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CHAPTER 1

INTRODUCTION

Moving forward to Third Generation Mobile Communication System (3G), point-to-point microwave link will continue to serve as the backhaul link for wireless systems. However, the heavy rain in tropical region country limits the full implementation of the system in terms of installation distance and frequency usage. As the frequency increasing, the rain attenuation will become worse [5-6]. The installation distance could be reduced in order to have lower rain attenuation; however the implementation cost will become higher since more microwave link is required. Furthermore, frequency spectrum congestion unavoidable will force the future system to operate in higher frequency band.

Numbers of researches have been conducted for measuring the rain attenuation at point-to-point microwave link. However, research for the method to overcome the problem is quite limited. Although power control system also integrated in some of the point-to-point microwave communication system, the discussions are limited to only the restrictions, applications and operations rather than system design and performance analysis [6-8]. The research reported in this paper therefore aims to give solution for rain attenuation problem at point-to-point microwave link by introducing adaptive transmit power control (ATPC) in the front-end of radio unit.

The response of ATPC to the receive signal level (RSL) decides how fast the system can compensate for the fading and prevent the system from outage. The design of radio system with ATPC needs to fulfill some regulations in the operating country in order to install the equipment. European fixed radio systems

recommendations are taken as reference for determining the effect of ATPC to transceiver system [7]. The ATPC is designed to provide sufficient power to overcome the propagation path loss, without introducing excessive distortion and spurious that will cause bit-error-rate (BER) performance degradation. Analysis of transceiver system involves with harmonics and inter modulation that could not be achieved with simple mathematical calculations. The system analysis will become more complex when digital modulated signal is processed.

For terrestrial microwave links operating at frequencies higher than **10** *GHz,* rain-induced degradations are significant. Major degradations caused by rain that affect the reliability and availability of terrestrial links are rain attenuation and rain fade. Besides attenuation, rain fade is another major factor affecting the performance of microwave links. Rain fade is the dynamic fluctuation of receive signal due to in homogeneities of the signal path, ranging from a few seconds to a few minutes. Rain fade provides additional information on understanding the characteristics of rain-induced degradations.

1.1 Objectives of the project

At the end of Project 1 and 2, I hope to achieve these 3 objectives:

* To calculate the estimation of rain attenuation on terrestrial point-to-point microwave link based on rain data captured.
* To study the basic concept and operational of an Automatic Transmit Power Control (ATPC) applied in point-to-point microwave link.
* To study the performance of ATPC to overcome rain attenuation for point-to-point microwave link in Malaysia

1.2 Scope of the project

This project will focus on three main scope of study.

1) The estimated calculation of rain attenuation on terrestrial point-to-point microwave link based on rain data captured. This will involve the understanding and computational of rain attenuation equation using the Matlab software.
2) Basic concept and operational of ATPC applied in transceiver module of microwave link.
3) Performance of ATPC on actual microwave link install in Celcom microwave network. The performance will be measured on receive signal level on the actual system with ATPC option enable and disable for a certain period of time.

MATLAB will be used in this project to calculate the estimated rain attenuation based on rain rate data captured. I choose to use MATLAB as the computer language to design the PSK based communications systems because it is one of the most popular computer simulation languages in the world

1.3 Problem statement

Attenuation due to rainfall can severely degrade the radio wave propagation at centimeter or millimeter wavelengths. It restricts the path length of radio communication systems and limits the use of higher frequencies for line-of-sight microwave links and satellite communications. The attenuation will pose a greater problem to communication as the frequency of occurrence of heavy rain increases. In a tropical region, like Malaysia, where excessive rainfall is a common phenomenon throughout the year, the knowledge of the rain attenuation at the frequency of operation is extremely required for the design of a reliable terrestrial and earth space communication link at a particular location.

1.4 Methodology and Report Structure

This is a simulation project as well as life data captured from the system. To achieve its objectives the following methodology are followed.

1) Select the experimental point to point microwave link for case study
2) Calculate the estimated RSL based on the path profile; transmit power and gain of the system.
3) Calculate the estimated rain attenuation based on the planning path profile and ITU-R recommendation.
4) Set up one experimental point to point microwave link at bench to simulate the ATPC performance by capturing the RSL with ATPC enable and disable using the results calculated on the above. Plot the graph RSL vs time and compare the results.
5) Capture the RSL on the experimental link with ATPC enable and compare the result with the link without ATPC.

Prior to the actual modeling and simulation of ATPC performance of the systems, objectives, scope, motivations and problem statements are identified. This is documented in Chapter 1 together with the overview of the project. The timelines for Project 1 and Project 2 are attached in Appendix A and B.

The second chapter delves deeper into the subject matter which is digital point to point microwave link and propagation attenuation due to rain. Extensive research is carried out on the existing point to point microwave communications system and its underlying siganal propoagation restrictions.

The third chapter outlines the modeling and calculation of rain attenuation prediction based on ITU-R recommendations. This chapter illustrates the mathematical models used to in writing the MATLAB codes

Subsequently, the next chapter, Chapter 4, writes about the ATPC design concept. Two type of design consideration is introduced and basic operation of ATPC module loopback type was clearly explained.

The fifth chapter puts together all the flow chart in writing the MATLAB script to calculate the rain attenuation predictions.

The final section of this report gives all the results obtained throughout the project. Discussions and analysis on the results are included in this section.