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A mobile based application for retrieving site data by telecommunication field engineers

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DECLARATION AND APPROVAL

I declare that this work has not been previously submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made in the dissertation itself.

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Date: June 2015

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ABSTRACT

Information sharing has been the base to support decision making in several scenarios. In the Telecommunication industry several solutions have been adopted by the various functional units like customer care, finance and technology to improve the speed and quality of decisions made by the managers in delivering there day to day work. Traditionally, the most common ways of sharing or retrieving information by field engineers have been through methods such as making calls to database engineers or to other field engineers located in the office who can access the information using their desktop computers. While these methods usually deliver the required data, they are inefficient, slow and offer poor quality data.

Based on the aforementioned challenges, this dissertation explores the use of mobile phone applications to ease the process of data access from the field by site engineers in the telecommunication industry by employing the use of a waterfall methodology. The underlying idea of the proposed solution is to provide an automated method of retrieving data from a centralized server by field engineers. The solution offers efficient method to deliver data with high quality at high speed.

The solution recorded 95% accuracy rate and performed well in tests carried out to verify its viability and reliability against the objectives set out and will serve as an impetus for the engineering arm of the business to realize the potential of mobile phones in helping to solve some of the daily problems that face the field engineers like data accuracy, reliability of information provided and the speed with which required information is delivered.

KEYWORDS: RAN Optimization – Radio Access Optimization, GPS – Global positioning system, Antenna, Azimuth.

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LIST OF ABBREVIATIONS

2G	……	Second generation GSM Technology
3G	……	Third Generation GSM technologies
API	……	Application Programming Interface
BTS	……	Base Transmitter Station
CSS	……	Cascading Style Sheet
DB	……	Database
DBMS	……	Database Management System
FTP	……	File Transfer Protocol
GSM	……	Global System mobile
GUI	……	Graphical User Interface
HTML	……	Hyper Text Markup Language
HTTP	……	Hyper Text Transfer Protocol
HTTPS	……	Hypertext Transfer Protocol Secure
OOP	……	Object Oriented Programming
RF	……	Radio Frequency
SDCCH	……	Signaling Data Channel
SMTP	……	Simple Mail Transfer Protocol
SQL	……	Structured Query Language
TCH	……	Traffic channel
UI	……	User Interface
WCDMA	……	Third Generation GSM technologies

CHAPTER 1: INTRODUCTION

1.1 Background of the Study

Mobile communication has increasingly become popular and in addition there has been an accelerated penetration of smart phones which has led to a significant increase in the use of mobile data services (Statista: The statistics portal,2016). This growth, together with a prediction for the coming years is shown in Figure1.1.

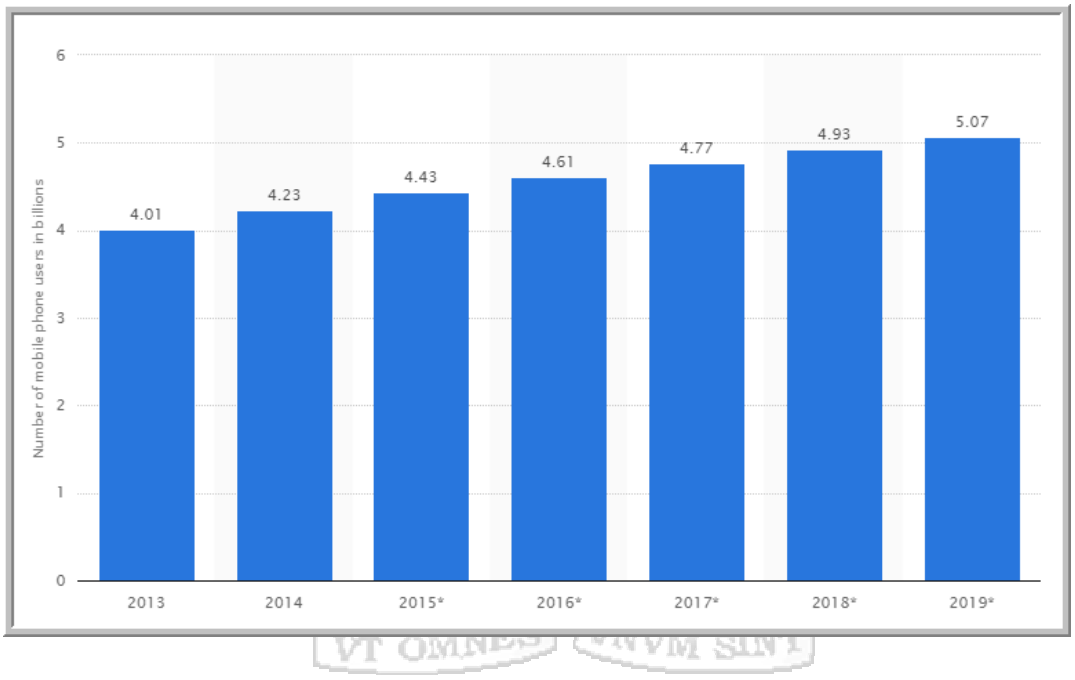

Figure 1.1: Number of Mobile Phone Users (Adapted from The statistics portal, 2016)

The availability and ease of acquiring smartphones that can be used to implement this solution was a key decision point on the methodology of delivering this solution. In network engineering, radio optimization involves application of allowable and desirable changes to the physical network to achieve improved signal coverage and increased traffic uptake at a particular site.

The process is a combination of basic process such as antenna change, re-cabling, azimuth re-direction, antenna up tilting or down tilting among others. It can also achieve signal improvements through the use of software parameter changes but this will not be the aim of this dissertation and thus will not be covered.

To achieve a desired output, there is need for an accurate set of information as input to the process. The field engineer needs to know the current state of the network in terms of antenna type, the current azimuth, tilts and cable connections that have been deployed.

The information is obtained from network data that has been stored in enterprise computers at the time of equipment installation and changes are also required to be made whenever a change is made to the network. Currently, the information is stored in a centralized server which is queried through desktop computer connections. This introduces a challenge to access to information because most of the users of this information are field persons who rarely go to the desk computers.

The solution looks at an alternative way of achieving this access to information without much hustle, yet still being able to achieve the same engineering objectives.

1.2 Problem Statement

Access to and utilization of site data for decision support and change implementation by telecommunication field engineers is not effective, and therefore requires to be automated in order to offer efficiency, accuracy and high speed in delivery of data. From research findings conducted during this study, the current data access methods by field engineers are not as accurate and reliable as the field engineers expect them to be. Challenges occur in the process of acquiring this data where the person in the field has to call somebody in the office to get the required data. This means that certain problems are inherent in the model of the current solutions such as delays in getting information, inability to get the information if the engineer is in an area with poor coverage and a need to keep written material to refer to.

Based on the aforementioned challenges, this dissertation seeks to provide an automated and more efficient method of accessing site data. The proposed solution reduces the workload required and minimize on the use of resources which can be deployed in other tasks to achieve efficiency. The solution is a distributed system capable of handling multiple requests at the same time and responding to request within agreed service level agreement times. It also cuts down on paper resource utilization which is important for our environment as most transactions will be on the user's phone.

1.3 Objectives

This dissertation is based on the following objectives:

i. To identify sources and types of site data that is required by field engineers.
ii. To review existing mechanisms to access site data.
iii. To develop an automated mobile based application to access site data.
iv. To test the validity and effectiveness of the automated system

1.4 Research Questions

This dissertation is based on the following research questions:

i. What are the sources and types of data required by telecommunication field engineers?
ii. What are the existing mechanisms that are used to obtain site data?
iii. How can an automated system be developed?
iv. How can the proposed solution be tested for validity and effectiveness?

1.5 Significance of the Study

This dissertation research study provides information on the issues faced by field engineers when they try to access site data particularly on the speed, efficiency and accuracy of the information obtained. The study would be beneficial to the Telecommunication sector especially the engineering teams that would find it improving the way they carry out their daily duties. It will also serve to enhance the knowledge and adoption rate of automated systems that can be used to ease daily tasks of data transfer.

Furthermore, this study is beneficial to the mobile telephony service providers and the users as this study would provide the necessary information on the different threats and attacks of using mobile application technology. To the future researchers, this study can provide baseline information on the recent status of mobile application development.

1.6 Scope of Study

The dissertation is bounded to deliver a solution to the engineering division of mobile telecommunications setups that deal with site visits and site correction especially on radio frequency parameters. These parameters include the azimuth of the antennas, which is the direction the antenna is facing relative to the true north, the height of the antenna position from the ground and the type of the antenna used at a particular site.

A site here refers to the three antennas sectors that form a single base station location and help to provide service to a particular cluster location of the telecommunication business. The particular antennas are referred to as cells and will be treated separately when looked at in terms of the technology implemented.

1.7 Dissertation Structure

The dissertation report contains six more chapters excluding the introduction, broken down as below.

Chapter 2 – Literature Review: Reports on previous works done that are similar in scope to the element of this dissertation. The chapter attempts to analyze the methodologies applied and their shortfall and how previous researchers have attempted to use mobile applications to address similar challenges.

Chapter 3 – Research Methodology: This chapter gives basic guidelines for the design of a mobile application and database and provides ways of solving problems using android development platforms.

Chapter 4 – System design and architecture: The chapter explains the approach taken to deliver the complete solution including the application, the database and the server engine connectivity.

Chapter 5 – System Implementation and testing: The chapter discusses how the application was implemented and tested for various scenarios.

Chapter 6 – Results: This chapter discusses the results from the tests carried out and documented in chapter five. An analysis of results obtained from a questionnaire issued to respondents who were mainly from telecommunication engineering field work background have also been discussed here.

Chapter 7 – Discussion of findings: The chapter discusses the summary of the findings of the dissertation according to the analysis of the results carried out in the previous chapter.

Chapter 8 – Conclusion, Recommendation and Future work: The chapter shows the main achievements of the project and proposed future improvement work that other researchers can work on. It provides an opportunity to compare previous works to the current proposed solution and what other solutions can be incorporated into the developed solution.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of the literature related to the dissertation. A short history of the trend of mobile phone use in the country is mentioned together with the transition in mobile telephony technology over time. The definition and history of mobile applications is reviewed.

The literature review also discusses the use of android development kit as a tool for developing powerful mobile applications that can be used across any industry or setup for mobile access to information.

It also discusses the available options for designing databases and their comparisons, and a look at database access methods that can be used to achieve a quick and smooth connectivity from the user's mobile phones to the office database that contains the information they seek to access.

2.2 Telecommunication in Kenya

Kenya's earliest telecommunications connections to the outside world were the submarine cables linking Zanzibar, Mombasa, and Dar es Salaam laid by the Eastern & South African Telegraph Company in 1888. Internally, the construction of a telegraph network began with a 200-mile coastal line linking the port city of Mombasa with Lamu. Extension into the interior of the country began in 1896 in conjunction with the building of the railway system, forming a dual "backbone" for Kenya's communications infrastructure (Mobile cellular, 2002).

The extension of the telegraph line even overtook railway construction, reaching Nairobi in 1898 and Kampala and Entebbe in Uganda in 1900. Telephone service soon followed. In 1908, the public telephone network began service in Nairobi, the capital, and in Mombasa. In Nairobi that year, eighteen telephone subscribers were connected (Tyler & Jonscher, 1982).

The subsequent history of Kenya's network was one of gradual but sustained expansion. By 1980, there were 73,932 direct exchange lines (DELs) in use in the public telephone network; just over 84% were connected to automatic switching equipment and 75% had direct long-distance dialing (STD or subscriber trunk dialing) capability.

There were 1,228 telex lines in use and 50 leased data transmission circuits in use. The network of 1980 represented a solid foundation for future expansion even though it had significant shortcomings: 33% of long-distance call attempts failed due to congestion, and at any given time 15% of exchange lines were not in working order (Tyler & Jonscher, 1982).

In the 1980s, growth of Kenya's network occurred on a larger scale. KP&TC undertook three telecommunications development programs: the First Program ran from 1979 to 1983; the Second Program began in 1984 and was completed in 1988; and World Bank fun ding for the Third Program was negotiated in 1985-86, with disbursements beginning in 1987 and completion achieved in 1992.

The First Program called for the addition of 58,800 exchange lines of capacity, a 60% increase over the system capacity available at the end of 1979. It also called for the provision of public telephones in two hundred previously unserved locations, urban and rural. External funding was provided by the World Bank (International Bank for Reconstruction and Development, or IBRD) and bilateral development assistance programs, notably those of Japan and the Netherlands. Although the ambitious targets were by no means fully met, substantial growth was achieved (e.g. the number of working DELs rose from 69,996 at the end of 1979 to 95,000 at the end of 1983) (Statista: The statistics portal,2016,p.45).

The Second Program stressed the expansion of service in Kenya's rural areas, with the emphasis on "District Focus"--installation of new digital switches in nine locations to ensure that all forty-one "District Headquarters" locations in Kenya had automatic telephone service. This goal was achieved in 1988 (Tyler & Jonscher, 1982, p.4).

The Third Program largely continued the approach established by the first two but included two significant innovations: extensive replacement of small manual exchanges in rural areas with digital switching equipment and the introduction of optical fiber transmission for the links (known as "junctions") connecting nearby exchanges.

As table 2.1 shows, the three programs succeeded in achieving rapid growth of the network, especially since 1983. The network doubled from just under 96,000 working exchange lines at the end of 1983 to nearly 214,000 in 1993, a compound annual growth rate of almost 8% (2006 data reported by the ITU).

Table 2.1: Expansion of the telecommunications network in Kenya (Adapted from ITU, 2006)

	1978	1980	1983	1985	1987/88 [6]	Jan. 31, 1991	1992 [7]
Direct exchange lines (DELs) in use	65,344	73,932	95,749	118,361	151,964	184,583	207,328
% of DELs in use served by automatic switching	86.2%	84.5%	86.7%	88.5%	91.4%		92. 92%
Public telephones	1,490 [2]	N. A.	734 [3]	2,189 [3]	3,630 [3]	5,631 [3]	5,631 [3]
Telex lines in use	1,017	1,228	1,750	2,188	2,536	2,357	2,031
Data modems [4]	N. A.	50 [5]	169	216	307	N. A.	N. A.

2.3 Mobile Phone Technology Generations

In 1895, Guglielmo Marconi opened the way for modern wireless communications by transmitting the three-dot Morse code for the letter 'S' over a distance of three kilometers using electromagnetic waves. First, wireless communications relies on a scarce resource – namely, radio spectrum state. In order to foster the development of wireless communications (including telephony and Broadcasting) those assets were privatized. Second, use of spectrum for wireless communications required the development of key complementary technologies; especially those that allowed higher frequencies to be utilized more efficiently. Finally, because of its special nature, the efficient use of spectrum required the coordinated development of standards. In the past few decades, mobile wireless technologies have been classified according to their generation, which largely specifies the type of services and the data transfer speeds of each class of technologies (Andrea, 2000, p.15).

2.3.1 0 Generation (0G)

0G refers to pre-cellular mobile telephony technology in 1970s. These mobile telephones were usually mounted in cars or trucks, though briefcase models were also made. Mobile radio telephone systems preceded modern cellular mobile telephony technology. Since they were the predecessors of the first generation of cellular telephones, these systems are sometimes referred to as 0G (zero generation) systems. Technologies used in 0G systems included PTT (Push to Talk), MTS (Mobile Telephone System), IMTS (Improved Mobile Telephone Service), AMTS (Advanced Mobile Telephone System), OLT (Norwegian for Offentlig Landmobil Telefoni, Public Land Mobile Telephony) and MTD .0.5G is a group of technologies with improved feature than the basic 0 G technologies (Tachikawa, & Keiji, 2003, p.96).

2.3.2 1st Generation (1G)

In 1980 the mobile cellular era had started, and since then mobile communications have undergone significant changes and experienced enormous growth. First-generation mobile systems used analog transmission for speech services. In 1979, the first cellular system in the world became operational by Nippon Telephone and Telegraph (NTT) in Tokyo, Japan. Two years later, the cellular epoch reached Europe (L. Stuber, Principles of Mobile Communication. Boston, Kluwer). The two most popular analogue systems were Nordic Mobile Telephones (NMT) and Total Access Communication Systems (TACS). Other than NMT and TACS, some other analog systems were also introduced in 1980s across the Europe. All of these systems offered handover and roaming capabilities but the cellular networks were unable to interoperate between countries. This was one of the inevitable disadvantages of first-generation mobile networks. In the United States, the Advanced Mobile Phone System (AMPS) was launched in 1982 (Hau, 2003, p.34).

2.3.3 2nd Generation (2G EDGE)

EDGE (EGPRS) is an abbreviation for Enhanced Data rates for GSM Evolution, is a digital mobile phone technology which acts as a bolt-on enhancement to 2G and 2.5G General Packet Radio Service (GPRS) networks. This technology works in GSM networks. EDGE is a superset to GPRS and can function on any network with GPRS deployed on it, provided the carrier implements the necessary upgrades.

EDGE technology is an extended version of GSM. It allows the clear and fast transmission of data and information. It is also termed as IMT-SC or single carrier. EDGE technology was invented and introduced by Cingular, which is now known as AT& T. EDGE is radio technology and is a part of third generation technologies. EDGE technology is preferred over GSM due to its flexibility to carry packet switch data and circuit switch data (Hau, 2003, p.48). The use of EDGE technology has augmented the use of black berry, N97 and N95 mobile phones. EDGE transfers data in fewer seconds if we compare it with GPRS Technology. For example a typical text file of 40KB is transferred in only 2 seconds as compared to the transfer from GPRS technology, which is 6 seconds. The biggest advantage of using EDGE technology is one does not need to install any additional hardware and software in order to make use of EDGE Technology.

2.3.4 3rd Generation (3G)

3G refers to the third generation of mobile telephony (that is, cellular) technology. The third generation, as the name suggests, follows two earlier generations. The first generation (1G) began in the early 80's with commercial deployment of Advanced Mobile Phone Service (AMPS) cellular networks (Stuber, 1998, p.12). Early AMPS networks used Frequency Division Multiplexing Access (FDMA) to carry analog voice over channels in the 800 MHz frequency band. 3G technologies enable network operators to offer users a wider range of more advanced services while achieving greater network capacity through improved spectral efficiency. Services include wide area wireless voice telephony, video calls, and broadband wireless data, all in a mobile environment. Additional features also include HSPA data transmission capabilities able to deliver speeds up to 14.4Mbit/s on the downlink and 5.8Mbit/s on the uplink. Spectral efficiency or spectrum efficiency refers to the amount of information that can be transmitted over a given bandwidth in a specific digital communication system. High-Speed Packet Access (HSPA) is a collection of mobile telephony protocols that extend and improve the performance of existing UMTS protocols.

2.3.5 4th Generation (4G)

4G refers to the fourth generation of cellular wireless standards. It is a successor to 3G and 2Gfamilies of standards. The nomenclature of the generations generally refers to a change in the fundamental nature of the service, non-backwards compatible transmission technology and new frequency bands. The first was the move from 1981 analogue (1G) to digital (2G) transmission in1992. This was followed, in 2002, by 3G multi-media support, spread spectrum transmission and at least 200 kbit/s, soon expected to be followed by 4G, which refers to all-IP packet-switched networks, mobile ultra-broadband (gigabit speed) access and multi-carrier transmission. Pre-4Gtechnologies such as mobile WiMAX and first-release 3G Long Term Evolution (LTE) have been available on the market since 2006and 2009 respectively. It is basically the extension in the 3G technology with more bandwidth and services offers in the 3G.The expectation for the 4G technology is basically the high quality audio/video streaming over end to end Internet Protocol. If the Internet Protocol (IP) multimedia sub-system movement achieves what it going to do, nothing of this possibly will matter. WiMAX or mobile structural design will become progressively more translucent, and therefore the acceptance of several architectures by a particular network operator ever more common (Hau, 2003, page 54-59).

2.3.6 5th Generation (5G)

5G (5th generation mobile networks or 5th generation wireless systems) is a name used in some research papers and projects to denote the next major phase of mobile telecommunication standards beyond the upcoming 4G standards, which are expected to be finalized between approximately 2011 and 2013 (Yu & Yeung,2003, p.44).

Currently 5G is not a term officially used for any particular specification or in any official document yet made public by telecommunication companies or standardization bodies such as 3GPP, WiMAX Forum or ITU-R. New 3GPP standard releases beyond4G and LTE Advanced are in progress, but not considered as new mobile generations.5G Technology stands for 5th Generation Mobile technology. 5G technology has changed the means to use cell phones within very high bandwidth. Users never experienced ever before such a high value technology. Nowadays mobile users have much awareness of the cell phone (mobile) technology. The 5G technologies include all type of advanced features which makes 5G technology most powerful and in huge demand in near future.

The growth and features of the different technology over time can be seen in table 2.2.

Table 2.2: Mobile phone technologies trends (Adapted from Stuber, 1998)

COMPARISON BETWEEN 1G, 2G, 3G, 4G AND 5G

Technology / Features	*1G*	*2/2.5G*	*3G*	*4G*	*5G*
Start/ Deployment	1970/ 1984	1980/ 1999	1990/ 2002	2000/ 2010	2010/ 2015
Data Bandwidth	2 kbps	14.4-64 kbps	2 Mbps	200 Mbps to 1 Gbps for low mobility	1 Gbps and higher
Standards	AMPS	2G: TDMA, CDMA, GSM 2.5G: GPRS, EDGE,1xRTT	WCDMA, CDMA-2000	Single unified standard	Single unified standard
Technology	Analog cellular technology	Digital cellular technology	Broad bandwidth CDMA, IP technology	Unified IP and seamless combination of broadband, LAN/WAN/	Unified IP and seamless combination of broadband,

2.4 Key Stakeholders

These are the people whose decisions and experience with the use of this mobile application will determine whether it has met its intended objectives or not (Blake, 2010). Thus their input and test results must be analyzed and taken into consideration throughout the period of implementation and roll out.

2.4.1 Content Providers

In this case, the content provider will be the telecommunication company whose network is being optimized by the engineers. Usually, most telecommunication companies keep a database recording of their network as it is on the ground to ease planning and introduce efficiency in network monitoring processes. This information includes site location in terms of geo coordinates, site mast heights, antenna direction, the type of antennas in use, their mechanical tilts and height position from ground, the type of equipment used at the base station and the power among others. This is the content that this application will filter through to deliver to the engineer on the ground the most useful kind of information for his consumption when it comes to decision making.

2.4.2 System Administrators

This is the person or group of people who will be responsible for the upkeep, configuration, and reliable operation of the system, and especially the server end. The system administrator seeks to ensure that the uptime, performance, resources, and security of the computers he or she manages meet the needs of the users, without exceeding the budget.

2.4.3 Field Engineers

This is the group of specialized persons who are tasked with the day to day improvement of user experience in mobile service delivery on the radio access technology. They require a combination of complex information to be delivered to them so as to make decisions that will improve the network without introducing any revenue losses or poor performance in the key performance indicators, also referred to as the KPI's. This entity will be the main users of the user end part of this application as they will utilize it to access secure database systems holding information that is related to the network.

2.4.4 Management

Management in businesses and organizations is the function that coordinates the efforts of people to accomplish goals and objectives by using available resources efficiently and effectively. Management will come in to play both control and facilitation roles to the users and administrators of this system.

They will ensure, through constant checks that only authorized users are able to access the system and that only authorized functions are carried out in the system. This will help in countering instances of fraud and misuse of information. They will also facilitate such requirements as system upgrade and user training to impact knowledge into the users of the system.

2.5 Mechanisms to Share Information

In this sub section, the research compares and contrasts the two main methods of storing and distributing usable information to the final recipients which are distributed systems and centralized systems. This will provide a basis for judgment on why this research prefers a distributed system as opposed to the more traditional centralized systems. The benefits of a Centralized model are lower capital and operational cost (minimal hardware at each site), security (all data stored in a secured datacenter), less administrative overhead (fewer resources needed since all equipment is in one location), less backup complexity, and greater control over potential risk areas such as Internet access (Kawabata & Kasah, 2007, p. 67).

The downside to a Centralized model is that your remote site's WAN connection is now a major point of failure. Whether this is a point-to-point, MPLS, or VPN connection, if this link goes down, that site now has zero access to anything at the Datacenter. A backup WAN and failover capability is a must if you choose a highly Centralized computing model. On the other hand the benefit of a Distributed model is that each site can 'survive' on its own. There is no Single Point of Failure in this regard. The downside to this approach, obviously, is cost. Not only would this require additional hardware and software costs, but you most certainly would require at least a partial onsite presence at each location regardless of how many remote management components are in place.

The client–server model of computing is a distributed application structure that partitions tasks or workloads between the providers of a resource or service, called servers, and service requesters, called clients (Gemino & Parker, 2009, p.30). Often clients and servers communicate over a computer network on separate hardware, but both client and server may reside in the same system. A server host runs one or more server programs which share their resources with clients. A client does not share any of its resources, but requests a server's content or service function. Clients therefore initiate communication sessions with servers which await incoming requests (Kawabata & Kasah, 2007, p.44).

2.6 Existing Solutions for Accessing Site Data

This section will discuss some of the existing solutions that have implemented by other designs for the purpose of solving the problem of data access by field engineers.

2.6.1 RF signal tracker

This is an engineering application that is in the market for doing hand held drive tests with an android phone. Usually, to monitor the received signal levels and perceived quality by users, one requires specialized tools to drive around a particular base station of interest or a computer device and walk into the location of interest, mostly inside the house or premises of work of an affected subscriber (Android Developers, 2015, p.89). A screen shot of this application is shown in Figure 2.1 below.

Figure 2.1: RF Signal Tracker User Interface (Adapted from Android Developers, 2015)

The difference between this application and the proposed solution is in the fact that the proposed solution will be used to mine data that is stored in a database about the serving cell while RF Signal Tracker is used to measure the power as emitted from the serving cell. However, both applications will be used by optimization engineers in their daily tasks of improving coverage and quality of the network. The advantage in the deployment of the RF Signal Tracker over the proposed solution is in its use of maps that assist the user to visualize his or her current location as compared to the location of the serving cell.

2.6.2 G-NetTrack

A description of GNET TRACK from its technical manual describes it as a wireless network monitor and drive test tool for Android OS devices that allows for monitoring and logging of mobile network parameters without using specialized equipment (Developer.android.com, 2015). See Figure 2.2 below.

Figure 2.2: G-NETTrack User Interface (Adapted from Android Developers, 2015)

It can be used by professionals to get better insight on the network or by radio enthusiasts to learn more about wireless networks. It can be used even if you want just to make easy representation of your traveled route. G-NetTrack has a similar requirement as RF Master when it comes to displaying sites on the application because it requires a cell reference file to be imported into the application. From this file, it can be localized and used by a specific service provider to show the location of their sites relative to the location of the user. However, cell

reference files are usually coordinate points and may not have such information relating to the antenna or what is referred to as the RF design of a GSM or UMTS system. Here is where the innovation behind the proposed solution helps because it bridges this gap by further providing all the recorded information about the antenna and azimuth directions.

2.6.3 Lambert

This application has a well-organized interface, collects basic metadata (e.g., GPS location, strike and dip), allows the user to override recorded values or add comments, and provides a stereonet display with several different views. The application even allows deletion of data points directly in the stereonet. However, the application does not support export in CSV, it only exports plaintext (Kim & Ryan, 2009, p.90).

2.6.4 FieldMove

This application captures basic metadata, has easy export to CSV, allows overriding of measurements and geographic mapping, and has a compatible desktop application that allows visualization and manipulation of data. However, its stereonet functionality is a paid-only option, and the full desktop application costs quite a pretty penny (Lohr & Steve, 2010, p.45).

2.6.5 Rocklogger

This application captures basic metadata, has support for photos, CSV export through the native sharing menu, and Google Maps functionality. However, the application does not support editing of records for overriding values. Copying records is a paid-only option (Hardesty & Larry 2012, p.65).

2.6.6 GeoCompass

This one supports a very complete set of metadata, with good accuracy of measurements. In addition, the application supports CSV export via email, the use of photos and video, and various information management options like video or photo quality. The organization of the user interface is quite clear, making it easy to navigate through. However, the application does not support offline mapping due to use of Apple MapKit. Users cannot override values or add new fields (Hardesty & Larry 2012, p.67).

2.6.7 Qgis

This application has very extensive functionality and superb integration with GIS mapping functions. However, it is very hard to install and requires the use of GIS software which is not freely available (Andrew, 2015, p.77).

2.7 Summary

The literature review has discussed topics that are related to the implementation of this dissertation, citing examples of similar projects that have been done before and critically looking at the merits and demerits of these applications over the application under consideration. Different pieces of work have been reviewed and general challenges observed and reported.

Based on the literature review, we see strong and weak points of this dissertation, the biggest being in its lack of implementation of a map plug in which appears to be very useful in the operation of the application. However, the traditional applications do not provide details about the site that can be used in the implementation of decisions by engineers on the ground. This application bridges some of the gaps that had been overlooked by earlier developers, while leaving out aspects of earlier applications that may hamper the speed of operation of the application because of their demand for computing resources. This ensures that queried results are presented in real time for use in making crucial decisions.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

In this chapter, the system methodology to which this dissertation project has been adapted to will be discussed, together with the reasons why it was preferred over the other existing methodologies. A system development methodology refers to the framework that is used to structure, plan, and control the process of developing an information system.

3.2 System Development Methodology

The study uses waterfall software engineering methodology to structure, organization, and control the procedure to develop the proposed mobile solution. The model has been selected because of the following reasons:

i. Usability: By use of waterfall approach users' needs are well looked into.
ii. Reduce cost: Both the logical and physical system design is separated when using the waterfall approach. This means the development of system do not need to implement new hardware and software.
iii. Timelines: Allows good planning and management of the project.

Figure 3.1 shows the basic steps in a waterfall design model (Lee, 2004, p.74). The waterfall methodology is considered to be linear. This dissertation project is divided into sequential phases, with some overlap and splash back acceptable between phases.

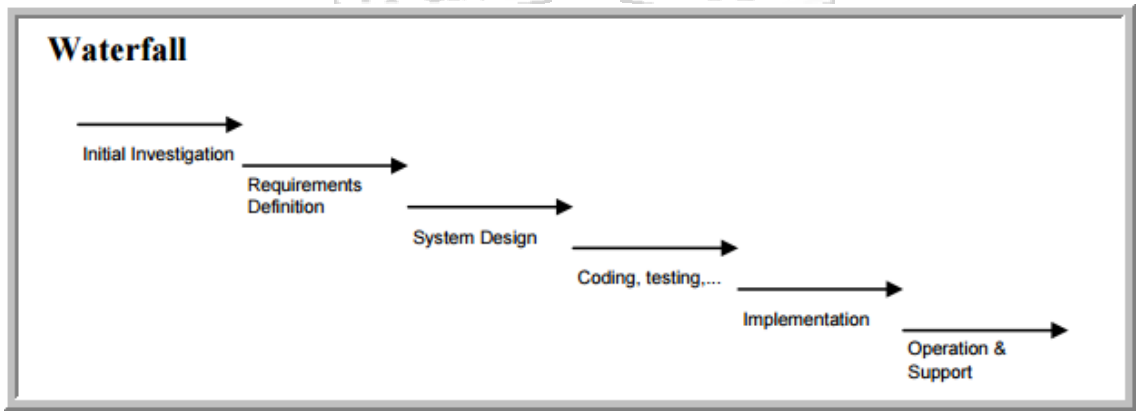

Figure 3.1: Waterfall model (Adapted from Lee, 2004)

Emphasis is on planning, time schedules, target dates, budgets and implementation of an entire system at one time mirroring the waterfall methodology shown above.

Tight control is maintained over the life of the project through the use of extensive written documentation, as well as through formal reviews and approval/signoff by the user and information technology management occurring at the end of most phases before beginning the next phase (Kawabata & Kasah, 2007, p.56).

Some of the strengths and reasons for opting for the waterfall methodology are that it is ideal for supporting less experienced project teams and project managers, or project teams whose composition fluctuates and the progress of system development over time is measurable. Furthermore the orderly sequence of development steps and strict controls for ensuring the adequacy of documentation and design reviews helps ensure the quality, reliability, and maintainability of the developed software.

However, there are inherent bottlenecks to using this kind of methodology as compared to the others such as the fact that requirements inconsistencies, missing system components, and unexpected development needs are often discovered during design and coding. It is also inflexible, slow, costly and cumbersome due to significant structure and tight controls. System performance cannot be tested until the system is almost fully coded and under capacity. There is also little room for use of iteration, which can reduce manageability if used.

3.3 Requirements Determination

From the expected solutions that this application is expected to provided, the requirements have been divided into two categories, one for the functional requirements and another for the non-functional requirements. This dissertation has interviewed field engineers and other stakeholders to determine the requirements for the new solution. In a nutshell, the information gathered assisted in formulating the functional and non-functional requirements of the proposed solution.

3.3.1 Functional Requirements

To the users, the application is expected to:

i. Provide static data from computer servers to mobile phones in the field

ii. Be able to update the database from the field in good time

To the database administrators, the application should be able to

i. Show user access logs for a defined duration of time

ii. Adding information such as access credentials and new fields to the system as it grows.

3.3.2 Non Functional Requirements

Performance

The application should respond rapidly to the users input from login information response to exiting the application. A response time of less than one second for every action by the user is desirable because it helps keep the user engaged to the application.

Maintainability

System administrators and users of the system should be able to access and change information in the system with ease and speed. This information should be accessible to all users immediately once authenticity verification has been done to ensure that the system remains reliable.

Security

The service provider's network information should be kept secure from malicious persons outside the organizations engineering functions through the use of secure passwords and encryption algorithms during information exchange. The information about the users must also be kept private by both the system and its administrators.

Scalability

This application should be able to scale in terms of the number of users and the services it can provide. It should also be able to scale to cover new technologies because the telecommunication engineering field is rapidly expanding to cover new frontiers, with introduction of modern ways of service delivery. Without this capability, the application would soon rather than later be rendered irrelevant.

Interoperability

By this, it means the application should be platform independent and its background communication to the database should be seamless regardless of the database structure and the platform on which the background is running on. This allows the application to be transferred from one network to another.

3.4 Database Design Tools

Data flow diagram is graphical representation of flow of data in an information system. It is capable of depicting incoming data flow, outgoing data flow and stored data. The DFD does not mention anything about how data flows through the system. There is a prominent difference between DFD and Flowchart. The flowchart depicts flow of control in program modules (Nenad & Richard, 2000, p.114). DFDs depict flow of data in the system at various levels. DFD does not contain any control or branch elements. Some DFD components are shown in Figure 3.4 below.

Figure 3.2: DFD Components (Adapted from Nenad & Richard, 2000)

3.5 Database Design Concepts

This application uses a database for storing and managing records of loans and reservations, equipment details and user details. It uses basic database interactions such as insert, select, delete and update in different scenarios (for example when registering equipment or user, displaying equipment details, modifying and deleting equipment or user details, inserting loans and reservations).

3.6 Target Population

The participants of the requirements collection phase were drawn from all the two hundred and fifty field engineers of a local telecommunication service provider. The company has about four hundred engineers out of whom 250 are based in the field. This means that as much as they go back to the office in the evening to create and submit daily reports, they spend most of their time in the field and they will be assisted most by this application.

3.7 Sample Size Determination

The technology division of the company for which the dissertation was designed around has about two hundred and fifty field engineers. Using this, variability on information needs was estimated at 0.2625 and substituted in Cochran's formula for sample size calculation.

Formula: $$n = \left(\frac{t^2 \times p(1-p)}{d^2}\right) \times Design\ Effect$$ (Cochran ,1977)

Where:

n - Total sample size

t - Value for selected alpha level (it indicates the level of risk the researcher is willing to take that true margin of error may exceed the acceptable margin of error.)

p - Estimate of information needs.

d - Acceptable margin of error for mean of outcome

Further, under conventional assumptions of design effect of 2, t = 1.96 (alpha = 5%) and d = 6% the actual sample size was estimated to be n is 97.

3.8 Data Collection

The dissertation applied both quantitative and qualitative research techniques to gather requirements data. These included the use of questionnaires and observation to collect data. The questionnaires were given to a randomly selected but uniformly distributed group of eighty (80) field engineers and twenty (20) office based engineers, making a total of one hundred participants. The questions were carefully drafted using the research questions captured in chapter one so as to ensure that the research objective was met.

3.9 Ethical Considerations

Prior to conducting the data collection, detailed information was provided at the start of the questionnaire and in accepting to fill in the questionnaire the respondent was assumed to have given consent. The respondents were assured that all data collected from them was kept confidential (Appendix E). Organizational related data has been kept in confidence and only public information has been shared in this report. Also, the names and personal information of the field engineers, though captured have not been indicated anywhere in this dissertation for purposes of confidentiality and privacy. The dynamics that must be maintained when observing data ethics are as shown in Figure 3.3.

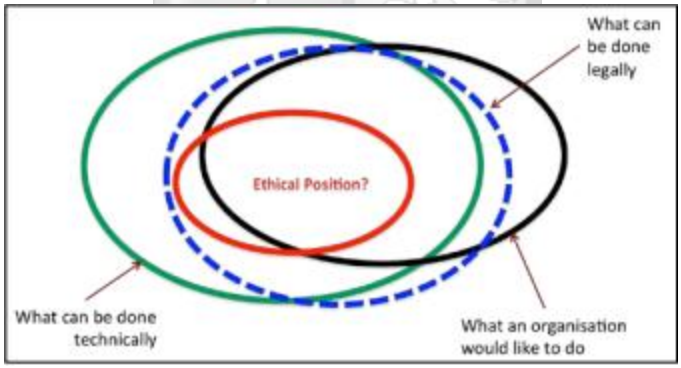

Figure 3.3: Ethical considerations

3.10 Summary

This chapter has gone into how the data was collected to establish the grounds that provide reasons for going into this research. It has also established the choice of the prototype model that was used in the system development phase and the design tools that were preferred. A discussion of the results that were obtained from the questionnaires that had been submitted to the field engineers has also been done and the results will be captured in the next chapter.

CHAPTER 4: DATA ANALYSIS

4.1 Introduction

In this chapter the results of the data analysis are presented. The data were collected and then processed in response to the problems posed in chapter one of this dissertation. Two fundamental goals drove the collection of the data and the subsequent data analysis. Those goals were to determine the current problems being faced by field engineers in their day to day tasks , and to determine if current mobile applications can be used to help develop a solution for data access while the site engineer is away from office. These objectives were accomplished. The findings presented in this chapter demonstrate the potential of mobile technology in not only solving the problems highlighted in the problem statement but to also be used in other ways to ease work and improve efficiency.

4.2 Data Analysis Tools

The following analysis was mainly done through the use of windows office excel tables to come up with the charts and tables after manipulating the data in the data that had been captured and entered manually to the excel sheets. This data was captured from returned questionnaires that had been issued to a select number of the users of the current system detailing questions extended from the objective of the research.

The IBM SPSS predictive analytics software was used partly to predict with a confidence of over 90% what will happen if we implemented the results of the findings of the data collected. However, the main analysis and what follows herein was obtained mainly through MS Excel tool.

4.3 Questionnaire Response Rate

One hundred field engineers out of approximately two hundred and fifty were selected for interviewing based on their distribution around the country. The data was collected through the use of a simple questionnaire (annexed in the appendix) to capture the thoughts of the current field engineers about the ease of use of the current system of data access and what their thought were also as regards the implementation of a new system that was automated and will allow them to access this data directly through their mobile phones from their field locations.

A total of 100 questionnaires were issued and Figure 4.1 below shows a breakdown of the response rate as determined by the number of questionnaires that were returned. The overall questionnaire response rate stood at 70%.

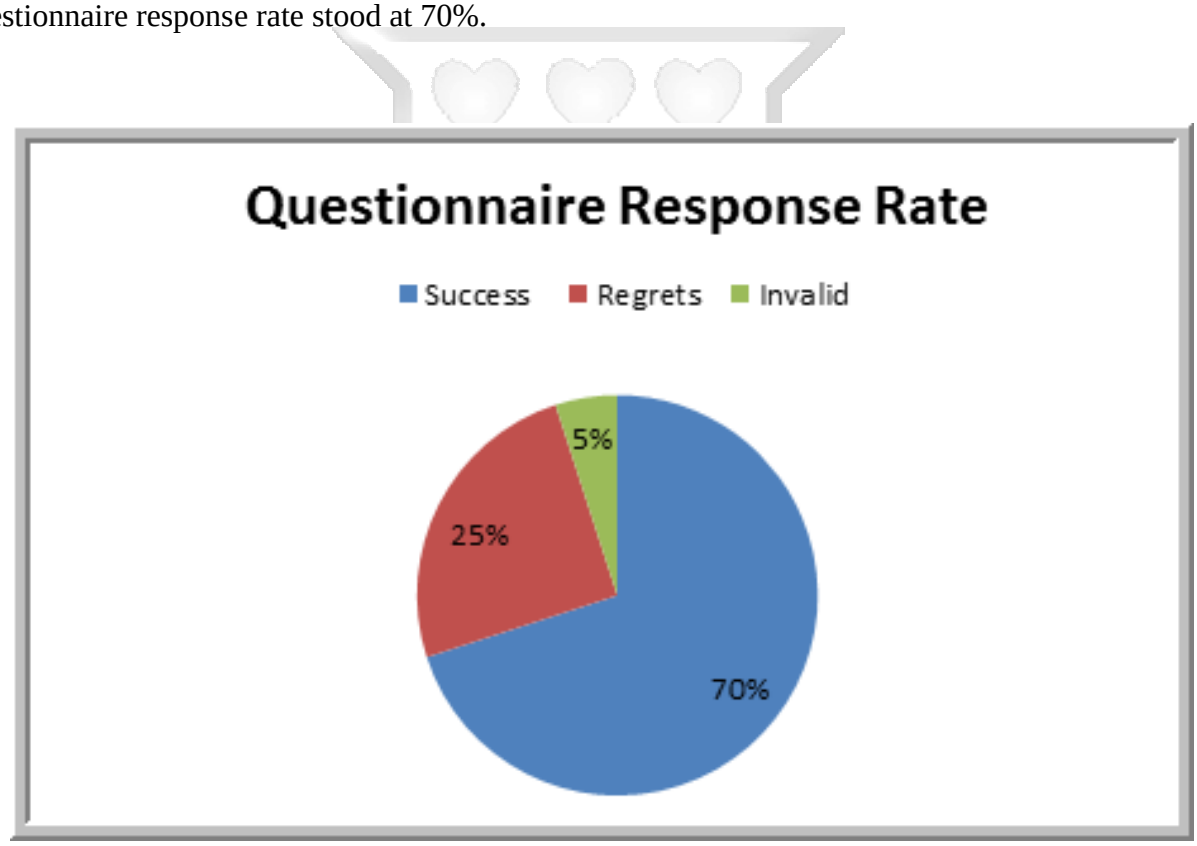

Figure 4.1: Questionnaire response Rate

4.4 Suitability of the Current System

The suitability of the current methods of data collection was asked for and analyzed to try and justify the objectives of this dissertation. Most users agreed strongly that the current system does not fully meet their needs, with over 50% of the respondents who replied replying negatively when asked of the current system is properly supporting them See Figure 4.2 below for a complete breakdown of the responses.

However, a few of the respondents said they have no particular issue with the current methods they use to access data that they need for troubleshooting at their sites. There was no respondent who was not sure whether he or she is okay or not okay with the current system.

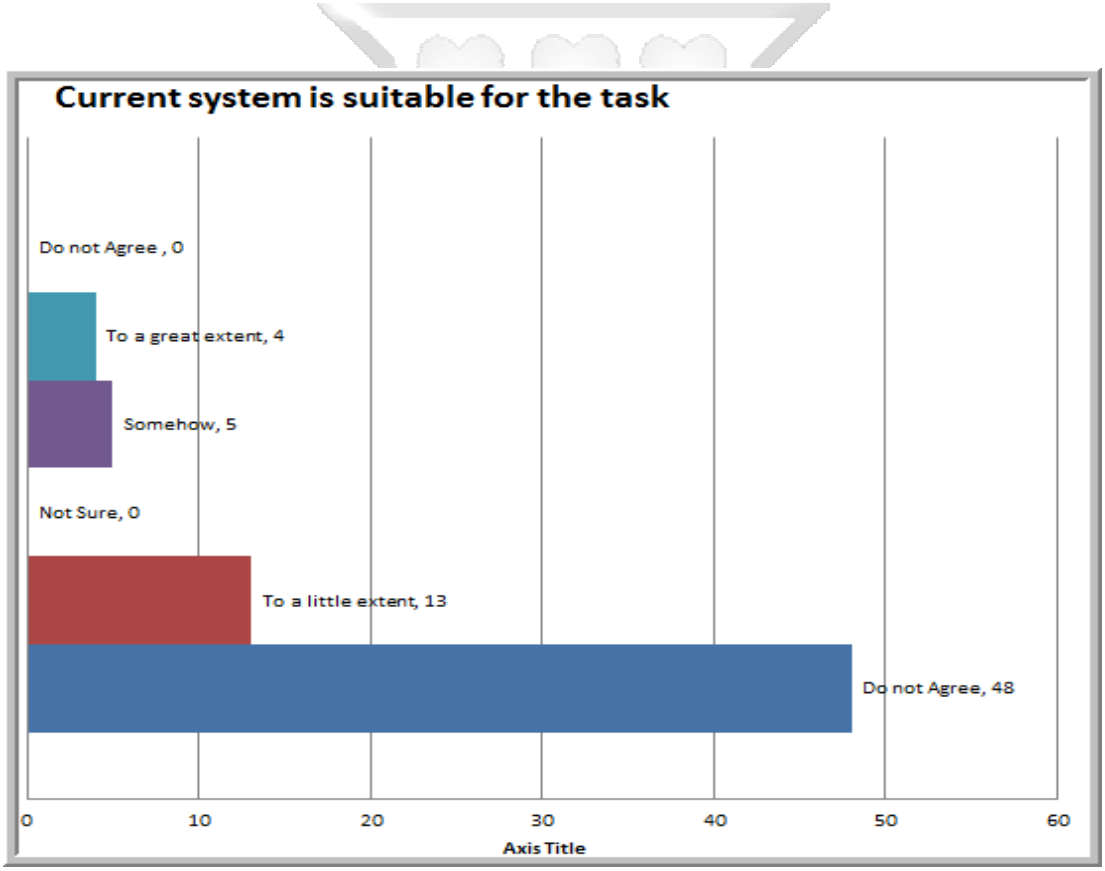

Figure 4.2: Analysis of the suitability of the current system

4.5 Current Methods of Data Collection

The Figure 4.3 below is a percentage breakdown of the methods used by the respondents to obtain data from the office for use in their field engagements. Most of the respondents prefer to call either a colleague or the database administrator or someone else who has access to the system to obtain this information. Quite good percentages also prefer collecting the data and assembling it in notepads before leaving the office to go to site. This makes their work easy as all the data that they would need is easily accessible. However, it means that they need to carry around a bunch of papers for every site that they need to visit in their daily assignments.

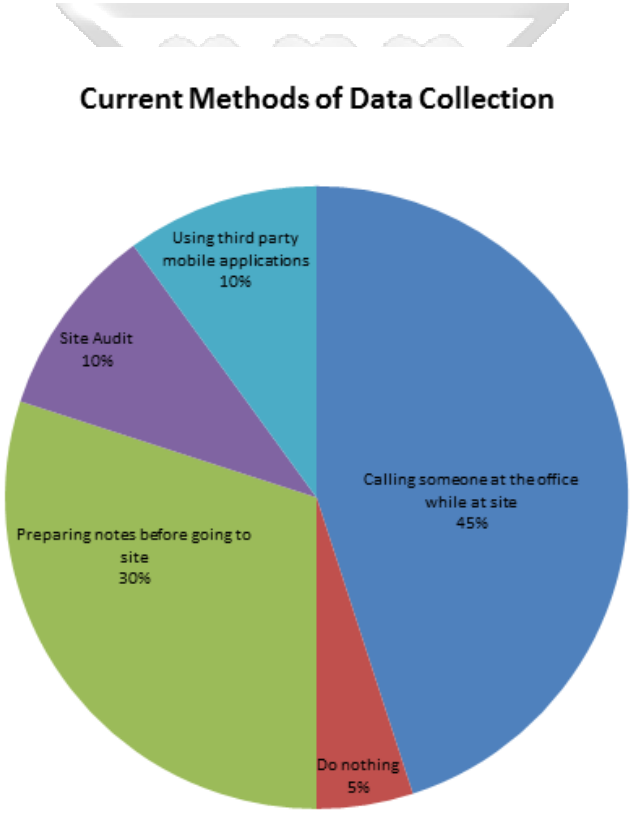

Figure 4.3: Questionnaire Results

4.6 Required Data

From an analysis of the returned questionnaires, the following are some of the key data areas that the interviewed persons suggested would be highly dependent on in the availability of data from the central servers.

4.6.1 Site location

This would be in terms of the geographical positioning which is given by the latitude and longitude of the site. This is important for the general location of a site especially to a person who is new in the area or the company.

4.6.2 Antenna Height

It is relatively difficult to tell the height of the antenna from the ground and site measurements are made near impossible by the high location of the antenna from the grounds that require specialized skills and tools to access in order to measure the height from the ground.

4.6.3 Antenna Type

Other than the height from ground being so high that a user is unable to read directly, some of the antenna labels have been rained on or bleached due to the effect of sunshine and are unreadable even when they have been successfully accessed.

4.6.4 Azimuth

This also requires specialized equipment and skills for reading and this may hamper simple troubleshooting. But if the field engineer can access this data from the central servers, then his or her work will be made simpler and now he can focus on providing solutions to customers.

4.7 Degree of Challenges in Data Access

Some of the challenges that were mentioned as hampering access to data were captured and are listed below.

- Poor network coverage introducing such challenges as inability to call for support from th office or consult other team members by using your mobile phone.
- Poor voice connectivity that causes unreliability of relayed information due to introduced background noise. This can lead to the field engineer recording different values from what he or she is being told.
- Insecure method of data access. The field engineers are not sure whether the information being relayed to them is secure with the given channels of communication.
- Data availability is not guaranteed. The data relayed about a particular site may not be available because it has not been stored or it has not been edited to reflect the current status.

4.8 Proposed Features of the New System

The graph below has been arranged to allow the reader to easily identify the most urgent features that the filed engineers would require to be incorporated in any new system. These are the features that would make a difference from the current way of doing things to a more effective way. Each column of feature has been rated according to the rating that was given to it by the respondents. Refer to Figure 4.3 for a classification of the importance of the features that users were asked to categorize.

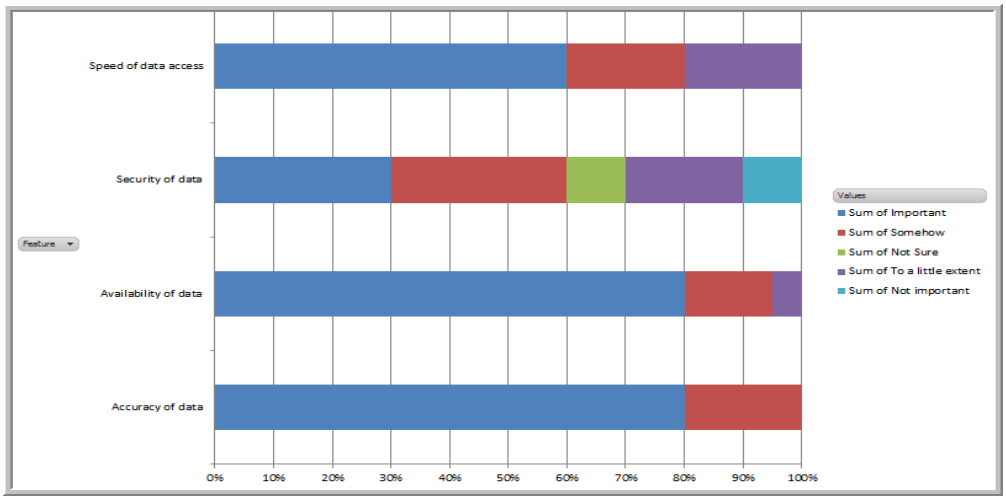

Figure 4.4: Proposed features

It shows that users are highly worried about the accuracy of the data more than anything. Security is a feature that was mentioned but from the sample results, it is not highly required by the users.

4.9 Summary

The following are the valid responses to the questionnaires that were filled and returned clustered in a graphical chart. The trend shows the importance of availability of timely data and its accuracy for the purposes of making decision while in the field.

It also shows that the current field engineers undergo some frustrations when trying to access this data. See Figure 4.4 below.

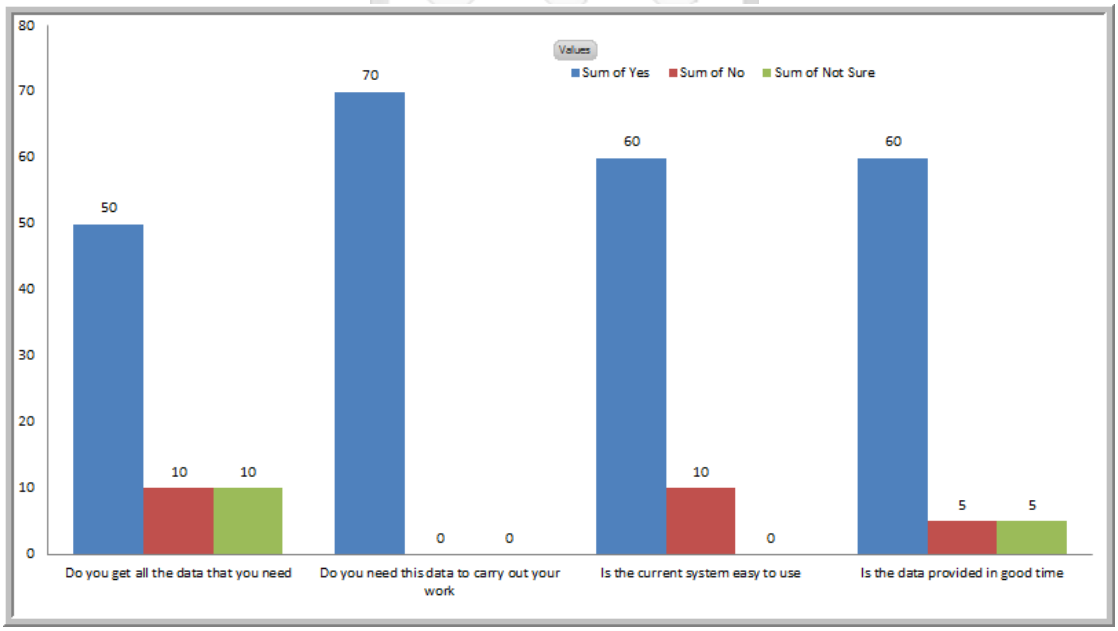

Figure 4.5: Summary of Questionnaire Results

The data analysis done provides a credible ground for the development of a proposed solution that would capture the analyzed needs of the users other than achieving the main objective of this dissertation.

CHAPTER 5: SYSTEM DESIGN AND ARCHITECTURE

5.1 Introduction

This chapter describes the physical and logical outlay of the technologies brought together to achieve the working solution. It includes the user end of the solution which is the mobile application and the server end that hosts the data that is to be accessed by field engineers using their mobile phones.

5.2 System Architecture

The system is designed as shown in Figure 5.1 below. The user connects to the central database through an API interface using his or her mobile phone. The communication to the server will be implemented using GET or POST methods as shown in Figure 5.1 below.

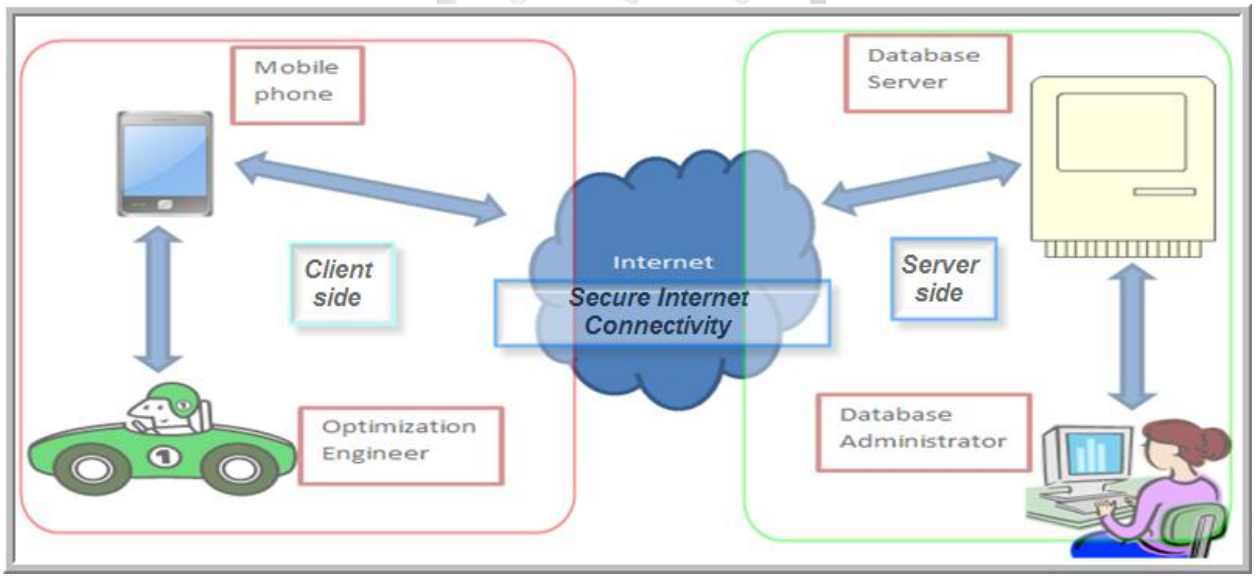

Figure 5.1: System connectivity diagram

Communication between the mobile device and the server will be made secure through standard methods that have been adopted before in such systems to prevent hacking and unauthorized access to the system. This will include the use of passwords and encryption methods. The diagram just presents an overall view of the general interaction between the user end of the system and the database resource located back at the central office is as shown.

5.3 Entity Relationship Diagram

An entity-relationship diagram, or ERD, visually represents the relationship between database entities. ERDs model an organization's data storage requirements with three main components: entities, attributes, and relationships. The ERD shown in the diagram below displays the attributes that were defined during the creation of the database for this application. The diagram also shows the attributes that were defined as key for every database table and the relationship between these tables. This is important because it defines the existing interaction between table entries and ensures that a change that may affect an item in the database is replicated throughout in the database where the entry exists. This kind of a database ensures minimal redundancy as records are only stored in one location but can be accessed by anyone who is allowed to view the details. Figure 5.2 shows the entity relationship diagram for the developed application.

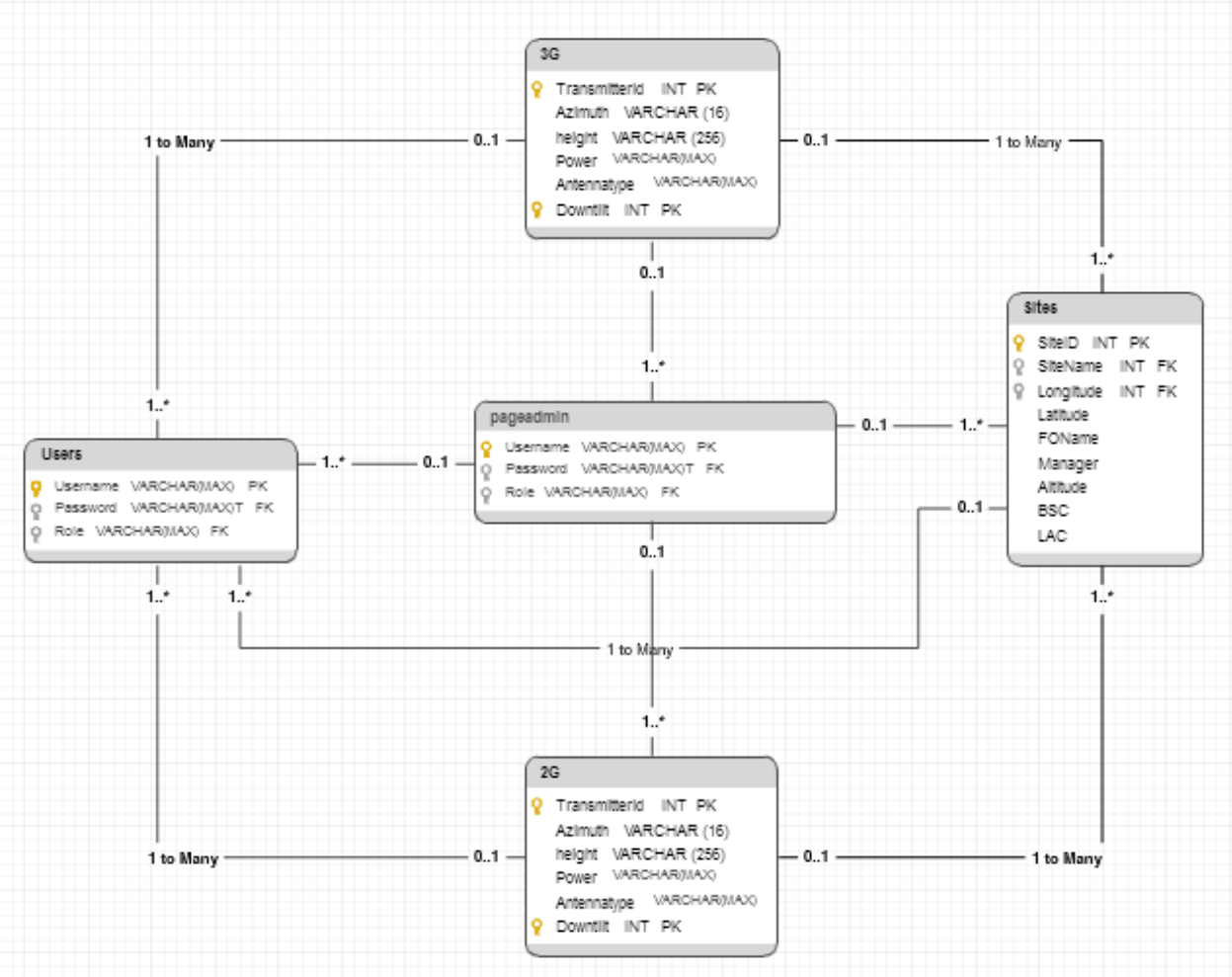

Figure 5.2: Entity relationship diagram

5.4 Data Flow Diagram

A data flow diagram (DFD) illustrates how data is processed by a system in terms of inputs and outputs (Vidgen, 2003, p.98). The beginning of data transaction for this system occurs when the user is asked for details to verify his or her authenticity before they can log into the system. If the attempt is unsuccessful, the user is logged out and the process comes to an end, or iterates until the user can successfully log into the system.

If the attempt is successful, the user is presented with a number of transactions and his or her choice will then depend on what they want to do in the application. Finally, after carrying out the transaction and getting the necessary replies from the system, the user has the option of exiting the system which then goes to the end (stop). Figure 5.3 is an illustration of the level 0 data flow diagram for this project, which is also referred to as its context diagram.

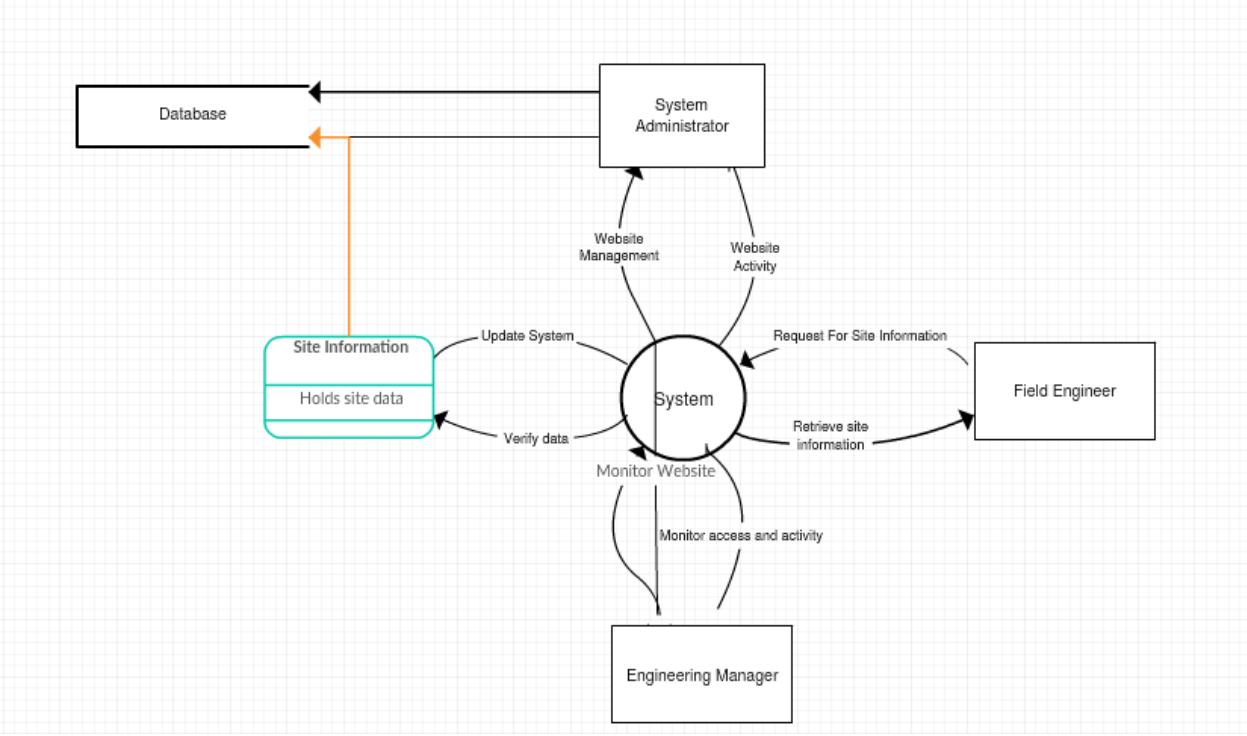

Figure 5.3: Context Diagram

5.5 Use Case Diagram

A use case diagram at its simplest is a representation of a user's interaction with the system that shows the relationship between the user and the different use cases in which the user is involved. The use case diagram for this system is as shown in Figure 5.4 below. It shows how the system administrator has been allocated the functions of creating new users and deleting existing accounts.

It also describes the interactions between the main users of the system, who in this case will the field engineers and the fact that they will be required to access the system by entering authentic credentials. The management will perform an overall role of monitoring and only intervene with the system in very minimal circumstances. Their access to the system will also be restricted through the use of usernames and corresponding passwords.

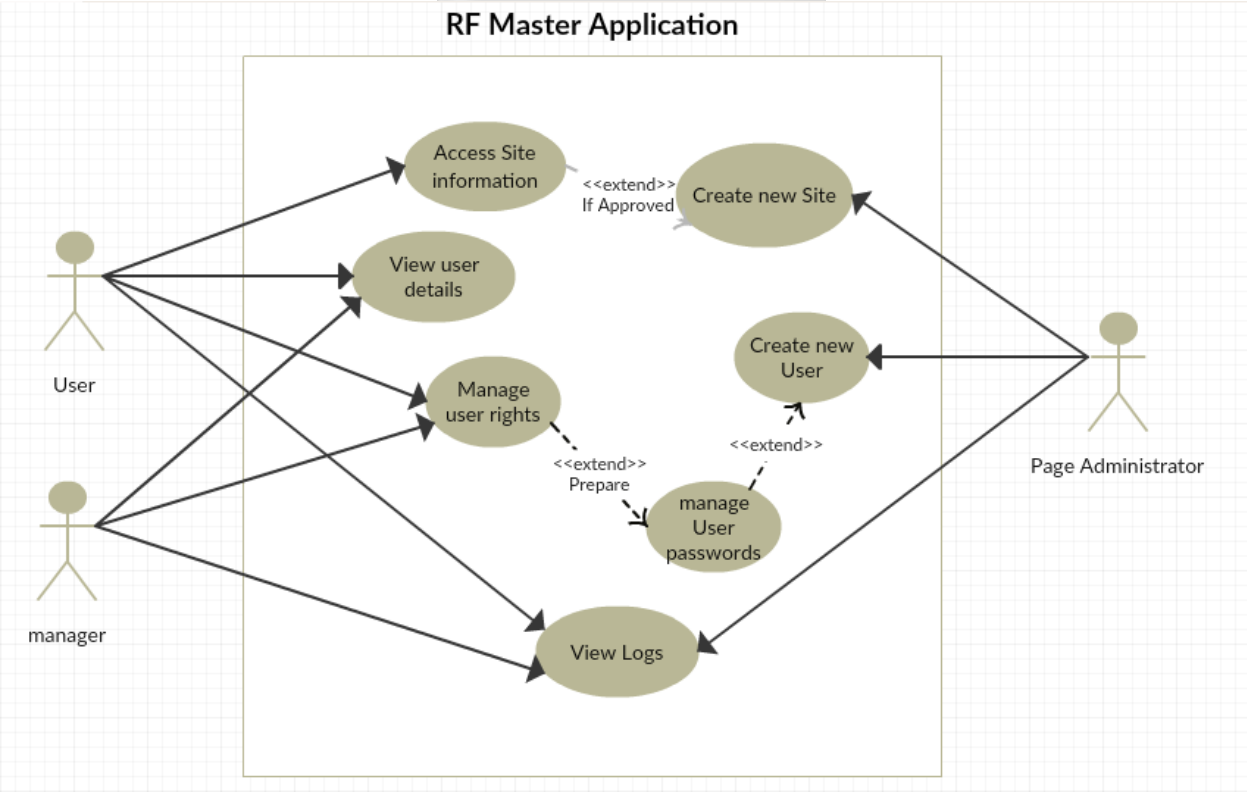

Figure 5.4: Use case diagram

5.6 Use Case Descriptions

These are tables showing the actors and descriptions of the major use cases that have been adopted into the project solution.

Table 5.1: Use case description for create user

Use Case ID	001
Use Case Name	Create User
Actor	System Adminstrator
Description	Creates a user in the system
Pre-conditions	User must be management or field Engineer
Post Conditions	User should be able to access app services
Major inputs	Username and Password
Major Outputs	Login Success
Includes	Access rights definition
Special Requirements	Employee Verifications
Assumptions	None

Table 5.2: Use case description for delete user

Use Case ID	002
Use Case Name	Delete User
Actor	System Adminstrator
Description	Remove user from the system
Pre-conditions	User is created in the system
Post Conditions	User is removed from the system
Major inputs	Username
Major Outputs	User deleted
Includes	Remove all rights
Special Requirements	Employee Verifications
Assumptions	User no longer needs services

Table 5.3: Use case description for get site information

Use Case ID	003
Use Case Name	Get Site Information
Actor	User
Description	View information about a site
Pre-conditions	Successful login
Post Conditions	Logout from the system
Major inputs	Username, password, site id, site name
Major Outputs	Azimuth, Tilts, Antenna type, Site Name
Includes	Options to update database
Special Requirements	Employee Verification
Assumptions	Engineer is at location

Table 5.4: Use case description for update site information

Use Case ID	004
Use Case Name	Update Site Information
Actor	User
Description	Upload changes to database
Pre-conditions	Successful Login
Post Conditions	Database Updated Successfully
Major inputs	Site Information
Major Outputs	Database updated
Includes	Options to be updated
Special Requirements	Employee Verification
Assumptions	Engineer is at location

Table 5.5: Use case description for view logs

Use Case ID	005
Use Case Name	View logs
Actor	Management
Description	View who makes changes to sites
Pre-conditions	Management credentials
Post Conditions	View all logs
Major inputs	Username and password
Major Outputs	User Logs
Includes	Site information
Special Requirements	Manager verification
Assumptions	None

Table 5.6: Use case description for help

Use Case ID	006
Use Case Name	Help Information
Actor	Management, Adminstrator, Users
Description	How to use the system
Pre-conditions	Succesful login
Post Conditions	View Help information
Major inputs	Username and password
Major Outputs	Help
Includes	Site information
Special Requirements	User verification
Assumptions	None

5.7 Class Diagram

The following is a brief diagram that describes the structure of this application system by showing the system's classes, their attributes, operations (or methods), and the relationships among objects. A class diagram for the application is shown in Figure 5.5. It mainly shows how the systems main class functions will interact to deliver results to users who have logged into it.

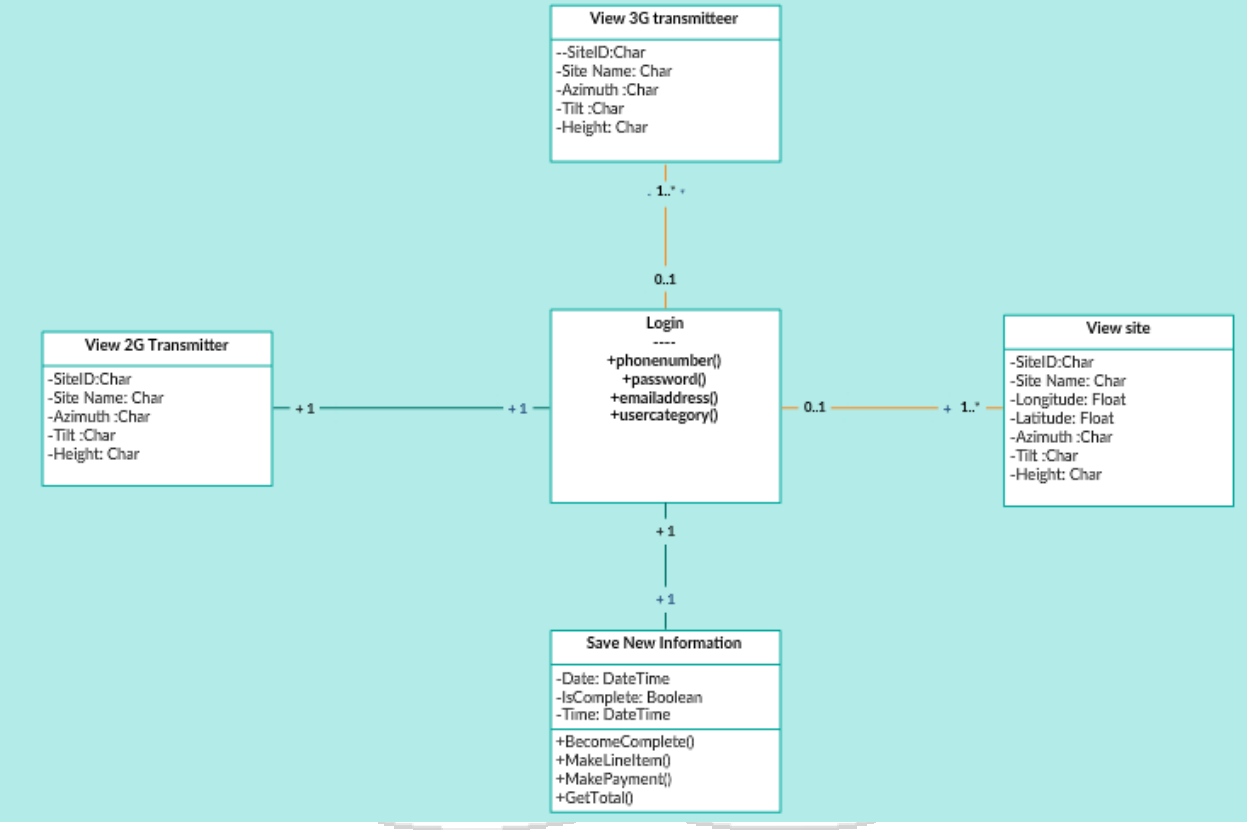

Figure 5.5: Class diagram

5.8 Summary

This chapter has explained and discussed the overall design of the system including its database components and architecture. It displays the data flow diagram of the system alongside the relationship of its particular attributes in the database. It is important for understanding the thinking behind the design of the system as opposed to a choice of other existing models.

CHAPTER 6: SYSTEM IMPLEMENTATION AND TESTING

6.1 Introduction

This application was developed and tested on an actual mobile phone using a computer hosted query server as the source of the information. This chapter breaks down the development and tests carried out into the two major parts of the client side implementation, which would refer to the mobile phone and the server side implementation.

The chapter also goes on further to display how the administrator's portal was designed and implemented to ensure efficient support is put in place for running the application services. The actual code that was used to achieve the functionalities described below is annexed in the appendix section of this dissertation document.

6.2 Implementation Environment

Android is a relatively new platform. It is produced by Google, Inc., and its first release was presented in 2007 (Meier, 2010, p.90). Android is installed on many different mobile devices and its users can download Android apps and other content through Google Play service, which replaced the old Android Market (Bishop, 2012, p.76).

Android has emerged as a new mobile development platform, building on past successes while avoiding past failures of other platforms. Designed to empower mobile software developers to write innovative mobile applications, Android is open source platform, with no up-front fees, and developers enjoy many benefits over other competing platforms.

An open source platform for mobile, embedded and wearable devices Google is the principle maintainer other companies contribute to the system. Each device manufacturer can customize android to suit their needs. The android architecture design is as shown in Figure 6.1 below.

Figure 6.1: Android architecture

This dissertation discusses technologies incorporated in Android application development and how they apply to the research problem. As the official Android website describes this platform, "Android is a software stack for mobile devices that includes an operating system, middleware and key applications" (What is Android, 2012, p.13).

Android provides the "core set of applications including an email client, SMS program, calendar, maps, browser, contacts, and others" (What is Android, 2012, p.13), while additional applications can be downloaded through Google Play service (Bishop, 2012, p.54). Google (n.d.) claims that "Android powers millions of phones, tablets and other devices." Phones and tablets are mobile devices that can have Android applications installed on them.

These applications are written in Java programming language ("What is Android," 2012) and they are called mobile device applications or apps. Development techniques for apps are structured sets of Java code focused on implementing particular task that provides content for a mobile device application.

6.3 Programming Language Used

Eclipse IDE was used in the development and integration of this mobile application. Eclipse is an open source, extensible Integrated Development Environment (IDE) that is very popular among Java programmers. It runs on most versions of Windows, Red Hat and SuSE Linux, Solaris, Macintosh OS X and other platforms. It has a Java editor that finds all syntax errors as you type.

An example of a hello application when eclipse environment is started is shown in Figure 6.2 below.

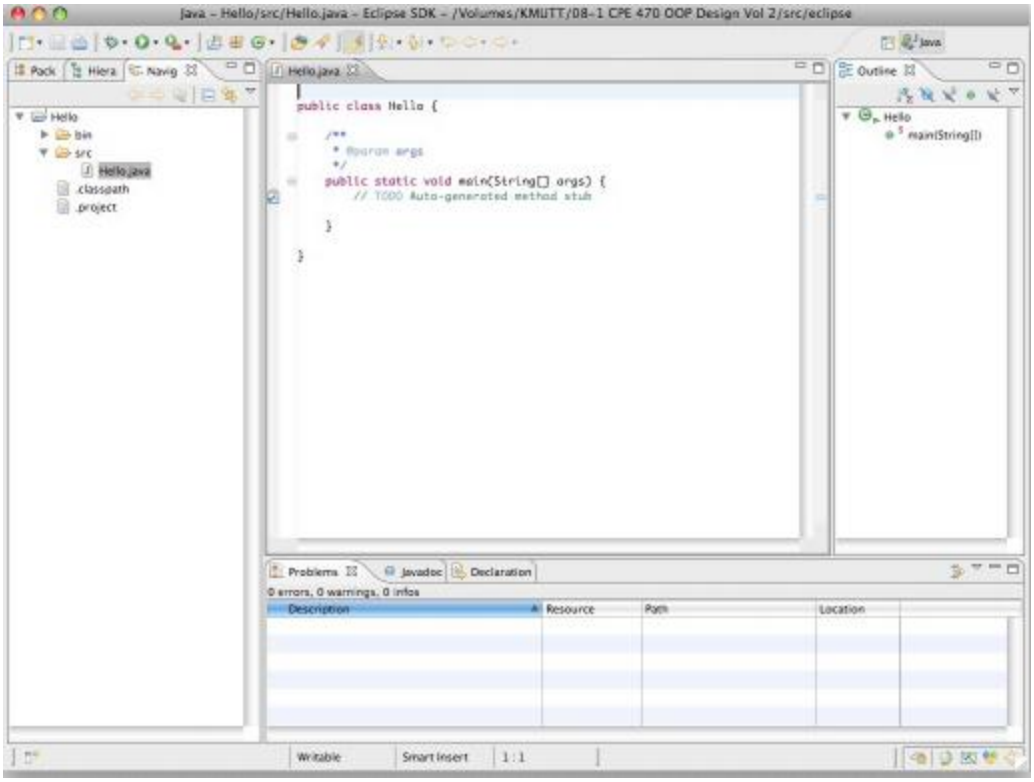

Figure 6.2: Eclipse Platform

6.4 Mobile Application Implementation

This optimization Android Mobile Portal is fully developed and tested on an actual device. The application's file structure is presented in the Figure 6.3 below. This is how the application appears on the eclipse android studio development platform.

The file structure is broken down into three major noticeable parts namely:

i. Manifest

ii. Main java file

iii. Resources file

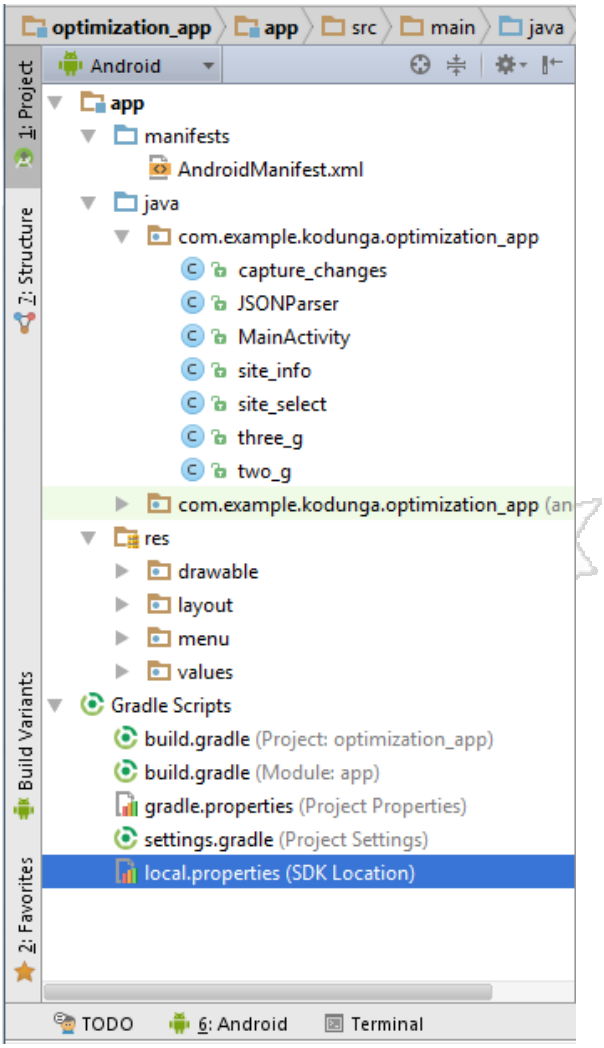

Figure 6.3: Optimization Application File Structure

As shown, the application was implemented with six different java classes. The main one is MainAcivity.java that usually runs when the application has been started. It provides the landing page for the user and its graphical interface design is as shown in Figure 6.4 below.

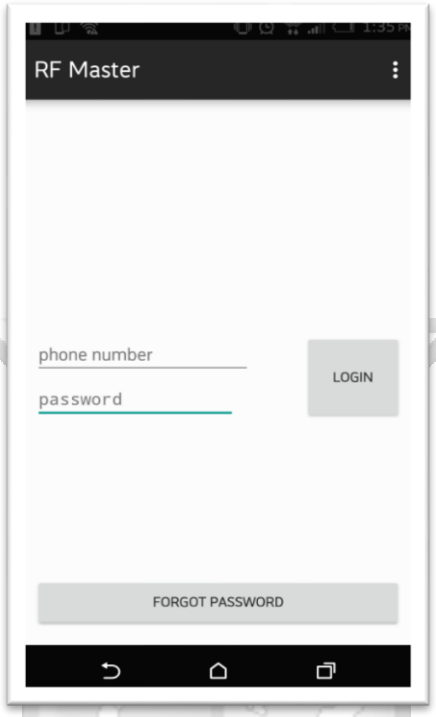

Figure 6.4: Main Activity GUI

This homepage allows validated users to log into the system by providing a previously created username and password. It further implements security features by denying access to the system if the password is not correct. The password provided should match the user's phone number as defined in the database system.

If this is not correct, the user will be notified of the failure to access the system but will not be told exactly what the main problem is. This is also an added layer of security against such attacks as brute force attacks whereby if a hacker knows a username, he or she can run as many passwords against that username as possible.

The error that is displayed on the screen upon attempting to enter wrong details is as shown Figure 6.5 below.

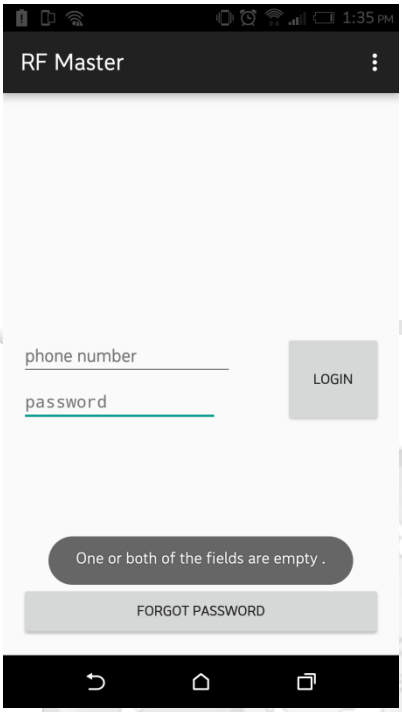

Figure 6.5: Login Failure Error Message

If the user supplies the correct username and password to the system without any errors, the system will alert him of an attempt to login as it tries to establish contact with the server database for authentication. See Figure 6.6.

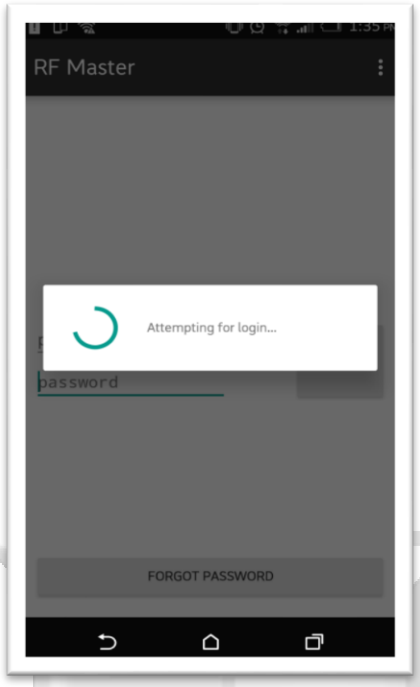

Figure 6.6: Login Attempt

A successful authentication and connection process will take the mobile application user to the main page of the application which is shown below. This page will give the user the options of inputting information that is relevant to what he wants to see.

The network, as had been mentioned earlier in literature review, is divided into two main technologies of interest but both technologies are housed in a single site. These are the second generation technology also referred to as 2G and the third generation technology also referred to as 3G.

If the user wants information regarding the site itself, for example it exact coordinates or the name and contacts of the ground person in charge of it, he enters the site number in the site field and queries, and the application will provide this information as shown in Figure 6.7 below.

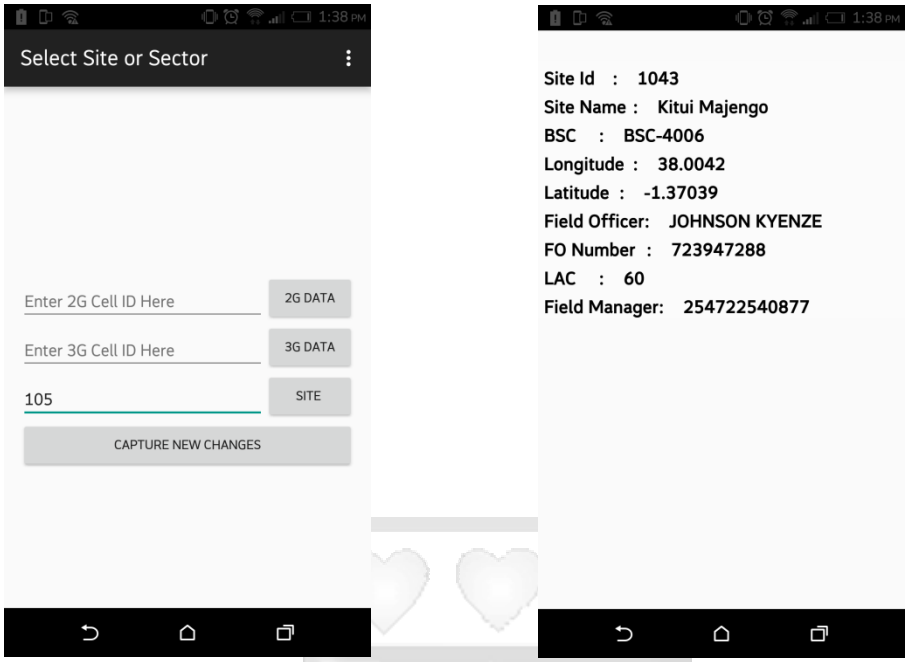

Figure 6.7: Site Information Request and Site Information reply

A similar process has been implemented and tested for both queries for the second generation network and the third generation network. However, the key differentiator of the fields for these two databases has been selected as the transmitter number, which is a field that derives its uniqueness from combining the site number and the number of the antenna, labeled differently for both technologies and for the three transmitters of each technology.

Figure 6.8 shows the process for the second generation technology while Figure 6.9 has a similar process display for the third generation technology cells.

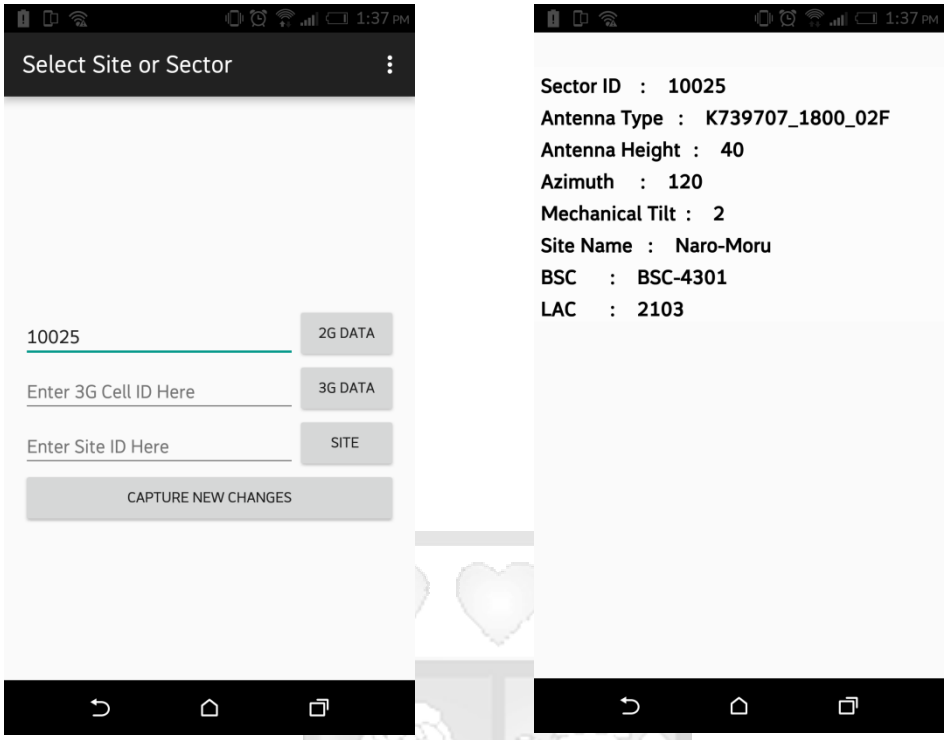

Figure 6.8: 2G Information Request and Site Information reply

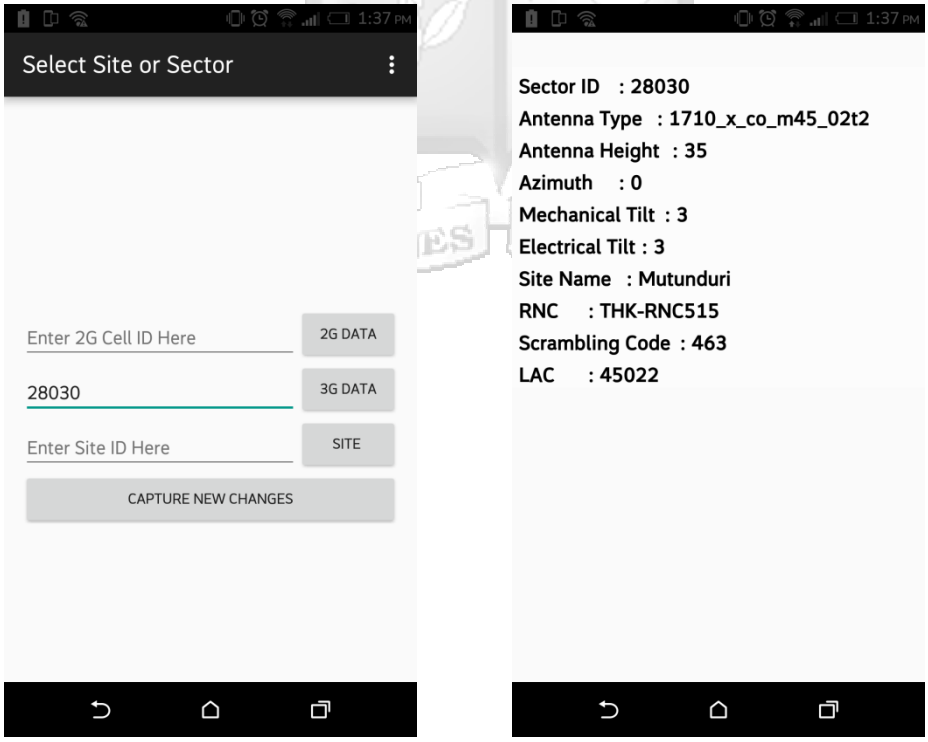

Figure 6.9: 3G Information Request and Site Information reply

If in any case the user has forgotten his or her password, he will tap on the “forgot password” button and an email notification will be sent to the administrator of the system to contact him and assist him in recreating the credentials, see an illustration in Figure 6.10.

Due to the sensitive nature of the information and to prevent users from unnecessarily interacting with the system to overload it with creation of new passwords, only the administrator has the privileges of creating a new site and updating user details in the system.

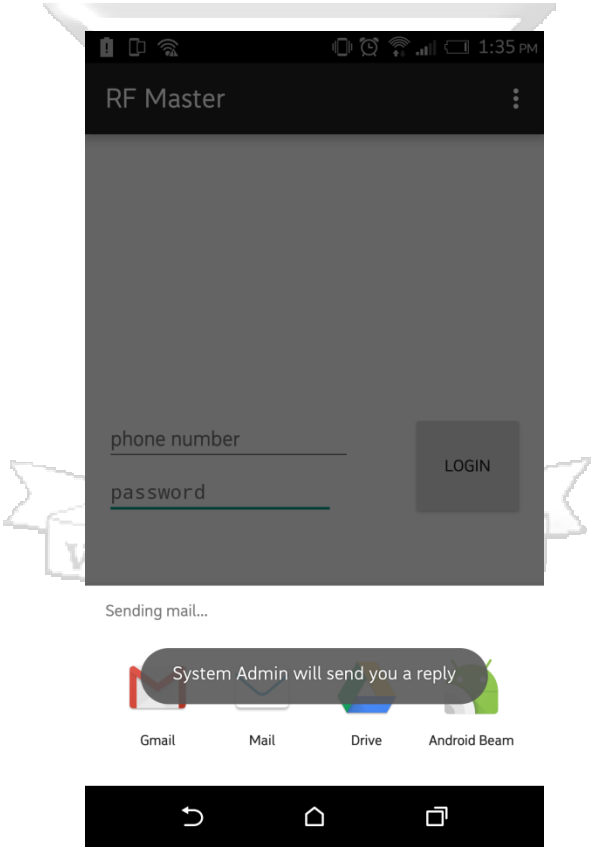

Figure 6.10: Password recovery

The full implementation of the mobile application will yield a home page application that will appear on the users phone screen as shown in the Figure 6.11 below.

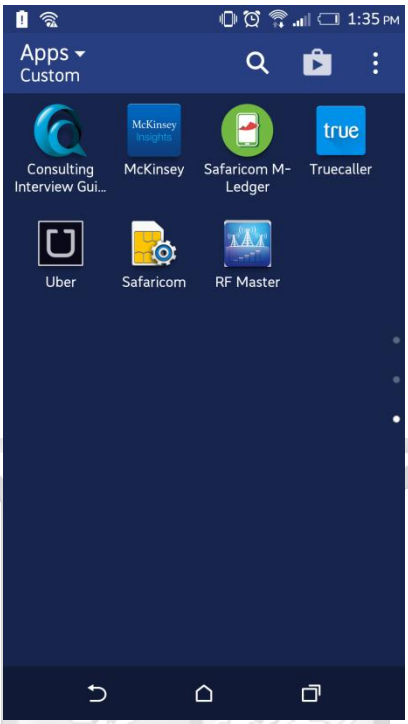

Figure 6.11: Application as it appears on a phone

6.5 Administrators Web Portal Implementation

This portal provides for a simple way for the database administrator to access and retrieve relevant information about the application, its users and its content. Like the mobile application, it is implemented with security layers to prohibit malicious or accidental access that may lead to loss of data or its misuse.

The user is taken first to the home page which requires them to provide accurate login credentials of a username and its matching password. These are verified against accepted security standards of removing hashes that might be used to go around the password measures.

The ease of use is implemented in such a way that the user is exempted from checking for spaces in his or her entered username as the webpage is actively filtering them. Simplicity is also observed in the page which has few details that are required for access to the system only. See the Figure 6.12 below.

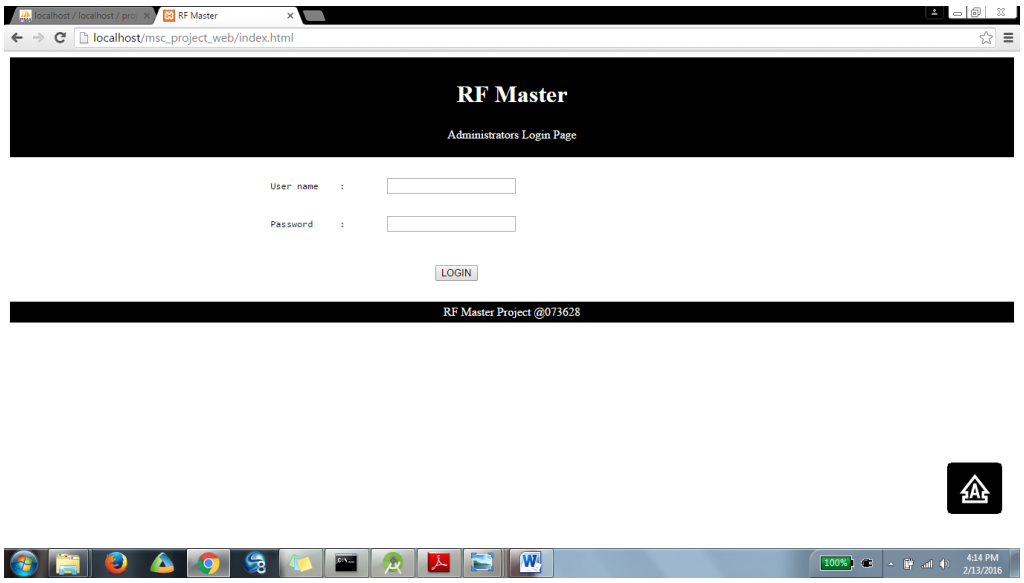

Figure 6.12: Admin Portal home page

If successful authentication and connectivity are done, the user is then taken to the landing page from where he can navigate to a number of links that cover all the work that has been allowed to be performed by the webmaster. These include such tasks as adding new users, deleting existing users of the mobile application, viewing sites and deleting them. Figure 6.13 has shown some all the tasks that an administrator can carry out from the landing page.

Functions of site addition and administrator account creation are done independent of this system. The new sites will be added by planning engineers who have the requisite tools and skills for this job. Creation of the system administrators is usually encoded into the system when acquired, but for this case, it can manually be edited in the phpmyadmin columns.

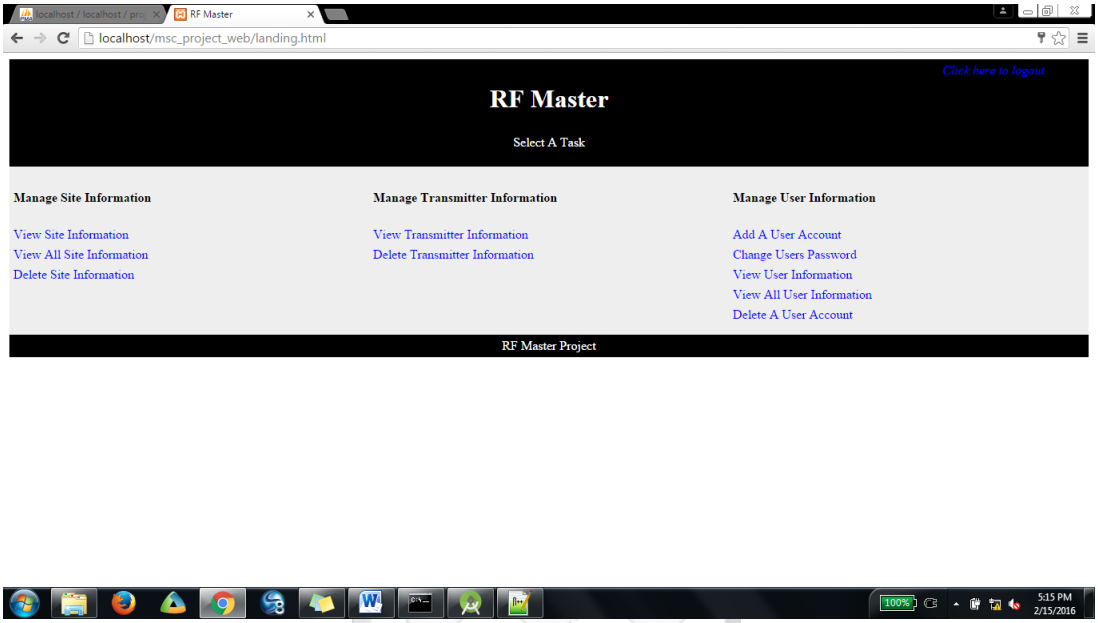

Figure 6.13: Admin Landing page

An example of a task generation activity is shown below where the admin wants to view all the user information of the mobile application users as in Figure 6.14 below.

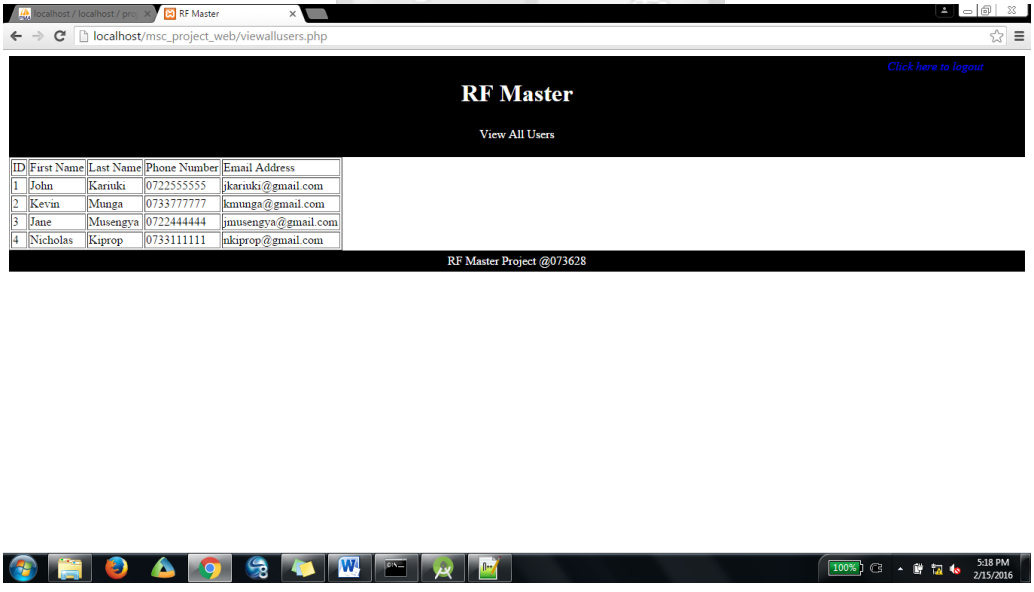

Figure 6.14: Results Output

CHAPTER 7: DISCUSSION AND FINDINGS

7.1 Introduction

In this chapter the results and findings of this dissertation are correlated to the objectives and research questions that had been identified in chapter one. This chapter also discusses areas of further recommendation based on the research done and suggests areas that may be exploited for future work. The recommendations are based on the findings that were carried out during the preparation of this dissertation document and in the process of the mobile application development. The proposals for future work include areas that should be researched into but due to the limitations of this project were not looked into such as operation on a multi device platform.

7.2 Summary of Findings

The dissertation wanted to establish the kind of information that may be required by field engineers in their daily tasks of implementing changes. Several key pieces of data are crucial for an accurate and objective decision to be made. The engineer is unreliable if he or she were to solely rely on visual aids and instinctive judgment. Some of this information includes such items like the current antenna positioning in terms of height from the ground, azimuth from the true north and mechanical down tilts. It was also established that an automated solution can be designed to help address some of these challenges. This was fully implemented and its operation tested against set criteria of acceptance annexed in this document. The implementation was a success and the results were impressive. The Engineering division has not been left behind in trying to adopt some of abilities inbuilt into the mobile phones. This kind of automation has seen an improvement in efficiency, speed of delivery and quality of service.

Banking on these advantages, this dissertation research attempts to address one of the biggest challenges faced by engineering field teams in the telecommunication sector which is the difficulty of obtaining or correlating information on the grounds or site location with the data that is currently stored in relation to this site or the job at hand. The dissertation also looked at previous similar applications and their shortcomings. Most of them were company specific and could not be applied to the engineering field as in general. The developed application looks at the attributes as an input to the field engineering requirements and can be applied across board in any mobile telecommunication service provider.

7.3 Discussion

The objectives of this dissertation were achieved fully while the pending works and recommendations for future inclusion have been captured in the following section. In summary, the implementation of this dissertation in a larger industrial scale shows improvement in efficiency and delivery of solutions as shown in the time needed to deliver changes in the results sections. The solution proposes and implements an application that will be installed in the phones of the field engineers which they can use to query and update information on the go while at the site locations without having to go through the difficulties that are currently experienced.

Some of the problems faced by engineers in delivering their work include inability to get instant information about the sites which they are working on thus they have to make calls back to the office to the database administrator who then relays this information back to them through the phone call. Sometimes this information may not be accurate due to background noise or reply to wrong information. The situation worsens when the engineer is in a location where the coverage is poor and phone services are down, meaning that even the phone call can no longer be initiated to request for the much needed information. After making changes and collecting new data, it needs to be updated into the system and this again poses a new challenge especially because the field engineer has no access to the system until the time he gets back to his desk computer. This application provides a platform to address this challenge by saving notes taken while in the field and automatically sending them to engineers mail address with a particular reminder for him to commit the changes into the database system.

This works in two ways to ease the work of the field engineer, first, by acting as reminder for him or her because most of the time, changes committed in the ground or at site are usually not reflected in the database because of forgetfulness or loss of the document used to capture the change. Secondly, it reduces the cumbersome way of carrying notebooks along with scrap papers to the preferable way of only carrying your mobile phone. However, in going into production, factors of security and reliability must be looked into critically to ensure reliability of the system. If developed fully to its potential, I believe the project will be a resourceful application that will ease the amount of effort put by our engineers in delivering solutions.

Other than the problems, the engineers were also asked for a recommendation or what they thought would be the most suitable way to address some of the problems they were facing. These comments were collected and they have been analyzed and discussed further in the discussions and recommendations section of this document.

Several mobile applications currently available for field work in official application stores were surveyed. Each of these applications addresses different aspects of the engineer's data collection workflow. The existing mobile applications are an important step towards improving data collection for engineers on the field and have functionality that could help them become more efficient.

Unfortunately, all of the mobile applications have significant shortcomings that have prevented them from becoming more widely used. As new versions of these applications or entirely new ones are developed over time, these shortcomings may be addressed. These shortcomings may explain the lack of uptake from field engineers, and suggest the need for the development of new software of support.

CHAPTER 8: CONCLUSION

8.1 Introduction

The purpose of this dissertation was to research on the current methods of data access by telecommunication field engineers and the difficulties that they go through in trying to obtain crucial data for use in their day to day tasks. This was to be followed by another research into a possible solution and implementation of this solution for purposes of demonstration to show how automation can be used to address some of the difficulties found above.

8.2 Recommendations

The following recommendations are offered as possible ways to improve this dissertation:

i. Use a respondent's pool to determine the effectiveness of this application in providing a solution to the problem of data access and data updating. This will help to capture the input of one of the key stakeholders of this solution, the field engineer and how they feel about the solution.

ii. The diversification of the platform of access from the mobile to the laptops and tablets so that this solution can be accessed by anyone at any time without the limitations of device access. Say for example, if an engineer's mobile phone runs out of power, he or she should be able to do the same work but using may be a tablet or a phone.

iii. Standardization of inputs and outputs across different service providers and vendor platforms to enable the application to be used across different companies without being subjected to major changes of design. This will ensure rapid deployment and ease of user training as they get to continue doing what they are used to.

iv. Implementation of better security methods to protect provider information from malicious attacks from cyber hackers. Any breach of information may lead to misleading information being fed to the field engineers and this can cause confusion and lead to lack of trust in the system. User must be verified for authenticity before being allowed to submit information to the system to prevent compromise, and data transmitted over communication channels should be scrambled to prevent eavesdropping.

8.3 Future Work

i. Develop the application to be device independent

A device independent application would be one that can still be useful when used on any device other than the one it was developed for. The application should be okay whether the user's phone is on landscape or portrait mode and all the fields should be easily accessible. This can be provided for by providing for testing over a variety of mobile phones that are currently in the market with a particular emphasis on what the developers think may be the most commonly used devices by the field engineers.

ii. Develop the application to be platform independent

A platform independent application is one that has been modeled to run over any mobile device without experiencing any glitch or mishap in its operation regardless of the operating software on which the device is running on. In this case, it would be better for the application to be developed to be able to run on ios for apple devices and windows for Nokia devices. Currently it has been developed for only android phones and this might be limiting to the other users who don't have these phone models that run on android.

iii. Develop the user interface to an internationally acceptable standard

The design of user interfaces for machines and software, such as computers, home appliances, mobile devices, and other electronic devices, with the focus on maximizing the user experience. The goal of user interface design is to make the user's interaction as simple and efficient as possible; in terms of accomplishing user goals (user-centered design).Good user interface design facilitates finishing the task at hand without drawing unnecessary attention to it.

iv. Improve the interaction speeds to support over 100tps (transactions per seconds)

This is referred to as machine tuning and it involves the use of efficient systems to provide a faster response to submitted queries by databases and other computing devices. This may involve the use of faster machines or software upgrades to remove such things as bugs that may be hindering faster performance. This will lead to user satisfaction especially when the system is being accessed by multiple users at the same time, or during peak hours.

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APPENDIX A

Dissertation Budget

Table A.1: Dissertation Budget

ITEM	Approximate COST
2 Android capable Mobile Phones	50000
Computer Equipped with Android Developer Tools	30000
Database Server	Free
Printing Costs	5000
Research Costs	5000
Internet Costs	5000
Total	**95000**

Testing Plan

Table A.2: Testing Plan

ITEM	TEST	Item Check List	Comments
Graphical User Interface	Ease of Use an Understanding	Application Information	About Button
		Buttons Distribution	Simplicity
		Number of pages	Few
Back End Intergration	Connectivity to the database	Database is running	ok
		Database properly linked	ok
		Connectivity	Fast
Application Intergration	Expected Behaviour of buttons	Size	Big enough
		Color	Can be seen
		Response	Single Touch
E-Mail Communication	Send and Receive Emails	Can send mails	ok
		Can receive mails	ok
		No Internet	Buffer mails
Platform Independence	To be tested on different development platforms	Android	ok
		Windows	not ready
		Apple ios	not ready
Device Independence	To be tested on different phone models	samsung	ok
		htc	ok
		Nokia	not ready
Responsivity	Wake up time and command response time	Wake up time	less than one second
		Exit time	less than one second
Uptime	Availability tests	With network	ok
		Without Network	ok

APPENDIX B: Dissertation Schedule

Below is an approximate time schedule that shows the duration that each section took towards the completion of this dissertation.

Table B.1: Dissertation Schedule

ITEM / DATE	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16
Dissertation proposal											
Proposal Defense											
Application Development											
Database Design and Implementation											
Application Documentation											
End to end Application deployment											
Application Testing											
Project Presentation											
Follow up											

APPENDIX C: Administrator Web Portal Code

WEB PAGE STYLING

Styles.css

```
<style>
body, html {
height:100%;
}
a:link {
    color: #0000FF;
            text-decoration:none
}
h1{
    background-color:black;
    color:white;
            clear:both;
    text-align:center;
    padding:5px;
}
#header {
    background-color:black;
    color:white;
            clear:both;
    text-align:center;
    padding:5px;
}
#nav {
    line-height:25px;
    background-color:#eeeeee;
    height:520px;
    width:300px;
    float:left;
    padding:5px;
}
#navi{
    line-height:25px;
    background-color:#eeeeee;
    height:200px;
    width:440px;
    float:left;
    padding:5px;
}
#logger {
    float:right;
            }
#section {
    float:left;
}
#footer {
    background-color:black;
    color:white;
    clear:both;
    text-align:center;
    padding:5px;
}
</style>
```

HOME PAGE

Landing.html

```
<!DOCTYPE html>
<html>
	<head>
		<link rel="stylesheet" href="styles.css">
		<title>RF Master</title>
	</head>
	<body>
		<div id="header">
<div id="logger">
<i>
<a href="logout.php" >Click here to logout</a>
</i>
</div>
			<h1>RF Master</h1>
			<p>Select A Task</p>

		</div>
		<div id="navi">
		<h4>Manage Site Information</h4>
		<a href="viewsite.html">View Site Information<br></a>
		<a href="viewallsitedetails.php">View All Site Information<br></a>
		<a href="deletesite.html">Delete Site Information<br></a>
		</div>
		<div id="navi">
		<h4>Manage Transmitter Information</h4>
		<a href="viewtx.html">View Transmitter Information<br></a>
		<a href="deletetx.html">Delete Transmitter Information<br></a>
		</div>
		<div id="navi">
		<h4>Manage User Information</h4>
		<a href="adduser.html">Add A User Account<br></a>
		<a href="changeuserdetails.html">Change Users Password<br></a>
		<a href="viewuser.html">View User Information<br></a>
		<a href="viewallusers.php">View All User Information<br></a>
		<a href="deleteuser.html">Delete A User Account<br></a>
		</div>
		<div id="footer">
			RF Master Project


		</div>
	</body>
</html>
```

LOGIN PAGE

Login.php

```
<script>
function myFunctionfail() {
   alert("Check Username and/or Password");
}
</script>

<?php
include("db.php");
// Connect to server and select database.
$con = mysql_connect ($server,$user,$pass);
if (!$con)
 {
 die('Could not connect: ' . mysql_error());
 }
mysql_select_db($db, $con);
// username and password sent from form
$myusername=$_POST['username'];
$mypassword=$_POST['password'];
// To protect MySQL injection
$myusername = stripslashes($myusername);
$mypassword = stripslashes($mypassword);
$myusername = mysql_real_escape_string($myusername);
$mypassword = mysql_real_escape_string($mypassword);
$sql="SELECT * FROM pageadmin WHERE username='$myusername' and
password='$mypassword'";
$result=mysql_query($sql);
// Mysql_num_row is counting table row
$count=mysql_num_rows($result);
// If result matched $myusername and $mypassword, table row must be 1 row
if($count==1){
// Register $myusername, $mypassword and redirect to file landing.html"
session_register("myusername");
session_register("mypassword");
header("location:landing.html");
}
else {
        echo ' <script> myFunctionfail(); </script>';
        echo ' <script> window.location.href = "index.html"; </script>';
}
?>
```

VIEW SITES

Viewallsites.php

```
<script>
function myFunctionfail() {
   alert("Check Username and/or Password");
}
</script>

<?php
include("db.php");
// Connect to server and select database.
$con = mysql_connect ($server,$user,$pass);
if (!$con)
  {
  die('Could not connect: ' . mysql_error());
  }
mysql_select_db($db, $con);
// username and password sent from form
$myusername=$_POST['username'];
$mypassword=$_POST['password'];
// To protect MySQL injection
$myusername = stripslashes($myusername);
$mypassword = stripslashes($mypassword);
$myusername = mysql_real_escape_string($myusername);
$mypassword = mysql_real_escape_string($mypassword);
$sql="SELECT * FROM pageadmin WHERE username='$myusername' and
password='$mypassword'";
$result=mysql_query($sql);
// Mysql_num_row is counting table row
$count=mysql_num_rows($result);
// If result matched $myusername and $mypassword, table row must be 1 row
if($count==1){
// Register $myusername, $mypassword and redirect to file landing.html"
session_register("myusername");
session_register("mypassword");
header("location:landing.html");
}
else {
        echo ' <script> myFunctionfail(); </script>';
        echo ' <script> window.location.href = "index.html"; </script>';
}
?>
```

DELETE A USER

Deleteuser.php

```
<script>
function myFunctionsuccess() {
   alert("Successfully Deleted");
}
function myFunctionfail() {
   alert("Record Does Not Exist");
}
</script>

<?php
session_start();
$phone_number=$_POST['phone_number'];
include("db.php");
$con = mysql_connect ($server,$user,$pass);
if (!$con)
  {
  die('Could not connect: ' . mysql_error());
  }
else
{
mysql_select_db($db, $con);

$query = "DELETE FROM users where `phone_number` = '$phone_number' ";
$result = mysql_query($query) or die(mysql_error());
}
if( mysql_affected_rows()>0)
{
echo ' <script> myFunctionsuccess(); </script>';
echo ' <script> window.location.href = "landing.html"; </script>';
}
else
{
echo ' <script> myFunctionfail(); </script>';
echo ' <script> window.location.href = "deleteuser.html"; </script>';
}
?>
```

APPENDIX D: Mobile Application Code

MANIFEST

```
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
   package="com.example.kodunga.optimization_app" >

   <uses-permission android:name="android.permission.ACCESS_NETWORK_STATE" />
   <uses-permission android:name="android.permission.INTERNET" />

   <application
      android:allowBackup="true"
      android:icon="@drawable/ic_launcher"
      android:label="RF Master"
      android:theme="@style/AppTheme" >
      <activity
         android:name=".MainActivity"
         android:label="RF Master" >
         <intent-filter>
            <action android:name="android.intent.action.MAIN" />

            <category android:name="android.intent.category.LAUNCHER" />
         </intent-filter>
      </activity>
      <activity
         android:name=".site_select"
         android:label="@string/title_activity_site_select" >
      </activity>
      <activity
         android:name=".capture_changes"
         android:label="@string/title_activity_capture_changes" >
      </activity>
      <activity
         android:name=".two_g"
         android:label="@string/title_activity_two_g" >
      </activity>
      <activity
         android:name=".three_g"
         android:label="@string/title_activity_three_g" >
      </activity>
      <activity
         android:name=".site_info"
         android:label="@string/title_activity_site_info" >
      </activity>
      <activity
         android:name=".JSONParser"
         android:label="@string/title_activity_jsonparser" >
      </activity>
   </application>

</manifest>
```

LAUNCHER ACTIVITY

Mainactivity.java

```
package com.example.kodunga.optimization_app;

import android.support.v7.app.ActionBarActivity;
import android.os.Bundle;
import android.widget.Toast;
import android.content.Intent;
import android.view.View;
import android.view.View.OnClickListener;
import android.widget.Button;
import java.util.ArrayList;
import java.util.List;
import org.apache.http.NameValuePair;
import org.apache.http.message.BasicNameValuePair;
import org.json.JSONException;
import org.json.JSONObject;
import android.app.ProgressDialog;
import android.os.AsyncTask;
import android.util.Log;
import android.widget.EditText;
import android.view.Menu;
import android.view.MenuItem;

public class MainActivity extends ActionBarActivity {

    Button login, forgotPassword;
    EditText phone, pass;
    private ProgressDialog pDialog;
    JSONParser jsonParser = new JSONParser();
    private static final String LOGIN_URL = "http://192.168.173.1/project_msc/db_login.php";
    private static final String TAG_SUCCESS = "success";
    private static final String TAG_MESSAGE = "message";

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_main);

        phone = (EditText) findViewById(R.id.editText3);
        pass = (EditText) findViewById(R.id.editText2);
        login = (Button) findViewById(R.id.button);

        login.setOnClickListener(new OnClickListener() {

            @Override
            public void onClick(View v) {
                // TODO Auto-generated method stub
                new AttemptLogin().execute();
            }
        });

        forgotPassword = (Button) findViewById(R.id.button8);
        forgotPassword.setOnClickListener(new OnClickListener() {

            @Override
            public void onClick(View v) {
                // TODO Auto-generated method stub

                Intent i = new Intent(Intent.ACTION_SEND);
```

```
            i.setType("message/rfc822");
            i.putExtra(Intent.EXTRA_EMAIL, new String[]{"kodunga@gmail.com"});
            i.putExtra(Intent.EXTRA_SUBJECT, "Password Recovery");
            i.putExtra(Intent.EXTRA_TEXT, "Kindly send me my password");
            try {
               startActivity(Intent.createChooser(i, "Sending mail..."));
            } catch (android.content.ActivityNotFoundException ex) {
               Toast.makeText(MainActivity.this, "There are no email clients installed.", Toast.LENGTH_SHORT).show();
            }
            Toast.makeText(getApplicationContext(),
                  "System Admin will send you a reply", Toast.LENGTH_LONG).show();
         }
      });
   }


   class AttemptLogin extends AsyncTask<String, String, String> {
      /**
       * Before starting background thread Show Progress Dialog *
       */
      boolean failure = false;

      @Override
      protected void onPreExecute() {
         super.onPreExecute();
         pDialog = new ProgressDialog(MainActivity.this);
         pDialog.setMessage("Attempting for login...");
         pDialog.setIndeterminate(false);
         pDialog.setCancelable(true);
         pDialog.show();
      }

      @Override
      protected String doInBackground(String... args) {

         int success;
         String phone_number = phone.getText().toString();
         String password = pass.getText().toString();
         try {
            List<NameValuePair> params = new ArrayList<NameValuePair>();
            params.add(new BasicNameValuePair("phone_number", phone_number));
            params.add(new BasicNameValuePair("password", password));
            Log.d("request!", "starting");

            JSONObject json = jsonParser.makeHttpRequest(LOGIN_URL, "POST", params);

            // checking log for json response
            Log.d("Login attempt", json.toString());

            //success tag for json
            success = json.getInt(TAG_SUCCESS);
            if (success == 1) {
               Log.d("Login Successful!", json.toString());
               //Options.PHONE = phone_number;
               Intent ii = new Intent(MainActivity.this, site_select.class);//here Options.class is the activity where we will move once login is authenticated.
               finish();
               startActivity(ii);
               return json.getString(TAG_MESSAGE);
            } else {
               Log.d("Login Failure!", json.getString(TAG_MESSAGE));
               return json.getString(TAG_MESSAGE);
```

```
            }
        } catch (JSONException e) {
            e.printStackTrace();
        }

        return null;

    }

    /**
     * Once the background process is done we need to Dismiss the progress dialog asap * *
     */
    protected void onPostExecute(String message) {
        pDialog.dismiss();
        if (message != null) {
            Toast.makeText(MainActivity.this, message, Toast.LENGTH_LONG).show();
        }
    }

}
@Override
public boolean onCreateOptionsMenu(Menu menu) {
    // Inflate the menu; this adds items to the action bar if it is present.
    getMenuInflater().inflate(R.menu.menu_two_g, menu);
    return true;
}

@Override
public boolean onOptionsItemSelected(MenuItem item) {
    // Handle action bar item clicks here. The action bar will
    // automatically handle clicks on the Home/Up button, so long
    // as you specify a parent activity in AndroidManifest.xml.
    int id = item.getItemId();

    //noinspection SimplifiableIfStatement
    if (id == R.id.action_settings) {
        return true;
    }

    return super.onOptionsItemSelected(item);
}
}
```

JSON PARSER

JSONParser.java

```
package com.example.kodunga.optimization_app;

import java.io.BufferedReader;
import java.io.IOException;
import java.io.InputStream;
import java.io.InputStreamReader;
import java.io.UnsupportedEncodingException;
import java.util.List;

import org.apache.http.HttpEntity;
import org.apache.http.HttpResponse;
import org.apache.http.NameValuePair;
import org.apache.http.client.ClientProtocolException;
import org.apache.http.client.entity.UrlEncodedFormEntity;
import org.apache.http.client.methods.HttpGet;
import org.apache.http.client.methods.HttpPost;
import org.apache.http.client.utils.URLEncodedUtils;
import org.apache.http.impl.client.DefaultHttpClient;
import org.json.JSONException;
import org.json.JSONObject;

import android.util.Log;

public class JSONParser {

    static InputStream is = null;
    static JSONObject jObj = null;
    static String json = "";

    // constructor
    public JSONParser() {

    }

    // function get json from url
    // by making HTTP POST or GET mehtod
    public JSONObject makeHttpRequest(String url, String method,
                                      List<NameValuePair> params) {

        // Making HTTP request
        try {

            // check for request method
            if(method == "POST"){
                // request method is POST
                // defaultHttpClient
                DefaultHttpClient httpClient = new DefaultHttpClient();
                HttpPost httpPost = new HttpPost(url);
                httpPost.setEntity(new UrlEncodedFormEntity(params));

                HttpResponse httpResponse = httpClient.execute(httpPost);
                HttpEntity httpEntity = httpResponse.getEntity();
                is = httpEntity.getContent();

            }else if(method == "GET"){
                // request method is GET
                DefaultHttpClient httpClient = new DefaultHttpClient();
                String paramString = URLEncodedUtils.format(params, "utf-8");
```

```
            url += "?" + paramString;
            HttpGet httpGet = new HttpGet(url);

            HttpResponse httpResponse = httpClient.execute(httpGet);
            HttpEntity httpEntity = httpResponse.getEntity();
            is = httpEntity.getContent();
         }

      } catch (UnsupportedEncodingException e) {
         e.printStackTrace();
      } catch (ClientProtocolException e) {
         e.printStackTrace();
      } catch (IOException e) {
         e.printStackTrace();
      }

      try {
         BufferedReader reader = new BufferedReader(new InputStreamReader(
               is, "iso-8859-1"), 8);
         StringBuilder sb = new StringBuilder();
         String line = null;
         while ((line = reader.readLine()) != null) {
            sb.append(line + "\n");
         }
         is.close();
         json = sb.toString();
      } catch (Exception e) {
         Log.e("Buffer Error", "Error converting result " + e.toString());
      }

      // try parse the string to a JSON object
      try {
         jObj = new JSONObject(json);
      } catch (JSONException e) {
         Log.e("JSON Parser", "Error parsing data " + e.toString());
      }

      // return JSON String
      return jObj;

   }
}
```

MAKE CHANGES

Capture_changes.java

```
public class capture_changes extends ActionBarActivity {

   Button savechanges;

   @Override
   protected void onCreate(Bundle savedInstanceState) {
      super.onCreate(savedInstanceState);
      setContentView(R.layout.activity_capture_changes);

      savechanges=(Button)findViewById(R.id.button5);
      savechanges.setOnClickListener(new View.OnClickListener() {

         @Override
         public void onClick(View v) {
            // TODO Auto-generated method stub

            Intent i = new Intent(Intent.ACTION_SEND);
            i.setType("message/rfc822");
            i.putExtra(Intent.EXTRA_EMAIL  , new String[]{"kodunga@gmail.com"});
            i.putExtra(Intent.EXTRA_SUBJECT, "Commit Changes Made to Site");
            i.putExtra(Intent.EXTRA_TEXT   , "body of email");
            try {
               startActivity(Intent.createChooser(i, "Send mail..."));
            } catch (android.content.ActivityNotFoundException ex) {
               Toast.makeText(capture_changes.this, "There are no email clients installed.", Toast.LENGTH_SHORT).show();
            }
            Toast.makeText(getApplicationContext(),
                  "Your notes have been sent to your office email as a reminder", Toast.LENGTH_LONG).show();
         }
      });

   }

   @Override
   public boolean onCreateOptionsMenu(Menu menu) {
      // Inflate the menu; this adds items to the action bar if it is present.
      getMenuInflater().inflate(R.menu.menu_capture_changes, menu);
      return true;
   }
   @Override
   public boolean onOptionsItemSelected(MenuItem item) {
      // Handle action bar item clicks here. The action bar will
      // automatically handle clicks on the Home/Up button, so long
      // as you specify a parent activity in AndroidManifest.xml.
      int id = item.getItemId();

      //noinspection SimplifiableIfStatement
      if (id == R.id.action_settings) {
         return true;
      }
      return super.onOptionsItemSelected(item);
   }
}
```

LAYOUT FOR MAIN ACTIVITY

```
<RelativeLayout xmlns:android="http://schemas.android.com/apk/res/android"
   xmlns:tools="http://schemas.android.com/tools" android:layout_width="match_parent"
   android:layout_height="match_parent" android:paddingLeft="@dimen/activity_horizontal_margin"
   android:paddingRight="@dimen/activity_horizontal_margin"
   android:paddingTop="@dimen/activity_vertical_margin"
   android:paddingBottom="@dimen/activity_vertical_margin" tools:context=".MainActivity">

   <EditText
      android:layout_width="wrap_content"
      android:layout_height="wrap_content"
      android:inputType="textPassword"
      android:ems="10"
      android:id="@+id/editText2"
      android:hint="password"
      android:layout_below="@+id/editText3"
      android:layout_alignParentLeft="true"
      android:layout_alignParentStart="true" />

   <EditText
      android:layout_width="wrap_content"
      android:layout_height="wrap_content"
      android:inputType="phone"
      android:ems="10"
      android:id="@+id/editText3"
      android:hint="phone number"
      android:layout_alignParentTop="true"
      android:layout_alignParentLeft="true"
      android:layout_alignParentStart="true"
      android:layout_marginTop="203dp" />

   <Button
      android:layout_width="wrap_content"
      android:layout_height="wrap_content"
      android:text="Login"
      android:id="@+id/button"
      android:layout_alignParentRight="true"
      android:layout_alignParentEnd="true"
      android:layout_alignBottom="@+id/editText2"
      android:layout_alignTop="@+id/editText3" />

   <Button
      android:layout_width="wrap_content"
      android:layout_height="wrap_content"
      android:text="Forgot Password"
      android:id="@+id/button8"
      android:layout_alignParentBottom="true"
      android:layout_alignRight="@+id/button"
      android:layout_alignEnd="@+id/button"
      android:layout_alignParentLeft="true"
      android:layout_alignParentStart="true" />
</RelativeLayout>
```

LAYOUT ACTIVITY TO SELECT SITE

```
<RelativeLayout xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:tools="http://schemas.android.com/tools" android:layout_width="match_parent"
    android:layout_height="match_parent" android:paddingLeft="@dimen/activity_horizontal_margin"
    android:paddingRight="@dimen/activity_horizontal_margin"
    android:paddingTop="@dimen/activity_vertical_margin"
    android:paddingBottom="@dimen/activity_vertical_margin"
    tools:context="com.example.kodunga.optimization_app.site_select"
    android:id="@+id/viewID">

    <Button
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:text="2G Data"
        android:id="@+id/button2"
        android:layout_above="@+id/button3"
        android:layout_alignParentRight="true"
        android:layout_alignParentEnd="true" />

    <Button
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:text="3G DATA"
        android:id="@+id/button3"
        android:layout_centerVertical="true"
        android:layout_alignParentRight="true"
        android:layout_alignParentEnd="true" />

    <EditText
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:id="@+id/editText"
        android:hint="Enter 2G Cell ID Here "
        android:layout_alignBottom="@+id/button2"
        android:layout_alignRight="@+id/editText5"
        android:layout_alignEnd="@+id/editText5"
        android:layout_alignParentLeft="true"
        android:layout_alignParentStart="true" />

    <Button
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:text="CAPTURE NEW CHANGES"
        android:id="@+id/button4"
        android:layout_below="@+id/button9"
        android:layout_alignParentRight="true"
        android:layout_alignParentEnd="true"
        android:layout_alignParentLeft="true"
        android:layout_alignParentStart="true" />

    <Button
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:text="SITE "
        android:id="@+id/button9"
        android:layout_below="@+id/button3"
        android:layout_alignParentRight="true"
        android:layout_alignParentEnd="true" />

    <EditText
```

```
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:id="@+id/editText5"
        android:hint="Enter 3G Cell ID Here"
        android:layout_alignBottom="@+id/button3"
        android:layout_toLeftOf="@+id/button3"
        android:layout_alignParentLeft="true"
        android:layout_alignParentStart="true" />

    <EditText
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:id="@+id/editText8"
        android:hint="Enter Site ID Here"
        android:layout_alignBottom="@+id/button9"
        android:layout_toLeftOf="@+id/button9"
        android:layout_alignParentLeft="true"
        android:layout_alignParentStart="true" />
</RelativeLayout>
```

LIST SITES ACTIVITY

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:orientation="vertical" android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:background="#fffbfbfb">

    <TextView
        android:id="@+id/CELLID"
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
        android:paddingLeft="6dip"
        android:paddingTop="6dip"
        android:textColor="#000000"
        android:textSize="17dip"
        android:textStyle="bold" />
    <TextView
        android:id="@+id/Site_Name"
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
        android:paddingLeft="6dip"
        android:paddingTop="6dip"
        android:textColor="#000000"
        android:textSize="17dip"
        android:textStyle="bold" />
    <TextView
        android:id="@+id/BSC"
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
        android:paddingLeft="6dip"
        android:paddingTop="6dip"
        android:textColor="#000000"
        android:textSize="17dip"
        android:textStyle="bold" />
    <TextView
        android:id="@+id/Longitude"
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
        android:paddingLeft="6dip"
```

```
        android:paddingTop="6dip"
        android:textColor="#000000"
        android:textSize="17dip"
        android:textStyle="bold" />
    <TextView
        android:id="@+id/Latitude"
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
        android:paddingLeft="6dip"
        android:paddingTop="6dip"
        android:textColor="#000000"
        android:textSize="17dip"
        android:textStyle="bold" />
    <TextView
        android:id="@+id/Field_Officer"
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
        android:paddingLeft="6dip"
        android:paddingTop="6dip"
        android:textColor="#000000"
        android:textSize="17dip"
        android:textStyle="bold" />
    <TextView
        android:id="@+id/FO_Number"
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
        android:paddingLeft="6dip"
        android:paddingTop="6dip"
        android:textColor="#000000"
        android:textSize="17dip"
        android:textStyle="bold" />
    <TextView
        android:id="@+id/LAC"
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
        android:paddingLeft="6dip"
        android:paddingTop="6dip"
        android:textColor="#000000"
        android:textSize="17dip"
        android:textStyle="bold" />
    <TextView
        android:id="@+id/Manager"
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
        android:paddingLeft="6dip"
        android:paddingTop="6dip"
        android:textColor="#000000"
        android:textSize="17dip"
        android:textStyle="bold" />

</LinearLayout>
```

APPENDIX E: Questionnaire Introduction Letter

Date: ……

Field Engineer Name: …….

RE: ADMINSTRATION OF QUESTIONNAIRES

I am Kennedy Odunga, a post graduate student of Masters of Science Degree in Telecommunication Innovation at Strathmore University and am carrying out a research study on the ease and difficulty of accessing site data while out in the field for work assignments in the Telecommunication engineering division.

This letter is meant to request for your participation in responding to the questionnaire attached. I wish to assure you that the response gathered will be used for this academic research only. Any information that is submitted to me during the research process will be kept confidential.

Regards,

Kennedy Odunga Narotso

Student Number 73628

Strathmore University

Faculty of Information Technology

APPENDIX F: Dissertation Questionnaire

Kindly take some time and answer the following questions.

1. Company
   Safaricom [ ] Safaricom Contractor [ ]

2. Sex
   Male [ ] Female [ ]

3. Job Position
   Field Engineer [ ] Office Engineer [ ]

4. Do you go to site to carry out your work?
   Yes [ ] No [ ]

5. In your own opinion, is the current way of data access secure?
   Yes [ ] No [ ]

6. How do you record collected data?
   ……
   ……

7. What are some of the information that you need concerning sites and their sources?
   ……
   ……
   ……
   ……
   ……
   ……
   ……
   ……

8. If YES in question 4 above, to what extent do you agree with the following statements related to data access while in the field
   (1-Do not Agree, 2 – To a little extent, 3 – Not Sure, 4 – Somehow, 5 - To a great extent)

Question	1	2	3	4	5
Is the current system easy to use					
Do you get all the data that you need					
Is the data provided in good time					
Do you need this data to carry out your work					

9. What are other challenges that you face regarding data access? (Example, speed, quality, accuracy and so on).

   ……

   ……

   ……

10. How important are the following features to your job in a new automated system regarding data access?
    (1-Not important, 2 – To a little extent, 3 – Not Sure, 4 – Somehow, 5 - Important)

Feature	1	2	3	4	5
Security of data					
Accuracy of data					
Speed of data access					
Availability of data					

11. What are your suggestions for an improved method of data access?

    ……

    ……

    ……

THANK YOU

APPENDIX G: Questionnaire Results

Bio Data

Number of Participants	100
Number of valid Responses	70
Gender	Male =90% ,Female = 10%
Company	Safaricom (100%)
Field Engineer	Yes (80%), No (20%)

Table G.1: Bio Data

New Features Proposed

Feature	Percentage Respondents
Security of data	40%
Availability of data	80%
Speed of data	70%
Accuracy of data	90%
More Information	30%
Ability to save edited information	20%

Table G.2: New Features Proposed

Information needed from the site

Information Required	Percentage Respondents
Antenna Azimuth	100%
Down Tilts	100%
Site Location	70%
Antenna height above ground	100%
Name of Site	30%
Site manager contacts	80%

Table G.3: Information needed from the site

APPENDIX H: Turnitin Report

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turnitin

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Assignment title:	MSc. MTI Proposal 2015
Submission title:	Kennedy Odunga, 73628
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File size:	122.86K
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Word count:	16,552
Character count:	99,522
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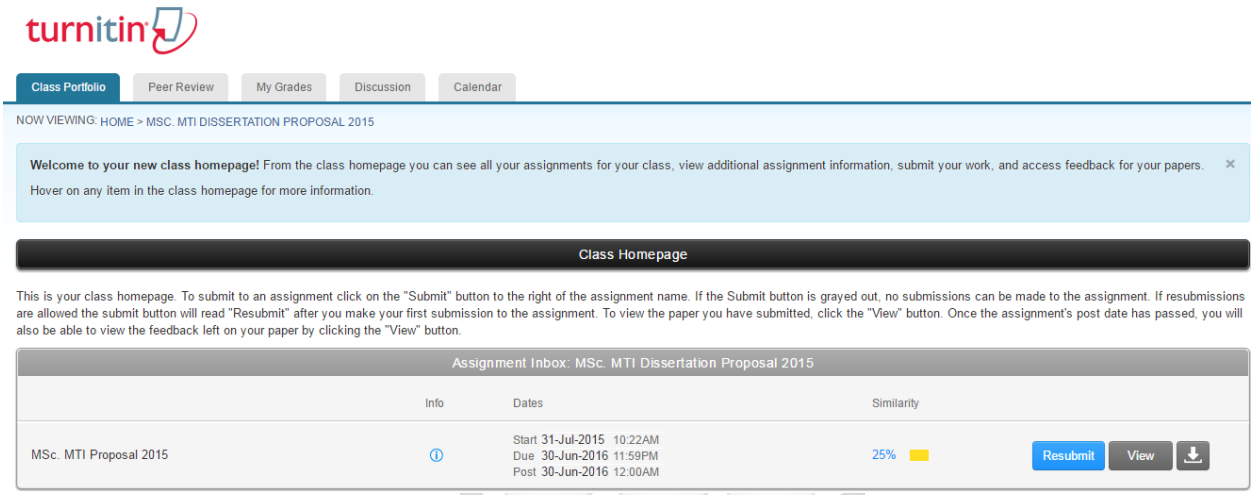

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