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Study on The Dual-Orthogonal Polarized MIMO Wideband Satellite Mobile Channel Based on a 4-State LMS Model[1]

Qingfeng Jing* and Guan Jinxin**

Nanjing University of Aeronautics and Astronautics, Nanjing, China
**e-mail: jing_nuaa@163.com*
***e-mail: guanjx@nuaa.edu.cn*

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Abstract—This paper focused on establishing a MIMO wideband land mobile satellite (LMS) channel statistics model. The particularity of this channel modeling was its wideband characteristics and the DPAs structure. Based on the Loo and Fontan model, a 4-state wideband LMS model was analyzed by combination of a Markov chain and properties of the wideband channel including its multipath excess delay and temporal-correlation performance. The paper also studied the effects of DPAs on channel modeling including the Cross Polarization Discrimination (XPD) and Cross Polarization Coupling (XPC). Through detailed analysis of the 4-state wideband LMS model and the effects of DPAs on channel modeling above, a typical dual-orthogonal polarized MIMO wideband satellite mobile channel model could be built. According to the modeling steps, channel time-series can be generated to assist further analysis of the system performance and evaluation of new technologies.

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1. INTRODUCTION

Proper application of the multiple input multiple output (MIMO) technology in communication systems can greatly improve the channel capacity, diversity gain and be able to combat the multipath fading [1]. In the field of land mobile communication MIMO technology has been included in the 4-th generation (4G) systems. Nevertheless, the line of sight (LOS) signal is dominant in wideband satellite mobile communication systems so the application of MIMO technology lacks obvious advantages to combat the multipath fading, but is still able to obtain the channel capacity gain and diversity gain; hence, it has a good application prospects [2, 3].

1.1. Benefits of DPAs in Satellite Communication Systems

In a wideband satellite communication system, the satellite and mobile terminals may suffer serious coupling among the antennas due to a limited volume and smaller antenna array spacing. Perfect channel independence among the antennas cannot be guaranteed [4]. For example, in order to make antennas independent among the transmitting or receiving arrays the space between each antenna in transmitting and receiving arrays should be more than 16 wavelengths and 0.75 wavelengths, respectively, when the communication distance is 3.5 km at S-band [5]. Since the communication distance is much greater than 3.5 km in satellite communication systems, the antenna spacing should be further exptended to ensure the channel independence between the antennas, which is impractical [3].

In order to solve this problem, two adjacent antennas separately using the orthogonal polarization component of electromagnetic wave can be placed on satellites or on mobile terminals to form the DPAs structure. Dual-orthogonal polarized antennas (DPAs) can achieve good independence between antennas with relatively small space in transmit and receive antenna arrays [6]. Therefore, the MIMO system with DPAs can also provide the same diversity gain and capacity as the MIMO system with enough space antennas array. The structure of a MIMO wideband satellite mobile communication system with DPAs is shown in Fig. 1.

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