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Characteristics of mobile satellite L-band signal in mid-latitude region: GPS approach

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Mobile satellite L-band signal that propagates from the transmitting satellite to the receiver experiences impairment mainly due to shadowing and multipath effects. In the present study, open space data has been obtained for Fukuoka, Japan (mid-latitude) using portable global positioning system (GPS) satellite receiver. The received signal performance, fading characteristic and cumulative distribution function of certain GPS satellites over the sky of Fukuoka have been observed and analysed. A general mathematical model representing the signal strength for the open space environment has been deduced based on the collected data. The outcome of this study can be used in future research to determine the effect of different mobile satellite environment on the arriving mobile satellite signal in improving the quality of service perceived by mobile satellite users.

Keywords: Mobile satellite L-band signal, Mobile signal performance, Satellite propagation data, Signal-to-noise ratio (SNR)

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1 Introduction

Mobile satellite (MS) system has been designed to provide communication services to area where terrestrial communication is not available. Wide area coverage, higher bandwidth and the ability to serve users while they are on the move are the main characteristics of the MS system and reflect the reliability of the system to the mobile users[1]. Therefore, its reliability is higher and more flexible in term of navigation system on the moving vehicles. It also serves as an alternative to the current communication system which has a high potential for further development in order to support the ever increasing demand of personal and multimedia communications[2].

MS communication system operates in L-band. The L-band, with frequencies 1-2 GHz, is particularly effective in providing rapid and flexible communication through mobile and portable terminal or transportable earth station[3-6]. The voice and data communication services especially can be provided through the link between the satellite and the ground terminal.

Mid-latitude is the region in the latitude range of 30°-60° North and South, respectively[7]. For the present study, data obtained in mid-latitude region of Fukuoka, Japan (33°35'N of equator and 130°24'E of Greenwich) (ref. 8) has been analysed.

The attenuation effects such as shadowing and multipath degrade the received signal quality of the MS system. Multipath fading is due to the arrival of the reflected line-of-sight (LOS) signals of different amplitude and phase which can cause signal fluctuations[9]. These reflections are due to the surrounding environment such as buildings, trees and electric poles. In addition, shadowing effect is caused by presence of obstacles that impede the visibility of the LOS signal from the satellite such as building and trees[9]. However, the current study only concentrated on satellite received signals in open space environment.

A simple and low-cost data acquisition GPS system had been used to carry out measurement for this study. Common methods used to carry out experimental work utilize the existing geostationary satellite network or airborne platform such as airplane and helicopter[10-11]. However, both methods are complicated and costly. Moreover, these methods limit the number of studies that can be carried out for the MS link.

GPS system is a constellation of Medium-Earth-Orbit (MEO) satellites arranged on six planes where