, WBAN is classified into three-layer, the lowest layer is hardware layer, which includes the hardware devices like ECG equipment's, etc., Middle layer consists of middleware layer which includes a technology CORBA, RMI and Device Drivers like Mobile Phones, laptop or PDA devices used in the middleware layer. The Top Most Layer is the application layer used to predict the values of a human physical body part. These are the layers used in Wireless Body Area Network.

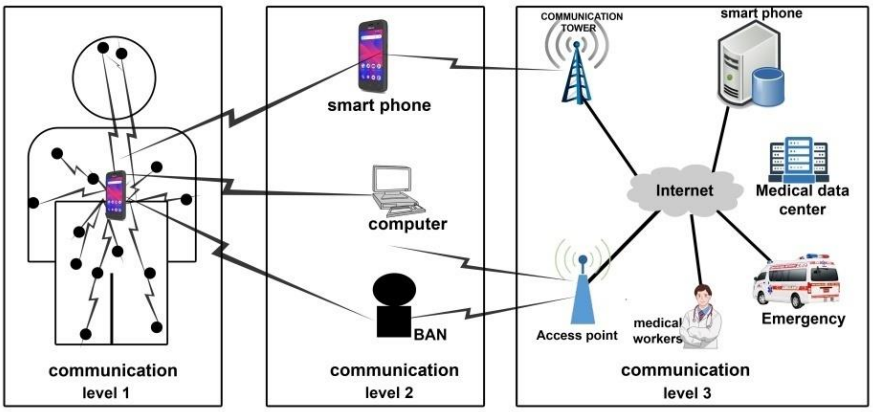

Fig.4 WBAN Architecture

System Model of WBAN architecture includes three-tier architecture as discussed above, Let us discuss the WBAN Architecture. With the speedy development of wireless communication technology and sensing element technology, Wide Body Area Network (WBAN) has been developed as new technology.

WBAN could be a three-tier design body network as shown in Figure 4.

- The tier-1 consists of sensors connected to the body surface or planted into the body. It perform is to gather and transmit varied physiological data regarding the figure.
- The tier-2 consists of smartphones, personal computers, or alternative intelligent electronic devices. Knowledge sent by sensors is forwarded to the terminal data center by a wireless mode.
- In tier-3 of WBAN, the terminal information center is especially composed of remote servers providing varied applications.

The performance is to collate and analyze the received information, to supply a dynamic response. Particularly once the sensing element node collects abnormal information; it'll perform emergency transmission and alarm, which may speed up the emergency process and rescue.

4. Methodologies

ISSN: 2233-7857 IJFGCN

The Methodologies of the research work are classified into four types as shown in the following figure 5.

Fig.5 Methodology

Monitoring: This phase used to monitor the heart beat, blood pressure of both new born baby and mother. This phase also include the distance between the new born baby and mother connected via wireless sensor network. if the new born baby and mother distance more, the sensor used to alert the hospital.

Classification: Periodically the information about the new born baby with mother's details connected with internet. The Classification mainly focused on the protocol used to transmit the information using zigbee technologies. The Classification shown in the figure 6.

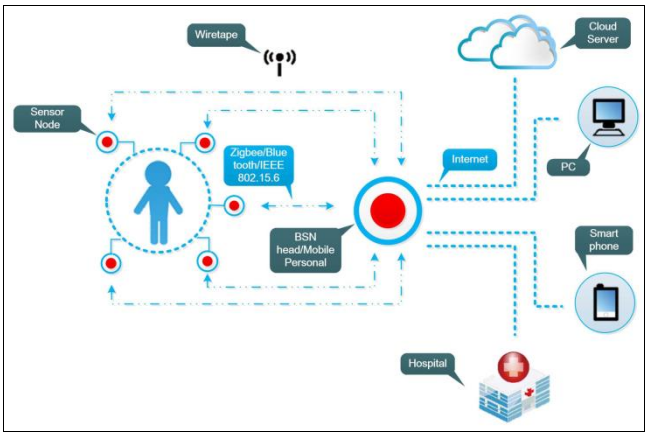

Fig.6 Classification of Zig Bee

Routing: Information Routed with LEACH Algorithm, in order to avoid the transmission delay through online with a heterogeneous network. This Routing of information is referring transmission of information through WBAN with Nagles and LEACH Algorithms.

Security:A solution to detect and prevent theft of newborn babies in hospitals. This work leverages RFID to record and track babies' data and identity.The solution continuously monitors the babies in the ward. As soon as a baby is taken out of the word, an alarm is triggered in the ward.An option to send an SMS alert to the registered people is also used. An administration console would allow the ward administrator to record and fetch and details of the babies. The system would have security features to allow only authorized ward personnel to operate the system.

5. Description of Research Work

The main objective of the research work is classified into three layers, first one information security provided by tied RFID tag to both mother and child, if the tag accidentally or incidentally moves

ISSN: 2233-7857 IJFGCN

away then an alarm will be sent to the hospital. The second layer is to provide the information transmission, which will provide the necessary details about the child, mother about their heartbeat and pressure, etc. The third layer mainly focused on Information Management System which is used in heterogeneous networks with IoT based on Network Security. The following figure 7 represents the description of the research work.

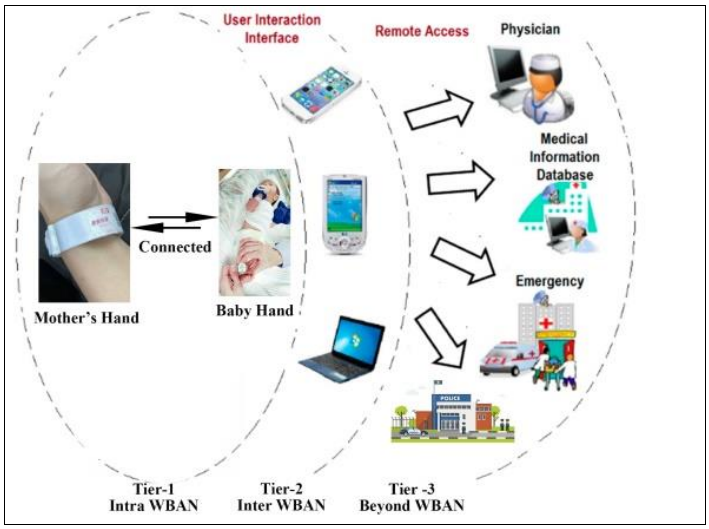

Fig.7 Description of the research

The research Work which classified into five layers with appropriate algorithm as shown in table1.

Table 1 Research Work – Wireless Network Layer

Wireless Network Layer	Algorithm
Front End Layer	I-NCMD
Transport Layer	I-LEACH & P- MHRP
Network Layer	E-Nagles
Data Link Layer	Wi-fi
Physical Layer	Wireless Sensor

Front End: Improvised Energy-Efficient and Distributed Network Management Cost Minimization (NCMD) value decrease and distributed chance routing NCMD with nominal network management prices were projected. Experiments to show that once WBAN is during a dynamic scene, the configuration is often intermediate and continuous state, which causes massive transmission delay and better network maintenance prices.

Transport Layer: Improvised- LEACH Algorithm which uses dynamic Selection of Cluster head at run time to distribute the load evenly on all the nodes. It's Uses Priory Information of a node to make the decision to make itself as cluster head. Once the cluster head is selected and the local cluster is formed, data fusion and compression can be used to send the aggregated response to the base station. This algorithm works in two-phase, the first phase is the cluster selection phase and the second is the steady state where data is sent to the base station using compression and aggregation techniques. Cluster head selection: In cluster Head Section, nodes use priory information to decide whether or not to become a cluster head for the current round. This is a local decision and it depends on the prior history of the node under consideration.

Improvised Mobility Handling Routing Protocol mainly used a sensor which consists of two relays with seven nodes to determine the heart rate and their functionality.

Network Layer: Enhanced Nagle's algorithm works by combining a number of small outgoing messages and sending them all at once. Specifically, as long as there is a sent packet for which the sender has received no acknowledgment, the sender should keep buffering its output until it has a full packet's worth of output, thus allowing output to be sent all at once. The RFC describes what he called the "small-packet problem", where an application repeatedly emits data in small chunks, frequently

ISSN: 2233-7857 IJFGCN

only 1 byte in size. Since TCP packets have a 40-byte header (20 bytes for TCP, 20 bytes for IPv4), this results in a 41-byte packet for 1 byte of useful information, a huge overhead. This situation often occurs in Telnet sessions, where most keypresses generate a single byte of data that is transmitted immediately. Worse, over slow links, many such packets can be in transit at the same time, potentially leading to congestion collapse

Data Link Layer: This layer mainly focused on WIFI connection of the hospital.

Physical Layer: This Layer include sensor connected with band of mother and new born baby.

6. Implementation

Three Algorithm is proposed which would be improvised, the fundamental concept of these three algorithms are as follows.

Enhanced -Nagles Algorithm

if there is new data to send then

*if the window size ≥ MSS(**Maximum Segment Size)** and available data is ≥ MSS then*

send complete MSS segment now
else
if there are unconfirmed data still in the pipe then
enqueue data in the buffer until an acknowledge is received
else
send data immediately
end if
end if
end if

Improvised - LEACH Algorithm

The general process of creating fundamentalalgorithm can be divided into several steps:

- **Topology definition:** To ease the creation of basic facilities and define their interrelationships, ns-3 has a system of containers and helpers that facilitates this process.
- **Model development:** Models are added to simulation (for example, UDP, IPv4, point-to-point devices and links, applications); most of the time this is done using helpers.
- **Node and link configuration:** models set their default values (for example, the size of packets sent by an application or MTU of a point-to-point link); most of the time this is done using the attribute system.
- **Execution**: Simulation facilities generate events, data requested by the user is logged.
- **Performance analysis**: After the simulation is finished and data is available as a time-stamped event trace. This data can then be statistically analyzed.

a) MHRP Mobility Handling Routing Protocol determines the best path of elbow action which is categorized by four. The four paths are,

$$\Delta 1 = D_1+D_2+D_3,\ \Delta 2=D_1+D_4,\ \Delta 3=D_5+D_3,\ \Delta 4=D_6 \qquad (1)$$

This Mobility Handling Routing Protocol mainly used a sensor which consists of two relays with seven nodes to determine the heart rate and their functionality. Typically, the dynamic routing protocol algorithm can be explained as follows:

1. The router delivers and receives the routing messages on the router interfaces.
2. The routing messages and information are shared with other routers, which use exactly the same routing protocol.
3. Routers swap the routing information to discover data about remote networks.

ISSN: 2233-7857 IJFGCN

4. Whenever a router finds a change in topology, the routing protocol advertises this topology change to other routers.

Dynamic routing is easy to configure on large networks and is more intuitive at selecting the best route, detecting route changes and discovering remote networks. However, because routers share updates, they consume more bandwidth than in static routing; the routers' CPUs and RAM may also face additional loads as a result of routing protocols. Finally, dynamic routing is less secure than static routing.

b) Energy-Efficient and Distributed Network Management Cost Minimization (NCMD)

WBAN is during a dynamic scene, the configuration is often in AN intermittent and continuous state, which causes massive transmission delay and better network maintenance prices. Also, with the rise of mobile speed, numerous QoS indicators go to pot and worse. On top of issues, this paper proposes AN expedient transmission link institution rule, to reduce the price of the network. Energy optimization is calculated from equation 2 to equation 5 which are given below.

$$C^t = \sum_{i=1}^{N}\sum_{j=1}^{M} S_{ij}\left[1+\frac{\alpha_{ij}^t}{\alpha_{\max}}(X^t - Y^t)\right] \quad (2)$$

$$Z^t = C^t + D^t + I^t + Q^t + E^t + D_T^t \quad (3)$$

$$\min imize \quad v = \sum_{t=1}^{T} Z^t \quad (4)$$

$$subject\ to \sum_{t=1}^{T} C^t \geq C^{th}, Q^t \geq Q^{th}, I^t \geq I^{th} \quad (5)$$

Where,

- $\boldsymbol{C^t}$ – Connection Cost
- $\boldsymbol{D^t}$- Data Transmission Cost
- $\boldsymbol{I^t}$- Interference Management Cost
- $\boldsymbol{Q_t}$- QoS Management Cost
- $\boldsymbol{Et}$ – Energy Management Cost
- $\boldsymbol{D^t_T}$– Dynamic Topology Management Cost.

Data Transmission Cost, Interference Management Cost, and Dynamic Topology Management Cost are the corresponding thresholds respectively.

Based on equation 2 to equation 5, a Lagrange operator was used to determine the optimized cost for the total network management. From the above equations, sample data were provided as input and determine the output through the simulation tools. The data showed are more adaptable protocol through dynamic WBAN Environment to determine the shortest connection path, if a node may fail in the network. This process used to reduce the cost and also improve the stability of the current WBAN Network.

7. Experimental Result and Analysis

Based on the above framework analysis part are mainly done with sample data based on their Goal, Complexity, Delay and Energy Efficiency.

a) Goal: Table 2 predicts the goal of posture based routing protocol to determine their performance.

Table 2 Goal and Characteristics

Protocol	Goal	Characteristics
Mobility Handling	Dynamic Environment-	Fault-Tolerant

ISSN: 2233-7857 IJFGCN

Routing Protocol	Wrist Monitoring using Band	System
Energy Efficiency and Distributed Network Management Cost Minimization	Dynamic Environment-Fracture	Minimizing Network Management

b) Complexity: The complexity of the WBAN is predicted based on MHRP and Distributed Network Management Cost Minimization is as follows.

Table 3 Complexity

Protocol	**Complexity**
Mobility Handling Routing Protocol	Low
Energy Efficiency and Distributed Network Management Cost Minimization	High

From the above table, can determine that the complexity will be high in Energy Efficiency and Distributed Network Management Cost Minimization and Low in MHRP.

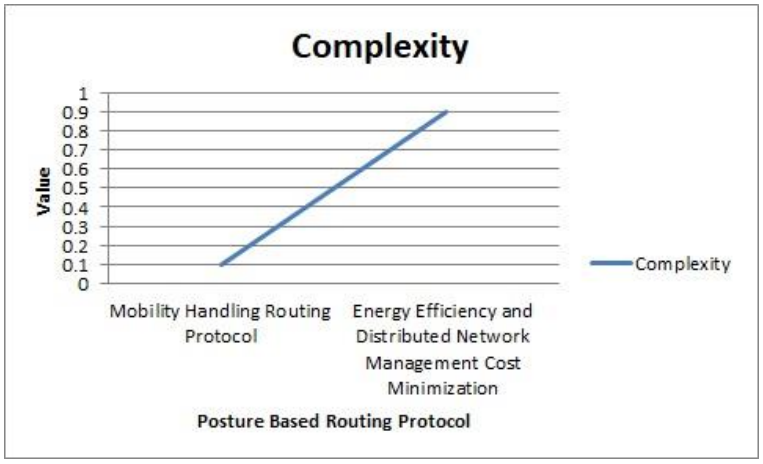

Fig. 8 Complexity

From the above graph, determined that the complexity of the WBAN using Posture Based Routing Protocol with Mobility Handling Routing protocol are very low compared with Energy Efficiency and Distributed Network Management Cost Minimization.

c) Delay and Energy Efficiency

The Last Comparison used to determine the Energy Efficiency and Delay time used for the simulation report are as follows in the below table 4.

Table 4 Energy Efficiency and Delay Process

Protocol	**Delay**	**Energy Efficiency**
Mobility Handling Routing Protocol	Low	High
Energy Efficiency and Distributed Network Management Cost Minimization	Low	High

ISSN: 2233-7857 IJFGCN

From the above table, determine that the delay time was very low in both the protocol used in posture routing protocol and very high in both Energy Efficiency with cost minimization and also delay time in transmitting the data.

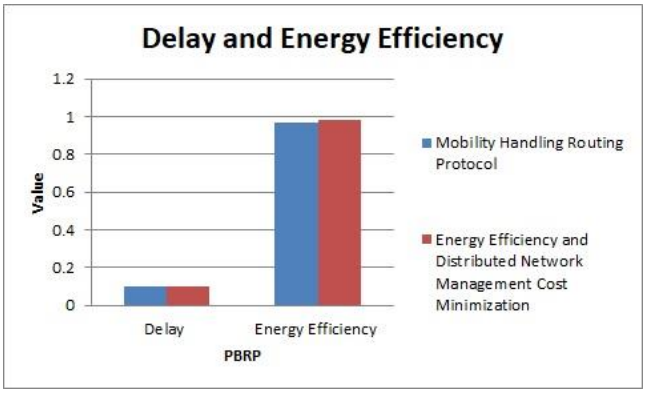

Fig. 9 Delay and Energy Efficiency

From the above graph, both and MHRP and Energy Efficiency are predicted with sample data are very low, which prescribed in terms of 0 as an assumption. Similarly, MHRP and Energy Efficiency and Distributed Network Management Cost Minimization will be determined as High Value which assumed to be 0.9 to 1.

d) Nagles Algorithm mainly focused with Maximum Segment Size with Wireless Sensor Network based on the bytes of data transformed from analog to digital.

e) Leach Algorithm focused with clustering and steady state of each transmission of data from one node to another node.

8. Conclusions

This research work would conclude that child and mother safety in the hospital, monitoring the physical parts of both child and mother through RFID tag with WBAN using IoT. The information Management plays a vital role in monitoring and controlling the data online with IoT based devices used in the hospital. The improvised protocols are the subset of the Posture Routing Based Protocol, which is determined the routing path and also the cost minimization of the network. Concluded that MHRP and Cost Minimization Routing Protocol are very low in delay process and very high in Energy optimization along with the cost. The complexity of the problem was very high in Energy Optimization rather than MHRP. Thus research work will be effective and efficient when compared with existing technologies and strategies.

9. Reference

1. Albaeazanchi, Israa, Haiderrasheedabdulshaheed, Shihab A. Shawkat, and Sitirahayubintiselamat. "Identification key scheme to enhance network performance in a wireless body area network." periodicals of engineering and natural sciences 7, no. 2 (2019): 895-906.
2. Dharshini, P. MeenaPriya, and M. Tamilarasi. "Adaptive reliable cooperative data transmission technique for wireless body area network." In International Conference on Information Communication and Embedded Systems (ICICES2014), pp. 1-4. IEEE, 2014.
3. Gang Sun, Kai Wang, Hongfang Yu, Xiaojiang Du, and Mohsen Guizani. "Priority-based medium access control for wireless body area networks with high-performance design." IEEE Internet of Things Journal 6, no. 3 (2019): 5363-5375.
4. Jiang, Qi, Zhiren Chen, Jianfeng Ma, Xindi Ma, JianShen, and Dapeng Wu. "Optimized fuzzy commitment based key agreement protocol for wireless body area network." IEEE Transactions on Emerging Topics in Computing (2019).
5. Kathe, K. S., and Umesh A. Deshpande. "A Thermal Aware Routing Algorithm for a wireless body area network." Wireless Personal Communications 105, no. 4 (2019): 1353-1380.

ISSN: 2233-7857 IJFGCN

6. Khalid Hasan, KamanashisBiswas, Khandakar Ahmed, Nazmus S. Nafi, and MdSaiful Islam. "A comprehensive review of wireless body area network." Journal of Network and Computer Applications 143 (2019): 178-198.
7. MarwaSalayma, Ahmed Al-Dubai, ImedRomdhani, and Youssef Nasser. "Wireless Body Area Network (WBAN) A Survey on Reliability, Fault Tolerance, and Technologies Coexistence." ACM Computing Surveys (CSUR) 50, no. 1 (2017): 1-38.
8. MdTaslimArefin, Mohammad Hanif Ali, and AKM FazlulHaque. "Wireless body area network: an overview and various applications." Journal of Computer and Communications 5, no. 7 (2017): 53-64.
9. Rim Negra, ImenJemili, and AbdelfettahBelghith. "Wireless body area networks: Applications and technologies." Procedia Computer Science 83 (2016): 1274-1281.
10. SavitaSindhu, ShrutiVashiath, and S. K. Chakravarti. "A Review on Wireless Body Area Network (WBAN) for Health Monitoring System, Implementation Protocol." Communication on Applied Electronics, Foundation of Computer Science, Newyork, USA 4, no. 7 (2016).
11. ShashwatPathak, Mayur Kumara, Amrita Mohanb, Basant Kumara, "Energy Optimization of ZigBee based WBAN for Patient Monitoring", Procedia Computer Science 70 (2015): 414-420.
12. YatingQu, GuoqiangZheng , Huahong Ma, Xintong Wang, BaofengJi, and Honghai Wu, "A Survey of Routing Protocols in WBAN for Healthcare Applications", International Journal of Sensor, 2019.
13. H. Zhang, J. Li, B. Wen, Y. Xun, and J. Liu, "Connecting intelligent things in smart hospitals using NB-IoT," IEEE Internet Things J., vol. 5, no. 3, pp. 1550–1560, Jun. 2018.
14. J. Liu, Y. Kawamoto, H. Nishiyama, N. Kato, and N. Kadowaki, "Device-to-device communications achieve efficient load balancing in LTE-advanced networks," IEEE Wireless Commun., vol. 21, no. 2, pp. 57–65, Apr. 2014.
15. J. Liu, S. Zhang, N. Kato et al., "Device-to-device communications for enhancing quality of experience in software defined multi-tier LTE-A networks," IEEE Netw., vol. 29, no. 4, pp. 46–52, Jul. 2015.
16. J. Liu, N. Kato, J. Ma, and N. Kadowaki, "Device-to-device communi- cation in LTE-advanced networks: A survey," IEEE Commun. Surveys Tut., vol. 17, no. 4, pp. 1923–1940, Fourthquarter 2015.
17. J. Liu and N. Kato, "A markovian analysis for explicit probabilistic stopping-based information propagation in postdisaster ad hoc mobile networks," IEEE Trans. Wireless Commun., vol. 15, no. 1, pp. 81–90, Jan. 2016.
18. J. Liu, H. Nishiyama, N. Kato, and J. Guo, "On the outage proba- bility of device-to-device-communication-enabled multichannel cellular networks: An RSS-threshold-based perspective," IEEE J. Sel. Areas Commun., vol. 34, no. 1, pp. 163–175, Jan. 2016.
19. Z. Su, Y. Hui, Q. Xu, T. Yang, J. Liu, and Y. Jia, "An edge caching scheme to distribute content in vehicular networks," IEEE Trans. Veh. Technol., vol. 67, no. 6, pp. 5346–5356, Jun. 2018.
20. Z. Su, Y. Wang, Q. Xu, M. Fei, Y. Tian, and N. Zhang, "A secure charging scheme for electric vehicles with smart communities in energy blockchain," IEEE Internet Things J., pp. 1–1, 2018.
21. S. Movassaghi, M. Abolhasan, J. Lipman, D. Smith, and A. Jamalipour, "Wireless body area networks: A survey," IEEE Commun. Surveys Tuts., vol. 16, no. 3, pp. 1658–1686, Jul.-Sep. 2014.
22. S. M. R. Islam, D. Kwak, M. H. Kabir, M. Hossain, and K. S. Kwak, "The Internet of Things for health care: A comprehensive survey," IEEE Access, vol. 3, pp. 678–708, 2015.
23. H. Zhang, J. Liu, R. Li, and H. Le, "Fault diagnosis of body sensor networks using hidden markov model," Peer-to-Peer Netw. Appl., vol. 10, no. 6, pp. 1285–1298, 2017.
24. H. Zhang, J. Liu, and N. Kato, "Threshold tuning-based wearable sensor fault detection for reliable medical monitoring using bayesian network model," IEEE Syst. J., vol. 12, no. 2, pp. 1886–1896, Jun. 2018.
25. S. Rashwand and J. Misˇic´, "Bridging between ieee 802.15. 6 and ieee
26. 802.11 e for wireless healthcare networks." Ad Hoc Sensor Wireless Netw., vol. 26, no. 1-4, pp. 303–337, 2015.

ISSN: 2233-7857 IJFGCN

27. R. Lu, X. Lin, and X. Shen, "SPOC: A secure and privacy-preserving opportunistic computing framework for mobile-healthcare emergency," IEEE Trans. Parallel Distrib. Syst., vol. 24, no. 3, pp. 614–624, Mar. 2013.
28. J. Wan, C. Zou, S. Ullah, C. F. Lai, M. Zhou, and X. Wang, "Cloud- enabled wireless body area networks for pervasive healthcare," IEEE Network, vol. 27, no. 5, pp. 56–61, Sep. 2013.

ISSN: 2233-7857 IJFGCN