Total atmospheric absorption of fixed satellite communication signal due to oxygen and water vapor in Nigeria

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Abstract:

Total atmospheric absorption values due to oxygen and water vapor on terrestrial and Earth-space paths at frequencies between 1 GHz and 50 GHz were evaluated for 1% unavailability of an average year at two elevation angles of 5° and 55°, which are typical for terrestrial and Earth-space links, respectively. Practical links to the Nigerian communication satellite (NigComsat1) uplink/downlink in the Ku (12/14 GHz), Ka (20/30 GHz), and V (40/50 GHz) bands for 1% unavailability of an average year were also investigated. The basic input climatic data used included monthly and yearly mean meteorological parameters for each station, such as surface and vertical profiles of pressure, temperature, and relative humidity, obtained from the Atmospheric Infrared Sounder (AIRS) instrument on NASA's Aqua spacecraft for seven years (2002 to 2009). The International Telecommunication Union Radio Propagation Recommendation (2009) procedure was used for the computation of gaseous attenuation for each of the 37 stations in Nigeria. The results obtained at various elevation angles (of 44° to 55°) for Earth-space links to NigComsat-1 showed that in the absence of rain, 99% availability was possible at Ku, Ka, and V bands for uplink and downlink at all of the 37 stations in Nigeria, as the gaseous attenuation values obtained were between 0.05 dB to 4.81 dB. For low elevation angles of 5°(terrestrial link) at V band, 99% availability was not practical, as atmospheric loss was between 15.30 dB to 17.62 dB in Nigeria. The results consistently showed that gaseous attenuation was very high at six stations across Nigeria; Calabar (South-South regions), followed, in descending order, by the Ikeja (South-West), Abakaliki (South-East), Abuja (Middle-Belt), Dutse (North-East), and Kastina (North-West) regions. The present results of gaseous attenuation will be very useful for satellite communication-system design engineers across the six regions in Nigeria.

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1. Introduction

The demand for new satellite services and global broadband communications services, such as very-small-aperture terminals (VSATs) for Internet access and multimedia applications, has caused a greater demand for bandwidth. This has pushed up the frequencies for satellite communications beyond the Ku (12/14 GHz) band to the Ka (20/30 GHz) and V (40/50 GHz) bands, because larger bandwidths are available at the Ka and V bands. In the absence of rain, clouds and atmospheric gases can play an important role. Their effects must be assessed in order to determine their impact on satellite communications [1]. The higher frequencies at the Ka and V bands are more vulnerable to propagation effects such as oxygen and water-vapor absorption for both fixed and mobile satellite communications. An extensive database of total atmospheric absorption, and an accurate propagation model for deciding on the fade margin for satellite communication-link design in clear sky conditions, are therefore needed [2].

Keywords