Simulink design of DVB-T2 system using BCH and LDPC codes

M.Venkata Manikanta

Student, M.Tech (ECE), Bapatla Engineering College, Bapatla, Guntur, AP, India, 522601

ABSTRACT: DVB-T2 is an abbreviation for Digital Video Broadcasting– Second Generation Terrestrial. 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 OFDM modulation technique (modes of 1k, 2k, 4k, 8k, 16k, and 32k). In this paper, we study in detail Simulink design of DVB-T2 and different digital modulations are in the context of non-hierarchical 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. FEC is concatenated a low density parity check code (LDPC) and BCH codes (as in DVB-S2 and DVB-C2), with different code rates 1/2, 3/5, 2/3, 3/4, 4/5, and 5/6. The performance is evaluated by means of computer simulations. For the computer simulations we have used a configuration of 64QAM, code rate 1/2.The simulation results obtained in the presence of AWGN .Our investigation shows that we can transmit a large amount of data with accuracy by using Simulink design of DVB-T2 systems using BCH and LDPC codes with non-hierarchical transmission and the utilization of BCH and LDPC codes in the DVB-T2 systems are highly beneficial in noise environment.

. **Index Terms** – QAM, BCH and LDPC codes, DVB-T2, UL-FEC, time interleaving.

I.INTRODUCTION

The DVB-T2 (Terrestrial 2nd generation) standard[1] 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 [2]. 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. DVB-T2 targeting the mobile signal in the presence of high fading scenarios. DVB-T2 incorporates advanced transmission technologies such as BCH codes and low-density parity check (LDPC) codes [3].DVB-T2 also introduces the concept of physical layer pipes (PLPs) to enable service specific robustness [4]. By means of multiple PLPs it is possible to accommodate multiple use cases, i.e. static, portable and mobile, in the same frequency channel.

Compared to previous investigations, the work presented in this paper describes Simulink design of DVB-T2 using BCH and LDPC codes in the presence of AWGN noise and its non-hierarchical transmission. Regarding the simulation results, we have taken the signal from the OFDM receiver is taken and BER bit error rate and SNR signal to noise ratio calculated. We have also evaluated the MISO and UL-FEC protection [5]. These results are not available in the literature and represent a very significant contribution in the context of the future T2 specification. The performance evaluation of DVB-T2 system 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 TV services in terrestrial networks.

II.PROBLEM STATEMENT

DVB-T2 is an advanced version of DVB-T. Simulink design of DVB-T is already designed by using RS codes and conventional convolutional codes. Now the main challenging criterion is Simulink design of DVB-T2 by using BCH codes and LDPC codes with non-hierarchical transmission. The use of BCH and LDPC codes are increasing the robustness of DVB-T2, and reducing the errors while transmitting large number of frames of data in fast fading and noise environment without delay. And AWGN noise is another cause for disturbance for transmission of a signal that's also another main challenging criterion for transmission in digital video broadcasting technology.

III.METHODOLOGY

A.BLOCK DIAGRAM

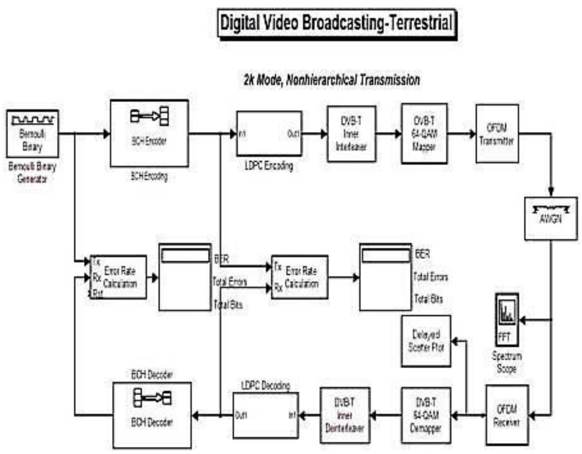

Fig 1. Simulink design of DVB –T2 using BCH and LDPC codes.

In this block diagram we are using Bernoulli binary generator to generate large amount of input data stream in the form of binary. After that BCH encoding, LDPC coding DVB-T inner interleaver, DVB-T mapper, OFDM transmitter and AWGN noise.

A. BCH codes

The Bose, Chaudhuri, and Hocquenghem (BCH) codes form a large class of powerful random error-correcting cyclic codes. This class of codes is a remarkable generalization of the Hamming code for multiple-error correction. BCH codes are two types binary and Non binary BCH codes [10]. We only consider only Non-binary BCH codes such as Reed-Solomon codes will be discussed in previous. i.e. in DVB-T. For any positive integers $m \geq 3$ and $t < 2m-1$, there exists a binary BCH code with the following parameters: Block length: $n = 2m - 1$ Number of parity-check digits: $n - k \leq mt$. Minimum distance: $d_{min} \geq 2t + 1$.We call this code a t-error-correcting BCH code [15]. Let α be a primitive element in GF (2^m). The generator polynomial g(x) of the t-error-correcting BCH code of length $2^m - 1$ is the lowest-degree polynomial over GF(2) which has α, α2 , α3 , . . . , α2t as its roots. g(αi) = 0 for $1 \leq i \leq 2t$ and g(x) has α, α2 , . . . , α2t and their conjugates as all its roots. Let φ_i (x) be the minimal polynomial of αi . Then g(x) must be the least common multiple of $\varphi_1(x)$, $\varphi_2(x)$ . . . $\varphi_{2t}(x)$, i.e., g(x) = LCM {$\varphi_1(x)$, $\varphi_2(x)$. . . $\varphi_{2t}(x)$}. If i is an even integer, it can be expressed as i = i "2! Where i " is odd and " > 1. Then αi =! αi! "2! is a conjugate of αi ! . Hence, $\varphi_i(x) = \varphi_{i!}$ (x).

g(x) = LCM{$\varphi_1(x)$, $\varphi_2(x)$, . . . , $\varphi_{2t-1}(x)$}. The degree of g(x) is at most mt. That is, the number of parity-check digits, $n - k$, of the code is at most equal to mt. If t is small, $n - k$ is exactly equal to mt. since α is a primitive element, the BCH codes defined are usually called primitive (or narrow-sense) BCH codes.

B. LDPC codes

These LDPC [8] codes were invented by Gallager in his Ph.D. dissertation at M.I.T. in 1960.They were ignored for many years since they were thought to be impractical. But with present day technology they are very practical .Their performance is similar to turbo codes but they may have some implementation advantages. A binary parity check code is a block code: i.e., a collection of binary vectors of fixed length n. The symbols in the code satisfy r parity check equations of the form: xa⊕ xb ⊕ xc ⊕ … ⊕ xz = 0 where ⊕ means modulo 2 addition and xa , xb , xc , … , xz are the code symbols in the equation. Each codeword of length 'n' can contain (n-r)=k information digits and r check digits. A parity check matrix is an r-row by 'n' column binary matrix. Remember k=n-r. The rows represent the equations and the columns represent the digits in the code word. There is a 1 in the i-th row and j-th column if and only if the i-th code digit is contained in the j-th equation. The percentage of 1's in the parity check matrix for a LDPC code is low. A regular LDPC code has the property that every code digit is contained in the same number of equations and each equation contains the same number of code symbols. An irregular LDPC code relaxes these conditions. Generally any communication system employs some kind of Forward Error Correction (FEC) coding [6]. FEC mechanisms rely on the transmission of repair information to protect loss events on underlying levels without a need for feedback (return channel), such that the receiver can detect and possibly correct errors occurred during the transmission. DVB-T2 inherits the FEC coding scheme from DVB-S2 [13] 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 and BCH codes improves the robustness of the transmitted signal compared to the convolutional and Reed-Solomon codes used in DVB-T [4]. DVB-T was entirely based on the transmission of MPEG-2 transport streams (TS), DVB-T2 also supports generic streams (GS) as input format. 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.

DVB-T2 is based on orthogonal frequency-division multiplexing (OFDM). 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 64QAM (Quadrature Amplitude Modulation) [9]. 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 T2 frames [11], 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.

C. Time Interleaving In DVB-T2

The time interleaver in DVB-T2 consists on a block interleaver that operates on sets of cells referred to as time inter-leaving [7].

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). 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. 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.

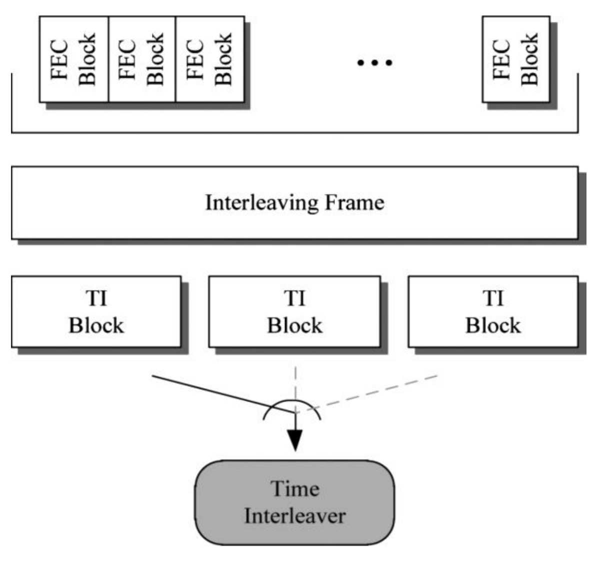

Fig.2. Time interleaving in DVB-T2. In the figure, one interleaving frame is partitioned into three TI blocks.

IV. RESULTS

Results DVB-T2 is evaluated by means of computer simulations. Table 1 shows the simulation parameters for the Simulink design of DVB-T2 system by using BCH and LDPC codes. Simulink model is as shown in fig 1.

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
Transmission type	Non hierarchical

We have selected the BB FER (Baseband Frame Error Rate) 1% as quality of service (QoS) criterion at the physical layer,. Bit error ratios (BER) were used to evaluate the system performance in the standardization process of DVB-T2 is as shown in fig**3**. 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 are done by using AWGN channel model.

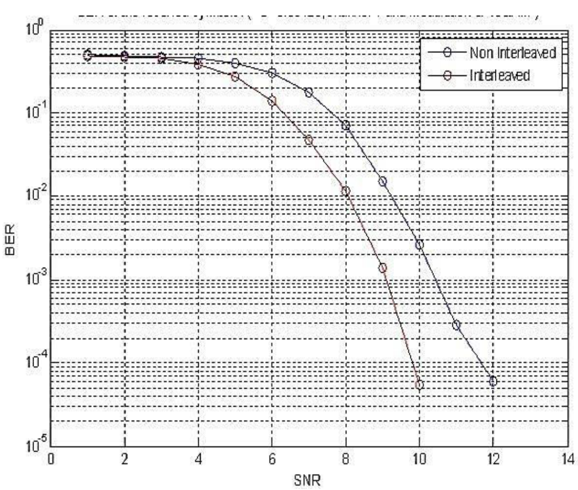

Fig3. Response of SNR and BER

Signal from the receiver is another important performance evaluation factor. The OFDM signal contains in-phase and quadrature phase components are as shown in fig4.

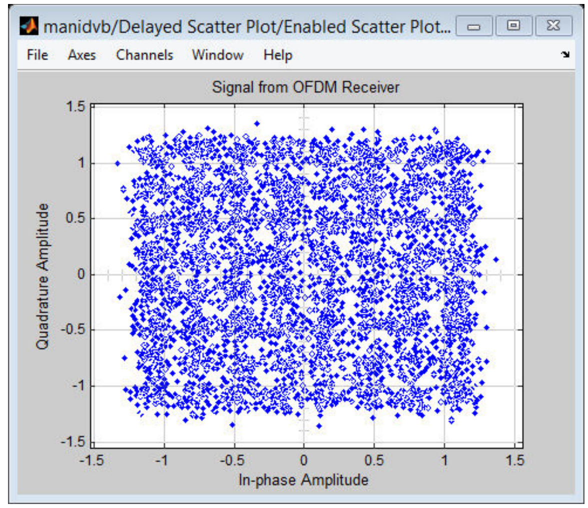

Fig4. Signal from the OFDM receiver

The Spectrum of OFDM receiver signal is plotted and is shown in fig5. The spectrum is measured in terms of power spectral density and it is plotted using delayed scattered plot.

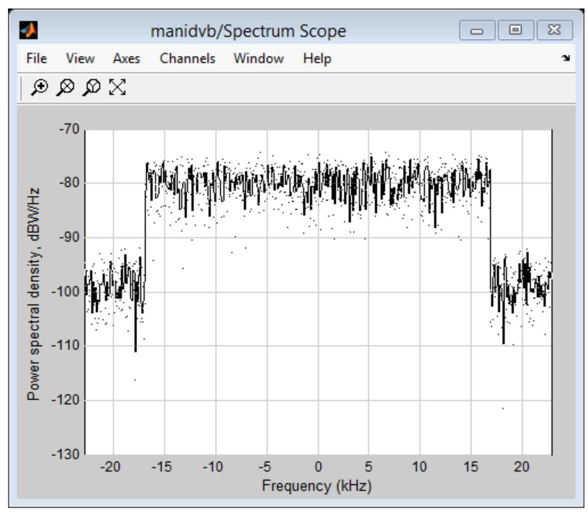

Fig5. Plot of power spectral density (dB Hz) and frequency (kHz) .

V. CONCLUSION

In this paper we have investigated the use of Simulink design of DVB-T2 system using BCH and LDPC codes with large number of bits are transmitted with small possible errors. In addition to Simulink design we also discuss time interleaving in DVB-T2. The LDPC codes are very useful and have

Implementation advantages and improve robustness of transmission of data compared to other error correcting codes. Here we are using QAM scheme and it is extended to other modulation schemes like QPSK and different code rates .This is useful for next digital video broadcasting technologies by using BCH and LDPC codes.

VI.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. Vangelista et al.,"Key technologies for next-generation terrestrial digital television standard DVB-T2," IEEE Commun. Mag., vol. 47, no. 10, pp. 146–153, 2009.

[4] 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.

[5] D. Gómez-Barquero, D. Gozálvez, and N. Cardona, "Application layer FEC for mobile TV delivery in IP datacast overDVB-H systems," IEEE Trans. Broadcast., vol. 55, no. 2, pp. 396–406, Mar. 2009.

[6] Upper Layer Forward Error Correction for DVB Systems (ULFEC), ETSI Std. TR 102 993 v1.1.1, 2011.

[7] 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.

[8] Xiao Y., Kim K, "Alternative good LDPC codes for DVB-S2", 9th International Conference on Signal Processing, 2008. ICSP 2008.Beijing, 26-29 Oct. 2008, Page(s):1959 – 1962.

[9] 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.

[10] L. Yi-Min, C. Chih-Lung, H.-C. Chang, and L. Chen-Yi, "A 26.9 K 314.5 Mb/s Soft (32400,32208) BCH Decoder Chip for DVB-S2 System," Solid-State Circuits, IEEE Journal of, vol. 45, pp. 2330-2340, 2010.

[11] EN 302 755 V1.2.1 (2011-02). Digital Video Broadcasting (DVB); Frame structure channel coding and modulation for a second generation digital terrestrial television broadcasting system (DVB-T2), European Standard ETSI, 2011

[11] Implementation Guidelines for DVB Handheld Services, ETSI Std. TR 102 377 v1.4.1, 2009.

[12] 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.

[13] A. Morello and V. Mignone, "DVB-S2: The second generation standard for satellite broad-band services," Proc. IEEE, vol.94, pp.210–227, Jan. 2006.

[14] S. M. Alamouti, "A simple transmit diversity technique for wireless communications," IEEE J. Sel. Areas Commun., vol. 16, no. 8, pp. 1451–1458, 1998.

[15]"An iterative decoding scheme of concatenated LDPC and BCH codes" for optical transport network Wei Zhou; Shaoliang Zhangm 2016 Conference on Lasers and Electro-Optics (CLEO),Year: 2016

.