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Digital Terrestrial TV: Allocation of Resources and Licensing – A Cross Country Study of Selected EU Countries

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Abstract

The paper provides an overview of the digital terrestrial TV in 11 selected EU countries with different number of TV channels available in the terrestrial networks. The idea is to discuss the reasons for these differences and the parameters that affect the number of TV channels/services in different countries. The paper discusses to what extent economic, social and political interests, framing the analogue era, continue to influence the organizational and institutional set-up when switching to digital TV. From a purely technological point of view, one would expect that the number of TV channels made available in the different countries with given spectrum resources would vary only a little taking cross-border frequency interference into consideration. In fact, there are large differences between the various countries, which can be explained by the differences in economic, social and political interests and a certain degree of path-dependence in the organizational and institutional set-up in the different countries.

Keywords: Digital TV, Convergence, Multiplex operator, Spectrum resources, Digital dividend, Regulatory framework, MUX, HDTV.

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1 Introduction

The expectations regarding the switch-over from analogue to digital terrestrial TV were high in the first decade of the millennium. The European Commission recommended that the switch-over should be completed in EU countries by 1 January 2012, and though most EU countries followed this recommendation, there have been a few late-comers. The general expectations were 1) higher efficiency of digital infrastructures in utilizing the scarce spectrum resources, enabling a radical increase in quality of TV signals and/or a radical increase in the number of TV services on the market, 2) the possibility for interactivity and user participation, 3) convergence and synergy between the development of TV broadcast and Internet based services, and 4) the possibility for mobile reception.

The realities have turned out to be an increase in the number of TV services (channels) and an improved audio-visual quality. The other expectations have not been fulfilled and have been by-passed by Internet developments (Tadayoni and Henten, 2013). The potentials for interactivity have not been developed – digital TV has stayed as a one-way mode of communications; the convergence of broadcast and Internet has happened on the Internet with OTT services or via managed IP services as IPTV; and, mobile broadcast reception has also developed as an Internet based service.

Digital terrestrial TV is, however, still an important area of mass-communication and will remain so for the coming decade – though to a decreasing extent – and the aim of the paper is to analyse the experiences of various EU countries with digital terrestrial TV. The paper provides an overview of a detailed cross-country case study of 11 selected EU countries with different number of TV channels available in the terrestrial networks. The idea is to discuss the reasons for these differences and the parameters that affect the number of TV channels/services in different countries. The focus is here on the licensing procedure, content, prices and prerequisites to be able to apply for a TV license. Moreover, there is information on the number of TV licenses. The counties included in this study are the following: Austria, Bulgaria, Cyprus, Czech Republic, France, Germany, Italy, Poland, Portugal, Romania and Spain.

The paper illustrates that economic, social and political interests, framing the analogue era, continue to influence the organizational and institutional set-up when switching to digital TV. From a purely technological point of view, one would expect that the number of TV channels made available in the

different countries with given spectrum resources would vary only a little taking cross-border frequency interference into consideration. In fact, there are large differences between the various countries, which can be explained by the differences in economic, social and political interests and a certain degree of path-dependence in the organizational and institutional set-up in the different countries.

The data in the paper comes from different sources: national regulatory bodies; academic literature and newsletters from industry associations. Also, direct contacts to the representatives of regulatory bodies in selected countries have provided us with valuable information.

Section 2 includes a brief discussion of the important issues related to the technology, market and regulation. Section 3 provides in tables/a figure an overview of the case studies of the selected countries, based on the parameters identified in Section 2. Section 4 presents the conclusion of the paper. Section 5 is references.

2 Technology, Market and Regulation

2.1 General Issues

At the beginning of the millennium, the different countries, regions and countries should decide if they would make the transition from analogue to digital TV as recommended by the EU and if so, what would the main benefits be; which standards should they follow; and what were the major challenges in this transformation. The challenges identified were complex and were related to various aspects, including the technological, market/business models and regulatory issues (Tadayoni and Skouby, 1999).

A major advantage of digital TV versus analogue TV was the more efficient utilisation of the spectrum resources in digital TV compared to analogue TV. The same spectrum band being occupied by one analogue TV channel could be shared by several digital TV channels. The number depended on the desired technical quality of the signal, e.g., Standard Definition TV (SDTV) or High Definition TV (HDTV), etc. (Jaksic et al., 2014). This spectral efficiency was the major parameter forcing the transition from analogue to digital. Apart from this, some of the other driving forces were seen to be the possible convergence with Internet services and the possibility for interactivity enabling end-user participation in specific programs, time-shift, place-shift and possibility for personalisation.

For the satellite TV, the decision on transition from analogue to digital TV was straight forward as spectrum is a costly resource in satellite networks and the change to digital would obviously reduce transmission cost. Consequently, satellite TV was one of the first TV platforms to go digital even when there were costs at the end user side related to the replacement of the analogue set top boxes to digital.

The digital transition in cable TV was also based mainly on the transmission costs. However, there was enough spectrum in modern cable TV network to introduce digital TV gradually without stopping the analogue transmission. The cable TV operators therefore for some years (in Denmark until 2016), provided simulcast analogue and digital TV. The pressure on stopping analogue transmission came mainly from the general technical development towards high quality digital TV content including HDTV and also from the development of broadband, as cable TV networks became an important infrastructure for broadband development, and to accommodate this, more spectrum resources were needed.

With terrestrial TV, the focus of this paper, the change to digital was a complex process including different actors with different interests and agendas influencing the process. On the one side, the mobile industry pushed for getting access to the valuable spectrum resources used for TV, arguing that less spectrum was needed for TV and, therefore, there was room for allocating part of the spectrum to mobile communication. This was actually done by re-allocating parts of the spectrum, known as the digital dividend, for other purposes than TV services. Some actors from the mobile industry went further and argued to out-phase terrestrial TV transmission, as satellite and cable were considered more appropriate for TV transmission, and as broadband networks showed potentials for TV transmission in the future.

Today even players from the broadcast industry are open to the idea that dedicated Digital Terrestrial TV (DTT) platforms will not survive in a 10 to 20 years' perspective. On the other hand, the TV industry and the institutions behind it want to keep the spectrum for further development of digital TV and has argued that digitalisation gave new qualities that were needed for this development (Iosifidis, 2006). The major argument for keeping the allocated TV spectrum for digital TV has been the possibility for creating a terrestrial multi-channel platform to and that terrestrial networks were superior to the other networks as cable and satellite could not deliver mobility and portability. Furthermore, the provision of local TV, and a geographic

regionalisation of TV was easier and more cost efficient to offer in terrestrial networks.

The majority of the literature from the beginning of the millennium focused on the discussions raised above, including the advantages and drawbacks of a transition to digital and the political, economic and technological aspects of this transition (Iosifidis, 2006; Adda et al., 2005). Trinidad et al. (2006) provided an overview of the digital TV switch-over in the US, Europe and Japan. That paper illustrates the different strategies used in the three regions, i.e., the fact that from the outset in the US, digital TV was almost synonymous with HDTV, while in Europe and Japan, a combination of SDTV and HDTV was used – in Europe in the beginning mainly SDTV.

Kevin & Schneeberger (2015) discuss two of the aspects of access to TV platforms, namely the must carry rules and access to free DTT services in Europe. The statistics and the data from the report are extensively used in this paper.

2.2 The Number of TV Services in Terrestrial Networks

Digital Terrestrial TV (DTT) in a country is organised in a number of Multiplexes (MUXes). According to DigitalUK, "A DTT multiplex is a bundle of TV services that have been digitised, compressed and combined into a data-stream for transmission to the consumer over a single channel. The receiver separates each service from this compressed data-stream and turns it into a form which can be viewed"[1]. The frequency bandwidth of a MUX in the UHF band is 8 MHz. Depending on the geographical extent of a MUX, i.e., if it is countrywide, regional or a local MUX, one or more 8 MHz TV channels are used to compose the MUX.

How much spectrum is available for DTT in a country depends on several technical and administrative/political parameters:

1. Spectrum allocations: The allocation of spectrum for different uses is done by the International Telecommunication Union (ITU) at radio frequency conferences. The national governments can influence the allocations at these conferences but when the allocation is decided, they must follow the decision.

[1] http://www.digitaluk.co.uk/operations/multiplexes

2. Harmonisation of spectrum with neighbouring countries: The spectrum must be planned so that the interference with the neighbouring countries is minimised.
3. Analogue-digital switch-over: As far as there is simulcast of analogue and digital TV, part of the spectrum is occupied by analogue TV. The analogue-digital switch-over makes it possible to utilise the whole spectrum allocated for TV for digital TV.
4. Single Frequency Network (SFN) versus Multi Frequency Networks (MFN): In digital TV it is possible to use the same frequency in the neighbouring channels without creating interference. This is called SFN and it enables much more efficient utilisation of spectrum resources.
5. Digital dividend: This is the part of the spectrum re-allocated for other uses which obviously influences the amount of spectrum that can be used for digital TV and, consequently, the number of multiplexes in a country.

In an analysis by DiGiTAG and Analysis Mason (2014) on roadmaps for the evolution of TV, the technology parameters are listed as: Channel formats, transmission, encoding, On Demand (e.g. HBBTV), portability and mobility and devices. The number of multiplexes discussed above is related to the 'transmission' while 'channel format' and 'encoding' relates to the quality of the signal and the level of compression, i.e., whether SDTV, HDTV, UHDTV, etc. are delivered and the compression technologies deployed, MPEG-2, MPEG-4, etc. Statistical multiplexing is also an important parameter for how many services can be offered in one MUX.

2.3 Framework for the Analysis of the Digital Transition in the Case Study Countries

The digital transition has been heavily influenced by political processes. There are a number reasons for this – the major one being that terrestrial radio and television has always been regulated by the national governments based on political cultural concerns. Therefore, the provision of terrestrial broadcast has been made by state owned companies or public service and commercial companies tightly regulated by the national governments.

In Europe and in particular the European Union, harmonised regulation of media has been important for its development. The major directives, first TV without frontiers and later the AVMS directive, put specific requirement on broadcast content. And, when it comes to DTT, the harmonised switch-over dates at the EU level and recommendations on the use of digital dividend spectrum have been important for the development.

In different European countries, various institutions are involved in the regulation of broadcast. In some countries, the content issues are dealt with in the ministry of culture whereas the spectrum locations have been dealt with by departments under the ministry of communications. The convergence process has influenced the institutional set-up and converged regulatory authorities like OFCOM in the UK have been constructed.

TV resources are, as mentioned, organised in DTT multiplexes (MUXes) and a need for a multiplex operator has emerged. Multiplex operators are situated between the service/content providers and the end users and are in charge of delivering the content to the end users and clearing the payment for the commercial services. The multiplex operators are the gate keepers for terrestrial TV and their organisation and regulation has been important for the national governments.

In the following cases studies, we identify the DTT landscape in 11 EU countries. This includes the number of TV services; the legal basis for media regulation in different countries and the institutions involved in this regulation; the requirements and prerequisites for obtaining licenses for the provision of DTT services; specific regulations of the multiplex operators and the TV service providers; the organisational models for multiplex operators in different countries and the relationships between the multiplex operators and the service/content providers.

3 Country Cases

The tables and the figure below summarizes the analysis of the DTT landscape in the 11 countries. It shows that they are at different levels of development when it comes to the legal basis, licensing conditions, number of multiplexes, number of TV services available in the terrestrial networks, etc. The data for Table 2 and Figure 1 are mainly from the MAVISE database[2].

[2]http://mavise.obs.coe.int/

Table 1 Number of MUX, regulatory, organisational and revenue model issues

Country	No of MUX/ Free DTT Services	Legal Basis for Regulation of DTT	Licensing Conditions	MUX Operator and TV Services	Revenue Models for DTT
Austria	6	KommAustria Act. Federal Act on Audiovisual Media Services (Audiovisual Media Services Act – AMD-G). Federal Act on the Austrian Broadcasting Corporation (ORF Act).	Any person who provides terrestrial and mobile terrestrial television or satellite television and is established in Austria requires a license. A media service provider is deemed to be established in Austria if its head office is in Austria and the editorial decisions on the audio-visual media service are made in Austria. Applications for being granted a license for providing terrestrial television services (including mobile terrestrial television) or satellite television services must be filed with the regulatory authority. No fees for license, but a yearly percentage of turn-over must be paid.	Austria's national free DTT service is operated by the transmitter company ORS, which is owned by public broadcaster ORF (60%) and the Medicur Sendeanlagen GmbH (40%). Since April 2013, ORS also operates a pay DTT service: Simpli TV When applying for the license, the broadcaster must have a prior agreement with the MUX operator.	FTA

Table 1 Continued

Bulgaria	3	Radio and television Law of Bulgaria.	Commercial & public radio and television operators shall hold licenses for radio and television activities. Chapter 6 in Radio and Television Law of Bulgaria states the provisions for 'Licensing of radio and TV operators'. Three titles are listed: General provisions, Procedure for granting of licenses, Supervision, amendment and termination.	There are currently two companies running multiplexes: 1) Digital EAD carries the public broadcaster (4 channels) and 2) NURTS Digital EAD carries ten private channels	FTA
Cyprus	3	The Cyprus Radiotelevision Authority (CRTA) grants licenses media service providers. The Policy and Regulation Framework for Licensing Networks of Digital Terrestrial Television from 2009. The Radio and Television Broadcasting Station Law	The public broadcaster will carry audio-visual services only, must avoid competition with private operators and will not be allowed to develop other electronic communications services except very specific public utility ones. There is not legal limit on the number of channels on the multiplex for private channels,	The private network will have the obligation to carry the signal of all licensed TV (and radio) channels, on special contracts and terms set in a framework decided by the CECPR (Commissioner of Electronic Communication and Post office Regulation). Only the operator of the commercial network will be allowed and obliged	FTA

(*Continued*)

Table 1 Continued

Country	No of MUX/ Free DTT Services	Legal Basis for Regulation of DTT	Licensing Conditions	MUX Operator and TV Services	Revenue Models for DTT
			but according to information from Velister (MUX operator), they can host up to 40 TV broadcast channels. The prices for the temporary one-year licenses are the following: • EUR 51.400 – for each TV channel • EUR 8.534 – to examine a license for the establishment, installation and operation of a Cyprus radio stations.	to offer services of both electronic communications and information society.	
Czech Republic	4	Act no. 231 from 2001 (amended last time in 2010) on 'Radio and television broadcasting and on amendments to other acts'	In the manual on procedures for licensing the prerequisites for participation in the proceedings for granting a license for operation of broadcasting, the following prerequisites are stated:	There are four DTT multiplexes in operation. Three multiplexes are operated by Ceske Radiokomunikace (who took over the Czech Digital Group CDG in 2011). The fourth multiplex is operated	FTA

Table 1 Continued

			1. Prerequisite that a legal person is granted a license or registration is that he meets the conditions stipulated for business in the Czech Republic by special legal enactment. If a legal person has a legal form of a joint-stock company, presumption for granting a license is that his shares are inscribed shares. 2. Prerequisite that a natural person is granted a license or registration is that he has full competence to perform legal acts, and meets the conditions stipulated for business in the Czech Republic by special legal enactment. 3. If a person mentioned in paragraph 2 is a foreign person, who has not an organizational component or permanent residence in the Czech Republic, it is obliged to appoint its representative in the Czech Republic, authorized	by Digital Broadcasting s.r.o. (carrying private entertainment channels and some local channels). Some smaller regional multiplexes are also in operation. The channels with nation-wide licenses can freely choose between the 4 multiplexes for transmission.	

(*Continued*)

Table 1 Continued

Country	No of MUX/ Free DTT Services	Legal Basis for Regulation of DTT	Licensing Conditions	MUX Operator and TV Services	Revenue Models for DTT
			to act for him in the affairs governed by this Act. There is a one-off fee (no annual fee) for obtaining a license in the Czech Republic. The present fee is 90.000 Czech Kurona. No limit on the number of licenses for terrestrial TV broadcasting in general.		
France	8	CSA (Conseil Supérieur de l'Audiovisuel) is in charge of awarding licenses to private, national and local, television channels	Licenses are awarded to private, national and local, television channels, following a process made up of successive stages: a. A call for tenders (appel à candidatures) is published by the CSA, specifying the relevant geographic zone, and the frequencies that may be allocated.	There are a total of eight multiplexes run by different companies. These carry the ten public channels (France 2, France 3, France 4, France 5, France Ô, France 2 HD, Arte, Arte HD, Public Sénat, LCP), and 19 private channels (TF1, M6, TF1 HD, M6 HD, I-Télé, BFM TV, D 8, Gulli, D 17, W9, NT1, NRJ 12, TMC, HD1,	FTA & Pay TV

Table 1 Continued

			b. Upon expiration of the term, the CSA draws up a list of qualified tenderers (candidates), hears them in public, and subsequently makes the selection. c. Upon signature of a legal agreement (convention), the CSA issues a license for up to ten years. In the digital licensing process, as in the preceding analogue era, the CSA must take into account 'the interest of each project for the public', with regard to safeguarding pluralism, the diversification of operators, and preservation of free competition. In DTT licensing, the CSA is also to consider 'the need to provide services likely to meet a wide audience and to encourage a rapid development of DTT'. Priority rights to use DTT frequencies have also been granted to channels with	Chérie 25, L'Equipe 21, 6ter, RMC Découverte, Numéro 23) (and since 2013 the former pay channel LCI). In addition, there are 48 local services and 8 Pay DTT channels	

(*Continued*)

Table 1 Continued

Country	No of MUX/ Free DTT Services	Legal Basis for Regulation of DTT	Licensing Conditions	MUX Operator and TV Services	Revenue Models for DTT
			public service missions (France Télévisions, Audiovisuel extérieur de la France, ARTE, and the Parliamentary Channel) to allow them to have the resources needed to accomplish these tasks in the general interest. Licenses to broadcast over free DTT have been based on the 'beauty contest'		
Germany	4	Broadcasting is organized in a two-tiered system: for the national (Bundes) transmission and for regional (Länder) transmission (RStV §1,1). Access to capacity for national transmission is decided unanimously by the prime ministers of the regional states (RStv §51 (2)). Access to capacity for transmission in the regional states is decided by the	An authorization to broadcast may only be issued given to a person or a legal person that (RStV §20a (1)): • is legally competent, • has the ability to serve in public offices not has violated the fundamental right of freedom of expression (the constitution §18)	The public ARD collaboration has 14 national channels and 16 regional channels The national Public Service Broadcaster ZDF has 9 generalist and thematic channels.	FTA

Table 1 Continued

		respective regional media authorities (Landesmedieanstalten) (RStV §51 (1)). The regional authorities are organised in a joint management office, the Association of Media Authorities (ALM).	• not is banned as an association, • is established or resident in the Federal Republic of Germany, any other member state of the European Union or another signatory country on the Eupean Economic Area and can be prosecuted, • provides assurance that the relevant legal rules will be adhered to and followed in the proposed broadcast activity There is no payment for license to broadcast FTA TV in Germany, but a number of requirements (cf. above). The basic idea is that independent broadcast should serve the democratic needs of society.		

(*Continued*)

Table 1 Continued

Country	No of MUX/ Free DTT Services	Legal Basis for Regulation of DTT	Licensing Conditions	MUX Operator and TV Services	Revenue Models for DTT
Italy	19	AGCOM (Autorità per le garanzie nelle comunicazioni) is in charga of regulation of broadcast In Italy. The Ministry of Economic Development is the competent authority for awarding authorisations with regard to digital terrestrial broadcasting according to the rules defined by AGCOM.	The required authorisation can be obtained by broadcasters/ AVMS providers that are established in the European Economic Area (EEA) or outside the EEA but with a mutual recognition agreement with Italy. There is no requirement for channels to be licensed in the country. Foreign broadcasters should have a license from an EU member state or from a party of the European Convention on Transfrontier Television. There are specific production requirements for the channels. These are related to the promotion of European works	There are two broadcasting tower networks with national coverage (EI Towers owned by Mediaset and state-controlled Rai Way) and six MUX operators that manage a total of 19 multiplexes. A distinctive characteristic of the Italian audio-visual market is a large number of terrestrial local and regional TV channels and one-third of available television multiplexes are reserved for local television broadcasters to promote pluralism and diversity.	FTA & Pay TV

Table 1 Continued

			(50% of programming), independent works (10% investment quota) and cinematographic works of Italian original expression (1% of programming time for generalist channels and 3% of transmission time for thematic channels). Quotas are defined by Art. 44 of the Italian AVMS Code and implemented in detail by AGCOM regulation 66/09/CONS.	There are 136 TV channels in the national TV network; out of them 104 are FTA TV channels, which can be accessed without fee.	
Poland	4	Broadcasting licenses are awarded by the National Council (KRRiT). All channels broadcast on DTT require a Polish license. Polish Parliament enacted the Act on the introduction of terrestrial digital television which also contained significant changes to the Broadcasting Act	The Broadcasting Act mentions specific linguistic (Art. 15) and production requirements (Art. 15a). According to these rules, television broadcasters are obliged to reserve at least 33% of their quarterly transmission time for programmes originally produced in Polish. Further, the rules stipulate that television broadcasters shall reserve at least 10% of their quarterly transmission time for European works produced by independent producers.	The Krakow-based company TP Emitel is the owner of the national DTT network and technical operator of MUX1-MUX3 (on the basis of the agreements with broadcasters) and of the new (Sept 2015) MUX8. The reservation of frequencies is for broadcasters whose services are transmitted in these multiplexes.	FTA & Pay TV

(*Continued*)

Table 1 Continued

Country	No of MUX/ Free DTT Services	Legal Basis for Regulation of DTT	Licensing Conditions	MUX Operator and TV Services	Revenue Models for DTT
Portugal	1	In Portugal the TV broadcast is regulated by two different regulatory bodies: the Portuguese Regulatory Authority for the Media ERC (Regulatory Entity for the Media) and the Autoridade Nacional de Comunicações (ANACOM). The legal framework on television broadcasting is based on the Television Act, which governs the access and exercise of television activity (Law 27/2007 of 30 July, implementing Directive 89/552/EEC – 'Television without frontiers', as amended). The main regulatory authority for such activity is the Portuguese Regulatory Authority for the Media	The basic licensing procedure was foreseen in the television act of 2007, complemented with the Electronic Communication Act of 2004. the capacity is managed as a whole by a multiplex/network operator who enjoys some leeway in using the capacity and selecting the channels which compose the line-up. Broadcasters no longer have to take part in a tendering process. An authorization (rather than a license) is granted to every applicant fulfilling certain minimum requirements concerning professional and economic standards. However, such an authorization does not secure the access to the digital terrestrial transmission network and the licensee must	PT Comunicações (Portugal Telecom) was awarded the license for the free-to-air Multiplex, and the service was officially launched in April 2009. It carries the four national terrestrial channels (RTP1 and 2, TVI and SIC) and two autonomous regional channels. The parliamentary channel ARTV was added at the end of 2012 (Kevin D. et al., 2015)	FTA

Table 1 Continued

			negotiate with the multiplex operator to get access and be distributed. Hence, access to the DTT Multiplex in Portugal is negotiated with Portugal Telecom (PT) (Kevin et al., 2015).		
Romania	3	The broadcasting market in Romania is regulated by two institutions: 1) The National Audiovisual Council (NAC) and 2) the National Authority for Management and Regulation in Communications (ANCOM). NAC is in charge of licensing of TV channels and ANCOM is in charge of organizing frequency resources and assigning Multiplexes	If a company fulfils the requirements to the law, including having a sound business model they get a license. There is no limit on the number of licenses. If a TV company has a license in another European country they don't need license but must register at National Audiovisual Council and get authorization for retransmission in Romania.	Initiated in March 2014, the licensing procedure made available to the interested parties 5 digital terrestrial television multiplexes in the DVB-T2 standard with national coverage. In June, ANCOM designated the SNR as action winner, being awarded with three available multiplexes, for EUR 1,020,002.	FTA
Spain	8	The legislation which deals with audiovisual media services in Spain is Law 7/2010, of 31 March, General Law on Audiovisual Communication.	According to article 22 of Audiovisual Spanish Law in order to provide audiovisual services by means of terrestrial electro-magnetic waves,	ABERTIS, is the Spanish telecommunications infrastructure operator, who owns and manages the only national terrestrial	FTA

(*Continued*)

Table 1 Continued

Country	No of MUX/ Free DTT Services	Legal Basis for Regulation of DTT	Licensing Conditions	MUX Operator and TV Services	Revenue Models for DTT
		This Law splits the Audiovisual competences mainly between two Institutions: i) The Spanish National Authority for Markets and Competition (hereinafter CNMC) and ii) the Ministry of Industry, Energy and Tourism.	it is required prior licensing by the competent audiovisual authority by means of competitive tendering. At this regards, it has to take into account that when providers do not use the spectrum, they just shall make an official communication to the competent audiovisual authority prior to commencement of the activity. The Audiovisual Spanish Law does not set a specific cost neither to get a license nor to make the prior notification. Nevertheless, Audiovisual Providers who use the spectrum are obliged to pay an annual amount for using it.	network for the broadcasting of DTT signals in Spain, is the only provider of transport services (from the television broadcaster offices to the terrestrial broadcasting stations) and distribution services (from the terrestrial broadcasting stations to viewers homes) of DTT signals to Spanish national television broadcasters.	

Source: Kevin & Schneeberger (2015); Digi. TV 2011; EPRA; Sousa et al. (2013) and direct contact with relevant stakeholders.

Table 2 Number of FTA and Pay TV

Country	FTA TV	Pay TV
AT	14	6
BG	9	3
CY	10	0
CZ	32	0
FR	31	10
DE	15	4
IT	104	32
PL	17	3
PT	6	0
RO	12	0
ES	24	1

Source: MAVISE database.

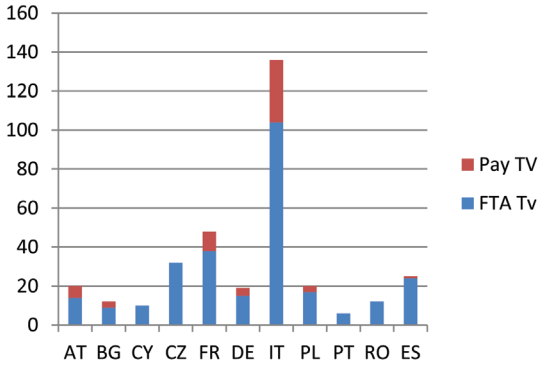

Figure 1 FTA and Pay TV

Source: MAVISE database.

4 Conclusion

As seen in the different country cases, the frequency spectrum for digital terrestrial TV is assigned to one or more MUX operators in a country, and TV providers obtain licenses or authorisation from the government appointed authorities, and in some cases the license holders further negotiate with the MUX operators to be included in a specific MUX. The conditions for obtaining license/authorisation and negotiation with MUX operators differ from country to country.

The major limiting factor for the number of TV services in the terrestrial platforms is obviously the amount of spectrum assigned, i.e., the number of MUXes that are planned in a country. This number is very different across Europe as illustrated in the case studies presented in the paper with the Italy as one extreme case having 100+ FTA TV services and some pay services in the terrestrial platform, and Portugal as another having only 6 FTA channels in the terrestrial platform.

In a number of countries, there are no fees for getting a license for TV provision, and in some countries like Cypress and Romania, specific fees must be paid for each TV broadcast channel or the fees can be based on the annual turnover like in Austria. In the countries with no fee, there can be some administration cost to the authorities and cost to the MUX operator. In other countries like Portugal, there is no need for a license, and an authorisation is granted for the applicants fulfilling minimum requirements.

Austria, France and Spain have assigned 6 to 8 MUXes in the DTT. These countries are comparable with many other European countries like Denmark, Sweden, the UK, etc. It seems that in these countries the assignment follows the international allocations for TV and the difference in numbers can be explained by the coordination/harmonisation with neighbouring countries and the choice of quality, i.e., HDTV, SDTV, etc. Even though the numbers of MUXes and by that the number of TV channels are similar in these countries, the organisation of MUX operators and the collaboration between the TV content providers and MUX operators, and the number of commercial and FTA TV channels can be different.

A group of countries including the Czech Republic, Germany and Poland with 4 MUXes seem to underutilise the allocated spectrum but still they have created multi-channel TV provision in terrestrial platform. Looking at the viewing behaviour of mainstream consumers, where the majority view a handful TV channels (mainly national TV channels), the DTT platform is capable of competing with other multi-channel platforms like satellite and cable TV.

Romania, Cypress, Bulgaria and Portugal are the countries performing poorest in the assignment of MUXes. In particular Portugal has assigned resources far below what is possible in the framework of international allocation of spectrum for TV. The reason for this is definitely not technical and is mainly due to historical, structural and political factors.

Italy is the other extreme with 19 MUXes. The explanation can be seen in, that in Italy a number of regional and local MUXes has been assigned. This decision has roots in the Italian TV landscape/structure and the viewing behaviour of the consumers.

We have in this study seen that in some of the elven case countries (like many other counties) the assignment of spectrum for digital terrestrial TV does not follow the international allocations, and many countries underutilise the resources. The technology and technical assignment mechanism does not vary much between the countries. There are some harmonisation issues for countries with many neighbouring countries and some issues related to the extent to which single frequency or multi frequency networks are possible or desirable in a specific country. Other technical parameters like the choice of coding standard or quality levels (HDTV or SDTV) also have some influence, and they are decided by the governments and market players. Leading to the conclusion that it is not technical limitations, but cultural, political, institutional and economic factors with a clear element of path-dependence that explain the differences – as it is very clear when comparing the situation in Italy and Portugal.

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