Federal University of Campina Grande (UFCG)
Department of Electrical Engineering
Institute of Advanced Studies in Communications (Iecom)

Universidade Federal de Campina Grande

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

Authors: MSc. Kesia C. dos Santos Farias – kesia.farias@ifpb.edu.br
Dr. Marcelo Sampaio de Alencar - malencar@dee.ufcg.edu.br

➢ 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 bitrate that can be achieved in OFDM systems is given by [1], [4]

$$R_b = \frac{N \nu R_{RS} R}{T_u (1+\Delta)}$$

in which N is the number of useful sub-carriers, ν 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, Δ is the guard interval length and T_u 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 scenery, it is possible to minimize the delay spread, once the distance among the receiver and transmitter is reduced.

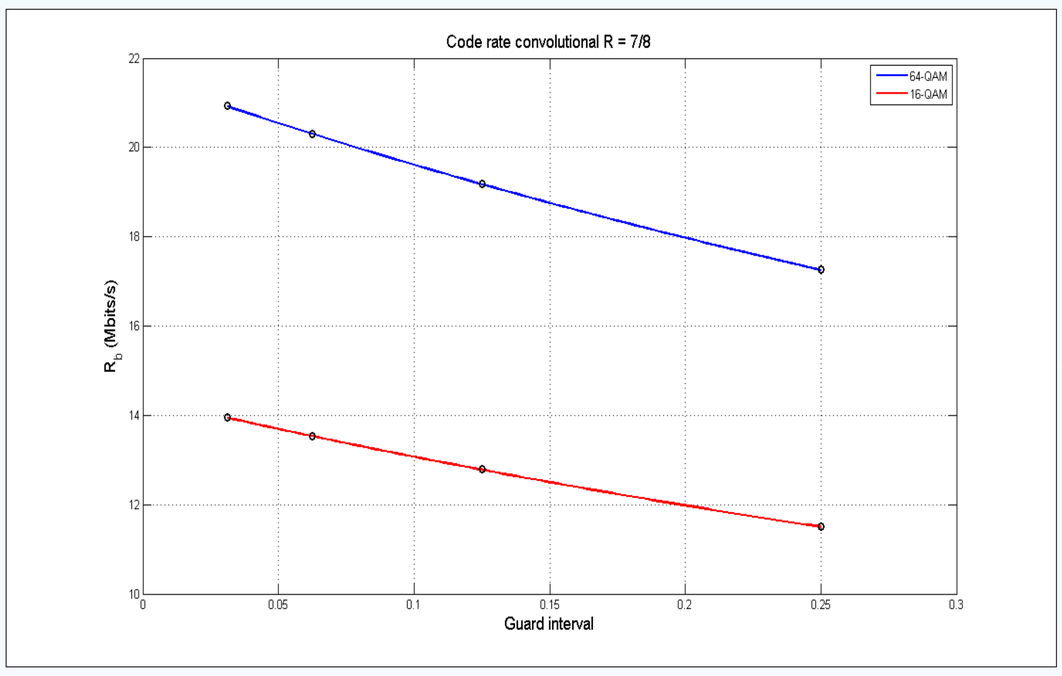

Fig. 1. Bitrate as a function of the guard interval duration, for a R=7/8 convolutional coder.

▪To ensure HDTV coverage in the concession area with minimum failure, it is necessary to consider the time delay spread in the coverage planning. For the continuation of this research, a coverage planning method for the ISDB-Tb will be proposed, considering the effect of time delay spread and multiple transmitters. This method will allow the correct dimensioning of the system, and a more realistic BER estimation.

➢REFERENCES

[1] F. Sanzi and J. Speidel, An adaptive Two-Dimensional Channel Estimator for Wireless OFDM with Application to Mobile DVB-T, IEEE Trans. on Broadcasting, vol. 46, no. 2, June 2000.

[2] H. Arslan and T. Yücek, Delay Spread Estimation for Wireless Communication Systems, Proceedings of the Eighth IEEE International Symposium on Computers and Communication (ISCC'03), 2003.

[3] J. C-I CHUANG, The Effects of Time Delay Spread on Portable Radio Communications Channels with Digital Modulation, IEEE Journal on Selected Areas in Communications, vol. SAC-5, no. 5, June 1987.

[4] A. Goldsmith, Wireless Communication, Cambridge Press, 2005.

[5] M. J. Feuerstein, K. L. Blackard, T. S. Rappaport, S. Y. Seidel, and H. H. Xia, Path Loss, Delay Spread, and Outage Models as Functions of Antenna Height for Microcellular System Design, IEEE Trans. on Vehicular Technology, vol. 43, no. 3, August 1994.

[6] L. J. CIMINI, JR, Analysis and Simulation of a Digital Mobile Channel Using Orthogonal Frequency Division Multiplexing, IEEE Trans. on Communications, vol. COM-33, no. 7, JULY 1985.

[7] M. S. Varela and M. G. Sánchez, RMS Delay and Coherence Bandwdith Measurements in Indoor Radio Channel in the UHF Band, IEEE Trans. on vehicular Technology, vol. 50, no. 2, March 2001.

[8] ABNT NBR 15601 Digital Television Terrestrial -- Transmission System, 2007.

[9] K. C. Santos, E. F. Silva, M. S. Alencar, Statistical Analysis of Digital Television Planning for the ISDTV System, 58th Annual IEEE Broadcast Symposium, October 2008, Virginia, USA.

[10] H. Parviainen, P. Kyösti, X. Zhao, H. Himmanen, P.H.K. Talmola and J. Rinne, Novel Radio Channel Models for Evalution if DVB-H Broadcast Systems, The 17th Annual IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC'06), 2006.

[11] S. Tang, C. Pan, K. Gong and Z. Yang, Propagation Characteristics of Distributed Transmission with Two Synchronized Transmitters, IEEE, 2006.

[12] M. S. Alencar, Digital Television, Érica Publisher Ltd, São Paulo, 2007.

CAPES

INSTITUTO FEDERAL DE EDUCAÇÃO, CIÊNCIA E TECNOLOGIA PARAÍBA