

Terrestrial Digital Transmission of the High-Definition Television in Europe

Branimir Jaksic¹, Mile Petrovic¹, Marko Smilic², Branko Gvozdic¹, Aleksandar Markovic²

¹ Faculty of Technical Sciences, University of Pristina

² Faculty of Natural Sciences and Mathematics, University of Pristina

E-mail: branimir.jaksic@pr.ac.rs

Abstract - In this paper the premise of condition of digital terrestrial TV transmission in Europe in 01.07.2014 is given. Special significance is given to HDTV in terrestrial transmission DVB and compression standards which are used in European countries are shown, and also the number of national multiplexes. We also present and discuss data about the number of free and coded SDTV and HDTV channels available in multiplexes of terrestrial digital transmission in European countries.

1 Introduction

In period during 15 May - 16 June 2006 in Geneva, International Telecommunication Union organized Regional conference on radio-communication in order to establish the new international agreement for digital transmission of radio and television program. Final Acts were adopted on conference RRC-06, with new agreement Geneva 2006 – (GE06) which enables introduction of completely digital diffuse radio transmission in planned zones. All European countries obligated themselves to switch to digital transmission of radio and television signal no later than 17th of June 2015, and to perform analog switch off (ASO). In many countries this has already been implemented [1].

European countries adopted DVB-T standard (Digital Video Broadcasting - Terrestrial), and also DVB-T2. First concepts of DVB-T were adopted in 1993, and first final version in 1997. It implies transmission of digitalized audio and video content across the earth using transmission technology in VHF i UHF extent with help of conventional systems of transmitters and receivers [2-3].

DVB-T2 is most advanced version of DVB standard for terrestrial transmission. In comparison to DVB-T, DVB-T2 offers significantly smaller sensitivity on disturbance and noise and provides 30-50% increased flow of data which particularly suits HDTV (High-definition television). DVB-T2 uses COFDM modulation, DVB-T, and considering number of carriers (1K, 2K, 4K, 8K, 16K, 32K) modulations that are used are (QPSK, 16-QAM, 64-QAM, 256-QAM) [2, 4-5].

Considering that busyness of frequency spectrum depends on bit flow, it is necessary to reduce it, so the compression of signal is performed using several methods. Standard that is widely used for digital television is MPEG-2, followed by MPEG-4,

H.264/AVC. It had several improvements considering new means of coding and reducing bit flow without image degradation. Compression of signal is followed by multiplexion which consists of forming of package of appropriate longitude and they form transporting sequence.

With development of digital telecommunication it is enabled that besides standard digital television (SDTV - Standard Definition Television) we can use television of high resolution - HDTV. HDTV is technology that offers quality of image and sound which is significantly better compared to traditional technologies used to display image and sound. In Table 1 were given basic features of primary digital TV standards.

Table 1. Primary DTV standards.

DTV	resolution	aspect ratio	number of frames per second
HDTV	1920 x 1080	16:9	25p, 50i
	1280 x 720	16:9	25p, 50i
SDTV	720 x 576	16:9	25p, 50i
	720 x 576	4:3	25p, 50i

HDTV offers two qualities of signal: 720 i 1080 are basic standards, and we add to them letter “i” or letter “p” which marks how image is drawn (i = interlaced – every second line is drawn; p = progressive – every line is drawn). 720 and 1080 represent “height” of image, and width is 1280 and 1920 pixels respectively). Number of images in second is quoted beside the mark, for example, 720p50 which marks resolution 1280×720, progressive way of image drawing with 50 images in second [6].

Television of Ultra high definition (UHDTV – Ultra High Definition Television) includes 4K UHDTV (2160p) and 8K UHDTV (4320p), which are two digital video formats that were suggested by NHK Science & Technology Research Laboratories and approved by International Telecommunication (ITU). Minimal resolution of this format is 3.840x2.160 pixels [7].

2 Use of DVB-T standard in Europe

Many countries in Europe have fully transferred to digital terrestrial TV broadcasting, and the further analog switch off (ASO).

Table 2. Main characteristics of digital terrestrial TV transmission in European countries.

Country	Population [million]	MUX	DVB Standard / Video Compression	Start	ASO
Andora	0.07	6	DVB-T / MPEG-2	2005.	2007.
Austria	8.5	6	DVB-T / MPEG-2 DVB-T2 / MPEG4 for pay TV and HD	2004.	2010.
Belgium	11.2	2	DVB-T / MPEG-2	2002.	2011.
Bulgaria	7.2	3	DVB-T / MPEG-4	2004.	2013.
Croatia	4.3	5	DVB-T / MPEG-2 DVB-T2 / MPEG-4 for pay TV	2002.	2010.
Cyprus	1.1	4	DVB-T / MPEG-4	2010.	2011.
Czech Republic	10.5	3	DVB-T / MPEG-2 DVB-T2 / MPEG-4 for experimental HD	2000.	2012.
Denmark	5.6	6	DVB-T / MPEG-4 DVB-T2 / MPEG-4 for pay TV	2003.	2009.
Estonia	1.3	4	DVB-T / MPEG-4 DVB-T2 / MPEG-4 for HD	2004.	2010.
Finland	5.4	9	DVB-T / MPEG-2 DVB-T2 / MPEG-4	1999.	2007.
France	65.9	8	DVB-T / MPEG-2 / MPEG-4 for pay TV and HD DVB-T2 / MPEG-4 tests	2005.	2011.
Germany	80.8	5	DVB-T / MPEG-2	2002.	2008.
Hungary	9.8	3	DVB-T / MPEG-4	2004.	2013.
Ireland	4.6	2	DVB-T / MPEG-4	2006.	2012.
Italy	60.7	22	DVB-T / MPEG2 / MPEG for pay TV DVB-T2 tests	1998.	2012.
Latvia	2.0	7	DVB-T / MPEG-4	2002.	2010.
Lithuania	2.9	5	DVB-T / MPEG-4	2003.	2012.
Luxemburg	0.5	4	DVB-T / MPEG2	2002.	2010.
Macedonia	2.0	7	DVB-T / H.264/MPEG-4 AVC	2004.	2013.
Netherlands	16.8	5	DVB-T / MPEG-2	1998.	2006.
Norway	5.1	5	DVB-T / MPEG-4	1999.	2009.
Poland	38.5	3	DVB-T / MPEG-4	2001.	2013.
Portugal	10.4	1	DVB-T / MPEG-4	2009.	2012.
Slovakia	5.4	4	DVB-T / MPEG-2 / MPEG-4 for HD DVB-T2 / MPEG-4 tests	2009.	2012.
Slovenia	2.0	2	DVB-T / MPEG-4	2001.	2010.
Spain	46.5	8	DVB-T / MPEG-2 / MPEG-4 for HD	1999.	2010.
Sweden	9.1	7	DVB-T / MPEG-2 / MPEG-4 for SD DVB-T2 / MPEG-4 for SD and HD	1999.	2007.
Switzerland	8.1	4	DVB-T / MPEG-2	2000.	2008.
United Kingdom	64.1	6	DVB-T / MPEG-2 DVB-T2 / MPEG-4 for HD	1998.	2012.
Albania	2.9	10	DVB-T / MPEG-2 / MPEG-4 for HD DVB-T2 / MPEG-4 for HD	2004.	
Belarus	9.4	3	DVB-T / MPEG-4 DVB-T2 / MPEG-4 for pay TV	2004.	
Greece	11.1	8	DVB-T / MPEG-2 / MPEG-4	2006.	
Iceland	0.33	3	DVB-T / MPEG-2 DVB-T2 / MPEG-4	2005.	
Moldova	3.5	2	DVB-T / MPEG-4 DVB-T2 / MPEG-4	2003.	
Montenegro	0.62	1	DVB-T2 / MPEG-4	2014.	
Romania	19.9	3	DVB-T / MPEG-4 DVB-T2 / MPEG-4 adopted	2005.	
Russia	146.1	2	DVB-T2 / MPEG-4	2005.	
Serbia	7.1	1	DVB-T2 / MPEG-4	2005.	
Turkey	76.7	1	DVB-T2 / MPEG-4	2006.	
Ukraine	42.8	4	DVB-T2 / MPEG-4	2007.	

The remaining countries are in the process of digitalization, which according to plans will be completed by June 2015. Currently, only in Bosnia and Herzegovina the process of digitalization fieldwork has not yet begun.

The main characteristics regarding the use of DVB-T standards in the countries in Europe are given in Table 2. Number of national multiplex (MUX) is given, local and regional non-represented. Video compression standards used in different countries are shown, as well as when digital terrestrial TV transmission started and year ASO was executed. First, the beginning of DVB-T broadcasting refers to an experimental broadcasting, while the regular and commercial broadcast started later. Data were collected from the official websites of national regulatory agencies and providers of digital terrestrial transmission [8-41].

From Table 2 it can be seen that the countries that have moved completely to digital broadcasting generally use DVB-T standard, or used in parallel and DVB-T2, while countries that used the phase transition to digital transmission decided for the DVB-T2 standard. A small number of countries using the DVB-T standard include MPEG-2 compression, generally for free-to-air (FTA). Compression standard MPEG-4, due to savings in capacity, i.e. able to broadcast more TV programs in a single multiplex, generally used for scrambled channels, i.e. pay TV and HDTV. An increasing number of countries using the DVB-T standard plan to move to improved DVB-T2 standard in the near future.

3 Number of FTA and PAY HDTV channels

Table 3 provides an overview of the number of FTA and PAY SDTV and HDTV channels available in digital terrestrial TV multiplexes. The channel number is related to the national channels, i.e. channels covering the entire territory of the country. Regional and local channels are not taken into consideration. Data represent state at 1st of July 2014, and were collected from the official websites of national regulatory agencies and providers of digital terrestrial transmission in a particular country [8-41].

Figure 1 is a graph showing the total number of HDTV channels (FTA + PAY) in European countries that are available in digital terrestrial TV multiplexes.

Number of SDTV and HDTV channels is directly related to the number of available and applied multiplex DVB-T and compression standards shown in Table 2. Thus, by far the largest number of national channels of SDTV (154) is available in Italy, followed by Albania, United Kingdom, Sweden, Finland and Latvia. According to the given data, a highly developed terrestrial Pay TV is Albania, Latvia, Finland, Sweden, Macedonia, Croatia, Norway, Belarus, Denmark, Italy, Netherlands, Hungary, Estonia, Hungary and Lithuania.

The largest number of HDTV channels available in Finland, followed by France, Albania, Denmark, Italy, United Kingdom, Austria, Sweden and Norway. In Spain among 6 national HDTV channels are available and 9 regional HDTV channels are available in certain areas of the country. Most FTA HDTV channels are available in France and the United Kingdom, followed by Italy, Spain and the Czech Republic. Some countries (Andorra, Belgium, Germany, Netherlands, Switzerland) in which the fully executed ASO have HDTV channels in terrestrial multiplexes.

Table 3. Number of FTA and PAY SDTV and HDTV channels in European countries.

Country	SDTV		HDTV	
	FTA	PAY	FTA	PAY
Andora	28	-	-	-
Austria	8	20	3	6
Belgium	7	-	-	-
Bulgaria	8	-	2	-
Croatia	11	41	1	2
Cyprus	19	1	1	-
Czech Republic	17	-	6	-
Denmark	6	33	2	8
Estonia	7	26	1	-
Finland	17	34	6	6
France	19	7	10	1
Germany	28	-	-	-
Hungary	7	27	3	-
Ireland	5	-	2	-
Italy	121	33	6	4
Latvia	5	55	-	3
Lithuania	14	31	-	3
Luxemburg	12	-	1	-
Macedonia	8	41	1	-
Netherlands	4	25	-	-
Norway	-	34	3	4
Poland	22	-	2	-
Portugal	6	-	1	-
Slovakia	11	12	1	-
Slovenia	9	-	2	-
Spain	20	1	6+9	-
Sweden	7	44	2	6
Switzerland	7	-	-	-
United Kingdom	48	3	9	-
Albania	3	72	-	11
Belarus	8	34	-	-
Greece	14	2	1	-
Iceland	8	11	1	-
Moldova	5	-	-	-
Montenegro	2	-	-	-
Romania	9	-	1	2
Russia	20	-	-	-
Serbia	8	-	1	-
Turkey	3	-	1	-
Ukraine	31	-	-	-

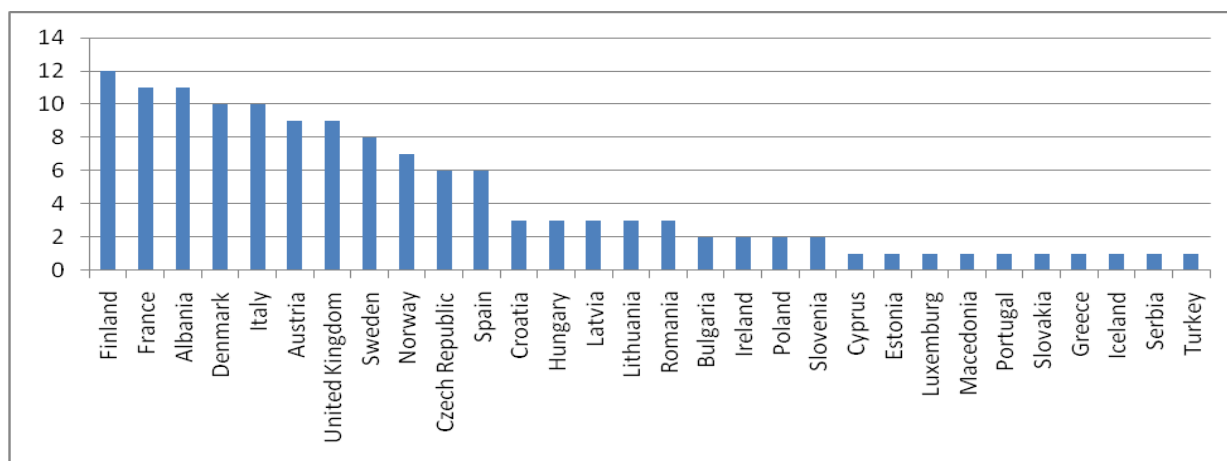


Figure 1. Total number of HDTV channels in digital terrestrial TV multiplexes.

4 Conclusion

The total exclusion of analogue terrestrial TV is less than a year away. Most European countries have switched to digital transmission, while the remaining countries that have not done so, plan to completely cross over in the following years. Countries that have completely switched over to digital terrestrial transmission using DVB-T standard with MPEG-2 and MPEG-4 compression standard, however, in the near future they plan to replace it with an advanced DVB-T2 standard. The use of DVB-T2 standard will enable the transmission of a large number of TV channels in one multiplex, first of all allow increasing the number of HDTV channels. Countries that are in the process of switching to digital transmission decided exclusively for the DVB-T2 standard.

The largest number of HDTV channel is available in Europe in Finland (12), followed by France and Albania with 11, Denmark and Italy with 10 HDTV channels. Terrestrial HDTV transmission is partially limited by the availability of the spectrum. The introduction of DVB-T2 standard European terrestrial HDTV market will be intensively developed. The following steps are the introduction of Ultra HDTV channels, which have emerged during the first tests in 2014 in the United Kingdom and the Czech Republic [42].

Literature

- [1] DVB Project: <http://www.dvb.org>
- [2] W. Fischer, *Digital Video and Audio Broadcasting Technology*, Springer-Verlag, Berlin Heidelberg, 2008.
- [3] DVB, *History of the DVB Project - DVB Standards and Specifications*, Ver. 11.0, August, 2008.
- [4] DVB, *Framing structure, channel coding and modulation for terrestrial television*, European Standard (EN) 300 744 V1.5.1, European Telecommunications Standards Institute (ETSI), Nov., 2004.
- [5] DVB, *Implementation guidelines for a second generation digital terrestrial television broadcasting system (DVB-T2)*, DVB Document 133, Feb. 2009.
- [6] S. Pechard, M. Carnec, P. Le Callet, D. Barba, "From SD to HD television: effects of H.264 distortions versus display size on quality of experience," *IEEE International Conference on Image Processing*, Atlanta, USA, 2006, pp. 409-412.
- [7] S. Marcotte, "The road to UHDTV," *Miranda Technologies*, 2012, Qubeck, Canada.
- [8] Servei de Telecomunicacions d'Andorra (STA): <http://www.andorratelecom.ad/>
- [9] DVB-T Austria: <http://www.dvb-t.at/>
- [10] Conseil Supérieur de l'Audiovisuel (CSA): <http://www.csa.be/>
- [11] Commission for Communications Regulation (CRC): <http://www.crc.bg/>
- [12] Odsiljaci i veze (OiV): <http://www.oiv.hr/>
- [13] Cesky Telekomunikacni (CTU): <http://www.ctu.cz>
- [14] Boxer TV Denmark: www.boxertv.dk/
- [15] Levira: www.levira.ee
- [16] DigiTV: www.digita.fi/
- [17] TéléDiffusion de France: <http://www.tdf.fr/>
- [18] DasÜberallFernsehen: <http://www.ueberallfernsehen.de/>
- [19] Greek National Council for Radio and Television (NCRTV): <https://diavgeia.gov.gr>
- [20] Antenna Hungária: <http://ahrt.hu/>
- [21] Digital Iceland: <http://www.vodafone.is/sjonvarp/>
- [22] Commission for Communications Regulation (COMREG): <http://www.comreg.ie/>
- [23] Autorita per le Garanzie nelle Comunicazioni (AGCOM): <http://www.agcom.it/>
- [24] Lat Telecom: <http://www.lattelecom.lv/>
- [25] Lietuvos Respublikos Ryšių reguliavimo tarnyba: <http://www.rtt.lt/titulinis.html>
- [26] Institut Luxembourgeois de Régulation (ILR): www.ilr.public.lu/
- [27] Boom TV: www.boomtv.mk
- [28] Predajnici i veze: www.rdc.co.me
- [29] KPN: <http://www.kpn.com/>
- [30] Risks TV: <https://www.rikstv.no/>
- [31] TP Emitel: <http://www.emitel.pl/>
- [32] TDT - Televisão Digital Terrestre: <http://tdt.telecom.pt/>
- [33] DVB-T Romania: www.dvbt.ro
- [34] Emisiona tehnika i veze: <http://www.etv.rs/>
- [35] DVB-T Slovakia: www.dvbt.towercom.sk
- [36] DVB-T Slovenia (APEK): <http://dvb-t.akos-rs.si/>
- [37] Television Digital Terrestre (TDT): www.televisiondigital.es
- [38] Boxer TV Sweden: <http://www.boxer.se/>
- [39] SRG SSR idée suisse: <http://www.srgssr.ch/en/>
- [40] Digital UK: <http://www.digitaluk.co.uk/>
- [41] Freeview: <http://www.freeview.co.uk/>
- [42] Broadband TV News: www.broadbandtvnews.com