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**【論文の内容の要旨】**

For rapid demand of large capacity and high speed satellite communication and broadcasting, radio wave in higher frequency bands such as Ku- and Ka-bands will be used and high throughput satellite communication system (HTS) can be realized. For example, WINDS(Japan) is a one of HTS for demonstrates the technologies related to ultra-high-speed and large-volume data communication. There are other HTS such as ViaSat-1(US), Eutelsat(France), IPSTAR(Thailand), etc. However, rain influence such as rain attenuation has a strong effect on satellite communication systems that use frequencies above 10 GHz, including the Ku-, Ka-bands or higher bands. Several impairment mitigation strategies including time diversity, adaptive satellite power control, site diversity, or adaptive channel coding and modulation control, are proposed or have been used to reduce the influence of rain attenuation. Each method has unique advantages and disadvantages depending on its services.

The above mentioned methods may be based on qualitative proposals or empirical knowledge. It is needed to evaluate above future methods quantitatively in order to realize efficient practical link impairments mitigation.  This thesis deals mainly three rain attenuation mitigation methods to maintain satellite link service: time diversity, adaptive satellite power control and site diversity. The evaluations of these methods are done by using measured rainfall rate data all over Japan and Thailand,

and measured received level data of satellite signals in Japan and Thailand. Time diversity is shown to likely be the most effective method. The adaptive satellite power control method can be used to improve satellite communication or broadcasting performance in narrow targeted areas. Regarding site diversity method, spatial correlation property of rainfall rate is investigated precisely. It is found that the spatial correlation of rainfall rates has anisotropic characteristics. This is useful to design efficient site diversity design.

This thesis also re-considers the theoretical relationships among rainfall rate, attenuation and depolarization due to rain up to 100 GHz using latest rain model such a Gamma distribution raindrop size distribution. Dual polarization wireless communication link is useful to increase link capacity twice as much. However, the above mentioned depolarization effect is expected to play a more significant role in such a dual-polarized link design.

This thesis consists of the following 6 chapters and each chapter contents is as follows:

Chapter 1 reviews recent rapid demand of large capacity and high speed communication performance in satellite communication and broadcasting systems. Necessity of much higher radio wave frequency bands is mentioned and as a result importance of rain effect mitigation technology is mentioned especially in Asian region where rain may happen seriously in comparison to USA and Europe.  Introduction of rain attenuation mitigation methods are shown by using classification of the methods into 3 categories

Chapter 2 derives theoretical relationships among rainfall rate, attenuation and depolarization using latest rain model. And practically useful approximated relations are derived to predict depolarization due to rainfall based on the assumption of a gamma raindrop size distribution and Marshall-and-Palmer raindrop size distribution from 10-100 GHz. Moreover, the differences in the relation of rainfall rates between the homogeneity and the inhomogeneity rain models are described.

Chapter 3 evaluates the time diversity method derived by using two different kinds of information. The first one is beacon signal data from satellites and the second one is rain radar data. For beacon data, beacon data from Thailand and Japan represent the rain attenuation behavior in tropical and non-tropical areas, respectively. Moreover, beacon data can be used to analyze the dynamic properties of rain fade, such as fade duration and fade slope. By using high resolution rainfall rate data in time and space all over Japan produced by Japanese Meteorological Office, time diversity effect is evaluated and it is found the method is quite effective especially in broadcasting application.

Chapter 4 evaluates the adaptive satellite power control method using above mentioned rain data all over Japan. It is simulated that the power boost is done by several boost beams with several sizes.  The optimal control parameters are derived or suggested to recover service availability throughout Japan.

Chapter 5 evaluates the site diversity method by using the rain gauge network at the center of Thailand. The spatial correlation is investigated site-by-site and is presented as a 2-dimensional spatial correlation map. It is found that to enhance the performance of site diversity gain, the direction factor should be taken into account.

Chapter 6 concludes the thesis and presents areas for future work to continuously improve rain effect mitigation technologies.