International Journal For Technological Research In Engineering
Volume 2, Issue 9, May-2015 *ISSN (Online): 2347 - 4718*

PERFORMANCE STUDY ON IMPLEMENTATION OF DVB-S2X LDPC CODES ON AWGN CHANNEL

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Abstract: Low density parity check (LDPC) codes and Bose-Chaudhuri-Hocquenghem (BCH) are one of the best error correcting codes known to approach the Shannon limit. This paper scrutinize the effect of different rates and code lengths of low complexity Linear Minimum Mean Square Error (LMMSE) Min Sum-3 LDPC algorithm on the performance of digital video broadcasting-satellite-second generation extension (DVB-S2X) with different number of iterations on Additive white Gaussian Noise (AWGN) channel using 256 Amplitude phase shift keying (APSK) Modulation using MATLAB. As a result efficiency gain of 36% is achieved compared to DVB-S2 practically.
Keywords: Digital Video Broadcasting, Inner LDPC Encoding, Outer BCH Encoding, 256 APSK Modulation, AWGN.

I. INTRODUCTION

DVB is the abbreviation for Digital Video Broadcasting. The term Broadcasting is used inclusively to describe the transportation of the media content from the point of origin to multiple receivers, irrespective of physical networks used for transportation. DVB is a system that distributes or transmits data using a variety of approaches that includes satellite, cable, terrestrial television and terrestrial television for handhelds [1]. The mentioned approaches uses physical layer and data link layer of the distribution system. Devices will interact with the physical layer via a synchronous serial interface (SSI), synchronous parallel interface (SPI) or asynchronous serial interface (ASI) [2]. Adaptations have been developed so that the audio and the video files can be transmitted through DVB which uses MPEG-2 transport stream or other information coded digitally. The container sizes vary depending on the data rate which is usable of the broadcasting channel. The household management inside the data container can be identified as program specific information (PSI) and service information (SI) [3]. Digital Video Broadcasting's work involved establishing standards to enable the delivery of digital Television to the consumer via the traditional broadcast networks. The three main key standards were DVB-S [4] for Satellite networks, DVB-C [5] for Cable networks, DVB-T [6] for Terrestrial networks. Accompanying these standards, a wide range of supporting standards were required to be developed covering areas such as Service information (DVB-SI), subtitling (DVB-SUB), Interfacing DVB-ASI, etc., [7] DVB-S, the first standard for satellite video broadcasting over GEO satellite systems hired an outer shortened Reed Solomon (RS) and inner variable length convolutional code as its Forward Error Correction (FEC) technique [7]. DVB-S2, the refinement of DVB-S standard exploits 30% channel efficiency improvement using better FEC technique[8-11].Both technologies comparison are described in [12] in this paper. It is claimed that the new Digital Video Broadcasting Satellite (DVB-S2X) standard is able to provide capacity gains for professional applications by up to 20-30% and for some scenarios, gains up to 50% theoretically over the DVB-S2 standard. Objective is to improve operating performance in the core telecom markets (Direct To Home-DTH) as well as for increased operating range to cover emerging markets such as mobile and professional applications. While retaining S2's architecture, in sequence to make easy quick implementation and launch on the market. DVB-S2X demonstrates not only that satellite networks are ready for 4K UHDTV but also that DVB-S2X is ready to help satellite operators and broadcasters costs or deliver more content within the same capacity [13-16]. The block diagram of our simulation system used in MATLAB to evaluate the error correction ability of the LDPC FEC scheme is described in Figure 1.Amongst the various improvements in this work compared to DVB-S2 is higher modulation stratagem (256 APSK), smaller roll off factors and modernize filtering procedure making it possible to have smaller carrier spacing[17]. The project objective is to reduce the bit error rate (BER) and increase the PSNR performance of DVB-S2X transmission using LMMSE Min Sum-3 LDPC inner coding and BCH other coding under AWGN channel [18].

II. PROPOSED METHODOLOGY

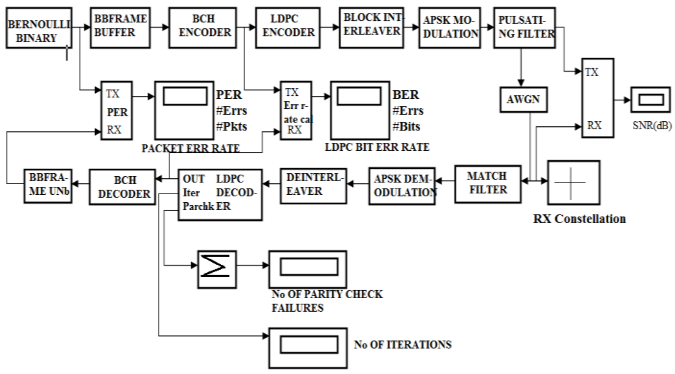

Fig 1: DVB-S2X BLOCK DIAGRAM

A. BERNOULLI SEQUENCE GENERATOR

The very first block is responsible for generating a balanced, in terms of probability of incidents, random binary sequence. Bernoulli sequence is a distribution of zeroes and ones by probabilities of p and (p-1) respectively. In this model, p equals to 0.5 resulting in equal probability of happening for 0 and 1. Output of this block is frame based with the same size as a MPEG-2 TS packet which is 188 bytes of 8 bits making it 1504 bits [19].

B. BBFRAME BUFFERING/UNBUFFERING

Output of packet source generator is buffered to make a Base Band Frame (BBFRAME).The size of this frame is related to the coding rate being used, equal to BCH encoder input size. Information bits or called Data Field (DFL) can be calculated as given in below formula:

$$DFL = K_{bch} - 80 \qquad (1)$$

Where, K_{bch} is the size of outer FEC Encoder BCH input, and 80 is the BBFRAME header size. Structure of a BBFRAME is shown In fig 2 below [19]:

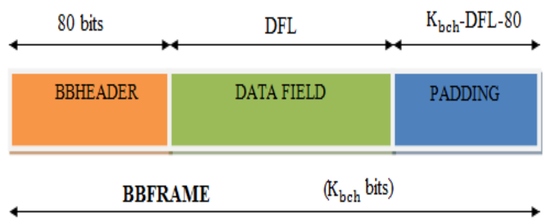

Fig 2: BBFRAME STRUCTURE

Number of MPEG packets that can be fitted in one BBFRAME can be shown as:

$$\text{Number of packets} = \frac{K_{bch} - 80}{1504} \qquad (2)$$

To fulfill BBFRAME size to match BCH encoder input, post zero padding will be applied. At the receiver side unbuffering block is responsible for excluding added zero pads and the BBHeader to generate MPEG packets from received frame. Number of zero pad added can be shown as [19]:

$$ZeroPadNo = K_{bch} - ((NumberofPackets * 1504) + 80) \qquad (3)$$

C. BCH ENCODER/DECODER

One of DVB-S2X standard advances is the forward error correction which is deployed to reduce BER in transmissions is BCH error correction. Output of BBFRAME buffering block at the sender side, as above mentioned, are frames of K_{bch} bits where a BCH (N_{bch}, K_{bch}) error correction with the correcting power of t will be applied to them [15]. A t-error correcting BCH (K_{bch}, N_{bch}) code shall be applied to each BBFRAME (K_{bch}) to generate an error protected packet. The output of BCH encoder called BCHFEC frame will be created by adding parity check bits to make a frame with N_{bch} size. N_{bch} is the input of inner LDPC encoder which is also named K_{ldpc} .The structure of whole FECFRAME is shown in the fig 3 below [19]:

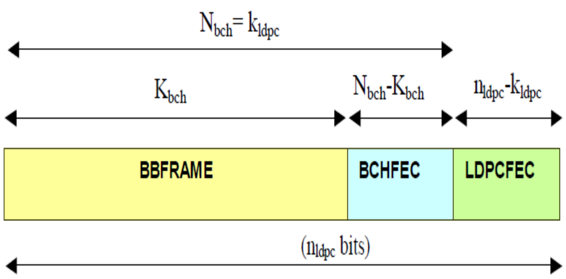

Fig 3: FECFRAME STRUCTURE

D. LDPC ENCODER/DECODER

N_{bch}, the BCH encoder output as the input of inner FEC encoder will be processed at LDPC encoder to be protected from error with parity bits [20].

$$\text{Number of parity bits} = N_{ldpc} - N_{bch} \qquad (4)$$

LDPC encoder supports eleven coding rates. These coding rates are the ratio between information bits (N_{bch} bits) and LDPC coded block bits which is the FECFRAME. For every 1 bit of information sent from outer FEC coder (BCH),there will be 3 bits of parity checks added in LDPC encoder. At the receiver side, LDPC decoder will check the received sequence till the parity checks are satisfied up to ten iterations [19].

F. INTERLEVER/DEINTERLEAVER

The output of the LDPC encoder shall be bit interleaved using a block interleaver. Data is serially written into the interleaver column-wise, and serially read out row-wise. The MSB of the BBHEADER is read out first [20]. Interleaving process creates rows in a matrix from the LDPC encoder output according to the modulation order M, so each row will contain a symbol ready to be mapped in the next block, modulation. At the receiver side Deinterleaver block will receive the output of demodulator block as input and will apply the reverse process to create a serial output for the LDPC decoder input [20]. The bit interleaving scheme is shown in fig 4 below [19]:

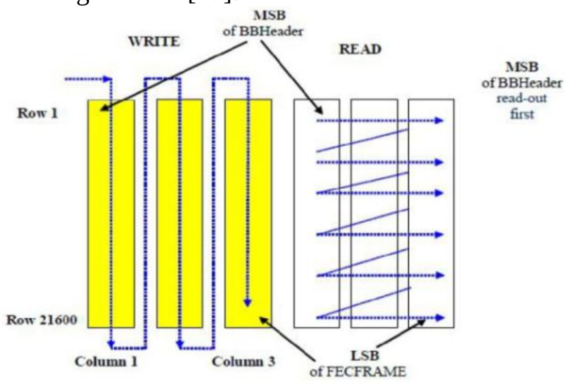

Fig 4: BIT-INTERLEAVING

G. MODULATOR/DEMODULATOR

Higher order modulations presented by DVB-S2X, provides higher spectrum efficiency comparing to the earlier generations of DVB-S2. To analyze the BER performance of DVB-S2X , we include Modulation for 256 APSK. Modulation block is responsible for mapping to prepare the base band signal for transmission [19].

H. AWGN CHANNEL

Additive White Gaussian Noise (AWGN) block in Matlab comply with Transmission channel in Ka band. This block adds a noise to the complex signal sent from modulator based on a manual parameter being set by the user. This parameter can be defined as Es/No, Eb/No or SNR, any how the block will calculate the noise variance and will add a noise with zero mean to the signal [19].

III. EXPERIMENTAL RESULT

A new customized Min Sum-3 decoding algorithm based on LMMS Estimate criterion for LDPC codes is obtainable. The simulation results show that compared with other kinds of modified Min Sum algorithms, this algorithm possesses the following characteristics: easiness of calculation for estimated parameters, minimum mean square error estimate , low computation complexity, good decoding performance and simplicity in hardware implementation. The simulation result and the reduced FER (Frame Error Rate) as well as BER (Bit Error Rate) is shown in fig 5, fig 6 and fig 7 respectively. Transmission error versus peak signal to noise ratio (PSNR) is shown in fig 8.Frame error rate and Bit error rate increase in efficiency is shown in Table 1 and Table 2 respectively. Finally, the number of frames retransmitted is shown in fig 9 .From this graphs we can conclude an increase in efficiency of 0.35 in DVB-S2X compared to DVB-S2.

ES: Existing System , PS: Proposed System

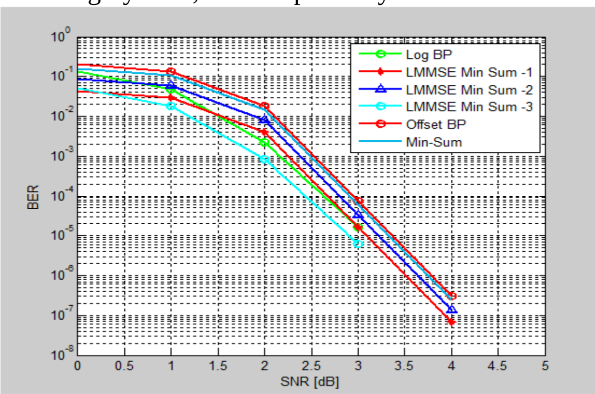

Fig 5: The BER curves of various decoding LDPC algorithms

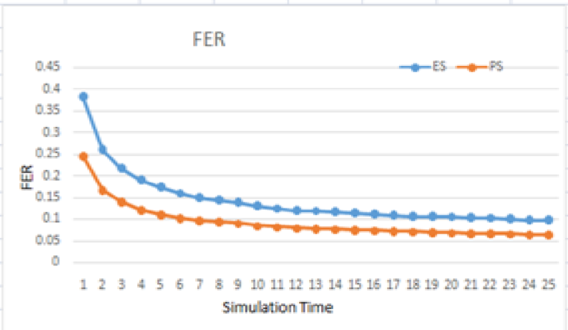

Fig 6: FRAME ERROR RATE

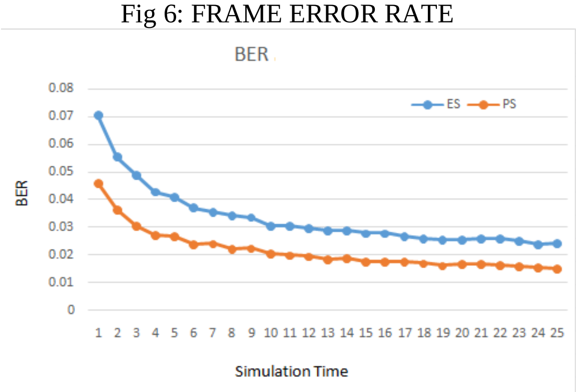

Fig 7: BIT ERROR RATE

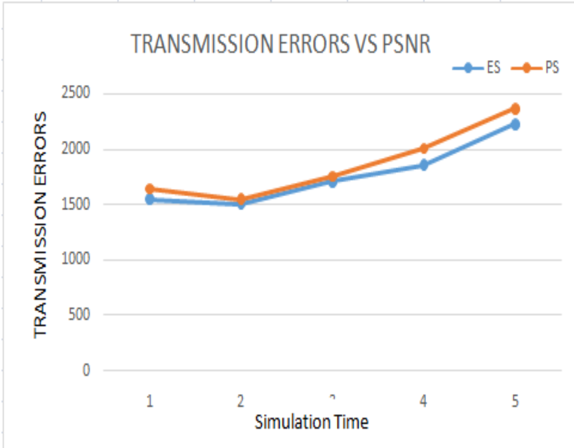

Fig 8: PEAK SIGNAL TO NOISE RATIO

TABLE 1: FER EFFICIENCY

FRAME ERROR RATE		
ES	PS	Efficiency
0.143235331	0.092861615	35.16%

TABLE 2: BER EFFICIENCY

BIT ERROR RATE		
ES	PS	Efficiency
0.033288661	0.021566889	35.20%

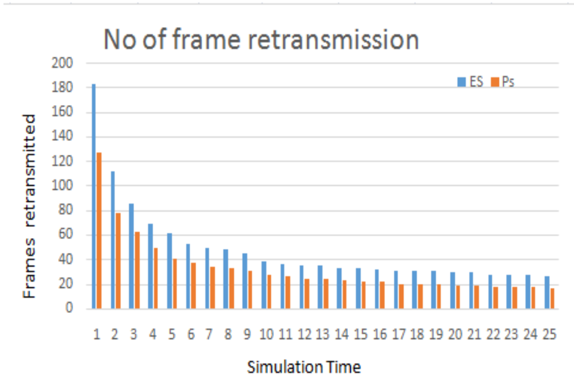

Fig 9: FRAME RETRANSMISSION

IV. CONCLUSION

In this study, we proposed a complete DVB-S2X model for GEO satellite communication system implemented in Matlab. Specifically, we added high order modulation scheme, 256APSK. Instead of random inputs we used MP89EG-2 TS and we analyzed the quality of the received video streams. By using more efficient LMMSE Min Sum-3 inner LDPC and outer BCH FEC , we showed that the model corresponds to the standard in terms of BER performance. Then we investigate the model performance according to the PSNR of received video and we compared the results with some results in the literature. The results show a 0.35 dB improvement in the required Es/No defined by ETSI.

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