DESIGN AND ANALYSIS THE PERFORMANCE OF HIGH GAIN ARRAY ANTENNA AT 3.5GHZ FOR 5G COMMUNICATION

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THIS REPORT IS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF BACHELOR OF ELECTRONIC ENGINEERING WITH HONOURS

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DEDICATION

I dedicate this project to God Almighty my creator, my strong pillar, my source of inspiration, wisdom, knowledge and understanding. He has been the source of my strength throughout this project. To my beloved father and mother, Mr Kanniah Subramaniam and Mrs Santa Venggattasamy and my sister, Piriya Kanniah. This thesis is purely of your tremendously support and sacrifice. I dedicate this to all of you. May God always bless every each of you.

ABSTRACT

The fifth-generation wireless 5G is the repetition of cellular technology, engineered to greatly increase the prospective, speed and responsiveness of wireless network. Moreover, 5G communication let a substantial increase in the amount of information's sent through the wireless system receivable to a greater bandwidth and advanced antenna technology. These days antennas suffer from poor radiation features that limit used in many active applications. Such wireless system required an array antenna with high realized gain. Due to these issues, this project will be concentrated to design a high gain array antenna at 3.5GHz for 5G communication. A directional patch antenna will be designed for a specific base station to provide high-capacity network connectivity and high quality of communication. Furthermore, high gain array antenna at 3.5GHz is more focused to be used at long distance point to point connections. In this project, 4x4 patch antenna will be designed in CST software and fabricated on FR4 epoxy material to achieve high gain for long distance signal transmission.

ABSTRAK

5G tanpa wayar generasi kelima ialah pengulangan teknologi selular, yang direka bentuk untuk meningkatkan prospek, kelajuan dan responsif rangkaian wayarles dengan banyak. Selain itu, komunikasi 5G membolehkan peningkatan yang ketara dalam jumlah maklumat yang dihantar melalui sistem wayarles yang boleh diterima kepada jalur lebar yang lebih besar dan teknologi antena termaju. Pada masa kini, antena mengalami ciri sinaran yang lemah yang mengehadkan penggunaan dalam banyak aplikasi aktif. Sistem wayarles sedemikian memerlukan antena tatasusunan dengan keuntungan yang direalisasikan tinggi. Disebabkan oleh isu-isu ini, projek ini akan tertumpu untuk mereka bentuk antena tatasusunan keuntungan tinggi pada 3.5GHz untuk komunikasi 5G. Antena tampalan berarah akan direka bentuk untuk stesen pangkalan tertentu untuk menyediakan sambungan rangkaian berkapasiti tinggi dan kualiti komunikasi yang tinggi. Tambahan pula, antena tatasusunan bergain tinggi pada 3.5GHz lebih fokus untuk digunakan pada sambungan titik ke titik jarak jauh. Dalam projek ini, antena tampalan 4x4 akan direka bentuk dalam perisian CST dan direka pada bahan epoksi FR4 untuk mencapai keuntungan tinggi untuk penghantaran isyarat jarak jauh.

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In the present world of competition, there is a race of existence in which those are having the will to come forward to succeed. Project is like a bridge between theoretical and practical working. With this willing, we joined this project. First, i would like to thank the supreme power the Almighty God who is obviously the one has always guided us to work on the right path of life. Without his grace, this project could not become reality. Next to him are our parents, whom we greatly indebted for us brought up with love and encouragement to this stage. We are feeling oblige in taking the opportunity to sincerely thanks to Dr. Mohamad Harris Bin Misran as my supervisor in this project whose help, suggestions and encouragement also helped us to coordinate the project. At last, but not least I'm thankful to all lecturers and friends who have been always helping and encouraging us throughout this semester even though we are currently facing unprecedented situation due to covid-19. We have no valuable words to express our thanks, but our heart is still full of the favors received from every person. Lastly, we would like to appreciate the guidance given by another supervisor as well as the panels especially in our project presentation that has been improved our presentation skills by their comments and tips.

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LIST OF SYMBOLS AND ABBREVIATIONS

εr : Dielectric Constant of Substrate

W : Width of Patch

L : Length of Patch

Wg : Width of Ground Plane

Lg : Length of Ground Plane

hs : Thickness of Dielectric Constant

ht : Thickness of Conductor

Wf : Feedline Width

Lf : Feedline Distance

$\boldsymbol{\lambda}$: Width of Substrate

$\boldsymbol{reff}$: Effective Dielectric Constant

$\Delta\boldsymbol{L}$: Extension in Length

G : Gain

D : Directivity

RL : Return Loss

I : Inner of the hexagonal slotted

O : Outer of the hexagonal slotted

r : Distance from patch-to-patch

Ws : Width of Substrate

Ls : Length of Substrate

CHAPTER 1

INTRODUCTION

1.1 Project Background

The fifth generation (5G) of communication has been widely discussed to provide high-speed connectivity in the future. The design and validation of the 5G communication system are dependent upon an understanding of the propagation channels [1]. Beyond the 4G standards, 5G Technology is a term used in many research publications and projects to describe the next most crucial stage of mobile communication standards. Currently, there is no official term for 5G specs.3GPP standard release beyond 4G and LTE [2]. At current, the 5G mobile system are broaden their range to improve high data rate. The World Radio Communication Conference (WRC) in 2015 discussed 5G possible frequency bands below 6GHz, as

well as the frequency ranges that go with them. 470-694MHz, 1427-1518 MHz, 3300-3800 MHz, and 4500-4900 MHz are among the frequency the frequencies recommended. Among these, 3.5GHz has been widely considered, as it is widely recognized for its superior performance.

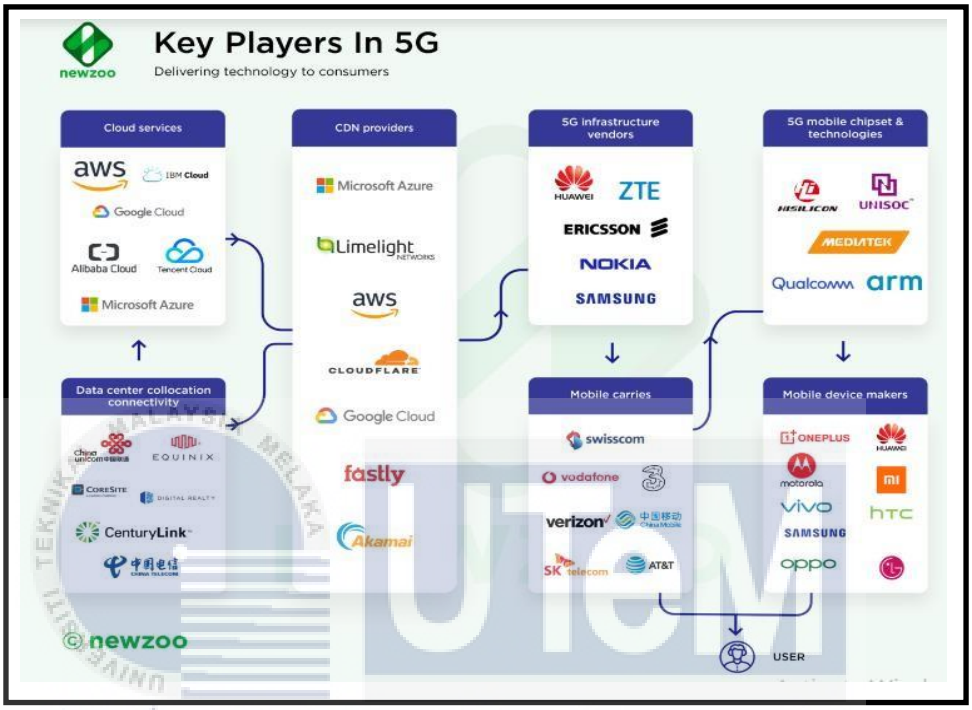

Figure 1.1: The 5G Ecosystem (The Key Players Involved)

The main advantages of 5G are data rates that can reach and exceed 10 Gbps, which can provide a better client experience and increase the download and upload speeds. Aside from that, 5G will boost resolution and enable bi-directional large bandwidth shaping. 5G mm-wave will be capable of achieving an inactivity rate of less than 1ms, allowing for faster connection establishment and delivery with the 5G organization by 5G cell phones, as well as a reduction in traffic load. Furthermore, 5G has the potential to provide a global network that is consistent, stable, and continuous. 5G technology allows all networks to be consolidated into a single platform, resulting in a 10x reduction in latency, a 100x increase in traffic capacity, a 10x increase in

connection density, a 3x increase in spectrum efficiency, and a 100x increase in network competency. In comparison to previous generations, the fifth generation is easier to manage.

Because of fast advancements in communication technology, researchers have been drawn to high frequencies and high gain antennas. Lossless long-range communication higher received signal strength, and a less crowded environment are all required by the increasing growth of communication networks. Because of their large capacity and ability to enable high transmission speeds, millimeter-wave (MMW) frequency bands have become more important [3]. These frequency ranges have large path losses, according to Friis' formula [4]. To offset these route losses, high gain antennas or arrays are necessary, which may be easily included into millimeter wave circuitry. The MMW bands have been standardized globally by the Federal Communications Commission (FCC). The FCC has recommended regulated bands of 28, 37, and 39 GHz, as well as an unlicensed spectrum of 64-71 GHz, as prospective Fifth Generation (5G) candidates [5]. Antennas developed for 5G must have a minimum gain of 12 dBi and a bandwidth of 1 GHz [6].

Wireless communication was coined in the nineteenth century, and wireless communication technology has advanced in the years thereafter. The electromagnetic exchange of data between at least two centers that are not connected by an electrical connection is known as wireless communication. Antenna is a type of wireless communication. An antenna, also known as an aerial, is an electrical device that converts electric energy into radio waves and vice versa. It's usually used in conjunction with a radio transmitter or radio receiver.

1.2 Problem statement

In the years of the twentieth century, all aspects of wireless communications are subject to rapid change throughout the world. As networks become dense, the expense of having fiber into each small cell turns out to be restrictively expensive, consume more time and need more manpower. Moreover, when the gain is poor and its might be not sufficient for a base station, because the coverage is extremely limited due to the narrow wavelength. In some rural areas, the network coverage is very low and the people living there might not having better telecommunication system.

According to research, the fifth generation (5G) of communication has been widely discussed to provide high-speed connectivity in the future. The design and validation of the 5G communication system are dependent upon an understanding of the propagation channels. In the upcoming 5G cellular standards, it is pin one's hopes on upon to satisfy the rapidly developing needs for information by network densification utilizing small cells with high gain limit.

To overcome these issues, a high gain array antenna needs to be proposed to provide greater gain than 10dB which guarantees the antenna catches a greater amount of the signal, again extending signal strength. Then by obtaining return loss value less than -10dB, it offers high quality and capacity network connectivity. Other than that, high gain antenna may cover the more extensive distance concerning 5G communications.

1.3 Objective

- To design a high gain array antenna for 5G wireless communication at 3.5 GHz frequency band with a greater gain of 10 dB.
- To investigate the performance of high gain array antenna for 5G wireless communication at 3.5GHz including gain, return loss, directivity, and radiation pattern.

1.4 Antenna design specification

The specification references Table 1.1 as it pertains to the research. The specification will serve as the major source of information for constructing the antenna prototype.

Parameter	Value
Operating Frequency, fr	3.5 GHz
Gain, G	>10 dB

Table 1.0: Antenna Parameter

1.5 Scope of work

The main goal of this project is to design a high gain array antenna at 3.5GHz for 5G communication by achieving all the objectives. In the process of the designing high gain array antenna for 5G communication, the fundamental achievement of this project is to provide high quality and capacity network connectivity with more gain than 10 dBi for 3.5 GHz.

For the simulation part, CST software 2020 will be utilized to design and simulate the proposed antenna. By using CST software, the antenna design will be