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Implementation and Error Rate Verification of Digital Video Broadcasting (DVB) Standard

Shivyia Gupta[1] and Ritika[2]

[1] M. Tech Scholar, Department of ECE, Sri Sai College of Engineering & Technology, Badhani, Punjab, India

[2]Asstt. Professor, Department of ECE, Sri Sai College of Engineering & Technology, Badhani, Punjab, India

Abstract

High Definition Television (HDTV) services are the major requirement in the television broadcasting. The system of broadcasting has been specified around three concepts: best transmission performance approaching the Shannon limit, total flexibility, and reasonable receiver complexity. This paper provides a brief introduction to the DVB system. The DVB-S system provides direct to- home (DTH) services, as well as collective antenna systems (satellite master antenna television SMATV) and cable television head-end stations. The paper provides a tutorial overview of the DVB system, describing its main features and performance in various scenarios and applications.

Keywords: *DTV, Channel Coding, DVB-S2, satellite broadcasting.*

1. Introduction

The current European standard for Terrestrial Digital Video Broadcasting (DVB-T) [1] was approved by European Telecommunications Standards Institute (ETSI) in December 1995. The DVB-T system is based on multi-carrier Orthogonal Frequency Division Multiplex (OFDM) technique to combat effects of the terrestrial transmission channels. The forward error correction coding (FEC) in DVB-T structure is based on concatenation of a Reed-Solomon (RS) and convolutional code. DVB-T standard is introduced in 1995 and since then coding theory becomes very advanced. More efficient FEC techniques have been discovered and computational resources for decoding them are now available even in portable hand-held appliances. Low Density Parity Check (LDPC) codes together with turbo codes are introduced to perform very close to the theoretical upper limit for the spectrum efficiency introduced by Claude Shannon in 1948.

As digital television is moving towards High Definition Television (HDTV) based services, more capacity from the transmission network is required. Digital TV appeared as a natural evolution of analog TV. Early on all the parts of TV use sound and image which are generated in the studios as analog. DVB can be defined as an industry-led consortium of broadcasters, manufacturers, network operators, software developers and regularity bodies committed to designing open technical standards for the digital television and data services (DVB Organization 2003). For this purpose, DVB firstly published specifications for three different standards which are DVB-C (ETSI EN 300 429 1998) for cable systems, DVB-S (ETSI EN 300 421 1997) for satellite systems and DVB-T for terrestrial systems. DVB-H (ETSI TR 102 377 2001) for handheld systems can be defined as a derivative of DVB-T and it is meant for handheld mobile terminals. Although DVB-T deserves a great success in digital broadcasting area, it is thought that DVB-T requires some improvements. However DVB-T systems are developed for the stationary and portable devices, by the vast increase in the mobile communication technology, it requires adaptation for the portable devices that moves faster and that is inside of the buildings. These facts provide a new and updated standard for DVB-T and this led to the standardization of DVB-T2. DVB-T2 specification was firstly published in September 2009 and in this document, new baseline transmission system is described (ETSI EN 302 755 2011).

2. DVB Transmission

DVB standard based systems distribute data using a variety of approaches which include:

(a) Satellite: DVB-S, DVB-S2 and DVB-SH DVB-SMATV for distribution via SMATV
(b) Cable: DVB-C, DVB-C2
(c) Terrestrial television: DVB-T, DVB-T2

These systems depict the physical layer and data link layer of the distribution. The DVB-T2 standard gives more robust television reception and increases the possible bit rate by over 30% for single transmitters. The standard should increase the maxmum bit rate by over 50% in large single-frequency networks. DVB has established a 3D television group (CM-3DTV) to identify "what kind of 3D television solution does the market want and need and

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how can DVB play an active part in the creation of that solution?". DVB now defines a new standard for 3D video broadcast: DVB 3D-TV system. Devices interact with the physical layer via a synchronous parallel interface (SPI), synchronous serial interface (SSI), or asynchronous serial interface (ASI). All data is transmitted in streams with some additional constraints (DVB-MPEG). A standard for temporally-compressed distribution to mobile devices (DVB-H) was published in November 2004. These distribution systems differ mainly in the modulation schemes used and error correcting codes used, due to the different technical constraints. DVB-S (SHF) uses QPSK, 8-PSK or 16-QAM. DVB-S2 uses QPSK, 8-PSK, 16-APSK or 32-APSK, at the broadcaster's decision. QPSK and 8-PSK are the only versions regularly used. DVB-C (VHF/UHF) uses QAM: 16-QAM, 32-QAM, 64-QAM, 128-QAM or 256-QAM. In Digital Video Broadcasting, There are different types of modes and features of DVB-Cable, Satellite and Terrestrial.

DVB-T as a digital transmission delivers data in a series of discrete blocks at the rate. DVB-T is a COFDM transmission technique which includes the use of a Guard Interval. It allows the receiver to cope with strong multipath situations.

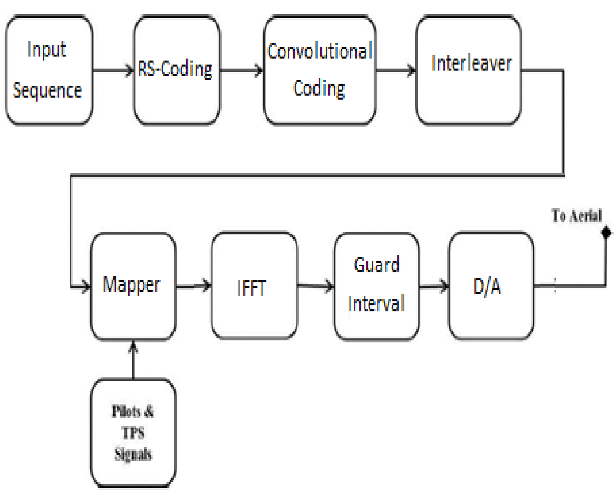

Figure 1: Functional Block of DVB-T.

Figure 1 shows Structure of DVB-T Transmission system, the description of the signal processing blocks are follows:

DVB-T systems are designed to perform adaptation of the baseband TV signals from the output of the MPEG-2 transport multiplexer to terrestrial channel characteristics. Data stream which is the output of MPEG-2 block is processed. Main blocks of the system are defined in [38] and summarized as follows:

- Radom PR Sequence Generator
- Outer coding (RS coding)
- Inner coding (Convolutional coding)
- Interleaving
- Mapping and modulation
- IFFT (OFDM) transmission

There are two modes of operations, "2K mode" and "8K mode", for DVB-T transmission. Exclusively for use in DVB-H systems, a third transmission mode, "4K mode", is defined and addressing the specific needs of handheld terminals. The system allows different levels of QAM modulation and different inner code rates to be used to trade bit rate versus ruggedness.

Table 1 lists the physical layer parameters that affect the channel bit rate and robustness against channel errors. For modulation type, from QPSK to 16QAM, channel bit rate and error probability increases.

Table 1: Physical layer parameters

Parameter	**Options**	**Explanation**
Modulation	3	QPSK, 16-QAM, 64-QAM
FFT-Size	3	2K, 4K, 8K
In-depth inter-leaver	2	On/Off (for 2K & 4K)
Guard Interval	4	¼, 1/8, 1/16, 1/32
Convolutional Code Rate	5	1/2, 2/3, 3/4, 5/6, 7/8

4. DVB-T Results

The performance of the developed system is analyzed with BER under varying parameters. The parameters used are CP length, modulation and coding rate.

Figure 2 and figure 32 shows the performance of developed DVB model having cyclic prefix of 0.25 (1/4) and 0.5 (1/2) for different modulations under AWGN Channel. The values of BER under different SNR are shown in table 2 and table 3.

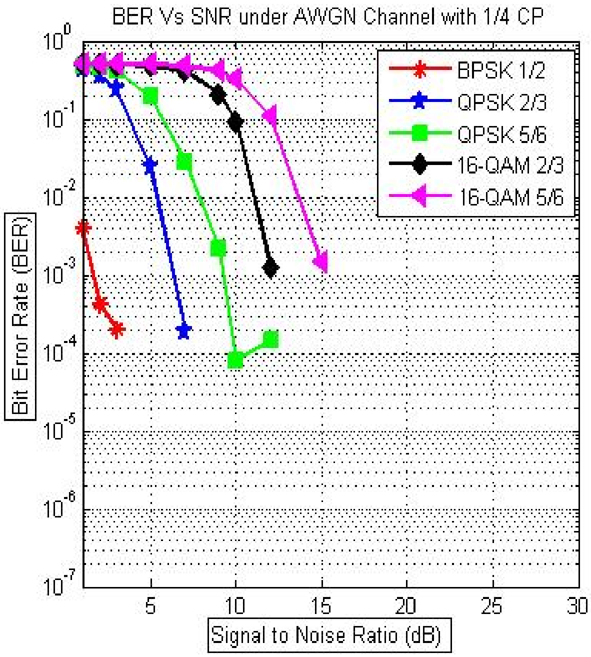

Figure 2: BER Evaluation with CP 1/4.

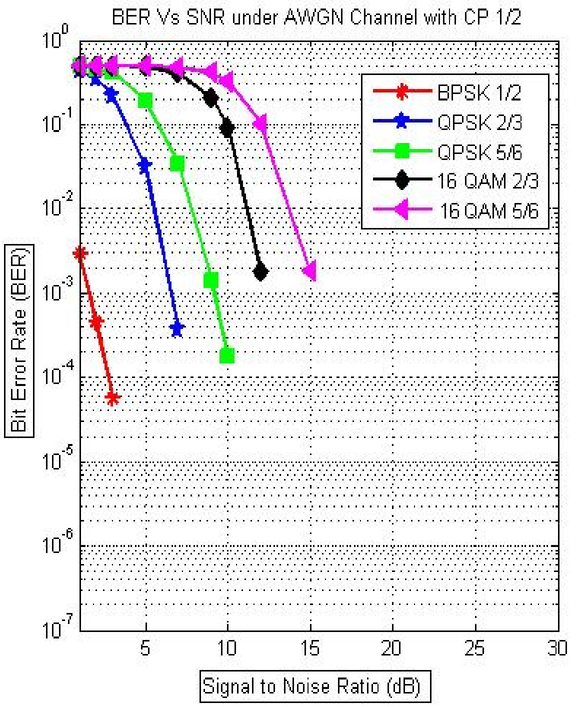

Figure 3: BER Evaluation with CP 1/2.

Table 1: BER for various SNR values with CP 1/4

SNR (dB)	BPSK – 1/2	QPSK - 2/3	QPSK-5/6	16-QAM 2/3	16-QAM 5/6
	BER	BER	BER	BER	BER
1	0.0039	0.4292	0.4824	0.4984	0.4981
2	0.0004	0.3543	0.4626	0.4988	0.5008
3	0.0002	0.2359	0.4084	0.4950	0.4994
5	0	0.0240	0.1932	0.4805	0.4970
7	0	0.0002	0.0282	0.4113	0.4778
9	0	0	0.0021	0.2080	0.4137
10	0	0	0.0001	0.0918	0.3240
12	0	0	0.0001	0.0012	0.1054
15	0	0	0	0	0.0015
17	0	0	0	0	0
20	0	0	0	0	0
22	0	0	0	0	0
25	0	0	0	0	0
27	0	0	0	0	0
30	0	0	0	0	0

Table 2: BER for various SNR values with CP 1/2

SNR (dB)	BPSK – 1/2	QPSK-2/3	QPSK-5/6	16-QAM 2/3	16-QAM 5/6
	BER	BER	BER	BER	BER
1	0.0030	0.4240	0.4812	0.4971	0.5011
2	0.0005	0.3507	0.4540	0.5003	0.4985
3	0.0001	0.2182	0.4206	0.4919	0.5008
5	0	0.0309	0.1909	0.4808	0.4964
7	0	0.0004	0.0340	0.4059	0.4796
9	0	0	0.0014	0.2056	0.4091
10	0	0	0.0002	0.0920	0.3252
12	0	0	0	0.0018	0.1006
15	0	0	0	0	0.0018
17	0	0	0	0	0
20	0	0	0	0	0
22	0	0	0	0	0
25	0	0	0	0	0
27	0	0	0	0	0
30	0	0	0	0	0

5. Conclusions

The results reveal that the Lower modulation and coding scheme provides better performance with less SNR. Therefore we can say that the system perform well when we use BPSK Modulation Scheme. BER is minimum for lower coding rate i.e coding rate 1/2 perform better than 2/3 and 5/6 code rate. The PSK modulation gives better performance as compared to QAM modulation schemes.

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