UNIVERSITI PUTRA MALAYSIA

DEVELOPMENT OF MINIMAST ANTENNA SYSTEM IN BASE TRANSMISSION STATION

MUHAMMAD SABIR HUSSAIN

DEVELOPMENT OF MINIMAST ANTENNA SYSTEM IN BASE TRANSMISSION STATION

By

MUHAMMAD SABIR HUSSAIN

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirements for the Degree of Master of Science

SEPTEMBER 2012

Dedication

Do they say: 'He has invented this Book himself?' Say: 'If that is so, bring ten surahs the like of it of your composition, and call upon all (the deities or gods) you can other than Allah to your help. Do so if you are truthful **(Surah Houd, Ayat # 13)**

I dedicate this humble effort, the fruit of my thoughts & study to my Parents (Muhammad Ramzan & Sehnaz), my Brothers (Babar, Jabir, Bilawal and Tayyab), and to all those who love me for their support and encouragement they provided me to achieve this goal.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

DEVELOPMENT OF MINIMAST ANTENNA SYSTEM IN BASE TRANSMISSION STATION

By

MUHAMMAD SABIR HUSSAIN

September 2012

Chairman: Nasri b. Sulaiman, PhD

Faculty : Engineering

Presently the cellular mobile technology is widely used as the major means of communication world wide. The day by day increasing demand has resulted in an incessant growth of traffic in cellular mobile communication system. For the successful use of cellular mobile technology, the designing in the coverage of antennas and signal time delay are the major technical challenges. Its difficulty is further accentuated due to the eternally limited availability of radio spectrum. For ultra dense urban environments where the cell site antennas are placed well below the rooftops of surrounding building, some innovative network architectures have been presented.

This thesis discusses the development of Minimast using the uplink and downlink performance of the Base Transmission Station (BTS) and air interference of antenna's were used to cover the growth of traffic in cellular mobile communication

system. The height of Minimast antenna was 20m and three antennas erected on it including one microwave with the frequency range of 2.3-2.4GHz. It was analyzed to determine the signal flows from BTS to antenna's and the usefulness of this design for radio frequency (RF) signals. A Radio Frequency Unit (RFU-C) System was fixed inside the BTS to connect fibre optic cable, microwave and Minimast design. The signals travelled from BTS to Minimast to cover the area using RFU-C System. It is measured that time duration of the signal flow was much lesser (25m) than the tower or monopole design in addition its comparitively lower cost. The results from the Minimast design clearly shows that the voltage standing wave ratio value of 1.21 at frequency 2.4 GHz is better than the previous value of voltage standing wave ratio at frequency 2.4 GHz is 1.08 using tower design. Moreover, Minimast design has lower height, covers more area of cellular system, less distorted signals and can be troubleshooted using Handheld 32-bit software.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PEMBANGUNAN SISTEM ANTENA MINIMAST DI STESEN PENGHANTARAN BASE

Oleh

MUHAMMAD SABIR HUSSAIN

September 2012

Pengerusi: Nasri b. Sulaiman, PhD

Fakulti : Kejuruteraan

Pada masa ini teknologi mudah alih selular digunakan secara meluas sebagai cara utama komunikasi di seluruh dunia. Permintaan yang kian meningkat hari demi hari telah menyebabkan pertumbuhan yang tidak berhenti-henti dalam system lalulintas komunikasi mudah alih selular. Untuk kegunaan teknologi mudah alih selular yang berjaya, rekaan dalam liputan antena dan isyarat masa lengah menjadi cabaran teknikal yang utama. Kesukarannya yang lebih menyerlah dilanjutkan oleh ketersediaan abadi yang terhad dalam spektrum radio. Bagi persekitaran bandar yang padat di mana antena tapak sel diletakkan di bawah bumbung sekitar bangunan, beberapa seni bina rangkaian yang inovatif telah dibentangkan.

Tesis ini membincangkan reka bentuk Minimast menggunakan prestasi sambung naik dan sambungan turun Stesen Tapak Pemancar (BTS) dan gangguan udara

antena telah digunakan untuk menampung pertumbuhan trafik dalam sistem komunikasi mudah alih selular. Ketinggian Minimast antena untuk ketiga-tiga antena yang didirikan di atasnya adalah 20m, dan ini termasuk satu gelombang mikro dengan julat frekuensi 2.3-2.4 GHz. Ia telah dianalisis untuk mengetahui aliran isyarat dari BTS ke antena dan menguji keberkesanan reka bentuk ini dalam penghantaran isyarat frekuensi radio RF. Sistem Unit Frekuensi Radio (RFU-C) telah ditetapkan di dalam BTS untuk menyambungkan kabel gentian optik, gelombang mikro dan reka bentuk Minimast. Isyarat-isyarat dihantar dari BTS ke Minimast untuk meliputi kawasan dengan menggunakan sistem RFU-C. Ia diukur untuk tempoh masa di mana aliran isyarat adalah 25m kurang daripada Menara atau reka bentuk Monopole di samping dengan kos yang lebih rendah. Hasil daripada reka bentuk Minimast jelas menunjukkan nilai VSWR adalah 1.21 pada frekuensi 2.4 GHz di mana lebih baik daripada nilai sebelumnya iaitu VSWR pada frekuensi 2.4 GHz 1.08 menggunakan reka bentuk menara. Di samping itu, reka bentuk Minimast mempunyai ketinggian lebih rendah, meliputi kawasan yang lebih dalam sistem selular, isyaratnya kurang dibenyotkan dan boleh diperbaiki dengan menggunakan pegangan 32-bit perisian.

ACKNOWLEDGEMENTS

In the name of Allah, The Most Merciful and Most Benevolent

I am extremely thankful to my supervisor, Dr Nasri b. Sulaiman for his inspiring encouragement and full support from the initial phase of implementation to completion and for diligence in reviewing the draft and final copies of the manuscripts.

I bow my head before Allah Almighty Who blessed me with good health and vision to accomplish this endeavor. These research investigations were supervised by Senior Lecturer Dr Nasri b. Sulaiman and Professor Nor Kamariah Binti Noordin . I wish to express my sincere thanks to worthy members of my supervisory committee for their consistent guidance, support and encouragement throughout the study period. Special thanks to the teaching faculty and staff of the faculty who provided me the advance knowledge and training in related fields. My special thanks are extended to Mr. Brain Kee, Dr Ammad ud Din, Dr Ng Chee Kyun and Dr Muhammad Babar Hussain for their encouragement and assistance during this period. To those individuals and agencies not mentioned, but who in one way or another contributed in the completion of this research work, thank you for your cooperation, JAZAKUMULLAH……..

Finally I wish to express my gratitude to my parents for their prayers, love, continuous support and encouragement. I would like to acknowledge that all these endeavours and achievements are endowed to my father Muhammad Ramzan, my mother Sehnaz , brothers, Babar, Jabir, DR Bilawal and especially my Loving brother Tayyab kaka for their love, patience and understanding they showed throughout this period.

I certify that a Thesis Examination Committee has met on 24th of September 2012 to conduct the final examination of **MUHAMMAD SABIR HUSSAIN** on his **Master of Science** thesis entitled "**Development of Minimast Antenna System in Base Transmission Station**" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U. (A) 106] 15 March 1998. The Committee recommends that the student be awarded the relevant degree.

Members of the Thesis Examination Committee were as follows:

Chairman, PhD
Professor
Faculty of Engineering, Universiti Putra Malaysia
(Chairman)

Examiner 1, PhD
Professor
Faculty of Engineering, Universiti Putra Malaysia
(Internal Examiner)

Examiner 3, PhD
Professor
Faculty of Engineering, Universiti Putra Malaysia
(External Examiner)

Zulkarnain Zainal , PhD
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

This thesis was submitted to the Senate of the Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

Nasri b. Sulaiman, PhD
Senior Lecturer
Faculty of Engineering
Universiti Putra Malaysia
(Chairman)

Nor Kamariah Binti Noordin, PhD
Professor
Faculty of Engineering
Universiti Putra Malaysia
(Member)

BUJANG BIN KIM HUAT, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

DECLARATION

I declare that the thesis is my original work except for quotations and citation which have been duly acknowledged. I also declare that it has not been previously and is not concurrently, submitted for any other degree at University Putra Malaysia or other institutions.

MUHAMMAD SABIR HUSSAIN

Date: 24 September 2012

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVATIONS

ARQ	Automatic Repeat Request
B	Width of Footing
BTS	Base Transmission Station
BSS	Base Sub Station
BSC	Base Station Controller
BTSM	Base Transceiver Station Management
c	Velocity of Light, c= 3 x 10^8 (m/s)
CN	Core Network
CCDP	Co-channel Dual Polarization
CDMA	Code Division Multiple Access
dB	Decibel
f	Frequency
HLR	Home Location Register
ISDN	Integrated Services Digital Network
L	Range
LOS	Line of Sight
MBS	Minimast Base Station
MGB	Minimast Grounding Bar
MS	Mobile System
NB	Narrow Band
OFD	Optical Fibre Distributor
OFDMA	Orthogonal frequency division multiple access
PSDN	Public Switched Telephone Network
QoS	Quality of Service
RR	Radio Resource management

RU	Radio Unit
RFU	Radio Frequency Unit
RAS	Radio Access Station
RRH	Remote Radio Head
SMS	Short Message Service
SDU	Surge Device Unit
Td	Time Delay
VSWR	Voltage Standing Waveform Ratio
V_{DD}	Positive Supply Voltage
V_{dsat}	Drain-source Saturation Voltage
V_{GS}	Gate-source Voltage
V_{th}	Threshold Voltage
WB	Wideband
W/L	Aspect Ratio
XPIC	Cross Polarization Interference Canceller
LTE	Long Term Evolution
LAN	Local Area Network
WAN	Wide Area Network
VOIP	Voice over Internet Protocol

CHAPTER 1

INTRODUCTION

1.1 Brief Introduction

Cellular mobile technology is one of the most rapidly developing fields in the past decades. According to the incessant growth of using mobile and telephone technology the demand is growing day by day and moves towards a Wimax technology. In the history of cellular technology records the development of interconnection between the public switched telephone systems to radio transceivers technology. Moreover, cellular technology and microprocessor control systems allow automatic and pervasive use of mobile phones for voice and data. Due to this growing demand, extensive research to develop latest and more compact equipment design are carried out by various organizations and institutions throughout the world to tackle the requirement needed for a cellular technology, compact, high cost and vigorous range of frequencies system. A design that has been introduced is Minimast design that is the most attractive and cheapest solution for that. If deeply noticed about Minimast in our surroundings, there are a lot of perfect examples. Like the height of Minimast is twenty five meter shorter than the other design like Tower, Monopole and Unipole equipment mostly used in industrial and commercial areas.

The pioneer of radio frequency (RF) cellular technology measurement is Reginald Fessenden's, who imagined the invention and generates the demonstration of radio telephony, through the Second World War with military use of radio telephony links. Mobile telephones for automobiles became available from few telephone companies

in the 1950s. The history of cellular technology is further divided into more than three generations (first, second, third and so on) to mark a significant step changes in capabilities of technology improved over the years. In December 1947 Philip T. Porter introduced the signal generation system through Tower design and in 1973 Fluhr and Nussbaum introduced a cellular telephone switching plan. By 2009, it had become clear that, at some point, 3G networks would be overwhelmed by the growth of bandwidth-intensive applications like streaming media. Consequently, the industry began looking to data-optimized 4th-generation technologies, with the promise of speed improvements up to 10-fold over existing 3G technologies. The first two commercially available technologies billed as 4G were the Wimax standard (offered in the U.S. by Sprint) and the long term evolution (LTE) standard, first offered in Scandinavia by Teliasonera. One of the main ways in which 4G differed technologically from 3G was in its elimination of circuit switching, instead employing an all-IP network. Thus, 4G ushered in a treatment of voice calls just like any other type of streaming audio media, utilizing packet switching over internet, local area network (LAN) or wide area network (WAN) networks via voice over internet protocol (VoIP). For the coverage of the time delay of signal distribution the design that was introduced is Minimast Design for 4G and further technology for erection of antennas transmission as shown in Figure 1.1. The height of Minimast antenna was 20m and three antennas were erected on it including one microwave with the frequency range of (2.3 – 2.4) GHz.

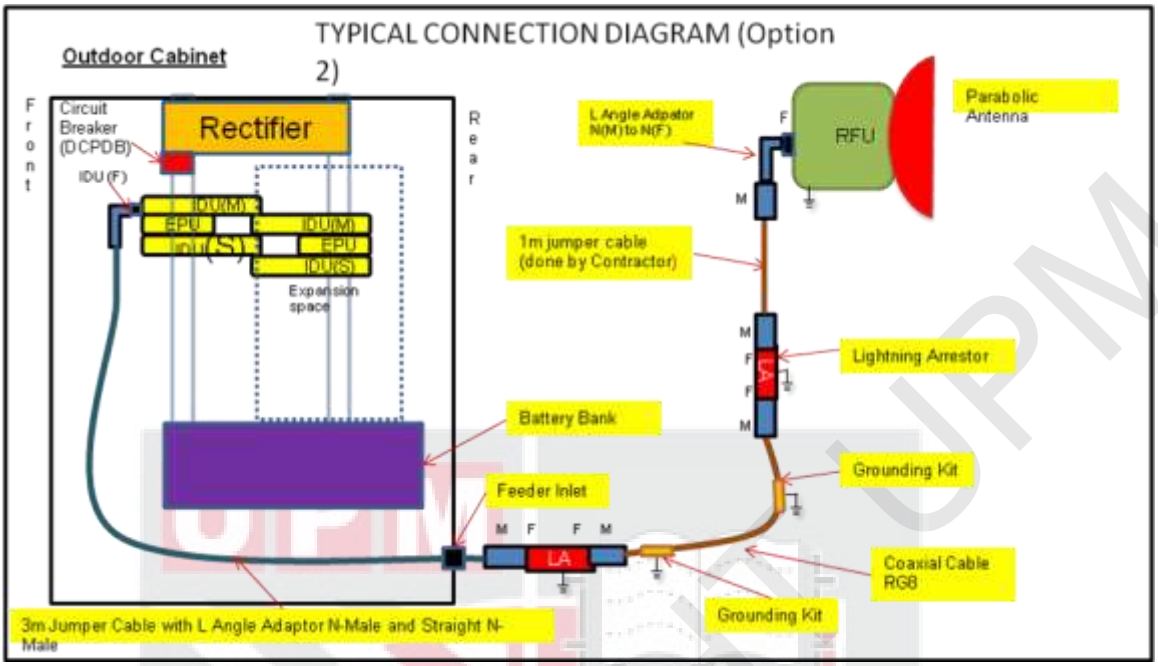

Figure 1.1: Minimast Design with RAS Rectifier and Antenna Distribution.

It was analyzed to determine the signal flows from BTS to antennas and the usefulness of this design to be used for RF signals. A radio access station (RAS) System that consists of rectifier, circuit breaker and internal device unit IDU, Eternal processing unit (EPU), Feeder inlet, jumper, adaptor, coaxial cable, lighting arrestor was fixed inside the BTS to connect through fibre optic cable to the microwave and Minimast antennas design. Then the signals travelled from BTS to Minimast to cover the area using RFU-C System. It has been concluded that time duration of the signal flow was faster than the tower or monopole design in addition to its comparatively less cost due to less metal used in Minimast development. Moreover Minimast design has lower height 20m,covers more area of cellular system, less distorted signals and can be troubleshooted using Handheld 32-bit software.

1.2 Problem Statement

Linearity of the signals mainly depends on the voltage standing wave ratio (VSWR). In Minimast technology, the method of choice for achieving high speed and highly efficient signal transfer is to reduce the distortion of signal, time delay of the signal that travel through fibre optic with a large range of frequency between 2.3GHz to 2.4GHz.

1.3 Aim and Objective

The aim of this research is to develop a Minimast system with three sectors of antennas to cover a large area of cellular system with frequency range of (2.3-2.4) GHz. In order to achieve this aim the objectives of the research are:

- To optimize the height of the Minimast.
- To optimize the angle of three sectors of antennas.
- To optimize the power consumption for base transmission station.

1.4 Scope of Work

There are varieties of methods which can be used to acquire the RF signals. Here the novel method of Minimast design is used to achieve this objective. The Minimast design consists of power transmission with three sector antennas, optical fiber networking, and OFD box for frequency distribution.

1.5 Thesis Layout

This thesis is composed of five chapters. The first chapter 1 is the introductory chapter and it provides basic background of the study, problem statement, objectives, and scope of the work.

Chapter 2 presents the review and analysis of several previous research works on mobile technology and different types of design antennas and microwave with tower and monopole. Moreover, a roughly compare preliminaries of Tower measurement with the other state of the art measurement principles i.e. radio access station (RAS) and fibre optic cable circulation. The basic working principles will be discussed, as well as typical advantages and disadvantages. Since 4G RF technology is proposed for this work, materials regarding Minimast design are reviewed. At the end of the Chapter there is an explanation of Minimast comparison.

Chapter 3 presents the methodology and research design to achieve the objectives of this work is discussed and explained.

Chapter 4, including the detailed discussions on results and findings on voltage standing wave ratio VSWR analysis. Moreover, there is comparison of Tower, Monopole and Minimast results are also shown. Each result has its own explanation and discussion according to the reviews. The results are verified and compared with previous works. A final discussion is also made to give the final words about the importance of this work.

Finally, in Chapter 5 a conclusion for this work is presented. Minimast Design is the most suitable equipment when to generate a signal through antenna and microwave due to its high gain, low power consumption and Design simplicity. Contributions from this work are also stated and ideas for future development of the RF Technology design are suggested.

REFERENCES

Bird, T. S. (2009). Definition and Misuse of Return Loss. IEEE Antennas & Propagation Magazine. vol. 51, no. 2, pp. 166-167.

Chen, Z., Yang, H., Wang, X., Wang, J., & Huang, X. (2011). Theoretical analysis and test for off-axis cassegrain optical antenna. vol. 7, no. 12.pp. 11-15

Charriere, P., Brouet, J., & Kumar, V. (1997). Optimum Channel Selection Strategies for Mobility Management in High Traffic TDMA – Based Network with Distributed Coverage. IEEE international Conference on Personal Wireless Communications. pp. 167-172.

Cardarilli, G. C., Di Nunzio, L., Fazzolari, R., Lenci, C., & Re. M. (2010). VLSI Implementation of Reconfigurable Cells for RFU in Embedded Processors. 17th IEEE International Conference on Electronics, Circuits, and Systems (ICECS 2010). pp. 1180-1183.

Demers, F., Yanikomeroglu, H., & St-Hilaire, M. (2011). A Survey of Opportunities for Free Space Optics in Next Generation Cellular Networks. pp. 210 - 216.

Guizani, M. (2004). Wireless Communications Systems and Networks Information Technology, Transmission, Processing and Storage. vol.15, pp.109-119.

Hunter, A. M., Ganti, R. K., & Andrews, J. G. (2010). Transmission capacity of multi-antenna ad hoc networks with CSMA. pp. 1577 – 1581.

Hill, G. (2007). The Cable and Telecommunications Professionals' Reference, Third Edition: PSTN, IP and Cellular Networks, and Mathematical Techniques.

Herscovici, N., & Christodouloc, C. (2003). Wideband monopole antennas for multi-band wireless systems. IEEE Antennas and Propagation Magazine. vol. 45, no. 2. pp. 266-279.

Karakayali, M. K., Foschini, G. J., & Valenzuela. R. A. (2006). Network Coordination for Spectrally Efficient Communication in Cellular Systems. vol. 13, pp. 56-61.

K. Huang, et al., (2009). Analysis of space off-axis and performance of cassegrain optical antenna system optic. pp. 29-37

Newton, H. (2011). Telecom Dictionary Telecommunications, Networking, Information Technologies, the Internet, Wired, Wireless, Satellites and Fibre. Broadband Microstrip Antennas by Artech House.

Ommer, B., & Buhmann, J. M. (2007). Learning the compositional nature of visual objects in Proceedings of CVPR. pp. 1–8.

Peters, S. W., & Heath, R.W. Jr. (2009). The future of Wimax multihop relaying. IEEE communication Magazine. vol. 47, no. 1, pp. 104-111.

Proakis, J. G. (2001). Digital Communication. 4th ed.McGraw-Hill. Xu, M.,& Petrou, M. (2011). Corrections 3D Scene interpretation by combining probability theory and logic. vol. 115, no. 11, pp. 1581-1596.

Sansoni, G., et al., (2009). State-of-The-Art and Applications of 3D Imaging Sensors in Industry, Cultural Heritage, Medicine, and Criminal Investigation. Sensors Journal. vol. 17, pp. 568-601.

Trainotti, V. (2002). MF AM folded monopole characteristics. IEEE Transactions on Broadcasting, vol. 4, no. 8, pp. 324-330.

Teizer, J. (2008). 3D Range Imaging Camera Sensing for Active Safety in Construction. vol. 13, pp. 103-117.

Wautier, A. (1996). Effects de la Reception Multisite dans UN Reseau da type GSM/DCS. Alcatel internal Report. pp. 108-119.

Zhang, Z. (2011). Antenna Design for Mobile Devices. John Wiley & Sons (Asia)