UNIVERSITI TEKNIKAL MALAYSIA MELAKA

INVESTIGATION OF MOBILE NETWORK COVERAGE PERFORMANCE IN UTEM'S TECHNOLOGY CAMPUS USING COVERAGE PROFILING

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electronic Engineering Technology (Telecommunication) with Honours.

By

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APPROVAL

This report is submitted to the Faculty of Engineering Technology, Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirements for the conferment of degree of Bachelor of Engineering Technology (Bachelor's Degree In Electronic Engineering Technology Telecommunication) (Honours'.). The member of the supervisory is as follows:

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ABSTRAK

Salah satu faktor utama untuk mengenal pasti sejauh mana penerimaan sesuatu isyarat telekomunikasi dan prestasi rangkaian telekomunikasi pada suatu tempat adalah nilai RSSI ("Received Signal Strength Indicator"). Nilai tersebut adalah sangat penting kepada para jurutera rangkaian telekomunikasi untuk mencari penyelesaian memberikan perkhidmatan yang terbaik dan tanpa gangguan dalam liputan isyarat telekomunikasi kepada pelanggan. Untuk tujuan ini, kajian ini bertujuan untuk menyiasat sejauh mana prestasi dua penyedia perkhidmatan telefon yang dipilih, iaitu U Mobile dan Digi yang akan dikaji dalam telefon Xiaomi Redmi 3s dan Asus Zenfone 4, dan kajian ini dijalankan di Kampus Teknologi, UTeM dengan menggunakan kaedah "Coverage Profilling". Analysis statistik juga akan dijalankan dalam kajian ini. Daripada hasil kajian dan analisis, penyedia perkhidmatan telefon yang dapat memberikan perkhidmatan yang terbaik dan liputan yang lebih bagus dapat dikenal pasti supaya para jurutera rangkaian dapat menggunakan hasil kajian tersebut untuk meningkatkan prestasi liputan rangkaian mudah alih di kawasan Kampus Teknologi UTeM.

ABSTRACT

One of the key factors to find the reception and performance of a mobile network serving in a given geographical area is the value of RSSI (Received Signal Strength Indicator). These values are vital for the telecommunication network engineers to find a solution on providing a better uninterrupted network signal reception and performance to the customers. For this reason, this research is aimed to investigate the performance of U Mobile and Digi mobile cellular network under Xiaomi Redmi 3s and Asus Zenfone 4 at UTeM's Technology Campus by using coverage profiling. Statistical analysis is also included on the research as well. From the results and analysis, the best mobile network that brings better coverage and performance can be determined so that these findings can be used for the network engineers to improve the mobile network performance in UTeM's Technology Campus area.

DEDICATION

Dedicated to my beloved parents, Mr. M. Balakirisnan A/L P. Muniandy and Mrs. Maria Binti Gudiman @ Diman which encourages me to complete this final year project.

Special thanks to my supervisor, Puan Rahaini Binti Mohd Said and to my co-supervisor, Puan Zahariah Binti Manap.

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Lord, I dedicate all my works to You.

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All glory, praises and thanksgiving to God for the completion of this final year project that I've undergone for two semesters, and the completion of this thesis on the time of final evaluation and presentation.

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I would like to give thanks to my beloved parents, for all they have done to ensure that I can able to finish up what I have started from the first day I entered diploma at Politeknik Kuching Sarawak until to the completion of degree at Universiti Teknikal Malaysia Melaka. Even though both of you are busy to make ends meet, but you never fail on showing care, love, understanding and support to me and my sibilings.

Finally, I would express my gratitude to my friends and other persons who directly or indirectly involved and distributed in completing this project and not forget to all my friends who give their full commitment and their best effort. Thank you all so much and God bless you.

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CHAPTER 1
INTRODUCTION

This chapter will briefly discuss on the overview of research. This chapter also emphasizes the problem statement, research objective, scope, and the organisation of the whole report.

1.1 Overview Of Research

The Malaysian telecommunication landscape centers on four major mobile network operators (MNO), namely Celcom, U Mobile, Digi and Maxis, together with few mobile virtual mobile operators (MVNO) such as Tune Talk, XOX, Tron, ALTEL, Friendi, YES, TMgo, Webe, etc. These MVNO's utilize any one of four major mobile network infrastructures that depends on which of them bags the network 'riding' agreement with any one of four major MNO's. The growth of mobile telecommunications networks suggests that in the next several years, the number of cellular users keep continue growing as well as the services demand, (Huerta-Barrientos & Elizondo-Cortés, 2013).

On the other hand, mobile network coverage is one the major factors for planning process of cellular networks. In fact, all telecommunication companies are putting a greater emphasis and concern on network coverage, (Taghizadeh, Krishnaswamy, Rahman, & Malekifar, 2014). The planning process means to permit the maximum number of users sending and receiving proper signal strength in a cell (Guo, Zhang, & Maple, 2003).

Nevertheless, different MNO's does have different network coverage area. This also means that the mobile network performance depends on the user's location, the network coverage in that particular location, and the mode of radio propagation

with respect to the user's location (indoor and outdoor). For this reason, it is very important to evaluate the coverage area in a mobile network operator in order to provide the better service to users.

The aim of this research is about finding out and identifying the best mobile network operators performs in Technology Campus area, Universiti Teknikal Malaysia Melaka. It is done by measuring the reception level of each designated points in the campus area. Next, the mobile network coverage profile for two selected mobile network operators is generated and the network performance between these MNO's is analysed by using ANOVA analysis of statistical methods. From there, we can know which MNO has the better network coverage.

1.2 Problem Statement

Every Mobile Network Operator (MNO) and even Mobile Virtual Network Operator (MVNO) claims to have the best coverage in Malaysia and MNO's coverage area provided in their respective websites (MCMC, 2017; OpenSignal, 2016).

At the moment, there are no data or statistics that can prove the network performance specifically at Technology Campus, UTeM. Therefore, there's a need to investigate the mobile network performance, to determine which mobile operator that gives stable coverage and better performance on the studied area.

1.3 Objectives

The objective of this research is:

a) To study the network performance of different network operators in Malaysia.
b) To design the mobile network coverage profile at UTEM's Technology Campus.
c) To analyse the network performance between different network operators.

1.4 Scope

The scope of this project covers only UTeM's Technology Campus area, but comes with some limitations. Among them are:

a) The area of research covers indoor and outdoor areas.
b) For indoor areas, only cafeteria, FTK building, FKM building, Factory 1, Factory 2, Factory 3 and UTeM Holdings building are covered.
c) The warehouses (including indoor and outdoor areas) located between Factory 1, Factory 2 and Factory 3 does not covered due to constructions happening on the area and permissions entering the area are unable to be secured at this year of research.
d) Restricted areas as defined by the university's management (such as control room, roof areas, etc.) does not covered.

In addition, two mobile phones are used in this research, which is Xiaomi Redmi 3S and Asus Zenfone 4 (A400CG). There are two Mobile Network Operators (MNO), which are U Mobile and Digi that are used in this research.

1.5 Report Outline

This report consists of five chapters, in which:

a) Chapter 1 basically focuses on introducing the research, along with the problem statement, research objective, scope and the outline of this report.
b) Chapter 2 shall emphasize on the literature review which is crucial and relevant to the research topic.
c) Chapter 3 shall explain the methodology used in research. These includes the flowchart to explain the research developmental stages and Gantt Chart to track the progress of the research.
d) Chapter 4 shall emphasize more on the outcome of the research, in which it is presented in the statistical and descriptive analysis. The discussion of results obtained throughout the research is also emphasized as well.

e) Chapter 5 shall cover the overall conclusion of the research, alongside the future recommendations of this research.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

As a part of a requirement to complete this research, a literature review was conducted to obtain information and knowledge about related theories associated with cellular systems, radio frequency, GSM technology, radio propagation methods and any other relevant topics which are necessary for this research. The main sources for this project was mostly based on reference books, journals obtained through IEEE, ResearchGate and other websites. Previous project reports and related research journals was covered as well to get a better view of this research.

2.2 Radio Frequency

Radio frequency is defined as any of the electromagnetic wave frequencies that are ranged between the frequency bands 3kHz and 300GHz bands and also includes the frequencies used for communication signals, for instance, radio and television broadcast, mobile phone and satellite transmission (Merriam-Webster, 2016).

2.3 History Of Cellular Systems

One of the key aims of modern communication networks is to deploy high-capacity coverage over a wide area. In 1947, United States was the first country to deploy the cellular concept (Song & Shen, 2010). The 1970's era has sparked a

revived interest in cellular systems. Since that time, technologies of cellular systems have changed dramatically. There are several generations of cellular communication technologies that have been outlined by most industry experts.

2.3.1 First Generation (1G)

Known as First Generation (1G), it was the earliest generation of cellular systems technology developed in early 1980's. At that time, it is a set of wireless standards developed that features some prominent cellular systems and technologies such as Improved Mobile Telephone Service (IMTS), Mobile Telephone System (MTS), Advanced Mobile Phone System (AMPS), TACS (Total Access Communications System), C-450, Radiocom 2000, Radio Telefono Mobile Integrato (RTMI) and Push to Talk (PTT).

1G wireless networks utilize analog signals, which are radio frequency transmissions that are transmitted similarly to sinusoidal waveforms. For the 1G network, it's transmission speed varies between that of a 28k modem (28kbps) and 56k modem (56kbps), which means that the actual download speeds are ranging between 2.9kbps to 5.6kbps.

Circuit-switching technology is another part of technologies used in 1G. A dedicated and direct physical connection is made between the caller and the recipient of the call, through the telephone company's switch. The connection remains open between only these two users during the telephone conversation. For that, the busy tone will be sent for those who dial any of these engaged phones, since no other calls can be made from the phone while the first conversation is going on. This direct connection will last for the length of the call, in which the switch drops the connection.

In terms of overall connection quality, they are prone to interference and it does not have the same quality as a digital signal, In addition, a modem or similar device is required in the case of data transmission over an analog signal, since it is used for conversion of signals from analog to digital and vice versa. On the other hand, it has low capacity, unreliable handoff, poor voice links, and no security at all since voice calls were played back in radio

towers, making these calls susceptible to unwanted eavesdropping by third parties. Due to these limitations, 1G is only basically be used for voice communications. Although 1G is the pioneer in cellular telephony despite its limitations and disadvantages, it was soon replaced with improved digital technology.

2.3.2 Second Generation (2G)

Second Generation (2G) is the next iteration of cellular telephony, starting to establish in the early 90's and remained active until today. 2G cellular mobile networks were commercially launched on the GSM standard in Finland by Radiolinja in 1991 (Nitesh & Kakkar, 2016). 2G network transmits data between 9.6kbps and 14.4kbps in the 800MHz and 1900MHz frequencies. Like 1G systems, 2G systems are also circuit-switched networks.

Starting with 2G systems, it utilizes digital transmission over analog transmission. 2G went a step ahead by providing new services such as The features of 2G services are summarized as follows:

a) The shift from using analog transmission to digital transmission, enabling efficient use of frequency spectrum and transmission power and enables smaller and cheaper individual receivers and transmitters.
b) Providing new services such as Short Messaging Services (SMS), Multimedia Messaging Services (MMS) and Voice Mail System
c) Introduction of GPRS by enabling the air interface for transmission of data for internet services. Later superseded by EDGE technology with higher internet speeds than GPRS.
d) Better voice call quality and the inclusion of digital encryption on phone signals.
e) Better compression and multiplexing of digital voice data, allowing for the calls to be packed into the same amount of radio bandwidth.

Although 2G systems are widely accepted, there are some drawbacks of it. For instance, strong digital signals and proper network coverage in the specified area are required to make the mobile phones work. In low population density areas, the weaker digital signal on higher frequencies might not be enough to reach a cell tower, albeit that it does not pose any problems for transmission at lower frequencies.

While digital calls are free of static and background noise, the lossy compression used by the codecs suffers a lot, as the range of sound that they convey is reduced. A recipient will hear less of the tonality of someone's voice talking on a digital cell phone, but the recipient will hear it more clearly.

Another drawback of 2G technology are it is difficult to handle complex data such as video. Plus, the packet data transfer that leads into lower system efficiency

2.3.3 Third Generation (3G)

To resolve the drawbacks of 2G and at the same time to standardize a single global network protocol instead of different other techniques, 3G was introduced.

Introduced in 2000, it is based on wide band wireless network and fulfilling the International Mobile Telecommunications 2000 (IMT-2000) specifications. 3G utilizes packet-switching technology systems although that requires the infrastructure change to the previous 2G systems. The features of 3G are as follows:

a) Like 2G, the usage of TDMA and CDMA technology is still evident.
b) Introduction of 3G-based value added services (VAS) such as mobile television, video streaming, GPS (global positioning system) and video conferencing.

c) The basic feature of 3G is high-speed data transfer rates, with the speeds can reach up to 42Mbps (with HSPA+ technology). This makes video calls and high-speed mobile internet access possible in their mobile devices.

d) Packet Switching technique is used to send the data, along with Voice Communication services.

Despite the emergence of 3G mobile technologies, there are also drawbacks of it. 3G requires higher bandwidth for transmission compared to previous mobile technologies. The infrastructure of 3G at that time, isn't easy to build. The usage of 3G technology also calls for a mobile phone with a larger battery capacity since usage of 3G networks decreases the battery life due to high power utilization. Applying for 3G Service License also is quite expensive.

2.4 GSM Architecture

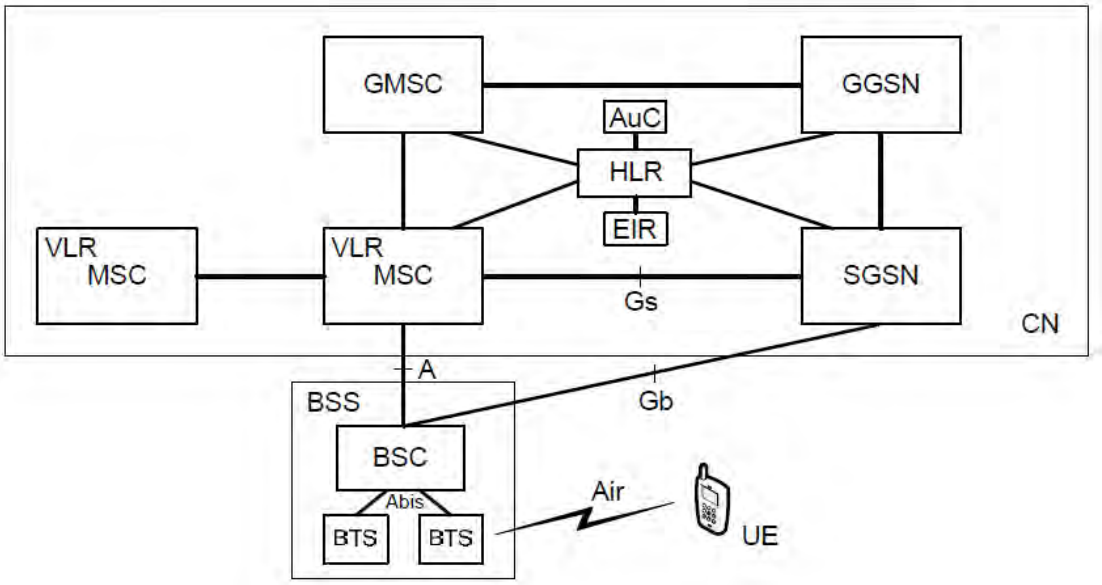

Figure 2.1: General Architecture of GSM System

Figure 2.1 shows the network structure of GSM system, where three basic subsystems can be distinguished, which are Base Station Subsystem (BSS), Core Network (CN) And User Equipment (UE). The interfaces between the elements of