The Effect of the Time Delay Spread on the Coverage of the Brazilian Digital Television Broadcasting

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INTRODUCTION

The wireless digital communications systems are subject to temporal dispersion produced by the multipath effect, and the delayed signal replicas cause the well known effect of frequency selectiveness.

The Brazilian digital television broadcasting system uses orthogonal frequency division multiplexing (OFDM), a technique that inserts a guard interval between the symbols as a form of avoiding superposition. However, the length of guard interval must, at least, equal the channel delay spread [1], [2].

Delay spread limits the maximum symbol rate [3], [4]. Regarding wireless communications systems, the literature indicates that one of effects is digital signal degradation due to overlap of consecutive received symbols, which produces ISI [2], [5], [6], and [7].

The bit rate that can be achieved in OFDM systems is given by [1], [4]

\[ R_b = \frac{N v R_{RS} R}{T_s (1 + \Delta)} \]

in which \( N \) is the number of useful sub-carriers, \( v \) is the number of bits per sub-carrier, that depends on the chosen modulation scheme, \( R_{RS} \) is the Reed-Solomon code rate, \( R \) is the convolutional code rate, \( \Delta \) is the guard interval length and \( T_s \) is the OFDM symbol duration.

In agreement with the parameters values defined for the Integrated Digital Services Broadcasting – Terrestrial (ISDB-Tb) standard [8], and using Equation 1, Figure 1 relates the transmission bitrate and the guard interval duration.

The maximum channel delay spread depends on the propagation environment conditions, therefore the guard interval must be specified for the worst case (i.e. longer time delay spread). The total symbol length is fixed, which means that an increase on the guard interval reduces the useful information part, thereby reducing the spectral efficiency [2]. To increase the spectral efficiency, one can use an adaptive guard interval length, depending of the environment propagation conditions [1].

To increase the coverage of digital television broadcasting is possible to use multiple transmitters [9]. For this solution is possible to consider the spatial diversity gain, and the channel delay spread is larger than in a single transmitter scenario [10] and [11].

The ISDB-Tb standard defines the transmission of high definition television (HDTV) [12]. For severe channel propagation conditions, causing a delay spread longer than the guard interval, the ISI probability increases. Consequently, the bit error rate (BER) also increases, causing reception failure and interruption.

It is possible to use the technique of multiple transmitters without considering the spatial diversity gain, in this case, the receiver will communicate only with the transmitter which presents the higher field strength. In this scenario, it is possible to minimize the delay spread, once the distance among the receiver and transmitter is reduced.

REFERENCES