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EFFECT OF TIME INTERLEAVING PARAMETERS IN MOBILE DVB-T2 SYSTEMS

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ABSTRACT

DVB-T2 is an abbreviation for Digital Video Broadcasting– Second Generation Terrestrial.It is the extension of the television standard DVB-T. DVB-T2 succeeds in achieving the reception quality and a capacity increase of 50% over its predecessor DVB-T. This system transmits compressed digital audio, video, and other data using physical layer pipes (PLPs),using OFDM modulationtechnique (modes of 1k, 2k, 4k, 8k, 16k, and 32k)with concatenated channel coding and interleaving. DVB-T2 implements a very flexible time interleaving that allows multiple tradeoffs in terms of time diversity, latency and power saving. In this paper, we study in detail these tradeoffs in the context of mobile reception.. In addition, we propose the utilization of upper layer FEC protection in order to overcome the limitations of the DVB-T2 physical layer for the provision of long time interleaving, and enable fast zapping. Using this UL-FEC we can get gains up to 4 dB to 9 dB in highdiversity scenarios.FEC is concatenated low density parity check code(LDPC) and BCH codes (as in DVB-S2 and DVB-C2), with rates 1/2, 3/5, 2/3, 3/4, 4/5, and 5/6.The performance is evaluated by means ofcomputer simulations. For the simulations we have used a configuration of 64QAM, code rate 1/2 and maximumsub-slicing. Our investigation shows that the utilization of sub-slicing is highly beneficial in fast fading scenarios.

KEYWORDS: Channel coding, DVB-T2, mobile TV, time diversity, time interleaving.

INTRODUCTION

The DVB-T2 (Terrestrial 2nd generation) [1] standard was developed by the DVB (Digital Video Broadcasting) project in order to increase the capacity of terrestrial channels and accommodate high definition TV (HDTV) services. DVB-T2 succeeds in achieving a capacity increase of 50% over its predecessor DVB-T. The first commercial transmissions of DVB-T2 services began in the UK in December of 2009, and since then, Italy, Sweden and Finland have seen the launch of DVB-T2 services. Although DVB-T2 primarily targets static and portable reception, it also incorporates time interleaving in order to benefit from time diversity in mobile signal.. It also allows different tradeoff sin terms of time diversity, latency and power saving by means of inter-frame interleaving, sub-slicing and frame hopping. In addition, DVB-T2 incorporates advanced transmission technologies such as low-density parity check (LDPC) codes.DVB-T2 also introduces the concept of physical layer pipes (PLPs) to enable service specific robustness. By means ofmultiple PLPs it is possible to accommodate multiple use cases, i.e. static, portable and mobile, in the same frequency channel. Nevertheless, the simultaneous provision of static and mobile DVB-T2 services in the same frequency channel is limited by the fact that the fast Fourier transform (FFT) size and the pilot pattern have to be defined for the entire DVB-T2 transmission. Static services are generally transmitted with large FFTs and sparse pilot patterns in order to achieve a high spectral efficiency in static channels. However, reception at high velocities requires the utilization of smaller FFTs and more dense pilot patterns to cope with the inter-carrier interference (ICI) that is caused by the Doppler spread.

Compared to previous investigations, the work presented in this paper describes in detail all the relevant aspects related to the use of time interleaving in DVB-T2. Regarding the simulation results, we have obtained the performance gain achieved by means of inter-frame interleaving.We have also evaluated the impact of reduced

TDI memory, Alamouti-based MISO [5] and UL-FEC protection[2]. These results are not available in the literature and represent a very significant contribution in the context of the futureT2-mobile specification. The performance evaluation of mobile DVB-T2 systems when the received signal experiments both fast fading is another important contribution of the paper.as it constitutes a more challenging scenario than regular fast fading channels for the provision of mobile services in terrestrial networks.

PROBLEM STATEMENT

DVB-T2 is an advanced version of DVB-T,it is by using bch codes and ldpc codes which are used in DVB-S2 .the use of ldpc codes increase the robustness of DVB-T2, and errors while transmitting large number of frames of data are reduced by doing bch coding and also large number of frames will be transmitted in fast fading and noise environment without delay.AWGN noise is cause for disturbance for transmission of a signal that’s the main challenging criteria for transmission in digital video broadcasting technology.

METHODOLOGY

1. Data Path

DVB-T2 is based on orthogonal frequency-division multiplexing (OFDM)[3]. FFT modes with sizes of 1K, 4K, 16K and 32K OFDM sub-carriers have been added to the original 2K and 8K modes in order to provide a wider selection of network configurations. The utilization of larger FFTs increases the capacity of the system for the same absolute value of the guard interval, as a higher proportion of the OFDM symbols can be devoted to the transport of data. Compared to DVB-T, it is also possible to transmit more bits in each sub-carrier by means of 256QAM (Quadrature Amplitude Modulation), which has been added to QPSK (Quaternary Phase Shift Keying), 16QAM and 64QAM. The overhead due to channel sampling is also reduced in DVB-T2 by means of multiple pilot patterns. While DVB-T employs a single pilot pattern, DVB-T2 defines 8 different patterns depending on the selected FFT mode and guard interval. DVB-T2 signals are arranged as a sequence of T2frames, Which extend across several OFDM symbols and can be configured with a maximum length of 250 ms. Future extension frames (FEFs) have been also included in the standard in order to allow the introduction of future services in DVB-T2 transmissions Legacy receivers that are not compatible with the service carried within the FEFs can ignore their reception and wait until the arrival of the next compatible T2 frame. Regarding channel coding, DVB-T2 inherits the FEC coding scheme from DVB-S2 based on the concatenation of LDPC and BCH (Bose Chaudhuri Hocquenghem) codes. There are six code rates (1/2, 3/5, 2/3, 3/4, 4/5 and 5/6) and two different FEC word lengths (16200 and 64800 bits) supported in DVB-T2 for the data path. The combined use of LDPC andBCH codes improves the robustness of the transmitted signal compared to the convolutional and Reed-Solomon codes used in DVB-T.DVB-T was entirely based on the transmission of MPEG-2 transport streams (TS), DVB-T2 also supports generic streams (GS) as input format [4]. The utilization of generic streams provides a more efficient encapsulation of IP packets and results in less overhead due to packet headers. TS or GS packets are encapsulated inside baseband frames (BB frames) before being modulated and transmitted over the air. Each BB frame constitutes a FEC code word that is independently encoded by the LDPC and BCH codes. The FEC blocks that result from LDPC and BCH encoding have a fixed size of 16200or 64800 bits depending on the selected LDPC code length.

2. Signaling Path

Layer 1 (L1) signaling in DVB-T2 is transmitted inside preamble symbols known as P1 and P2 at the beginning of each T2 frame The P1 symbol is the first OFDM symbol transmitted in the T2 frames, and is intended for fast identification of available T2 signals. At the same time, it also enables the reception of the P2 symbols in a very robust way. P2 symbols are transmitted right after the P1 symbol and carry the L1 signaling. The number of P2 symbols per T2 frame is given by the FFT mode (e.g. 2 P2 symbols are used in the 8K FFT mode). The L1 signaling transmitted in the P2 symbols can be divided in L1-pre and L1-post signaling. The L1-pre signaling enables the reception of the L1-post signaling and is always transmitted with BPSK (Binary Phase Shift Keying) modulation and code rate 1/5. The L1-post signaling enables the reception of the actual data and is transmitted with modulations 64QAM and code rate 1/2. L1 signaling is protected by the same BCH and LDPC codes used for the data path.

Shortening and puncturing is used to adjust the LDPC code to the amount of L1-post information to be transmitted. The code words containing the L1 signaling information are uniformly distributed over all the P2 symbols of one T2 frame in order to maximize the time diversity.

TIME INTERLEAVING IN DVB-T2

1. Data Path

The time interleaver in DVB-T2 [9] consists on a block interleaver that operates on sets of cells referred to as time inter-leaving.

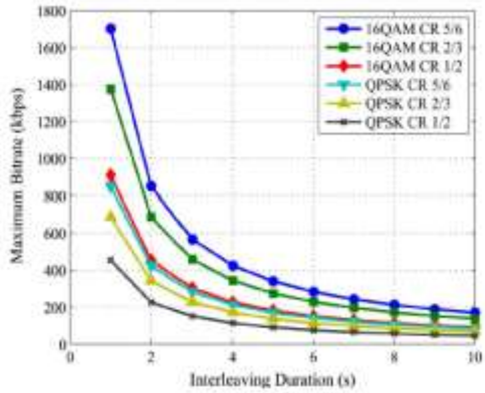


Fig. 1. Maximum PLP data rate supported in DVB-T2 with respect to the interleaving duration for different constellations and code rates.

The maximum Interleaving duration in DVB-T2 can be computed as
$T_{intmax} = (TDI \times CR \times \log \mu_{db.})/R_b$

Where TDI is the amount of TDI memory, CR is the code rate, μ is the number of symbols in the constellation (e.g., 4 for QPSK), and R_b is the PLP data rate (in bps). It should be noted that in the case of T2-mobile, the TDI memory is limited to approximately cells and hence, the maximum supported PLP data rate shown in Fig. 1 would be halved for any given interleaving duration. The PLP data rate is determined in a major way by the PLP input mode. The utilization of input mode B divides the overall data rate among different PLPs [10]. This way, each PLP ends up with a lower individual data rate and can be transmitted with a longer interleaving duration.The arrangement of FEC blocks for time interleaving is illustrated in Fig. 2. In this case, one interleaving frame is partitioned into three different TI blocks that are interleaved by the time interleaver one after the other.

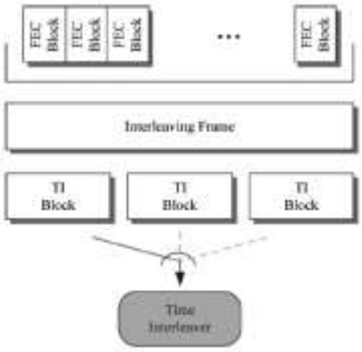


Fig. 2. Time interleaving in DVB-T2. In the figure, one interleaving frame is partitioned into three TI blocks.

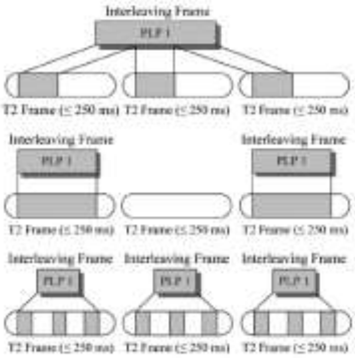


Fig. 3. Frame mapping options in DVB-T2. (Top) Inter-frame interleaving, (center) frame hopping, and (bottom) sub-slicing.

This is due to signaling issues and undesirable interactions with the frequency interleaver that may result in the loss of frequency diversity. It should be noted that the maximum number of allowed sub-slices decreases with higher values of inter-frame interleaving. The transmission of three sub-slices per T2 frame is illustrated in Fig. 3 (bottom).

2. Signaling Path

The L1 signaling transmitted in the P2 symbols does not feature time interleaving, and the interleaving duration is restricted to several milliseconds. DVB-T2 includes two mechanisms for increasing the robustness of the L1 signaling known as L1 repetition and in-band signaling. The former increases the robustness of the L1 signaling by transmitting in each T2 frame the signaling information that corresponds to the current and the next T2 frame. The latter transmits the L1 signaling embedded in the data path so that it possesses the same robustness as the data. In particular, when in-band signaling is used, the first BB frame of each interleaving frame carries the L1 signaling corresponding to the next interleaving frame. This way it is possible to improve the continuous reception of the service without the need of receiving the P2 symbols. Although the utilization of L1 repetition and in-band signaling introduces a delay in transmission of one T2 frame and one interleaving frame respectively, it does not result in an increase of the channel change time.

3. Time Diversity—Power Saving

DVB-T2 receivers can switch-off their RF components during the periods of time between time slices of the same PLP [11] in order to reduce the power consumption. If frame hopping is enabled, receivers can still achieve power saving by skipping the reception of entire T2 frames and switching off their front-ends until the arrival of the next frame with PLP information. This way it is possible to perform power saving even when the PLPs are transmitted continuously within the T2 frames. The duration of the time slices inside a T2 frame is given by:

$$T_{slice} = [N_{cells}/(N_{data} * N_{slices})] * T_{symbol}.$$

Where N_{cells} is the number of cells from the same PLP to be transmitted in the T2 frame, N data is the amount of data carriers per OFDM symbol, N slices is the number of sub-slices per T2 frame and T_{symbol} is the duration of the OFDM symbols.In turn, the power consumption in DVB-T2 can be computed as:

$$P = \min \{T_{frames}, N_{slices} * (T_{synchro} + T_{slice})\} / (FI * T_{frame}).$$

Where N slices is the number of slices in one T2 frame, T synchro is the time required for synchronization, T slice is the duration of one slice, FI is the frame interval and T frame is the duration of the T2 frame.

PERFORMANCE EVALUATION METHOD

We have investigated the use of time diversity in DVB-T2 by means of computer simulations. Table I shows the simulation parameters.

Table 1:simulation parameters

Parameters	**Values**
Bandwidth	10 MHZ
FFT mode	2K
FEC code length	32400
Code Rate	½
Channel estimation	Perfect
QAM Demapping	Hard decision
Channel Model	AWGN 18.5 db.
QoS	Bb frame 1%
Input	Binary

We have selected the BB FER (Baseband Frame Error Rate) 1% as quality of service (QoS) criterion at the physical layer, whereas we have selected the IP PER (IP Packet Error Rate) 1% in the case of UL-FEC [6]. Bit error ratios (BER) were used to evaluate the system performance in the standardization process of DVB-T2. More specifically, the QoS criterion followed was a BER of after LDPC decoding.BER criterions only indicate the percentage of erroneous bits and are not a proper indicator of the QoS seen by upper layers. The simulations AWGN channel model, which is representative of mobile reception in fast fading scenarios for Doppler frequencies above 10 Hz. correlation distance (d_{corr}) . The user velocity is given by the Doppler frequency (f_d) and the carrier frequency (f_c). In the simulations we have used Doppler frequencies of 10 Hz and 80 Hz with a carrier frequency of 600 MHz, which correspond to user velocities of 18 km/h and 144 km/h respectively. The shadowing model outputs CNR [12]This way it is possible to combine the presence of fast fading. It is important to note that the CNR values shown in this paper correspond to average dB CNR (µ), not average CNR in 10 log (µ) .The relation between these two values is given by.

$$10\log \mu = \mu_{db.} + (sigma)^2_{db} \ln(10/20).$$

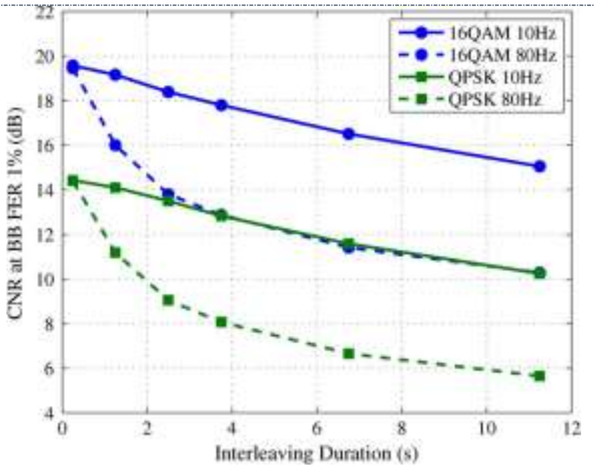
SIMULATION RESULTS

1. Fast Fading—Data Path

The performance of sub-slicing in conjunction with interface interleaving is illustrated in Fig. 8, where we show the results for inter-frame interleaving values ranging from one to six T2 frames. This corresponds to interleaving durations from 250 ms to 1.5 s in steps of 250 ms. It should be noted that the results lack the case with four T2 frames, as it is not allowed in the standard for the short LDPC code and 64QAM [7]. Regarding sub-slicing, we have employed the maximum value allowed by the standard for each configuration.

2. Fast Fading—Signaling Path

The previous results represent the worst case scenario in which the data path is transmitted with the most robust constellation (QPSK) and code rate (1/2). If the data path is transmitted with a less robust configuration, the difference between the robustness of the signaling and the data path increases. For example, if 16QAM and code rate 1/2 are used for the data path, according to Fig. 9, reception at BB FER 1% is possible with 8 dB of CNR for 10 Hz of Doppler and with 7.5 dB for 80 Hz.



CONCLUSION

In this paper we have investigated the use of time diversityin mobile DVB-T2 systems the standard incorporates a very flexible time interleaving scheme that allows multiple tradeoffs in terms of time diversity, latency and power saving by means of inter-frame interleaving. The utilization of interframe interleaving achieves very important gains in shadowing scenarios. Specifically, gains up to 4 dB and 9 dB can be obtained with 10 s of interleaving depending on the user mobility. Nevertheless, the lack of fast zapping support at the physical layer prevents the utilization of inter-frame interleaving for long interleaving durations due to channel change time issues. Regarding the robustness of the signaling in mobile channels, our simulations show that the utilization of L1 repetition and BPSK (Binary Phase Shift Keying) modulation in the signaling path ensure a higher robustness than the data path in the case of Fast fading. If a less robust configuration than QPSK and code rate 1/2 is employed for the data path, it may be possible to use higher order constellations than BPSK for the signaling path and still achieve a higher robustness.

REFERENCES

[1] Frame Structure Channel Coding and Modulation for a Second Generation Digital Terrestrial Television Broadcasting System (DVB-T2),ETSI Std. EN 302 755 v1.2.1, 2011.
[2] Implementation Guidelines for a Second Generation Digital Terrestrial Television Broadcasting System (DVB-T2), ETSI Std. TR 102 831v0.10.4, 2010.
[3] L. Vangelistaet al., “Key technologies for next-generation terrestrial digital television standard DVB-T2,” IEEE Commun.Mag., vol. 47, no. 10, pp. 146–153, 2009.
[4] H. Fuchs and N. Färber, “Optimizing channel change time in IPTV applications,” in Proc. IEEE Broadband Multimedia Syst. Broadcast.,Las Vegas, Mar. 2008.
[5] D. Gozálvez, D. Gómez-Barquero, and N. Cardona, “Performance evaluation of the MPE-iFEC sliding RS encoding for DVB-H streaming services,” in Proc. IEEE Pers., Indoor Mobile Radio Conf., Cannes, France, Sep. 2008.
[6] D. Gómez-Barquero, D. Gozálvez, and N. Cardona, “Application layer FEC for mobile TV delivery in IP datacastoverDVB-H systems,” IEEETrans. Broadcast., vol. 55, no. 2, pp. 396–406, Mar. 2009.
[7] Upper Layer Forward Error Correction for DVB Systems (ULFEC), ETSI Std. TR 102 993 v1.1.1, 2011.
[8] Multi-Protocol Encapsulation—inter-burst Forward Error Correction (MPE-iFEC), ETSI Std. TS 102 772 v1.1.1, 2010.
[9] D. Gozálvez, D. Vargas, D. Gómez-Barquero, and N. Cardona, “Performance evaluation of DVB-T2 time interleaving in mobile environments,” in Proc. IEEE Veh. Technol. Conf., Ottawa, Canada, Sep. 2010.
[10] T. Jokela, M. Tupala, and J. Paavola, “Analysis of physical layer signaling transmission in DVB-T2 systems,” IEEE Trans. Broadcast., vol. 56, no. 3, pp. 410–417, Sep. 2010.
[11] C. Abdel Nour and C. Douillard, “Rotated QAM constellations to improve BICM performance for DVB-T2,” in Proc. IEEE Int. Symp.Spread Spectrum Techn. Appl., Bologna, Italy, Aug. 2008.
[12] S. M. Alamouti, “A simple transmit diversity technique for wireless communications,” IEEE J. Sel. Areas Commun., vol. 16, no. 8, pp. 1451–1458, 1998.

[13] Implementation Guidelines for DVB Handheld Services, ETSI Std. TR 102 377 v1.4.1, 2009.
[14] M. L. Alberi Morel et al., “Performance evaluation of channel change for DVB-SH streaming services,” in Proc. IEEE Int. Conf. Commun.,South Africa, May 2010.
[15] Guidelines for the Implementation for Satellite Services to Handheld Devices (SH) Below 3GHz, ETSI Std. TS 102 584 v1.2.1, 2011

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