# Research on Rain Fade Attenuation at Indian Region by Fade Mitigation Techniques

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***Abstract:*** *Rain attenuation is by far the most important of losses for frequencies above 10 GHz, because it can cause the largest attenuation and is usually, therefore, the limiting factor at Ku-band satellite link design. Rain rate distribution is one of the most important factors for calculating rainfall attenuation at a specific location. The most effective way of obtaining the cumulative rainfall distribution is through direct measurement. However due to the shortage of the required rainfall data at certain locations, rainfall models need to be introduced to predict the rainfall rate and attenuation distribution at location of interest. Making use of Fade Mitigation Techniques involves adapting in real time the link budget to the propagation conditions. These FMT rely on the principles of Up-Link Power Control, Data Rate Reduction and Adaptive Coding. ULPC is used to keep a constant level of all the carriers at the input of the repeater, while maintaining the uplink budget close to target. Use of FMTs enables the system to cope with important fades and therefore to comply with the required availability.*

***Keywords: Rain Attenuation; Satellite Link design; Power Control***

## 1. INTRODUCTION (*RAIN ATEENUATION ON SATELLITE COMMUNICATION*)

Satellite transmissions are carried on one of two frequencies: C-band or Ku-band. When operating at the higher frequency Ku-band, the strength of the satellite signal maybe temporarily reduced under severe rain conditions. To compensate for these potential effects, earth stations located in heavy rain areas are designed with more transmit power. C-band transmissions are virtually immune to adverse weather conditions. Generally, rain attenuation increases as the signal frequency increases. Therefore, transmissions at 6/4 GHz will experience insignificant attenuation, while transmissions at 14/12 GHz will experience greater attenuation. For 6/4 GHz signals to be affected would require rain storms approaching hurricane conditions.

Signals at higher frequencies can be affected by less severe storms. Based on the link margin and the built-in rain attenuation margin, each customer should typically meet or exceed space segment performance specifications 99.9 per cent of the time over one year for 14/12 GHz service, and 99.95 per cent of the time over one year for 6/4 GHz service. This reduces the possibility of rain attenuation affecting your service, and confines the effects to very heavy and very infrequent rain periods.

## 2. ITU-R Model:

ITU-R Model is the newest prediction model that proposed by ITU-R. A few reasons have been considered in order to develop this model. Below are three main reasons that have been considered for developing this model.

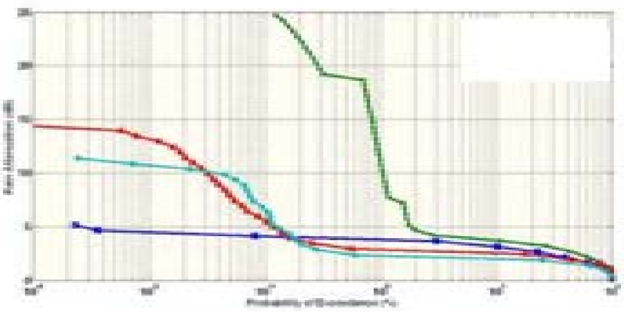
• For a variety of radio communication services, they required the information on the dynamic of outage events

• For the evaluation of parameters associated with the risk of failure to provide a certain quality and reliability of services, the probability of occurrences of fades of certain duration must be known

## 3. Monthly Cumulative Time of Rain Attenuation:

Monthly cumulative time in Hassan during August-November 2012 was shown in figure below. It can be seen that during the monsoon season for the months, September and October Rain rate is almost reached a value of 180 mm/hr for 0.1 % probability of time, and during the August month the maximum Rain rate observed was 60 mm/hr for 0.001% and for November it is of 80 mm/hr for 0.01 % probability of time.

The rain attenuation observed from measurements varies from month to month because of variation in rainfall intensity. Four months CDF shows that for a probability of 0.01 the attenuation observed was about 24 dB which is considered to be more than actual ITU-R given values.



(X-AXIS: Probability exceedance; Y-Axis: Rain Attenuation)

(Dark blue indicates:August;Green:September;Red:October;Sky blue:November)

## 4. CONCLUSION

In this paper the histograms and the cumulative distributions of fade slope and fade duration results obtained from the INSAT propagation experimental simulation, carried out for Vishakhaptanam location at different frequencies 11.6 and 14.2 GHz and also few results for other range of frequencies. The reader of this paper can easily find the probability of occurring of a fade slope value in a month, year or for all time interval. Also it can be see the dispersion of the fade slope values from the origin and find which is the worst month statistics to take into consideration for the development of propagation impairment mitigation techniques. Using the experimental data collected at Hassan, the cumulative distribution function of the rain rate and rain attenuation was plotted and is compared with number of models. Also number of frequencies which are in operation for different application in India was chosen to predict the rain attenuation which will be useful for propagation engineer for the effective estimation of link availability during the rainy days. The world wide used ITU-R method underestimating the rain attenuation for a Hassan location, showing a difference about 10 dB. It is well known fact that long term experimental data is very much required to predict the rain attenuation of the desired location, and the data considered is only 4months may not provide accurate results. And the measurements made for a location Hassan are been compared with the world wide used propagation prediction models resulting either underestimating or overestimating the observed measurements. This is because of most of the models are developed and are valid in mid latitudes or temperate regions are considered to be estimation on global means. Attempt has been made to predict the rain attenuation using the INSAT Ku band downlink satellite beacon in India.

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