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Designing Digital Video Broadcasting-Cable System with Reed-Solomon Encoding and 64-QAM Modulator

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Abstract: DVB-C stands for Digital Video Broadcasting-Cable. The standard was first published by the ETSI in 1994, and subsequently became the most widely used transmission system for digital cable television in Europe. The operation starts when video, audio, and data streams are multiplexed into MPEG-2 transport stream. The MPEG-TS is identified as a sequence of data packets, of fixed length (188 bytes). A first level of protection is then applied to the transmitted data, using a non-binary block code, a Reed-Solomon RS (204, 188) code, allowing the correction of up to a maximum of 8 wrong bytes for each 188-byte packet. Though there are many virtues of implementing DVB-C system, there are many shortcomings too of the same which cannot be neglected. The very first limitation and an important one too, is in the form of bit error rates supported by it. They are limited and not compatible with the existing and rapidly changing wireless standards. For the transmission of HDTV – high-definition television and also for accommodating more channels for broadcasting, there was a strong need of new standard. The second limitation of the DVB-C system is its hugely inferior performance with portability or mobility which restricted its usages in moving vehicles. To design a Digital Video Broadcasting – Cable System with MPEG-2 data as input. Analyze this system with different interleaving schemes (such as convolutional, block, random, helical and matrix interleaver), 64-QAM modulation and Reed-Solomon error detection and correction encoding for improving the efficiency of this system.

Keywords: DVB-C, QAM, RS, BER

I. INTRODUCTION OF DVB

Digital Video Broadcasting (DVB) is a set of standards that define digital broadcasting using existing satellite, cable, and terrestrial infrastructures. In the early 1990s, European broadcasters, consumer equipment manufacturers, and regulatory bodies formed the European Launching Group (ELG) to discuss introducing Digital Television (DTV) throughout Europe. The ELG realized that mutual respect and trust had to be established between members later became the DVB Project. Today, the DVB Project consists of over 220 organizations in more than 29 countries worldwide. DVB-compliant digital broadcasting and equipment is widely available and is distinguished by the DVB logo. Numerous DVB broadcast services are available in Europe, North and South America, Africa, Asia, and Australia. The term *digital television* is sometimes used as a synonym for DVB. However, the Advanced Television Systems Committee (ATSC) standard is the digital broadcasting standard used in the U.S.

A fundamental decision of the DVB Project was the selection of MPEG-2, one of a series of MPEG standards for compression of audio and video signals. MPEG-2 reduces a single signal from 166 Mbits to 5 Mbits allowing broadcasters to transmit digital signals using existing cable, satellite, and terrestrial systems. MPEG-2 uses the lossy compression method, which means that the digital signal sent to the television is compressed and some data is lost. This lost data does not affect how the human eye perceives the picture. Two digital television formats that use MPEG-2 compression are Standard Definition Television (SDTV) and High Definition Television (HDTV). SDTV's picture and sound quality is similar to Digital Versatile Disk (DVD). HDTV programming presents five times as much information to the eye than SDTV, resulting in cinema-quality programming.

DVB uses Conditional Access (CA) systems to prevent external piracy. There are numerous CA systems available to content providers allowing them to choose the CA system that they feel is adequate for the services they provide. Each CA system provides a security module that scrambles and encrypts data. This security module is embedded within the receiver or is detachable in the form of a PC card. Inside the receiver, there is a smart card that contains the user's access information. The following describes the conditional access process:

(a). The receiver receives the digital data stream.

(b). The data flows into the conditional access module, which contains the content provider's unscrambling algorithms.

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(c). The conditional access module verifies the existence of a smart card that contains the subscriber's authorization code.
(d). If the authorization code is accepted, the conditional access module unscrambles the data and returns the data to the receiver. If the code is not accepted, the data remains scrambled restricting access.
(e). The receiver then decodes the data and outputs it for viewing.

For years, smart cards have been used for pay TV programming. Smart cards are inexpensive allowing the content provider to issue updated smart cards periodically to prevent piracy. Detachable PC cards allow subscribers to use DVB services anywhere DVB technology is supported.
DVB is an open system as opposed to a closed system. Closed systems are content provider-specific, not expandable, and optimized only for television. Open systems such as DVB allow the subscriber to choose different content providers and allows integration of PCs and televisions. DVB systems are optimized for not only television but also for home shopping and banking, private network broadcasting, and interactive viewing. DVB offers the future possibilities of providing high-quality television display in buses, cars, trains, and hand-held devices. DVB allows content providers to offer their services anywhere DVB is supported regardless of geographic location, expand their services easily and inexpensively, and ensure restricted access to subscribers, thus reducing lost revenue due to unauthorized viewing.

II. SYSTEM MODEL OF DVB

Technical Description of DVB-C Transmitter

(a). Source coding and MPEG-2 Multiplexing (MUX): video, audio, and data streams are multiplexed into an MPEG program stream (MPEG-PS). One or more MPEG-PSs are joined together into an MPEG Transport Stream (MPEG-TS). This is the basic digital stream which is being transmitted and received by home Set Top Boxes (STB) or relevant integrable decoder module. Allowed bitrates for the transported MPEG-2 depend on a number of modulation parameters: it can range from about 6 to about 64 Mbit/s.

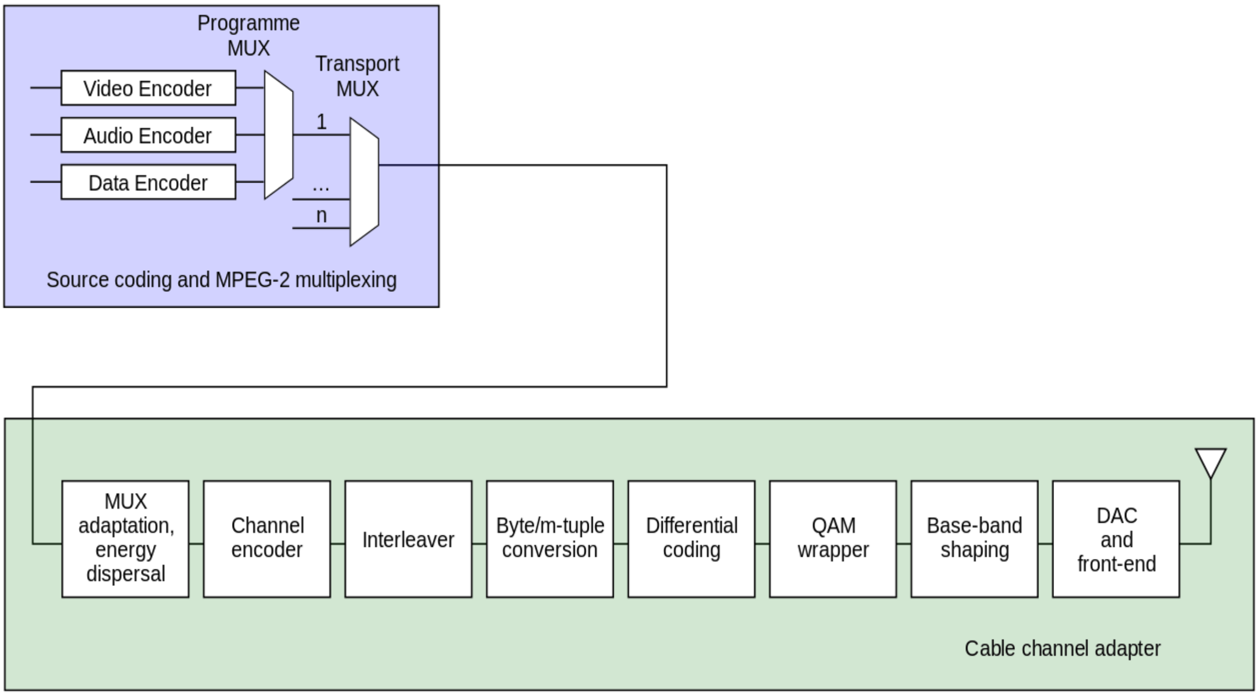

Figure 1. DVB-C Transmission System

(b). MUX adaptation and energy dispersal: the MPEG-TS is identified as a sequence of data packets, of fixed length (188 bytes). With a technique called energy dispersal, the byte sequence is decorrelated.
(c). External encoder: a first level of protection is applied to the transmitted data, using a nonbinary block code, a Reed-Solomon RS (204, 188) code, allowing the correction of up to a maximum of 8 wrong bytes for each 188-byte packet.
(d). External interleaver: convolutional interleaving is used to rearrange the transmitted data sequence, such way it becomes more rugged to long sequences of errors.

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(e). Byte/m-tuple conversion: data bytes are encoded into bit m-tuples (m = 4, 5, 6, 7, or 8).
(f). Differential coding: In order to get a rotation-invariant constellation, this unit shall apply a differential encoding of the two Most Significant Bits (MSBs) of each symbol.
(g). QAM Mapper: the bit sequence is mapped into a base-band digital sequence of complex symbols. There are 5 allowed modulation modes: 16-QAM, 32-QAM, 64-QAM, 128-QAM, 256-QAM.
(h). Base-band shaping: the QAM signal is filtered with a raised-cosine shaped filter, in order to remove mutual signal interference at the receiving side.
(i). DAC and front-end: the digital signal is transformed into an analog signal, with a digital-to-analog converter (DAC), and then modulated to radio frequency by the RF front-end.

III. DVB-C PERFORMANCE ANALYSIS

Simulation of Digital Video Broadcasting-Cable (DVB-C) system is done in Simulink tool of MATLAB. The simulation results are plotted in term of the performance of DVB-C system that is Bit Error Rate (BER). First the DVB-C system is analyzed with 64-QAM Modulation and Reed-Solomon Encoding and the Bit Error Rate (BER) of DVB-C system with these modulation schemes is calculated to check the system performance. Analysis was done by observing the simulation result and tabulating the analysis results to make it more convenient to be read. In the performance analysis of DVB-C system the transmitted signal, received signal, scattered plot and bit error rate of the systems are analyzed.

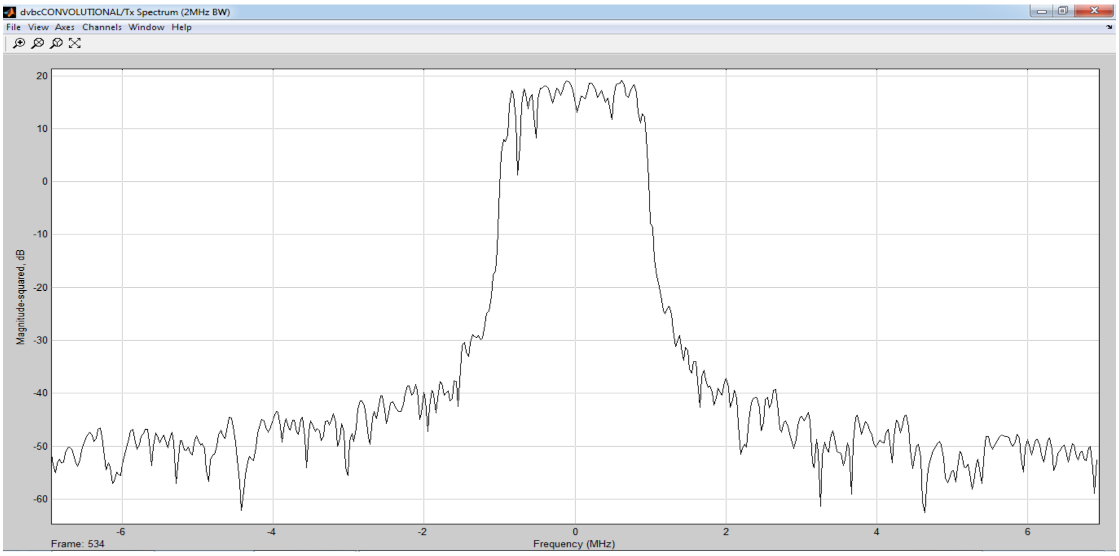

Figure 2. Transmitted Signal of DVB-C.

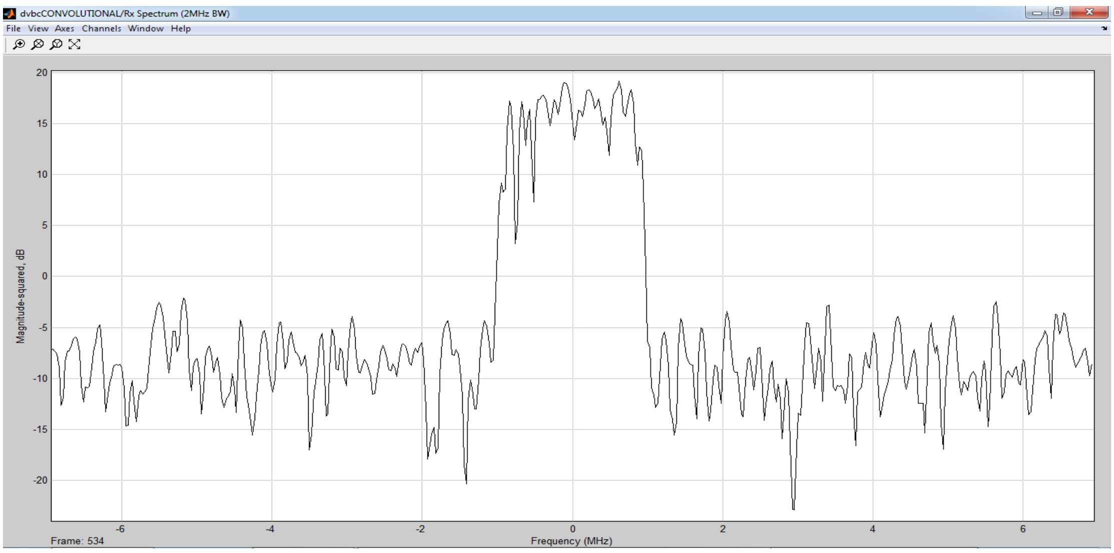

Figure 3. Received Signal of DVB-C.

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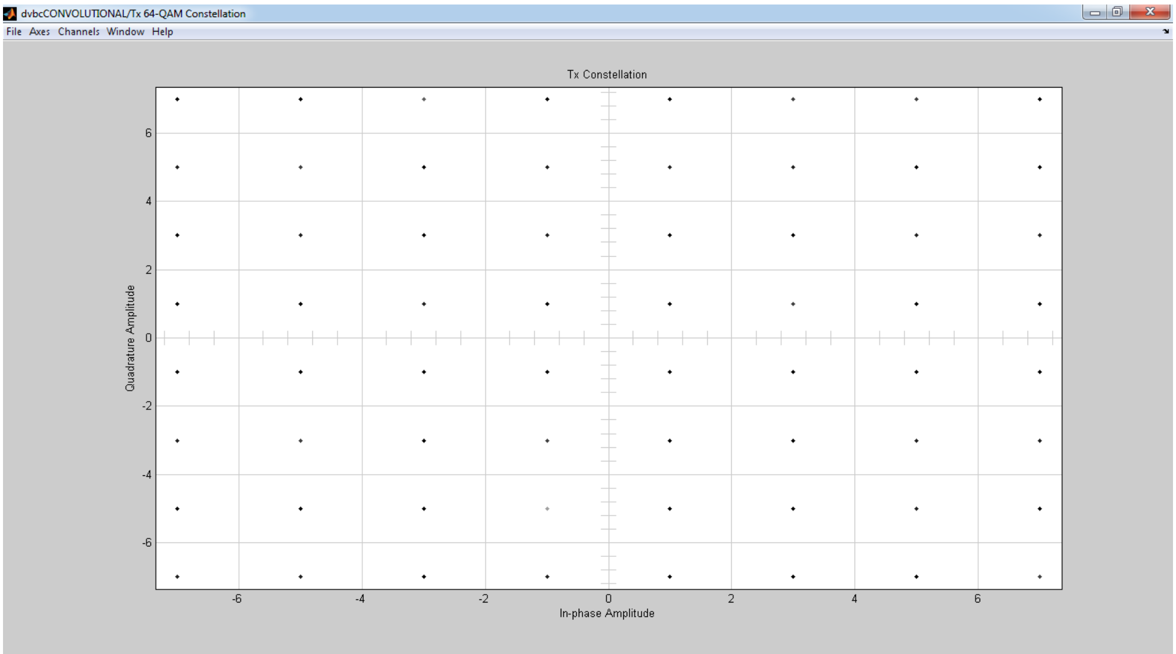

Figure 4. Scatter Plot of DVB-C Transmitted Signal.

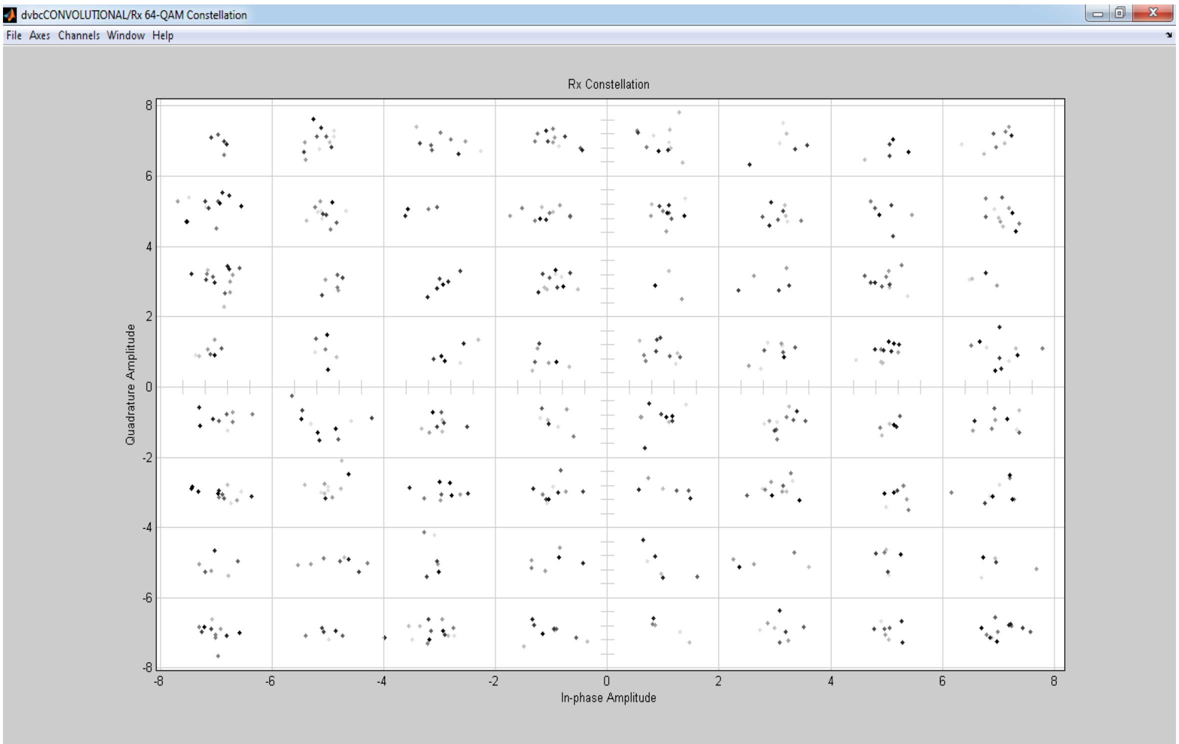

Figure 5. Scatter Plot of DVB-C Received Signal.

The Figure shows the transmitted and received signal of DVB-C system. To plot these signals spectrum scope is used. The Spectrum Scope block computes and displays the periodogram of the input. From the plot of transmitted and received signal it is clear that the received signal is so much distorted as comparison to transmitted signal due to channel. The simulation results are plotted in term of the performance of DVB-C system that is transmitted, received signal.

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IV. CONCLUSION

The new model is important to minimize the BER in the standard DVB-C. The proposed and standard models are simulated using Matlab software. A gain was obtained from the proposed model relative to the standard model at the AWGN channel. In the presence of impulse noise, the BER for both models was increased but the proposed model has less BER than the standard model in all range of SNR. So, the proposed model can be considered as an alternative technique to the standard one.

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