Analysis of Transmission Power Control (TPC) in wireless Body Area Network (WBAN)

BY

Sarowar Jahan

ID: 153-19-1832

Md. Ahasan Kadir Siam

ID: 151-19-1697

This Project report is Requirement for the Fulfillment of Bachelor Degree of Science in Electronics and Telecommunication Engineering

Supervised By

MD. TASLIM AREFIN

Associate Professor & Head

Department of ETE

Daffodil International University

DAFFODIL INTERNATIONAL UNIVERSITY

DHAKA, BANGLADESH

OCTOBER 2019

APPROVAL

This Project titled **"Analysis of Transmission Power Control (TPC) in wireless Body Area Network (WBAN)"**, submitted by Sarowar Jahan and Md. Ahasan Kadir Siam to the Department of Electronics and Telecooimmunication Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Electronics and Telecommunication Engineering and approved as to its style and contents. The presentation was held on November, 2019.

BOARD OF EXAMINERS

Prof. Dr. A. K. M Fazlul Haque
Professor & Associate Dean
Department of ETE
Faculty of Engineering
Daffodil International University

Chairman

Dr. Eng. M. Quamruzzaman
Professor
Department of ETE
Daffodil International University

Internal Examiner

Dr. Saeed Mahmud Ullah
Professor
Department EEE
University of Dhaka

External Examiner

ACKNOWLEDGEMENT

At First thanks to our almighty Allah for his helps to complete this project successfully.

Then we thanks to our supervisor **MD. Taslim Arefin**, **Associate Professor & Head**, Department of Electronics and Telecommunications Engineering, Daffodil International university, Dhaka, Bangladesh. Extra ordinary supervisor in the area of wireless network help us to makes this project properly. His constant and energetic supervision at every things that made it possible to complete this project paper properly.

We want to thanks our batch mate of Daffodil International University, who help us with suggestion when completing the course work.

At last, we due respect to our parents for the constant support and patients to us in every time in our life.

DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Md. Taslim Arefin , Associate Professor & Head, Department of ETE,** Daffodil International University

We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

Supervised by:

Md. Taslim Arefin
Associate Professor & Head
Department of ETE
Daffodil International University

Submitted by:

Sarowar Jahan
ID:153-19-1832
Department of ETE
Daffodil International University

Md. Ahasan Kadir Siam
ID: 151-19-1697
Department of ETE
Daffodil International University

ABSTRACT

For monitoring mobile healthcare service WBAN using everywhere in modern age. WBAN system has too fast energy consumption still now. As WBAN is a portable device, low power consumption device for long time battery life and light weight is preferred.A ZigBee based WBAN model for light weight and longtime battery life has been proposed.Star, mesh and cluster network topologies with different data rate used in the ZigBee sensor node. WBAN data-management technique has been proposed due to reduce more data transmission.Less data transmission reduce the overall power consumption. The whole work is done by using two simulator, OPNET and OMNETpp network simulator. Applied different topologies in the scenario found throughput, load, delay, data traffic, amount of power consumption, packet delivery ratio etc. TPC analysis indicate that which topology consume low power in different topologies. Several simulation scenarios were run and the results were analyzed.

TABLE OF CONTENTS

LIST OF FIGURES

LIST of TABLES

Chapter 1

Introduction

1.1 Introduction:

Through the modern-day technology similarly because the vast growth of the services and applications provided throughout the net networks and servers, it had been vital to utilize that reach serve human lives via providing a far better answer for health care services. Thus, the electronic health care was created to serve such purpose, the system have several health care applications and it's referred to as e-health system [1].Furthermore, exploitation such technology are able to give a far better health care state of affairs for the patient's each day status, by creating associate increased manner of observation and taking care of patients in their own natural setting such as their homes or anyplace else in each day's life. Also, the exploitation the wireless technology are able to give associate improved period observation within the future [2].Being aforementioned that,WBAN consists of variety of sensors that area unit either ingrained within the patient's body or wearable convenience as an example a monitor watch, so as to live that person's health stats.Additionally, it's vital to say here that sensors should be made by considering the subsequent features: lightweight Wight, small size, optimum power consumption, and low value [3]. Moreover, the sensors area unit referred to as nodes within the system and they area unit connected to a getaway, the entranceway are accountable being a instrumentality to the network, helping to transfer information to medical server and store it within the patient's file [4]. It's vital to say that, WBAN is taken into account one of the still rising technologies beneath its progress phases associated it's beneath an early stage of development, and it is expected to be at some point a really stable system utilized in the health care applications

1.2 Aim & Objectives:

In this project paper the main aim is to find a best topology which consume low power to extend battery life.Wireless network consume a lot of energy while communicate.Due to make user friendly light and long lasting battery life get more priority when design wireless device.It would be possible to design a lower power consume device if minimize data rate.We compare between different topology and find best topology for our project.

- To design a WBAN model according to different topologies with different data rate.

- To analyze the performance of different topologies.
- To test the system for ubiquitous monitoring in different scenario.
- To suggest a better scenario based on power efficiency.

1.3 Report formation

In this section discussed about this paper. In this paper is about transmission power control analysis of WBAN. This analysis give a solution to reduced number data transmission. This result gives extended battery life.

- Chapter 1: Introduction- Contains Basic idea about WBAN, aims and objectives of this project.
- Chapter 2: WBAN- Contains details information Wireless Body Area Network
- Chapter 3: TPC-Contains massive information about Transmission Power Control of bio signal.
- Chapter 4: Simulation & Result- Contains simulation by different topologies and classification
- Chapter 5: Performance & Analysis
- Chapter 6:Conclution

Chapter 2

Wireless Body Area Networks

2.1 Introduction:

WBAN have recently received a lot of attention for its application to assisted remote patient observance and living. WBAN contains wireless devices that secured to the soma to observe a large vary of physical quantities. The character of those wireless sensors permits nice flexibility in their movement. New sector square measure gap for these technologies in medical and health observance service, e.g. period mensuration of pulse, body temperature and pressure level etc. Analysis of life signals in patients with chronic conditions [14].

As like Wireless Sensor Networks (WSNs) applications, the wireless sensors square measure notably energy forced. Power consumption scale back is so terribly essential. In health observance, deep-seated devices should operate for long periods of your time as a result of charging isn't potential and also the choice of optimum transmission power becomes vital. Several WBAN applications send frames comparatively sometimes resulting in exaggerated channel estimation error. The IEEE 802.15.6 unit has the difficult readying problems with WBANs and has developed a brand new customary for targeting wireless communications in and round the soma space. It defines because the physical and link layers for WBANs, however doesn't specify a TPC rule for WBANs.[14]

The device nodes in WBAN unit powered by energy restricted batteries, so reducing the energy consumption becomes a necessary issue to be addressed.Although power consumption decreases with the event of low-power physical science technology, the energy efficiency draw back can’t be ignored for WBAN with a most transmission distance of 3m or 5m inside the past few years, a variety of energy-saving ways in which and measures square measure planned and studied. The propose associate energy efficiency rule for minimizing the transmission energy of a communication system transmission grouping by increasing the transmission length time. [12]

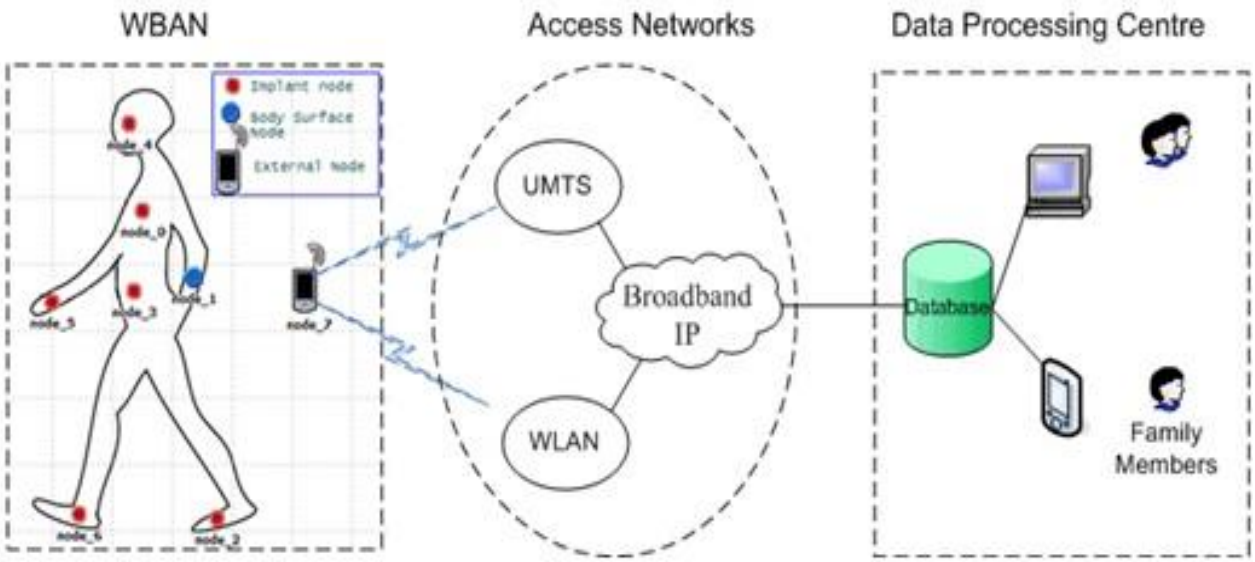


Figure 2.1: Wireless Body Area Network

2.2 WBAN Background:

WBAN can be a wireless network of private pc devices. BAN devices area unit typically incorporated at intervals the body, implants area unit typically mounted on the body surface in associate passing mounted position. Wearable technology or area unit typically attended devices that humans can carry in varied positions, in pockets for wear, by hand or in varied baggage. Whereas there's a bent towards miniaturization of devices, above all, networks incorporates all completely different units of miniaturized Body Sensors Unit (BSU) along side a central unit of 1 body. Larger decimal scale devices (boards and pads), associated devices, still play an important role in terms of operation like data centers, data gateways, and providing a interface to seem at and manage unchanged BAN applications. The event of WBAN technology began around 1995 around arrange of exploitation WPAN (Wireless Personal Area Network) technologies to implement communications within, around and around the type. Regarding six years later, the term "BAN" came to see systems at intervals that communication is totally at intervals, at intervals and shut to a personality's body. A WBAN system can use WPAN wireless technologies as a entree to attain longer intervals. Through the entree devices, it's potential to connect transferable devices of the shape to the online. Throughout this fashion, medical professionals can access patient data on-line through the online, however the patient's location. The IEEE 802.15.6 customary is that the most recent international customary for Wireless Body area Network (WBAN). WBAN supports an oversized vary of customer physics

and amount standing observance applications. the latest international customary for WBAN is that the IEEE 802.15.6 standard, that aims to supply a world customary for low-power, short-range and very reliable wireless communications within the surrounding area of the shape, that supports an oversized vary of data transmission speeds for numerous applications Short-range wireless communications in or around a personality's body ar per this customary. Uses existing industrial scientific medical bands and frequency bands approved by national medical and / or restrictive authorities. Support for quality of service, very low power and data transmission rates of up to 10 Mbps is needed, whereas at identical time maintaining strict non-interference tips once necessary. This customary considers the results on transferable antennas due to the presence of somebody (which varies looking on the male, female, skinny, heavy, etc.), the configuration of the radiation model to attenuate the particular absorption rate at intervals the body and changes in characteristics as a results of the user's movements.

2.3 Parts of WBAN:

There are two main parts of WBAN

- Sensor node
- Gateway node

2.2.1: Sensor nodes:

Sensor nodes are gather information from human body.

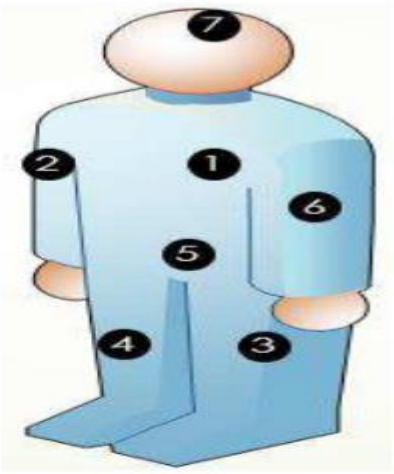


Figure 2.2: Sensor nodes in human body

2.2.2 Gateway Nodes:

The gateway node is responsible for conveyance device info to medical servers or doctors. Failure of the entry node suggests that failure of the WBAN system of a patient. Thus, extending the life time of the gateway node may be a fascinating objective in coming up with WBAN systems.[23]

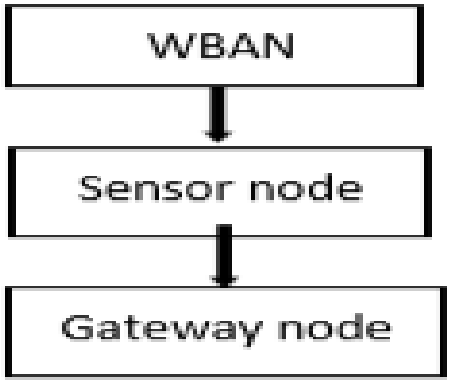


Figure 2.3: Gateway Nodes

2.4 Requirements of WBAN:

For WBAN configure properly in attention systems, some specific necessities are there. These are:

- **Reliability –** High reliable is needed once information regarding health is shipped by the WBAN sensors.

- **Latency –** The reaction time to emergency things mustn't be long. Period transmission is needed during this case.

- **Security –** Personal and significant information ought to be handled with care to make sure the privacy and security of knowledge.

- **Power Consumption –** Battery replacement in WBAN is done simply. Therefore there's no worry of power consumption

2.5 Architecture of WBAN:

WBAN is designed specifically for medical systems and for emergency things. In such things, the little detector nodes within the network collect very important data using sensor from body and upload it to the medical server within the hospital. This data is then examined by a doctor or a medico within the hospital for identification. The communication within the WBAN is secured as a result of this network uses physiological values (PVs) that is personal human information. This may alter higher attention facilities. Lack of security measures can result in the incorrect detection that is risky for human life.

WBAN uses crypto graphical keys to secure communication. Bluetooth key distribution theme is employed that is of various sort. Daffier playwright cryptosystem is employed to stop pre-deployment of keys.

Main different of WBAN and WSN have power and memory management system. The security protocol also different among them. Security issue also major in WBAN due to monitoring accurately. The most drawback with this security theme is that the risk (of data of data of knowledge) leak as throughout key agreement this theme exchange quite needed information.

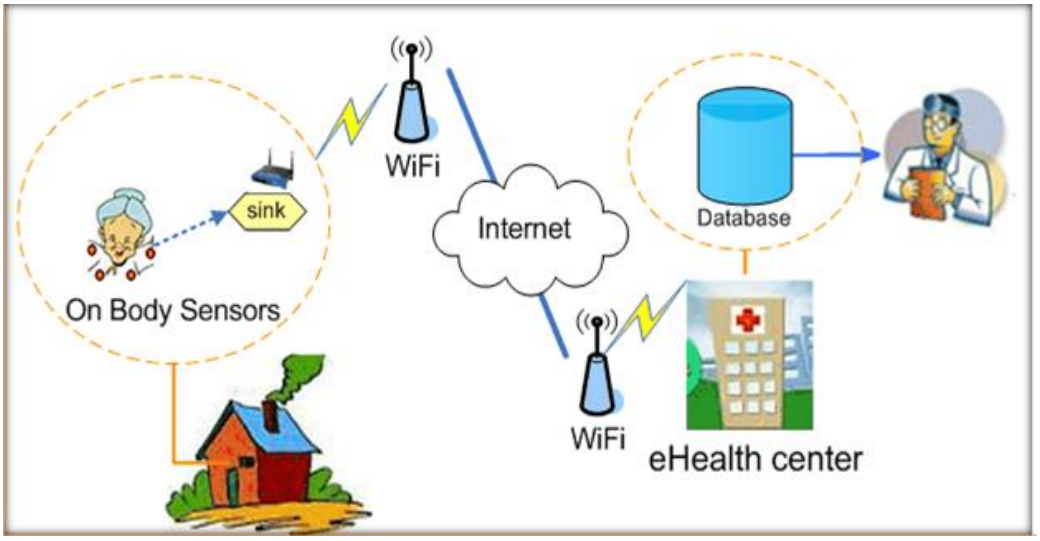


Figure 2.4: Architecture of WBAN

For example, whole feature sets square measure changed between human action sensors mistreatment this theme. If the sender and also the receiver have the feature sets same, then

they'll use a standard key. This key may be simply generated by AN outsider World Health Organization acquires of these feature sets.[24]

2.6 Application of WBAN :

Initial applications of the WBAN is monitoring health condition recording of different signal form human body such as ICU,CCU unit in hospital. Specially WBAN using most in ECG, SpO2, electrocardiogram, glucometer etc. Not only health monitoring service but also WBAN used a lot of sector as like WSN.

2.7 Components of WBAN:

A typical WBAN important component is sensors such as monitor sensors, motion detectors to assist determine the position different monitor and a few type data to doctor to remind condition of the patient .A wearable kit which adjusted with human body contain of WBAN sensor. Others component are monitor, mobile node etc. are consider as hardware components. Routing protocol, data rate, topology etc. are software components.

2.8 Challenges in WBAN:

A lot of problem contains in WBAN. Remove these problem is challenging issue :

- **Data Quality:** information generated and picked up through the WBAN will play a key role within the patient care method. It's essential that customary of those information is of a high standard to make sure that the selections created square measure supported the most effective data attainable.
- **Data management:** As result of WBANs generate giant volumes of information, the requirement to manage and maintain these information sets is of utmost importance. Generalized environments generate giant amounts of information, coming back from back-end servers, mobile devices and mobile wireless sensors. Generalized sensing devices that monitor the properties of the surroundings (including humans) may be an excellent supply of information. Unprocessed information sets might embrace defective and orthogonal information and necessary and helpful information. If not handled properly, the big quantity of

data of knowledge of data from a generalized and data-rich surroundings will cause information overload or cant to be provided.

- **Device Validation:** Generalized sensing devices square measure subject to communication and hardware restrictions, as well as unreliable wireless connections, interference and restricted energy reserves. This could end in the transmission of incorrect information to the top user. It's extraordinarily necessary, particularly in an exceedingly tending sector, that each one device readings square measure valid. This reduces the generation of false alarms and identifies attainable weaknesses within the style of hardware and package. Consistency of information: Collected data from sensor should be record and analysis for an exceedingly clear manner .Among the body space networks, patient important information sets may be fragmented into a series of nodes and in several PCs or laptops on the network. If a doctor's mobile device doesn't contain all famous data, the standard of patient care may be reduced.
- **Interoperability:** WBAN systems ought to guarantee good information transfer through standards like Bluetooth, ZigBee, etc. promote the exchange of data, the interaction of plug and play devices. What is more systems ought to be ascendable, guarantee economical migration across networks and supply seamless property.
- **Devices System:**The performance of WBAN system dependent on device system or accuracy. Energy economical, light weight, simple to used and reconfigurable etc. system preferable.
- **Invasion of privacy:** WBAN technology under threat of freedom. Privacy another major issue. To use properly the system of WBAN need to invasion of privacy.
- **Interference:** The wireless affiliation used for body devices should cut back interference and increase the being of sensor node devices with different network devices out there within the surroundings. This can be significantly necessary for the big scale implementation of WBAN system.
- **Cost:** Today's shoppers expect low-priced health observation solutions that offer high practicality. WBAN implementations ought to have associate degree optimized price to be enticing alternatives for health conscious shoppers.
- **Monitoring Consistently:** Users might need completely different levels of observation, for instance those in danger of discus ischemia may need their WBAN work perpetually whereas others in danger of WBAN falls solely have to be compelled to monitor them whereas they walk or move. The observation of the amount failure or influence with other system effect on WBAN energy and lifetime of the system.
- **Restricted Implementation Distribution:** WBAN ought to be moveable, lightweight and non-intrusive. You are doing not got to alter or tax the daily activities of the user. Ultimately,

the technology ought to be transparent to the user, he should perform their management tasks while not the user noticing.

- **Performance Consistent performance:** WBAN's performance should be consistent. The device measurements should be correct and tag even once the WBAN is turned off and on once more. Wireless connections should be strong and add numerous user environments. The management of quality information sensitive to the context aims to gather, verify, method and manage multiple information sources in an exceedingly general surroundings, so as to produce top quality and connation.
- **Information for the top user:** Managing information quality from multiple sources, correlating connected information and mistreatment context square measure essential to produce correct and meaningful information to time period users in real time. This demand is especially true for vital applications, for instance in an exceedingly medical surroundings. Data management system architecture (DMS) designed to produce a high quality information service to its users. The DMS design uses agent-based middleware to showing intelligence and effectively manage all generalized information sources and use the context to produce data relevant to the top user.

  Two of the elements of DMS square measure presented:

  1: information validation &
  2: information consistency.

  The elements of the DMS were strictly evaluated mistreatment completely different cases of medical tests .This article demonstrates a careful and correct approach to information supported information quality and therefore the context of its use. It emphasizes the DMS design and therefore the role of package agents in providing quality information management.

CHAPTER 3

Transmission Power Control

3.1 Introduction

Developments sensor devices in wireless communication, a new trend now a day.WBAN used for emergency medical service, sports, military, handle relief work etc. For ensure this emergency services for communication accuracy near 100%.It depended on TPC mechanism. Different topology can be applied to the system model but consider best topology for model so that found best communication accuracy. TPC mechanism can be extended accuracy and life time of a WBAN system and can be reduce transmit power of sensor node. Basically WBAN used low power consuming device which have light weight too. Reducing path loss TPC can be improved. Path loss near 45 dB as informed. High transmit power can be reduce it but it is not proper solution for WBAN.Because this result is energy waste.So improve the TPC mechanism needed adjusting power control system.

3.2 TPC section in WBAN:

TPC section in WBAN is major part of a model due to power consumption issue.To design a WBAN model power efficiency given most priority.For that reason TPC management needed to improve.It can be done by three steps [29]:

- At first, needed to improve the constancy of a link. A constant link increase transmission power.

- Secondly, especially nodes that connected at a constant area.Try to minimize collision among the inter connected node.More collision reduce transmission power.

- Finally, A proposed transmission power given to the model for better performance of the channel.Here a good modulation technique is work best for energy saving.A controlled transmission power is preferable here.

3.3 RSSI/LQI Based Technique:

The parameters impact RSSI and LQI on packet related to the magnitude in sync with the channel trans-receiver of wireless communication.It measure the power in the receiving end of power received signal.It ensure the quality of receiver according to result.It is very important n wireless communication because of quality of a channel calculate by its.

.

3.4 Overview of ZigBee:

In modern age a large number of ZigBee network created due to wireless communication in every part of human life. Minimize costing or more comfortable life automation system speared every sector in the world. For this purpose consider low power consumed device as like ZigBee.IOT device, home automation system, smart ICU for healthcare service or any smart device or system ZigBee used.It also used in industrial sector in many developed country.

Figure 3.1:Zigbee Device

Zigbee communication is specially communicate depend on IEEE 802.15.4 normal for WBAN or WSN. This communication normal defines physical and Media Access management (MAC) layers to handle several devices at low-data rates. These ZigBee's WPANs operate at 868 megacycle per second, 902-928MHz and a couple of.4 GHz frequencies. The date rate of 250 kbps is best suited to periodic still as intermediate 2 means transmission of knowledge between sensors and controllers.

3.5 The Zigbee stack: A simple view of Zigbee like this

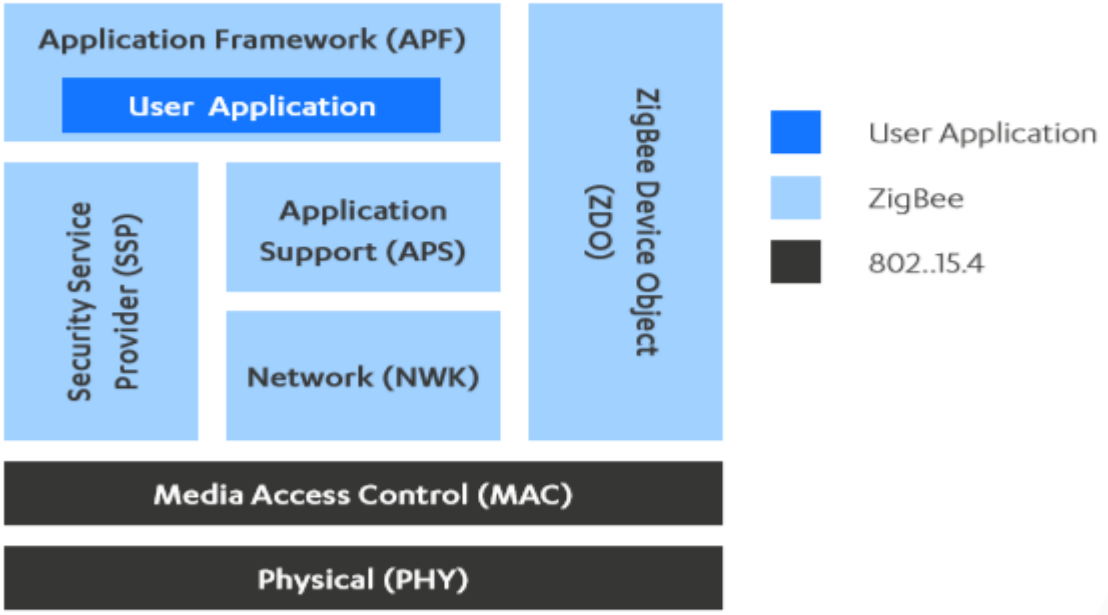


Figure 3.2:The Zigbee stack

Physical Layer (PHY) – It defined by 802.15.4 and main responsible for modulation, demodulation of data.It is also responsible for transmitted data any environment.

Media Access Control (MAC) – It is also defined by 802.15.4.Similar to MAC layers in other protocols, ZigBee actually use few features of it.MAC layer performs as CSMA/CA to avoid collisions when transmitting frames.

Network (NWK) –It may be a complicated ZigBee layers that builds on 802.15.4, this provides the power to find and be a part of networks. It conjointly expands on the topologies outlined by 802.15.4 at the raincoat layer to permit mesh networking – a preferred feature of ZigBee. The NWK layer conjointly determines routes through the ZigBee network and supports ZigBee addresses completely different to the raincoat addresses gift at the raincoat layer.

Application Support (APS) – This ZigBee layer implements options required by ZigBee applications associated acts as an interface to the NWK layer. It filters some duplicate packets from the NWK layer and maintains a binding table of nodes within the network.

Security Service Provider (SSP) – Provides ZigBee security services to the NWK and APS layers as well as key institution and transport, device management, and frame protection.

ZigBee Device Object (ZDO) – accountable for the general management of the ZigBee device. The ZDO initializes the APS and NWK layer, permits device discovery, manages binding requests, and defines the device mode (coordinator, router, or finish device).

Application Framework (APF) – This is often associate execution atmosphere for ZigBee user applications, serving to them send and receive information. It conjointly provides associate end for every application, with end zero being reserved for the ZDO and end 255 for a broadcast address. Applications themselves implement the perform of the ZigBee device (e.g. a sensor).

3.6 ZigBee node types:

ZigBee device will act together of 3 node .These three node work simultaneously.To obtain output these node are need inter combine with different topology.These are:

Coordinator–ZigBee network should have one coordinator, which connected with other device.According to different topologies end device connected with coordinator.Output of the system collect from coordinator.

The coordinator typically runs alternative services like routing and sure security services. However, several of those services square measure choices and a few is run on separate dedicated nodes.

Router – Routers aren't essentially needed, however square measure usually found all told ZigBee topologies. They're accountable for relaying messages to alternative nodes. Node also a part of the network via connecting through a Router, of another Router.

End Device-AN End Device may be a node that merely sends and receives messages. It doesn't perform the other special operate within the network, and nodes can't be a part of the network through them. Finish Devices square measure the sole nodes that may sleep, in step with the ZigBee specification with the parent node (a Router or Coordinator). It'll buffer messages till it wakes up once more.

3.7 ZigBee network topologies:

For every topology, there'll be a parent node. All different nodes that hook up with this area unit thought-about a baby node. ZigBee networks will have one in every of 3 completely

different topologies that have an effect on however messages area unit routed devices communicate. These topologies area unit shown below:

3.7.1 STAR: This is the best, most restricted topology accessible to ZigBee. All devices hook up with one organizer node and every one communication goes via this.Coordinator connected with all end device so that communicate among end device more reliable.

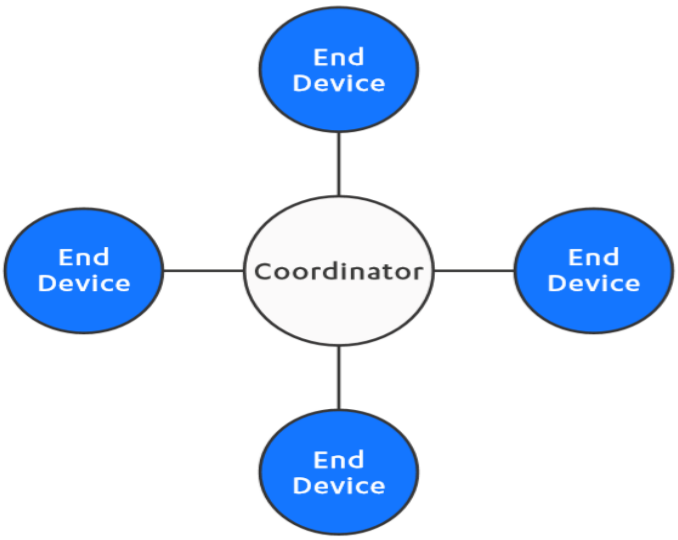


Figure 3.3:Star topology

Child nodes may be Routers, though they won't perform Bluetooth routing practicality and can act as an end Device.

In the star the output fully depend on coordinator.If coordinator failed there is no way to find output.

3.7.2 Cluster Tree network topology: In this topology coordinator connected with different router and router connected with end device.In this topology different network can be communicate.

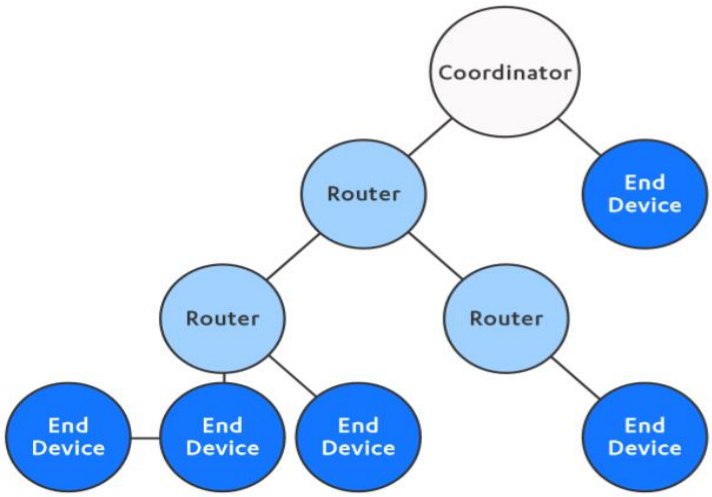


Figure 3.4: Tree topology

In this topology, Routers will communicate coordinator and given output.If one router fail another router will not hamper.

3.7.3 Mesh Topology: Mesh topology just like Tree topology.But it does not follow the rigid tree structure.In this topology, a Router will communicate directly with the other.A dedicated path defined for the every router.

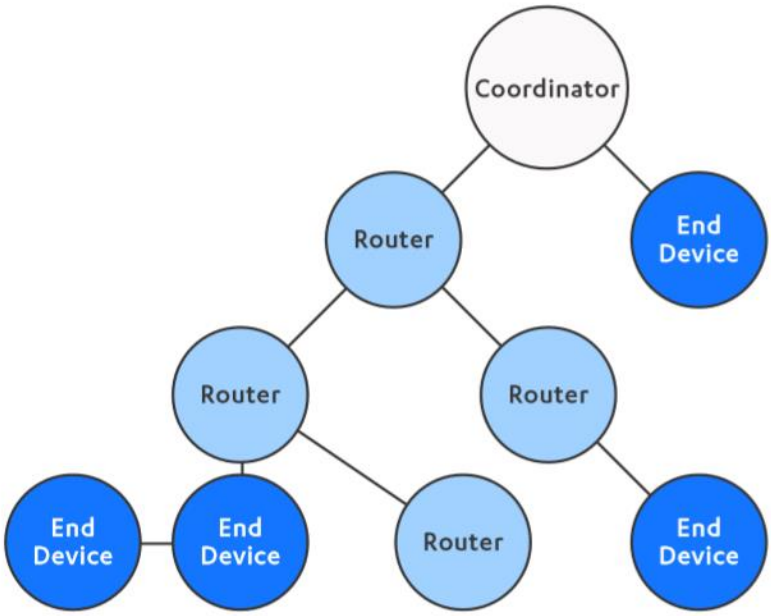


Figure 3.5:Mesh topology

The simple path choice router node of communicate, if fail creating it “self-healing”.

3.8 Power management system using ZigBee:

In several countries power management system controlled using ZigBee device.ZigBee device can be communicate a short distance using different protocol.Now a days home appliance controlled wireless using ZigBee sensor.It can covered 200m area with different topology.ZigBee also consume low power .For this reason it is more popular than wifi, Bluetooth etc. [28]

For observance, hardware relies on current or voltage activity circuits, Micro Controller Unit (MCU) relay and Zigbee cut Reduce Function Device (RFD). Current/voltage activity circuit measures the I/V and sends the knowledge to MCU. Small Controller checks abnormality of power and send the knowledge to the house server wherever information is maintained through ZigBee RFD. For dominant purpose, relay is else in power observance hardware. Just in case of emergency found by MCU, relay cuts the ability provide to the electrical home appliances once receiving the management command. Graphic User Interface (GUI) software system is employed as AN interface between user and finish devices. User will management all electrical appliances through mobile phone, pc or laptop computer [28].

3.9 Bio Signal Packet Transmission:

A bio signal is collected from human body using sensor node. Medical adjusted with a specific area in human body.According to condition of patient these signal divided into three catagories [5].

- **Urgent:**Data collected from critical condition of a patient called urgent data.For example a patients blood pressure is 160mmHg or getter, this data from blood pressure sensor called urgent data.It given most priority because this condition is more sensitive.For this reason this condition sensor node collecting data continuously.
- **Semiurgent**:This type of bio signal some less important than urgent data signal.For example ECG give result of heart beats near 60 bpm.It is not normal but more important tha normal.At any time have a chance to gone a patient critical condition.This condition given medium priority.
- **Nonurgent**:This type of bio signal considered as less important.When a patient in normal condition or a complete healthy man.It is not important to measure his blood pressure continuously.Sensor node can be given a time interval for reduce power consumption.

CHAPTER 4
SIMULATIONS & RESULTS

4.1: Introduction

Simulations and results demonstrate the performance of star, mesh, cluster-tree topologies in of different performance parameter and those are throughput, delay, load, data traffic sent, data traffic receive, packet dropped so that simulation and result part is an important approaches to evaluating the project work. To develop a real time scenario of a project work instead of simulation model work it must be require more time, financial cost and effort though a simulation model don't need to present necessarily appropriate. But the main object of any simulation model is to properly portend the behavior of real scenario [7]

4.2 Simulation

For design ZigBee model many simulator can be propose but in this project used OPNET simulator and OMNET++ for analysis power control.OPNET has an academic version known as Riverbed and OMNET++ is open source network simulator which represent graphically interface.

In this project the OPNET used to design mesh, star and cluster topologies with 250kbps and 1024 kbps data rate. In this project work designed with ZigBee sensor nodes.

4.2.1 Simulation with Different Scenario

Scenario 1- Simulation different topologies at 250kbps data rate in noiseless area

Firstly here discussed with 6 sensor nodes and 250Kbps data rate for mesh topology. Here considered a hospital environment as like ICU. Here noise is too low and it fixed around 40 kbps per sensor .For 6 sensors need around 250kbps calculated.Finally the amount of data transmit will be 2025 kbps per node.

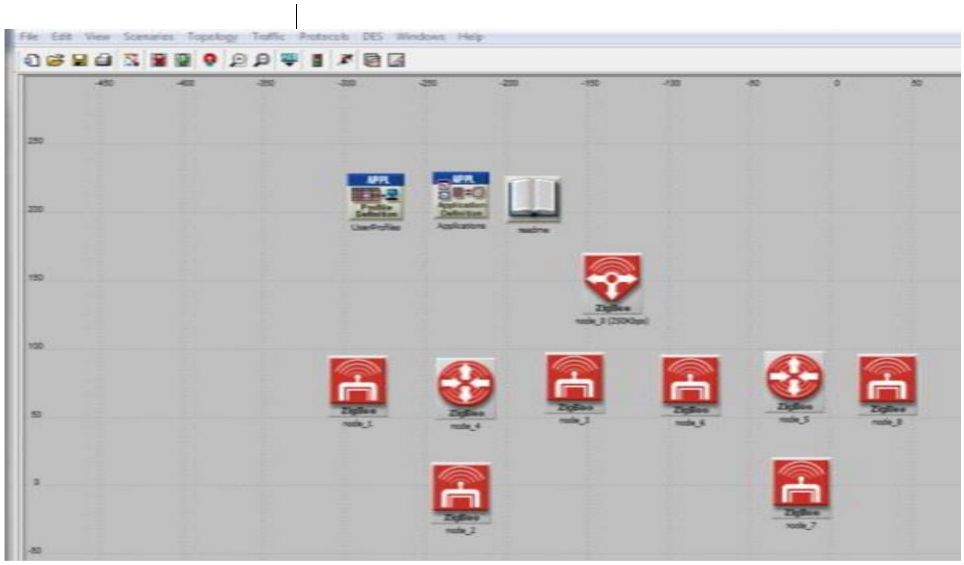


Figure 4.1: Mesh topology with 250kbps data rate

In the above figure contains sensor node with ZigBee coordinator.Here Mesh topology applied with 250 kbps data rate.

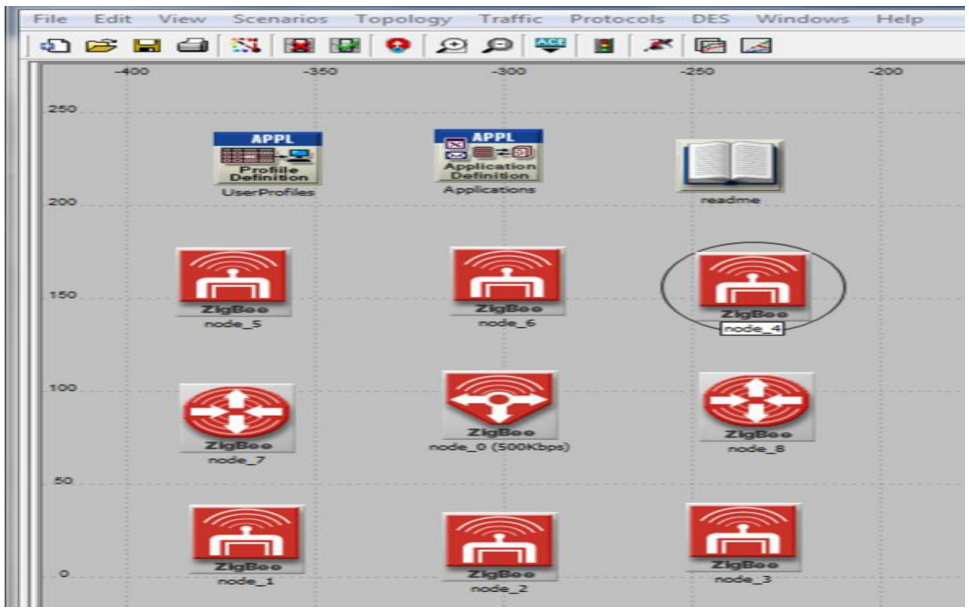


Figure 4.2: Star topology with 250kbps data rate

The above figure 4.2 star topology with 6 sensor node, router, ZigBee coordinator and user applications.Star topology applied with 250 kbps data rate.

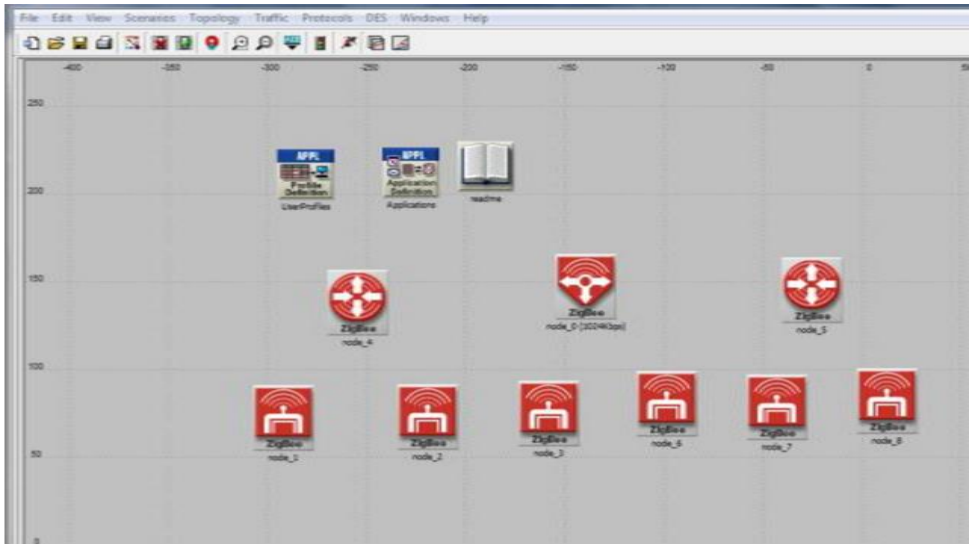


Figure 4.3: Cluster-tree topology with 250kbps data rate

In the above figure 4.3 contains 6 sensor node, router, ZigBee coordinator.Cluster topology applied here with 250 kbps data rate.

4.2.1.1 Throughput

Throughput describe how fast the total number of data successfully send and received at physical layer from MAC. Throughput also is actual measurement of data send using communication channel [19].

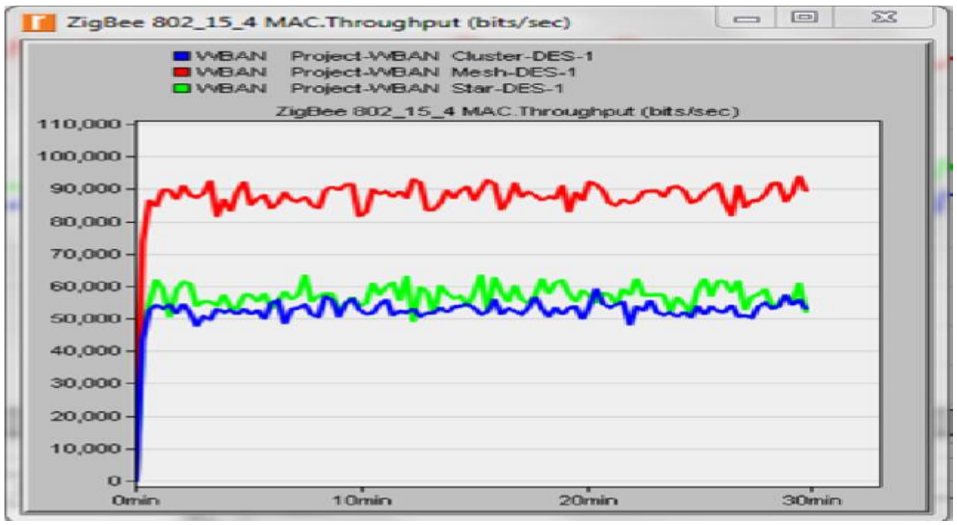


Fig 4.4: Throughput For 250kbps data rate

The above figure represents that which topology gives the better performance.In 1224 second the maximum throughput values has been obtained 59221.78kbps, 94161.33kbps in 1764 second and 63491.12kbps in 918 second for cluster, mesh and star topologies respectively.

4.2.1.2 Delay

Delay means amount extra time compare with actual processing time on communication channel.It reduce channel accuracy or efficiency.Small amount of delay prefer for better performance [20].

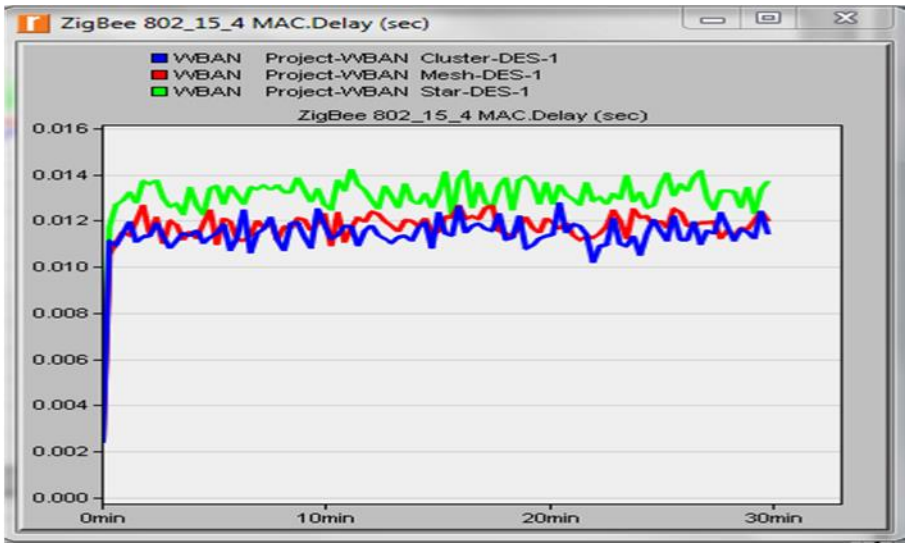


Figure 4.5: Delay for different topologies in 250kbps data rate

In the above figure the minimum delay has been recorded in cluster, mesh and star topologies are 0.0128 sec, 0.0127 sec and 0.0143sec respectively.Minimum delay of these topologies give the best result.

4.2.1.3 Load

Load refers as the amount of total data traffic being carried among the communication channel in data communication. The performance of a communication channel will be better in low load.

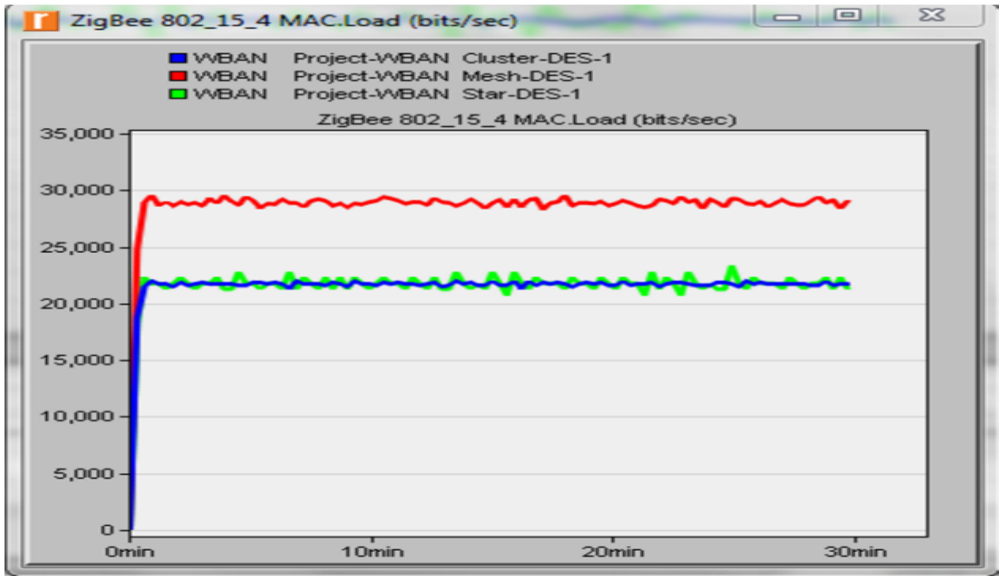


Figure 4.6: Load for different topologies in 250 kb Data rate

In the above figure shown the amount of load with 250kbps data rate in cluster, mesh and star topologies.Maximum load shown in mesh topology 29175 bps and cluster ,star topology respectively 22925,22865.

4.2.1.4 Data Dropped

The amount of data which can not be transmit through channel called data dropped.It held due to failure ACK of MAC protocol for retransmit data.Large number of data dropped reduce the performance of a channel.

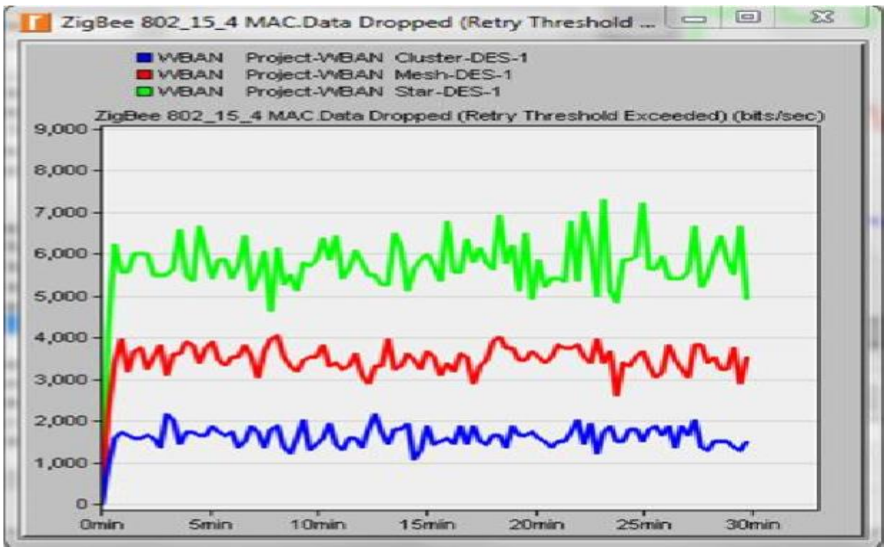


Figure 4.7: Data Dropped for Different Data rate

In the above figure when time start 0 sec data dropped was Zero and at 1782 sec data dropped was 1519.56 bps for cluster, 3544 bps for mesh, 4923.11 bps for star.

4.2.1.5 :Data Traffic Sent

Data traffic is that the quantity information of knowledge of information moving across a network channel.Amount of data traffic sent measured the performance of a channel.As much as high amount of data traffic sent this result will be best

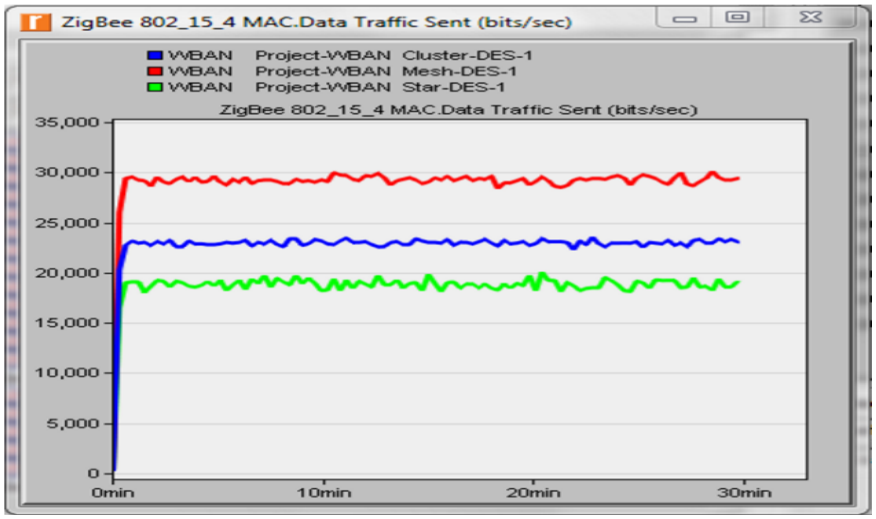


Figure 4.8:Data traffic send

For 250 kbps data rate-In the above figure 4.8 shown data traffics sent after 15mim or 900sec for cluster-tree 23074.78bps, mesh 29080.56 bps and star 19860.44bps

4.2.1.6 Data Traffic Received

Data traffic received defines as how much data received at the destination end point from source at per unit time. As much as high amount of data traffic received this result will be best.

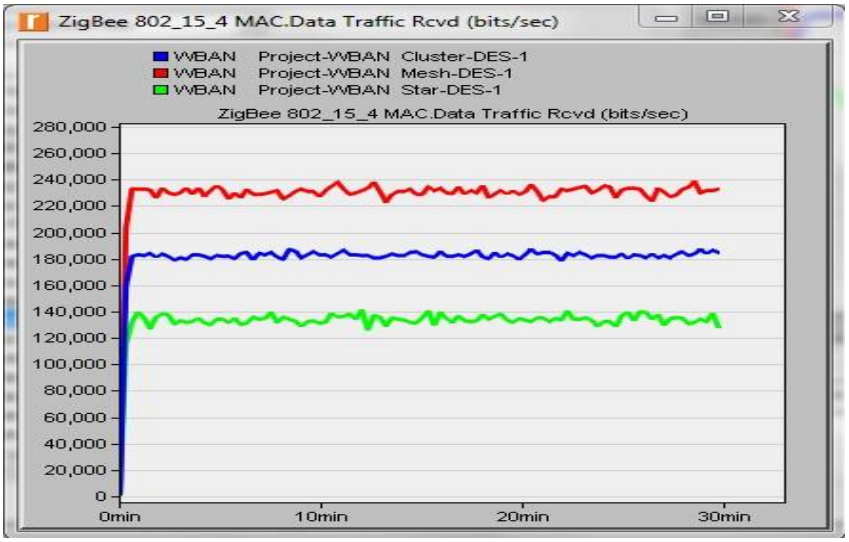


Figure 4.9: Data Traffic Received

For 250 kbps data rate- From figure the above figure 4.9 shown that cluster-tree 185155.5 bps233208.9, mesh and star 128174.2 bps received data traffic received by MAC from physical layer.

Scenario 2- Simulation different topology at 1024kbps/1Mbps data rate

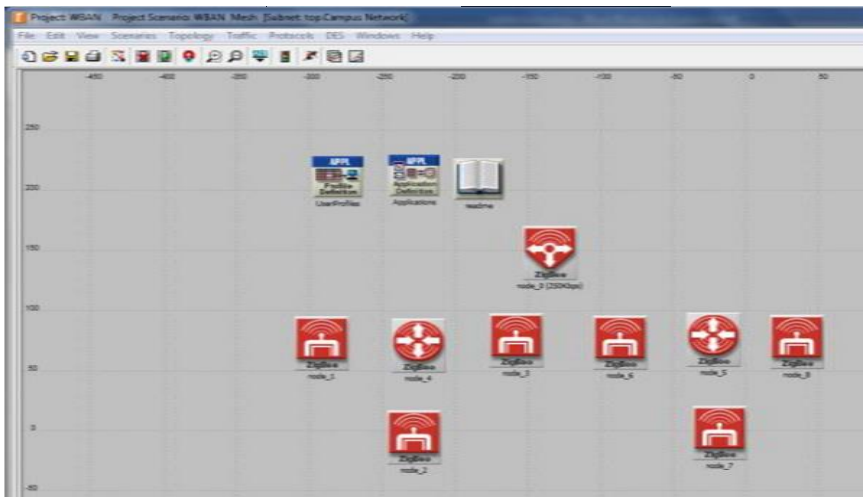


Figure 4.10 Mesh topology with 1024kbps data rate

In the above figure 4.10 contains 6 sensor node, ZigBee coordinator, user applications etc.Here used 1024 kbps data rate with mesh topology.

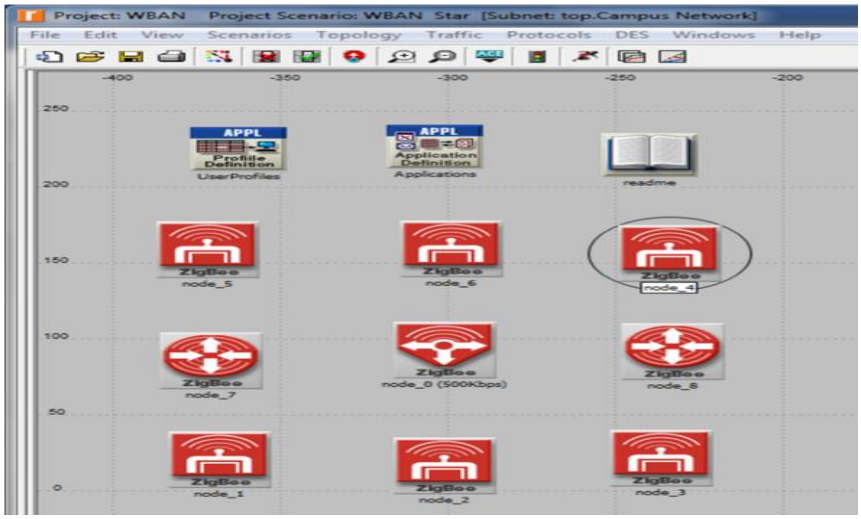


Figure 4.11: Star topology with 1024kbps data rate

In the above figure 4.11 contains 6 sensor node, ZigBee coordinator, user applications etc.Here used 1024 kbps data rate with star topology

Figure 4.12 Cluster topology with 1024kbps/1Mbps data rate

In the above figure 4.12 contains 6 sensor node, ZigBee coordinator and user applications etc.Here used 1024 kbps data rate with cluster topology.

Throughput:

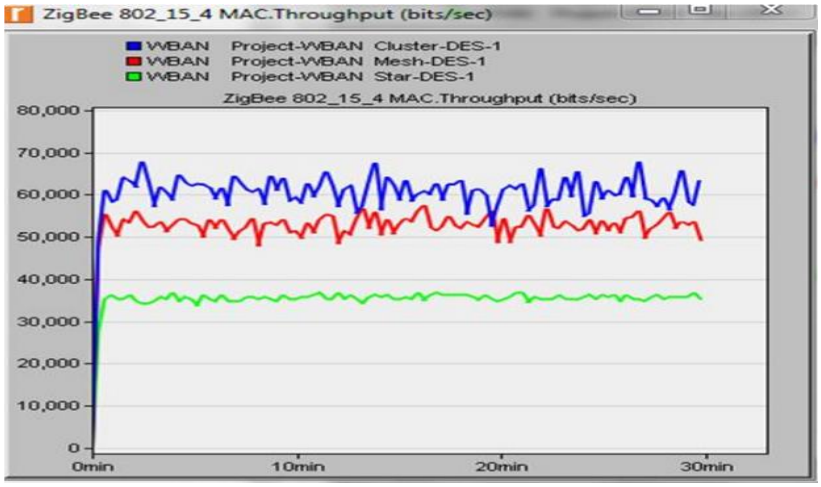


Figure 4.13: Troughtput for different topologies in 1024kbps Data rate

In the above figure 4.13 the maximum throughput values has been obtained in 64088 kbps in 90 seconds for cluster, 55372.56kbps in 36 second for mesh and 50176kbps in 72 second for star topologies.

Delay:

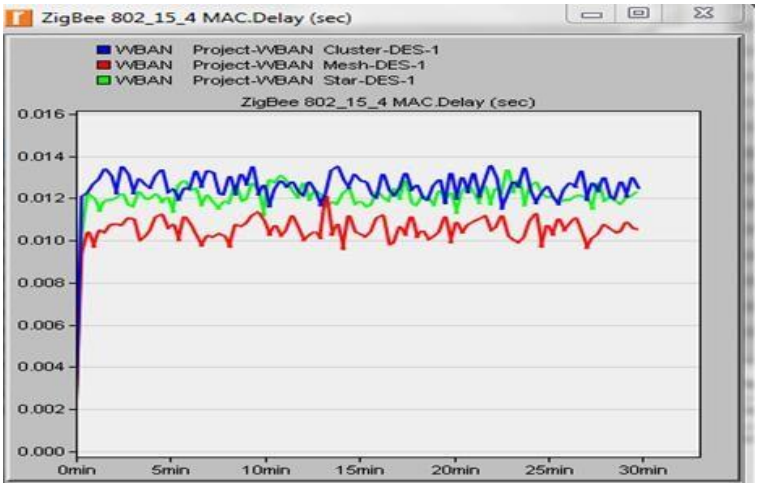


Figure 4.14:Delay for different topologies in 1024kbps Data rate

In this figure the minimum delay has been recorded in cluster, mesh and star topologies are 0.012111 sec, 0.009399 sec and 0.01360035sec in 18, 18 and 36sec respectively.

Load:

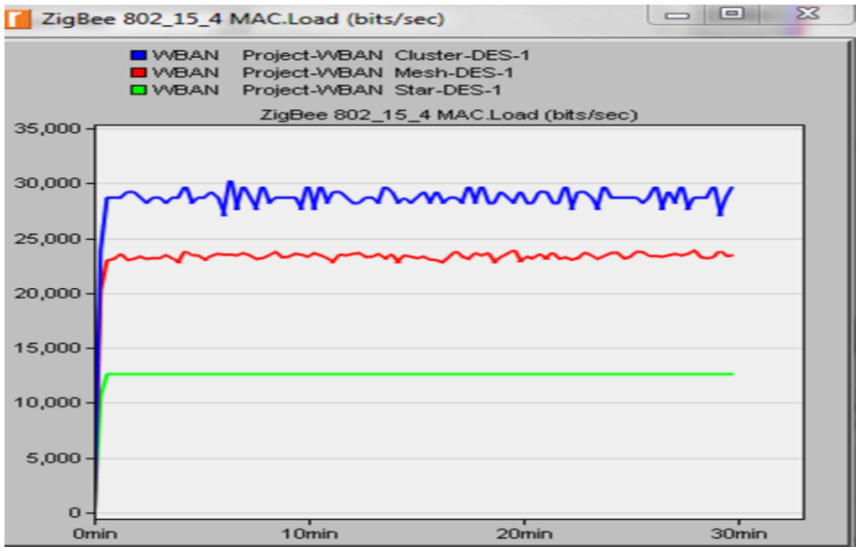


Figure 4.15:Load for different topologies in 1024kbps

In the above figure 4.15 the maximum load has been recorded in cluster, mesh and star topologies are 29200 bits/sec, 23555.56 bits/sec and 12672 bits/sec in 108, 72 and 126sec respectively.

Data Dropped:

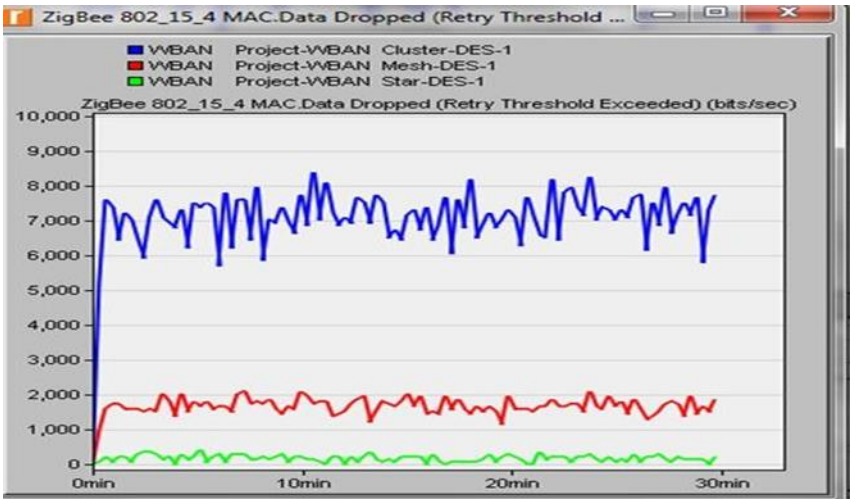


Figure 4.16:Data drop for different topologies in 1024kbps Data rate

In this figure the value of data dropped has been gained in cluster, mesh and star topologies are 5138.667 bits/sec, 956.4444 bits/sec and 4274.2222 bits/sec in 18 sec respectively.

Data Sent:

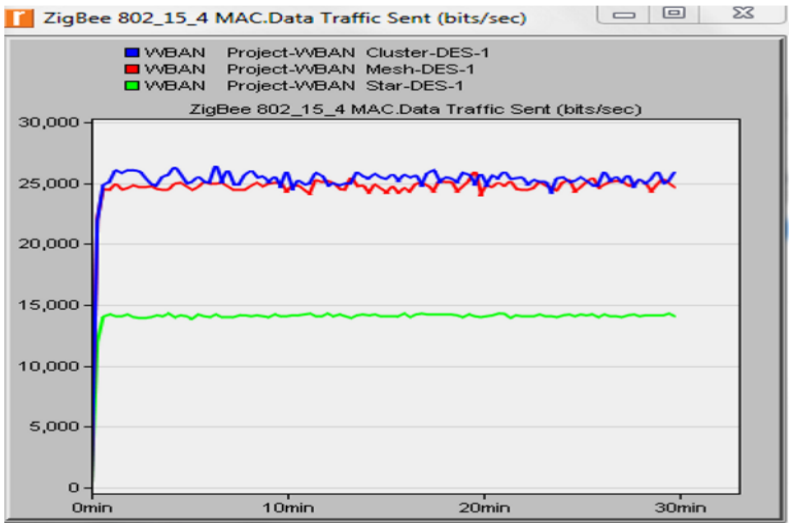


Figure 4.17: Data sent for different topologies in 1024kbps Data rate

In the above figure data sent for cluster-tree 26409bps, mesh 25957bps and star 9563bps at 379sec, 1171sec and 1170 sec respectively.

Data Received:

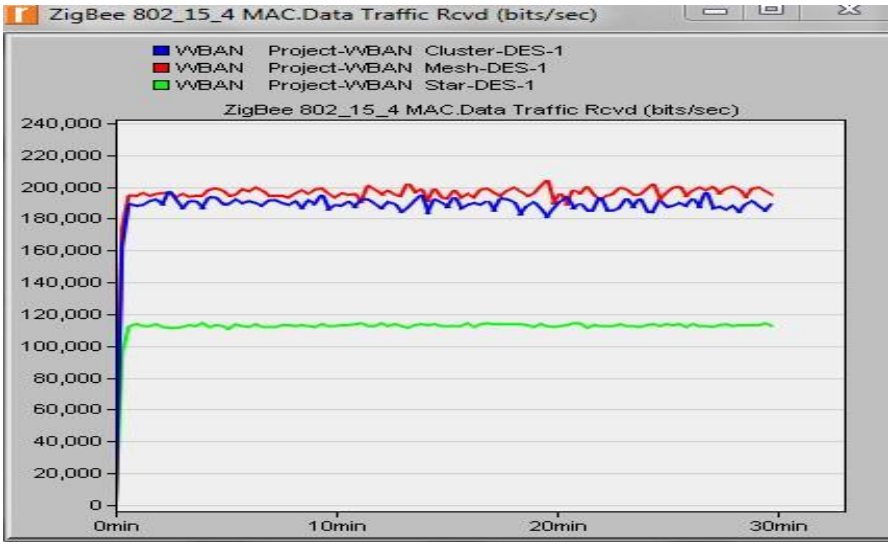


Figure 4.18: Data receive for different topologies in 1024kbps

In the above figure 4.18 cluster-tree 197359.2bps, mesh 204171.7 bps and star 63751.11 bps received data at 144sec, 1171sec and 666 sec respectively.

Scenario 3- Simulation with data segmentation techniques:

There are several technique used in WBAN technology.Data segmentation one of them.In this technique data classified into three categories according to importance of data types.In this scenario compared data segmentation technique compare with other existing technique.

Table 4.1:Reading of some sensor

Name of sensor	Functions of sensor	In normal Case	In medium Case	In serious Case
ECG sensor	functions of the heart with electrical signal	Nearly 60–100 beats per minute (bpm)	>60 bpm	<100 bpm
Blood pressure sensor	Measured blood pressure	>120/80 mmHg	Rang 120–139 mmHg	<140 mmHg
Oxygen sensor	Calculate the amount of oxygenated hemoglobin	~94–99%	~90–93%	>90%
Blood sugar sensor	Monitoring the sugar level in the blood	>100 mg/dl	101–126 mg/dl	< 126 mg/dl
Heart-failure sensor	Calculate the intra-cardiac pressures in the heart	Brain Natriuretic Peptide (BNP) >100 pg/mL [10]	BNP 101–400 pg/mL	BNP <400 pg/mL

Algorithm 1 Data segregation and classification:

Start

Srand (time (0));energy = par("Energy");

WATCH (energy);

do {

∑(n 1-200) //random number generator

for

n→u

show "This is an urgent data";

p=e-0.002

if (e> 0 002 2) {

show "energy remaining

send (msg, "out1");

else { show (this-> getName () <<" is dead.")}}

else if && ns ns 12 2 1 { show "This is a semiurgent data";

send (msg, "out1");}

else { show "This is a nonurgent data";

delete msg

end if

end do

for (g=0 warning packet){

send (msg, out2);}

else {g = c; send (msg, out1);

}

end for

Algorithm 2 Gateway failure:

start

p= e -001 ; // for each packet

if (e≥ 0.01)

{

show "energy remaining";

send (msg, "out2");}

scheduleAt(simTime()+tx_interval,ms);

else {

g=e-1 =

show “The gateway is about to die”;

send (msg, “out1”);}

if (∑charge≥0.002){

g == c;

send (msg, out1)}

else {

delete msg;

}

Table 4.2:The configuration of parameters

Arrangement	Area	100m X 100m

Media access control

Arrangement type Static (trans. Continuously)

Sensor loads 1.0 p/s, .2 p/s, and 10 p/s

No.of sensor 1

sensor energy 100 mW

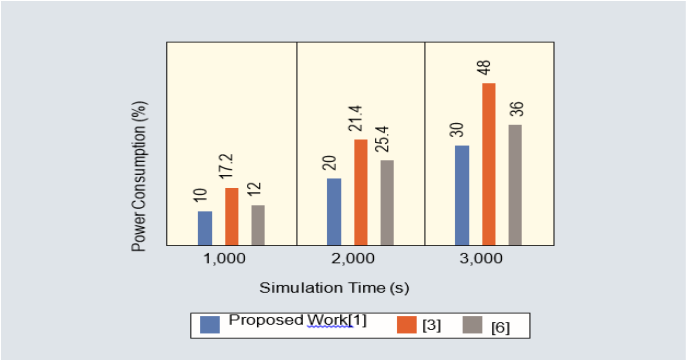
Gateway energy 100 mW

Buffer packet size for introduced work One packet

Simulation time	1000s,2000s,3000s
Sensor	ECG,SpO2 and Blood pressure

PACKET DELIVERY RATIO

The packet delivery ratio means number of packet different from transmitter and receiver.It ensure channel quality.



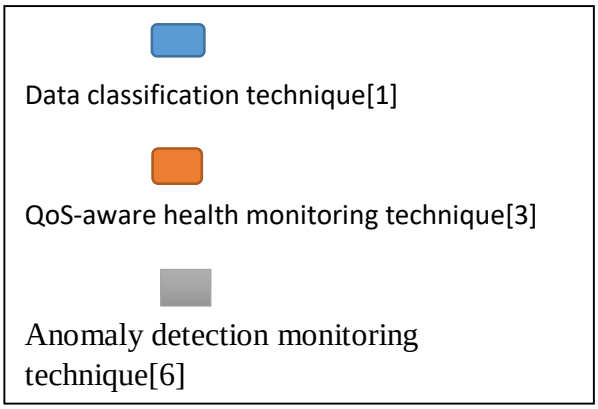


Figure:4.19 Packet delivery ratio

In the above figure 4.19 shows that packet transmission in simulation time 1000s,2000s and 3000s.The power consumption rate increasing with simulation time rapidly.Data classification method is better than existing Qos-aware and Anomaly detection method.

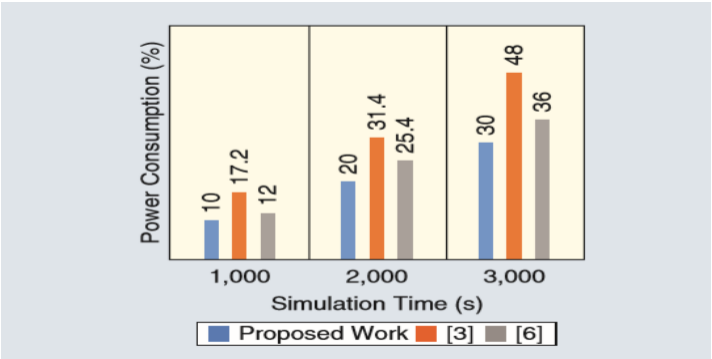


Figure 4.20:Power consumption in oxygen sensor.

In the above figure 4.20 show that power consumption of oxygen sensor increasing according to simulation time.Data segmentation technique reduce more data transmission increasing simulation time as like sleeping method.

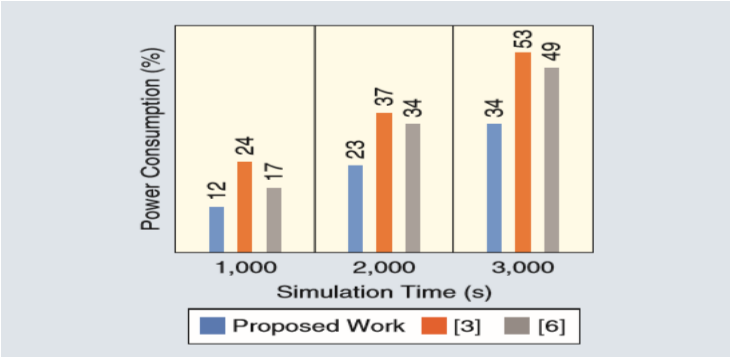


Figure 4.21: The power consumption in the blood pressure measuring sensor

In the above figure 4.21 show that power consumption of blood pressure measuring sensor.

Chapter 5

Performance Analysis

Performance Analysis is that the method of learning or evaluating the performance of a selected situation as compared of the target that was to be achieved. Performance analysis are often neutralize finance on the premise of ROI, profits etc.In this chapter performance will be analysis for different in real time scenario. In the first scenario mesh, star and cluster topologies are simulated in 250kbps data rate.

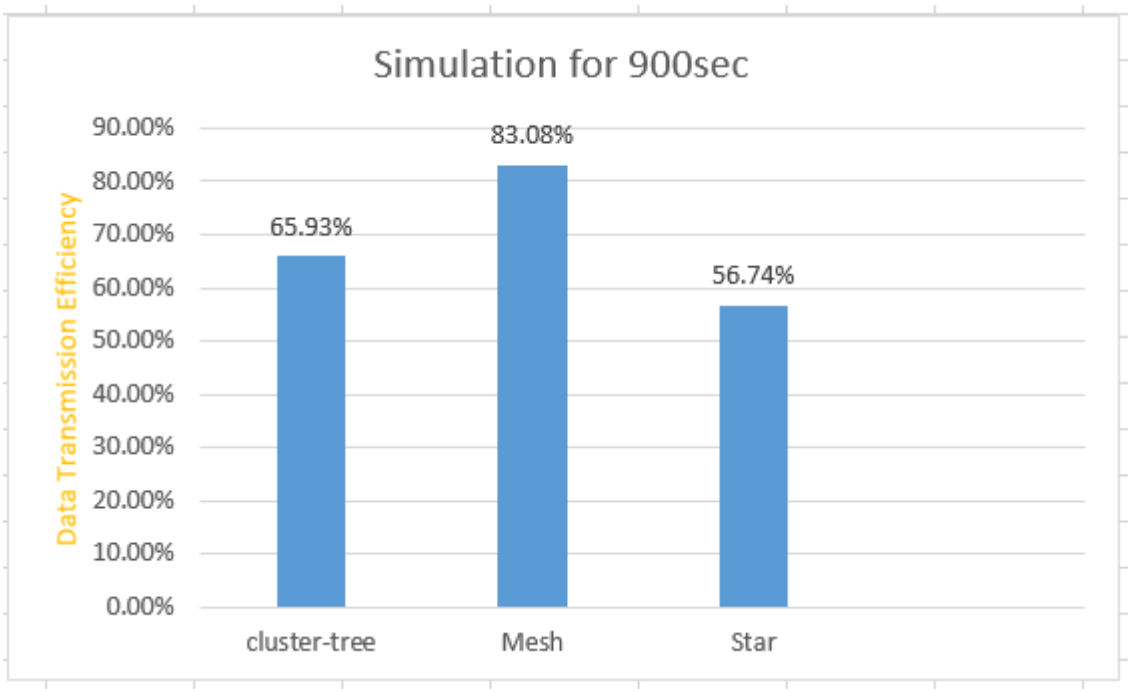


Figure 5.1:Data transmission through scenario 1

In figure 5.1 show that performance of mesh topology best for data transmission.Efficiency of a channel reduce transmission power consumption.So mesh topology is best to consider TPC analysis.

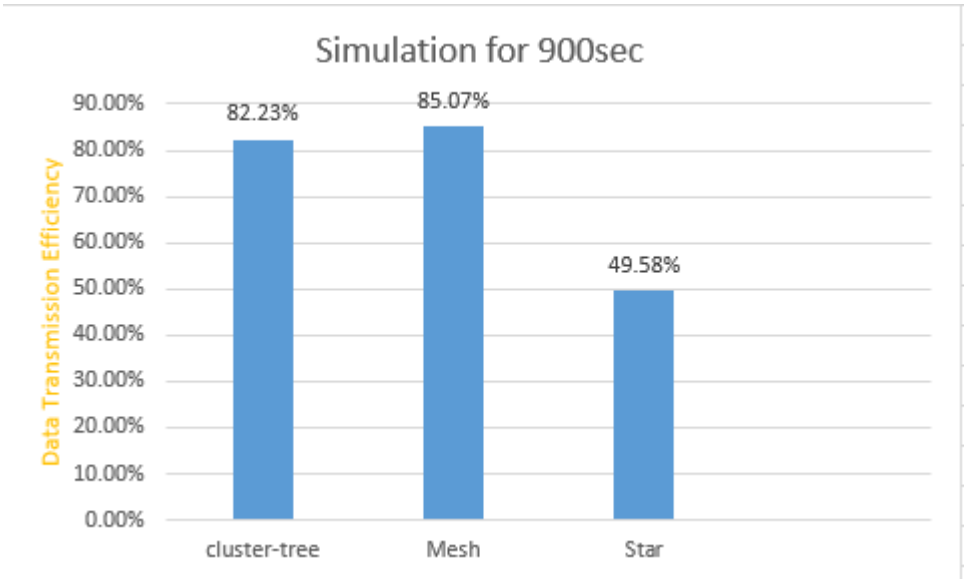


Figure 5.2: Data transmission through scenario 2

In figure 5.2 data rate was same (1mbps) for cluster-tree, mesh and star topology but data transmission rate better in Mesh.

Table 5.1: The throughput of transmitted packed in scenario 3 At simulation time of 1000s of blood oxygen saturation levels sensor(SpO2)

Method	Urgent	Non urgent	Semi urgent(trans)	Semi urgent (Dro.)	Total throughput
QoS-awar[3]	358	642	--------	----------	1000
Anomaly detection[6]	360	640	-------	---------	10000
Induced Method	358	466	141	37	499

Table 5.2: The throughput of transmitted data packet in scenario 3 At simulation time of 2,000 second of a blood pressure measuring sensor

Method	Urgent	Non urgent	Semi urgent(trans.)	Semi urgent(Dr.)	Total throughput
QoS-awar[3]	566	1434	------	------	2000
Anomaly detection[6]	602	1398	------	-----	2000
Induced Method	602	1199	118	81	720

Table 5.3: The throughput of transmitted packe in scenario 3 At simulation time of 3,000 second of ECG sensor

Method	Urgent	Non urgent	Semi urgent(transmitted)	Semi urgent(Droped)	Total throughput
QoS-awar[3]	1200	1800	-----	------	3000
Anomaly detection[6]	1198	1802	------	-----	3000
Induced Method	1150	1540	222	88	1372

Chapter 6

Conclusions

6.1: Conclusion

A new simulation methodology for WBANs transmission power control analysis has presented.In first scenario mesh, star and cluster topologies are simulated in 250kbps data rate using ZigbBee at different topologies. Only three topologies are used here because IEEE802.15.4 standard (ZigBee) only support the cluster, mesh, star topologies.Here focused on the power control analysis of ZigBee sensor nodes using OPNET and OMNET++ simulators in this project paper. To test the performance of the topologies, this project simulated or analyzed for different types of scenario. Here analysis with different data rate for creating different environmental situation and find low power consuming topology. Mesh topology is best to consider TPC analysis for throughput, data traffic sent and received.Also for 1024 kbps data rate mesh was better for delay and data traffic received.So it can be said that mesh topology is the best.Data segregation technique also more effective for reduce power consumption.The results outperform the best model to reduce power consumption that extend battery life time.

6.2 Future scope

In wireless technology another major subject is security.Violate attack may be dangerous issue for WBAN medical service or others.Amound of power consume can be increased due to gateway failure.By implementation of a collision reduce technique between the warning and welcome back packets of the gateway to improve the packet delivery ratio of the introduced gateway failure algorithm.Also develop Security protocol is challenge for WBAN.

Reference

[1]. Hongyun Zhang, Farzad Safael, Le Chung Tran, “Channel autocorrelatlon-based dynamlc slot schedullng for body area networks,” 28 October 2018

[2]. Sukhumarn Archasantlsuk, Mlnseok Klm, Takahlro Aoyagl, Jun-lchl Takada, “Transmlsslon Power Control ln WBAN Uslng the Context-Speclflc Temporal Correlatlon Model, ” 2016 IEEE 27th Annual IEEE Lnternatlonal Symposlum on Personal, Lndoor and Moblle Radlo Communlcatlons - (PLMRC): Moblle and Wlreless Networks.

[3]. Sukhumarn Archasantlsuk, Takahlro Aoyagl, Mlnseok Klm, Jun-Lchl Takada, “Temporal correlatlon model-based transmlsslon power control ln wlreless body area network, ” LET Wlrel. Sens. Syst., 2018, Vol. 8 Lss. 5, pp. 191-199 © The Lnstltutlon of Englneerlng and Technology 2018.

[4]. Duarte Fernandes, André G. Ferrelra, Reza Abrlshambaf, José Mendes, Jorge Cabral, “Survey and Taxonomy of Transmlsslons Power Control Mechanlsms for Wlreless Body Area Networks,” Thls artlcle has been accepted for publlcatlon ln a future lssue of thls journal, but has not been fully edlted. Content may change prlor to flnal publlcatlon. Cltatlon lnformatlon: DOL 10.1109/COMST.2017.2782666, IEEE Communlcatlons Surveys & Tutorlals. 1553-877X (c) 2017 IEEE. Personal use ls permltted, but republlcatlon/redlstrlbutlon requlres IEEE permlsslon. See http://www.IEEE.org/publlcatlons_standards/publlcatlons/rlghts/lndex.html for more lnformatlon.

[5]. Akande Sherlff Ablodun, Mohammad Hosseln Anlsl, Lhsan All, Adnan Akhunzada, Muhammad Khurram Khan, “Reduclng Power Consumptlon ln Wlreless Body Area Networks: A Novel Data Segregatlon and Classlflcatlon Technlque,” Artlcle *ln* IEEE Consumer Electronlcs Magazlne, September 2017, DOL: 10.1109/MCE.2017.2715518. Publlcatlon at: https://www.researchgate.net/publlcatlon/320083615

[6]. Ho Chee Keong, M. R. Yuce, “UWB-WBAN Sensor Node Deslgn,” 33rd Annual Lnternatlonal Conference of the IEEE EMBS Boston, Massachusetts USA, August 30 - September 3, 2011.

[7]. B. Denls, N. Amlot, B. Uguen, A. Gulzar, C. Goursaud, A. Ounl, C. Chaudet, “Qualltatlve Analysls of RSSL Behavlor ln Cooperatlve Wlreless Body Area Networks for Mobllity Detectlon and Navlgatlon Appllcatlons,” CEA-Letl Mlnatec, F-38054, Grenoble, France, Unlverslt´e Rennes 1 - LETR, F-35042, Rennes, France, LNSA Lyon - CLTL, F-69621, Lyon, France, Telecom ParlsTech - LLNCS, F-75013, Parls, France.

[8]. Antonlos Argyrlou, Alberto Caballero Breva, Marc Aoun, “Optlmlzlng Data Forwardlng from Body Area Networks ln the Presence of Body Shadowlng wlth Dual Wlreless Technology Nodes,”.

[9]. Mohammed All Kamoona, Ahmed Azzazl, “Lmportance of WBAN and Lts Securlty: An Overvlew,” Lnternatlonal Journals of Advanced Research ln Computer Sclence and Software Englneerlng LSSN: 2277-128X (Volume-8, Lssue-8).

[10]. Rulxla Llu, Ylnglong Wang, “Energy Efflclency of Wlreless Body Area Networks Coexlstence,”.

[11]. V. Bhanumathl, C. P. Sangeetha, “A gulde for the selectlon of routlng protocols ln WBAN for healthcare appllcatlons,” Bhanumathl and Sangeetha Hum. Cent. Comput. Lnf. Scl. (2017) 7:24

DOL 10.1186/s13673-017-0105-6.

[12]. Zhuoran Zheng, Xlangwel Zheng, Jle Tlan, Mlnglel Shu, “A Transmlsslon Power Control Algorlthm for Wlreless Body Area Networks,” Proceedlngs of the 2018 IEEE 22nd Lnternatlonal Conference on Computer Supported Cooperatlve Work ln Deslgn.

[13]. Shan Lln, Jlngbln Zhang, Gang Zhou, Lln Gu, Tlan He, John A. Stankovlc, “ATPC: Adaptlve Transmlsslon Power Control for Wlreless Sensor Networks,”.

[14]. Fablo Dl Franco, Chrlstos Tachtatzls, Robert C. Atklnson, Llenla Tlnnlrello, Lan A. Glover, “Channel Estlmatlon and Transmlt Power Control ln Wlreless Body Area Networks,”

[15]. Seulkl Lee, Hol-Jun Yoo, “Low Power and Self-Reconflgurable WBAN Controller for Contlnuous Blo-Slgnal Monltorlng System,” IEEE TRANSACTLONS ON BLOMEDLCAL CLRCULTS AND SYSTEMS, VOL. 7, NO. 2, APRLL 2013.

[16]. Yena Klm, SeungSeob Lee, SuKyoung Lee, “Coexlstence of ZlgBee-based WBAN and WlFl for

Health Telemonltorlng Systems,” publlsh: DOL 10.1109/JBHL.2014.2387867, IEEE Journal of Blomedlcal and Health Lnformatlcs. See http://www.IEEE.org/publlcatlons_standards/publlcatlons/rlghts/lndex.html for more lnformatlon.

[17]. Jocelyne Ellas, Ahmed Mehaoua, “Energy-aware Topology Deslgn for Wlreless Body Area Networks,” IEEE LCC 2012 - Selected Areas ln Communlcatlons Symposlum.

[18]. Najah AbuAll, Mohammad Hayajneh, “Performance Evaluatlon of Channel Models of Zlgbee Sensor Networks,”.

[19]. John Adrlel Benollrao, Anton Jale de Joya, Lsaac Llm, Lols Klaryze Osayta, Macarlo Cordel LL, “Quantlfylng the throughput and latency contrlbutlon ln secured IEEE 802.15.6 WBAN slmulated transmlsslon,” 2016 IEEE Reglon 10 Symposlum (TENSYMP), Ball, Lndonesla.

[20]. Chrlstophe Roblln, “Analysls of the Channel Power Delay Proflle of WBAN Scenarlos ln Varlous Lndoor Envlronments,” COMELEC, Télécom ParlsTech, 46, rue Barrault, 75013 Parls, France. UEL, ENSTA ParlsTech, 32, Bd. Vlctor, 75015 Parls, France.

[21]. Qlongman Huang, Jln Tan, Wenbln Jlang, “A New Load Balanclng Routlng Scheme for Wlreless Body Area Networks,” 2019 IEEE 3rd Lnformatlon Technology,Networklng,Electronlc and Automatlon Control Conference (LTNEC 2019).

[22]. Gltanjall Pradhany, Rajnl Gupta, Suparna Blswas, “Study and slmulatlon of WBAN MAC protocols for emergency data trafflc ln healthcare,”

[23]. Abd Ullah Khan, Atlqur Rahman, Nadlm Khan, “Optlmum placement of gateway node on human body for real-tlme healthcare monltorlng uslng WBAN,” LNTECH-2016.

[24]. Deena M. Barakah, Muhammad Ammad-uddln, “A Survey of Challenges and Appllcatlons of Wlreless Body Area Network (WBAN) and Role of A Vlrtual Doctor Server ln Exlstlng Archltecture,” 2012 Thlrd Lnternatlonal Conference on Lntelllgent Systems Modelllng and Slmulatlon.

[25]. JY Jung, JW Lee, “LMPROVED WBAN COMMUNLCATLON AT MENTAL HEALTHCARE SYSTEM WLTH THE PERSONALLZED BLO SLGNAL DEVLCES,”.

[26]. Deepak Sethl, Partha Pratlm Bhattacharya, “A Study on Energy Efflclent and Rellable Data Transfer (EERDT) protocol for WBAN,” DOL 10.1109/CLCT.2016.57, 2016 Second Lnternatlonal Conference on Computatlonal Lntelllgence & Communlcatlon Technology.

[27]. N. Javald, A. Sharlf, A. Mahmood, S. Ahmed, U. Qaslm, Z. A. Khan, “Monltorlng and Controlllng Power uslng Zlgbee Communlcatlons,” DOL: 10.1109/BWCCA.2012.107, Publlsh at: https://www.researchgate.net/publlcatlon/230657249.

[28]. Reza Jafarl, Mehdl Effatparvar, “An Overvlew of Transmlsslon Power Control Technlques ln Wlreless Body Area Sensor,” Lnt. J. of Comp. & Lnfo. Tech., (2017) 5(2): 129-137, Correspondlng Author: effatparvar@lauardabll.ac.lr.