UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN RADIO FREQUENCY PLANNING TOOL USING MATLAB SOFTWARE

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor's Degree of Electronics Engineering Technology (Telecommunication) with Honours

by

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Engineering Technology (Bachelor degree in Electronic Engineering Technology (Telecommunication)) (Hons.). The member of the supervisory is as follow:

……

(Project Supervisor)

ABSTRAK

Tujuan projek ini ialah untuk mengguna pakai frekuensi Spektrum bagi Operator GSM. GSM spektrum sangat terhad oleh itu Operator perlu berkongsi frekuensi. Salah satu cara untuk memanfaatkan frekuensi spektrum ini adalah dengan menguna semula frekuensi itu sekali lagi. Mengguna pakai frekeunsi ini memberi maanfaat dari segi liputan, kapasiti pengguna dan kualiti panggilan kepada Operator. Projek ini terbahagi kepada dua bahagian. Bahagian pertama mengetahui kehilangan gelombang magnet berdasarkan model propagation. Model tersebut adalah Okumura, Hata dan COST-231. Tiga model ini dianalisis berdasarkan jarak 5Km, 10Km dan 15Km di kawasan bandar. Bahagian kedua adalah Merancang frekuensi 9MHz dan membuat pembahagian frekuensi kepada tujuh kumpulan sel yang berbeza. Di dalam sel tersebut terdapat antenna sektor. Antenna sektor digunakan untuk tingkatkan kapasiti pengguna. Projek ini mengunakan perisian MATLAB (GUI).

ABSTRACT

The purpose of this project is to reuse frequency spectrum for the exiting operator of GSM. GSM spectrum availability is very limited because of that, the exiting operator need to share the spectrum frequency. One way to optimize the frequency spectrum is reuse the frequency. Frequency reuse provides cost effective in term of coverage, capacity and quality to the operator. The planning of the process divided into two parts. The first part begins with estimate signal path loss by using the propagation model. The model such as Okumura, Hata and COST-231. This project will compare and analysis three types path loss model at different distance of 5Km, 10Km and 15 Km in a suburban environment. Second part, frequency planning for 9 MHz and assign this frequency in seven cells. This cell consists of sector antenna. Sector antenna was used to increase the subscriber.this simulation based on MATLAB (GUI) software.

DEDICATION

To my beloved parents

Kadariyah Binti yup and my dearest sisters.

Thank you for your infinite loves.

I could not have done this without any one of you.

ACKNOWLEDGEMENT

Alhamdulillah, infinite thanks to Allah S.W.T that I finished my project in time. Without His bless and guidance, I could not complete this project successfully.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

AUC	-	Authentication Centre
ARFCN	-	Absolute Radio frequency Channel Number
BCH	-	Brocast Common Control Channel
BS	-	Base Station
BSC	-	Base Station Controller
BSS	-	Base Station Subsystem
BTS	-	Base Transceiver Station
CCH	-	Control Channel
DCCH	-	Dedicated Control Channel
EIR	-	Equipment Identify Register
FDMA	-	Frequency Division Multiple Access
FSL	-	Free Space Loss
GUI	-	Graphical User Interface
GOS	-	Grade of Service
GSM -	-	Global System For Mobile
HLR	-	Home Location Registry
ISDN	-	Integrated Service Digital Network
ITU	-	International Telecommunication Union
MS	-	Mobile Station
NSS	-	Network Subsystem
PSTN	-	Public Switch Telephone Network
TS	-	Time Slot
TCH	-	Traffic Channel
TDMA	-	Time Division Multiple Access
VLR	-	Visitor Location registry

CHAPTER 1
INTRODUCTION

GSM spectrum availability is very limited because of that, the exiting operator need to share the spectrum frequency. In order to solve this kind of problem a frequency planning is created so it can help the Operator improving coverage, capacity and quality efficiency.

1.1 Project Overview

GSM lies under a second generation system that replaced first generation analog system. There are many types GSM solutions known as GSM900 and GSM1800. In this research will more focus on the GSM 900 because it is widely used in the world. GSM 900 spectrum was deployed using 890-915MHz for uplink and 935-960MHz for downlink transmission. In Malaysia spectrum availability for an operator is very limited because of that, there need share spectrum frequency between other operators. The operator in Malaysia such as Telekom Malaysia, Celcom, Maxis, Digi and other. Besides, at the same time this operator need to cater to millions of subscribers. In order to serve millions of this subscriber, RF planning was introduced. RF planning is a process, assign frequency that provides cost effective in term of coverage, capacity and quality. In cellular radio system channel allocation and frequency reuse scheme are very important because it leads to bandwidth saving. Thus, to design this process, the cell has to be known first. Then, the frequency will assign for every cell

1.2 Problem Statement

With the increasing popularity of cellular telephony service, the subscriber increase drastically especially in metropolitan areas. This condition results traffic congestion since the existing operator cannot provide enough capacity for the user due to limit frequency spectrum. Because of that frequency interference will affect call performance. The alternative solution to provide operator can serve millions of this subscriber is by using frequency planning. So this frequency will be plan wisely to reduce interference.

1.3 Project Objective

There are three main objectives in this study which lead to project success. The objective of the project is to;

1) Assign frequency planning for GSM 900.
2) Frequency reuse and minimize interference.
3) Develop a simulation tool by using MATLAB software (GUI).

1.4 Project Scope

In order to achieve the objective of the study, the scope has been outlined. There are two parts in this project, which are Project Sarjana Muda I for the first semester and Project Sarjana Muda II for second Semester. By the first semester, include a literature review and methodology which more related about the project research and the concept of mobile cellular. While for second semester simulate result and discussion.

The scope of study includes;

1. Design GSM 900 with propagation model
2. Planning frequency planning
3. Design and develop user-friendly web based Graphical User Interface (GUI) in MATLAB.
4. Simulate the program.

1.5 Thesis Outline

The thesis outline is divided into two parts which is final year project 1 and final year project 2. The outlined as follows:

a) Final Year Project 1 Report.

The introduction is briefly discussed in chapter 1. In this chapter, the background of the research, such as the objectives, problem statement and scope of the project is mentioned. Chapter 2 is about the literature review of previous research regarding on mobile cellular. The methodology and procedures applied in this study are explained in details in chapter 3.

b) Final Year Project 2 Report.

Chapter 4 presents the result and discussion of this project. In this chapter, both, the result is compared to verify the performance of path loss. Finally the conclusion of this study and recommendation are summarized in chapter 5.

CHAPTER 2
LITERATURE REVIEW

This section present about literature review. Findings related to RF planning tool before design the Radio Frequency, need to understand the concept of Cellular system and how it works. The concept of Radio Frequency is described in more detail. In addition, the previous research based on RF planning also included in this chapter.

2.1 Introduction GSM

Global System for Mobile (GSM) is a second generation that replaced first generation analog system's was developed to solve the fragmentation problem of the first cellular system and it specifies digital modulation technique and network architecture.

2.1.1 GSM Structure

Figure 2.1 illustrates the GSM network and it divides into three main subsystem part which is the Base Station Subsystem, Network switching subsystem and Operation Maintenance Subsystem.

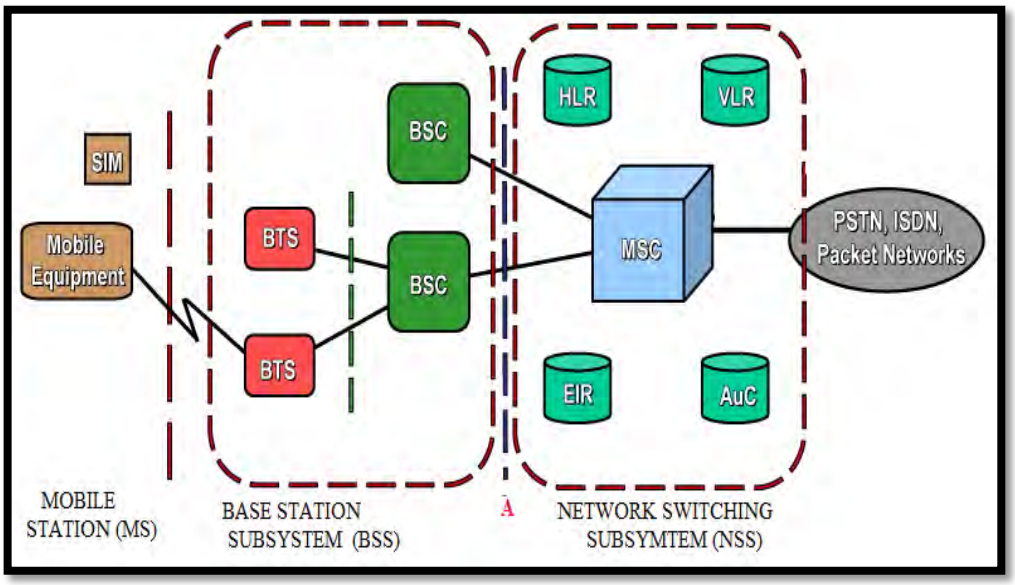

Figure 2.1 GSM Structure

2.1.2 GSM Air Interface

This air interface frequency band was assigned by the ITU. Generally there are two types of channel in air interface which is physical and logical. Physical channel are the entire time slot (TS) of the BTS. Since the radio spectrum is limited, TDMA and FDMA technique was used to divide bandwidth among user as possible. The original frequency band for GSM was 25 MHz.The forward and reverse frequency band are generally split into channel each 200KHz wide and they know as Absolute Radio Frequency Channel Number (ARFCN).It denotes forward and reverse channel pair and it separates the frequency 45MHz. TDMA concept can be used for time sharing to cover all the subscriber.

According to Arokiamary,V.J (2012)., Fundamental of TDMA scheme is called a burst period and lasts approx. 0.557ms. Eight burst periods are grouped into a TDMA frame (approximate 4.625ms) which form the basic unit for the definition of logical channels.one physical channel is one burst period per TDMA frame

2.1.3 Logical Channel

There are two types logical channels within GSM system;

- Traffic Channel (TCH)

  Traffic channel is used to transmit user data which can be voice, fax etc. This traffic can be full duplex or half duplex .Full duplex the data rate is 22.8kB/s and half duplex only 11.4KB/sin order to determine the number of TRX for each cell, it's necessary to estimate the amount of the user demand where this cell is used as best server by considering the amount of traffic and also Grade of Service (GOS).

- Control channel

  Carry signals and synchnous command between BS and MS. There consist 3 channels BCH, CCCH, DCCH. This research focuses on BCH only. BCH stands for Broadcast Channel Occasionally and monitor by mobile in the neighbour cell so that received a power and MAHO decision may be made by out of cell users.

2.2 Cellular Concept

The aspiration to communicate while on the move resulted in the genesis of cellular mobile communication. The service area is divided into smaller pieces called 'Cell'. This cell was developed by Bell Labs 1960's – 1970's. The shape in hexagon. Hexagonal shape of the cell provides the maximum processing density than any other geometrical shape. Besides, the hexagonal cells approximate circle in shape which can emulate the electromagnetic wave propagation equally in all directions and no overlapped area. So this cell can be drawn faster. Haiken, A. (2009) state that each cell has only 1 base station to cover service area and had a different frequency. In order to cover service area, omni or three sectors antenna are used.

2.2.1 Omni and Sector Antenna

According to Sharma.B (2007), Omni directional antenna can be used in the place where the traffic load very low or it is preferred for low subscriber capacity in rural area. While three sector antenna is preferred for high subscriber capacity in demand area such urban area. With Omni directional antenna it serves 360^0 angles and sectors have covered 180^0 ,120^0 and also $60^{0.}$

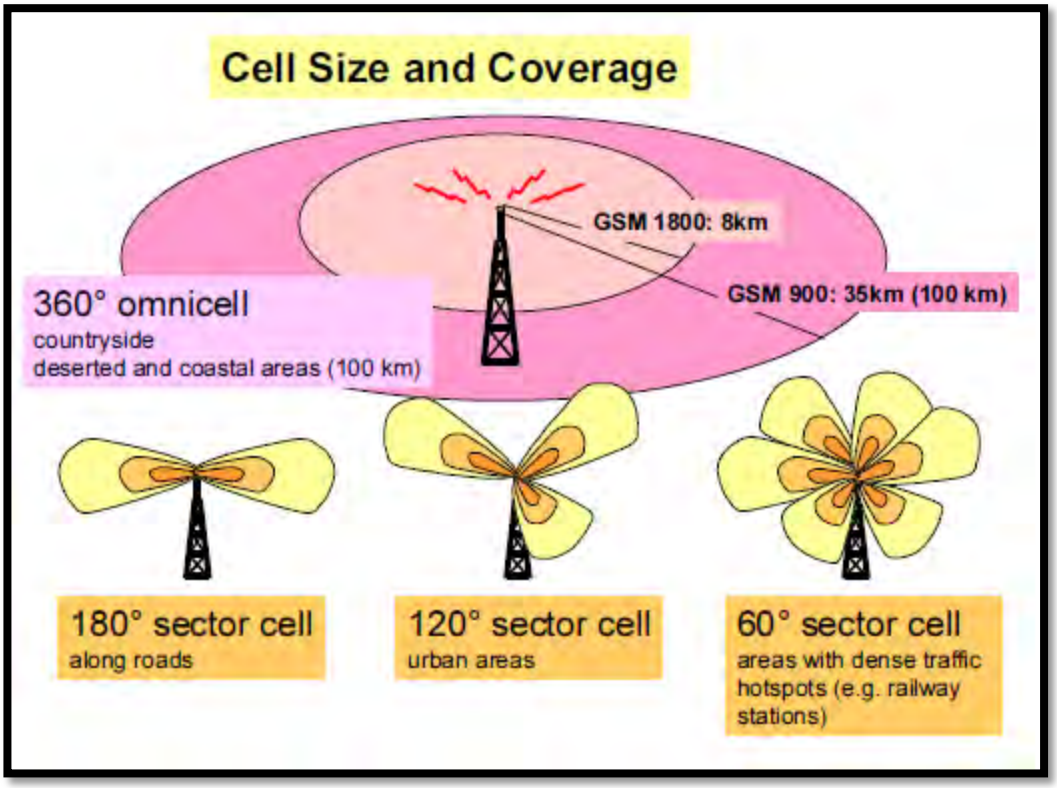

Figure 2.2 Omni and Sector Antenna

2.2.2 Type of Cell Size

The cell size varies from 10's meter up to several kilometres and they have different name as follows:

- Picocells: 10m - 20m
- Microcells :>20m – 2Km
- Macrocells: 2Km – 15KM

The picocells concept applied in a building like the foyer of the theatre or the exhibition Centre whereas the microcells size is applied in the metropolitan area communication system. Macrocellls are used to cover suburban or metropolitan cities.

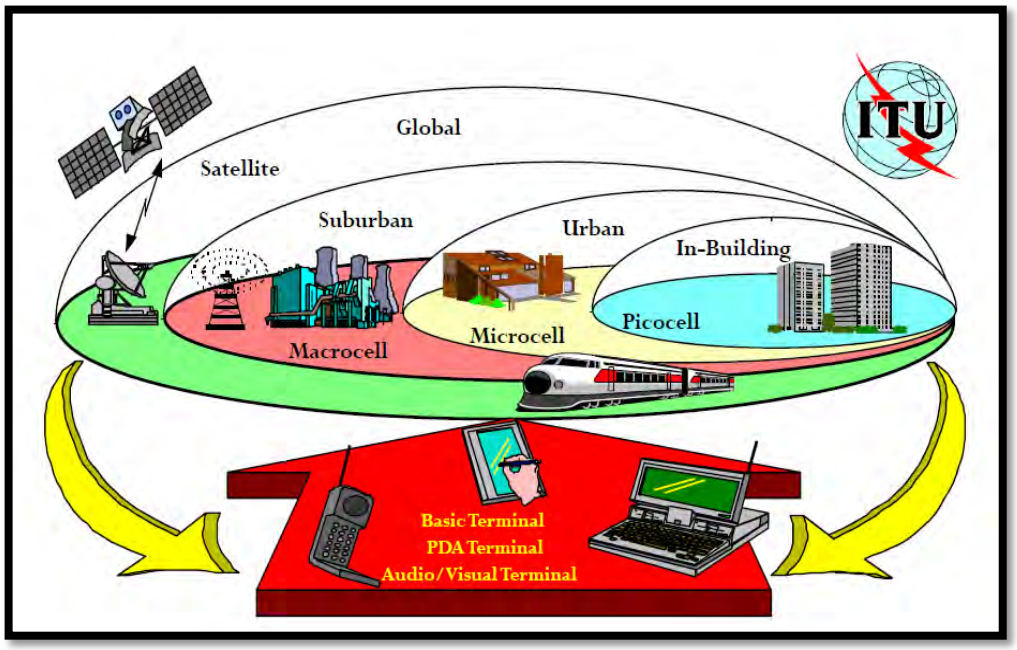

Figure 2.3 : Cell size

2.3 Frequency Reuse

Generally in GSM900 consist 124 channel carriers. Each carrier carrying 8 time slots. Only 868 call can be made at the same time. This call is not sufficient to meet the growing demand of subscribers over a large area because the entire existing operator shares this carrier and gets only a few of call. To manage this situation a technique called 'Frequency reuses' is adopted. Frequency reuses is a set of frequency ranges that located at different locations in the cell. According to Theodore S. Rappaport (2002), Group of cell call as cluster. In one cluster every cell used a different frequency. Figure 2.4 illustrates the concept of frequency reuse, where cell with the same letter uses the same set of frequency.

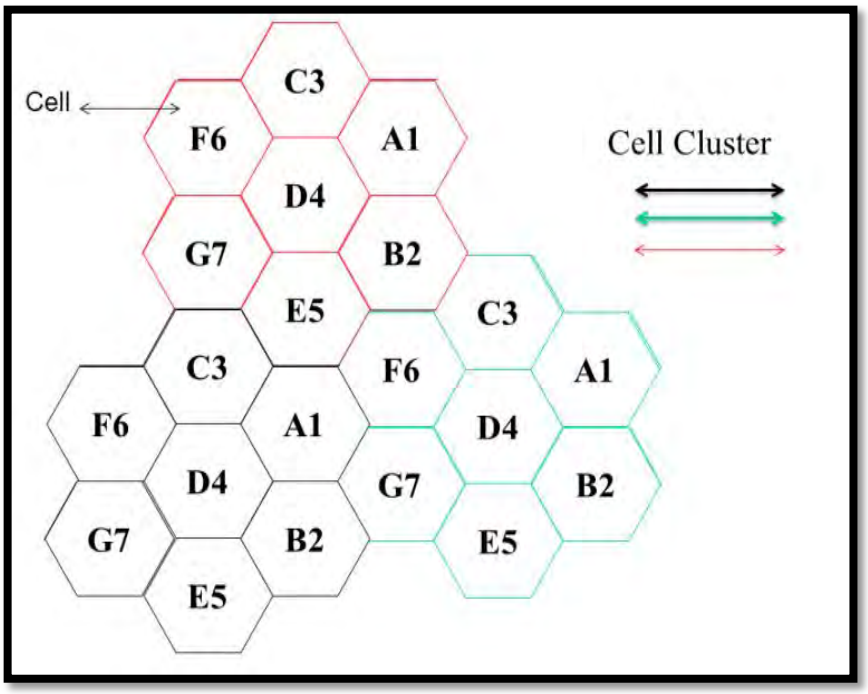

Figure 2.4: The concept of frequency reuse.

The frequency reuse concept can be illustrated mathematically by considering a system with a fixed number of full duplex channels available in a given area. it can be expressed mathematically as equation (1).

$$F=GN \quad (1)$$

Where,

F = No off full duplex cellular channel available in a cluster.

G = Number of channel in the cell.

N = No of cell in Cluster.

When a cluster duplicated ‘ m’ times within a given service area, the total number of full duplex channel can be expressed mathematically as eqution (2,3)

$$C=Mgn \quad (2)$$

OR

$$C=mF \quad (3)$$

Where.

C=Total Channel Capacity in given area.

m= No of cluster in given area

G= Number of channel in cell

N= Number of cell in cluster

2.3.1 Cell Reuse Pattern

Generally 7/21 and 4/12 reuse pattern are used. That mean 7 site repeat pattern and 4 site repeat pattern are used. The smaller number of frequency group, the higher carrier per cell. In an other word reduction number of frequency group would allow each site to carry more capacity. However, this reduction frequency group could affect frequency reuse distance which result in lower average C/I distribution. Figure 2.4 and figure 2.5 illustrates the cell reuse pattern.

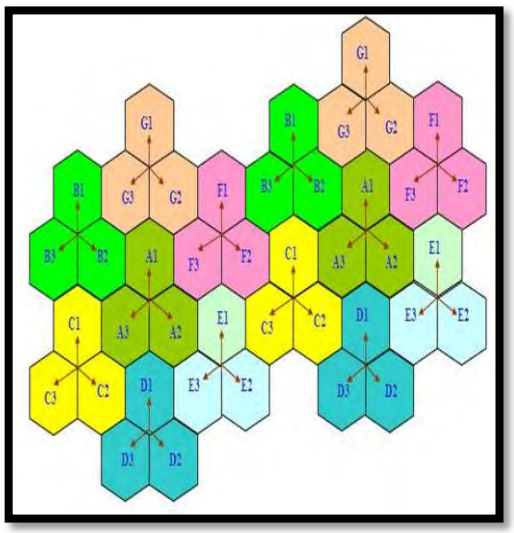

Figure 2.5 : 7/21 Reuse Patten

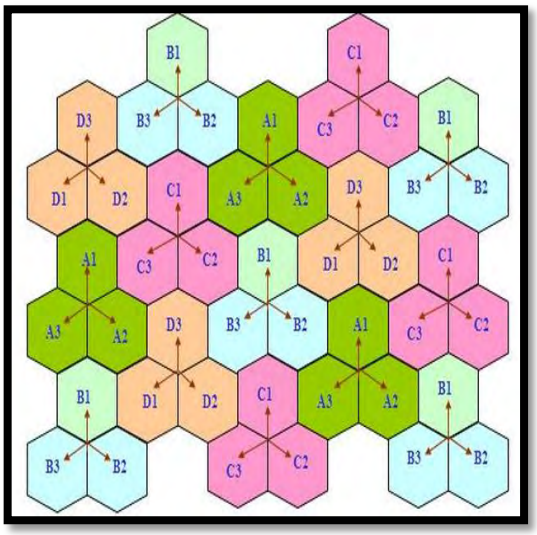

Figure 2.6: 4/12 Reuse Patten