Ku-band Satellite Signal Propagation Experiments of Post-PARTNERS Project

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1. Introduction

KMITL has joined experiments with CRL Japan under Post-PARTNERS project by using JCSAT-3 satellite since 1997. The experiments are included satellite signal propagation, tele-education, TV conference and so on. The experiments on satellite signal propagation are rain attenuation in Ku-band, carrier-to-noise ratio(C/N ratio) and bit error rate (BER) measurements.

Thailand located in monsoon region, in rainy season the amount of rainfall has been observed about 1000 millimeter per month. The satellite-receiving signal was attenuated by rainfall. By our observation, the beacon signal level from JCSAT-3 was decreased about 3 dB/km at rain rate of 160 mm/hr. The measured value of C/N ratio at KMITL is lower than C/N at CRL about 2 dB.

2.The Experimental Configuration

The experimental configuration of Ku-band satellite signal propagation at KMITL is shown in Table 1.

Table 1. Specification for measurement

Site coordinates	13.7°N, 100.6°E
Satellite	JCSAT-3
Satellite Position	128°E
Azimuth	114.6°
Elevation	54.6°
Beacon Frequency	12747.5MHz
Antenna Height	20 m above sea level
Antenna Configuration	Offset Parabolic
Antenna Diameter	1.8 m
Antenna EIRP	44.6 dBW
Eff. Slant path	6.1 km
Hor. Slant path	3.5 km

Figure 1. Gives an overview of the measurement system at KMITL, Bangkok. The rainfall rate at site was measured using quick response type (0.0083mm)-rain gauge with one-minute integration time. Another rain gauge, tipping bucket type, was install at 2 km away from site along the beacon signal path. The beacon signal strength was measured using beacon level monitor at one-minute interval. Other meteorological factors such as temperature, humidity, pressure, wind speed and wind direction are also recorded simultaneously by the data logging system.

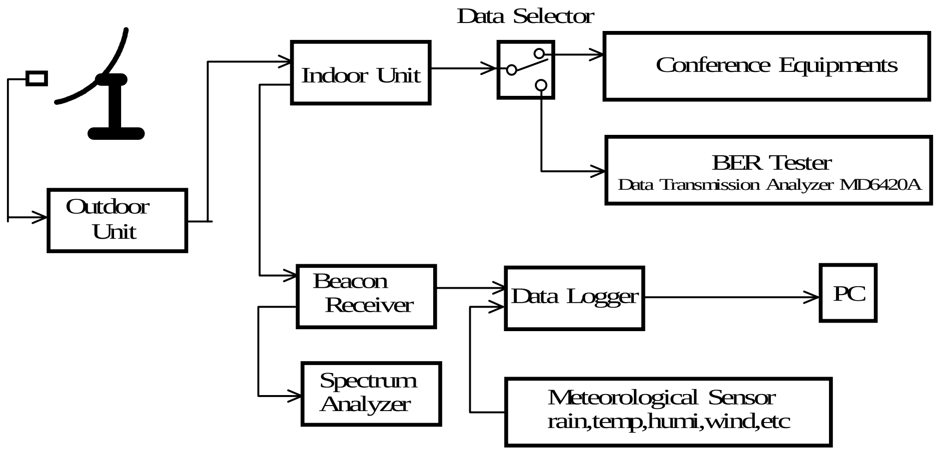

Figure 1. Configuration of Experiments System

3.Result of the Experiments

3.1 Bit Error Rate Measurement

The quality of satellite transmission signal depends on transmission power and bit error rate at that time. The experiment was done by vary the transmission power between CRL, Japan and KMITL, Thailand and measured bit error rate at each transmission rate. Figure 2 show the relation of bit error rate (BER) and transmission power of both sites. We can see that the transmission power at CRL is lower than KMITL about 1 dB for transmission rate 768 kbps and about 3 dB for 512, 1536 kbps at the same BER. And if we consider BER at 10^{-6} , bit rate 512, 768 and 1536 kbps, the transmission power should be 26, 29 and 32 dBm at CRL site and 29, 30.5, and 35 dBm at KMITL site

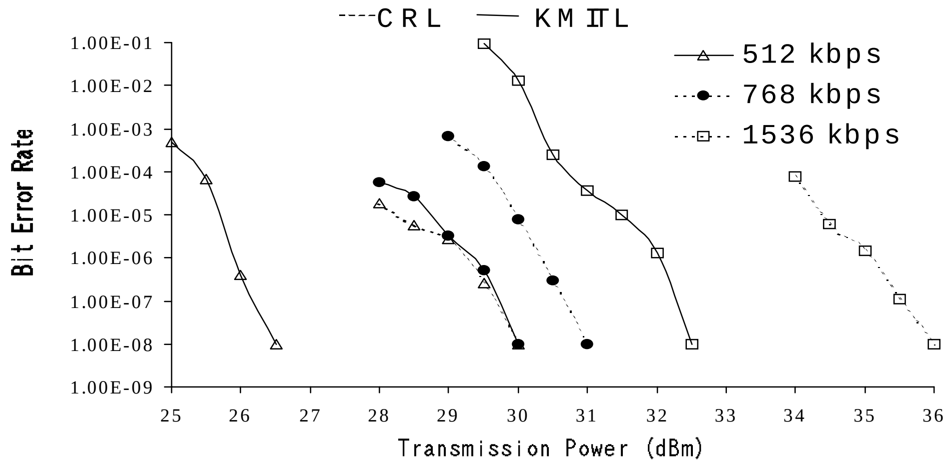

Figure 2. Relation of BER and Transmission power at the different transmission rate.

3.2 Carrier-to-Noise Ratio Measurement

The carrier and noise of reception signal are varying by the atmosphere condition and interference. We looped back the transmissions signal at KMITL site and measured the C/N ratio at each hour by vary the transmission power from 35.5 to 30.5 dBm. The result of experiment is shown in Figure 3. The graph represents the variation of C/N ratio on 22-23 Feb and 2-3 Mar. 1999. The variation of C/N ratio is about 3 dB in a day.

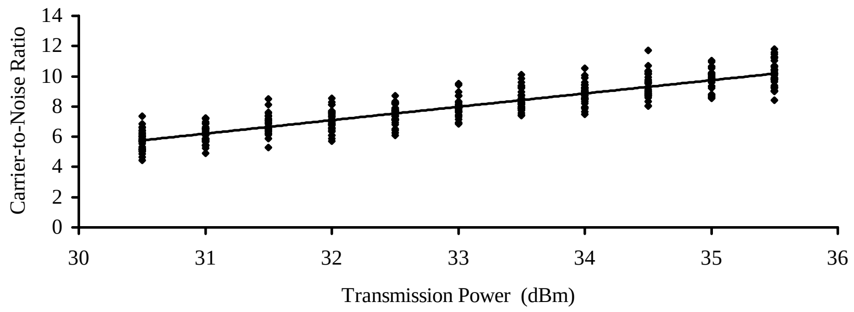

Figure 3. Variation of C/N ratio

3.3 Rain Attenuation measurement

In Thailand rainfall is concentrated in the rainy season. Figure 4 shows the average monthly rainfall of observed period. Figure 5 shows the cumulative probability of rain attenuation. In November ’99 probability of greatest attenuation which is over 20dB is almost same as August to October ’99, but totally cumulative probability of rain attenuation is lower.

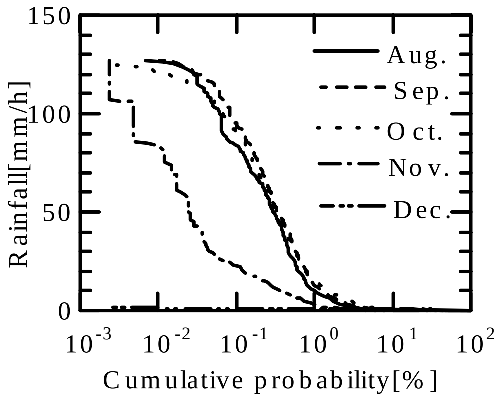

Fig.4 Cumulative probability of rainfall

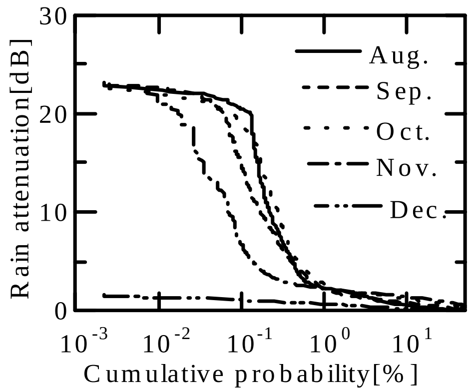

Fig.5 Cumulative probability of rain attenuation

Figure 6 shows the rain attenuation occurred when there was certain rainfall. When it was heavy rain for example over 100 mm/h less than 5dB attenuation occurred in 30% ratio.

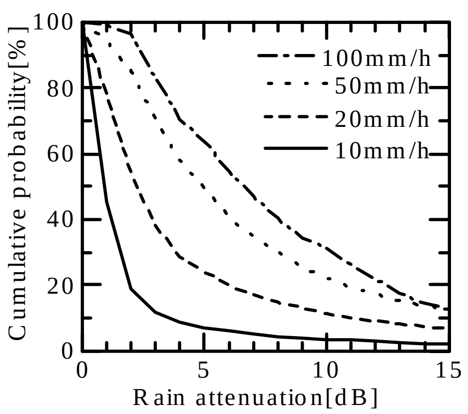

Fig.6 Probability of rain attenuation for rain intensity

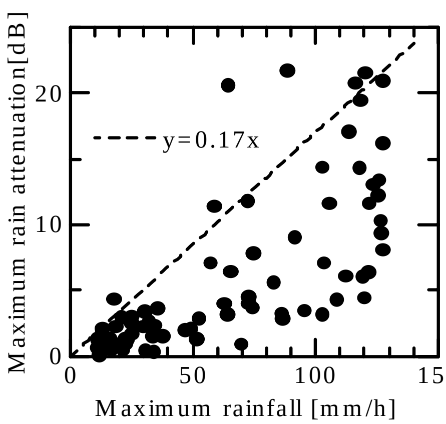

Fig.7 Maximum rainfall and rain attenuation

If we consider occurrence number and duration time of continuous rain attenuation, Figure 8 shows the relation of attenuation duration time and attenuation occurrence number.

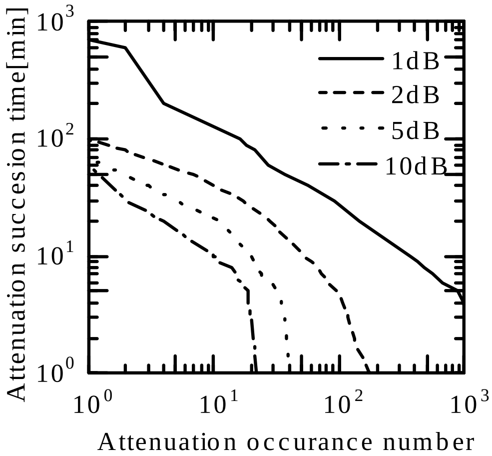

Fig.8 Rain attenuation occurrence number and duration time

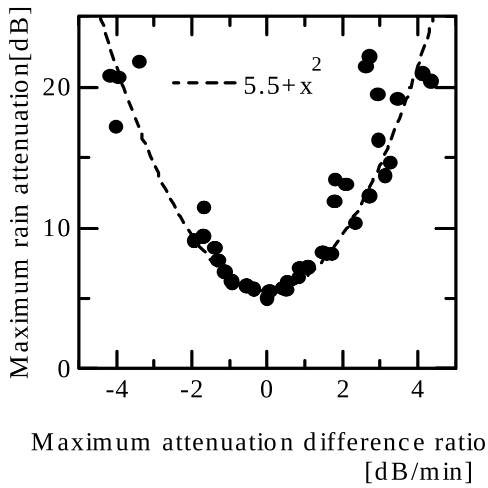

Fig.9 Maximum rain attenuation and maximum attenuation difference ratio

Next, we consider the relation between maximum rain attenuation and maximum level change ratio during continuous attenuation that is over 5 minute and over 5dB as shown in Figure 9.

4. Conclusion

The experiments under Post-PARTNERS Project are summarizing. The carrier-to-noise ratio or C/N measured at KMITL is lower than CRL about 2 dB. The C/N ratio in a day is varied about 3 dB. The BER at 10^{-6}, bit rate 512, 768 and 1536 kbps, the transmission power should be 26, 29 and 32 dBm at CRL site and 29, 30.5, and 35 dBm at KMITL site respectively. The result of rain attenuation by beacon signal of JCSAT-3 is about 20 dB at rain rate of 120 mm/hr.

5. Acknowledgement

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