# CHAPTER 1
# INTRODUCTION

## 1.1. Background

Communication with high data rate is continuesly growing up. On the other hand, we know that the radio frequency spectrum is a limited resource. Currently, implementation of satellite communication systems in C-band and Ku-band frequency are already very crowded. Satellite communication system using C-band frequency with bandwidth of 800 MHz has uplink frequency of 5925 - 6725 MHz and downlink frequency of 3400-4200 MHz. System using Ku-band frequency with bandwidth of 750 MHz has uplink frequency of 14000 - 14500 MHz and 11450 – 11700 MHz, and downlink frequency of 12250 – 12750 MHz and 10950 – 11200 MHz. Satellite communication system using C-band or Ku-band frequency with single beam satellite footprint provides services on a limited throughput. Capacity or throughput of satellites with single beam are constrained by the availability of used bandwidth and the distribution of dispersed satellites power throughout the coverage area of the satellite. Single beam satellite footprint produces total bandwidth that is identical to the width of used frequency spectrum, while the effectiveness of satellite power distribution will depend on the area of services that fall within in coverage of a single satellite beam. Satellite power distribution in a single beam is relatively less optimum due to the satellite power will be distributed to the entire coverage of the service area without seeing land or sea. In addition, if a single beam coverage is spread in a large area, it will have consequences to degrade the quality of signal or power of satellites that are received by the users. If we want to maintain the quality of the satellite power and high throughput in a whole of the satellite's coverage area, it means that the single beam satellite footprint must be concentrated in a relatively narrow area [3]

To increase the capacity of satellite services and increase the effectiveness of satellite power distribution can be done by applying Ka-band High Throughput Satellite (HTS) system by using a concept of multi spot-beams and frequency re-use. Ka-band frequency with high bandwidth has uplink frequency of 27000 – 31000 MHz and downlink frequency of 17700 – 21200 MHz. Characteristic of Ka-band frequency that works at high frequency with a narrow beam-width, it is possible to do the frequency re-use by using the multi spot-beams with a distance between the spot-beams are relatively close, therefore it will create a total number of multi spot-beams which is enough to produce the multiplication of high throughput. Ka-band HTS systems will produce double capacity or throughput correspond to the number of spot-beams and the amount of the repetition of distributed frequency in multi spot-beams [3]

To obtain the optimum system, it needs to apply the modeling by correlating and adjusting system parameters of Ka-band HTS system to the condition of Indonesia's geographical areas that are unique and specific. With these adjustments, it is expected to provide a guaranteed capacity of Ka-band HTS systems that represent the characteristics of Indonesia's demand. This research proposed a concept of accomodative throughput to be implemented in Ka-band HTS system in Indonesia. The accomodative throughput means there were many possibilities to allocate the capacity in each spot-beam with various number of allocated bandwidth while still maintain the colour pattern allocation of those spot-beams, in order to have the flexibility for the HTS system to accomodate the growth or dynamic traffic demand in the future after the HTS system had been launched.

### 1.2. The Gap of the Real Condition and The Future

When we are launching the new satellite, we will use the given traffic prediction as a based line of demand to create the total capacity of the satellite. It will remain to be kept for long enough periode in accordance with the lifetime of its satellite. In practical, we will have around 15 years of satellite's normal life time periode. In case of there are some demand changing in the middle of this satellite life time periode, currently we are not able to adjust the mapping of the distribution of the throughput allocation with respect to the distribution of the traffic demand of each spot-beams.

### 1.3. The Problem Definition

To increase the service capacity of satellite communications systems and to increase the effectiveness of satellite power distribution systems can be done by applying a Ka-band High Throughput Satellite (HTS) using the concept of multi spot-beams and frequency re-use.

When we are applying HTS Ka-band system by using the concept of multi spot-beam and frequency reuse, we will get a high total throughput. But the problem is that we do not know the minimum guaranteed throughput for each spot-beam and the minimum guaranteed total throughput that is delivered up to the all of spot-beams

### 1.4. Problem Limitations

The optimization of throughput in Ka-band HTS systems are not included the interference analysis among the spot beams. This is due to the modeling of multi spot-beams with frequency re-use is done by using different frequency and/ or polarization for the adjacent or intersect spot-beams, so that interference between those beams can be avoided and in this research we ignore inter-beam interference, because we consider very narrow spot beams over a large number of spot beams [1].

The interference analysis between the satellite communication systems and the terrestrial radio communication system are also not included with the assumption that the used frequency band in HTS systems are not used by terrestrial systems.

### 1.5. The Research aim and Objectives

The aim of this research is to have a modeling of Ka-band HTS system in Indonesia by implementing the proportional and optimized multi spot-beams and frequency re-use. This model is designed in order to get the capacity of satellite services with high and optimum throughput in accordance with the model/real data demand of broadband satellite services. In addition, the aim of this research is to analyze the minimum guaranteed throughput value of each spot-beam and the minimum total throughput that is delivered to all of spot-beams.

After the launching process, a satellite will have an operating lifetime of approximately 15 years. The research model is designed so that during the lifetime of satellite, it might be possible to re-optimize the throughput of multi spot-beams in relation to the dynamic needs of broadband data that occurred in every spot-beam area.

### 1.6. Hypotheses

Ka-band frequency spectrum in the modeling of HTS systems have relatively large bandwidth (2 GHz). In addition, the Ka-band frequency is a high frequency, so that based on the concept of antenna directivity, the use of the Ka-band frequencies will produce small beam width. In the HTS system modeling, small beam width will generate small spot-beam. By repetiting or technical engineering we can produce a multi spot-beams system. Through a combination of multi spot-beams and frequency reuse (repetition of used frequency in different spot-beams) and the application of high power (EIRP) in each of the spot-beam will produce a high total throughput. Due to the geographic areas of Indonesia are spreading in tropical regions, the throughput variations of each spot-beam and total throughput of HTS Ka-band system in Indonesia will be greatly affected by rain attenuation, and other weather effects, as well.

### 1.7. Scope of Work

The work contains five part activities as follows:

1. Develop the model of multi spot-beams of Ka-band HTS in Indonesia.
2. Develop the model of frequency channel to be allocated in the spot-beaam.
3. Allocate frequency channel or bandwidth to the model of multi spot-beams of Ka-band HTS in Indonesia by adapting to the model/real demand for each spot-beam in order to have the conformity of the distribution of throughput of each spot-beam in the geographical area of Indonesia.
4. Perform the throughput calculation of each spot-beam by varying the use of modulation and coding, coresspond to the bandwidth, power and the link attenuation of its those spot-beams, including to present the guaranteed throughput for each spot-beam.

5. Perform the total throughput calculation of the model of heterogen and proportional multi spot-beams of Ka-band HTS in Indonesia, including to present the total guaranteed throughput.