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Digital Video Broadcasting (DVB): Architecture, Applications, benefits and Design

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Abstract

Video Broadcasting is playing an important role in communication systems. Conventional digital broadcasting systems were designed with fixed modulation techniques, which had to guarantee reliable communication even with very hostile channel environment. In this paper a survey is conducted of Digital Video Broadcasting. The detail architecture, DVB variants, benefits, application and comparison of different variants of DVB is presented.

Keywords— Digital video broadcasting, DVB-T, SNR, BER.

Introduction

DVB is the world's most advanced digital television system which offers more robustness, more efficiency and flexibility than any other Digital TV system. DVB standard supports HD, SD, UHD and mobile TV. Digital Video Broadcasting-Terrestrial (DVB- T/T2) television is nowadays an efficient communication technology for TV broadcasting. It is a 2G terrestrial broadcast transmission developed by DVB project since 2006 whose main purpose was to increase capacity, ruggedness and flexibility. Higher spectral efficiency of DVB means that with the same amount of spectrum, a larger number of programs can be broadcast or the same number of programs broadcast with a higher audio/video quality or coverage quality. With the addition/employment of improved source coding (MPEG-4), the gain in broadcast transmission is remarkable [1].

DVB permits the simultaneous transmission of various services having different configuration and therefore with different robustness and quality. This allows new type of reception scenarios for these digital terrestrial signals, like mobile and handheld pedestrian reception scenarios. Therefore DVB can be used for providing both fixed and mobile services within the same channel thanks to the number of configurations supported [2].

Digital television is steadily gaining a large interest from users therefore the DVB organization design a new physical layer for digital terrestrial television whose main goal were to achieve more bandwidth targeting HDTV services, provide service specific robustness, improve single frequency networks and target services for fixed.

DVB Benefit

DVB as a broadcasting technique provides many benefits [3]:

- Allow receiving signals with the current analogue antenna domestic system. The frequencies that the DVB-T system will use are the same as those of the analogue TV services.
- Allows the portable and movement reception.
- Require less transmission power than other systems.
- The behaviour of digital signal due to interferences is better than analogue signal one.
- Carry out the regional/local broadcasting.
- To reduce the network implementation costs, thanks to the reuse of the existing analogue infrastructure.
- Allows the convergence TV.

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DVB Standards

DVB is a set of internationally accepted open standards for digital television. DVB standards are developed by the DVB Project, an international industry consortium with more than 270 members. Its objective is to agree specifications for digital media delivery systems, including broadcasting. It is originally of European origin but now worldwide [4].

Table 1: DVB Standard Family

DVB Family	Modulation	Channel Bandwidth	Data Rate
DVB-S (satellite)	QPSK	33 MHz	38 Mbit/sec
DVB-C (Cable)	64 QAM	8 MHz	38 Mbit/sec
DVB-T (Terrestrial)	QPSK, 16- QAM, 64-QAM	5, 6, 7 or 8 MHz	22 to 25 Mbit/sec

The development of the DVB Project was very successful therefore started to promote its open standards globally to make digital television a reality. DVB standards became the popular choice for digital TV around the world. Japan and USA, where other digital satellite standard/systems are used, also began to use DVB-S. Although the DVB-T system was more slowly to use for all the countries than the digital satellite and cable, it's estimated than more than 120 million of DVB receivers are around the world. During 2009, 10 countries had completed the process to change from analogue to digital terrestrial broadcasting adopting the standard DVB-T [5].

Related Work

Analog video broadcasting is being replaced by the digital video broadcasting technology. The main problems in analog video broadcasting are ghost images. This is because of multipath distortion in the radio/fading channel and noise signals that degrades the quality of the signal. This problem is efficiently solved by a digital television.

Alberto Morello and Vittoria Mignone [6] provides a tutorial overview of the DVB-S2 system, describing its main features and performance in various scenarios and applications. Adaptive coding and modulation, when used in one-to-one links, then allows optimization of the transmission parameters for each individual user, dependant on path conditions. Backward-compatible modes are also available, allowing existing DVB-S integrated receivers–decoders to continue working during the transitional period.

M V Raghavendra and Others [7] provides a brief introduction to the DVB-S system based on [EN-300-421]. The overview covers the physical layer that comprises adaptation, framing, coding, interleaving and modulation, and discusses error performance requirements to achieve quality of service (QoS) targets.
Diego A. Samo and others [8] investigate the performance of DVB-T2 and DVB-T2-Lite for mobile receivers, assuming the TU6 mobile channel. They show that the use of sub-slicing and inter-frame interleaving yields a performance improvement for both DVB-T2 and DVB-T2-Lite, at the expense of increased decoding latency. They also illustrate that the performance advantage of inter-frame interleaving is significant, especially at low mobile speeds. Besides, at very high speeds, DVB-T2-Lite with lower code rates is able to outperform DVB-T2.

Cinta Oria and others [9] gives the application of code combining diversity in Digital Video Broadcasting Satellite to Handheld (DVB-SH) system. A meaningful diversity gain can be obtained in multiple frequency networks, allowing an improvement of the receiver robustness in both static and mobile scenarios.

F. Salman, J. Cosmas, and Y. Zhang [10] compare the performance of different configurations of DVB. Different types of scattered pilot patterns for DVB-T2 standard are analysed, evaluated and compared in BER through Linear interpolation and Spline Least Squares Best Fit estimator methods.

A. G. Armada, B. Bardon, and M. Calvo [11] presents realistic BER performance and compared to the suggested ideal values in the standard although the results in the AWGN channel agree, the performance achieved in non-ideal conditions is poorer than expected in multipath environment. H. Jiang and P. A. Wilford [12] presents that a digital broadcast system utilizes regulated frequency bands with fixed bandwidths. The capacity of a digital broadcast system is limited by transmission power of the system and channel impairments.

Design of DVB System

The block diagram of DVB-T/H transmission system is shown in Fig. 1. The transmitter consists of source encoder with multiplexer, channel encoder and transmitter. In the terrestrial transmission of digital television signals, according to the DVB-T/H standard, the most appropriate modulation method to cope with mentioned problems is COFDM modulation (Coded Orthogonal Frequency Division Multiplex). It means that OFDM modulation is preceded by channel coding FEC [31]. Payload carriers are mapped absolutely and they are not differentially coded. This requires channel estimation and correction for which numerous pilot signals are provided in DVB-T/H spectrum [32]. These are also used as test signals for channel estimation. Between the COFDM symbols a Guard Interval of defined, but often adjustable length, is maintained. Inside this Guard Interval, transient events due to echoes can decay which prevents ISI (Inter Symbol Interference). The Guard Interval must be longer than the longest echo delay time of the transmission system. Modulator of the DVB-T/H transmitter can cause I/Q modulation errors like amplitude imbalance, I/Q phase errors and lack of carrier suppression [33].

Noise AWGN (Additive White Gaussian Noise) is always present during all the processing. Then the signal is transmitted via terrestrial transmission link with multi-path reception with various echo paths caused by reflection, additive noise AWGN, narrow-band or wide-band interference sources and Doppler effects and its frequency shift in case of mobile reception.

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Table 2: Simulated system parameter

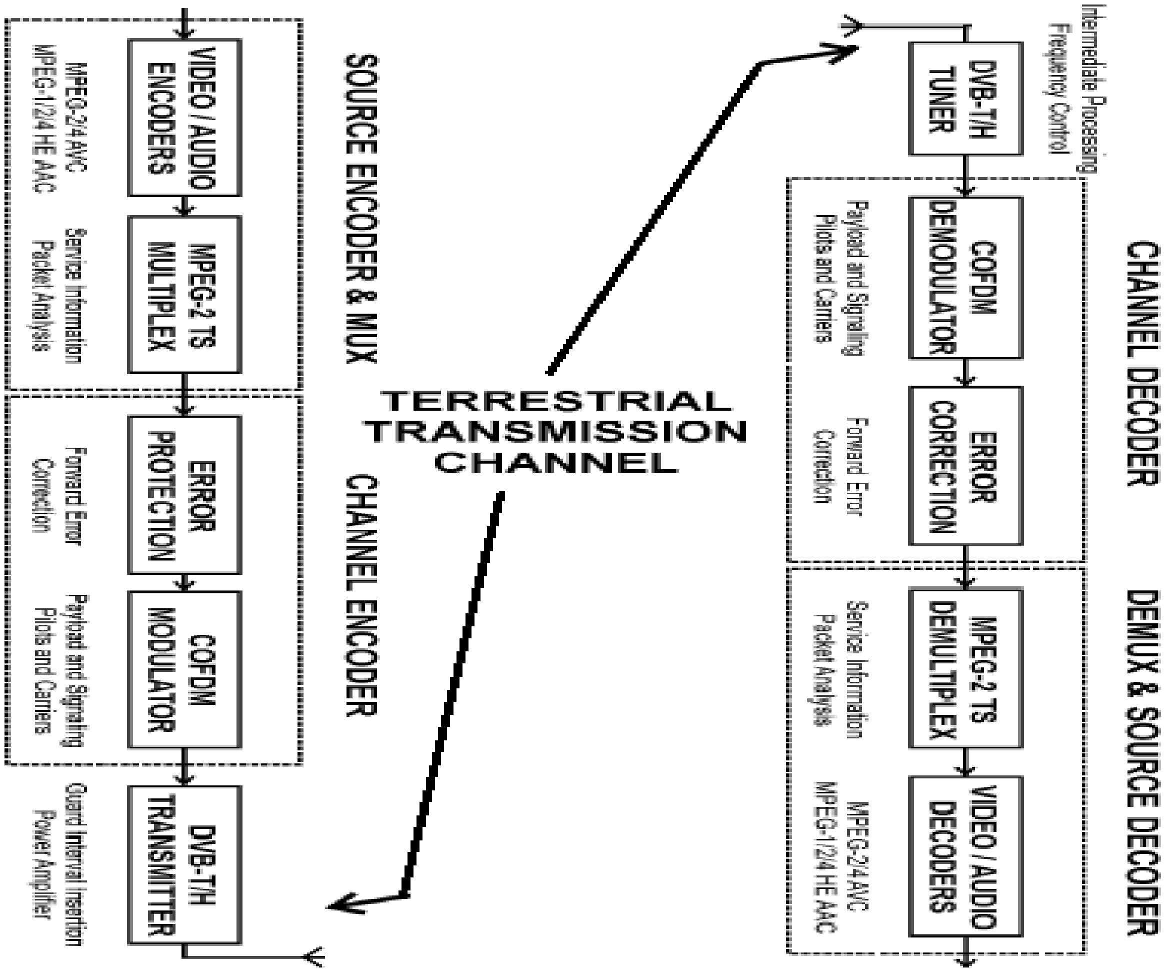

Fig. 1 Block diagram of the DVB system

In the ideal case, exactly one signal path arrives at the receiving antenna. The signal is then only attenuated to a greater or lesser extent and is merely subjected to noise AWGN. This channel with a direct view of the transmitter is called Gaussian channel and provides the best conditions of reception for the receiver. The receiver side consists of classical TV tuner with low noise level, channel encoder and transport stream de-multiplexer with selected program de-multiplexing and source decoding. DVB-T/H signal carries a pilot signals which can be used as measuring signals for channel estimation and channel correction in the receiver. A FFT sampling window of the COFDM demodulator is not placed precisely over the actual

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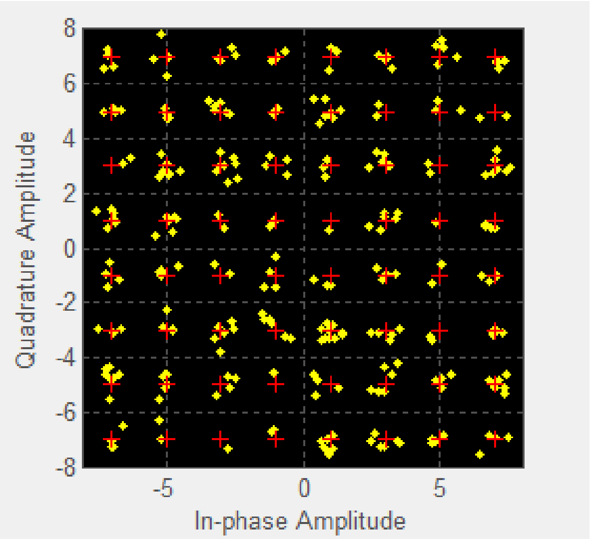
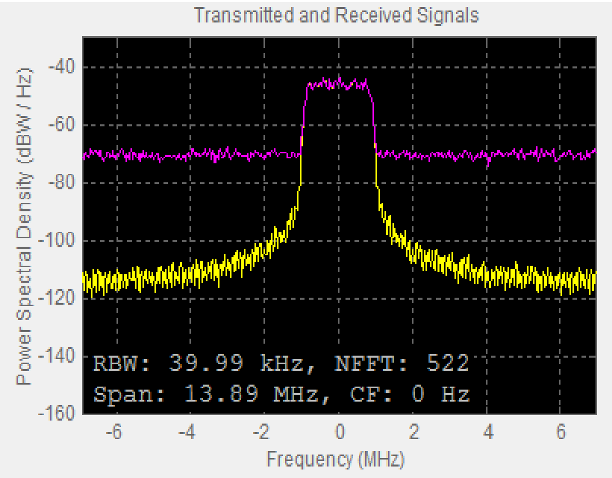
COFDM symbol. This causes phase shift in all subcarriers or twisted constellation, compression or expansion of the constellation [33]. Measuring the amplitudes and phase distortion of the continual and scattered pilots enables the correction function for the channel to be calculated and the transmission distortion can be removed.

Results





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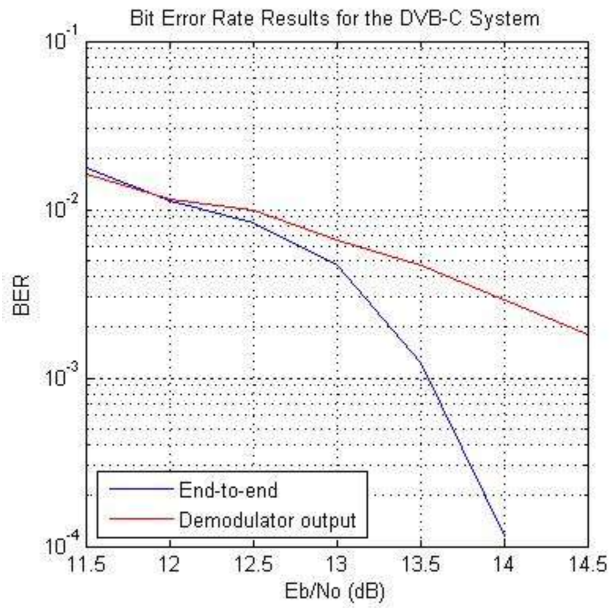

Fig. 2: (a) Constellation diagram Transmitter/receiver (b) Transmitted and receive Signal (c) BER of DVB-C

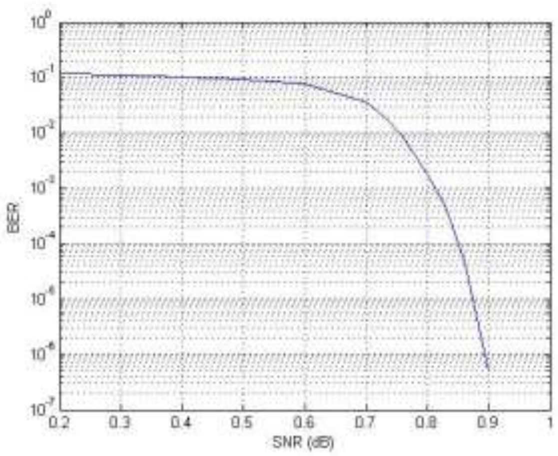

Fig. 3: BER of DVB-S.2

Conclusions

DVB system has been successfully implemented and more than 200 million devices around the world are receiving services that use DVB standards. Of these, about 100 million are satellite receivers and more than 60 million are receiving DVB-T signals. DVB-S/S2 forms the basis of digital satellite TV just about everywhere. DVB-C is the most commonly used system for digital cable TV. Hence the stability and flexibility are main parts comes with all DVB standards. The channel codes for DVB-S.2 provide a significant capacity gain over DVB-S under the same transmission conditions. Depending on the transmission mode, DVB-S.2 provides Quasi-Error-Free operation (packet error rate below 10^ -7) at about 0.7 dB to 1 dB from the Shannon limit.

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