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DOPPLER FREQUENCY COMPENSATION IN LEO SATELLITE BASED OFDM TRANSMISSION SYSTEMS

Abstract

Orthogonal Frequency Division Multiplexing (OFDM) based communication schemes are widely employed in terrestrial communications such as audio/video broadcasting, WiFi and WiMAX, and broadband wireless communication systems in general. In most such systems, either the transmitter or the receiver can be mobile, causing a Doppler shift in the received signal frequency. The frequency shift in such systems is usually in the order of hundreds of hertz, and can be effectively compensated for at the receiver. If an OFDM based transmission system were to be deployed on a LEO satellite though, due to the high velocity of the satellite the Doppler frequency would end up being in the order of hundreds of Kilohertz (thousand-fold increase over terrestrial OFDM systems) and thus require special consideration. This paper takes into consideration such an LEO satellite based transmission system and develops methods for estimating and subsequently compensating for the Doppler frequency at the receiver. Two methods for estimating the Doppler frequency are formulated. The first is in the time domain using the cyclic prefix embedded in the transmitted signal, and the second is in the frequency domain after the signal passes through the FFT at the receiver. Once the Doppler frequency along with any other frequency offsets is estimated, compensation can be performed on the received signal. Here again two methods are used for compensation. The first is the direct adjustment of the receiver sampling clock frequency to match the received signal, and the second is by digitally applying the reverse of the frequency offset estimate to the received signal. All estimation and compensation methods are simulated and their advantages as well as drawbacks analyzed. In conclusion it is shown that OFDM provides a viable means of radio communications for LEO satellites, in addition to the single carrier systems that are predominantly in use on such satellites.

NOTE: This paper is a continuation of the research by this author presented at the IAC19 in the following paper: IAC-19-B2.3.7 “PERFORMANCE OF LEO SATELLITE BASED OFDM TRANSMISSION SYSTEM IN A MARITIME ENVIRONMENT”. This paper refers to but does not depend on the content of the IAC19 paper, and can be read as a standalone paper.