CHAPTER I
INTRODUCTION

1.1 Background

The development of information technology has encouraged a significant increase in the use of data communications, especially the internet, which is what is most needed today. However, some places cannot be reached with home internet through terrestrial network and require an internet network~~,~~ especially from satellite, namely the use of satellite broadband for internet. There are several types of satellites with different frequencies such as C-Band, Ku-Band and Ka-Band. Ku-Band gained popularity recently uses higher frequencies than C and lower than Ka-Band for satellite communications and also both geostationary orbit satellite (GSO) network as well as non-geostationary orbit satellite (non-GSO) system. Non-GSO system recently has significant user adoption. One of the advantages of non-GSO system is its low latency below 100 ms. Latency in GSO network is around 550 ms and 600 ms. Latency is the delay in communication between the receiver and the receiving satellite. The increase in the adoption of Ku-Band frequency spectrum was due to its wider bandwidth which is more suitable for the High Throughout Satellite (HTS). The satellites used by Ku-Band usually use High Throughput Satellites to increase the capacity and speed of data transfer in satellite communications. Not only to increase capacity but HTS is also used for fast internet access and also various communications in every activity such as aviation, maritime, and the like. The Ku-Band frequency spectrum, however, has some disadvantages in its propagation characteristics. Propagation is the propagation of waves in free space with the influence of the frequency of the wave. Ku-Band propagation is the transmission of a signal with a Ku-Band frequency of 12 GHz to 18 GHz which propagates through free space and is affected by various factors such as the atmosphere and rain attenuation. Ku-Band are using multiple applications such as Fixed Satellite Services, Mobile Satellite Services and Broadcast Satellite Services[1].

High Throughput Satellite has more affordable than traditional satellite and these satellites has a feature for optimized a high frequencies and high data rate applications[2]. BRISAT is one of the High Throughput Satellite with geostationary orbit satellites that employs the Ku-Band system to provide broadband internet communication services in the Indonesia region, including remote areas. BRISAT orbits at an altitude of 35,786 kilometres above the equator with coordinates at 150.5° East longitude. But with the effect of latency on GSO and non-GSO satellites is the problem for the user experience on internet and streaming applications and this requires a calculation of the Ku-Band propagation. Analysis of the factors that will influence propagation will be calculated using the link budget and also based on ITU-R P.838-3 which will be the basis of this research analysis.

Satellite services will be adequate for internet and streaming needs, which shows that the availability and performance of satellite services in the area are met to provide these services. From several studies, there are several factors that influence Ku-Band propagation which are explained in one of the studies entitled A Survey on Non-Geostationary Satellite Systems. The Communication Perspective where it is explained that non-GSO satellites bring exciting new communications capabilities to provide non-terrestrial connectivity solutions and support a wide range of digital technologies from various industries. Non-GSO communication systems are known to have several key features such as lower propagation delay, smaller size, and lower signal loss compared to conventional geostationary satellites (GSO). However, despite several advantages, there are challenges that still need to be overcome in implementing the non-GSO system. This is done to support Video on Demand services, enterprise links with high data rates, and content distribution/backhaul links from small user terminals which require a large system to be able to support several of these services in remote areas. There are many factors to consider when conducting Ku-band propagation studies, including latency and Signal Attenuation due to high rainfall[3]. These aspects require technical analysis to assess whether Ku-band propagation in Indonesia can be optimized to mitigate signal degradation and ensure the quality of communication used by users which affect user experience, this is why a study will be made. The study on the effect of GSO and non-GSO latency as well as Ku-Band propagation and its impact to the user experience. User experience is how the user interaction with the services and provide them the individual experience. This includes how users perceive the quality of stable connectivity, adequate internet speed, and security when accessing and enjoying streaming content. In assessing user experience for satellite-based systems, important aspects to consider include connection quality, security, usability, and service availability. Connection quality involves the stability and speed of the internet, which affects the comfort of users when using the service[4].

This research aims to analyze how latency and propagation characteristics of Ku-band satellite systems influence user experience in internet and streaming applications. The study compares Geostationary Orbit (GSO) and non-Geostationary Orbit (non-GSO) technologies through the case of BRIsat and Starlink, which represent different satellite architectures. By integrating technical measurements and user perception data, the research explores how performance indicators such as latency, throughput, and weather-related attenuation affect user experience, including perceptions of reliability, service quality, satisfaction, and acceptance.

Statistical analysis, particularly the Mann-Whitney U test, is used to evaluate whether significant differences exist between the two systems from the user's perspective. The outcome of this study is expected to contribute to academic research on satellite communication performance and provide evidence-based recommendations to improve user experience, especially in regions where satellite-based internet is a primary means of access.

1.2 Research Purpose

The objectives of this study can be outlined as follows:

1) Analyze the impact of network technical parameters—latency, jitter, and throughput—of Ku-band satellite systems on user experience in internet and streaming applications.
2) Compare user experiences between Geostationary Orbit (GSO) technology represented by BRIsat and non-Geostationary Orbit (non-GSO) technology represented by Starlink.
3) Integrate technical measurement results (latency, jitter, and throughput) with user perception data to evaluate their effects on perceived reliability, service quality, satisfaction, and acceptance.
4) Assess whether significant differences exist between the two systems from the user's perspective using the Mann–Whitney U statistical test.
5) Provide evidence-based recommendations for improving satellite internet service quality, particularly in regions that rely on satellite connectivity as the primary means of internet access.

1.3 Identification of Problem

The identification of problems of this research is:

1). There is a considerable difference in propagation distance between Geostationary Orbit (GSO) and non-Geostationary Orbit (non-GSO) satellite systems, which may affect latency and, in turn, influence user experience.

2). The use of Ku-band frequencies makes satellite communication susceptible to rain attenuation, leading to signal degradation and increased propagation delay during adverse weather conditions.

3). Variations in satellite architecture and performance may result in different user experiences, especially in terms of perceived reliability, service quality, satisfaction, and acceptance.

4). There is limited integration between technical network performance data and user perception analysis in existing satellite internet research, especially in the context of remote regions relying heavily on satellite connectivity.

1.4 Scope of Problems

In this study, will be analyze the effect of propagation for user experience based on the performance metrics on site and from the calculation of link budget. Some the limits are determined are:

1. The study of the satellite is BRISAT with Geostationary Satellite Orbit (GSO) network.
2. The study of the Starlink satellite the second generation (Gen-2) with Non-Geostationary Satellite Orbit (non-GSO) system.
3. Calculation of Ku-Band Propagation and analysis of the impact of high rainfall.
4. The measurement user experiences using Quality of Experiences from ITU.

1.5 Research Method

To evaluate the performance and user experience of Ku-band satellite internet systems, this research was conducted in selected locations where internet and streaming activities are commonly carried out. Performance measurements were taken over five consecutive days to assess key technical parameters including latency, jitter, and throughput or quality of services from the satellites service. These technical measurements were complemented by user perception data collected using the ITU-T P.800 questionnaire, which has been validated for assessing Quality of Experience (QoE) and will be analyze with statistics analysis. By combining both objective and subjective data, the study aims to provide a comprehensive understanding of how GSO and non-GSO satellite systems perform under real-world conditions.

1.6 Hypothesis

The hypothesis in this thesis:

1) The technical performance (latency, jitter, throughput) of non-GSO satellite systems is expected to be better than that of GSO systems in the context of Ku-band internet services.
2) User perception regarding service quality, reliability, satisfaction, and acceptance of non-GSO systems is expected to be higher compared to GSO systems, based on assessment using the ITU-T P.800 questionnaire.

1.7 Research Methodology

The research methodology of the research is:

1) Studying literature studies to study problems related to the use of Ku-Band frequencies for satellite communication systems. especially from scientific journals.
2) Qualify the data into qualitative and quantitative.
3) Quantitative approach for measuring the Ku-Band propagation from 2 locations.
4) Qualitative approach using sampling method for focusing on user experiences.
5) Result data from findings in quantitative and qualitative are compiled into final data. Analysis final data to draw conclusions of the research with Regulatory, Economical and Technical implications.

1.8 Timeline

Table 1. 1 Timeline Research

No	Activity	October				November				December				January				February			
		Weeks				Weeks				Weeks				Weeks				Weeks			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1	Observation	P	P	P	P																
2	Making Proposal			P	P	P	P	P	P												
3	Data Retrieval							P	P	P	P	P	P								
4	Preparation Thesis							P	P	P	P	P	P	P	P	P					
5	Finishing Thesis																P	P	P	P	P