RAIN ATTENUATION STUDY OVER TERRESTRIAL AND EARTH-SATELLITE LINKS IN MALAYSIA

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ABSTRACT

Rainfall causes the absorption and scattering to microwave signals results in severe degradation of the receive signal level. Many rain attenuation studies are based on data collected from the temperate regions [1],[2]. These data were reportedly do not perform well when applied to tropical regions that experience high intensity of rain rate [3],[4]. This has resulted in urgent needs to perform rain attenuation studies in Malaysia. In this paper, the rain attenuation measurements were conducted on terrestrial and earth-satellite link. While the rainfall data for simulation purposes were collected from rain gauges and Tropical Rain Measuring Mission (TRMM) satellite systems [5].

INTRODUCTION

The advancement in microwave communication technologies especially in telecommunication and broadcasting has resulted in congestion for frequencies below 10 GHz. This has forced microwave designers to look for higher frequencies. Unfortunately, rain is a main factor of attenuation especially for tropical and equatorial countries that experience high rainfall rate throughout the year such as in Malaysia. According to Karim [6], the rainfall can give up to several decibels of total attenuation thus causing severe outages. In designing radio communication system, the outage time of the communication system can occur either due to equipment failure or propagation constrain. The equipment outage can be negligibly small in the modern systems with the introduction of automatic protection switching systems. However, the propagation restrains especially the rain attenuation is so severe.

DATA COLLECTION

The rain attenuation data collection can be divided into terrestrial and satellite rain attenuation data. The terrestrial rain attenuation data was measured from an experimental point-to-point microwave link operating at 26 GHz [7]. While the satellite rain attenuation data was collected from Malaysia-East Asia Satellite (MEASAT). MEASAT is a broadcasting satellite catering Direct-To-Home (DTH) broadcasting services to the South East Asia region operating at Ku band (14/12GHz). Both the terrestrial link and satellite receiver are located at Universiti Teknologi Malaysia (UTM). The availability of terrestrial rain attenuation data is for 2 years period from May 1,1998 to May 27, 2000. While the satellite link has rain attenuation data for one-year period from March 2001 to February 2002. The set-up of the satellite receiver is shown on Fig. 1. These rain attenuation data collected were analysed to produce cumulative distribution (CD) of rain attenuation data.

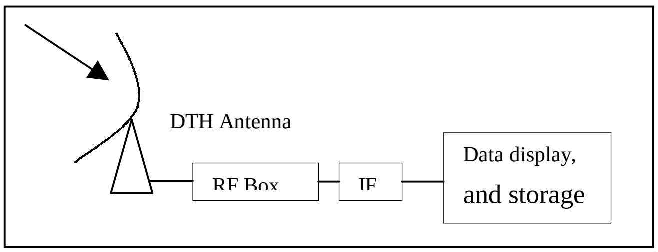

Fig. 1 Satellite Receiver Set Up

In addition to the rain attenuation data collected, one-minute integration time of rainfall data was also measured in UTM and downloaded from TRMM satellite system. A total of two years data were collected from April 2000 to February 2002 where the TRMM data is centred at Skudai, Malaysia (1.473°, 103.745°).

ANALYSIS & RESULTS

The CD of terrestrial rain attenuation data are shown on Fig. 2. The figure indicates that the measured attenuation data over-estimated the predicted rain attenuation data. The difference of 3 dB is recorded at 0.1% of the time where the difference is higher at lower percentage of time. The result gives some indication of the prediction models as compared to the exact measurement conducted at tropical region.

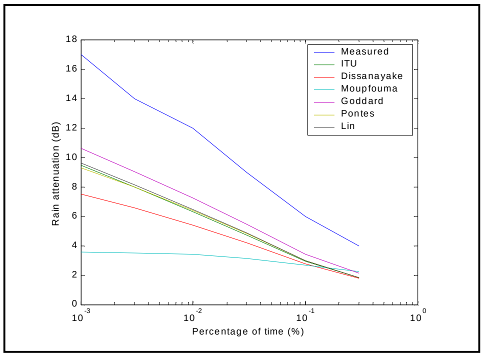

Fig. 2 Comparison Between Measured and Prediction Rain Attenuation Models

The analysis of satellite link is shown on Fig. 3. Comparison is made between the measured satellite rain attenuation data and the TRMM rainfall data. It is clearly indicated that the satellite receiver experienced rain attenuation of 25dB for 0.01% of the total time and 30 dB for 0.001%. However, the TRMM data gives a slightly lower attenuation level of 22dB at 0.01%. It is observed that the TRMM data experience lower attenuation as compared to the MEASAT link. The TRMM records lower rain attenuation due to the fact that TRMM is a LEO remote sensing satellite that is not stationary to the Malaysian skies while the MEASAT satellite is a GEO-stationary satellite. TRMM satellite passes a particular location in Malaysia approximately 70 times per year. Possible absence of the satellite during rain events results in inconsistency of scans, thus producing the rain attenuation value lower than actual. This causes an offset of the TRMM data as compared to the satellite receiver data.

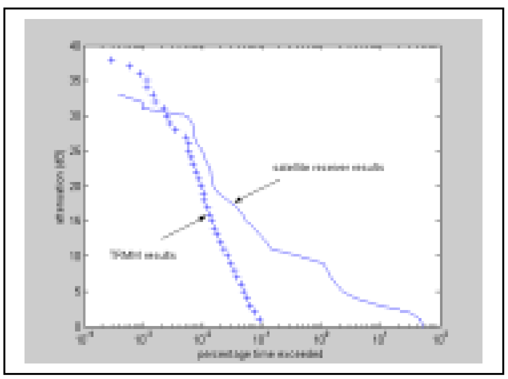

Fig. 3 Comparison Between MEASAT and TRMM Rain Attenuation Data

CONCLUSION

The analysis of rain rate and rain attenuation data shows that the measured rain attenuation data over-estimated the predicted rain attenuation data. In addition, the satellite receiver rain attenuation experience higher rain attenuation as compared to TRMM data. These rain attenuation data can be used to understand the rain attenuation effect of terrestrial and satellite link in tropical regions. The long-term data is essential to obtain a consistent and accurate data. In addition, the measured terrestrial rain attenuation data can be used to study the slant path model by applying the ITU-R recommendation model [8].

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