CHAPTER I
INTRODUCTION

1.1 Background

The need for the Internet has dramatically increased in recent decades. This is due to the increased population growth during that period. As of May 2024, the Central Statistics Agency (BPS) of Indonesia recorded a population in Indonesia of 279,596,080 people. The results of a survey conducted by the Indonesia Internet Service Providers Association (APJII) in 2023 recorded approximately 215,626,156 people connected to the internet, with an internet penetration rate of 78.19% in Indonesia. The increase in internet penetration can increase economic growth in a region, including in Indonesia [1][2][3] One of the systems that can increase internet penetration is the satellite network system.

Indonesia is an archipelago country with approximately 17,504 islands. This geographical condition requires satellite technology for the equitable distribution of internet access in Indonesia, including in areas that cannot be accessed by terrestrial telecommunication technology [4]. Internet Equity in Indonesia [4][5]

HTS and VHTS technologies have better capacity and *throughput* than ever before. They use multiple spot beams to reach service areas that are difficult to reach by conventional satellites. Multiple spot beams reuse frequencies to produce *bandwidth* with a high *data rate per Hertz* and maximize the allocation of existing frequencies. HTS and VHTS have a large number of [6], [7]*users* in one area with a large capacity per *user* (Mbps/user) [7]

Satria-1 is one of Indonesia's satellites with HTS technology for internet equality. It was developed by one of the satellite development companies in Indonesia in collaboration with the Indonesian government [8]. Meanwhile, Viasat-3 is a satellite with VHTS technology that can serve the needs of the Internet in various countries, including Indonesia. The satellite with VHTS technology was developed by the company Viasat Inc., which is located in Carlsbad, California, U.S.A. The Satria-1 and Viasat-3 satellites have the same working frequency spectrum, namely at 27 – 40 GHz or Ka-Band [9], [10] The use of Ka-Band in HTS and VHTS satellite technology in Indonesia can facilitate significant bandwidth needs but have high attenuation in satellite propagation signals caused by rain, considering that Indonesia is a tropical country with reasonably high rainfall [11], [12]In addition to having susceptibility to weather and atmospheric conditions, HTS and VHTS require transponders with a large enough capacity causing high implementation costs. Therefore, using Ka-Band frequencies is rarely used by satellite service provider operators. Another problem is the regulatory aspect of implementing HTS and VHTS in Indonesia, which is related to the government's readiness to adopt this technology. Related to the challenges in implementing HTS and VHTS technology in Indonesia, a *techno-economic* analysis is needed to implement these technologies, as well as further studies related to regulations related to HTS and VHTS technology implemented in Indonesia.

In the previous study, the implementation of HTS and VHTS in Indonesia has been studied from technical and economic aspects [8], [13], [14]. The study discusses the importance of HTS in accelerating the equitable distribution of broadband internet access in areas difficult to reach by terrestrial infrastructure from technical and economic aspects. In the study, there was no detailed explanation of technical and economic aspects, especially regarding the value of HTS calculations. Then, in the study, we discussed the Ku and Ka-band spectra used on high-throughput satellites in Indonesia to recommend the cost of BHP on both spectrums. Meanwhile, the study explains the frequency of Ku band's implementation of HTS in Indonesia using techno-economic methods and regulatory analysts for Indonesian governments. However, the study does not explain the implementation of the Ka-band in HTS operations in Indonesia [13][14][8]

Based on the three previous studies, no research has discussed in detail the technical and economic aspects of using Ka-band in the operation of HTS satellites and a detailed discussion of technical and economic aspects of using VHTS technology in Indonesia. This study will discuss the implementation of HTS and VHTS in Indonesia by using the Satria-1 and Viasat 3 satellites as reference satellites for implementing satellite networks in Indonesia. The two satellites were chosen because they have the same working frequency range, namely Ka-band and service areas in Indonesia.

SATRIA-1 is a reference satellite for HTS technology with an orbital point at 146°E, and ViaSat-3 is a VHTS technology satellite orbiting at 157.5°E with a service area in the Asia Pacific (APAC) region. This study will analyze the coordination between the SATRIA-1 and ViaSat-3 satellites in a service area in Indonesia with an area of 1,905,000 km2. at the 19th ITU Word Radio Conference (WRC) stated that arc distance ±16 degrees has the potential to experience interference[12]. Based on the conditions of using the same frequency spectrum, namely Ka-Band and arc distance that has the potential to experience interference in the implementation of HTS and VHTS in Indonesia, it is necessary to analyze the coordination between satellites using the calculation of link budget, and interference, and the calculation of the round trip time (RTT) to determine the potential for interference to occur in the implementation of HTS and VHTS in Indonesia. So, in this study, a technical analysis will be carried out, including capacity analysis and interference analysis. After the technical analysis, an economic analysis will be carried out to determine the investment feasibility of implementing HTS and VHTS. The economic analysis in this study will include calculating the cost needed to apply these two technologies per Mbps. A regulatory analysis of the implementation of HTS and VHTS is carried out by analyzing the impact of existing regulations on the implementation. In the regulatory analysis, there will also be harmonization between national and international regulations related to implementing HTS and VHTS. The analyses carried out in this study are expected to provide information about HTS or VHTS technology that can provide broadband services on satellite networks in Indonesia, as well as recommendations for regulations to the Indonesian government regarding HTS and VHTS technologies implemented simultaneously in Indonesia.

1.2 Problem Identification

The problems raised in this study are:

1. A technical analysis, including capacity analysis and interference analysis of the HTS and VHTS satellites, is needed. This is necessary because the two satellites on the same GSO orbit within 16° separation have a frequency overlap that can cause interference.
2. Interference among GSO may lead to capacity reductions that affect the spectral efficiency and economy of the satellite HTS and VHTS.

3. A regulatory analysis of the two satellites is needed. This is done to harmonize existing regulations with the results of technical analysis and interference analysis that has been carried out in this study.

1.3 Purpose

Based on the background and problems identified, this research aims to address several things.

1. Identify the frequency overlap that occurs in the HTS and VHTS satellites so that interference calculations can be carried out between the two satellites.
2. Determine the capacity of HTS and VHTS satellites before and after the interference to determine the effect of capacity reduction on spectral efficiency and calculation of the economy of HTS and VHTS satellites
3. Provide regulatory recommendations for HTS and VHTS technologies implemented simultaneously with orbitals and frequencies in the same area to the Indonesian government and satellite operators.

1.4 Scope of Work

To prevent the scope of discussion from expanding and to obtain optimal research results, this study has limitations in discussion. The limitations of the discussion are:

1 The satellite technologies used to optimize internet penetration in Indonesia are HTS and VHTS satellites.

2 The HTS and VHTS satellites used in this study are SATRIA-1 and ViaSat-3, which operate in the Ka-band frequency range.

3 The SATRIA-1 and ViaSat-3 satellites both orbit in GSO with coordinates of 146°E and 157.5°

4 The satellites used are satellites that serve services in Indonesia.

5 The study on the economic aspect used the 15-year life span of the satellite, which is taken from the average life span of satellites.

6 Technical analysis on the space side of HTS and VHTS power management uses budget link analysis and interference analysis.

7 Economic analysis only uses capex analysis

1.5 Hypothesis

This study has several hypotheses, namely:

1. The occurrence of interference between the Geostationary Orbit (GSO) satellite system in the case study of the SATRIA-1 and ViaSat-3 satellites. Interference occurs in the Uplink and Downlink systems.
2. There is a difference in satellite parameters, so it is suspected that the interference in SATRIA-1 will be more significant on the forward downlink side, and in VIASAT 3 will be more significant on the return uplink side.
3. A reduction in capacity occurs in both satellites.
4. The difference in the cost of providing internet network services from the two satellites is caused by the reduction in capacity caused by interference.

1.6 Research Methodology

The research methodology used in compiling this study is:

data on HTS and VHTS implemented in Indonesia through related literature.

a. Technical Analysis

Identify and process technical data from the Satria-1 and Viasat-3 satellites to analyze the implementation of HTS and VHTS technology in Indonesia.

b. Economic Analysis

Based on technical analysis, economic analysis can be carried out to see if there is a difference in economic terms caused by possible interference between the Satria-1 and Viasat 3 satellites.

c. Regulatory Analysis

The regulatory analysis is carried out based on the results of the technical and economic analyses that have been carried out, so it is expected to provide regulatory recommendations related to the implementation of HTS technology in Satria-1 and VHTS technology in Viasat-3 at the same time.

1.7 Systematics of Thesis Books

This research will be compiled from several parts, namely:

1. CHAPTER I – INTRODUCTION

   This chapter includes background, objectives, problem formulation, scope of work, hypothesis, research methodology, and writing systematics.

2. CHAPTER II – LITERATURE REVIEW

   This chapter will explain the theories used to support this research. Generally, the theories used in this chapter are theories related to satellite communication systems, frequency spectrum, and satellite frequency plans, HTS and VHTS satellite technology, technical aspects such as link budgets, interference, economic aspects consisting of CAPEX analysis, as well as regulatory aspects consisting of international regulations and national regulations.

3. CHAPTER III – SYSTEM DESIGN & MODELS

   In this chapter, we will discuss how the research scheme and what will be carried out, from the steps of data collection and processing data to being able to carry out the necessary analysis.

4. CHAPTER IV – RESULT & DISCUSSION

   This chapter consists of data processing and data analysis so that it can provide results from technical, economic, and regulatory analysis.

5. CHAPTER V – CONCLUSION, RECOMMENDATION & FUTURE WORK

   This chapter will describe the conclusions of the technical, economic, and regulatory analysis carried out, provide regulatory recommendations to the Ministry of Communication and Informatics and satellite operators, and provide recommendations related to further research from this study.