IJIREEICE

ISSN (Online) 2321-2004
ISSN (Print) 2321-5526

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering

Vol. 8, Issue 8, August 2020

DOI 10.17148/IJIREEICE.2020.8809

BER Analysis of DVB with Different Encoding and Interleaving Schemes

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Abstract: This paper investigates the performance of encoding and interleaving in DVB in the context of mobile reception. By means of time interleaving it is possible to provide time diversity and improve the robustness of the transmitted information in mobile environments. DVB implements a highly flexible time interleaving that allows different trade-offs in terms of time diversity, latency and power saving. DVB also includes the possibility to particularize the transmission parameters on a service basis by means of multiple physical layer pipes. This way, it is possible to accommodate different use cases: fixed, portable and mobile, in the same frequency channel. This paper evaluates the time interleaving capabilities of DVB by means of physical layer simulations.

Keywords: DVB, OFDM, BER, RS.

I. INTRODUCTION OF DVB

Digital broadcasting systems provide several mechanisms for transmitting data services to improve the conventional radio and TV services, and these systems also have the capability to support new multimedia services. There are several competing technologies for the broadcasting of digital content. In some parts of the world, we can tune into digital broadcasting on our digital TV set in the living room. The standards that provide this facility include Integrated Services Digital Broadcasting (ISDB), Digital Video Broadcasting (DVB), and Digital Multimedia Broadcast (DMB). These digital broadcast standards are being used in different parts of the world. In Japan, the ISDB standard is used to provide multimedia broadcast services to the terrestrial networks. The DMB standard is based on the Digital Audio Broadcast (DAB) standard and is deployed in South Korea[6]. It allows mobile reception of the multimedia content. The DVB standard is adopted in Europe for digital video broadcasting, and the European Telecommunications Standards Institute (ETSI) has regulated it. 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[2].
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[3].
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.
(c). The conditional access module verifies the existence of a smart card that contains the subscriber's authorization code.

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(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 [6]. 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-T

A single radio frequency (RF) channel, COFDM works by splitting the digital data stream into a large number of slower digital streams, each of which digitally modulates a set of closely spaced adjacent sub-carrier frequencies. In the case of DVB-T, there are two choices for the number of carriers known as 2K-mode or 8K-mode. These are actually 1,705 or 6,817 sub-carriers that are approximately 4 kHz or 1 kHz apart. DVB-T offers three different modulation schemes (QPSK, 16QAM, 64QAM). DVB-T as a digital transmission delivers data in a series of discrete blocks at the symbol 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. Within a geographical area, DVB-T also allows single-frequency network (SFN) operation, where two or more transmitters carrying the same data operate on the same frequency. In such cases the signals from each transmitter in the SFN needs to be accurately time-aligned, which is done by sync information in the stream and timing at each transmitter referenced to GPS[11].
The length of the Guard Interval can be chosen. It is a trade-off between data rate and SFN capability. The longer the guard interval the larger is the potential SFN area without creating intersymbol interference (ISI). It is possible to operate SFNs which do not fulfill the guard interval condition if the self-interference is properly planned and monitored. The digital TV system called DVB-T is designed to allow optimum use of the available frequency spectrum with a structure of broadcast data enough to accommodate numerous services: multiplex of up to 8 video programs in a 8 MHz bandwidth, multi-language stereo/surround channels, etc. The architecture of the DVB-T network consists in: program coder, multiplexer, SFN network adapter, COFDM (Coded Orthogonal Frequency Division Multiplex) modulator, up converter and transmitter. It specifies all the process to use terrestrial transmission channels: channel coding and modulation[9].
These blocks form the channel codification and the modulation scheme that is used by the system. The channel coding uses the Forward Error Correction (FEC) after the signal pass the transmission channel. Moreover, the modulation scheme showsthe transmission type OFDM (Orthogonal Frequency Division Multiplex). The combination of this one with the error correction and the multi-carrier modulation is the COFDM transmission type.

III. DVB PERFORMANCE ANALYSIS

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-T system the transmitted signal, received signal, scattered plot and bit error rate of the systems are analyzed. First calculate the BER for the DVB system with different modulation schemes such as 64-QAM and QPSK. The BER is calculated with error rate calculation block. In this block the transmitted and received signals are compared to calculate the BER.

Table 1. BER of DVB with Encoding.

	RS Encoding	CRC Encoding
For 64-QAM Modulation		
Bit Error Rate	0.4999	0.4703
Total Error Bits	15180001	13990000
Total Bits	30370000	30370000
For QPSK Modulation		
Bit Error Rate	0.4999	0.4970
Total Error Bits	15180001	15110000
Total Bits	30370000	30370000

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From these tables it is clear that while analyzing the different modulation schemes of DVB system with different encoding schemes, the 64-QAM modulation with CRC encoding gives better bit error rate as compare to other schemes.

IV. CONCLUSION

The digitalisation of television signals today is a well-known and widely implemented process. It consists basically of the representation of a picture - and the accompanying sound - by a binary bit-stream, a series of '0's and 'l's. However, compression and transmission of these signals through a communications channel- satellite, terrestrial or cable- becomes practical only after the raw digital data has been subject to a series of processes. And therefore, if it is wished to be able to interconnect digital TV equipment from different suppliers, or to receive such transmissions satisfactorily, different modulation and error detection schemes are used. So DVB system is designed to withstand with interference and fading in communication channel. Channel coding and modulation is needed for a system in order to sustain in any type of environment especially in multipath fading channel. Here DVB system is first analyzed with RS encoding and different modulation schemes i.e. 64-QAM and QPSK modulation. The bit error rate with both the modualtion schemes is same with RS encoding. Then DVB system is again analyzed with CRC encoding and different modulation schemes. It is concluded that 64-QAM modulation with CRC encoding is best suited scheme for proposed system.

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