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SIMULATOR OF HANDOFF STRATEGIES IN HEIRARCHICAL CELL
TOPOLOGY SYSTEM


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“Saya akui laporan ini adalah hasil kerja saya sendiri kecuali ringkasan dan petikan yang tiap-tiap satunya telah saya jelaskan sumbernya.”

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ABSTARCT

The objective of this project is to develop a simulator that can simulate handoff and channel assignment techniques real telecommunication system. This simulator will count how many mobile stations can perform this process well with parameters are given by user. With this simulator, an analysis can be made to see the quality of base station performing a handoff process. With this simulator also we can see the relationship between number of mobile station with successful of handoff process and number of macro and micro channel with successful of handoff process. Handoff is a process that always occurs in telecommunication system. It happened to avoid a call being terminated while in conversation when users move from cell A to cell B. It also prevents congested at base station. It is an important process in telecommunication. An interrupt during conversation like call being terminate always irritate users and this kind of problems are not forgivable if occur in any telecommunications company. So handoff process is made to control this problem. It makes sure users can get the best coverage and used it mobile fully. This simulator is built using Matlab software 7.0.

ABSTRAK

Projek ini bertujuan untuk membina sebuah simulator yang hampir menyerupai proses handoff yang berlaku di dalam system telekomunikasi. Simulator ini akan mengira berapa banyak *mobile station* yg boleh menjalankan proses handoff dengan beberapa parameter di tentukan oleh pengguna sendiri. Dengan proses handoff ini kita dapat mengaji perkaitan antara contohnya bilangan *mobile station* dan kejayaan proses handoff atau bilangan *micro/macro channel* dan kejayaan proses handoff. Handoff ialah satu proses yang biasa berlaku di dalam sistem telekomunikasi. Ia untuk mengelakkan berlakunya panggilan terputus apabila pengguna bertukar penggunaan cell dari cell A ke cell B. ia juga untuk mengelakkan berlakukan kesesakkan di dalam *base station*. Ia adalah satu proses yang penting. Sebarang gangguan semasa pengguna sedang dalam panggilan akan menyusahkan pengguna dan ini tidak sepatutnya berlaku. Oleh sebab itu proses handoff ini dicipta. Ia memastikan pengguna dapat menggunakan talian dengan lebih berkesan dan lancar tanpa gangguan. Simulator ini akan dibangunkan menggunakan perisian matlab 7.0 Perisian matlab ialah perisian yang terkini. Ia adalah perisian yang biasa digunakan di bahagian kejuruteraan.

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LIST OF SHORT FORM

BS	–	Base Station
MSC	–	Mobile Switching Center
PSTN	–	Public Switching Telephone Network
MS	–	Mobile Station

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Wireless is a technology that is very important now days. We can say that almost everything we used in daily using wireless technology. Example of usage of this wireless technology in our daily life was:

- Remote control
- Cordless telephone
- Garage openers
- Cell phones/modems
- Radio
- Pagers
- Satellite TV
- Wireless LAN cards

1 of this wireless technology that a heavily increase is cellular system. It is report that since 1996, number of new mobile phone subscribers exceeded number of new fixed phone subscribers. With this number of user that increase ever year, a reliable

and powerful system must be use to make sure that cellular system give their best to user.

1.2 Objectives

- To build a simulator that performs handoff process like handoff in cellular system.
- To study a handoff process in cellular system
- To learn using matlab software

1.3 Scope Project

- Learn about handoff process in cellular system
- Study how to implement handoff process in matlab
- Develop a simulator using matlab
- Develop a programming to create a simulator

1.4 Problem statement

In cellular system, they are a time when user move from one cell to other cell. While user move from one cell to other cell while user in conversation, he will face a problem where he call will be terminate. It is because the cell before this using a different channel compare with new cell user enter formerly. To overcome this problem, a handoff process is created. It will transfer the call to a new cell without terminate the conversation.

Some time when a user moves, it signals from Base station to Mobile station become weak. If this problem did not be surpassing, the call will be terminate. So handoff once again play it roll by saving a call that is in low signal by transfer the call to a base station that can give this mobile station enough signal to continue it call.

In a big city, users of the cellular system are so many. It make a metropolitan is a congested environment were frequency reuse face a higher demand. It is different with a place where traffic demands are low. This 2 situation need a different cellular system and coverage. It same goes for tall buildings like office and houses. Tall buildings need different types of cellular system compare to houses. To overcome this matter a handoff in hierarchical cell is created. It is solution for congested area and with a topology system makes it more reliable in different types of topology.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction of Cellular System

Before we continue with handoff, first we must understand the concept of cellular system and how it work. In cellular concept development, we can divide it into 2 stages.

First stage was early stage. In early stage, a large coverage with single, high-powered transmitter is used to transmit data. In this time there are no frequency re-use due to interference because we had many frequency left that we can use (radio is a new thing and only military used frequency in a large scale). In this time Frequency allocation such as co-channel interference is limited.

The second stage was modern stage. The concept of modern cellular concept is to replace single, high power transmitter (large cell) with many, low power transmitter (small cell). Base station will provide a radio access between mobile user and MSC (mobile switching center). Area to be covered by base station is a fairly small

geographical zone call cell. Cell a represent by hexagons. Each base station is given a total number of channel available in it system. Neighboring base stations an assigned with a different group of channel to avoid interference between base stations. With this system, channel can be reused as long the interference can be avoided. According to Theodore S. Rappaport[1], this interference can be occur as long as it kept below acceptable levels. The reason of using low power transmitter is frequency re-use can be implemented.

Base station in adjacent cell using a different group of channel and it is different with the neighboring cell. This can be archive because the antenna of the base station is design to archive the desired coverage in within particular cell. By limiting the coverage area to just in boundaries, same group of channel can be use by a different base station that are separated in a distance that enough to avoid interference. According to Theodore S. Rappaport[1], *the design process of selecting and allocating the channel group for all of the cellular base stations within a system is what we call frequency reuse or frequency planning*. With help from picture above we can fully understand what frequency reuse. Group of cell we call it cluster. In figure 2.3, it use cluster 7. In one cluster every cell used a different frequency. Cell with same letter use a same set of frequency.

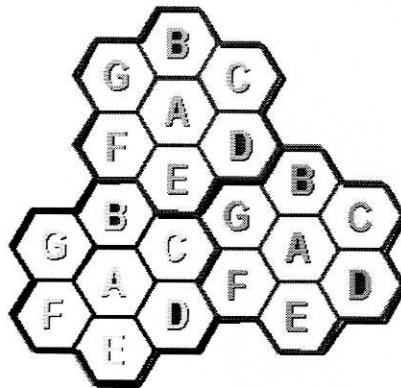


Figure 2.1 3 cluster with a frequency reuse cell

Each cell has its own BS (base station). This BS will communicate with MSCs (Mobile Switching Center). Then MSCs are inter-connected to PSTN (Public Switching Telephone Network) through local and transit exchange for outgoing call to and incoming call from fixed line telephone.

Everything in this world has its good side and bad side. Same goes with cellular system. It has its advantages and disadvantages. We can list some of its advantages as follows:-

- We can communicate without boundary at anytime, anywhere (as long as we had a coverage from the base station)
- we do not need a fibrous wires that always annoying
- we can move around while we were on call without limit.

This wireless concept also has its disadvantages too. First it has a major problem with noise and interference such as:-

- Environmental effects.
- Large amounts of noise.
- Leakage from adjacent channels and distant transmitters on the same channel.
- Multi-path fading (Rayleigh) and Doppler effect

Second is signal coverage such as:-

- Essential for deployment of wireless networks.

- Influenced by the radio frequency of operation, transmitted power and the terrain.

2.2 Introduction of Handoff

In cellular system, all space for transmit a signal is divide by a base station that can cover some amount of length. This base station coverage is imaging as a hexagons. Each hexagon is known as cell. Each cell has only 1 base station to cover it. Each cell has a different in frequency used. A situation where a mobile station will move from 1 cell to other station can occur. When this happened, and this mobile station is in conversation MSC (mobile switching center) will automatically transfer the call to a new channel that belong to a new cell. The process of changing a frequency from on cell to other cell is call handoff. It happened when a mobile station move from 1 cell to other cell and change it frequency.

Handoff strategies not only happen to single cell in a base station. It also happens to all cells in base coverage or we call it hierarchal topology. Easier way to describe this situation is to consider each cell is like “sub autonomous system” within the autonomous is a whole system. Handoff must be performs successfully and as fast as possible, and can be acceptable by user. In handoff strategies, the speed of vehicle, signal strength, and length of time are an import thing to make sure handoff strategies is work properly.

2.3 Definition of Handoff

When a mobile station is on call, and it move from one cell to other cell, it has to transfer it channel to a new channel of a new cell. Handoff also can occur when a transmission drop below a threshold given to each base station. The process of automatic transferring a call in progress from cell to another is to avoid a terminated call is called handoff. Handoff process required a detection of needed to change cell in preparation mode and a switching a communication from a channel in a given cell to other channel in another cell. Usually it not noticeable by user and at least keep user disturbance at minimal

2.4 Purpose Handoff

There are 3 types of handoff depends on their purpose. Each of this handoff has theirs own purpose to occur and why it functions. The 3 types of handoffs are:-

- Rescue handoff

The main propose of handoff process is to avoid losing a call in progress when mobile station level a coverage area of a cell and enter a new one. It will make user feel uncomfortable so it is an important matter in juggling the quality of the service provide by the subscribers. In communication this type of handoff is call rescue handoff. When it has a high possibility that the call will be lost if it not

change, handoff process is applied. It will reestablish the call, which attempt for mobile station to repair the connection after effective loss of communication with the serving cell.

- Traffic handoff

A second type of handoff we call it traffic handoff. It happens when a cell is congested and cannot be use. So the call is transfer to neighbour cell that not congested. When an actual cell always overlap a lot, it handing over some calls from one cell to a neighbour cells that less congested one that could improve temporarily congested situation. This type of handoff must be handle with care because it obviously in conflict with the confinement criteria. Traffic handoff will perturb cell planning and increase the level of interference in the area around.

- Confinement handoff

A handoff also can happen when it is of interest to change the serving cell of a given mobile station even if the transmission quality is still good. It may happen because the global interference level would be significantly improved if the mobile station would be in contact with another cell.

2.5 Handoff Criteria[2]

The criteria for handoff to be happen are depends on the purpose of the handoff. They always some information given to predict what will happen with and without handoff base on the destination cell. Each of these types of handoff has their own criteria:-

- Rescue handoff

In rescue handoff, the quality of the transmission for the ongoing connection, include both up and downlink is taken as the main criteria. The good quality of information will judge the transmission quality that been receive by both users. With transmission digital nowadays, the transmission error rate is a good quality indicator. The propagation path loss because of the radio transmission is an example. Propagation delay is another good example. On GSM radio interface, the transmission cannot usually support a high propagation delay. If it is to big and cannot be handle, a connection can be cut. All these measurement will be taken to make decision whether handoff need to be perform or not. The process to detected whether it need to perform handoff or not is start with both mobile station (MS) and BTS measure the transmission quality and the reception level. From this it can detect where the transmission is loss. This measurement will be transmits once or two per second.

- Traffic handoff

For traffic handoff it requires information on the load of each BTS. This information is know by MSCs and BSCs. Traffic handoff always utter the number of mobile station to handoff in a given cell, but not indicate which one should be handoff. Usually a traffic handoff picks those which is much more closer to be handoff. Hence, traffic handoff also relief on the other criteria and corresponding measurement. It also had it own algorithm for handoff decision and choice.

- **Confinement Handoff**

For the confinement handoff, it always refer to uplink and downlink transmission quality corresponding to each neighbour cell, were the mobile station are connected to cell. Since this information is difficult to get, it only made a process with only the path loss between MS and number of neighbour cells.

2.6 Handoff Types

There are two types of handoff that are use in cellular communication. These 2 types of handoff perform in a different situation to perform a handoff. It is macro mobility and micro mobility. Below is description of Macro mobility and micro mobility

- **Macro mobility**

Macro mobility is where process handoff happen in 2 adjacent cells that is not shares same base station. User move from a cell A that use base station A to a cell B that use base station B.

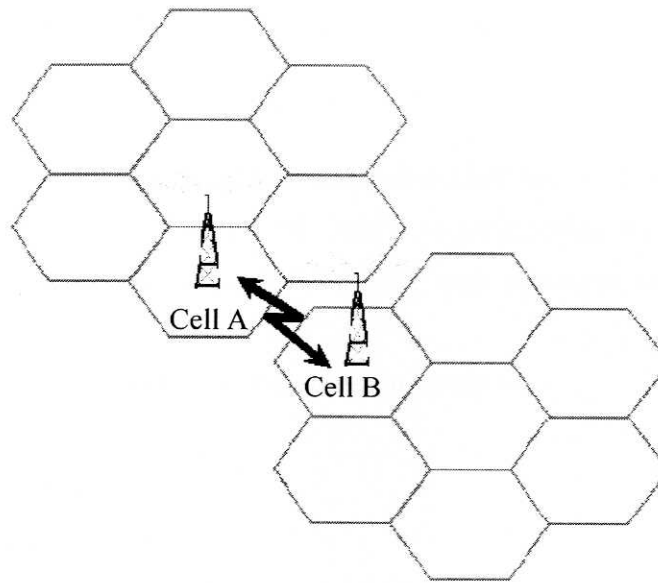


Figure 2.2 macro mobility

- Micro mobility

Micro mobility is a handoff process where it happens in 2 adjacent cells that use the same base station. A user moves from cell A that uses base station A to a cell B that also uses base station A.

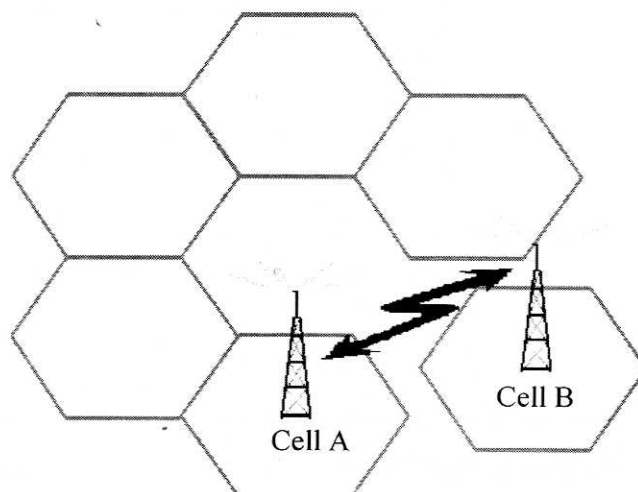


Figure 2.3 micro mobility

2.7 Handoff Parameter[2]

Before performing a handoff, some parameter must be set. This parameter is important to perform a successful handoff. Below is a parameter that is needed to perform a handoff (each types of handoff has their own parameter but below is in general)

1. Static data which is maximum power transmission power of:
 - Mobile station
 - Serving BTS
 - BTS's of neighbour cells
2. Real-time measurement performed by the mobile station:
 - Downlink transmission quality
 - Downlink reception level on the current channel
 - Downlink reception level from neighbour cell
3. Real-time measurement performed by the BTS:
 - The uplink transmission quality
 - The uplink reception level on the current channel
 - The timing advance
4. Traffic considerations, cell capacity and load

2.8 Handoff Operation

When moving from a serving cell (old cell) to a target one (new cell), a MS has to firstly initiate an access procedure to the BS want to perform handoff in order to adjust its transmission power and timing with this BS. Either make-before-break handoff or break-before-make handoff will have the access procedure for this BS.