OPTIMIZATION OF CHANNEL ASSIGNMENT IN MOBILE COMMUNICATION USING TABU SEARCH

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DECLARATION

I declare that this report entitled “Optimization of Channel Assignment in Mobile Communication using Tabu Search” is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any degree.

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Date : ……..

APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Degree of Electrical Engineering.

Signature	:	……..
Supervisor Name	:	DR. LOH SER LEE
Date	:	……..

DEDICATION

This project is dedicated to my beloved family especially my father, Ramli bin Hamid, my mother, Mashetoh binti Idris, and my siblings. Thank you for all your support and encouragement to me.

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ABSTRACT

Communication is one of the integral parts of science that has been a focus point for exchanging information among parties at locations physically apart. Mobile communication is a wireless form of communication in which voice and data information is emitted, transmitted and received via microwaves. It allows individuals to converse with one another and transmit and receive data while moving from place to place. With the increase in mobile user rates in the present, existing channels are quite limited and can lead to channel assignment problem (CAP). Therefore, to reduce the channel assignment problem an attempt or action must be taken by reusing existing channels to minimize interference in channel assignments. Reduced interference leads to an increase in capacity and throughout of the system. Tabu Search is one of the techniques that can be used to resolve channel assignment problem. Tabu Search is a meta-heuristic that guides a local heuristics search procedure to explore the solution space beyond local optimality. Optimization process is implemented by first to determine the initial solution then the initial solution is used to generate the solution of the neighborhood. The channel allocated being analyzed the value of the penalty cost based on the penalty cost function. The process will be repeated until obtain the lowest penalty cost function and chosen as the final solution. An analytical analysis is carried out to investigate the effect of number of iterations and number of available channels on cost value. The results will compare by varying the demand required in the channel assignment with different number of channels used and some improvement will be implemented in. As the result shows that the number of channel would have an effect in reducing cost values and with the new improved coding number of iterations can be reduced in getting the cost values.

ABSTRAK

Komunikasi merupakan salah satu bahagian yang penting daripada Sains yang telah menjadi satu titik tumpuan untuk bertukar-tukar maklumat antara pihak-pihak di lokasi fizikal selain. Komunikasi mudah alih adalah bentuk komunikasi di mana suara dan data maklumat dikeluarkan, dihantar dan diterima melalui ketuhar gelombang mikro tanpa wayar. Ia membolehkan individu untuk berbual antara satu sama lain dan menghantar dan menerima data semasa bergerak dari satu tempat ke tempat. Dengan peningkatan kadar pengguna telefon mudah alih pada masa sekarang, saluran sedia ada agak terhad dan boleh membawa kepada masalah tugasan saluran (CAP). Oleh itu, untuk mengurangkan saluran masalah tugasan sesuatu usaha atau tindakan mesti diambil dengan menggunakan semula saluran sedia ada untuk mengurangkan gangguan dalam saluran tugasan. Mengurangkan gangguan yang membawa kepada peningkatan dalam keupayaan dan sepanjang sistem. Cari tabu merupakan salah satu teknik yang boleh digunakan untuk menyelesaikan masalah tugasan saluran. Carian tabu adalah sebuah meta-heuristik yang membimbing prosedur carian tempatan heuristik untuk meneroka Ruang penyelesaian luar optimality tempatan. Pengoptimuman proses dilaksanakan oleh pertama untuk menentukan penyelesaian awal maka penyelesaian awal digunakan untuk menghasilkan penyelesaian kejiranan. Saluran yang diperuntukkan sedang dianalisis nilai kos hukuman berdasarkan fungsi kos penalti. Proses ini akan diulang sehingga mendapat penalti paling rendah kos fungsi dan dipilih sebagai penyelesaian muktamad. Analisis analisis dijalankan untuk menyiasat kesan jumlah lelaran dan bilangan saluran yang tersedia pada nilai kos. Keputusan akan membandingkan dengan permintaan yang diperlukan di dalam saluran tugasan dengan nombor yang berbeza daripada saluran yang digunakan dan beberapa penambahbaikan akan dilaksanakan pada tahun. Kerana hasilnya menunjukkan bahawa bilangan saluran akan mempunyai kesan dalam mengurangkan nilai-nilai kos dan dengan baru meningkat pengekodan jumlah lelaran boleh dikurangkan untuk mendapatkan nilai kos.

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MIN	-	Mobile Identification Number
MSC	-	Mobile Switching Centre
BS	-	Base Station
CAP	-	Channel Assignment Problem
FCA	-	Fixed Channel Assignment
DCA	-	Dynamic Channel Assignment
HCA	-	Hybrid Channel Assignment
AM	-	Amplitude Modulation
PSTN	-	Public Switched Telephone Network
GA	-	Genetic Algorithm
SA	-	Simulated Annealing
LS	-	Local Search
TS	-	Tabu Search

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Tracing the flows of globalization, communication is a way to connect with others somewhere in different places. Telephone is one of the tools used in communication process goes through radio frequency media. Frequency of radio is one of the electromagnetic wave frequency located in an environment ranging from 3 kHz to 300 GHz, including frequencies used in radio or radar communications.

Each phone has its own Mobile Identification Number (MIN). in the process of making one call, two important components will be involved namely Mobile Switching Centre (MSC) and Base Station (BS). In general, wireless communication will take place and be organized in one form of cell. Each cell has a channel controlled by BS and at the same time it is also controlled by the MSC. The communication process between the connector and the receiver occurs when the user makes a call through the MSC.

Therefore, the MIN receiver will be sent to the MSC and will be processed by sending it to BS to find where it is from. After that, BS will resend the signal to the MSC for notification that the phone is in its cell area. Furthermore, the MSC will request BS to access the unused voice channel pair of caller receivers to communicate.

With the rapid increase of mobile phone users, channel channeling methods should also be enhanced. In general, in the communication system will be a source and destination for the information transferred by channel. Each channel has a different frequency range and its own use. Then, as the number of user increase, the needs for existing channel also increases.

In using the channel reuse technique, it will lead to interruptions throughout the communication process. The disturbances are divided into three types; co-channel, adjacent channel and co-site channel. Co-channel interference occurs due to the allocation of the same channel to nearby cells. For example, when the communication process occurs the same channel will be used in several cells from different BS. Second, the adjacent channel occurs because of the adjacent channels allocation for a pair of adjacent cells together. Adjacent channel disorders occur when adjacent channels are used in nearby cells. Next, co-site interference is due to the adjacent channel allocation that cannot be separated by the minimum spacing within the same cell. Co-site interference occurs due to the recipient filter is not perfect that allow near frequencies to fit into the pass band. The interference can be mitigated by proper channel submission.

Channel assignment problem (CAP) is dividing into three models which are Fixed Channel Assignment (FCA), Dynamic Channel Assignment (DCA) and Hybrid Channel Assignment (HCA). The FCA involves a set of permanent nominal channels allocated to each cell. The number of channels in the system is divided into one set and assigned to the cell to cover the entire coverage area. DCA is the practice in which all channels are stored in a central pool and dynamically assigned to radio cells when a new call arrives in the system. After the call is completed, the channel is restored to the central pool. For HCA, the total number of channels available for service is divided into fixed and dynamic sets. A call blocking probability defined as the probability that a call arrives to a cell and finds both the fixed and dynamic channels busy.

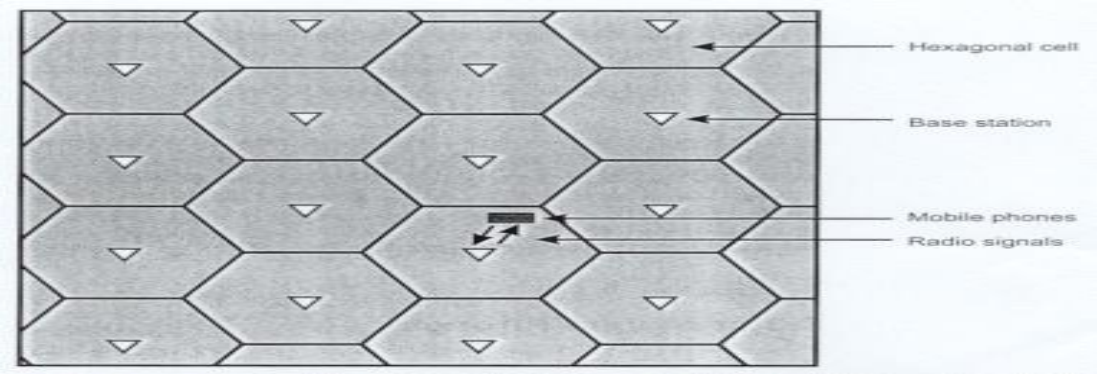

Figure 1.1: Base station in each of the cells

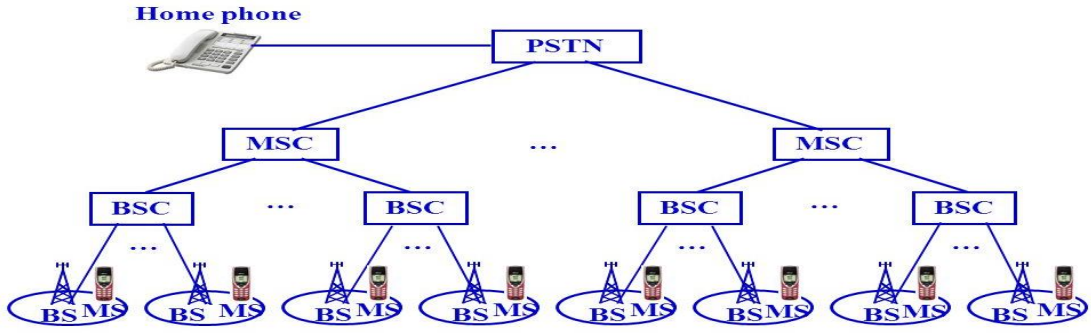

Figure 1.2: Structure of basic mobile communication

1.2 Motivation

Cell phones have become an important technology in everyday use. Mobile phone users have increased by 40 % each year. However, due to availability of existing channels. It can cause a noise or call problem to be denied. An interruption between channels in calls occurs when frequency constraints are not met in the channel assignment. Therefore, optimization of channel assignment problem is very important to get the best call quality. With existing technology, various ways have been used to solve this problem. Tabu Search is one of the methods in optimizing channel assignments to produce optimal solutions with minimal distractions to reduce declined call due to limited channels.

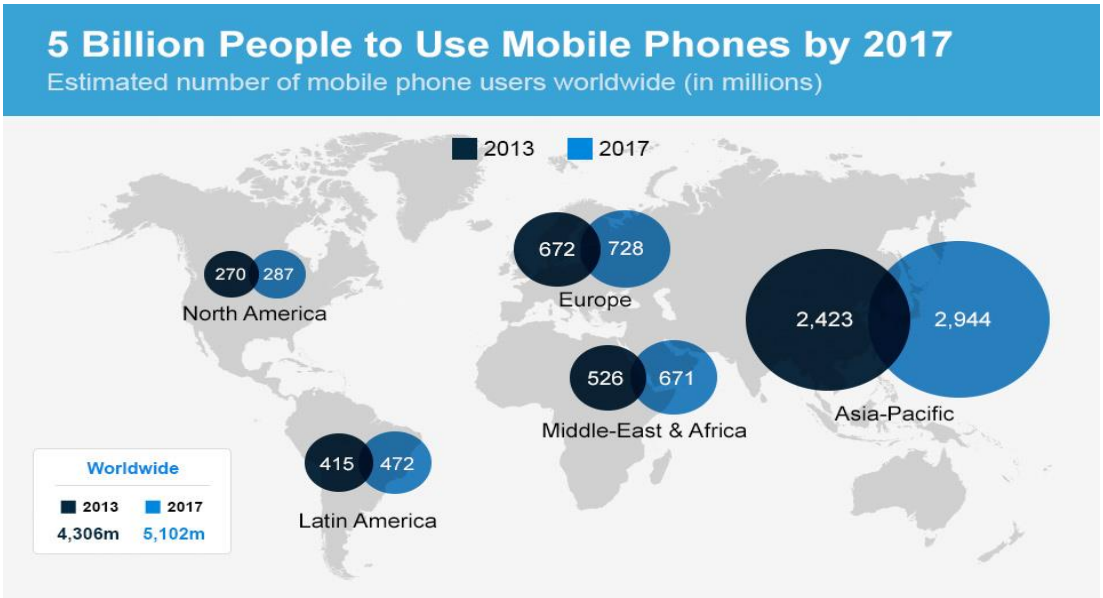

Figure 1.3: Mobile phone users' worldwide statistics

1.3 Problem Statement

Channel assignment problem is the main focus in this project. There would be an optimization that could be done. Interference in channel assignment or communication system would act as the disruption when making a call in other word, noise. So, the interference or cost values will be calculated by using the problem formulation that would be stated later in next paragraph and will be optimize to get the lower cost values.

The whole network is divided into N cells and total number of channels available is M. The channel request or demand is given in one-dimensional matrix D. The non-interference constraint is stored in a symmetrical $N \times N$ compatibility matrix C. C_{ij} provides the minimum frequency separation between the channels assigned to cells i and j, for a hassle-free task.

Suppose that $X_{j,k}$=$X_{j,l}$=1, calls in cells j and i have been assigned channels k and l, respectively. One way to measure the level of the interference caused by the assignments is to weigh every pair of tasks with a cost tensor $P_{i,j,m}$, where $m = k + 1$ is the distance between channels k and l.

To achieve interference-free assignment, the constraint of $C_{i,j}$ must be met. However, little disruption will be allowed to increase the availability of channels. If the minimum separation limit is violated, interruptions will occur and a penalty value will be imposed by cost tensor, $P_{i,j,m}$.

The penalty cost function indicates severe of the interference occurred between the given channels. In the value function cost of the project this is called the cost value. The problem formulation for the static channel assignment models is described below.

Penalty cost function:

$$F(X) = \sum_{j=1}^{N}\sum_{k=1}^{M} X_{j,k} \sum_{i=j}^{N}\sum_{i=k+1}^{M} P_{i,j,(k+1)}\, X_{i,l}$$

where $m = k + 1$

$$X_{j,k} = \begin{cases} 1, & if\ cell\ k\ is\ assign\ to\ channel\ j \\ 0, & otherwise \end{cases}$$

where $j = 1, 2, 3 \ldots N;\ k = 1, 2, 3 \ldots, M.$

$$\sum_{k=1}^{M} X_{j,k} = D_j$$

where $j = 1, 2, 3 \ldots N;\ k = 1, 2, 3 \ldots, M.$

The cost tensor:

$$P_{i,j,m} = \max\{C_{i,j} - m, 0\}$$

where $C_{i,j}$ is a matrix C with column i and row j.

Cost value, $F(X)$ is being charged due to channel disruption. It can be calculated based on the penalty cost function. The higher is the total cost value, the stronger is the interference that occurs between the channels among the cells. Costs are reduced when channels k and l are far from each other. The formula aims to reduce the total cost of penalty occurred.

1.4 Objectives

There are two main objectives associated with this project:

- To optimize channel assignment in cellular network using Tabu Search.
- To improve Tabu criterion and randomizing procedure of Tabu Search method.

1.5 Scope

Channel assignment problem is the primary target in this project in minimizing the disruption. The model used is a Fixed Channel Assignment (FCA) where each cell is assigned to a number of fixed voice channels. Tabu Search technique is being used in this project and Tabu Search coding will be generated using MATLAB software and data is analyzed for 100 maximum iterations which means the recurring coding algorithm is for a maximum of 100 times.

1.6 Significant of Study

The main target in this project is to optimize the limited channel allocation in mobile communications. Low distractions can generate high quality communication. The optimum solution where the channel disruption value is minimized and at the same time the use of existing channels will be maximized and will leading to an efficient communication between users.

1.7 Project Outcomes

At the end of this project the expected result is minimizing interference by improved Tabu Search algorithm for channel assignment problem. To optimize channel assignments, the process of creating an immediate settlement of the best solution in the hope of finding a better solution until the pre-reach trial limit is reached. Analysis will be conducted to confirm the effectiveness of the proposed Tabu Search increase.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

Literature research on channel assignment problem, channel allocation schemes and heuristic techniques will be described in this chapter. Heuristic technique is popular when it optimizes the channel assignment problem and has been used by researchers using various types of techniques.

2.2 Communication History and Setting

Communication is one of the important parts that are always focused on exchanging information between users in different locations. The first wire line telephone system was introduced in the year 1877 and mobile communication system as early as 1934 was based on Amplitude Modulations (AM) [1]. With increased demand for newer and better mobile communications and the development of mobile communication systems have started with any new changes. Initially, mobile communication was limited to certain users and the concept cellular was never designed to be commercially made.

However, with the development of newer and better techniques starting from the 1970s and with the mobile users now connected to the Public Switched Telephone Network (PSTN), there has been an astronomical growth in the cellular communication systems[1]. In addition, various movements are defined by the transmitter power, the type of antenna usage and the frequency of operation. With the increasing number of telephone users, the frequency spectrum becomes more limited in its use and has made it a major problem.

2.3 Channel Assignment

The problem of channel assignment in cellular networks has been modelled as an optimization problem with binary solutions. The problem is broken down into several cells and multiple channels. Channel assignment problem can be divided into different categories depending on the comparison basis. It can be divided into three models, Fixed Channel Assignment (FCA), Dynamic Channel Assignment (DCA) and Hybrid Channel Assignment (HCA).

The FCA involves a set of permanent nominal channels allocated to each cell. The number of channels in the system is divided into one set and assigned to the cell to cover the entire coverage area. DCA is the practice in which all channels are stored in a central pool and dynamically assigned to radio cells when a new call arrives in the system. After the call is completed, the channel is restored to the central pool. For HCA, the total number of channels available for service is divided into fixed and dynamic sets. A call blocking probability defined as the probability that a call arrives to a cell and finds both the fixed and dynamic channels busy. HCA scheme is defined as the probability that a call arrives to a cell and finds both the fixed and dynamic channels is busy [2].

2.4 FCA Vs. DCA

There are several comparisons between FCA and DCA. The FCA model is more in line with the high uniform traffic load, while DCA performs better lower traffic density if the traffic loads are not uniform. On the other hand, the FCA model has low freedom in the channel and maximum in the success of the channel but DCA is very flexible to allocate the channels and not necessarily the maximum channel acceptance. Other comparisons between these two schemes are shown in the Table 2.1.

Table 2.1: Comparison between FCA and DCA [2]

Fixed Channel Assignment	**Dynamic Channel Assignment**
Success of maximal channel reuse	Not always success of maximal channel reuse
Sensitive to time and space changes	Insensitive to time and time space changes
Grade is unstable on the service of each cell in an interference cell group	Grade is stable on the service of each cell in an interference cell group
High forced of call rejection probability	Low to moderate forced of call rejection probability
Suitable for large cell environment	Suitable in micro-cellular environment

2.5 Heuristic Techniques in Channel Assignment Problem

Heuristic techniques are the best approach to problem solving that use practical methods but are not optimally guaranteed but sufficient to achieve the goals. There have few main types of heuristic techniques, Genetic Algorithms (GA), Simulated Annealing (SA), Local Search (LS) and Tabu Search (TS).