SYSTEMS ENGINEERING

An overview on the standard of digital video broadcasting – terrestrial

INGENIERÍA DE SISTEMAS

Una visión general del estándar de transmisión de televisión digital terrestre

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RESUMEN

Digital Video Broadcasting (DVB) es un consorcio formado por industriales de los medios de comunicación, que está integrado por radiodifusores, fabricantes, operadores de redes, desarrolladores de software y organismos reguladores. El consorcio fue creado con el fin de definir las normas técnicas para estandarizar todos los aspectos relacionados con la prestación de servicios de televisión digital. El estándar DVB ha sido adoptado en Europa, Oriente Medio, Suráfrica y Australasia. Adicionalmente, el estándar DVB fue seleccionado en Colombia y Panamá como el sistema de transmisión de televisión digital terrestre (DVB-T/T2). El estándar DVB es un conjunto de especificaciones que permiten la integración de información multimedia para proveer servicios de información, educación, negocios y entretenimiento. La implementación de DVB requiere de acuerdos entre los radiodifusores, operadores de redes y fabricantes en la definición de los parámetros de operación, además de tener en cuenta las normativas gubernamentales. Este artículo presenta un resumen de los principales elementos definidos en el estándar DVB-T/T2, basado en los documentos guía elaborados por el consorcio DVB, e incluye algunas de las acciones tomadas durante el proceso de implementación de DVB-T/T2 en Colombia.

Palabras clave: *Estándar DVB-T, MPEG2/4, Televisión Digital Terrestre.*

ABSTRACT

The Digital Video Broadcasting (DVB) is an industry-led consortium integrated by broadcasters, manufactures, network operators, software developers and regulatory bodies, among others. It was created in order to designate technical standards for the global delivery of digital television services. DVB standards for digital television have been adopted in Europe, Middle East, Southern Africa, and Australasia. Moreover, the DVB has been adopted in Colombia and Panama as the terrestrial digital television system (DVB-T/T2). The DVB standard is a set of specifications for integrating multimedia as a unique base for information, education, business, and entertainment development. The standard describes the coding constraints that apply to the use of the MPEG 2/4 specifications in the digital television system including mandatory, main and optional enhanced services. However, launching DVB requires of agreements among broadcasters, network operators and manufacturers on setting parameters, along with government regulations. In this paper, an overview of key elements – in technical specifications – is compiled from DVB-T/T2 documents, along with actions taken in regard to the release of DVB-T/T2 in Colombia.

Keywords: *Digital terrestrial television, DVB-T standard, MPEG2/4.*

1. Introduction

Initially, the Digital Television (DTV) market was a vertical one. The broadcasters rented the set-top boxes to the consumer as part of the subscription agreement. In this market, broadcasters controlled specifications for the receivers. The content delivery chain of digital TV signal, in a vertical market, broadcasters choose the middleware for running applications on the receiver. Different broadcasters can choose different middleware systems. Thus, content providers may have to re-author their applications if they want to sell content to different broadcasters. However, an open standard allows the consumer to buy a receiver from an electronic store and expect it to work with any broadcaster, like the current analogue broadcasting. Moreover, the content developers sell their content without having to re-author it, and receiver manufacturers have a wider choice of middleware suppliers.

An open standard defines the transmission rules. At the time of this writing, there are four main open standard systems for digital terrestrial television (DTT) broadcasting. In Japan, the Terrestrial Integrated Services Digital Broadcasting (ISDB-T) system is standardised by the Association of Radio Industries and Businesses (ARIB). This system is the base of the *Sistema Brasileiro de Televisão Digital Terrestre* (SBTVD-T). In China, the Digital Multimedia Broadcasting (DMB) is used as digital television standard. The Advanced Television System Committee (*ATSC*) has standardised the system for terrestrial broadcasting in the USA, Mexico and Canada. In Europe, the Joint Technical Committee (JTC) Broadcast has standardised the Digital Video Broadcasting Terrestrial (DVB-T/T2) for terrestrial broadcasting. Open standards are widely used for technologies that provide an efficient, cost-effective, higher quality, and interoperable digital broadcasting.

Initially, DVB concentrated on the development of technical specifications relevant for traditional broadcasting. The DVB Blue Books are specifications developed by the DVB Technical Module and approved by the Steering Board. These specifications turn into international standards after they are passed to the Joint Technical Committee (JTC) Broadcast formed by the European Broadcasting Union (EBU), the European Telecommunications Standards Institute (ETSI) and the *Comité Européen de Normalisation Electrotechnique* (CENELEC). In parallel, DVB delivers documents providing implementation guidelines accompanying the specifications. In particular, DVB-T is a technical standard that specifies the framing structure, channel coding and modulation for digital terrestrial television (DTTV) broadcasting, available at http://www.dvb.org/.

It allows network planning to deliver a wide range of services, from High-definition television (HDTV) to multichannel standard-definition television (SDTV), fixed, portable, mobile, and even handheld reception. DVB standards provide transmission technical specifications, and MPEG standards define video and audio coding technical specifications (ETSI-EN-300-744 2009).

The use of the DVB-T has advantages on analogue transmission, such as high degree of utilization of spectrum; immunity to interference and noise; use of MFN and SFN; MPEG-2 capabilities; different levels of image quality (LDTV, SDTV, EDTV, HDTV); possibility of fixed, portable and mobile reception; flexible bands: III, IV and V; and flexibility of configurations. In addition to DVB-T, supporting standards are required for covering areas, such as: service information (DVB-SI), subtitling (DVB-SUB) and interfacing (e.g. DVB-ASI), among others.

DVB-T deals with the transmission of compressed digital audio, video and other data in an MPEG transport stream (ETSI-TS-101-154 2009), using Coded Orthogonal Frequency Division Multiplexing (COFDM) modulation. In the OFDM, digital data stream is split into a large number of slower digital streams, each of which digitally modulates a set of closely spaced adjacent carrier frequencies. Also, flexibility of configurations is achieved by the DVB-T system parameters. A second generation, DVB-T2 increases the capacity of DTT of at least 30%, in comparison with the DBV-T (DigiTAG 2009). Also, it provides new services along with three new bandwidths, and reception in portable and mobile devices.

In this paper, an overview of key elements – in technical specifications – is compiled from DVB-T documents, including minor information on DVB-T2, along with action taken regarding the release of DVB-T2 in Colombia.

2. Terrestrial Digital Video Broadcasting - Transmitter

There are a wide field of applications of DVB-T technologies in order to exploit the capability of all possible underlying technologies; such as a data transmission technique. DVB will enable (Reimers 2006): a multiplication of the number of television programs which can be broadcast in one transmission channel, data transmission for entertainment and business purposes, a flexible choice of image and audio quality, full interactive services by interaction channels between the viewer and the network operator or content provider, an open and interoperable software platform for enhanced services, and the possible integration into the world of personal computers, among others.

At the systems level, guidelines document (ETSI-TS-101-154 2009) includes restrictions to the syntax and parameter values described by MPEG-2 and preferred values used in DVB-T applications. The baseband signal that is transmitted is an MPEG-2 transport stream (MPEG-2 TS) (ISO/IEC-13818 2007). Also; MPEG-4 content can be transported over an MPEG-2 TS. The DVB-T standard provides transmission technical specifications (ETSI-TR-101-190 2008), while MPEG specifications are used for video and audio coding (ETSI-TS-101-154 2009).

The DVB-T standard can be implemented using existing analogue networks by an individual set of radio frequencies for each transmission site. It intends to cope with different noise and bandwidth environment, and with multi-path. The DVB-T provides flexibility by serving a wide variety of applications and implementation scenarios, and specifying a wide range of options using different modulation formats, guard intervals, and code rates (ETSI-TR-101-190 2011). DVB-T transmitter consists of several signal-processing components, as it is illustrated in the functional block diagram of the system in (ETSI-EN-300-744 2009). A brief description of those components is presented as follows:

A. *Source coding and MPEG-2 multiplexing*: compressed video, audio and private data streams form elementary streams. Standards for video and audio compression in DVB-T systems are: Video compression – MPEG-2, H.264/AVC and VC-1. Audio compression – MPEG-1 or MPEG-2 layer 2 backward compatible audio, AC-3 audio, Enhanced AC-3 audio, DTS audio or MPEG-4 AAC audio.

Elementary streams are cut into packetized elementary streams (PES) and multiplexed into MPEG-2 transport stream (TS) (ETSI-EN-300-468 2010), (ETSI-TR-101-211 2009), (ETSI-TS-101-154 2009).

MPEG-2 TS is designed for transporting TV programs in environments affected by relatively high error rates (bit error rate (BER) higher than 10^{-4}). On the other hand, MPEG-2 program stream (PS) is designed for applications where the transmission channel or storage medium is susceptible to a low number of errors (BER<10^{-10}).

B. *Hierarchical modes.* DVB-T includes three modulation options (QPSK, 16QAM, 64QAM) and the option of hierarchical modes allowing carrying streams with different priorities corresponding to different degrees of robustness. Constellation diagram can have a greater distance between adjacent states located in different quadrants than between adjacent states belonging to the same quadrant. The constellation ratio α is used to determine the spacing between the groups of constellation points. α is the ratio of the spacing between the groups to the spacing between individual points within a group. The permitted values of α are 1, 2 and 4. Where, α =1 denotes a constellation as uniform, used in non-hierarchical transmission.

In the hierarchical modulation, two completely separate data streams can be modulated onto a single DVB-T signal. A "High Priority" (HP) stream is embedded within a "Low Priority" (LP) stream. In this case, the two Most Significant Bits (MSB) are used for the robust services, while the remaining bits contain higher bitrates. For instance, the same channel can be broadcasted in SDTV and HDTV and the receiver uses the one depending on receiving conditions.

C. *Transport multiplex adaptation and randomization for energy dispersal*. The system input will be organised in fixed length packets, following the MPEG-2 transport multiplexer. Energy dispersal is undertaken before the correction process for obtaining an evenly distributed energy within the RF channel. The signal is randomised in order to ensure the energy dispersal in the channel and to avoid long series of 0's or 1's. A Pseudo-Random Binary Sequence (PRBS) is used with the generator polynomial $1+X^{14}+X^{15}$ (ETSI TS 101 154 2009). The PRBS disperses the data but not the sync words (0x47) of the TS packets. The sync word is the first byte of each TS packet. Energy dispersal ensures a constant average modulator output level.

D. *External encoder (RS encoder)*. Forward Error Correction (FEC) is achieved by introducing redundancy to the structure of transport packets. External coding is used to make this possible is the Reed-Solomon type RS (204,188, t = 8). It can correct up to 8 erroneous bytes per packet.

E. *External interleaver (Convolutional Interleaver, I=12)*. Transmission errors corrupt not only a single bit but also many bits following it in the data stream. A convolutional interleaver rearranges the transmitted packets with the purpose to increase the efficiency of the Reed–Solomon decoding by spreading the burst errors introduced by the channel over a longer time. External interleaver inserts 11 bytes from other TS packets between bytes from the same TS packet (at the input). This allows burst errors of maximum 12x8=96 bytes to be corrected since only eight or fewer errored bytes per TS packet are obtained after the deinterleaver in the DVB receiver/decoder.

F. *Internal encoder (Punctured Convolutional Code)*. Internal encoder uses convolutional coding and is a complement to the Reed–Solomon coder and the external interleaver. It is based on a mother convolutional code of rate 1/2 with 64 states. Afterwards, puncturing the output of the convolutional encoder lowers the redundancy of the mother code. System allows code rates of 2/3, 3/4, 5/6 and 7/8, which involves not taking all successive bits of the two X and Y output bitstreams, but only one of the two simultaneous bits with a certain puncturing ratio.

G. *Internal interleaver*. The interleaving process is twofold: bit interleaver and symbol interleaver. Depending on the modulation mode – QPSK, 16QAM or 64QAM – the bit interleaver comprises 2, 4 or 6 paths. An input stream is demultiplexed into v sub-streams, where v = 2 for QPSK, v = 4 for 16-QAM, and v = 6 for 64-QAM.

Two modes are defined for the Coded Orthogonal Frequency Division Multiplexing (COFDM) multicarrier method: 2K with 1705 carriers and 8K with 6817 carriers. The purpose of the symbol interleaver is to map v bit words onto the useful 1512 (2K mode) or 6048 (8K mode) active carriers per Orthogonal Frequency Division Multiplex (OFDM) symbol. The interleaver output data words are grouped into 12 blocks of 126 bits in 2K mode and in 48 blocks of 126 bits in 8K mode.

The symbol interleaver processes the bit groups to generate COFDM symbols. The symbol interleaver allows insertion of scattered pilots, continual pilots and transmission parameter signalling (TPS) carriers at defined points of the COFDM symbol.

***H.** Mapper (+pilots and Transmission Parameter Signaling (TPS) carriers)*. Using OFDM, a SFN can be implemented in order to achieve a significant degree of spectrum efficiency improvement. Very small transmitters can be used to enhance local coverage. Small "*gap fillers*" may be even used to enhance indoor coverage for DVB-T. All data carriers in one OFDM frame are modulated using QPSK, 16-QAM, 64-QAM, non-uniform 16-QAM or non-uniform 64-QAM constellations. 68 consecutive symbols form one OFDM frame and 4 frames form OFDM super-frame. Non-hierarchical transmission uses only uniform constellations. Hierarchical modulation is possible only with 16-QAM or 64-QAM in the DVB-T system and can use all α-values (ETSI-EN-302-755 2010). There is a balance between the amount rate at which data can be transmitted and the signal to noise ratio that can be tolerated. The lower order modulation formats, like QPSK, do not transmit data as fast as the higher modulation formats, such as 64QAM, but they can be received when signal strengths are lower.

The continual and scattered pilots are modulated according to a Pseudo-Random Binary Sequence (PRBS) sequence, w_k, corresponding to their respective carrier index *k*. This sequence also governs the starting phase of the Transmission Parameter Signals (TPS) information. The PRBS is generated according the generator polynomial $1+X^2+X^{11}$, initialised at 11111111111. The PRBS is initialised in a way that the first output bit from the PRBS coincides with the first active carrier. A new value is generated by the PRBS on every used carrier (whether or not it is a pilot). The TPS carries convey information on: Modulation type (including α-value); Hierarchy information; Guard interval; Inner code rates; Transmission mode (2K or 8K); Frame number in a super-frame; and Cell identification.

TPS data is used in special cases – such as: changes in the parameters and resynchronisations – since the receiver has to be able to synchronise, equalise, and decode the signal to access the information held by the TPS pilots.

***I.** OFDM Transmitter and Guard Interval Insertion*. OFDM modulation consists of N orthogonal carriers of duration T_0 (each one is modulated with a conventional modulation scheme like QPSK, n-QAM or n-PSK), with a spacing of $1/T_0$ between two consecutive carriers. Increasing the number of carriers does not modify the payload bit rate, which remains constant. In DVB-T, OFDM uses 2048 or 8192 carriers (2K and 8K mode). Every OFDM block is extended, prefixing the end of the block to the beginning (cyclic prefix). The cyclic prefix serves as a guard interval and eliminates the intersymbol interference from the previous symbol. Insertion of the guard interval extends symbol duration by 1/4, 1/8, 1/16 or 1/32 to give the total symbol duration T_S. In this way, all echoes – caused by multipath reception, reception of other transmitters in the SFN or Doppler effects in mobile reception – have to settle or decay.

3. Terrestrial Digital Video Broadcasting - Receiver

The basic DVB-T modes and parameters important to the inner receiver are specified in ETS-EN-300-744 (2009) and EN-50083-9 (2002). The standard also defines interleaving across subcarriers, the data frame structure, a mechanism for robust signaling of transmission parameters (TPS), and dedicated synchronisation symbols embedded into the OFDM data stream. In addition, the following aspect must be determined (ETSI-TS-102-201 2005): 1) The range of SNR needed for the required outer receiver performance; 2) The upper bound on the additional noise caused by any transmission imperfection; 3) Bounds on the accuracy of parameter estimation, allowed receiver mobility, and the quality of analog components.

A set of minimum requirement specifications for DVB-T set-top-boxes receivers are presented as follows (Meyr, Moeneclaey & Fechtel 1997) (Kerttula & Jäntti 2011) (ETSI-EN-300-472

2003): a) General RF part: Reception and demodulation of the DVB-T signal transmitted in accordance with ETSI-EN-300-744 (2009); b) Reception mode: Reception of the DVB-T signal in SFN and MFN; c) Frequency bands: Reception of all channels in UHF and VHF; d) Reception combinations and parameters: Transmission mode, COFDM Modulation, Code rate, Guard interval and optional hierarchical mode; e) Echoes: reception of the DVB-T signal in environment with echoes according to ETSI-EN-300-744 (2009); f) Signal level and signal quality: Within the user interface the receiver has to provide the information of signal level and signal quality. The implementation of user interface is responsibility of the producer; g) Input connector: A receiver is required to be at least one tuner input connector in accordance with ETSI-TS-102-201 (2005). The input impedance is required to be 75 Ohm; h) Tuning/Scanning procedures: A receiver is required to – in case of same Transport stream Id and Service Id on two or more different frequencies – save all frequencies, or select the frequency with better signal. Also, a receiver is required to be able to receive and react on tuning parameters in PSI/SI tables; i) Interfaces for Conditional Access: CI-slot is required to comply with EN-50221 (1997); j) MPEG Demultiplexer: A Demultiplexer is required to be compliant to the MPEG-2 transport layer defined in ISO/IEC-13818-1 (2007) and ETSI-TS-101-154 (2009); k) MPEG Video Decoder: The decoder of a receiver is required to fully comply with ISO-IEC-14496-10 (2012) for decoding MPEG-4 AVC, a decoder is required to also comply with ETSI-TS-101-154 (2009) and decoding of MPEG-2 coded signal according to ISO/IEC-13818-2 (2000); l) Service information: A receiver is required to have system software for interpretation and handling of the active service information and control of the local hardware/software according to ETSI-EN-300-468 (2010) and ETSI-TR-101-211 (2009); m) Teletext: insertion of the Teletext data conform to ISO IEC 62216-1 (2010) and to requirements defined in ETSI-EN-300-706 (2003); n) Subtitling: decoding and displaying DVB subtitle services, which are transmitted in conformance with ETSI-EN-300-743 (2006), and *o)* Software update through the incoming DVB-T or DVB-T2 signal (DVB-SSU) is specified in ETSI-TS-102-006 (2008).

4. The DVB-T/T2 Colombia

Digital Television has already been deployed in Colombia, and the main competitors in the Colombian market for delivering television are satellite and cable providers. They operate in pay-to-air/satellite mode. Currently, there are 668 RF stations in Colombia from public and private network providers. The Consortium of Private National Channels (*Consorcio de Canales Nacionales Privados* — CCNP), and National Radio and Television of Colombia (*Radio Televisión Nacional de Colombia* — RTVC) are the main network providers. The Colombian *government* authority was the Colombia's National Television Commission (CNTV) – until April 2012. The CNTV decided to adopt the DVB-T standard for digital terrestrial television, using a video coding H.264/MPEG-4 AVC, in August 2008, and defined a transition period of ten years. The digital terrestrial television system adopted in Colombia operates in a free-to-air mode. Moreover, the CNTV was in charge of developing policy frameworks for telecommunications and content distribution due to the globalization and convergence of digital markets for content, information, application and services. The CNTV played a key role in setting minimum quality of service requirements, along with identifying and proposing solutions to any potential market failure in a timely manner (DigiTAG 2009). When Dr. Mauricio Zamudio, representative of the CNTV, visited the Universidad del Valle, on 6 April 2011, he provided detailed information on network and broadcasting service, network provider, channels, and number of stations and percentage of coverage. The official page, *Portal de Televisión Digital Terrestre en Colombia* (TDT) has available interactive information about Colombian states and coverage. In Zamudio´s presentation on 6 April 2011, the CNTV defined a strategy plan for deploying DVB-T in Colombia based on the following points: a) Communication to users, industry and manufacturers; b) Spectrum Planning; c) New Single Frequency Plan; d) DTTV coverage for national public television; e) Extending coverage of the television signal; f) Minimum technical requirements for TV and decoders; g) Regulation and normativity for open TV operators, and h) European Union Cooperation. Some of the actions taken for addressing the previous points are commented as follows.

4.1. DTTV coverage for national public television

In Zamudio´s presentation on 6 April 2011, the CNTV assigned to the RTVC the sum of $52.320,8 million Colombian pesos – in 2011 – for increasing power of the 13 principal stations covering Bogota, Barranquilla, Cali and Medellin: Manjui, Calatrava, south of Bogota, Cerro Kennedy Nogales, Padre Amaya, Bello, Itagui, Azalea, Cristo Rey, Terron Colorado, La Popa and Lebrija, in order to extend coverage of the national public TV. The 13 principal stations – covering Bogota, Barranquilla, Cali and Medellin – are listed in Table 1.

4.2. Extending coverage of the television signal

In Zamudio´s presentation on 6 April 2011, the CCNP implemented the expansion plan of coverage with digital transmitters in DVB-T H.264 MPEG-4 part 10, in Table 2. The percentage of population coverage was taken with respect to the coverage of towns with populations larger than 20.000 inhabitants.

Topography features in Colombia, such as the three Andean ranges and the lowlands between them, motivate the use of satellite for extending coverage of the television signal delivering. The RTVC acquired a satellite compression system, which allows carrying analogue channels and digital channels, in the process of implementation of DTT.

4.3. Minimum technical requirements for TV and decoders

The CNTV has established the minimum requirement for TV and Set-Top Box in order to guarantee the compatibility. Selected requirements and minimum specifications are included in Table 4. Manufacturers can incorporate specifications and applications in addition to the established minimum. Additionally, the Application

Table 1. *Detailed information of principal stations covering Bogota, Barranquilla, Cali and Medellin (In Mauricio Zamudio´s presentation, on 6 April 2011).*

Zone	Station Name	No. of Towns	Population (2009)	% Population
Center	Manjuí Calatrava Sur de Bogota	115	10.342.213	22,73
North	Centro Kennedy Nogales	73	3.3960.759	8,70
	La Popa	6	1.130.638	2,48
South West	La Azalea Terron Colorado Cristo Rey	39	3.908.650	8,59
North East	Lebrija	8	1.171.704	2,57
North West	Padre Amaya Bello Itagui	41	3.967.734	8,72
Total		282	24.481.698	53,78

Programming Interface (API) is the Multimedia Home Platform (MHP). It makes extensive use of JAVA™. A MHP test suite of software is available from ETSI to assist receiver manufacturers.

4.4. Transmission Parameters

The CNTV has delegated the transmission parameter setting to the RTVC and the CCNP. They have to decide on the test procedures and all aspects of transmission and distribution of the signals including primary distribution networks, transmitters, sharing with existing analogue services and re-broadcast transmitters. On the other hand, manufactures have the minimum requirements for developing software models for front-end receivers and demodulator components. Since January 2010, transmission tests have been carried out in main cities. Digital signal transmissions made in Bogota and Medellin, by the CCNP, are official and are serving the general public. The parameters that are currently being used are those that the operators consider appropriate and desirable for the business model seeking to develop. However, they are free to modify. As a result they can get from initial tests in case there are more favourable alternatives. Henry Giorgi, Assessor at the Subdirection Technical and Operations of the CNTV (Giorgi 2011, personal communication, 3 March), informed about the current transmission parameters, used by the CCNP: Modulation 16 QAM, FEC 3/4 (internal encoder), guard interval 1/8.

In November 2009, the Colombian Minister of Information Technologies and Communications issued a Resolution making available the 470 - 512 MHz spectrum (channels 14-20) for TV broadcasting, to facilitate the introduction of digital TV.

4.4. Adoption of DVB-T2

Following CNTV recommendation to migrate from the DVB-T standard for digital terrestrial television delivery to the more advanced DVB-T2 standard, the Colombian government has officially adopted DVB-T2 on December 20th 2011. Colombia is set to be the first country in Latin America to go on air with a DVB-T2 TV network.

Initially, DTT was planned to broadcast only in Bogotá, Medellín and metropolitan areas. During the year 2011, digital television reached up to 25% of the Colombian population which must be covered nationwide by 2019. Upon introducing DVB-T in 2010, the CCNP – consisting of the private operators Caracol TV and RCN TV – will gradually be updated to DVB-T2 in the coming months to deliver a digital signal to 25% of the population. During the next phase, eight more transmitter stations will be set up in major cities, providing 50% of Colombians with access to the new broadcasting network. This project is

Table 2. *The CCNP's expansion plan of coverage (In Mauricio Zamudio´s presentation, on 6 April 2011).*

	Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
%	Coverage	0,00%	25,00%	12,69%	12,19%	13,72%	10,15%	12,51%	7,12%	5,44%	1,18%
%	Accumulated	0,00%	25,00%	37,69%	49,88%	63,60%	73,75%	86,26%	93,38%	98,82%	100,00%

Table 3. *Some of the requirements for TV and Set- Top Box.*

Requirements	Channel bandwidth	Source coding		RF: VHF	RF: UHF	Video refresh
TV and Set-Top-Box	6MHz	H.264/MPEG-4 Video	MPEG-1/2 Audio	57-72 MHz; 76-88MHz; 174-216 MHz	470-806 MHz	60Hz

scheduled for completion by the end of 2012. Broadcasting is set to begin on January 1, 2013. (Scene eNews 2012).

5. Conclusions

The DVB Project has used and continues to expand extensively on standards from the ISO/IEC JTC MPEG. The DVB-T may be one of the more complex because it was intended to cope with different noise and bandwidth environment, and multi-path. The system has several dimensions of receiver 'agility', where the receiver is required to adapt its decoding according to signalling. The key element is the use of OFDM.

A more flexible and robust digital terrestrial system, DVB-T2 has also recently been developed. DVB-T2 has advantages over DVB-T such as: 30 - 60% more bandwidth enables more HDTV, SDTV and IP services; independent and flexible operation with multiple service providers; mobile (time/frequency sliced) and fixed services in same bandwidth; simple structure with constant coding and modulation for all programs; along with saving spectrum transmitting the same services.

The implementation of the DVB-T2 standard will provide broadcasters not only with the opportunity to deliver existing services using less frequency capacity but also to deliver more services using their existing frequency capacity.

The Multimedia Home Platform (MHP), covers the whole set of technologies that are necessary to implement digital interactive multimedia in the home – including protocols, common API languages, interfaces and recommendations. It makes extensive use of JAVA™. Great attention has been paid to mechanisms for checking whether implementations of MHP in receivers are able to fully and correctly decode MHP broadcasts, and a MHP test suite of software is available from ETSI to assist receiver manufacturers.

Manufacturers have to ensure that their DVB-T2 devices comply with the receiver specifications determined by national administrations and industry groups. However, to be able to benefit from economies of scale, manufacturers will encourage countries to adopt common receiver specifications. This will help to reduce the need to produce different DVB-T2 receivers for each market which can result in an increase in the cost of the receiver.

Viewers may resent the need to purchase new television receiving equipment. Depending on the services launched on the DVB-T2 platform, they may not clearly understand the new service offering nor what equipment is necessary to receive the new service. In the case of a launch of HDTV services, viewers will need a DVB-T2 receiver as well as an HD display which could create some confusion. In addition, the resentment may be exacerbated should viewers have only recently upgraded their television equipment as part of digital switchover. If a new frequency channel is used to launch DVB-T2, it may be necessary for viewers to change or upgrade their aerials. This can be an additional, and unexpected, cost.

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