UNIVERSITI TEKNIKAL MALAYSIA MELAKA

THE PLANNING OF HANDOVER IN 5G TECHNOLOGY

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

by

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DECLARATION

I hereby, declared this report entitled "The Planning of Handover in 5G Technology" is the results of my own research except as cited in references.

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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 Electronics Engineering Technology (Telecommunications) (Hons.). The member of the supervisory is as follow:

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(Mr. Win Adiyanshah Indra)

ABSTRAK

Teknologi mudah alih generasi kelima (5G) telah menjadi salah satu inovasi penting dalam bidang komunikasi. Perkembangan teknologi generasi kelima (5G) mewarisi teknologi sebelumnya seperti generasi ketiga (3G) dan generasi keempat (4G). Kekuatan generasi kelima berbanding teknologi sebelumnya adalah ia mempunyai kadar pemindahan data yang lebih tinggi (> 1Gbps) dan kependaman yang lebih rendah (<1ms). Walaupun proses teknologi 5G jalur lebar data lebih dari 1Gbps tetapi masih dianggap sebagai teknologi yang belum berkembang kerana perancangan yang lambat dan miskin pada kedua-dua penyerahan keras dan lembut. Kajian ini bertujuan untuk menganalisis dan mencadangkan perancangan atau penyerahan teknologi 5G yang tidak terhalang. Untuk mendapatkan pengalaman pengguna yang lebih baik pada rangkaian 5G, dua kriteria kritikal telah dipilih sebagai fokus objektif yang merupakan keadaan penyerahan dan jenis antena. Sebelum simulasi rangkaian 5G dilakukan, beberapa simulasi seperti simulasi frekuensi, simulasi lokasi dan simulasi simen semuanya dilakukan untuk memastikan ciri dan penstabilan gelombang 5G. Melalui simulasi kekerapan dan kajian, gelombang kekerapan 5G dijumpai sebagai kehilangan laluan yang tinggi tetapi pada masa yang sama kekal tinggi. Di dalam simulasi lokasi, keputusan yang dibenarkan gelombang 5G memerlukan jarak antara jarak yang rendah untuk mempunyai latensi yang lebih baik dan penerapan ketinggian pada simulasi sebenarnya akan mengoptimumkan topologi Bukit Beruang yang lebih tinggi. Simulasi antena menganalisis jenis antena yang sesuai dan kecondongan antena yang memberi kesan kepada zon tangan. Semua penemuan dan analisis dari simulasi ini adalah daripada mematuhi ramalan zon penyerahan rangkaian 5G dan liputan. Hasil penyerahan rangkaian 5G berjaya dan terbukti dengan perisian simulasi Fork Atoll. Ia dapat menyimpulkan bahawa, pelaksanaan rangkaian 5G di kawasan Bukit Beruang memerlukan pengetahuan dan pemahaman mengenai ciri frekuensi, ketinggian dan kecondongan antena.

ABSTRACT

The fifth generation mobile technology (5G) has been one of the crucial innovations in communication field. The development of the fifth generation (5G) technology inherited the previous technology such as third generation (3G) and fourth generation (4G). The strengths of fifth generation compared to previous technologies are it have a higher data transfer rate (>1Gbps) and lower latency (<1ms). Although 5G technology process of data bandwidth of more than 1Gbps but it is still consider as undeveloped technology due to the slow and poor planning on both hard and soft handover. This research is aim to analyze and propose unhindered planning or handover of 5G technology. In order to have better user experience on 5G network, two critical criteria have been selected as the focus of objectives which are handover condition and type of antenna. Before the 5G network simulation is done, few simulations such as frequency simulation, location simulation and antenna simulations were all performed to ensure the characteristic and the stabilization of 5G wave. Through the frequency simulation and study, 5G frequency wave found to be high path loss but on the same time remain high throughput. In the location simulation, results justified 5G wave require low inter-side distance in order to have better latency and application of altitude on the simulation would actually optimize the topology of Bukit Beruang which is higher ground level. Antenna simulation analyzed the best fit antenna type and the tilt of antenna which impact the handoff zone. All the finding and analyze from these simulation were than complied on the prediction of 5G network handover zone and coverage. The outcome of the 5G network handover was successful and proved with Fork Atoll simulation software. It can be conclude that, the implementation 5G network on Bukit Beruang area require the knowledge and understanding on frequency characteristic, altitude and tilt of antenna.

DEDICATIONS

This is devoted to my father who never stops believing and supporting me throughout my journey in building success and also to my mother who teaches me that nothing comes easy in life. This project also dedicated to my supervisor, Mr. Win Adiyanshah Indra who gives me a full support and suggestion to complete this project.

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LIST OF ABBREVIATIONS, SYMBOLS, AND NOMENCLATURE

1G	First Generation
2G	Second Generation
3G	Third Generation
3GPP	Third Generation Partnership Project
4G	Fourth Generation
5G	Fifth Generation
ACP	Automatic Cell Planning
AMC	Adaptive Modulation and Coding
AMPS	Advanced Mobile Phone System
AP	Access Points
bps	Bit per second
BTS	Base Station
CDMA	Code Division Multiple Access
CoMP	Coordinated Multipoint
CSD	Circuit Switched Data
D2D	Device to Device Communications
dB	Decibel
dBm	Decibel-milliwatt
DEM	Digital Elevation Model
DL	Downlink
DRGs	Digital Raster Graphics
DSP	Digital Signal Processing
EDGE	Enhanced Data Rates for GSM Evolution
EPC	Evolved Packet Core
ESRI	Environment Systems Research Institute
EV-DO	Evolution-Data Optimized
FCC	Federal Communications Commission
FDMA	Frequency Division Multiple Access
FM	Frequency Modulation
GIS	Geographic Information System

GPRS	General Packet Radio Service
GSM	Global System for Mobile Correspondence
HARQ	Hybrid Automatic Request
HF	High Frequency
HHO	Hard Handover
HPBW	Half Power Beam Width
HSDPA	High Speed Downlink Packet Access
HSPA+	High Speed Packet Access
HSUPA	High Speed Uplink Packet Access
Hz	Hertz
IMT	International Mobile Telecommunication System
IoT	Internet of Things
IPv6	Internet Protocol Version 6
ITU	International Telecommunication Union
km	Kilometer
KPIs	Key performance indicators
LAN	Local Area Network
LMDS	Local Multipoint Distribution Service
LTE	Long Term Evolution
LTE-A	LTE-Advanced
m	Meter
M2M	Machine to Machine Communications
MIMO	Multiple-Input and Multiple-Output
mm Wave	Millimeter wave
MMS	Multimedia Messaging Service
MRC	Maximal-Ratio Combining
MS	Mobile Station
MW	Microwave Band
NB-IoT	Narrowband-Internet of Things
NMT	Nordic Mobile Telephones
NNT	Nippon Telephone and Telegraph
OFDM	Orthogonal Frequency-Division Multiplexing
OFDMA	Orthogonal Frequency Division Multiple Access

PAN	Personal Area Networks
PSTN	Public Switched Telephone Network
QoS	Quality of Service
R&D	Research and Develop
RF	Radio Frequency
RNC	Radio Network Controller
RSSI	Received Signal Strength Indicator
SC-FDMA	Single Carrier-Frequency Division Multiple Access
SHO	Soft Handover
SIR	Signal-To-Interference Ratio
SMS	Short Message Service
SNR	Signal-To-Noise Ratio
SOA	Service-oriented Architecture
TACS	Total Access Communication Systems
TDMA	Time Division Multiple Access
UE	User Equipment
UL	Uplink
UMTS	Universal Mobile Telecommunications Service
USGS	United States Geological Survey
VoIP	Voice over Internet Protocol
WAN	Wide Area Network
WAP	Wireless Application Protocol
W-CDMA	Wideband Code Division Multiple Access
WiMAX	Worldwide Interoperability for Microwave Access
WLAN	Wireless Local Area Network
WRC	World Radio Communications

CHAPTER 1
INTRODUCTION

1.1 5G Technology

The creation, evolution and revolution of mobile wireless communication have been begun as early as 1970s. Mobile wireless technology has been through five generations of technology improvement, it has evolved from 1G to 5G generation in the past few decades (Kumar et al., 2015).In the simple sentence, 5G technology means fifth generation mobile technology. Several journals or project often use the name of 5G as the symbolization of the next upcoming mobile telecommunication standard.

On the current stage, 5G technology is consider as an under develop technology and haven't officially used by any public telecommunication companies (Patil et al., 2012).The 5G generation network offers wide range advanced features that user never experienced before. The enhancement in 5G technology contributes more reliability and robust than preceding 4G technology. The market demand for 5G technology will become a trend at a later time (Sapakal et al., 2013).Although 5G technology or any related cellular network have not been officially public or documentation, there are still some few features which listed in research study.

The features have been assorted into four regimentation which are capacity and data rate, latency, massive connectivity, spectral efficiency and the IoT technology (Falahy and Alani., 2017).5G mobile networks are awaited to increase capacity with fairly higher-speed data rates compared to 4G.Besides attaining high data rates, 5G

should be sustain latencies lower than 1ms to save energy and extend battery lifetimes. In order to conduct ultra-fast data speeds for more smartphones and tablets, improvement on spectral efficiency is crucial. The quantity of connected devices will surpass the number of human devices. Connectivity between machines has become a practical and feasible issue for M2M communications when the availability of mobile broadband rises up. Figure 1.1 indicates the development of different network over the years.

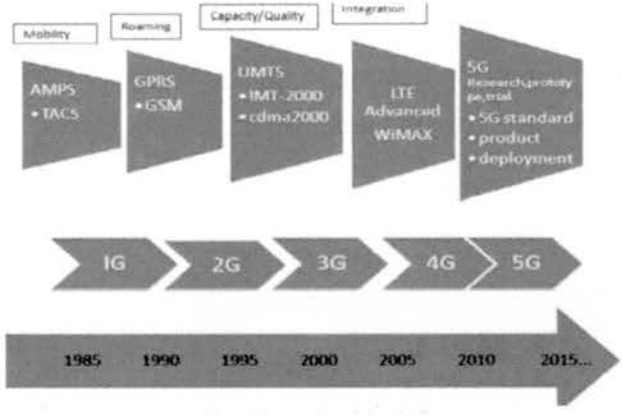

Figure 1.1: Development of different networks over the years (Kumar et al., 2015).

1.2 Network Architecture

Generally, different wireless networks from the sole terminal are used absolutely which means that is impossible for different wireless technologies to combine for the same session. At World Radio communication Conferences 2015, the major scope focused on put in additional spectrum for any mobile communications which below 6 GHz. While, the overall massive growth in the global mobile network traffic could not be performed or fulfilled by the action of additional spectrum (Falahy and Alani, 2017).

The trend pattern in forthcoming mobile networks (5G) has demonstrated a great vary mode from current existing networks, this is due to the main purpose has changed from offering users to connect wirelessly through the Internet to support large numbers of devices and users to seamlessly connect in smart cities by 2020 and beyond (Falahy and Alani, 2017).

According to Gohil et al. (2013), although 4G consists of multi-mode consumer terminals, but the unique operating pattern and security support mechanisms in special wireless technologies still remain unknown. The 5G multitier network architecture expect to support the user with simultaneously connect on the multiple wireless technologies and free to switch within them (Sapakal and Kadam, 2013). This should be able to support on merging special flows or connection from different technology to another technology (Gohil et al., 2013). The example of 5G multitier network architecture is show in the figure 1.2.

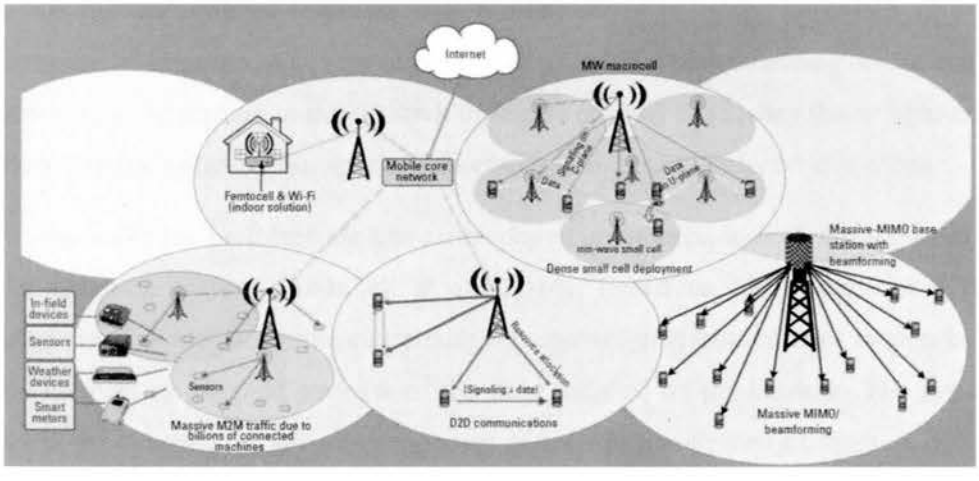

Figure 1.2: Example of 5G multitier network architecture (Falahy and Alani, 2017).

1.3 Antennas

In the world of radio and electronics, antenna serves as an electrical device that capable on converting electric power into electromagnetic waves or vice versa efficiently with minimum loss (Sharmaand Banga, 2016). A microwave antenna is one of the crucial system component which enable a microwave system to receive or transmit data within microwave sites (Ingate et al., 2013). The location of the antennas is usually placed at the top of the tower of a microwave site. It is undeniable that application of antennas has already blended into our daily life such as the use of telephone communications.

Antennas are vital in the entire communication systems. It is typically one of the bulk components in the system and troublesome for power transfer system (Furse and Chryster, 2014). An antenna connected to a transmitter is the tool that releases radio frequency, RF energy and transmit to a distant receiver, while the receiving antenna picks up the RF energy (Sharma and Banga, 2016).In order to obtain optimum performance of antennas, it is very important of us to have understanding on the antenna characteristics. According to the research of Ingate et al. in 2013, they throw light on the radiation pattern, polarization, aperture, directive gain, beamwidth and side lobes.

Basically the performance and efficiency of an antenna in a wireless system rely on the radiation pattern (Abdullah et al., 2016). Based on Chen and Luk (2009), radiation patterns are depict the electromagnetic power distribution in an open area and can be indicate as the field strength of the field radiated by the antenna. The radiation pattern is the delegate of radiation properties of antenna and known as function of space coordinate. The radiation pattern of antenna could divide into basic types which are omnidirectional antenna and directional antenna. In addition, the antenna polarization can be changed through the orientation of the electric field of radio wave and typically effect by antenna orientation and physical structure (Chen and Luk, 2009). In the research of Haji et al. (2009), they intend to combine two antennas to create a less complex antenna that can transmit either vertical or horizontal.

1.4 Problem Statement

Generation by generation, mobile network have become more familiar among teenagers and even old folks. The quality demand on mobile network becomes saturated. People are looking for any method in order to have a faster speed and wider coverage. This current situation has causing 4G technology become heavy duty and soon will become hampered (Patel et al., 2012).On the meantime, 5G has become yearn of public. Although 5G technology process of data bandwidth of more than 1Gbps but it is still consider as undeveloped technology (Sapakal and Kadam, 2013). This is due to the slow and poor planning on both hard and soft handover. There are different types of challenges in the planning of handover in 5G technology. Based on the view of the network provider, special designed troubleshooting tools or any improvements on the existing tools will definably be a great help on investigation those handover issues. These issues consists of network parameter such as transmit power, type of antenna use and the height of antenna. This research is aim to analyze and propose unhindered planning or handover of 5G technology. Figure 1.3 shows high demand of mobile compare to the fixed phone from 2005 to 2013.

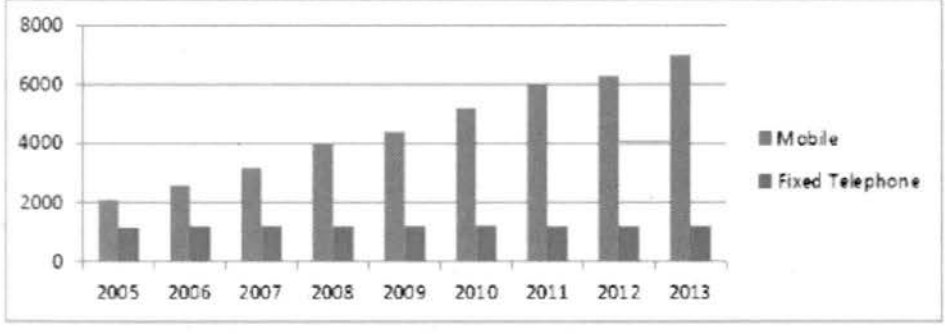

Figure 1.3: Dramatis growth of mobile user compare with fixed telephone in billion (Kumar et al., 2015).

1.5 Objective of Research

1. To study the planning of the 5G network that provides optimum topology.
2. To investigate the planning of handover which the network service will provide the good quality signal and enhanced connectivity.
3. To assert which types of antenna has the best performance on 5G signal.

1.6 Scope of Research

1. Studying and planning of 5G network that provides optimum topology at Bukit Beruang, Malacca.
2. Investigation on the map out of handover of 5G network service in term of signal quality toward the user.
3. Assertion on the types of antenna that is preponderance on providing stable 5G signal network.

In this research, the focus is mainly to the soft handover with refer to the overall performance. Soft handover effect strict requirement to control power and making capacity enhancement by adding a new cell as easy as no frequency planning in necessary. The soft handover includes configuring the network resources and parameters in a method that provides a good performance to users referring to quality of handover. Earth explorer and global mapper are used to select a target area and obtain digital map of that area. The selected area will be Bukit Beruang, Melaka. By using Forsk Atoll software, the focus zone is drawn to implement the base station and antenna. The predictions of handover status and coverage signal will be calculate for the output results.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

This chapter will basically cover the transformation of cellular network over the years, from the first generation to the latest fifth generation. The planning of fifth generation network IMT 2020 will be well introduce in term of configuration planning, capacity planning and parameter planning. Besides that, types of handover such as hard and soft handover also provided detail explanation. Last but not least, types of antenna are attach in the last segment in order to establish the third objective of this research.

2.2 Transformation of cellular network

2.2.1 1G Technology

The mobile communication system provided the way to user communicate with others. Evolution of mobile wireless technology is about enhancement in performance from 1G to 5G to fulfill the user needs. The concept of cellular was introduced with 1G networks. Mobile 1G established the foundation of mobile.1G stands for first generation wireless telephone technology.1G technology was born in 1980s and completely developed in early

1990's (Kumar et al., 2015). The enhancement of the first generation is the data rate of analog cell phones can be up to 2.4kbps.They applied transmission in analog form for speech services (Mir et al., 2015).

In 1979, Nippon Telephone and Telegraph (NNT) manipulated the first cellular system in the world. The cellular era reach Europe in two years later. The Advanced Mobile Phone System (AMPS) was launched in the United States in 1982. Besides, Nordic Mobile Telephones (NMT) and Total Access Communication Systems (TACS) both were the most prevalent analog systems at that time. The bandwidth or frequency range within 40-MHz to 900 MHz has been allocated by analog system. By using 120-degree directional antennas, the 18db signal-to-interference ratio (SIR) can be fulfilled the smallest reuse factor which was 7. In order to improve the AMPS, the 7-cell reuse pattern was utilized.

The process of transmission take place over the forward channel by using frequency range within 869 to 894MHz from base stations to user equipment. Whilst, the function of reverse channel is to make sure the transmissions occur from user equipment to base stations by using frequencies within 824 to 849MHz. For radio transmission purpose, the frequency modulation (FM) technique was used by AMPS and TACS. The traffic multiplexing method involved into Frequency Division Multiple Access (FDMA) system. There is FDMA in multiplexing possess circuit switching and adopts PSTN as primary network. While, it has only cover the outdoor area (Sharma, 2013).

1G was replaced by 2G because of the limitation in sound quality and the speed of data transfer. The limited capacity and limited scalability are the core problem for analog cell phone. Analog cell phone support for only one user per channel due to the transmission is inefficient at using limited spectrum. Other than that, analog devices are large in size, low power efficiency, and high cost. Besides, the geographical area of network divided into small part called cell. Thus, the term cellular phone originated based on this theory. The 1G networks were not compatible with each other due to standards of each network. Networks