COVERAGE PERFORMANCE OF 3G RADIO NETWORK

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To my beloved family

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ABSTRACT

There has been an incredible growth in wireless communication technology over the past decade. The significant increment is in subscribers, traffic and data rate. The solution is the Wideband CDMA (WCDMA). All WCDMA systems have a relation between coverage and capacity. WCDMA radio link budget is mainly designed to estimate the allowable path loss in a 3G system. This result is then used to estimate the cell range covered by a base station. In this project, a GUI is created by using Visual C++ to enable the users to calculate the cell range or E_b/N_0 ratio easily. This project also mentioned about the relation between the coverage and E_b/N_0 ratio and how they could lead to a better cell range performance.

ABSTRAK

Teknologi wayarles komunikasi telah mengalami perkembangan yang tidak diduka sejak beberapa dekad yang lalu. Peningkatan yang paling ketara termasuk jumlah langganan, trafik dan kadar data. Penyelesaiannya ialah jalur lebar CDMA (WCDMA). Semua sistem WCDMA mempunyai hubungan di antara liputan and muatan. WCDMA pautan radio bujet telah direka khas untuk mengira “allowable path loss” dalam sistem 3G. Hasil kiraan ini kemudiannya akan digunakan untuk mengira julat sel yang dirangkumi oleh satu “base station”. Dalam projek ini, satu GUI akan direka dengan menggunakan Visual C++ untuk membolehkan pengguna mengira sama ada julat sel atau nisbah E_b/N_0 dengan mudah. Projek ini juga menjelaskan hubungan di antara liputan dan nisbah E_b/N_0 dan bagaimana kedua-duanya boleh memberikan julat sel yang lebih bagus.

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LIST OF SYMBOLS

A	-	Slope of the propagation model
BW	-	Bandwidth
B	-	Intercept of the propagation model
C/I	-	Carrier to Interference ratio
d_c	-	Cell range (distance between base station and mobile station)
d	-	Propagation distance between the transmitter and receiver
E_0/I_0	-	Received signal power spectral density ratio
E_b/N_0	-	Energy per bit to the thermal noise ratio
E_C/I_0	-	Pilot channel chip energy to received signal power spectral density ratio
$EIRP$	-	Equivalent Isotropic Radiated Power
f	-	Frequency of signal of interest
F	-	Noise figure
G_r	-	Gains for the receive antenna
G_t	-	Gains for the transmit antenna
h_b	-	Height of the antenna of the base station
h_m	-	Height of the antenna of the mobile station
Hz	-	Hertz
I	-	Total received interference in the base station
k	-	Boltzmann’s constant
l	-	Attenuation due to propagation through the environment
L	-	Interference margin
L_{sys}	-	Total system loss
N_0	-	Thermal noise density
PG	-	Processing gain
P_j	-	Received signal power from user j

P_L	-	Allowable path loss
P_N	-	Noise power
P_r	-	Received power at the receiver
P_t	-	Transmitted power
r	-	Maximum cell range
R_b	-	Bit rate
R_c	-	Chip rate
R_j	-	Bit rate of user j
S	-	Coverage area
T	-	Temperature in Kelvin
v_j	-	Activity factor of user j
W	-	Chip rate
α_j	-	Orthogonality factor
η_{DL}	-	Downlink loading factor
η_{UL}	-	Uplink loading factor

LIST OF ABBREVIATIONS

2G	-	Second Generation
3G	-	Third Generation
AC	-	Admission Control
AMR	-	Adaptive Mean Rate
BLER	-	Bit Error Rate
BS	-	Base Station
BSC	-	Base Station Controller
BSS	-	Base Station Subsystem
BTS	-	Base Transmit Station
CCPCH	-	Common Control Packet Channel
CN	-	Core Network
CPICH	-	Common Pilot Channel
CSR	-	Call Success Rate
DCR	-	Dropped Call Rate
DECT	-	Digital Enhanced Cordless Telecommunications
DRNC	-	Drifting Radio Network Controller
EIRP	-	Equivalent Isotropic Radiation Power
ETSI	-	European Telecommunication Standard Institute
EURO-COST	-	European Co-operative for Scientific and Technical Research
FACH	-	Fast Associated Channel
FCC	-	Federal Communications Commission
FDD	-	Frequency Division Duplex
FTP	-	File Transfer Protocol
GSM	-	Global System for Mobile Communications
GUI	-	Graphical User Interface
IMT-2000	-	International Mobile Telecommunications 2000

ITU	-	International Telecommunications Union
KPI	-	Key Performance Indicator
LOS	-	Line of Sight
ME	-	Mobile Equipment
MHA	-	Mast Head Amplifier
MMS	-	Multimedia Messaging Services
MSC	-	Mobile Switching Center
MUD	-	Multiuser Detection
NMS	-	Network Management System
PCH	-	Paging Channel
PCS	-	Personal Communications Services
PICH	-	Paging Indication Channel
QoS	-	Quality of Service
RACH	-	Random Access Channel
RAN	-	Radio Access Network
RBS	-	Radio Base Station
RF	-	Radio Frequency
RLB	-	Radio Link Budget
RNC	-	Radio Network Controller
Rx	-	Receiver
SIR	-	Signal-to-Interference ratio
SMS	-	Short Messaging Services
SNR	-	Signal-to-Noise ratio
SPA	-	Self Provided Applications
SRNC	-	Serving Radio Network Controller
TDD	-	Time Division Duplex
TDMA	-	Time Division Multiple Access
TE	-	Terminal Equipment
Tx	-	Transmitter
UE	-	User Equipment

UMTS	-	Universal Terrestrial Mobile System
USIM	-	User Subscriber Identity Module
WARC	-	World Administrative Radio Conference
WCDMA	-	Wideband Code Division Multiple Access
WLL	-	Wireless Local Loop

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CHAPTER 1

INTRODUCTION

1.1 Introduction

This report is mainly about the work done on the coverage performance of the 3G radio network. This report can be divided into five main chapters. Chapter 1 is the introduction about the project report structure, objective, scope and background.

Chapter 2 is the literature review on the WCDMA systems such as the history, the WCDMA characteristic, elements in the system, 3G system general planning and optimization.

The work that had been done in this project is described in Chapter 3. Chapter 3 described the parameters involved in the prediction on the cell range of WCDMA system and the way how to calculate the maximum cell range by generating the GUI using the Visual C++ programming language.

The result and discussion is presented in Chapter 4. The discussion is about the relation between E_b/N_0 and the cell range. Chapter 5 is the conclusion and the recommended future work.

1.2 Project Objective

The first objective of this project is to understand the concept of the 3G radio network planning and optimization, especially the architecture of the 3G radio network, and also the flow of the planning and optimization process. It is important to understand the considerations that must be taken into account during the planning and optimization process.

The second objective of this project is to generate a proper link budget for the 3G radio network. The link budget can be used to either calculate the cell range covered by a base station when the E_b/N_0 ratio is known or vice versa. The calculations of the cell range or E_b/N_0 ratio are focused on a specific environment for three different types of service, the voice service, the circuit-switched data and the packet-switched data. Each service has different data rate.

The third objective is to study how to optimise the coverage of the 3G radio network based on the cell range. Therefore, it is a need to study the parameters that affect the cell range because cell range is directly related to the network coverage. Since the E_b/N_0 ratio is the parameter that will affect most the cell range, the focus will be given to study the relationship between this parameter and cell range.

1.3 Project Scope

The scopes of this project including the literature review, creating a GUI and thesis preparation. The literature review helped to have a better understanding about the 3G radio network planning and optimization. The WCDMA radio link budget is created using the Visual C++ in order to simulate the input parameters and

output the desired result/s. The result/s could be the cell range or the E_b/N_0 ratio based on the user selection. After that, the result/s is analyzed to determine the relationship between the cell range and the E_b/N_0 ration. Thesis preparation is divided into two parts. The first part is the report writing for Project 1 while the second part, is the total thesis write-up for the whole project.

1.4 Project Background

As the world moved towards an internet booming age in the twenty first century, the requirement for data communication in mobile equipment become more important. With broadband system becoming main stream products in the world today, there is a need for more capacity to accommodate the increasing number of subscriber for the mobile system.

The concept of 3G is based on the global International Mobile Telecommunications (IMT-2000) initiative sponsored by the International Telecommunications Union (ITU) to create a unified global set of standards that will lead to commercial deployment of advanced wireless services. WCDMA was developed in order to create a global standard for real-time multimedia services, where it can support higher data rates, at anytime, anywhere.

Wideband-CDMA (WCDMA) is the air-interface technology widely used in the 3G radio network. WCDMA interface different users can simultaneously transmit at different data rates and data rates can even vary in time. Therefore, it is a need to study the techniques used in WCDMA in the radio network planning process and how to optimise the WCDMA performance especially for a better coverage.

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