ANALYSIS AND MEASUREMENT OF ALIGNMENT AND TRACKING METHOD OF EARTH STATION ANTENNA IN SATELLITE COMMUNICATION SYSTEM

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ABSTRACT

Communication satellites in the geostationary orbits possess daily motion which causes the apparent position of the satellite to wander in the sky as seen by the earth station. If uncompensated, it will cause a variation in the performance of communication link. Therefore, the movement of the satellite has to be tracked by the earth station antenna. This reports aims to give an understanding of the satellite communication system and also the requirements in the alignment and tracking method of the earth station. In this report, we will explore the functions of communication system and its subsystems. The parameters in the link budget and earth station configuration will also be discussed. Other than that, the determination of the azimuth and elevation angles and slant range will be done in order to point the earth station to the satellite by using calculation and simulation method. Then, the results will be analyzed and compared. To conclude, the alignment and tracking is important to ensure reliable communication links between satellite and earth station.

Key words: Satellite communication system, earth station antenna, antenna alignment, antenna tracking

ABSTRAK

Satelit komunikasi pada orbit geopegun mempunyai gerakan harian yang menyebabkan kedudukan nyata satelit untuk berkeliaran di langit seperti yang dilihat oleh stesen bumi. Jika tidak dikompensasi, ia akan menyebabkan variasi dalam prestasi komunikasi. Oleh kerana itu, pergerakan satelit harus dikesan oleh stesen bumi antena. Laporan ini bertujuan untuk memberikan pemahaman tentang sistem komunikasi satelit dan juga faktor yang memainkan peranan dalam kaedah penjajaran dan pengesanan yang digunakan oleh stesen bumi. Dalam laporan ini, kita akan membincangkan fungsi sistem komunikasi dan sub sistemnya. Parameter dalam 'link budget' dan tatarajah stesen bumi juga akan dibincangkan. Selain itu, penentuan sudut azimuth dan elevasi dan jarak satelit dari stesen bumi akan dilakukan untuk menentukan titik stesen bumi ke satelit dengan menggunakan perhitungan dan kaedah simulasi. Kemudian, hasilnya akan dianalisis dan dibandingkan. Kesimpulannya, penyelarasan dan pengesanan adalah penting untuk memastikan hubungan komunikasi handal antara satelit dan stesen bumi.

Kata kunci: Satelit komunikasi, stesen bumi antenna, kaedah penjajaran antenna, kaedah pengesanan antena

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDIXES

CHAPTER I

INTRODUCTION

This chapter consists of the outline of the project in terms of objectives, scope, problem statement, expected outcomes and methodology. It aims to give the reader a deeper understanding of the project.

1.1 INTRODUCTION

Earth station antenna is a main component in satellite communication system and plays an important role in determining the quality of a signal. Antenna should be aligned precisely on the ground with the satellite beforehand in order to establish and maintain reliable and high quality two-way communication services at all time. While the satellite is moving at a certain path, the antenna should also follow the satellite movement. This action is called "antenna tracking". There are several methods in alignment and tracking which depend on the type of antenna and services. This project will analyze the alignment and tracking method from the theoretical, design, simulation and measurement aspect. The measurement presents azimuth and elevation angle, power loss, signal-to-noise ratio, carrier-to-noise ratio and other parameters that will be affected. Measurements will take place at FKEKK and Lendu Earth Station. Other than that, an animation on how the alignment and tracking method works will be done.

1.2 OBJECTIVE

The objectives of this project are:

- To gain knowledge and skill in alignment and tracking system of earth station antenna.
- To prepare the SOP and SMP of FKEKK earth station antenna.
- To be able to use FKEKK earth station antenna for student's experiment.
- To foster close relation between UTeM and Telekom in satellite field.

1.3 SCOPES OF WORK

This project will discuss on:

- Background of satellite communication system and earth station antenna.
- Parameters involved in the alignment and tracking system of earth station antenna.
- Design for alignment and tracking system.
- Implementation and simulation of the parameters involved in alignment and tracking system.
- Analysis and measurement of alignment and tracking of earth station antenna at FKEKK and Lendu Earth Station.
- Comparison between the theoretical, simulation and measurement results of the alignment and tracking system.

1.4 PROBLEM STATEMENT

Earth station consists of an antenna sub-system with an associated tracking system, transmitting and receiving section. This type of antenna can be seen in FKEKK, UTeM whereby it is used for television broadcasting. However, the Standard of Operating Procedure (SOP) and Standard of Maintenance Procedure (SMP) are not available for the antenna in UTeM. It will be a problem to realign and operate the antenna if crisis occurs such as the antenna's system break down. Moreover, there is not much study in satellite topic related at UTeM at this time. In other words, there is not much relation of UTeM with leading telecommunication company such as Telekom in terms of satellite studies at current time.

1.5 EXPECTED OUTCOMES

At the end of the project, the expected results will be as the following:

- Animation on alignment and tracking system of earth station antenna.
- Analysis of alignment and tracking of the satellite using FKEKK earth station antenna.
- Develop the SOP and SMP for FKEKK earth station antenna.
- Simulation of antenna alignment and tracking system.
- Conference technical paper.

1.6 METHODOLOGY

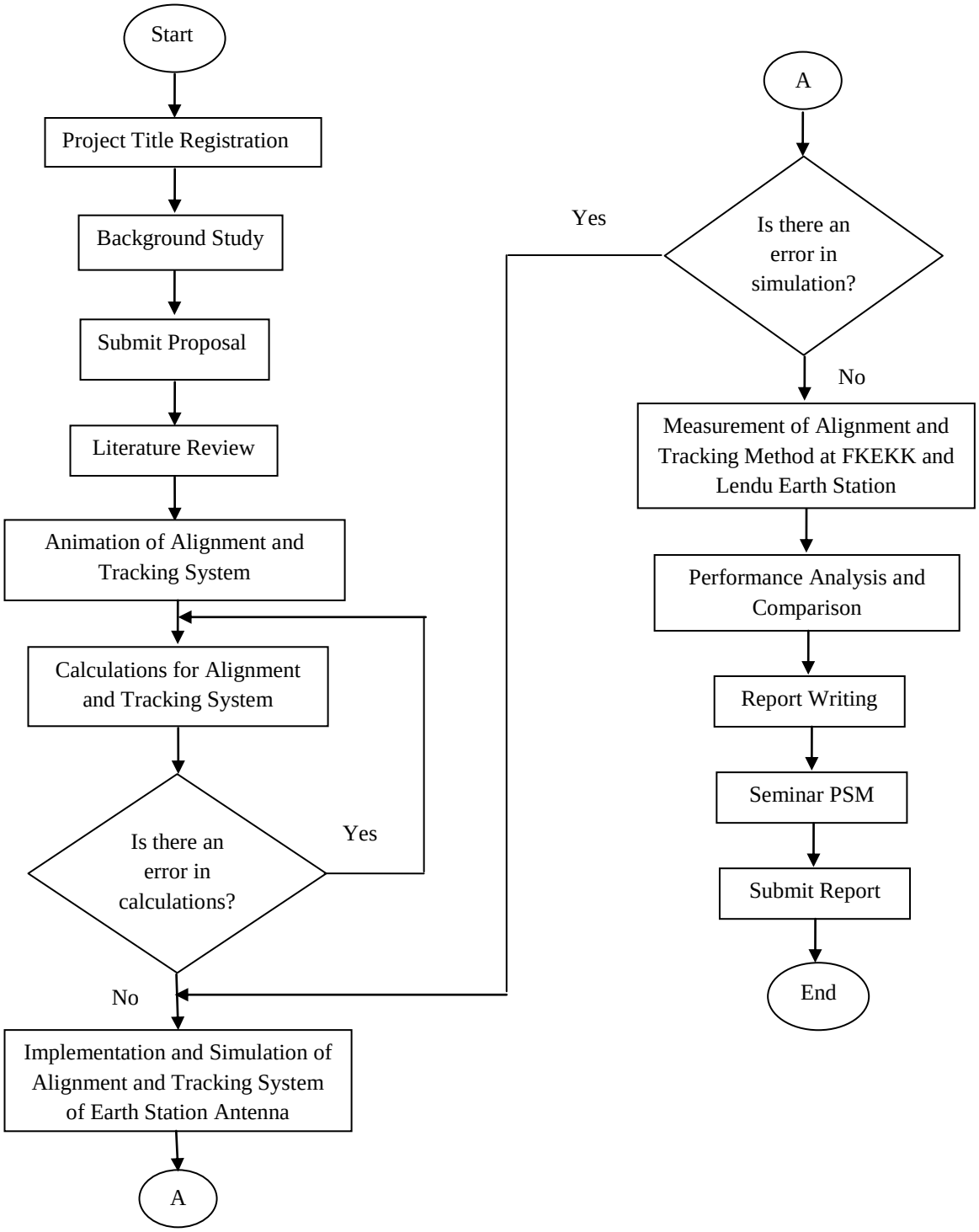

Figure 1.1: The flowchart of the project

CHAPTER II

LITERATURE REVIEW

This chapter is devoted to the studies on satellite communication system and its orbit. The allocation of frequency band based on space radio communication services is also discussed. This chapter will also sees into the link budget, organization of earth station and the characteristics of the antenna. In the last part, the alignment and tracking system will be examined.

2.1 INTRODUCTION TO A SATELLITE COMMUNICATION SYSTEM

A communication satellite is an orbiting artificial earth satellite that receives communication signal from a transmitting ground station, amplifies and then transmits it back to the earth for reception by one or more receiving ground stations.

In the mid-1960s, the commercial satellite communications industry has started and in less than 50 years, has progressed from an alternative technology to mainstream transmission technology. Today's communication satellites offer extensive capabilities in applications involving data, voice and video, with services provided to fixed, broadcast, mobile, personal communications and private network users.[1]

2.1.1 Configuration of A Satellite Communication System

Figure 2.1 gives an overview on the satellite communication system and its interfacing with terrestrial entities. The system is consists of space segment, control segment and ground segment.

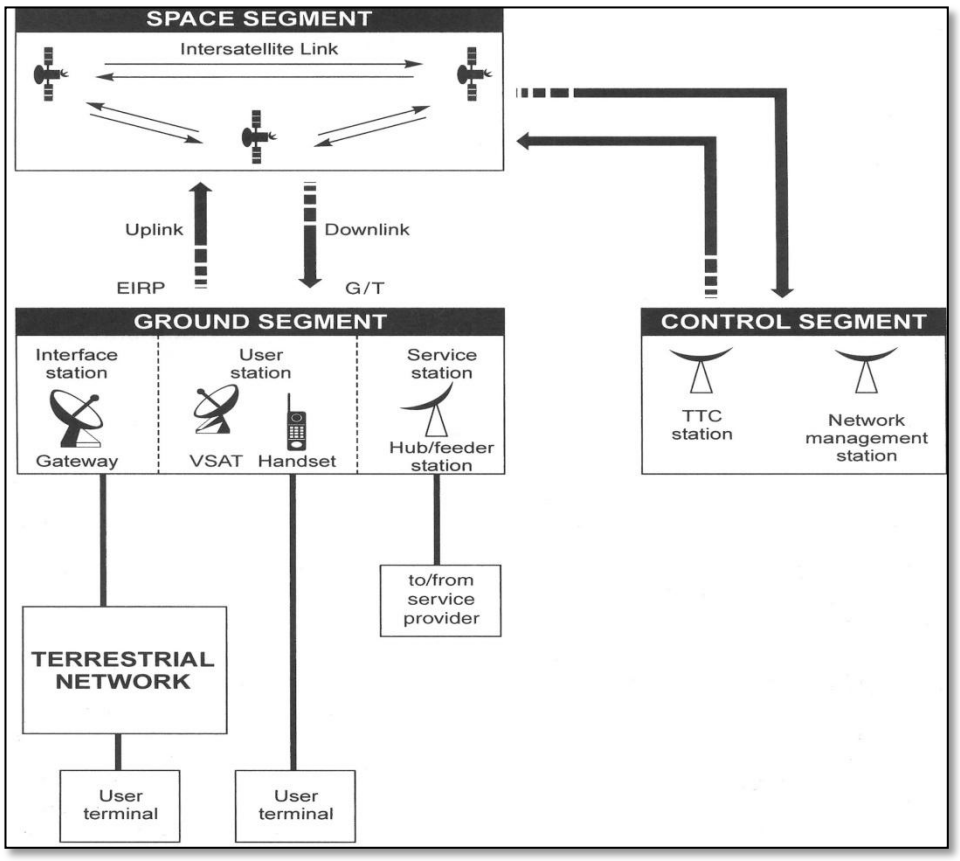

Figure 2.1: Satellite communication system

2.1.2 Communication Links

A link between a transmitting terminal and a receiving terminal consists of a radio or optical modulated carrier. The types of link are the uplinks from the earth stations to the satellites, downlinks from the satellites to the earth stations and the intersatellite links between the satellites. Uplinks and downlinks consist of radio frequency modulated carriers, while intersatellite links can be either radio frequency or optical. Carriers are modulated by baseband signals conveying information for communication purposes.

The link performance can be measured by the ratio of the received carrier power to the noise power spectral density, C/N_o ratio (Hz). This ratio will determine the quality of service of connection between the end terminals in baseband signal-to-noise power ratio, S/N or bit error rate (BER). [1]

2.1.3 The Space Segment

The space segment contains one or several active and spare satellites organized in a constellation and the satellite consists of the payload and the platform. In the payload, there are the receiving and transmitting antennas and all the electronic equipment which supports the transmission of the carriers. The two types of payload organization are transparent and regenerative. The platform consists of all the subsystems which permit the payload to operate. The Table 2.1 below lists these subsystems and indicates their respective main functions and characteristics: [1]

Table 2.1: Platform subsystems

Subsystem	Principal Functions	Characteristics
Attitude and orbit control (AOCS)	Attitude stabilisation and orbit determination	Accuracy
Propulsion	Provision of velocity increments	Specific impulse, mass of propellant
Electric power supply	Provision of electrical energy	Power, voltage stability
Telemetry, tracking and command (TTC)	Exchange of housekeeping information	Number of channels, security of communications
Thermal control	Temperature maintenance	Dissipation capability
Structure	Equipment support	Rigidity, lightness