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END-TO-END PERFORMANCE OF LEO SATELLITE USING VCM TECHNIQUES

Abstract

The current trend of Low Earth Orbit (LEO) satellites' performances is pushed up by very demanding customer requirements in terms of number of images and payload capabilities; given the limited available bandwidth (375MHz) and the proximity of DSN band allocated between 8.4GHz and 8.45GHz., the current CCSDS standard for modulation and coding coupled with single polarization transmission are not suitable to match the future needs for downlink performance in X-Band. A data rate increase can be enabled using higher modulation schemes (16APSK and beyond), associated with powerful coding schemes such as those based on Serial Concatenated Convolutional Coding (SCCC) and dual-polarization techniques; SCCC is currently candidate to become a new CCSDS standard for Earth Observation satellite at high symbol rate. The alternative to the use of X-Band is the migration towards the K-Band (25.5 – 27 GHz), four times wider and quite far from DSN protection band; its well known drawback is the atmospheric propagation strongly affected by the absorption. Consequently, a Ka-Band based system is likely to be equipped with very powerful coding schemes and it is more demanding in terms of EIRP. The study of X/K-Band propagation during a satellite pass allows identifying some potentialities deriving from Variable Coding Modulation (VCM) implementation by defining a pre-programmed sequence of coding, based on atmospheric propagation statistics, to adapt the spectral efficiency to the expected channel condition in a satellite pass, and thus improving the downlink performance. It is also noticed that the non-linear HPA and the effects of group delay of the on-board filter can imply, especially at high symbol rates, a degradation effect to be analyzed, modelled and quantified for a proper system sizing: algorithms such as pre-distortion and dual-polarization interference mitigation might reduce such effects. In the frame of the ESA study "Advanced Techniques for High Data Rate Links for Earth Exploration Satellites" Contract

n. 22455/09/NL/JK, a set of SW was developed to allow the system designer computing the end-to-end performance using VCM techniques and comparing it versus the achievable figure when Constant Coding Modulation (CCM) is used. Mission parameters can be customized, and the expected Es/No on-ground is computed. The transmission parameters such as amplifier and filter characteristics, pre-distortion and dual-polarization mitigation algorithms are also modelled to allow estimating the BER performance in a realistic transmission scenario, for any SCCC modulation and coding schemes (from QPSK to 64APSK).