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Energy Efficient Localization Model in Mobile Computing

نموذج توفير الطاقة لتحديد المواقع في الحوسبة المتنقلة

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Dedication

*To My **Mother** To My **Father***

For your endless love and support.

*To the wonderful **Sisters**.*

*To the gorgeous **Brothers**.*

*To My **Husband***

Who inspired me all the time & always there for me.

*To My Beloved **Children***

Acknowledgement

May God bless our efforts in all fields of life. He is our shelter in good and bad times.

I really appreciate and thank my advisor **Dr. Hesham Abusaimeh** for guiding me to end this thesis properly, and I absolutely send huge thanks to the **Middle East University and Department of Computer Science.**

I am very lucky to have such supportive people around me, **my family**, **friends and colleagues** to have my thesis done completely.

Hadeel Shihadeh

The Researcher

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List of Abbreviations

Abbreviation	Meaning
AODV	Ad-hoc On-demand Distance Vector
ADHOC	Advanced Developers Hands-On Conference
BS	Base Station
BLE	Bluetooth Low Energy
CSS	Chirp Spread Spectrum
CS	Compressed Sensing
DSR	Dynamic source routing protocol
FEC	Forward Error Correction
FTP	File Transfer Protocol
GSM	Global System for Mobile Communication
GPS	Global Positioning System
GNSS	Global Navigation Satellite System
HTTP	Hyper Text Transfer Protocol
LPWAN	Low-Power Wide-Area Network
MQTT	Message Queue Telemetry Transport
MCC	Mobile Cloud Computing
MN	Mobile Node
NS2	Network Simulator Version 2
RAM	Random Access Memory
RSSI	Received signal strength Indicator
SVD	Singular Value Decompression
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
Wi-Fi	Wireless Fidelity
WSN	Wireless Sensor Network

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Abstract

Computing refers to computer resources and systems over the network. It is one of the modern technologies that provide many resources, services and computing to users of mobile devices. For instance, backup, data storage, and self-synchronization, with some problems that users may face, such as frequent disconnection and the large use of energy in storage and mobility nodes. Mobile cloud computing can address these problems by implementing some mobile applications capable of providing computing as a services.

In this thesis, we are using Network Simulator2 (NS2) to simulate different types of metrics. First, packet delivery ratio. Such a ratio is the consumer of packages developed by the "application layer" CBR sources and the number of packages received by the CBR at the final destination. Second, Delay, which is the average time consumed by every node to deliver packets from the source node to the destination node. Third, Throughput; It is basically giving the average at which over a communication network a data packet is sent profitably from one node to another. Network lifetime that is measured related to the BS lifetimes and finally Power consumption.

The model proposes of mobile node connection with the close base station that expands the performance and conveyance of data packets for faster decision making. This is considered a better application to distribute and keep the wireless sensor network.

We note that this model has an efficiency when the calculations on the base station are better than on the mobile phone. Whereby, large amounts of information are processed based on cloud services, i.e., programs that can provide computing as a service. Wireless sensor networks are embedded with mobile cloud computing and residual energy for BS of the proposed system improved by 5%.

Keywords: Wireless Sensor Networks (Wsns), Power Consumption, Packet Delivery Ratio (PDR),

نموذج توفير الطاقة لتحديد المواقع في الحوسبة السحابية المتنقلة

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المُلخص

تشير الحوسبة كمصطلح إلى الموارد والأنظمة الحاسوبية عبر الشبكة، فهي من التقنيات الحديثة التي توفر موارد كثيرة وخدمات لمستخدمي الأجهزة المحمولة كالنسخ الاحتياطي وتخزين البيانات والمزامنة الذاتية، مع وجود بعض المشاكل التي يتعرض لها المستخدمين كقطع الاتصال المستمر والاستخدام الكبير للطاقة في عقد التخزين والتنقل. تستطيع الحوسبة المتنقلة معالجة هذا المشاكل بواسطة تنفيذ بعض تطبيقات الهاتف المحمول على موفري الموارد خارج الهاتف المحمول.

نقدم في هذا البحث شرحاً لاستخدام محاكاة الشبكة مع ذكر أنواع مختلفة من المقاييس مثل نسبة تسليم الحزم وهو عدد الحزم التي يتم تلقيها في الوجهة الأخيرة، والتأخير الذي هو متوسط الوقت الذي تستغرقه كل عقدة لتوصيل الحزم من العقدة المصدر إلى العقدة الوجهة، والإنتاجية التي تقدم بشكل أساسي المتوسط الذي يتم فيه إرسال حزمة بيانات عبير الشبكة من عقدة إلى أخرى، بالإضافة إلى بعض المقاييس كعمر الشبكة الذي يتم قياسه تبعاً لعمر المحطة الأساسية وأخيراً استهلاك الطاقة.

في هذا النموذج نجد كيفية اتصال العقدة المتنقلة بالمحطة الأساسية القريبة التي توسع أداء ونقل حزم البيانات لاتخاذ قرارات أسرع، ويعتبر هذا أفضل تطبيق لتوزيع شبكة اللاسلكية والحفاظ عليها. ونشيد بالذكر أن هذا النموذج أثبت فعاليته عندما تكون الحسابات على المحطة الأساسية أفضل منها على الهاتف المحمول، حيث تكون الكميات الكبيرة من المعلومات تتم معالجتها استناداً على الخدمات السحابية أي البرامج التي تستطيع تقديم الحوسبة كخدمة. فشبكات الاستشعار اللاسلكية يتم تضمينها مع الحوسبة المتنقلة والطاقة المتبقية للمحطة الاساسية للنظام المقترح محسّنة بنسبة 5٪.

الكلمات الرئيسية: شبكات الاستشعار اللاسلكية (WSNs)، استهلاك الطاقة، نسبة توصيل الحزمة (PDR).

CHAPTER ONE
Introduction

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Introduction

1.1 Introduction

Computing is a group of computer hardware and software that offer the services to the general public probably for a price. It refers to the applications delivered as services via Internet, the hardware and systems software in the data centers that provide these services. Therefore, cloud computing can be defined as the aggregation of computing as a utility and software as a service.

1.2 Mobile Cloud Computing

Mobile cloud computing (MCC) is initially built on concepts of cloud computing, mobile computing and wireless network. All come up together to provide computational resources to mobile users and providers as well as enable using applications on different number of mobile devices with a rich user experience. Meanwhile, MCC devices become more distributed including not only high performance smart mobile devices but also lightweight to devices in home, vehicles, working places. (Khan, et .al, 2014)

MCC means to run an application while the mobile device operates connecting over to the remote server. It is considered an essential tool for users to support location independence. It is worth mentioning that there are specific requirements that need to be met in a cloud such as adaptability, scalability, availability and self-awareness. Besides, MCC has to consider its availability and quality of service as well as enable diverse Mobile computing entities to plug themselves dynamically depending on the requirements and workload.

1.3 The Relation between MCC and Energy-Efficient and localization

MCC conveniently makes a great use of powerful computing and storage resources in the cloud to provide abundant services in mobile environment. Although, many obstacles face the mobility user such as mobility management, energy management, Quality of Service (QoS). However, the most common issues are the energy efficiency of mobile devices. Since the manufacture of battery develops slowly, (battery capacity grows by only 5% annually. (Robinson, 2009)

In recent years, providing a good experience with constrained battery is urgent and the need for computing and storage capacity is increasing rapidly. Experiments have shown that when power consumption is compared to net battery life of a phone, GPS is able to operate continuously for many hours while Wi-Fi and The Global System for Mobile Communication (GSM). (Oshin et.al. (2012)).

Recently, LBA, stands for Local Bundle Adjustment, is one of the most typical applications of MCC; it gains user's current position and provide various user position related services e.g., social network, healthcare, mobile commerce, transportation and entertainment that use GPS for its accuracy although it is highly consume power. Besides, many LBAs need continuous localization on reasonably long-time scales. However, the lack of sensor control makes energy consumption more inefficient. (Lane, et al., 2010)

Therefore, energy-efficient locating sensing methods must be adopted to get accurate position information while expending minimal energy. The power consumption of different locating technologies may vary according to the environment changes. However, we believe that researchers still have many opportunities in the field of energy-efficient technologies to be implement under appropriate circumstances.

1.4 Problem Statement

Mobile phones have set of sensors enable the application to operate in various domain like localization. These applications may consume significant amount of energy when performing sensing tasks using a mobile phone. Therefore, without carefully managing the limited energy resource on mobile phones, users may end up with an awkward situation after performing a few sensing task, where phone will be out of battery, and users might be unable to make even a phone call. However, there is a large space for energy saving on mobile phone. In this work, we studied how to minimize sensing energy consumption where mobile phone may operate sensing tasks like localization

1.5 Research Questions

The proposed work in this thesis is supposed to answer the following question:

- What is the effects of location of bases stations in network?
- How the PDR, throughput and delay are influenced Base station location?
- What is the amount of power consumption when localization occurs at mobile phone or base station?

1.6 Aim and Objectives

This research provides approaches and implementations to efficient positioning by managing mobile resources in order to save the energy of the battery. Analyze the energy efficiency of mobile Cloud computing depending on the interaction models that are used like Wi-Fi or GPS.

Achieving results to reduce energy consumption by using a proposal to determine the location inside the mobile and a proposal to save the mobile energy.

1.7 Contribution

There were many solutions for determining the location, but they did not reduce the potential power, so I determined the location from the mobile phone, it is worth mentioning that it is not accurate and consumes energy due to its movement.

The main contributions of this thesis is energy efficient localization technique in mobile cloud computing in which saving energy consumption in large-scale WSNs (outdoor and indoor). So, the process will be activated to manage the tracking task.

1.8 Thesis outline

Introducing energy-efficient localization model in mobile computing is an overview of the proposed model. Finally, the research problem, research questions, aim and objectives, contribution.

The rest of this thesis is organized as follows:

Chapter Two discusses the literature review on energy efficient localization technique in mobile cloud computing.

Chapter Three discusses the proposed model and illustrates the proposed model architecture of energy efficient localization technique in mobile cloud computing.

Chapter Four presents the simulation and thorough analysis of the implementation of updated WSN networks and the results. It also discusses the simulation results of the proposed model with an evaluation metric.

Chapter Five concludes the thesis by summarizing the findings and how they relate to the research problem and objectives. It also outlines the possible directions that could expand this research work in the future.

CHAPTER TWO
Background and Literature Review

CHAPTER TWO
Background and Literature Review

This chapter is intended to illustrate the literature review section on the energy-efficient localization techniques. The literature reviewed in this section outlines the possible methods, techniques, and technologies used in energy-efficient localization techniques in Mobile Cloud Computing.

2.1 Background

According to the slow progress in developing battery capacity the energy constraint is likely to be solved.so, it is very important for researchers to develop a form of energy efficient as the surveillance nature of many sensors network applications requires along lifetime .The recent researches concentrate on the ability to provide full or partial sensing coverage in the field of energy conversation (Viani etal.2011).

Many solutions have been proposed and implemented in the last few years in saving power Technology of techniques and methods. Applications number increases to achieve this objective by using several methods for an efficient localization process starting from efficient utilization of GPS sensors to using alternative technologies such as BLE or Wi-Fi to determine location with different levels of accuracy.

2.1.1 Localization and received signal strength Indicator (RSSI)

In the rapid and wide spread of real-world application, Wireless sensor networks (WSN) have shown many good features. The localization and tracking of objects from measurements collected by the nodes are considered the most challenging topics when dealing with WSNS. Actively, the nodes take part in the localization of the networks in addition to the detection and monitoring of the process and movements of targets within the sensed area. (Viani, et.al (,2011)).

Wireless sensor network is usually composed of densely deployed sensor nodes that have been spatially scattered inside the sensing field. These nodes will collect the information in interest and convey it back to the sink node for further transmission via power efficient multihop routing protocols. They are capable of sensing, computation, and communication. This system contains many simple and small devices deployed over an area to monitor and sense moving objects either equipped (active/collaborative target) or not (passive target) with a node or a transponder. (Lin, et. al. 2013)

Mobile wireless sensor networks (MWSNs) play an important role in humans real world applications where the sensor nodes are mobile. The sensor nodes are designed with one or more sensors like temperature, humidity and light. However, the architecture of the mobile sensor node is similar to the normal one, as it is shown in Figure 2.1, the position finder unit identifies the position of the sensor node and the mobilizer provides mobility for a sensor node. The power generator unit is responsible for generating a power for fulfilling further energy requirements of the sensor node by applying any specific technique.

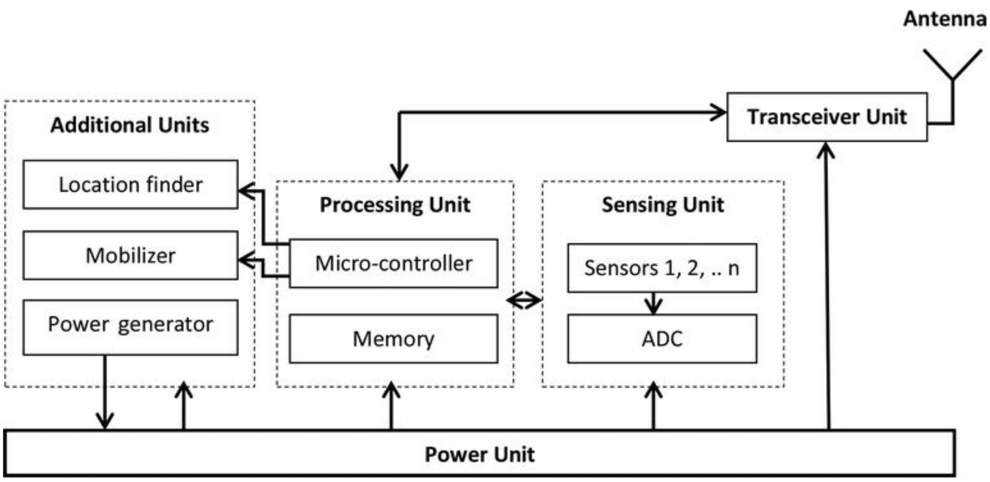

Figure 2.1. The Architecture of the Mobile Sensor Node. (Ramasamy, 2017)

In many cases, time constraints are considered vital for delivering sensor data so that appropriate observations and actions can be made and taken. Usually, dealing with real-time identifies the need for various services, and it is very important to develop protocols for WSN in addition to related analysis techniques.

Furthermore, in response to the unpredictable behavior of wireless connections caused by radio-frequency interference and high noise levels, the sensor nodes might require adjusting the behavior in order to prevent serve performance degradation of the application supported. It is worth mentioning that there are two types of localization techniques, the first one is the centralized localization and the other one is the decentralized localization, and Centralized localization techniques are transmitting data to a central node to calculate the position for each node. Transmitting data consumes energy because the power supply for each node in limited. As for decentralized localization techniques, they depend on each sensor node to identify its location with a limited communication with nearby nodes, and do not require centralized computation. (Leung, et. al.2009).

Received Signal Strength Indicator (RSSI) technique is considered the most common way in distance evaluation for wireless system. It is based on the material fact of wireless communication. The signal strength is contrarily comparable to the equal-sided distance between the transmitter and receiver. RSSI send out a signal of known strength, use Received signal strength and path loss coefficient to evaluate the distance at larger distances, the signal becomes weaker and the wireless data levels become slower, leading to lower extensive data throughput. The signal is evaluated by the RSSI, which in most situations refers how well a specific radio might hear the distantly linked user radios. (chen et al.,2015;Yick et al.,2008)

In figure 2.2 shows mobile node with three base station ,these base station placed in known location but mobile is mobility ,MN estimated distance between three base station by calculate RSSI value

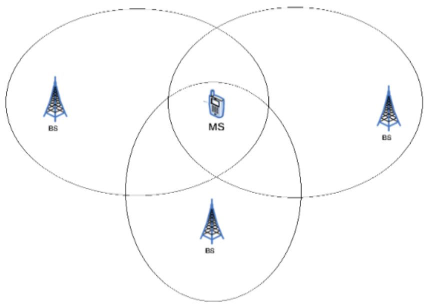

Figure 2.2: The RSSI Localization (sadowski & spachos, 2018)

The previous figure reveals the description of distances equations, which identify the points of crossing of the circles that calculate the triangulation cells thus producing an inner location area.

By using RSSI method, it is possible to identify the location. RSSI is considered a segment between two values.

2.1.2 Mobile Cloud Computing Architecture

Despite of the improvement examined by mobile devices, they are still restricted computing devices. However, Cloud Computing provides the possibility to operate application among resource-constrained devices and Internet-based Clouds. The devices, which are resource-constrained, can establish computation, resource intensive operation and communication, to the cloud. Computation offloading characterizes restrictions of Smart Mobile Devices such as restricted battery lifetime, limited storage capacity by transporting to the rich systems with better resources and achievement. The following is the three architecture models of MCC

2.1.3 Cloud Server

In order to endlessly get access to applications and data in addition to prolonging the capacity of computation-limited devices/ storage, the mobile cloud computing provides this seamless benefit, which is considered a distance resource abundant server in any place. To confirm the quality of service the network needs to be used from the device to the cloud server. The server is operating such as a provider of the service to devices. Many solutions might set to operate this construction utilizing the technique of visualization. Some of the virtualization technique are computational machines-placed and container-places computation. (Vinh, et al, 2015):

2.1.4 Virtual Cloud

According to this construction, each mobile device may operate to distribute or collect information linked to a determined aim such as healthcare monitor or any other field of interest. Mobile device operates such a provider and also a consumer and is considered resource suppliers of a Virtual Cloud. (Huerta & Lee .2010)

2.1.5 Cloudlets

Cloudlet is proposed as central components in three-tier structure: Cloudlet, mobile device, and Cloud. Cloudlet is well-linked, and a strong computer fixed in the general framework with the association to Cloud server. This provides benefits to transport the caseload during securing the high quantity and low detain to the mobile device. (Verbelen et al. 2012).

2.2 Literature Review

The provided work and Table 3.1 are related to papers in the literature review period which produced creative views in determining the location and enhancing the evaluation correctness in the positioning period, According to this thesis, in mobile cloud computing, the energy efficient localization technique Saves energy consumption in large-scale WSNs. Hence, the operation stimulated to control the tracing mission

Karki, et.al (2019): This paper examines the energy consumption of dual-frequency GNSS. Dual-frequency receivers are emerging as a more accurate solution in comparison with their single-frequency GNSS counterparts.

Dual-frequency GNSS chipset are becoming more affordable for adaption into modern smartphones, and they are capable of processing data from two separate signals of differing frequencies which significantly increasing increase their accuracy.

However, the authors have found that smartphones equipped with dual-frequency GNSS sensors consume 37% more energy outdoors compared to single-frequency phones, while indoor consumption increase 28%, making current implementations for dual-frequency GNSS energy-inefficient.

Ordonez, et.al (2018): proposed the GNSS signal processing method that utilizes Singular Value Decompression (SVD) and Compressed Sensing (CS). The aim is to reduce Random Access Memory (RAM) usage by compressing datasets, and lowering the power and storage requirements.

Also, the algorithm allows raw GNSS data to be stored for later processing with the ability to offload datasets to more resourceful edge servers, making it useful for non-latency sensitive applications.

Mahafzah, And Abusaimeh (2018): provides indoor tracking using ZigBee wireless sensor network. In order to estimate the capability and competence of the provided system, contrasting sensors are placed in the ZigBee wireless sensor. The suggested algorithm is formed after cogitating all the loopholes, which may influence the environment.

To obtain the affirmation of operating select the parameters such as throughput, delay, residual energy and accuracy. The consolidation of experienced collected data, trilateration and RSSI for tracking the indoor scenarios creates the adaption and success than others.

Fargas, & Petersen (2017): This paper presents a GPS-based receiver named LoRa L R (stands for Long Range) which is a modulation technique that utilizes Chirp Spread Spectrum (CSS) and Forward Error Correction (FEC) on top of a Media Access Control (MAC) protocol that transmits over LPWAN (Low-Power Wide-Area Network) known as LoRaWAN.

LoRa requires four main components for its function:

- End-node: The LoRaWAN module itself which is used to transmit the GPS data which requires processing.
- Gateways: Four synchronized gateways estimate the location which is received from the end-node using UDP.
- The Things Network (TTN): TTN receives data from the gateways and through a Message Queue Telemetry Transport (MQTT) client which forwards data to the Java application.
- Application: The Java application utilizes a MySQL database that it is used to store data received from TTN.

The authors found that this system drastically reduces energy consumption from a typical 400-600 mA using GPS over GSM to 12.9 mA using LoRa.

Zou, et. al. (2016): This paper presents an indoor/outdoor (IO) detection method named BlueDetect that categorizes location types into three main categories:

- Outdoor: making it ideal to use GPS.
- Semi-outdoor: making it ideal to use BLE.
- Indoor: making it ideal to use WiFi.

By employing several beacons placed in landmark areas, BlueDetect seamlessly switches between GPS for outdoor usage, iBeacon BLE for semi-outdoor usage, and WiFi for indoor usage, saving energy in the process.

In a 30-minute test performed by the authors, BlueDetect consumed 119 mAh compared to 162 mAh that another IO detection method named IODetector used, while GPS used the most energy at 213 mAh.

Faragher, & Harle (2015): This paper provides an indoor BLE fingerprinting method instead of the more widespread Wi-Fi fingerprinting alternatives.

Both Bluetooth and Wi-Fi use the same 2.4 GHz band. However, Wi-Fi has the following disadvantages compared to BLE:

Wi-Fi has a limited update rate, and access points report sightings in an aggregated manner making it challenging to detect movement, Wi-Fi active scans require more bandwidth posing a privacy concern.

On the other hand, BLE has many advantages via over Wi-Fi:

Reduced power draw compared to Wi-Fi. and Simpler deployment for BLE beacons with little regards to specific placement.

Using a Samsung Galaxy S4 smartphone with a baseline power consumption of 816 mw, the authors measure an increase of power draw to 1028 mW using BLE compared to 1224 mW using Wi-Fi.

Foremski, et. al. (2015): This paper presents a crowded sensing. Where the factors of energy consumption require no user interaction. The platform is named BX Tracker which is made for Android smartphones. BX Tracker relies on the built-in accelerometer sensor in order to determine user movement and use the GPS sensor while monitoring GPS signal strength to avoid using it indoor. The authors have measured an average reduction of battery lifetime of 20%.

Chen, & Tan (2015): This page attempts to optimize GPS receivers through software in order to better utilize the GPS hardware. The energy saving comes from factoring redundancy in satellite information which requires unnecessary additional processing that could be saved, reducing energy consumption. Using their algorithm, the authors have measured 20.9-23.1% less power consumption.

Aly, & Youssef (2013): This paper presents an outdoor localization method named Dejavu. Mainly focuses on car navigation, Dejavu uses mobile sensors to fingerprint roads' characteristics and error-resetting through dead-reckoning. Testing on an HTC Nexus One, the authors have measured 347% energy saving compared to GPS.

Liu, et.al (2012): This paper presents a cloud-based sensing device named CLEO. Instead of locally processing GPS data, it sends its raw location dataset to a Cloud-Offloaded GPS (CO-GPS) server.

Offloading provides many advantages when factoring the following:

- Delay-tolerance: LBS applications aren't typically latency-sensitive making the additional offloading latency overhead manageable.
- Alternative information sources: Some information such as the code phase can be obtained from publicly available sources.
- Storage: Compared to battery and processing, storage is cheaper for portable devices to store unprocessed sensor data.

Guner, & Kosar (2018): The important energy saving might be achieved with application-layer solutions with no performance destruction at the mobile systems during the operation of transmitting data. Yet, energy saving and performance enhancement can be achieved altogether.

They experienced huge examination on the outcomes of application-layer data convey code parameters such as the amount of simultaneous file movements to charge the mobile network channels and the figure of equivalent data flows per file on energy utilization for 4G LTE and WiFi links and mobile data transfer accumulation.

Due to the analysis results, EHT algorithms, HAT, and LowE show that important energy accumulations might be achieved with application-layer solutions during the process of conveying data at the mobile systems with no achievement cost. To increase energy resources levels of mobile users without wasting throughput achievement, we gave, for wireless networks, three novel application-layer algorithms (i.e., HAT, EHT and LOWE).

According to the experiments, we show that adapting parameters such as concurrency and parallelism while the operation of conveying data; energy can be saved to 2.7× by our LOWE algorithm. Altogether, performance enhancement and energy saving might be achieved. The energy-efficient EHT algorithm reaches its nearest challenger HTTP/2 by up to 5.2× times and gains the excessive overall throughput attain comparing to standard applications like WGET and CURL.

Dinh, et al. (2017): according to this paper, IOT-cloud provides sensing services on demand in the given location-based model, relied on site and interest of mobile users comparing to the standard regular sensing model. Depending on mobile user site chasing, the IOT-cloud has a part as a monitor. This creates schedules for material sensor networks on-demand. However, when a mobile user providing their location and requesting for sensing data, resource-constrained sensors are in need to set down their sensing data. Yet, they are put in power saving mode to retain energy. Due to analysis and examination outcomes, the given model of location-based improves the network existence of wireless sensor networks clearly.

Chen, & Tan (2015): The formulation of an energy model for a standard GPS receiver architecture as in academic and industrial designs displays the influence of key software parameters on hardware energy utilization. Our evaluations specifically show that the recipient's energy utilization is in large part straight with the number of traced satellites. Accordingly, a diagram should be made to determine tracking algorithm which provides same locating correctness (about 12m) with a subdivision of specific satellites, which conveys to an energy saving of 20.9-23.1% on the Namuru board.

Trestian, et.al (2012): Due to this paper, when operating multimedia streaming, the focus is on two elements: the influence of the technology of radio access network (UMTS, HSDPA, WLAN) and the influence of the traffic site in a WLAN. According to the energy assessment, outcomes show that the energy might be considerably kept when the user evaluated quality amount of the multimedia stream. Yet, by using the cellular attachment increased energy is taken (up to 61%) than by using the WLAN attachment.

2.3 Summery

Table 3.1 are related to papers in the literature review period which produced creative views in determining the location and enhancing the evaluation correctness in the positioning period, According to this thesis, in mobile cloud computing, the energy efficient localization technique in which Saving energy consumption in large-scale WSNs. Hence, the operation stimulated to control the tracing mission.

Table 2.1: Summery of Literature Review

Reference	Modality	Study Goals	Results
Karki, et.al(2019):	Addressing Power utilization of Dual-Frequency GNSS	Tests the utilization of energy of dual-frequency GNSS	dual-frequency GNSS sensors utilize 37% outdoors in comparison with single-frequency phones, while indoor increase 28%.
Ordonez, et.al(2018)	Energy efficient GNSS signal using	Reduce Random Access Memory (RAM) usage.	The provided method using sampling, rebuilding intermediate frequency
Mahafzah , And Abusaimeh (2018)	tracking wireless sensor network by using ZigBee	Examines energy consumption of tracking indoor system.	Tracking Error improved by 8% delay and Power consumption improved by 7%.
Fargas, & Petersen (2017)	GPS-free Geolocation using LoRa in Low-Power WANs	Utilizing Chirp Spread Spectrum (CSS) and Forward Error Correction (FEC)	They have found that the system reduces energy consumption from a typical 400-600 mA using GPS over GSM to 12.9 mA using LoRa

Reference	Modality	Study Goals	Results
Zou,,et .al (2016)	Multimodal Sensor Data Fusion on Smartphones	Categorize the location types into three main categories (Outdoor, Semi-outdoor and Indoor)	BlueDetect seamlessly switches between GPS for outdoor usage, BLE for semi-outdoor , and WiFi for indoor usage, saving energy in the process
Foremski, et. al. (2015)	Energy-Efficient Crowd sensing Human Mobile	Measure human mobility and signal coverage	Reduction of battery lifetime of 20%.
Chen, & Tan (2015)	GPS positioning	Forming an energy model for a standard GPS	The Namuru board shows 20.9-23.1\% of energy saving
Aly, & Youssef (2013)	Wifi-based device-free localization	Use mobile sensors to fingerprint roads.	measured 34.7% energy saving compared to GPS.
Liu, et. al (2012)	A cloud-based sensing device named CLEO	CLEO sends its raw location dataset to a Cloud-Offloaded GPS	Offloading provides Delay-tolerance, Alternative information sources, and Storage.
Guner, & Kosar (2018)	Energy Saving	Raise energy saving levels of mobile users without wasting throughput	Using LowE algorithm, saving increased up to 2.7× EHT algorithm exceeds its by 5.2× times
Dinh, et. al (2017)	mobile cloud computing by using a model for sensing location	mobile user addressing their place and requesting to sense data.	Notably, the provided location-based model enhances the network lifetime of wireless sensor networks.

Reference	Modality	Study Goals	Results
Trestian, et.al (2012)	(WLAN, HSDPA, UMTS)	The energy evaluated quality amount of the multimedia stream.	by using the cellular attachment increased energy is taken (up to 61%) than by using the WLAN attachment

CHAPTER THREE
Methodology and the Proposed Model

CHAPTER THREE
Methodology and the Proposed Model

3.1 Proposed model

This research provided model has been performed utilizing Network Simulator version 2.35 (NS2). Below is a flowchart about an overview of the system being built

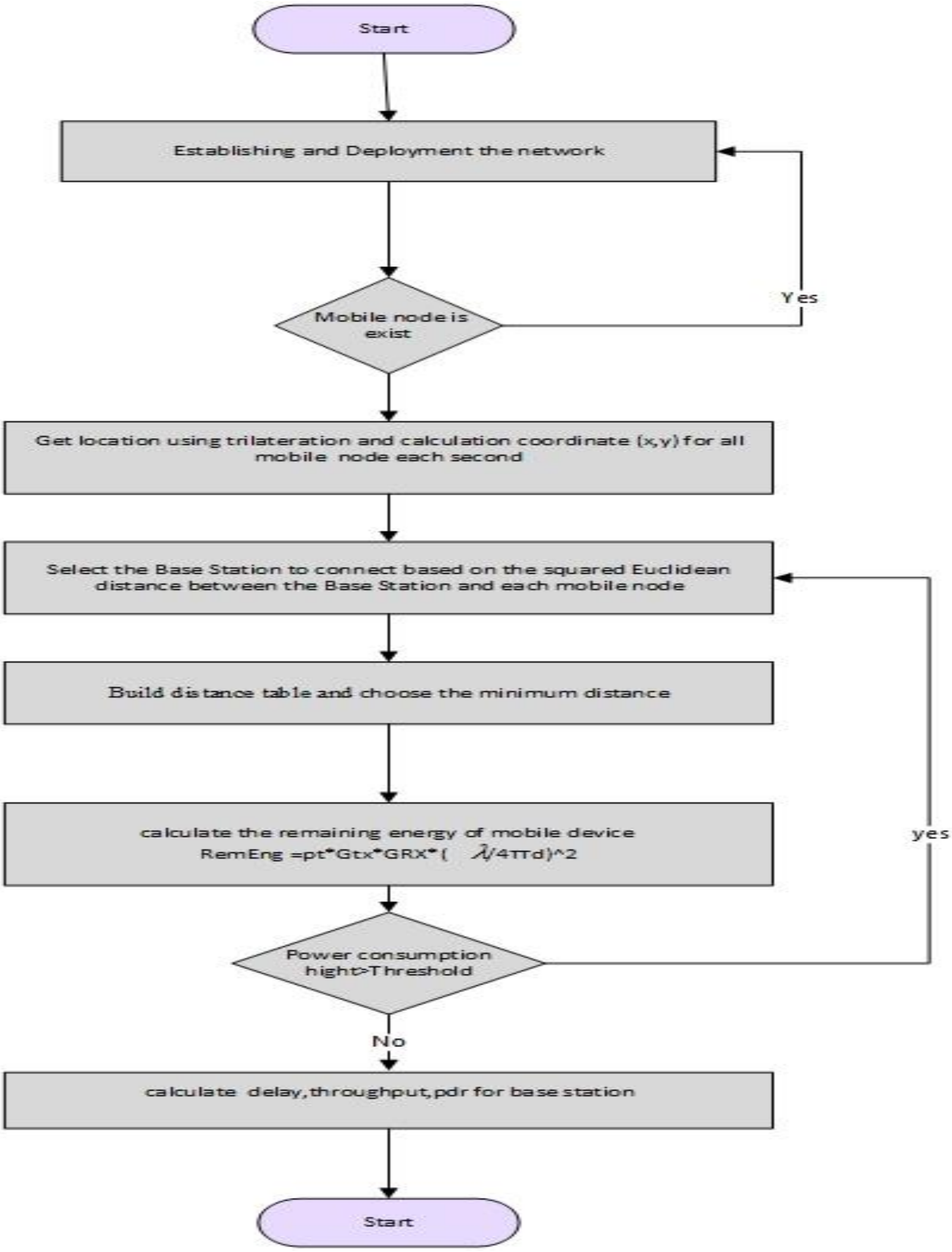

Figure 3.1: Flow chart of proposed model.

In proposed model, each node can adjust its transmission power and reception power individually based on its remaining and initial energy. We reduced the transmission power and the reception power based on the following mathematical formulas(abusaimeh,and yang,2009)

$$Pr = PrInit \times \frac{\text{RemEng}}{InitEng} \tag{3.1}$$

$$Pt = PtInit \times \frac{\text{RemEng}}{InitEng} \tag{3.2}$$

Where

Pr is the reception power

Pt is the transmission power

PrInit is the initial reception power

PtInit is the initial transmission power

RemEng is the remaining energy of the node

InitEng is the initial full energy of the node.

We calculate the remaining energy of the node based on our energy model in. However, this proposed model attempts to reduce the transmission power and the reception power until reaching the minimum power , which is required to transmit the packet between two nodes in a certain distance. The relationship between the transmission power, the received power and the distance can be found from the 3.1 and 3.2 formula.

One possibility to acquire a distance is measuring the (RSSI) of the incoming radio signal. The idea behind RSSI is that the configured transmission power at the transmitting device $PtInit$ directly affects the receiving power of the receiving device $PrInit$. According to transmission equation (Cook, 2005), the detected signal strength decreases quadratically with the distance to the sender. Received power can be expressed as in Equations (3.3).

$$\mathrm{RemEng} = Pt \times \mathrm{GTX} \times \mathrm{GRX}\left(\frac{\lambda}{4\pi d}\right)^2 \qquad (3.3)$$

Where, Pt *Transmission energy of sender.*

RemEng *Remaining energy of wave at receiver.*

GTX *Gain of the transmitter.*

GRX *Gain of the receiver.*

λ *Wavelength.*

d *Distance between transmitter and receiver.*

The basic idea of the model is to calculate the distance between the mobile nodes and the base station from the known anchor node. The positions of mobile nodes are calculated using trilateration method. In the first stage, anchor nodes broadcast their information to their neighboring nodes using distance vector exchange agreement. Anchor nodes contain the information (d, x, y) where d refers to the serial number of the anchor nodes, and (X1, Y1) refers to the current anchor and mobile nodes coordinate information.

the distance between the mobile node and base station we use Euclidian distance formula to calculate the distance as show in equation 3.4:

$$d = \sqrt{(\mathrm{X2} - \mathrm{X1})^2 + (\mathrm{Y2} - \mathrm{Y1})^2} \qquad (3.4)$$

Where (X1,X2) and (Y1,Y2) point refers to the mobile node and fixed node location respectively.

In embedded devices, the received signal strength is converted to a received signal strength indicator (RSSI) which is expressed as the ratio of the received power to reference power (PRef). Typically, the reference power represents the absolute value of PRef = 1 mW.as shown in equation (3.2). (pu,2009).

$$RSSI = 10 \times LOG \frac{\mathrm{RemEng}}{\mathrm{PRef}} \quad , [RSSI\ in\ dBm] \qquad (3.5)$$

According to equation (3.3) and (3.5), there exists an exponential relation between the strength of a signal sent out by a radio and the distance the signal travels. In reality, this correlation has proven to be less perfect, but it still exists. The reason is that the effective radio-signal propagation properties differ from the perfect theoretical relation that is assumed in the algorithm. The effects noted above such as reflections, fading, and multipath effects can significantly influence the effective signal propagation.

RSSI based localization systems are more competitive in terms of both accuracy and cost compared to other localization systems. It does not require a large DB and a long training phase; this decreases the size and computational burden of the DB.

figure 3.4 represent the simple desin for middle east university(MEU)) in builiding(B) first floor,which have 4 base station 2-indoor and 2-outdoor,mobile calculate the distance between three base station,then choose the minimum distance to connect with it.

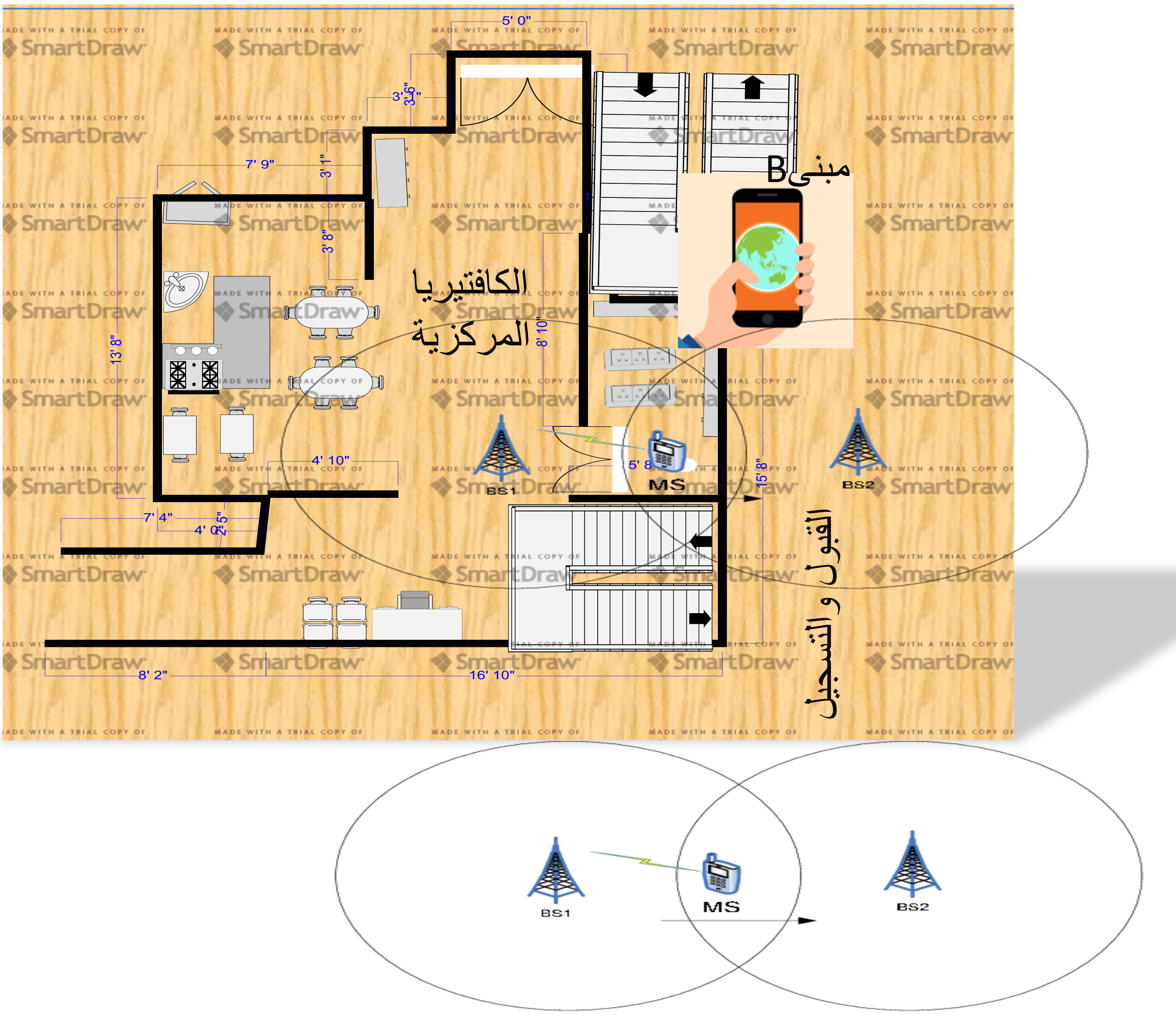

Figure 3.2 : simple desin for MEU

CHAPTER FOUR
Simulation Results and Discussion

CHAPTER FOUR
Simulation Results and Discussion

Introduction

This chapter explains the performance of the suggested approach using an extensive simulation. Before analyzing the simulation results, the accredited performance metrics and the simulation environment are presented.

4.1 Network simulator -NS2

Network Simulator (Version 2), widely known as NS2, is a software tool for computer network simulation it is a open source simulator mostly used for academic research and simply an event-driven simulation tool that has proved useful in studying the dynamic nature of communication networks. In general, NS2 provides users with a way of specifying such network protocols and simulating their corresponding behaviors. The current NS simulator is particularly well suited for packet-switched networks and large-size simulation.

figure 4.1 basic architecture of NS2,which consists mainly of two languages: C++ which is a compiled programming language. A C++ program need to be compiled into excitable machine code. Since the executable is in the form of machine code, C++ program is very fast to run. The second language is Object-oriented Tool Command Language (OTcL) which is an interpreted programming language that can run on the fly without the need for compilation. It sets up simulation by assembling and configuring the objects as well as scheduling discrete events. The C++ and the OTcl are linked together using TclCL.

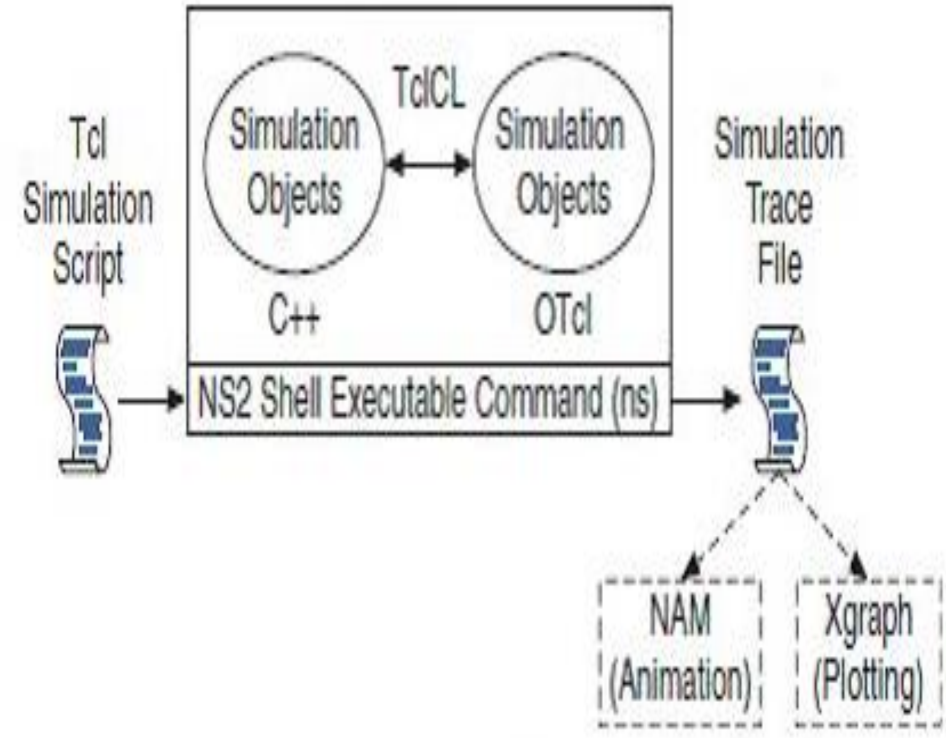

Figure 4.1: Basic Architecture of NS.(*Wei, et. al.2004).*

4.2 Evaluation Metric

In comparing and evaluating our algorithms, we are mentioning the following three metrics:

1. Throughput: It is basically gives the average at which over a communication network a data packet is sent profitably from one node to another. Throughput can be measured in packets per seconds or bits per second. (Khairnar, and Kotecha , 2013).

Throughput= $\frac{Dp\times Ds}{total\ duration\ of\ simulation}$

Dp is symbolized the number of sent packets

Ds is considered the size of a packet.

2. End-to-End Delay: This is the average time consumed by every node to deliver packets from the source node to the destination node. It is the delaying between delivering the information accompanied by the CBR resource and its statement at the comparable CBR recipient. It is worth mentioning that in end-to-end delay, every router has its own ranking delay at each node.

3. Packet Delivery Ratio: The packet delivery ratio is the consumer of packages developed by the "application layer" CBR sources and the number of packages received by the CBR at the final destination, in other words, Packet Delivery Ratio is the total number of data packets appeared at destination split by the total data packets sent from sources:(Khairnar, and Kotecha , 2013).

Packet Delivery Ratio = $\frac{\sum \text{Number of packet receiver}}{\sum \text{Number of packet sent}}$

4. Energy Consumption: Energy Consumption: It is the aim of quantifying the energy consumption during the implementation of the main tasks of a node within the network. It is important to consider the energy consumption in sensor networks because their execution must be simple, enduring, and resilient to topology or configuration changes. Relatively, sink nodes have higher energy levels than others. The basic energy of nodes are same but not for base station node. A node can consume energy with four types such as transmission power, receiving power, idle power, and sleep power.

4.3 Simulation Scenarios

The proposed model of energy efficient localization technique in mobile cloud computing has nodes in grid rectangle topology ranging from 0 to 100. Three of the whole number are called Base Station which are (25,64,88). About fifteen nodes are mobile nodes (3,7,13,19,23,26,32,46,59,63,69,71,82,87,97). The rest of the nodes are anchor nodes, and they are 82 fixed nodes.

During the simulation process, the base station is considered a sink node, and a specific mobile node is selected to communicate with the BS node through other anchor nodes. These nodes perform the sensing process, site location and other tasks such as gathering information related to nodes as (location, energy, packet transferring). It is worth mentioning that the movement of the mobile nodes are random.

The first scenario proposed, according to the simulation architecture, the mobile nodes move randomly and calculate the coordination (x,y) for each mobile node every second. They evaluate the distance between mobile node and the three BS nodes connecting the mobile node with the nearest BS and then send the evaluation to BS.

In the second Scenario, in order to transfer the data to the BS node, the mobile nodes have to use the anchor nodes as an intermediate tool. The fifteen nodes (3,7,13,19,23,26,32,46,59,63,69,71,82,87) are programmed and labeled as mobile nodes with higher energy than the anchor nodes in the first scenario.

Each of the nodes has 150 meters of the transmission range, so they can transfer the sensed data within 15 meters with the disability to exceed it. When the anchor nodes try to surpass their limits, the packets will drop. In result, the anchor nodes can make the routing path based on their range and the mobility of nodes, where the BS nodes are fixed and are only able to transmit data.

Figure 4.2 is the basic scenario of randomly deployed nodes, mobile nodes and BS node. The screenshot is captured at 0.0 seconds that shows the actual position of everything.

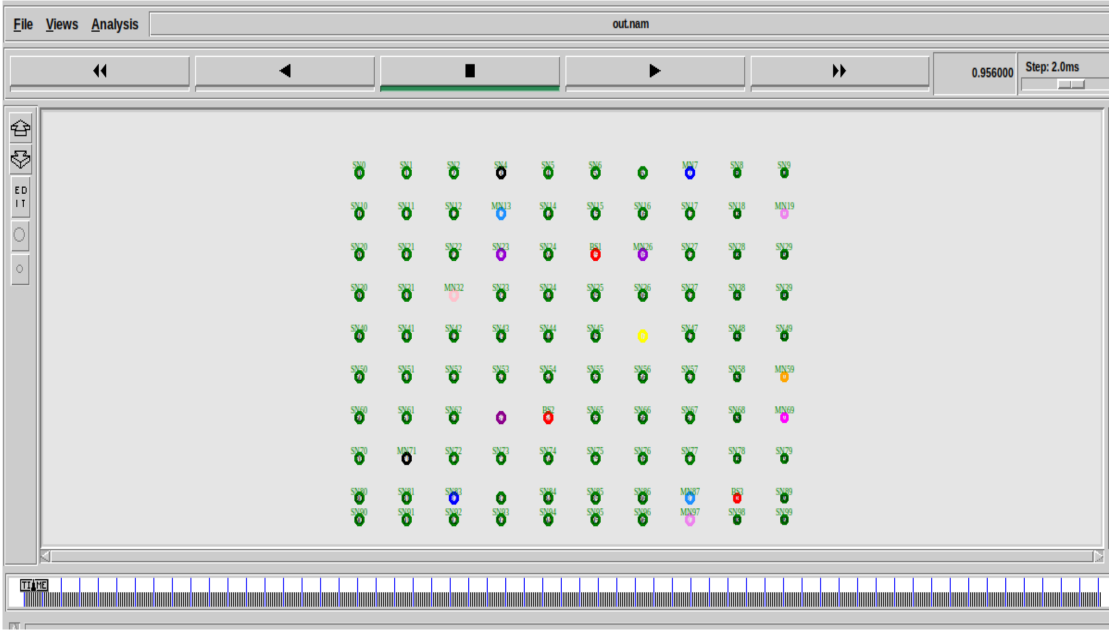

Figure 4.2: anchor and Mobile Nodes Development.

The simulation parameter that are used during all conducted simulation experiments are presented in Table 4.1. Unless otherwise stated in the thesis.

Table 4.1: Simulation Parameters.

Serial No.	Parameter Name	Parameter Value
1.	Area of flat grid	1551m*900m
2.	X dimension of topography	1551
3.	Y dimension of topography	900
4.	No. of anchor nodes	82
5.	No. of mobile nodes	15
6.	No. of Base Station	3
7.	Channel type	WirelessChannel
8.	Network interface type	Phy/WirelessPhy
9.	Interface queue type	Queue/DropTail/PriQueue
10.	max packet in ifq	50
11.	MAC layer Protocol	MAC/802.11
12.	Simulation time	100 s

13.	Antenna type	*OmniAntenna*
14.	radio-propagation model	*TowRayGround*
15.	Transmission range	150m
16.	Routing protocol	DSR
17.	Routing protocol	AODV
18.	energyModel	100 Joules
19.	T_x power	1.4 w
20.	R_x power	1.0 w
21.	idlePower	0.5
22.	sensePower	1
23.	DataSize	1000 Byte
24.	DataRate	5K bits/s

4.4 The Performance Evaluation of Proposed Method

The Ad-hoc On-demand Distance Vector (AODV) algorithm is suitable for the proposed system, it provides the flexibility to enable dynamic, self-starting, multiple routing between mobile nodes to build and maintain an ad hoc network. The AODV permits the mobile nodes to secure routes quickly for new destinations, and does not require nodes to keep routes to destinations that are not in active communication. In a timely manner, AODV permits mobile nodes to respond to link breakages and changes in network topology. It uses destination sequence numbers to secure loop freedom at all times avoiding problems like "counting to infinity" related to classical distance vector protocols.

MAC layer, WSN uses different MAC protocol, Adhoc wireless networks uses different MAC, they both use AODV as routing protocol. Therefore, the simulation will be not able to use the Zigbee protocol, which is used for WSN.

The Figure 4.3 below shows the contrast between anchor node, mobile node and base station. Different colors and labels reveal the types of nodes and the accurate picture of topology. The distribution of all nodes is created under 1551×900 topography. Hence, A wireless sensor network is characterized as a system of devices suggested as nodes determining the environment and transmit the data collected from the observed field via isolated or wireless connections. While a wireless ad-hoc network is a decentralized type of wireless network, it does not rely on a pre-existing infrastructure, however it includes wireless mesh networks, mobile ad-hoc networks, and vehicular ad-hoc networks.

Through the BS node, WNS basically concentrates on sensing the environmental data and convey it to the algorithmic center. While the Ad-hoc is based on Peer-to-Peer computing or networking which is a distributed application architecture that divides tasks between peers. It is worth noted that WSN is able to handle more numbers of networks in comparison with Ad-hoc ability.

Via one or more than two BS node, the communication traffic of WSN flows in the direction of the computation center. In the communication technology, WSN uses multiple wireless standards Like IEEE 801.11 and IEEE 801.15 variances in addition to GPS as needed, while Ad Hoc uses only one of the variances of IEEE 801.11. However, in Ad-hoc network, the communication could be established without a center control between two or more nodes.

Figure 4.3: anchor nodes, mobile nodes and BS node.

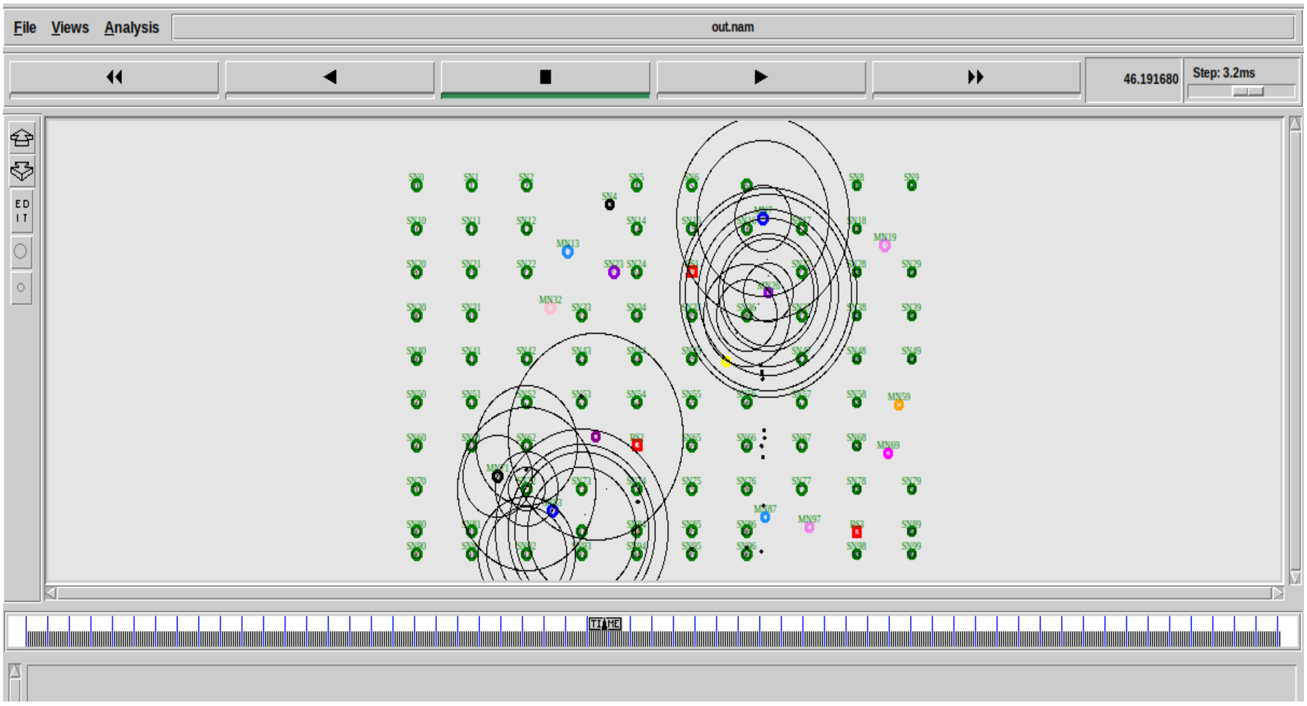

Figure 4.4: Energy level of nodes.

Figure 4.4 shows the energy level of different nodes at the end of simulation process. After performing multi tasks such as sensing, maintain table, and communicating with each other and eventually sending the data packets to sink node, the level of energy of all the anchor nodes gets low. In case of mobility, it is hard to predict the direction of mobility as the mobile nodes move once from their source to the destination and sometimes towards sink node or away from it.

RSSI localization technique is used for the connectivity of anchor nodes and mobile nodes, it is useful for calculating distance and locating the nodes. As for the energy level, the standard energy model is used.

4.5 Result Analysis

4.5.1 Throughput

Throughput is computed by accessing the Number of bytes that are processed during a very specified time which is usually measured in several data packets types to make it more reasonable to the impute data such as . Kbps, Mbps, and Gbps. Following are the data points of throughput that has been obtained during the simulation time at every second so that evaluation the proposed model is computed,as shown in table (4.2)

Table 4.2: Throughput of Results for base station

Simulation Time	Throughput 25	Throughput 64	Throughput 88
0	0	0	0
1	0	0	0
2	0	0	0
3	240	240	480
4	840	840	1200
5	1680	1680	2040
6	2520	2520	3000
7	3600	3600	4200
8	4800	4800	5400
9	6120	6120	6720
10	7440	7440	8040

Simulation Time	Throughput 25	Throughput 64	Throughput 88
90	392280	392280	394200
91	399600	399600	401520
92	406920	406920	408840
93	414360	414360	416280
94	421920	421920	423840
95	429600	429600	431520
96	437280	437280	439200
97	445080	445080	447000
98	453000	453000	454920
99	460920	460920	462840

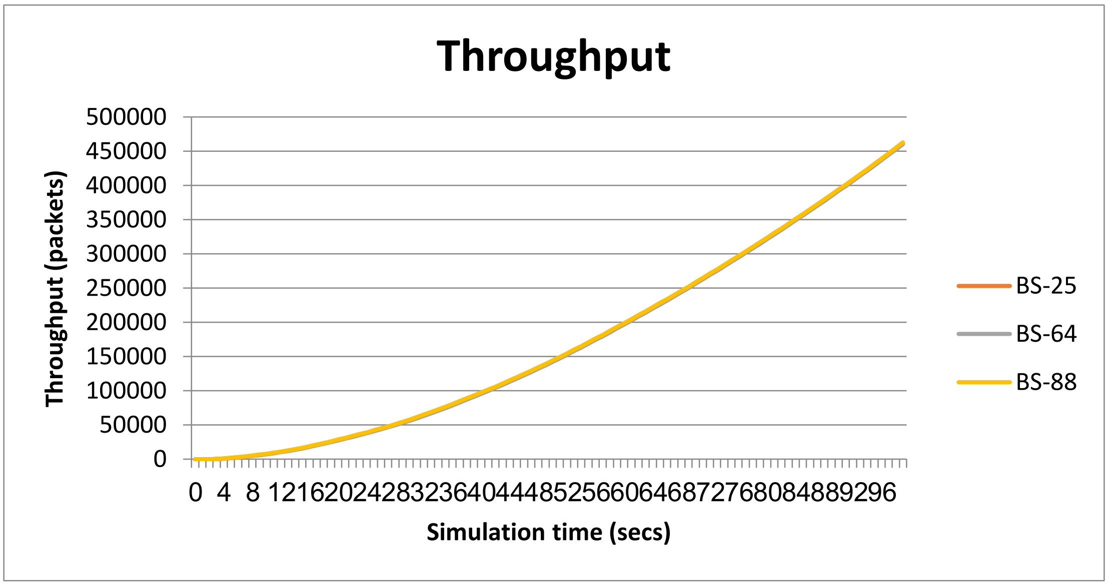

Figure 4.5: Network throughput

The above Figure 4.5 represents the network throughput of multiple base stations that are used during the simulation of proposed work. The x-axis represents the simulation time in seconds and y-axis represents the throughput computed in packets. The network throughput of base station number 88 is highest at the 462840 packets while the captured throughput of base station number 25 and base station number 64 is same at 460920. The simulation time is 100 seconds for the capturing the desired data.

4.5.2 Delay

Network delay plays a critical role while taking the decision about the given scenario. Base stations took the much time to take the decision as the network delay increases. So simply the lower the delay, as accurate the decision. delay is computed by calculating the time consumed by the nodes to discover the nearby base station route and the packets delivery over it. This also includes the queue time that any packet spends over to reach at their destination. The highest delay of the network is recorded at base station number 88 with 2.734259235 packets, as shown in table 4.3

Table 4.3: Delay results for base station

Simulation Time	Delay 25	Delay 64	Delay 88
0	0	0	0
1	0	0	0
2	0	0	0
3	1.259961707	0	1.417795221
4	1.148262377	0	1.281608331
5	1.24178778	0	1.281608331
6	1.24178778	0	1.44762811
7	1.329669731	0	1.326616701
8	1.329669731	0	1.326616701
9	1.486830326	0	1.326616701
10	1.486830326	0	1.326616701
90	1.981943778	0	2.734259235
91	1.981943778	0	2.734259235
92	1.981943778	0	2.734259235
93	2.021712075	0	2.734259235
94	1.979182019	0	2.734259235
95	1.968319204	0	2.734259235
96	1.968319204	0	2.734259235
97	1.963204517	0	2.734259235
98	1.955717743	0	2.734259235
99	1.955717743	0	2.734259235

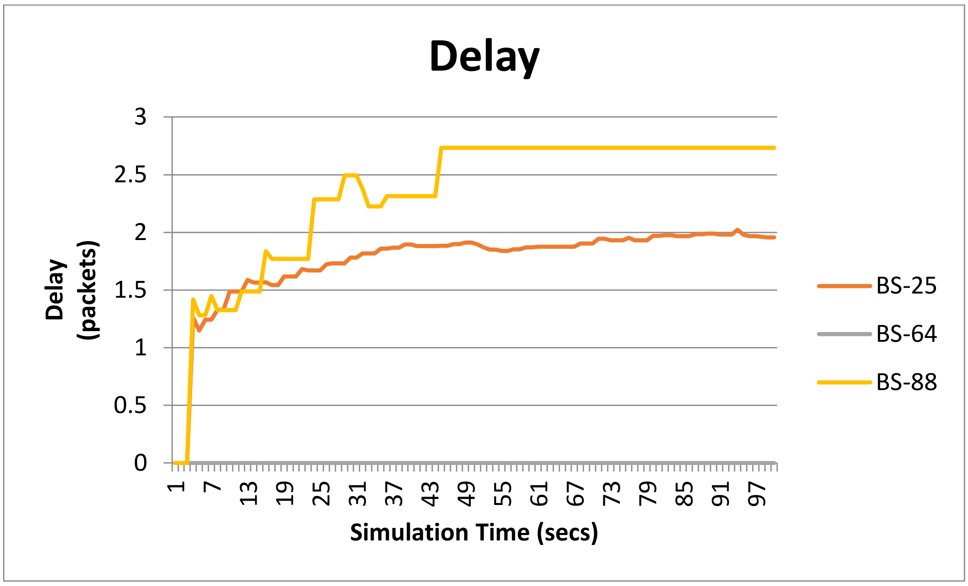

Figure 4.6: Delay of proposed system.

Proposed model has the maximum of 2.73 packets delay per seconds during the 100 seconds simulation time. The highest delay of the network is recorded at base station number 88 with 2.734259235 packets/seconds and minimum delay is recorded at base station number 25 with 1.955717743 packets/seconds. During the simulation proposed model only includes the successfully delivery data packets.

4.5.3 Packet Delivery Ratio

Packet delivery ratio or PDR is ratio of successfully delivered packets at the destination that includes the localization and can be affected by the energy level of nodes. PDR is calculated by subtracting the packets lost during simulation from total number of packets and after that divide the result by number of packets transmitted.as shown in table (4.4)

Table 4.4: PDR results

Simulation Time	PDR 25	PDR 64	PDR 88
0	0	0	0
1	0	0	0
2	0	0	0
3	2	0	2
4	3	0	3
5	4	0	3
6	4	0	4
7	5	0	5
8	5	0	5
9	6	0	5
10	6	0	5
…….			
90	43	0	12
91	43	0	12
92	43	0	12
93	44	0	12
94	45	0	12
95	46	0	12
96	46	0	12
97	47	0	12
98	48	0	12
99	48	0	12

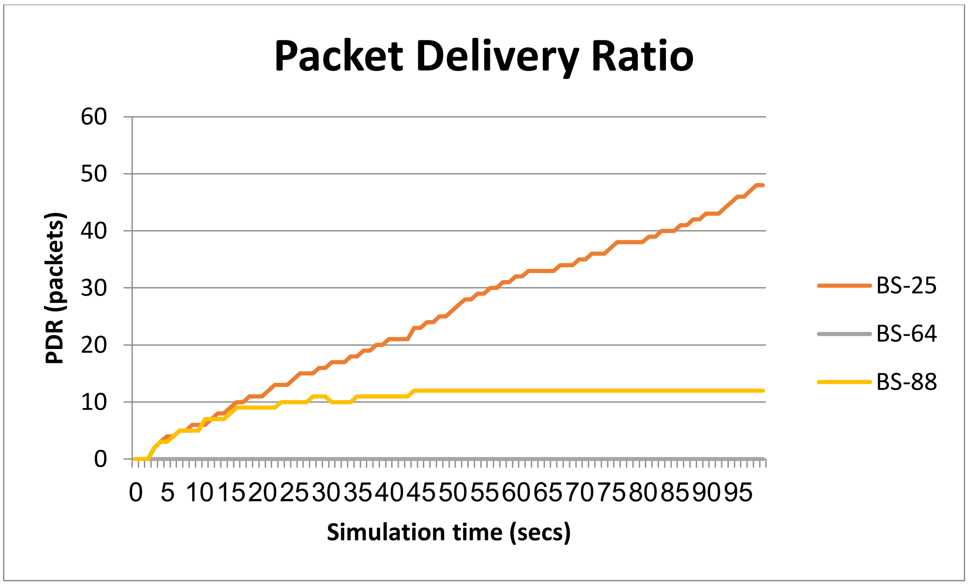

Figure 4.7 Packet delivery ratio of proposed system.

Figure 4.7 represents the simulation time at x-axis and PDR at y-axis. The highest PDR is recorded by the base station number 25 with 48 due to highest mobile nodes connectivity.

It is evident from graph data that few BS's performed an excellent job and some were very poor at performance. As we can see that BS 25 outperformed and 88 least performed. There are two reasons for this, as discussed earlier. One reason is less number of nodes entertained by BS and the other is a collision. This is obviously a BS that will have lower PDR if it entertains a few or very less few nodes. As we know when an area of nodes communication becomes denser, the chances of collision and packet drop increase. Because nodes are in the interference range of each other. If a node or BS is in a less dense area, it will surely have higher PDR as chances of collision become minimized, resulting in higher PDR.

4.5.4 Residual Energy

The energy model assigns the initial energy at 100 joules to each node. As the time increases and computation and processing if performed at respective nodes, the energy level is slowly declining till the 0 joules that means the node is now not having any energy left. This could be done due to packets transmission or locating the nearby base station or finding the shortest route to transmit the data packets. There are numerous things that can affect the energy level of nodes.

Table 4.5: Residual Energy results for BS

Simulation Time	Residual Energy 25	Residual Energy 64	Residual Energy 88
0	100	100	100
1	99.203493	99.12686	99.268443
2	98.572788	98.455295	98.604106
3	97.65011	97.521834	97.813399
4	96.790382	96.589787	97.076663
5	95.912756	95.647953	96.294249
6	95.028467	94.721015	95.512926
7	94.109793	93.793545	94.750103
8	93.223729	92.851665	94.003232
9	92.339166	91.918047	93.253618
10	91.455473	90.978482	92.52653
……			
90	18.729604	14.912002	25.06581
91	17.803923	13.954945	24.221615
92	16.876324	12.999604	23.339328
93	15.965204	12.031835	22.442247
94	15.081675	11.076259	21.566511
95	14.206816	10.11247	20.673334
96	13.303655	9.148444	19.798734
97	12.376891	8.197229	18.943074
98	11.462929	7.247565	18.064791
99	10.543509	6.29603	17.212436

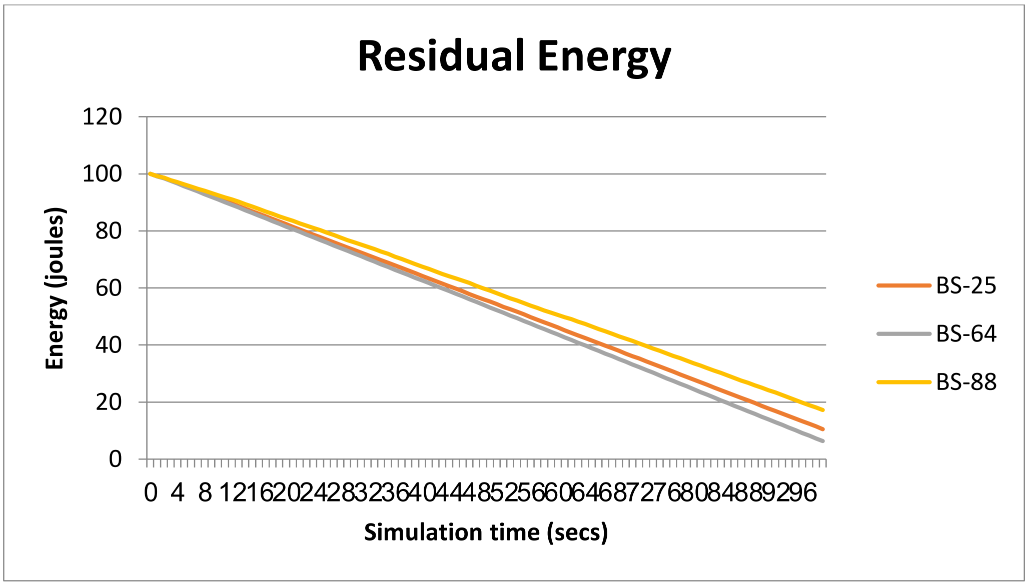

Figure 4.8: Residual energy for BS of proposed system.

The Figure 4.8 represents the simulation time at x-axis and the residual energy at the y-axis. This also represents the residual energy is declining as the time passes till the end of the simulation. Base station number 25 has the highest residual energy at the end of the simulation while the lowest residual energy is recorded at the base station number 64. This shows that the proposed model is fully functioning till the end of the simulation time and this is a better approach to deploy and maintain the wireless sensor network, the average of residual energy for base station is 15.

Table 4.6:Residual Energy results for MN

Time	mn3	mn7	mn13	mn19	mn23	mn32	mn46
0	100	100	100	100	100	100	100
1	99.25502	99.31607	99.21312	99.36147	99.18492	99.16994	99.14786
2	98.63009	98.68023	98.57998	98.71099	98.53697	98.51407	98.4677
3	97.80175	97.87006	97.69781	97.98181	97.62774	97.61985	97.5094
4	97.06349	97.15001	96.90263	97.31013	96.81063	96.80788	96.57594
5	96.23863	96.42293	96.02472	96.62512	95.89964	95.88666	95.64393
6	95.41235	95.62768	95.1539	95.8765	94.99952	94.9845	94.70639
7	94.59032	94.77799	94.29145	95.10263	94.11284	94.11513	93.75281
8	93.72633	94.01821	93.38688	94.39865	93.19811	93.21395	92.81184
...							
.....							
90	22.76	23.15045	19.17741	26.80664	18.19741	17.12268	17.67655
91	21.86	22.24591	18.21346	25.8939	17.25616	16.16674	16.73473
92	20.94	21.38072	17.27403	24.9811	16.31902	15.21632	15.77776
93	20.06	20.46229	16.33543	24.01414	15.37741	14.24585	14.823
94	19.22	19.56678	15.43087	23.06443	14.47311	13.28079	13.91003
95	18.38	18.68945	14.53822	22.17187	13.56029	12.32561	12.97349
96	17.50	17.80153	13.62831	21.22885	12.63515	11.36761	12.03518
97	16.65	16.86824	12.69593	20.2713	11.68454	10.40705	11.09502
98	15.80	15.9731	11.7984	19.33231	10.7475	9.442351	10.1733
99	14.97	15.06812	10.93793	18.44034	9.829933	8.513218	9.276277

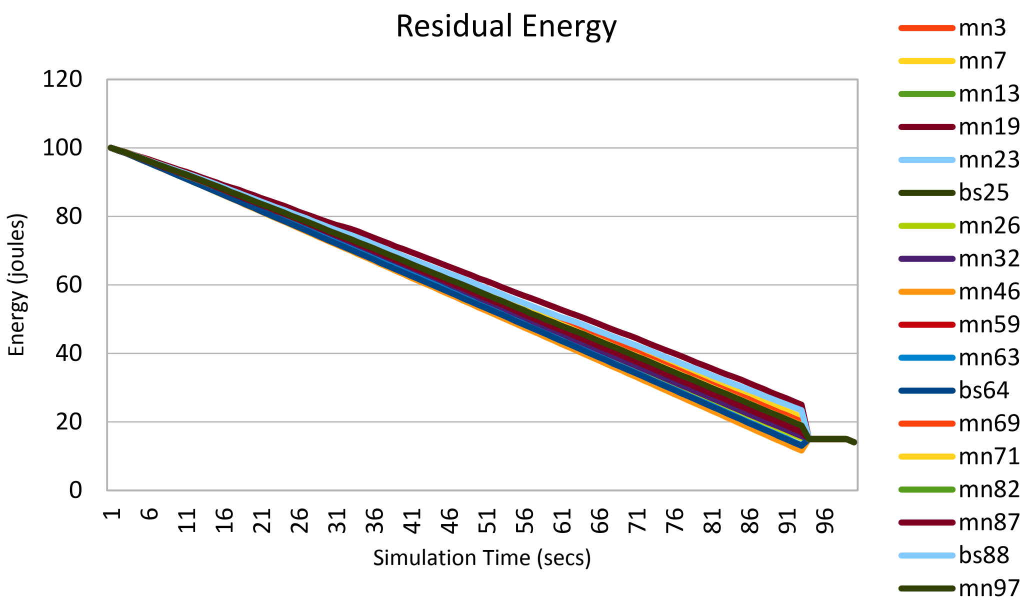

Figure 4.9: Residual energy for MN of proposed system.

figure 4.9 describes the comparison between energy consumed by the Mobile Nodes and the Base Station. This depicts that the energy of each mobile node and base station is continuously decreasing but survives the simulation till end. All this happens due to continuous movement of mobile nodes and simultaneously transmitting the sensed data to the Base Station. On the other hand Base station energy consumption increases due to the data collection from connected mobile nodes and taking decisions based on the collected data. where x-axis uses the simulation time and y-axis uses the residual energy of mobile nodes and base stations, the average of residual energy for mobile node is 20.

4.5.5 Nodes connection

Figure 4.10 depicts the mobile nodes connection with the base stations at a given point. The proposed model suggests the mobile node connection with the nearby base station that increases the efficiency and transmission of data packets for faster decision making.

In figure 4.10, x-axis represents the simulation time and y-axis represents the total number of mobile nodes connected with the nearby base station at every second. Base station number 25 decreases the mobile nodes connection because those nodes are getting in to the range of base station 64.

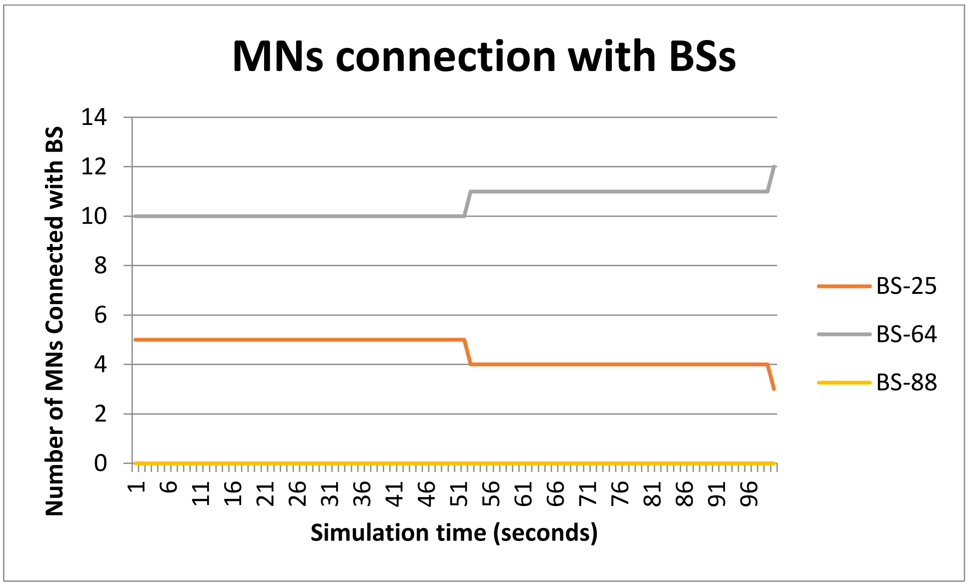

Figure 4.10 Number of mobile nodes connected with base station.

Therefore, if the network lifetime is measured related to the BS lifetimes then noticeably that the MN based on our balancing technique live 1.5 times. Even though, One of the BS can be in the sleep state .MCC improves the presentation of the portable processing gadgets by taking care of the assignments, which are huge and complex for MNs abilities.

CHAPTER FIVE
Conclusion and Future Work

CHAPTER FIVE
Conclusion and Future Work

5.1 Conclusion

The sensor network needs forming stable communication signals among mobile nodes, anchor nodes, and base stations. It is considered a network with low energy consuming, since multi hop communication is expected to take less power than the traditional one. This operation will absorb the sensor network maximum energy in efforts to make it well-connected topology. In order to settle this particular localization problem, 15 mobile nodes and 3 base stations are positioned in the network. After calculating the distance, mobile node is linked with the close base station that is already in the range.

Considering the lowest distance between mobile nodes and three BS is revealed as the selected base station and all the sensed data is conveyed to it. This operation is repeated every 1 second, thus the space between the BS and the mobile node should be in each other's range.

sink positions and best nodes could be evaluated taking into consideration the metrics like number of nodes, distance between nodes in the environment, number of hops, and the volume of power of each node

The propsed model attains the results needed in improving the existence of anchore nodes in comparison with the presented system. Wireless sensor networks are embedded with mobile cloud computing and residual energy for BS of the proposed system improved by 5%.

Where the NS2 simulator is utilized to perform the experimental design suitable for the research assigned to.

5.2 Future Work

When we focus on localization techniques, we could extend the future analysis in order to enlarge the provided power-efficient system to many target scenarios, expand the localization efficiency, and perform the provided approach on actual anchor nodes.

According to the capabilities and low cost of sensors, wireless sensor network will help in many fields, we provided previously a research to improve the localization accuracy after the first estimations of location gained from some existing algorithms.

Also, performing and testing the capability of the provided system in actual sensor nodes network application for tracing many mobile targets are considered one of the future work.

REFERENCE

- Abusaimeh,H.,AND yang,S.H.,(2009),Balancing the Power Consumption Speed in Flat and Hierarchical WSN. International Journal of automation and computing,5(4),366-375

- Aly, H., & Youssef, M. (2013, November). Dejavu: an accurate energy-efficient outdoor localization system. In Proceedings of the 21st ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems (pp. 154-163).
- Bermudez Ordonez, J. C., Arnaldo Valdes, R. M., & Gómez Comendador, F. (2018). Energy efficient GNSS signal acquisition using singular value decomposition (SVD). Sensors, 18(5), 1586.
- Chen, K., & Tan, G. (2015). Modeling and improving the energy performance of GPS receivers for mobile applications. arXiv preprint arXiv:1503.02656.
- Cook, B., & Buckberry, G., & Scowcroft, I., & Mitchell, J., & Allen, T., (2005), Indoor Location Using Trilateration Characteristics**, London Communications Symposium**.
- Dabbiere, A. J. (2001). *U.S. Patent No. 6,226,622*. Washington, DC: U.S. Patent and Trademark Office.
- Dinh, Thanh, Younghan Kim, and Hyukjoon Lee. "A location-based interactive model of internet of things and cloud (IoT-Cloud) for mobile cloud computing applications." *Sensors* 17.3 (2017): 489.
- Fargas, B. C., & Petersen, M. N. (2017, June). GPS-free geolocation using LoRa in low-power WANs. In 2017 global internet of things summit (Giots) (pp. 1-6). IEEE.
- Faragher, R., & Harle, R. (2015). Location fingerprinting with bluetooth low energy beacons. IEEE journal on Selected Areas in Communications, 33(11), 2418-2428.

- Foremski, P., Gorawski, M., Grochla, K., & Polys, K. (2015). Energy-efficient crowdsensing of human mobility and signal levels in cellular networks. Sensors, 15(9), 22060-22088.
- Lin,Q.M., Yang, J.,& Ye ,N. (2013). Face Recognition in Mobile Wireless Sensor Networks. International Journal of Distributed Sensor Networks,https://doi.org/10.1155/2013/890737.
- Liu, J., Priyantha, B., Hart, T., Ramos, H. S., Loureiro, A. A., & Wang, Q. (2012, November). Energy efficient GPS sensing with cloud offloading. In *Proceedings of the 10th ACM Conference on Embedded Network Sensor Systems* (pp. 85-98).
- Lane N, Miluzzo E, Lu H, Peebles D, Choudhury T, Campbell A . (2010) A survey of mobile phone sensing. In: Communications Magazine, vol 48, no 9. IEEE, New York, pp 140–150.
- Sheng, X., Tang, J., & Zhang, W. (2012, March). Energy-efficient collaborative sensing with mobile phones. In *2012 Proceedings IEEE INFOCOM* (pp. 1916-1924). IEEE.
- Trestian, R., Ormond, O., & Muntean, G. M. (2012, October). On the impact of wireless network traffic location and access technology on mobile device energy consumption. In *37th Annual IEEE Conference on Local Computer Networks* (pp. 200-203). IEEE.
- Karki, B., & Won, M. (2019). Characterizing Power Consumption of Dual-Frequency GNSS of a Smartphone. arXiv preprint arXiv:1910.13041.
- Yick, J., B. Mukherjee, and D. Ghosal (2008), Wireless sensor network survey, Comput. Netw., 52(12), 2292–2330.
- Energy-Efficient Mobile Network I/O. In *2018 IEEE Global Communications Conference (GLOBECOM)* (pp. 1-6). IEEE.

- Ramasamy, V. (2017). Mobile Wireless Sensor Networks: An Overview.DOI: 10.5772/intechopen.70592.
- Mahafzah,A.,and Abusaime,H. .(2018). Optimizing Power-Based Indoor Tracking System for Wireless Sensor Networks using ZigBee. (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 9, No. 12.
- Robinson, S.(2009). Cellphone energy gap: Desperately seeking solutions, Strategy Analytics Tech. Rep.
- Pu, C.-C., (2009), **Development of a New Collaborative Ranging Algorithm for RSSI Indoor LocationTracking in WSN**, **(**published doctoral dissertation**)**, Dongseo University, South Korea.
- Pu, C.,C, & Pu,c.,h., & Lee.,h.,j, (2011), Indoor location tracking usingreceived signal strength indicator, **Emerging Communications for Wireless Sensor Networks**.
- Liu, J., Priyantha, B., Hart, T., Ramos, H. S., Loureiro, A. A., & Wang, Q. (2012, November). Energy efficient GPS sensing with cloud offloading. In Proceedings of the 10th ACM Conference on Embedded Network Sensor Systems (pp. 85-98).
- Viani , F. Rocca , P. , Oliveri, G. , Trinchero , D. , &Massa, A.. (September 2011). Localization, tracking, and imaging of targets in wireless sensor networks: An invited review, First published, Volume 46, Issue5, https://doi.org/10.1029/2010RS004561.
- Zhuang, Z., Kim, K. H., & Singh, J. P. (2010, June). Improving energy efficiency of location sensing on smartphones. In *Proceedings of the 8th international conference on Mobile systems, applications, and services* (pp. 315-330).

- Zou, H., Jiang, H., Luo, Y., Zhu, J., Lu, X., & Xie, L. (2016). Bluedetect: An ibeacon-enabled scheme for accurate and energy-efficient indoor-outdoor detection and seamless location-based service. Sensors, 16(2), 268.
- T. Le Vinh, S. Bouzefrane, J. Farinone, A. Attar, B. Kennedy."Middleware to Integrate Mobile Devices,(2015). Sensors and CloudComputing", The 6th International Conference on AmbientSystems, Networks and Technologies (ANT), Vol. 25, pp.234–243, London.
- G., Huerta-Canepa, & D., Lee, .(2010)A virtual Cloud computingprovider for mobile devices", in: Proceedings of the 1st ACMWorkshop on Mobile Cloud Computing & Services: Social Networks and Beyond, MCS'10, ACM, New York, NY, USA, pp. 6:1–6:5.
- M. Satyanarayanan, P. Bahl, R. Caceres, N. Davies. (2009) . The casefor VM-based Cloudlets in mobile computing, IEEE PervasiveComputing ,14–23S.
- Simanta, K. Ha, G. Lewis, E. Morris, and M.Satyanarayanan.(2012).A reference architecture for mobile codeoffload in hostile environments," in International Conference on Mobile Computing, Applications, and Services,, pp. 274–293.
- Khan, A. u R.; Othman, M.; Madani, S. A.; Khan, S. U. (2014). A Survey of Mobile Cloud Computing Application Models. IEEE Communications Surveys and Tutorials. 16 (1): 393–413.
- Khairnar,V., Kotecha,K. .(2013).Simulation-Based Performance Evaluation of Routing Protocols in Vehicular Ad-hoc Network.International Journal of Scientific and Research Publications, Volume 3, Issue 10, ISSN 2250-3153.
- Oshin, T. O., Poslad, S., & Ma, A. (2012, June). Improving the energy-efficiency of GPS based location sensing smartphone applications. In *2012 IEEE 11th*

International Conference on Trust, Security and Privacy in Computing and Communications (pp. 1698-1705). IEEE.

- Viani, F., Rocca, P., Oliveri, G., Trinchero, D., & Massa, A. (2011). Localization, tracking, and imaging of targets in wireless sensor networks: An invited review. *Radio Science*, *46*(05), 1-1
- Leung, K. Y., Barfoot, T. D., & Liu, H. H. (2009). Decentralized localization of sparsely-communicating robot networks: A centralized-equivalent approach. *IEEE Transactions on Robotics*, *26*(1), 62-77.
- Sadowski, S., & Spachos, P. (2018). Rssi-based indoor localization with the internet of things. *IEEE Access*, *6*, 30149-30161.
- Huerta-Canepa, G., & Lee, D. (2010, June). A virtual cloud computing provider for mobile devices. In *proceedings of the 1st ACM workshop on mobile cloud computing & services: social networks and beyond* (pp. 1-5).
- Verbelen, T., Simoens, P., De Turck, F., & Dhoedt, B. (2012, June). Cloudlets: Bringing the cloud to the mobile user. In *Proceedings of the third ACM workshop on Mobile cloud computing and services* (pp. 29-36).
- Wei, J. L., Xiao, Y. H., & Zhang, C. (2004). Architecture of NS and its extending. *Computer Simulation*, *21*(8), 179-182.
- Guner, K., Nine, M. S. Z., Bulut, M. F., & Kosar, T. (2018, October). FastHLA: Energy-Efficient Mobile Data Transfer Optimization Based on Historical Log Analysis. In *Proceedings of the 16th ACM International Symposium on Mobility Management and Wireless Access* (pp. 59-66).