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What is the digital dividend?
State of play in Europe

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What is the digital dividend?
State of play in Europe

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State of play in Europe

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Abstract

Radio spectrum is a public resource, conventionally defined as the portion of electromagnetic spectrum characterised by waves with frequency varying between 3 kHz and 3000 GHz.
At the international level, the use of the radio spectrum is managed and coordinated by the International Telecommunication Union (ITU). Within the international framework defined by ITU, each country is entitled to manage the radio spectrum according to national interests. Moreover, regional organisations stand between the international and national layers. The role played by regional organisations is related to the convention introduced by ITU to divide the world into three Regions: Europe, Africa, the Middle East and northern part of Asia are included in Region 1, the Americas and some of the eastern pacific islands constitute Region 2, the southern part of Asia and Oceania are comprised in Region 3.
For many years, great part of the radio spectrum below 1 GHz has been allocated to analogue terrestrial broadcasting. However, with the advent of digital terrestrial television (DTT) and the consequent digital switchover a significant amount of the radio spectrum, in particular in the UHF band, has been freed up. In fact, DTT uses spectrum far more efficiently than analogue terrestrial television, requiring a smaller amount of spectrum in order to transmit the same content. The amount of spectrum that is above that nominally required to accommodate existing analogue television services in a digital form is defined as digital dividend.
In 2007 the ITU decided to allocate the upper part of the UHF band, released by the digital switchover, to the mobile service on a co-primary basis with terrestrial television. Moreover, in 2012, the ITU expanded the digital dividend including the 694-790 MHz band, in ITU Region 1, which will host both television broadcasting and mobile service on a co-primary basis from 2016.
The main purpose of the present thesis is to retrace the primary stages that have marked the evolution of the digital dividend issue. Nevertheless, the aim is to start early on, from a bit of history regarding the development of electromagnetic theory and the studies on radio waves, trying to gradually give the reader, which is not into this field, all the tools necessary to understand how events took place and why certain decisions were made, in particular in Europe.

Keywords: digital dividend, World Radiocommunication Conference (WRC), mobile services, digital terrestrial television (DTT).

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Table of Contents

1. Introduction 1

1.1. Summary 1

1.2. The aim 5

1.4. Methodology 6

1.5. Delimitations 7

2. The invisible radio waves 8

2.1. Historical background 8

2.2. Electromagnetic spectrum 9

2.3. Radio spectrum 11

3. Spectrum management 13

3.1. Spectrum management structure 13

3.1.1. International level 14

3.1.1.1. Spectrum allocation process 17

3.1.2. Regional level: Europe 20

3.1.3. National level 23

3.1.3.1. Spectrum allocation and assignment 24

4. Need for change 29

4.1. The “Mobile boom” 29

4.2. How to improve spectrum assignment 34

4.2.1. Technology-driven improvements: spectrum commons 35

4.2.2. Market-driven improvements 36

4.2.2.1. Spectrum markets: trading frequency licences 37

4.2.2.2. Auctions 39

4.2.2.3. Administrative Incentive Pricing - AIP 40

4.2.3. Conclusions 42

4.3. Final Considerations 42

5. The digital dividend 45

5.1. What is the digital dividend? 45

5.2. Size of the digital dividend 47

5.3. Potential uses of the digital dividend 48
5.3.1. The digital dividend to mobile service 54
5.3.2. A once-in-a-lifetime opportunity 55
6. International main events 57
6.1. RRC-06 57
6.2. WRCs preparatory work 61
6.3. WRC-07 63
6.3.1. Considerations 67
6.4. WRC-12 68
6.4.1. The 800 MHz band 69
6.4.2. The 700 MHz band 69
6.4.3. Additional spectrum 72
6.4.4. Considerations 73
7. European framework 77
7.1. The importance of European harmonisation 77
7.2. European common approach to radio spectrum 78
7.3. Europe and the digital switchover 80
7.4. Digital dividend taking centre stage 81
7.5. The 800 MHz band to mobile service 83
7.6. Decision No. 2010/267/EU 86
7.7. The first Radio Spectrum Policy Programme 87
7.8. EU policy on the 700 MHz band 90
8. National spectrum regulators 94
8.1. Introduction 94
8.2. The United Kingdom 95
8.2.1. Ofcom 95
8.2.2. Digital Terrestrial Television 96
8.2.3. First digital dividend 98
8.2.4. Second digital dividend 104
8.3. Italy 108
8.3.1. Agcom 108

8.3.2. Italian television anomaly 109
8.3.3. First digital dividend 112
8.3.4. Second digital dividend 118
8.4. The UK and Italy: a comparison 123
8.1. Introduction 123
8.2. Digital Terrestrial Television 124
8.3. First digital dividend 126
8.4. Second digital dividend 128
8.4. Conclusions 129
9. Implications for future research 131
References 135

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List of Figures

Figure 1. The electromagnetic spectrum 10

Figure 2. The electromagnetic wave 10

Figure 3. ITU-R organisation 15

Figure 4. ITU Regions 18

Figure 5. Global ICT developments, 2000-2010 30

Figure 6. Mobile subscriptions 30

Figure 7. Internet subscriptions 31

Figure 8. Global heatmap by year of LTE deployment 32

Figure 10. Global ICT trends and broadband penetration, 2008-2013 33

Figure 11. Digital Switchover: spectrum free from TV channels and available for other uses. 46

Figure 12. Digital dividend spectrum 47

Figure 13. The propagation characteristics of spectrum 52

Figure 14. International main events 57

Figure 15. RRC-06 planning area - 119 countries of the GE06 Agreement 59

Figure 16. The digital dividend Band – ITU Region 1 65

Figure 17. Cisco Forecasts 11.2 exabytes per month of mobile data traffic by 2017 74

Figure 18. Position of the digital terrestrial television platform in selected European countries 75

Figure 19. CEPT mandates 80

Figure 20. Preferred harmonised channelling arrangement for the 90-862 MHz band in EU 84

Figure 21. The digital dividend and adjacent spectrum use between 430 and 950 MHz 99

Figure 22. Changing the configuration of the UK's digital dividend 101

Figure 23. Proposed 800MHz band plan 103

Figure 24. UHF bands IV and V and the 700 MHz band 105

Figure 25. The available spectrum 106

Figure 26. 800MHz band plan 114

Figure 27. Research question: incentive auction 134

Figure 28. Research question: dynamic spectrum sharing 134

List of Tables

Table 1. Nine frequency bands of radio spectrum 17

Table 2. Table of Frequency Allocations: 8.3 – 110 kHz (portion) 18

Table 3. Candidate bands 64

Table 4. RSPG Opinions 79

Table 5. UK 4G auction results 104

Table 6. Italy: frequencies auctioned 115

Table 7. Spectrum blocks gained by operator and relative payment 116

Table 8. Six new subsets subdivided in groups L and U. 121

Table 9. Reorganization of Group L 122

List of Abbreviations

Agcom	Autorità per le Garanzie nelle Telecomunicazioni
AIP	Administrative Incentive Pricing
CEPT	European Conference of Postal and Telecommunications Administrations
CPG	Conference Preparatory Group
CPM	Conference Preparatory Meeting
DAE	Digital Agenda for Europe
DDR	Digital Dividend Review
DTT	Digital Terrestrial Television
DTV	Digital Television
DVB-T	Digital Video Broadcasting – Terrestrial.
EC	European Commission
ECC	Electronic Communications Committee
ECP	European Common Proposal
EP	European Parliament
ETSI	European Telecommunications Standards Institute
EU	European Union
FCC	Federal Communications Commission
GDP	Gross Domestic Product
GE06	Geneva 2006
GHz	Gigahertz
HD	High Definition
Hz	Hertz
ICT	Information and Communication Technology
IMT	International Mobile Telecommunication
ITU	International Telecommunication Union
ITU-R	ITU Radiocommunication Sector

kHz	Kilohertz
LTE	Long Term Evolution
MHz	Megahertz
NPV	Net Present Value
Ofcom	Office of Communications
PMSE	Programme Making and Special Events
RRC	Regional Radiocommunication Conference
RA	Radiocommunication Assembly
RAI	Radiotelevisione Italiana
RB	Radiocommunication Bureau
RR	Radio Regulations
RRB	Radio Regulations Board
RSC	Radio Spectrum Committee
RSPG	Radio Spectrum Policy Group
RSPP	Radio Spectrum Policy Programme
SD	Standard Definition
SMA	Spectrum Management Authority
T-DAB	Terrestrial – Digital Audio Broadcasting
TFA	Table of Frequency Allocations
UHF	Ultra High Frequency
US	United States
VHF	Very High Frequency
VOIP	Voice over Internet Protocol
WRC	World Radiocommunication Conference
3G	Third Generation
4G	Fourth Generation

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1. Introduction

1.1. Summary

In recent years, there has been rapid development in the Information and Communication Technology (ICT) sector, which has given birth to a huge variety of new services. In particular, the last twenty years have seen an exponential growth of mobile usage across the globe, with an explosion in terms of products, applications and contents offered by operators. Society is becoming more mobile, so more radio spectrum is required for the provision of mobile services. In fact, mobile communications rely on the use of the radio spectrum.

Radio spectrum is a public resource, conventionally defined as the portion of electromagnetic spectrum characterised by waves with frequency varying between 3 kHz and 3000 GHz. In each country, these frequencies are allocated to different public and private services with the aim to pursue a wide range of economic, social and scientific purposes. Among other unique properties, spectrum is considered a scarce resource, namely it has limited availability. In fact it is subject to congestion, as signals transmitted on the same or adjoining frequencies at the same time and in the same location can cause interference, which reduces or nullifies the usability of spectrum.

It is worth clarifying that radio spectrum is an artificial entity, an abstract mathematical idea introduced by the French mathematician and physicist Jean-Baptiste Fourier (1768-1830). It is not an existing and limited resource that has to be shared between different and more and more usages. It is actually the result of the regulation and the management of a universal natural phenomenon: radio waves.

Given the propagation characteristics of radio signals, limitation in the use of the radio spectrum is mainly due to the lack of availability of proper technologies and equipment, and frequency bands fitting for each type of service. Instead of saying that it is scarce, radio spectrum can be considered a "permanently constrained resource". Scarcity can be seen as a cyclic problem that has to be faced periodically.

Along with continuous technological changes and improvements that increase spectrum capacity and make spectrum better usable, more efficient and effective spectrum management approaches are needed.[1] An improper

[1] R. Struzak (2003). *Introduction to International Radio Regulations,* in S. M. Radicella (ed.), The Abdus Salam International Centre for Theoretical Physics ICTP Lecture Notes, Trieste, Italy, 2-22 February 2003. Available at:
http://wireless.ictp.trieste.it/school_2003/lectures/struzak/Introduction_to_Radio_Regulations/Introduction_to_International_Radio_Regulations.doc;
J.-M., Chaduc, G. Pogorel (2008). *The Radio Spectrum. Managing a strategic resource*. London, UK, New Jersey, USA: ISTE Ltd and John Wiley & Sons, Inc..

management approach can determine a suboptimal allocation of spectrum, creating artificial shortages and surplus across spectrum, leaving spectrum bands underused or misused. Basically, technological progress, spectrum management and demand of existing and new services together determine the use of radio frequencies. The goal is to actively find the right balance between them, in an extremely dynamic environment.

With regard to technological progress, the recent introduction of digital television (DTV) services is considered the most important development in the television field after the introduction of colour television in 1950s. With the advent of DTV, terrestrial broadcasting has become the centre of world attention, as digital terrestrial television (DTT) uses spectrum far more efficiently than analogue terrestrial television, requiring a smaller amount of spectrum in order to transmit the same content. The transition from analogue to digital terrestrial broadcasting has been occurring all over the world.

With this transition process, a significant part of the radio spectrum in particular in the UHF band has been freed up. These frequencies can be used for the provision of other services, in particular mobile services. The amount of spectrum that is above that nominally required to accommodate existing analogue television services in a digital form is defined as digital dividend.

It is important to fully understand the revolutionary impact of the digital dividend, which has been destabilizing the existing radio spectrum usage. It is worth noting that the digital dividend is part of the spectrum located between 200 MHz and 1 GHz, which is considered the most valuable part of the entire radio spectrum worldwide. It offers an attractive balance between transmission capacity and geographic coverage, which makes it suitable for a wide range of different uses. Keeping in mind this precious combination of key features, it can be easily understood why it is extremely rare to find unused UHF frequencies. Therefore, the digital dividend, which is a fairly large portion of the UHF spectrum, represents an once-in-a-lifetime opportunity to boost the growth of the ICT sector and a golden chance to meet the exponential demand for spectrum fuelled by mobile communications, by means of a more efficient use of the radio spectrum.

The allocation of the digital dividend is without any doubt an international issue. First of all because cross-border frequency coordination, where countries jointly agree on the same use of certain frequencies, is needed in order to avoid harmful interference with would impede the effective use of the spectrum by each country. In fact, radio emissions are not confined by national borders, as in their propagation, waves do not recognise boundaries, so they can cross frontiers and cause unwelcome interference. Moreover, a worldwide frequency harmonisation of the digital dividend usage would create enormous social and economic benefits for the mobile industry, the consumers and thus the whole economy.

At the international level, the use of the radio-frequency spectrum is managed and coordinated by the International Telecommunication Union (ITU). Within the international framework defined by ITU, each country is entitled to manage the radio spectrum according to national interests. However, although allocating the digital dividend falls ultimately within national prerogatives, regional organisations stand between the international and national layers. The role played by regional organisations is related to the convention introduced by ITU to divide the world into three Regions: Europe, Africa, the Middle East and northern part of Asia are included in Region 1; the Americas and some of the eastern pacific islands constitute Region 2; the southern part of Asia and Oceania are comprised in Region 3. The current trend shows a greater centralisation of spectrum decisions moving from national to regional level, in particular in Europe.

With specific regard to the digital dividend issue, in 2007 the ITU decided to allocate the upper part of the UHF band, released by the digital switchover, to the mobile service on a co-primary basis with terrestrial television. The allocation has been done, in each Region, as follows:

- 698-806 MHz band in Region 2 and nine countries in Region 3 (Bangladesh, China, Korea, India, Japan, New Zealand, Papua New Guinea, Philippines and Singapore);
- 790-862 MHz band in Region 1 and Region 3.

Within this new framework, national Spectrum Management Authorities (SMAs) have the freedom to choose which service should use the digital dividend, under the condition of bilateral or multilateral agreements with neighbouring countries about the selected use, in order to manage interference problems. Even though the allocation of those frequencies to mobile service is not compulsory, the growing importance of mobile service for both developed and developing countries is self-evident, given the widespread use of mobile applications and their undeniable positive social and economic benefits. Preserving the status quo would mean denying the progress made in the telecommunication sector and turning down the potential that advancements in mobile communication technologies can offer for a more efficient use of the spectrum and, thus, for the benefit of the whole society.

Obviously, SMAs will have to face broadcasters' opposition. In fact, they would be deprived of some spectrum frequencies historically used for television broadcasting, while they are eager to broadcast more channels in digital form. Moreover, SMAs need to settle new agreements with neighbouring countries in order to provide mobile services, while ensuring that interference problems will not arise. This negotiating process will profoundly modify the existing digital broadcasting plan, in particular in Region 1.

Moreover, in 2012, the ITU expanded the digital dividend including the 694-790 MHz band, in ITU Region 1, which will host both television broadcasting and mobile service on a co-primary basis from 2016. Focusing on Region 1,

reallocating the 694-790 MHz band for mobile service will be significantly more disruptive to terrestrial broadcasters than it is in the 790-862 MHz band. In fact, terrestrial broadcasters would lose 30% of the total remaining UHF television spectrum. Such a reallocation cannot be seen as a release of frequencies thanks to technology improvements, but it is clearly a forced reduction of broadcasting capacity. In addition, significant planning and coordination among neighbouring countries will be needed in order to preserve equitable access to spectrum and control interference, as freeing up the 694-790 MHz band from television broadcasting will severely interfere with the existing spectrum rights of each individual country.

As matters stand, the challenge posed by the reallocation of the 694-790 MHz band should not be underestimated. A lot of interests are at stake. On one side mobile operators are starving for more spectrum, being the just released 790-862 MHz band not enough for the deployment of their services. On the other side, television broadcasters will find themselves in a situation extremely difficult to handle, as many DTT systems have already been re-planned to free up the first digital dividend. Moreover, the 694-790 MHz band is seen as vital for the future development of digital broadcasting technologies, which would be prevented if more spectrum was released.

Despite the availability of other platforms, such as the Internet, cable and satellite, DTT is the primary means of delivering television in many European countries and in most of them there is evidence of demand for additional DTT services. However, the role broadband services are playing for the economy worldwide cannot be ignored, as well as the exponential increase in the volume of data traffic, which is growing even faster than predicted and will keep growing over the next years. As time passes, the true scale of the mobile phenomenon is becoming ever clearer.

While SMAs around the world are still working to re-farm the 790-862 MHz band for mobile service, countries in Region 1 and in particular EU Member States are setting the stage to face another challenge, harder than the previous one, regarding the 700 MHz band. In Europe, DTT is the dominant delivery platform for television with over than 275 million people watching television over DTT. Moreover, television broadcasting is widely considered as a crucial instrument in society for providing information and promoting shared values.

Europe has been working hard to structure a harmonised regional plan on the digital dividend, promoting coordination in the management and use of the spectrum, to be followed by all EU Member States. However, European countries are so different from each other that the existing discrepancies have led to a varied set of experiences regarding the national approach to the digital dividend.

SMAs, regional organisations, experts, broadcasting and mobile service operators and the whole ICT sector are looking forward to further international developments, which will occur in 2015. Decisions will be taken regarding the

future use of the radio spectrum, which will inevitably mark the future path of the services and technologies involved.

1.2. The aim

The main purpose of the present thesis is to retrace the primary stages that have marked the evolution of the digital dividend issue. Nevertheless, the aim is to start early on, from a bit of history regarding the development of electromagnetic theory and the studies on radio waves, trying to gradually give the reader, which is not into this field, all the tools necessary to understand how events took place and why certain decisions were made, in particular in Europe. For this reason the thesis is organised as follows.

Chapter 2 starts with a brief historical background regarding the development of electromagnetic theory. Then, the concepts of electromagnetic spectrum and radio spectrum are defined. With regard to radio spectrum, both technical and economic aspects are described.

Chapter 3 investigates the spectrum management issue in its three geographical layers: international, regional and national. The concepts of spectrum allocation and assignment are defined and, focusing on the national level, the main spectrum assignment approaches are broadly described.

Chapter 4 contains some data related to the recent developments in the ICT industry, in particular regarding the mobile service, whose widespread adoption calls for reforms in the spectrum assignment procedures. Thus, the main proposals seeking to define a renewed framework, distinguished in technology-driven and market-driven methods, are outlined.

Chapter 5 introduces the concept of digital dividend, trying to explain its origins and its main characteristics. Then, the chapter focuses on the potential uses of the digital dividend, supporting the rationale of an allocation in favour of the mobile service.

Chapter 6 starts illustrating the debate on the digital dividend issue. In particular, the chapter deals with the international main events which have led to the transition from analogue to digital terrestrial broadcasting, the allocation of the digital dividend to mobile services and further developments regarding the goal of extending the digital dividend in order to release additional spectrum to mobile service.

Chapter 7 focuses on the European approach towards the digital dividend, meaning that only the international decisions regarding Region 1 and the European actions on the digital dividend are taken into account.

The awareness of the immense scope of the issue addressed has led to the decision to concentrate mainly on one Region, Region 1, and, in more detail, on Europe. Choosing a Region would have been ensured a certain degree of consistency in the exposition, given that international actions are Regional-oriented, unless global decisions are taken. Moreover, the chapter lays stress on

Europe, for the same reason stated above, meaning for a need for uniformity in the exposition, but also because it is believed that the high degree of diversity among countries, the long tradition of terrestrial broadcasting service, the existing use of radio spectrum and other aspects that characterise Europe would have made the thesis more interesting.
Chapter 8 calls attention to the national level. Specifically, two cases studies are shown with the aim to briefly describe the different approaches adopted in the United Kingdom (UK) and in Italy to face the digital dividend issue.
A Conclusive Chapter 9 encourages further research, which may be conducted regarding the necessity to meet the growing demand for spectrum fuelled by mobile broadband in a context of spectrum scarcity. In particular, the Chapter hints at the decision of the Federal Communication Commission (FCC), the United States (US) telecommunications regulatory agency, to adopt an innovative procedure termed "incentive auction". It aims at encouraging existing broadcast television licensees to give up spectrum usage rights on a voluntary basis in exchange for a share of the proceeds from an auction of new licences to use the freed-up spectrum in the UHF band. The question is whether or not such a means can be implemented in Europe and how. Moreover, the Chapter refers to the on-going study on sharing spectrum in Europe and calls attention on the necessity to clearly understand why spectrum sharing is a feasible solution to the spectrum scarcity problem.

1.4. Methodology

In order to develop the thesis, an extensive desk research is conducted, which refers to the collection and examination of secondary data. The Internet is the main research tool. As secondary data are not all of the same quality in terms of authenticity and credibility, the purpose is to mainly rely on official documents, which can be considered more reliable than non-official documents. In this respect, most of the data are sourced from official websites and on-line archives of: the International Telecommunication Union (ITU); the European Union (EU); the European Commission (EC); the European Conference of Postal and Telecommunications Administrations (CEPT); the Radio Spectrum Policy Group (RSPG); the UK Office of Communications (Ofcom); the Italian Communications Regulatory Authority (Agcom).
ITU reports, articles, official documents related to the Regional Radiocommunication Conference held in 2006 (RRC-06), the World Radiocommunication Conferences held in 2007 (WRC-07) and 2012 (WRC-12) and the upcoming WRC-15, have been investigated.
As regards Europe, data are primarily sourced from: CEPT reports, released as result of the mandates placed by the EC; RSPG opinions; EC decisions, communications and recommendations; decisions of the European Parliament

(EP) and the Council of the European Union, which are judged as relevant for the purpose of the thesis.
Consultations, regulatory statements and associated documents published by Ofcom are not only used for the development of Chapter 8, but their contributions add greatly to the structure of the entire thesis, being judged as well-developed and highly explanatory. Agcom resolutions, regulations and press releases, along with some specific Italian laws are used just for shaping Chapter 8. Given the peculiarity of Italian television market, the newsletter of Federazione Radio Televisioni (FRT), a federation representing Italian broadcasting operators, is largely used.
Moreover, the PolicyTracker spectrum management newsletter, the Telecommunications Policy Journal and IEEEXplore digital library represent cardinal sources of data.

1.5. Delimitations

The purpose of the thesis is to illustrate the main events which have determined the evolutionary path of the digital dividend issue, from an international, European and national point of view. The exposition does not go deep into facts, but aims at displaying prominently the principal decisions and related consequences so as to be easily understood. Neither solutions nor predictions for future courses of actions are provided, although some considerations may have been expressed. Policy actions are not evaluated in a positive or negative sense; the aim is to call attention to results and effects of these policy interventions. Moreover, the thesis fails to proper investigate facts from a broadcasting point of view, emphasizing the mobile perspective.
Focusing on Europe, connections with African and Arab countries included in Region 1 are missing, as well as linkages to Region 2 and Region 3. A comparative analysis would be interesting as a better understanding of the reasons of certain decisions and of the origins of certain problems could be obtained.
In Chapter 8 the comparison between the UK and Italy purposes to show how national peculiarities such as geography, culture, political aspects and the level of development of certain technologies, may strongly impact on the way countries approach the digital dividend issue, although both countries are under the EU umbrella. No specific methods of investigation are applied.
In order to develop the thesis neither quantitative methodologies nor mathematical models are used, even though some remarks are supported by statistical data. The thesis limits itself to showing the results of a process of collection, organisation, analysis and synthesis of research material.

2. The invisible radio waves

2.1. Historical background

During the nineteenth century the development of electromagnetic theory arrived at a turning point. Since the eighteenth century many scientists and amateurs have been more intensely fascinated by electricity, magnetism and their properties. As phenomena, related to electricity and magnetism, were considered independent, they have always been objects of distinct investigations.[2]

However, in 1820, Andre-Marie Ampere (1775-1836) and Hans Cristian Oersted (1777-1851) demonstrated the connection between magnets and electric currents, meaning the possibility of transforming electricity into magnetism.[3] In 1831, Michael Faraday (1791-1867) discovered the electromagnetic induction phenomenon, showing that a magnetic field, which is changing with time, can produce an electric current.[4]

In 1864 James Clerk Maxwell (1831-1879) mathematically predicted the existence of electromagnetic waves, providing a complete description of electromagnetic phenomena. His article "Dynamical Theory of the Electromagnetic Field", published in 1865, is considered the basis of electromagnetic theory. Afterwards, many experimenters started deeply investigating Maxwell's system of equations.

A milestone in the history of electromagnetic theory is represented by Heinrich Rudolf Hertz's series of experiments through which he effectively produced radio waves, proving the foundation of Maxwell's theory, in 1887. The confirmation of Maxwell's prediction helped the general acceptance of Maxwell's discovery by the scientific community.[5] The pivotal contributions of Maxwell and Hertz (1857-1894), coupled with the development of electronics, paved the way to wireless communications.[6]

Guglielmo Marconi (1874-1937) is the inventor more closely connected with the development of wireless communications. Given his pioneering experiments with a wireless telegraphy system, he is widely considered the

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[2] A. J. Schwab, P. Fischer (1998). *Maxwell, Hertz, and German Radio-Wave History*, Proceedings of the IEEE, Vol. 86, No. 7, pp. 1312–1318. Available at: http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=681365&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D681365.

[3] J.-M. Chaduc, G. Pogorel (2008). *Op. cit.*, supra footnote 1.

[4] G. S. Smith (1997). *An Introduction to Classical Electromagnetic Radiation*. Cambridge, UK; New York, USA; Melbourne, Australia: Cambridge University Press, p. 1.

[5] D. L. Sengupta, T. K. Sarkar (2003). *Maxwell, Hertz, the Maxwellians, and the Early History of Electromagnetic Waves,* IEEE Antennas and Propagation Magazine, Vol. 45, No. 2, pp. 13–19. Available at: http://ieeexplore.ieee.org/xpl/articleDetails.jsp?tp=&arnumber=1203114&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D1203114.

[6] Institute of Electrical and Electronics Engineers – IEEE, *IEEE Global History Network* (accessed April 2013), http://www.ieeeghn.org/wiki/index.php/IEEE_Communications_Society_History.

father of radio, at that time called wireless telegraphy. In 1901, he was able to successfully transmit and receive the first transatlantic signal, proving the feasibility of long-distance radio communications.[7]

From now on, it was clear that, by modulating a given range of frequencies, it would have been possible to transmit information over distances between two or more points that are not physically connected.[8] Commercial, military and marine radio communications started to be developed. In 1915 the first wireless voice transmission was set up between New York and San Francisco and in 1920 the first commercial radio was established with WWJ station in Detroit and KDKA station in Pittsburgh. Television broadcasting, mobile telephony, satellite transmission are only few examples of innovations that came up over time with the advent of wireless communications.[9]

Wireless services represent an invaluable achievement in the telecommunication field and a great step forward in social progress. They have radically changed how society is organised and connected, and revolutionised the way people communicate.[10]

2.2. Electromagnetic spectrum

In wireless communication, information is transferred by electromagnetic waves. They can be defined as the self-propagating, mutual oscillation of electric and magnetic fields.[11] In fact, electromagnetic waves consist of both electric and magnetic fields and they propagate in space without artificial guide at the speed of light.[12] Scientists use the expression "electromagnetic spectrum" to indicate the entire range of electromagnetic radiation frequencies, usually classified into classes, on the basis of their propagation properties.[13] Electromagnetic radiation is described as a stream of massless particles, called

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[7] Lemelson-Mit Website, Inventor of the week, *Guglielmo Marconi*, (accessed April 2013), http://web.mit.edu/invent/iow/marconi.html.

[8] D. Hatfield, P. Weiser (2006). *Toward Property Rights in Spectrum. The difficult Policy Choices Ahead,* Cato Institute Policy Analysis Series No. 575. Available at: http://ssrn.com/abstract=975679 or http://dx.doi.org/10.2139/ssrn.975679.

[9] S. K. Majumdar, I. Vogelsang, M. E. Cave (2005). *Handbook of Telecommunications Economics,* Vol. 1, Amsterdam, The Netherlands: Elsevier B.V..

[10] G. Falciasecca, B. Valotti (2009). *Guglielmo Marconi: the pioneer of Wireless Communications*. Proceedings of the 39th European Microwave Conference, pp. 544–546. Available at: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5296358.

[11] Columbia University, Department of Earth and Environmental Sciences (2007), *Electromagnetic Waves,* (accessed April 2013), http://eesc.columbia.edu/courses/ees/climate/lectures/radiation/em_energy.html.

[12] International Telecommunication Union – ITU (2012). *Radio Regulations,* Vol. 1, Art. 1, Geneva, Switzerland. Available at: http://www.itu.int/pub/R-REG-RR-2012;

A. P. Godse, U.A. Bakshi (2009). *Basic Electronics Engineering*. Pune, India: Technical Publications Pune.

[13] National Imagery and Mapping Agency. *Chapter 10: Radio Waves* (accessed April 2013), http://msi.nga.mil/MSISiteContent/StaticFiles/NAV_PUBS/APN/Chapt-10.pdf.

photons, each travelling through space in a wave-like pattern at the speed of light. Each photon contains a certain amount of energy.
Types of radiation differ from each other in terms of energy, wavelength and frequency. As it is shown in Figure 1, radiation can be ordered from the highest energy/highest frequency/shortest wavelength (gamma rays) to the lowest energy/lowest frequency/longest wavelength (radio waves).[14]

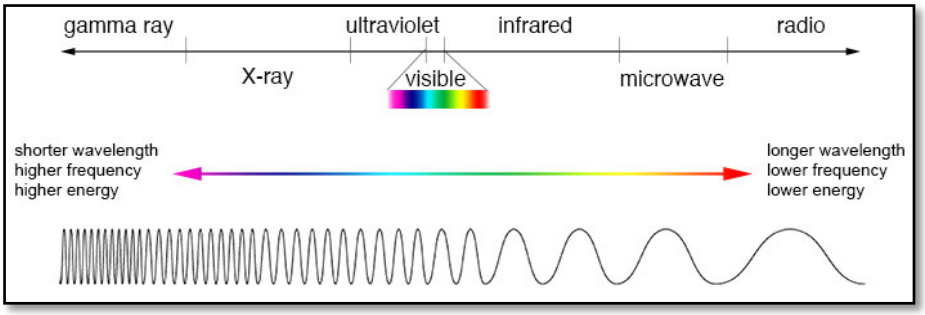

Figure 1. The electromagnetic spectrum
Source: Nasa Goddard Space Flight Center, Nasa's Imagine the Universe, *Electromagnetic Spectrum* (accessed April 2013), http://imagine.gsfc.nasa.gov/docs/science/know_l1/emspectrum.html.

The energy carried by a wave is related to the amplitude of a wave that is the maximum displacement of a peak from its undisturbed position.[15] In particular the greater the amplitude the greater is the quantity of energy transported.
The wavelength is defined as the distance travelled by an electromagnetic wave during the time of one cycle and it is measured in meters. One cycle is a complete sequence of values, as from crest to crest.
The frequency is the number of patterns or cycles that occur in unit time, usually one second, and it is expressed in hertz (cycles per second).

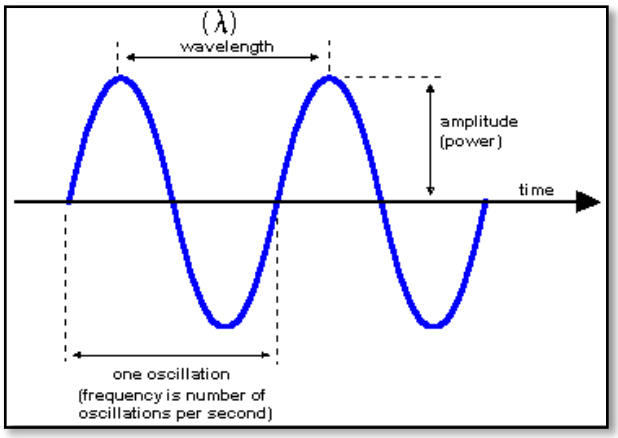

Figure 2. The electromagnetic wave
Source: JSAT International, Why satellite, *Frequency* (accessed April 2013), http://www.jsati.com/why-satellite-what-Frequency.asp

[14] Nasa Goddard Space Flight Center, Nasa's Imagine the Universe, *Electromagnetic Spectrum* (accessed April 2013), http://imagine.gsfc.nasa.gov/docs/science/know_l1/emspectrum.html.
[15] British Broadcasting Corporation – BBC, *An introduction to waves* (accessed April 2013), http://www.bbc.co.uk/schools/gcsebitesize/science/aqa_pre_2011/radiation/anintroductiontowavesrev2.shtml.

There exists a specific mathematical relation between frequency and wavelength. They are inversely proportional: the higher the frequency the shorter the wavelength. Instead frequency and energy are directly proportional.[16]

With respect to wireless communication, key characteristics of electromagnetic waves are the propagation features and the information-carrying capacity. In general, waves with higher frequencies reach shorter distances but can carry greater amount of information, instead waves with lower frequencies travel longer distances but have little capacity to carry information. The physical characteristics of electromagnetic waves help in identifying the spectrum bands suitable for different applications.[17] For instance, broadband services demand for lower parts of the spectrum that have greater propagation features. These particular waves have the capability to pass through obstacles, such as buildings, and this is very important for some kind of services such as radio and mobile broadcasting.[18]

2.3. Radio spectrum

Radio spectrum is the portion of electromagnetic spectrum characterised by radiation with the lowest frequency and the longest wavelength. Conventionally, radio waves have frequency that varies between 3 kHz and 3000 GHz.[19]

Radio spectrum is an indispensable public resource for a wide range of economic, social and scientific purposes. It is used for mobile, fixed and satellite wireless communication, transport, radiolocation, many applications such as alarms, microphones and medical equipment, radio and television broadcasting which, in particular, has become one of the main sources of information for most people in the world.[20] Specific frequencies are allocated to deliver public services such as defence, public safety, disaster warning, air-

[16] Nasa Goddard Space Flight Center, Nasa's Imagine the Universe, *Electromagnetic Spectrum* (accessed April 2013), http://imagine.gsfc.nasa.gov/docs/science/know_l1/emspectrum.html.

[17] McLean Foster & Co. in collaboration M. Cave and R. W. Jones (2007). *Radio Spectrum Management, Module 5, ICT Regulation Toolkit, Executive Summary*. Available at: http://www.ictregulationtoolkit.org/Documents/Document/Document/3729.

[18] European Commission - EC (2010). *Accompanying document to the Proposal for a Decision of the European Parliament and of the Council establishing the first radio spectrum policy programme,* {COM(2010) 471}. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:0471:FIN:EN:PDF.

[19] International Telecommunication Union – ITU (2012). *Op. cit.,* supra footnote 12.

[20] European Parliament – EP, Council of the European Union – the Council (2012). *Decision No. 243/2012/EU of the European Parliament and of the Council of 14 March 2012 establishing a multiannual radio spectrum policy programme*, Official Journal of the European Union. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:081:0007:0017:EN:PDF.

traffic control, maritime navigation, weather forecasts; and scientific activities, for instance radio astronomy and space research, among others.[21]

This natural resource presents some unique properties. It is not homogeneous, as different portions have different characteristics. It cannot be created or destroyed.[22] It is non-exhaustible: it will never run out because of its exploitation; but it is non-storable, meaning it cannot be accumulated for later use. It is considered a scarce resource, namely, at a given time and location, it has limited availability. In fact it is subject to congestion, as signals transmitted on the same or adjoining frequencies at the same time and in the same location may interfere with each other.[23] Interference represents a significant problem that reduces or nullifies the usability of spectrum.[24]

From a pure technical point of view, radio spectrum can be considered a public resource with indefinite capacity, which anybody can use. However, radio waves cannot be used for providing services if different radio systems arbitrarily use the same spectrum band, causing unwanted and harmful signal interference. This is the reason why since the very beginning of wireless services deployment, spectrum management arises to prevent harmful interferences, allowing the universal shared use of radio spectrum.

The necessity of coordination and regulation was immediately recognised, at the national and international level, for the effective use of radio communication.[25] Many services work worldwide, so a certain level of uniformity in the allocation of spectrum to services between countries is required. Moreover, radio emissions used for systems within a country are not confined by national borders, as in their propagation, waves do not recognise boundaries, so they can cross frontiers and cause unwelcome interference. Coordination is also necessary within the country in order to ensure the equitable access to spectrum by different services without creating constraints, which would impede the effective provision of services by each operator.[26]

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[21] M. Cave (2002). *Review of Radio Spectrum Management*. An independent review for Department of Trade and Industry and HM Treasury. Available at: http://www.ofcom.org.uk/static/archive/ra/spectrum-review/2002review/1_whole_job.pdf.

[22] G. L. Rosston, J. S. Steinberg (1997). *Using Market-Based Spectrum Policy to Promote the Public Interest*, Federal Communications Law Journal: Vol. 50, Iss. 1, Art. 4. Available at: http://www.repository.law.indiana.edu/fclj/vol50/iss1/4G.

[23] McLean Foster & Co. in collaboration M. Cave, R. W. Jones (2007). *Op. cit.*, supra footnote 17.

[24] European Commission - EC (2010). *Op. cit.*, supra footnote 18.

[25] J.-M. Chaduc, G. Pogorel (2008). *Op. cit.*, supra footnote 1.

[26] D. J. Withers (2009). *Radio Spectrum management: Management of the Spectrum and Regulation of Radio Services,* 2nd ed. London, UK: The Institution of Electrical Engineers.

3. Spectrum management

3.1. Spectrum management structure

Spectrum management framework has a three-tier geographical structure: international, regional and national. The ITU undertakes the task of internationally coordinating the use of the radio spectrum, managing interference and setting global standards.[27] It provides the basic framework for spectrum allocation, distributing spectrum portions to several categories of radiocommunication services.

Between the international and national level, regional organisations have emerged, which play a significant role in defining spectrum management policy.[28] Current trends show a greater centralisation of spectrum decisions moving from national to regional level, in particular in Europe.[29] Regional bodies aim at reaching a significant level of harmonisation in national allocation processes within the area of competence, and also of coordination in the assignment procedures, if it is believed necessary. Doing so, a more efficient use of the spectrum can be achieved.[30] Other specialised international organisations exist in certain sectors such as civil aviation, research and radio astronomy.[31]

However, radio spectrum management still chiefly remains a national responsibility. Within the allocation framework defined internationally, SMAs are in charge of the allocation process of spectrum to certain uses, defining a national table of frequency allocations, and of the assignment process of frequencies to users. As several services are allocated in each frequency band at the international level, SMAs can decide, with a high degree of flexibility, which kind of service to deploy, taking into account national needs.[32] As regards the assignment process, radio frequencies or radio frequency channels within each allocated band are assigned to specific individual users by means of national authorisation.[33]

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[27] S. K. Majumdar, I. Vogelsang, M. E. Cave (2005). *Op. cit.,* supra footnote 9.

[28] E. Lie (2004). *Radio Spectrum Management for a Converging World*, Background Paper prepared for the ITU Workshop on Radio Spectrum Management for a Converging World, Geneva, Switzerland, ITU New Initiative programme, 16-18 February 2004. Available at: http://www.itu.int/osg/spu/ni/spectrum/RSM-BG.pdf.

[29] K. Pearson, P. Marks (2012). *European Policies supporting Wireless Broadband*, Telecommunications Journal of Australia, Vol. 62, No. 1. Available at: http://tja.org.au/index.php/tja/article/view/287.

[30] D. J. Withers (2009). *Op. cit.,* supra footnote 26.

[31] International Telecommunication Union – ITU (2007). Report ITU-R SM. 2093 *Guidance on the regulatory framework for national spectrum management*, Geneva, Switzerland. Available at: http://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-SM.2093-2007-PDF-E.pdf.

[32] International Telecommunication Union - ITU (2012). *Digital Dividend: Insights for Spectrum Decisions*, Geneva, Switzerland. Available at: http://www.itu.int/ITU-D/tech/digital_broadcasting/Reports/DigitalDividend.pdf.

[33] D. Hatfield, P. Weiser (2006). *Op. cit.,* supra footnote 8.

This three-tier structure is set out with the primal aim to provide the necessary international harmonisation of allocations and, at the same time, to reserve a certain degree of flexibility to SMAs that are responsible for the final spectrum allocation to specific uses and assignation to individual users.[34]

3.1.1. International level

At the international level, the use of the radio-frequency spectrum is managed and coordinated by the ITU. Founded on 17 May 1865, ITU is the United Nations specialized agency for information and communication technologies (ICTs) that follows the aim to bring the benefits of modern communication technologies worldwide. At present, ITU membership includes 193 Member States, ICT regulators, leading institutions and over 700 private companies. It is headquartered in Geneva, Switzerland, and has four regional offices and eight area offices around the world.[35] ITU fulfils its objectives through its three Sectors: the Radiocommunication Sector (ITU-R), the Telecommunication Standardization Sector (ITU-T) and the Telecommunication Development Sector (ITU-D). In particular, the ITU-R is responsible for the allocation of frequency bands to generic types of uses.

Core responsibility of ITU-R is to ensure the rational, equitable, efficient and economical use of the radio-frequency spectrum by all radiocommunication services, including those using geostationary-satellite and satellite orbits, to facilitate coordination and agreement among countries about frequency allocation, to carry out studies and to approve recommendations on radiocommunication matters.[36] In pursuing this mission, ITU-R promulgates Radio Regulations (RR), which forms the international treaty governing the use of the radio frequency spectrum and satellite orbits, with binding effect on all ITU Members. Essentially, RR constitutes the heart of the international framework for frequency allocations that specifies how frequency bands must be allocated to radiocommunication services, and the procedures that SMAs must follow for implementing radio stations in order to avoid harmful interference.[37]

The RR is usually reviewed and, if necessary, revised every three to four years through ITU's World Radiocommunication Conferences (WRCs) to keep pace with new technological, economic and political developments.[38] Official

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[34] W. H. Melody, W. Lemstra (2011*). Liberalization in radio spectrum management* in M. Finger, R. W. Kunneke, International handbook of Network Industries. The liberalization of Infrastructure, Cheltenham, UK: Edward Elgar, pp. 123-143.

[35] International Telecommunication Union – ITU, *ITU Overview* (accessed April 2013), http://www.itu.int/en/about/Pages/overview.aspx.

[36] International Telecommunication Union – ITU, *ITU Constitution*, Geneva, Switzerland. Available at: http://www.itu.int/dms_pub/itu-s/oth/02/09/s02090000115201pdfe.pdf.

[37] International Telecommunication Union – ITU (2007). *Op. cit.,* supra footnote 31.

[38] International Telecommunication Union – ITU, *Radiocommunication Sector – ITU-R* (accessed April 2013), http://www.itu.int/ITU-R/index.asp?category=information&rlink=itur-welcome&lang=en.

governmental delegations of ITU Member States participate to the Conferences and other entities such as the United Nations, international organisations, regional telecommunication organisations may be admitted. Decisions are taken by consensus, which means that all ITU Member States should agree on what has been decided. This ensures that they will continue to comply with the RR.[39] Furthermore, the ITU may hold Regional Radiocommunication Conferences (RRCs) that can involve either an ITU Region or a smaller group of countries with the aim to solve spectrum use problems within a specific geographic area. RRCs cannot modify the RR and the decisions taken are only binding on those countries that have signed the agreement.[40] ITU-R also adopts recommendations with the aim to standardise radiocommunication equipment in order to favour harmonisation conditions across ITU members.[41] SMAs usually implement them, even though they do not have legal status.[42]

As shown in Figure 3, along with International and Regional Radiocommunication Conferences, the structure of the ITU-R encompasses several entities.

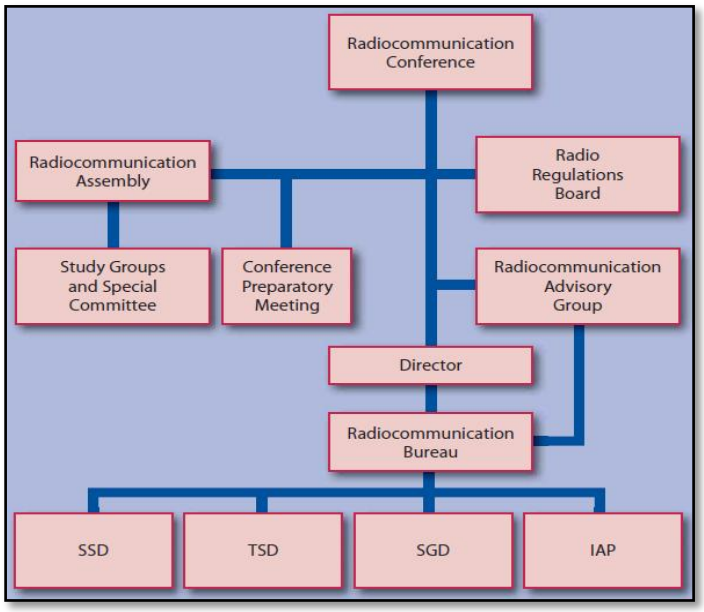

Figure 3. ITU-R organisation
Source: ITU, *Sector Organization* (accessed April 2013), http://www.itu.int/ITU-R/index.asp?category=information&rlink=sector-organization&lang=en.

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[39] F. Rancy, E. Zilles, J. J. Guitot (2011). *Transition to digital TV and digital dividend*, Telecommunication in Modern Satellite Cable and Broadcasting Services (TELSIKS), 10th International Conference on, Vol. 1, pp. 13–20, 5–8 October 2011. Available at: http://ieeexplore.us/xpl/articleDetails.jsp?tp=&arnumber=6112027&queryText%3DTransition+to+Digital+TV+and+Digital+Dividend.

[40] European Telecommunications Standards Institute – ETSI website, *Radio Spectrum* (accessed April 2013), http://www.etsi.org/technologies-clusters/technologies/radio/radio-spectrum;
L. Berlemann, B. H. Walke (2006). *Radio Spectrum Regulation* in B. H. Walke, S. Mangold, L. Berlemann, IEEE 802 Wireless Systems: Protocols, Multi-hop Mesh/Relaying, Performance and Spectrum Coexistence, Chichesrer, UK: John Wiley & Sons, Ltd.

[41] International Telecommunication Union - ITU (2012). *Op. cit.*, supra footnote 32.

[42] M. Cave (2002). *Op. cit.*, supra footnote 21.

Radiocommunication Assemblies (RAs) are responsible for structure, programme and approval of radiocommunication studies. They are normally convened every three to four years and may be associated in time and place with WRCs. Among other duties, RAs assign conference preparatory work and other questions to study groups, which develop the technical bases for decisions taken at WRCs and recommendations, reports and handbooks on radiocommunication matters. More than 4000 specialists representing ITU Member States and Sector and Associate Members throughout the world, participate in the work of the study groups.[43] In addition, a Special Committee (SC) undertakes required studies on matters relating to regulatory/procedural issues as part of preparations for WRCs.[44]

The Radiocommunication Bureau (RB) is the executive arm of the ITU-R and it is composed of a director and a team of highly skilled specialists. It is responsible for the coordination of the ITU-R activities, which are assigned to four different departments: Space Services Department (SSD), Terrestrial Services Department (TSD), Study Groups Department (SGD) and Informatics, Administration and Publications Department (IAP).[45]

The director of the Bureau is the Executive Secretary of the Radio Regulations Board (RRB). This is composed of 12 elected members, which perform their duties independently and on a part-time basis, normally meeting up to four times a year, in Geneva. Among other things, RRB approves the "Rules of Procedure" used by the RB in applying the provisions of the RR and in registering frequency assignments made by Member States. [46] In fact, the ITU requires its member countries to conform to arranged procedures of notification and registration of assigned frequencies to particular uses.[47]

The Radiocommunication Advisory Group (RAG) reviews priorities and strategies adopted by the ITU-R, and provides guidance for the work of the study groups and recommends measures to foster cooperation and coordination both with other organisations and other ITU Sectors.[48]

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[43] International Telecommunication Union – ITU, *Radiocommunication Assemblies* (accessed April 2013), http://www.itu.int/ITU-R/index.asp?category=conferences&rlink=ra&lang=en;
International Telecommunication Union – ITU, *Radiocommunication Study Groups* (accessed April 2013), http://www.itu.int/en/ITU-R/study-groups/Pages/default.aspx.

[44] International Telecommunication Union – ITU (2012). Resolution ITU-R 38-4 *Study of regulatory/procedural matters*, Geneva, Switzerland. Available at: http://www.itu.int/dms_pub/itu-r/opb/res/R-RES-R.38-4-2012-PDF-E.pdf.

[45] International Telecommunication Union – ITU, *Radiocommunication Bureau* (accessed April 2013), http://www.itu.int/ITU-R/index.asp?category=information&rlink=br&lang=en.

[46] International Telecommunication Union – ITU, *Radio Regulations Board* (accessed April 2013), http://www.itu.int/en/ITU-R/conferences/RRB/Pages/default.aspx.

[47] S. K. Majumdar, I. Vogelsang, M. E. Cave (2005). *Op. cit.,* supra footnote 9.

[48] International Telecommunication Union – ITU, *Radiocommunication Advisory Group* (accessed April 2013), http://www.itu.int/en/ITU-R/conferences/rag/Pages/default.aspx.

3.1.1.1. Spectrum allocation process

In the matter of spectrum allocation process, the ITU bases its task on three parameters: frequency, geographic location and priority of the user with regards to interference.[49]

With respect to frequency, ITU has conventionally divided the radio spectrum into nine frequency bands, as shown in Table 1. The range of frequencies occupied goes from 3 kHz to 3000 GHz.[50] The unit for frequency is the hertz (Hz); as a matter of practicality, it shall be expressed with hertz related multiples, such as kilohertz (1 kHz = 10^3 Hz); megahertz (1 MHz = 10^6 Hz); gigahertz (1Ghz = 10^9 Hz). Bands are designated by progressive whole numbers and are allocated to specific uses.[51]

Table 1. Nine frequency bands of radio spectrum

Band number	Symbols	Frequency range (lower limit exclusive, upper limit inclusive)	Correspondingmetric subdivision	Metric abbreviations for the bands
4	VLF	3 to 30 kHz	Myriametric waves	B.Mam
5	LF	30 to 300 kHz	Kilometric waves	B.km
6	MF	300 to 3 000 kHz	Hectometric waves	B.hm
7	HF	3 to 30 MHz	Decametric waves	B.dam
8	VHF	30 to 300 MHz	Metric waves	B.m
9	UHF	300 to 3 000 MHz	Decimetric waves	B.dm
10	SHF	3 to 30 GHz	Centimetric waves	B.cm
11	EHF	30 to 300 GHz	Millimetric waves	B.mm
12		300 to 3 000 GHz	Decimillimetric waves	

Source: ITU (2012). *Radio Regulations 2012*, *Vol. 1 Art. 5*. Available at: http://www.itu.int/pub/R-REG-RR-2012.

With respect to geographical dimension, the world is divided into three Regions: Europe, Africa, the Middle East and northern part of Asia are included in Region 1, the Americas and some of the eastern pacific islands constitute Region 2, the southern part of Asia and Oceania are comprised in Region 3.

[49] S. K. Majumdar, I. Vogelsang, M. E. Cave (2005). *Op. cit.*, supra footnote 9.

[50] Nasa Goddard Space Flight Center, Nasa's Imagine the Universe, *Electromagnetic Spectrum* (accessed April 2013), http://imagine.gsfc.nasa.gov/docs/science/know_l1/emspectrum.html.

[51] International Telecommunication Union – ITU (2012). *Op. cit.*, supra footnote 12.

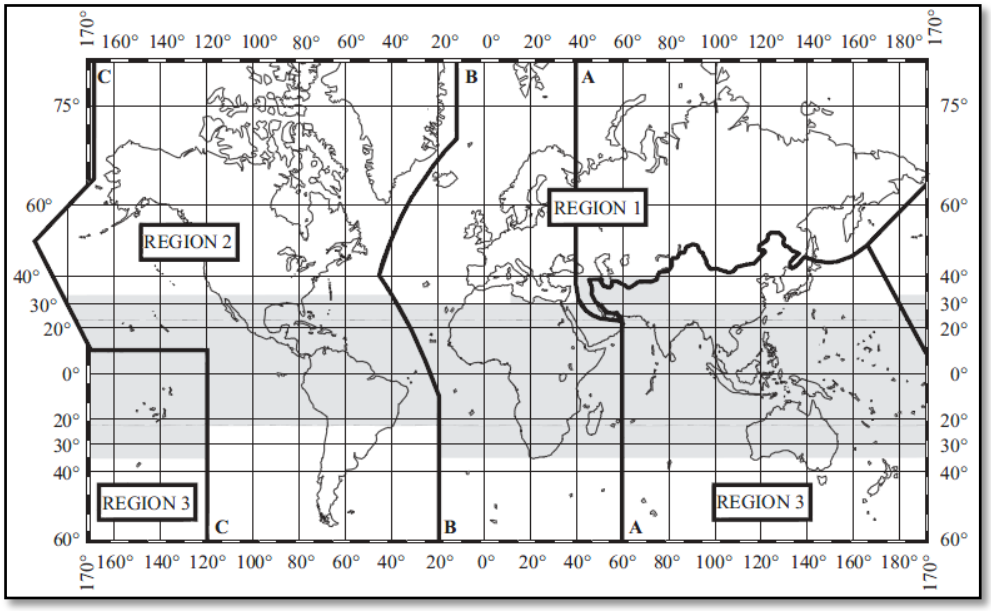

Figure 4. ITU Regions
Source: ITU (2012). *Radio Regulations 2012*, *Vol. 1 Art. 5*. Available at: http://www.itu.int/pub/R-REG-RR-2012.

Each Region defines its own set of frequency allocations, consistently with the boundaries imposed by the ITU in the international Table of Frequency Allocations (TFA), which authorises one or more radio services in each band. Table 2 shows a portion of a TFA, which can help to understand how a TFA is structured.

Table 2. Table of Frequency Allocations: 8.3 – 110 kHz (portion)

Allocation to services		
Region 1	Region 2	Region 3
Below 8.3	(Not allocated) 5.53 5.54	
8.3-9 **9-11.3**	METEOROLOGICAL AIDS 5.54A 5.54B 5.54C METEOROLOGICAL AIDS 5.54A RADIONAVIGATION	
11.3-14	RADIONAVIGATION	
14-19.95	FIXED MARITIME MOBILE 5.57 5.55 5.56	
19.95-20.05	STANDARD FREQUENCY AND TIME SIGNAL (20 kHz)	
20.05-70	FIXED MARITIME MOBILE 5.57 5.56 5.58	
70-72 RADIONAVIGATION 5.60	**70-90** FIXED MARITIME MOBILE 5.57 MARITIME RADIO-NAVIGATION 5.60 Radiolocation	**70-72** RADIONAVIGATION 5.60 Fixed Maritime mobile 5.57 5.59
72-84 FIXED MARITIME MOBILE 5.57 RADIONAVIGATION 5.60 5.56		**72-84** FIXED MARITIME MOBILE 5.57 RADIONAVIGATION 5.60

REGIONS

FREQUENCY BAND

PRIMARY SERVICE

GLOBAL ALLOCATION
no regional differences

FOOTNOTE
adjacent to service name
applicable only to that particular service

FOOTNOTE
to be applied to more than one of the allocated services or to the whole of the allocation concerned

SECONDARY SERVICE

REGIONAL ALLOCATION
different allocation for each Region

Source: ITU (2012). *Radio Regulations 2012*, *Vol. 1 Art. 5*. Available at: http://www.itu.int/pub/R-REG-RR-2012.

By differentiating the allocation of radio spectrum bands to broad categories of radio services within the three ITU Regions, each of them has the possibility of choosing, between different compatible services, those it wants to implement in its territory.[52] Moreover, the international regulation also recognises worldwide frequency allocations without any differences between ITU Regions. These global allocations, identical in all three ITU Regions, are preferred, if they are feasible, as markets for equipment and services can be created on a worldwide scale, conflicts between countries may be avoided and better development of radio services can be pursued.[53]

The current RR (RR2012) defines 40 different radiocommunication services: 30 of them appear in the TFA. Moreover SMAs could define other services.[54]

In the TFA, services are distinguished into primary and secondary services, where secondary services are hierarchically inferior. As the aim is to avoid harmful interference, stronger rights are associated to those identified as primary services.[55] A service is classified as primary service if its name is written in capital characters (i.e. FIXED). Otherwise, if its name is written in normal characters, the service is called secondary service (i.e. Mobile).

As it is established in the RR, stations of a secondary service:

- shall not cause harmful interference to stations of primary services to which frequencies are already assigned or to which frequencies may be assigned at a later date;
- cannot claim protection from harmful interference from stations of a primary service to which frequencies are already assigned or may be assigned at a later date;
- can claim protection, however, from harmful interference from stations of the same or other secondary service(s) to which frequencies may be assigned at a later date.[56]

Moreover, neighbouring countries can adopt allotment plans in order to prevent interference among users that are managed by different administrations.[57] Within an allotment plan, the use of a radio frequency or a radio frequency channel is destined to one or more administrations in one or more identified

[52] International Telecommunication Union – ITU (2007). *Op. cit.,* supra footnote 31.

[53] W. H. Melody, W. Lemstra (2011*). Op. cit.,* supra footnote 35.
J.-M. Chaduc, G. Pogorel (2008). *Op. cit.,* supra footnote 1.

[54] International Telecommunication Union – ITU (2010). *Spectrum Management System for developing countries* (PowerPoint), SMS4DC training seminar, October 2010. Available at: http://www.itu.int/ITU-D/asp/CMS/Events/2010/SMS4DC/SMS4DC2_AllocationsV2.pdf.

[55] McLean Foster & Co. in collaboration M. Cave, R. W. Jones (2007). *Op. cit.,* supra footnote 17.

[56] International Telecommunication Union – ITU (2012). *Radio Regulations,* Vol. 1, Art. 2, Geneva, Switzerland. Available at: http://www.itu.int/pub/R-REG-RR-2012.

[57] J. A. Stine, D. L. Portigal (2004). *An introduction to Spectrum Management*, Mitre Technical Report, Virginia, USA: the Mitre Corporation. Available at: http://www.mitre.org/work/tech_papers/tech_papers_04/04_0423/04_0423.pdf.

countries or geographical areas and under specified conditions. They are usually contained in Appendices to RR.[58]

In a band of the TFA there can be footnotes, which contain exceptions or more specific information about allocations, introduced by SMAs, for instance the allocation of a band or a portion of it in a geographic area smaller than an ITU Region.[59] Footnotes may refer to resolutions, contained in the RR, for further information.[60]

3.1.2. Regional level: Europe

At European level, the European Commission (EC), the Electronic Communications Committee (ECC) of the European Conference of Postal and Telecommunications Administrations (CEPT) and the European Telecommunications Standards Institute (ETSI) define and update the European spectrum policy and legislation framework, with the aim to coordinate spectrum management approaches across the EU.[61]

The EU regulatory framework is contained in the Radio Spectrum Policy Decision (Decision No. 676/2002/EC). It introduces a cooperation mechanism for the decision making process with regard to spectrum management which includes an on-going relationship involving the EC, the RSPG and the Radio Spectrum Committee (RSC).[62] Other bodies may be involved, depending on the regulatory issue.[63] This decision is aimed at establishing a legal framework with which ensuring a harmonised use of the spectrum across Europe. Moreover, it furthers the objective to protect the interests of the European Community in international negotiations on the use of the spectrum.[64]

The EC embodies and preserves the general interest of the 27 Member States. Their opinions are provided by the RSPG by means of public consultations.

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[58] International Telecommuication Union – ITU (2012). *Radio Regulations*, Geneva, Switzerland. Available at: http://www.itu.int/en/history/Pages/RadioRegulationsA.aspx?reg=41&be=S0202000024.

[59] International Telecommunication Union – ITU, InfoDev. ICT Regulation Toolkit (accessed April 2013), http://www.ictregulationtoolkit.org/en/Section.1668.html.

[60] T. Tjelta, A. L. Lillebø, E. O. Evenstad (2008). *ITU-R World Radiocommunication Conference 2007*, Telektronikk 1.2008, Telenor ASA, 2008. Available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.192.3095&rep=rep1&type=pdf.

[61] Electronic Communications Committee – ECC, European Telecommunications Standards Institute – ETSI (2011). *The European Regulatory Environment for radio equipment and spectrum. An introduction*. Available at: http://apps.cept.org/eccetsirel/data/catalogue.pdf.

[62] E. Bohlin, C. Blackman, S. Forge, A. Renda (2007). *A Common European Spectrum Policy. Barriers and Prospects*. Study requested by the European Parliament's Committee on Industry, Research and Energy. Available at: http://www.europarl.europa.eu/meetdocs/2004_2009/documents/dv/itre_st_2007_spectrum_poli/ITRE_ST_2007_SPECTRUM_POLICY.pdf.

[63] K. Pearson, P. Marks (2012). *Op. cit.*, supra footnote 29.

[64] European Parliament – EP, Council of the European Union – the Council (2002), *Decision No. 676/2002/EC of the European Parliament and of the Council of 7 March 2002 on a regulatory framework for radio spectrum policy in the European Community*, (Radio Spectrum Decision), Official Journal of the European Communities. Available at: http://europa.eu/legislation_summaries/information_society/radiofrequencies/l24218a_en.htm.

Four main functions of the EC can be distinguished:

- to propose legislation to Parliament and Council;
- to administer and implement Community policies;
- to enforce Community law;
- to negotiate international agreements.

In 2002, after the adoption of the Radio Spectrum Decision (Decision No. 676/2002/EC), the RSPG was established with Decision No. 2002/622/EC, amended in December 2009 (Decision No. 2009/978/EU). Its members are high-level governmental representatives of the EU Member States and of the EC. The RSPG plays an important role in fostering the economic, political, cultural, strategic, health and social aspects of the radio spectrum policy, giving strategic advices to the RSC. It also considers and tries to properly balance the various potentially conflicting needs of radio spectrum users. Other EU institutions, such as the EP and the Council can also request advice from the RSPG to issue an opinion or write a report on specific radio spectrum policy topics relating to electronic communications.[65]

Pursuant to Article 4 of the Radio Spectrum Decision, the EC, in consultation with the RSC, may place mandates to CEPT in order to have technical assistance within the harmonisation process of the use of the spectrum. CEPT deliverables are called reports. They contain compatibility studies' results, technical parameters and sharing conditions under which spectrum may be used. They constitute the basis for the development of EC recommendations, which are not binding on EU Member States and EC decisions, whose implementation is mandatory.

The RSC, on the basis of proposals made by the EC, takes decisions governing the use of the spectrum.[66] The RSC is a committee established in 2002 under the Radio Spectrum Decision. It is composed of representatives of the EU Member States and chaired by a representative of the EC. The RSC exercises its functions through advisory and regulatory procedures that are set out in the EU's Regulation No. 182/2011 of the EP and of the Council. Its major task consists of assisting the EC in formulating, developing and implementing a

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[65] Electronic Communications Committee – ECC, European Telecommunications Standards Institute – ETSI (2011). *Op. cit.,* supra footnote 61;
L. Berlemann, B. H. Walke (2006). *Op. cit.,* supra footnote 40;
European Telecommunications Standards Institute – ETSI, *ETSI website* (accessed April 2013), www.etsi.org;
European Conference of Postal and Telecommunications Administrations – CEPT, *CEPT website* (accessed April 2013), http://www.cept.org;
European Commission – EC (2013). Digital Agenda for Europe, *Radio Spectrum Committee* (accessed April 2013), http://ec.europa.eu/digital-agenda/en/radio-spectrum-committee-rsc;
European Commission – EC (2013). Digital Agenda for Europe, *Radio Spectrum Policy Group* (accessed April 2013), https://ec.europa.eu/digital-agenda/en/radio-spectrum-policy-group-rspg#the-rspgs-role.

[66] Office of Communications – Ofcom (2007). *Digital Dividend Review: a statement on our approach to awarding the digital dividend*. Available at: http://stakeholders.ofcom.org.uk/binaries/consultations/ddr/statement/statement.pdf.

Community radio spectrum policy to ensure a harmonised and efficient use of radio spectrum across Europe, having regard to the development and adoption of technical implementing measures related to radio spectrum.[67]

CEPT was established in 1959. It is a recognised voluntary organisation of 48 national regulatory administrations (including all EU Member States), covering almost the entire geographical area of Europe. They collaborate in the harmonisation process of telecommunications, radio spectrum and postal regulations throughout Europe to improve efficiency and coordination for the benefit of European society. CEPT conducts its work through three autonomous business committees (Com-ITU, ECC and CERP). The chairmen of these committees form the organisation's Presidency, supported by the Secretariat of CEPT that is the European Communications Office (ECO).

The Committee for ITU Policy (Com-ITU) is responsible for organising the CEPT's engagement with the ITU for all activities except WRCs, while the European Committee for Postal Regulation (CERP) is responsible for postal regulation and European coordination and preparation for Universal Postal Union (UPU) meetings.

The ECC conducts more detailed spectrum planning, developing common policies and non-binding regulations in electronic communications and related applications for Europe. It takes an active role at the international level, preparing common European proposals to report European interests to the ITU and other international organisations. The ECC helps radio frequency spectrum to be used in an efficient and harmonised way across Europe, carrying out regulations and providing decisions regarding the allocation of frequencies for radiocommunication services and applications within CEPT countries. In its functions, ECC is supported by working groups and project teams, which carry out regulatory and technical studies and consultations to inform ECC's policy, and to create deliverables, which have to be approved by ECC. ECC produces reports, decisions and recommendations on spectrum usage favouring European harmonisation at the allocation level. In particular, ECC reports represent the starting-point underlying ECC decisions.

In order to achieve its object to harmonise the efficient use of the radio spectrum within Europe, CEPT endorsed the proposal to create a European Framework for allocations and utilisation of radio frequencies: the European Common Allocation Table. The Working Group Frequency Management (WG FM) is responsible for developing and updating this Table.[68]

The ETSI was established in 1988 and recognised by the EU as a European Standards Organisation (ESO) in 1998. It is an independent, non-profit

[67] European Parliament – EP, Council of the European Union – the Council (2002). *Op. cit.,* supra footnote 64.

[68] Electronic Communications Committee – ECC (2013). *ERC Report 25: The European Table of Frequency Allocations and Applications in the Frequency Range 8.3 kHz to 3000 GHz* (ECA TABLE). Available at: http://www.erodocdb.dk/docs/doc98/official/pdf/ERCRep025.pdf.

association with more than 700 members, including SMAs, companies and international organisations from 62 countries worldwide. It deals with telecommunication standardisation activities, which were previously under CEPT responsibility. ETSI produces global standards for ICTs, including fixed, mobile, radio, converged, broadcast and Internet technologies. Much of the work is carried out in committees and working groups composed of members' technical experts. The ECC has a strong cooperation with ETSI in order to ensure coherence between ECC decisions and ETSI harmonised standards. A memorandum of understanding has been agreed between ETSI and the ECC in order to better coordinate their activities.

Even though spectrum management is principally a national competence, regional organisations have a main role to play in driving the establishment of States' policies. However the harmonisation of spectrum usage at European level is a very hard goal as EU Member States differ from each other in terms of internal specific conditions, such as geography configuration, political situation and spectrum management history.[69]

3.1.3. National level

Complying with the RR, further possible international agreements with neighbouring countries and the framework set out at regional level, radio spectrum management is a SMAs' responsibility. SMAs can be either a part of a government ministry or an independent agency, normally established by statute, with specified powers and responsibilities.[70] SMAs publish laws and regulations in order to establish the principles applicable to electronic communications.[71]

At the national level, spectrum management involves two main steps: the final allocation of spectrum bands to allowed uses and the assignment of usage rights to individual users.[72]

There are three main competing objectives spectrum regulators strive for:

- technical efficiency: it consists of the fullest possible use of all available radio spectrum, promoting the introduction of new technologies that can ensure a more productive use of the resource, the costs of which are justified by the value of the spectrum saved. Two measures of technical efficiency are occupancy and data rate (how much data and information can be transmitted for a given amount of spectrum capacity), used in determining how efficiently certain assigned frequencies are used by services and users.
- economic efficiency: an economically efficient distribution of spectrum is set out when spectrum is allocated to users and uses that derive the

[69] European Commission - EC (2010). *Op. cit.*, supra footnote 18.
[70] McLean Foster & Co. in collaboration M. Cave, R. W. Jones (2007). *Op. cit.*, supra footnote 17.
[71] J.-M. Chaduc, G. Pogorel (2008). *Op. cit.*, supra footnote 1.
[72] W. H. Melody, W. Lemstra (2011). *Op. cit.*, supra footnote 33.

highest economic value from it, meaning the overall benefits to society are maximised.

- social efficiency: the pursuit of technical and economic efficiencies is constrained by the necessity to provide certain public services, such as defence and safety and by international obligations on spectrum use.[73] Public policy objectives drive the decision on spectrum allocation and assignment, but government and political interference must be avoided, in order to ensure a transparent spectrum management approach.

From a technical point of view, some frequency bands will be more desirable than others for each particular kind of service, as having access to the most suitable frequency bands gives users the opportunity to minimise the cost of implementation and optimise the performance. Even though not all types of services will be able to use the frequency bands best suited, the aim is to allocate radio spectrum to its most productive uses.

Further considerations must be made when economic criteria are called upon in spectrum management issues. It can be said that the goal of economic efficiency is reached if radio spectrum is divided in such a way that the benefits to the economy as a whole from an additional amount of assigned spectrum are the same in each use.[74]

Last but not least, SMAs must always take into account public interest goals in administering radio spectrum, as they act for the benefit of citizens. Not only technical, economic and public interest objectives must be balanced, but a compromise should be found with spectrum allocations derived by past decisions and the forecasts of how radio spectrum could be allocated in the future.[75]

3.1.3.1. Spectrum allocation and assignment

The concept of spectrum scarcity underlies traditional spectrum management approaches. Spectrum, being a limited resource, need to be managed by SMAs, responsible of ensuring its best use, selecting services and operators.

SMAs are in charge of the final allocation of frequency bands to specific types of services in their respective territories, defining a detailed national frequency allocation table, in accordance with international allocation agreements.[76] The table may also indicate, for each frequency band, user categories and their respective rights and obligations. Traditional allocation processes are based on a weighing of both public and private needs for frequencies, considering carefully technical rules and engineering aspects of radio spectrum usage.[77]

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[73] E. Lie (2004). *Op. cit.*, supra footnote 28.

[74] McLean Foster & Co. in collaboration M. Cave, R. W. Jones (2007). *Op. cit.*, supra footnote 17.

[75] W. H. Melody, W. Lemstra (2011). *Op. cit.*, supra footnote 33.

[76] W. H. Melody, W. Lemstra (2011). *Op. cit.*, supra footnote 33.

[77] World Bank, InfoDev, IFC, ITU (2011). *Telecommunications Regulation Handbook*, 10th edition (edited by C. Blackman & L. Srivastava). Available at: http://www.itu.int/dms_pub/itu-d/opb/reg/D-REG-TRH.01-2011-PDF-E.pdf.

National allocations are revised occasionally to reflect allocation changes at the international level or technological improvements that allow reallocation to higher-value uses.[78]

SMAs define their own set of rules and procedures governing radio frequency usage. Moreover, they permanently supervise spectrum users, setting up proper controls and inspections in order to compel users to comply with the established rules and detect and stop unlicensed users.

Spectrum assignment is the activity of assigning radio frequencies or radio frequency channels within each allocated band to individual users by means of authorisation given by the SMA.[79] Frequency assignment decisions are based on the selection of those operators that result as being best qualified to provide the designated services. Thus, public needs and market conditions bear heavily on both the allocation and the assignment processes. The assignment of frequencies is carried out establishing specified conditions of usage, in particular technical standards, with which operators providing communications services must comply. The main purpose is to prevent harmful interference.[80]

Historically, frequencies have been distributed by means of the award of licences by the public administrative authority. Within a regime of exclusive licensing, public authorities decide on the assignment of usage rights. A set of technical parameters regarding frequency band, power of transmission, geographical location, direction and time of emission are specified and no secondary trading is permitted.[81]

This administrative approach, known also as command-and-control regime, has been introduced with the intent to coordinate frequencies use and avoid interference problems.[82] For many years, the traditional assignment process has been occurring on a first come-first served basis, as there was a limited demand for spectrum, so applicants' requests could be easily satisfied. However, when demand for a set of frequencies allocated for a particular type of service exceeds supply, regulators may use comparative hearings or beauty contests to choose between competing applicants those with the highest-profile in providing the designated service, on the basis of an established set of criteria, such as technical and financial conditions of applicants, their access to capital, technical characteristics of the proposal for using the frequencies and plans for

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[78] B. Wellenius, I. Neto (2006). *The radio spectrum: opportunities and challenges for the developing world*, info, Vol. 8, Iss. 2, pp. 18–33. Available at: http://www.emeraldinsight.com/journals.htm?articleid=1546217.

[79] International Telecommunication Union – ITU (2012). Report ITU-R SM. 2012-1. *Economic Aspects of Spectrum Management*, Geneva, Switzerland. Available at: http://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-SM.2012-1-2000-PDF-E.pdf.

[80] World Bank, InfoDev, IFC, ITU (2011). *Op. cit.,* supra footnote 77.

[81] G. R. Faulhaber, D. Farber (2002). *Spectrum Management: Property rights, Markets, and the Commons*. Paper presented at the 14th Biennal Conference of the International Telecommunication Society, Seoul, South Korea, No. 02-12, December 2002. Available at: http://assets.wharton.upenn.edu/~faulhabe/SPECTRUM_MANAGEMENTv51.pdf.

[82] McLean Foster & Co. in collaboration M. Cave, R. W. Jones (2007). *Op. cit.,* supra footnote 17.

developing the specific service. In some cases, lotteries may be used, awarding licences through random selection. However, the spectrum assignment to those operators who allocate the highest value to frequencies depends only on chance.[83]

With the command-and-control regime, regulators put too little attention on economic aspects and often spectrum bands are assigned to applicants who don't give them the highest value.[84] Instead, economic theory teaches that when a resource is scarce the decision making process should always consider the economic view-point and, in case of demand exceeding supply, a price-based system should be introduced.[85]

In the current environment characterised by fast changes in technology and market conditions, the administrative model has revealed its flaws: scarce flexibility, long delays, spectrum misallocation.[86] It appears to be not only extremely rigid but, even worse, often subject to political interference and corruption. Moreover, it has been recognised that an administrative approach that assigns valuable spectrum without charging a proper price to licences fails to provide appropriate incentives for an efficient use of the spectrum that may result wasted, misused or unused in some parts.[87] The low frequencies are mainly occupied by older, less efficient technologies while the most recent, improved technologies have to use higher frequencies with limited propagation capacity and higher roll-out costs.[88]

Given the physical characteristics of the radio spectrum, scarcity can originate when the demand for spectrum usage exceeds the spectrum available, and this is clear since the development of new advanced technologies that have increased the demand for specific bands.[89] But scarcity is often induced by inefficient spectrum management. Regulators may not be able to keep pace with rapid changes in technology and market conditions, causing spectrum misallocation with old and static policies.[90] Several surveys on spectrum usage

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[83] W. H. Melody, W. Lemstra (2011*). Op. cit.,* supra footnote 33.

[84] B. Wellenius, I. Neto (2006). *Op. cit.,* supra footnote 78.

[85] International Telecommunication Union – ITU (2012). *Op. cit.,* supra footnote 79.

[86] J. M. Bauer (2002). *A comparative Analysis of Spectrum Management Regimes*. Paper presented at the 30th Research Conference on Communication, Information and Internet Policy, Alexandria, VA, USA, 28-30 September 2002. Available at: http://www.comlab.hut.fi/studies/4210/papers/1_1.pdf.

[87] W. H. Melody, W. Lemstra (2011*). Op. cit.,* supra footnote 33.

[88] European Commission – EC (2005). Communication from the Commission to the Council, the European Parliament and the European Economic and Social Committee and the Committee of the Regions. *A market-based approach to spectrum management in the European Union*, {COM(2005) 400}. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2005:0400:FIN:EN:PDF.

[89] B. Freyens (2007). *The Economics of Spectrum Management: A Review*. Paper commissioned by the Australian Communication and Media Authority – ACMA. Available at: http://www.acma.gov.au/webwr/aca_home/publications/reports/spectrum%20-%20final%20draft%20-%203.pdf.

[90] European Commission - EC (2010). *Op. cit.,* supra footnote 18.

have been conducted. They show that only 5-10% of the most useful licensed spectrum is used at any given moment in time.[91]

The administrative approach has been discouraging innovation and opportunity to grow, as it is too slow in such a dynamic environment, too poorly equipped to plan an efficient frequency allocation and assignment and to correctly estimate the weight and the future expansion of some services, sometimes unfair as it is unclear who actually make decisions, how these decisions are made and which are the standards and criteria applied.[92]

The advent of new radio technologies and new spectrum applications places an ever-increasing pressure on the regulatory system. An effective radio spectrum management is required to seize the opportunity to improve the overall telecommunications infrastructure. Three main trades-offs need to be managed: firstly, regulators should enable new and valuable service to enter the market, while avoiding additional harmful interference. Other two big issues are the mismatch between the growing demand for spectrum by new services and the limited spectrum availability, and the suboptimal spectrum allocation and assignment with regard to the potential economic and social benefits being lost partly because of weak and incoherent spectrum management approaches.[93] Minimising these problems is crucial in order to take full advantage of spectrum resources. The access to the radio spectrum and its efficient use represent key factors to foster economic growth, to create new opportunities for innovation and to cut the digital divide, defined as the gap between information and communication technologies haves and have-nots. It is extremely important to respond dynamically to the new conditions of an ever-changing environment.[94] Inefficiencies in distribution and use of the spectrum create costs, lead to wasted opportunities for business and society and prevent the deployment of innovative technologies and services.[95]

Coordinated efforts of regulators and engineers can refine the use of the radio spectrum, making its capacity ever bigger.[96] The introduction of new technologies, new services and new market players should always be promoted, while taking into account rights and expectations of existing users.[97] An improper management approach can determine a suboptimal allocation of spectrum, creating artificial shortages and surplus across spectrum, leaving

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[91] L. Yang, L. Cao, H. Zheng (2013). *Proactive Channel Access in Dynamic Spectrum Networks* (work in progress). University of California, Santa Barbara: US. Available at: http://www.cs.ucsb.edu/~htzheng/publications/pdfs/proactive-crowncom.pdf;
M. McHenry - Shared Spectrum Company (2003). *Spectrum White Space Measurements*. Presentation to New America Foundation Broadband Forum, 20 June 2003. Available at: http://www.newamerica.net/files/nafmigration/archive/Doc_File_185_1.pdf.

[92] W. H. Melody, W. Lemstra (2011*). Op. cit.,* supra footnote 33.

[93] International Telecommunication Union – ITU (2012). *Op. cit.,* supra footnote 79.

[94] W. H. Melody, W. Lemstra (2011*). Op. cit.,* supra footnote 33.

[95] European Commission - EC (2010). *Op. cit.,* supra footnote 18.

[96] J.-M. Chaduc, G. Pogorel (2008). *Op. cit.,* supra footnote 1.

[97] McLean Foster & Co. in collaboration M. Cave, R. W. Jones (2007). *Op. cit.,* supra footnote 17.

spectrum bands underused or misused.[98] Basically, technological progress, spectrum management and demand of existing and new services together determine the use of the radio spectrum. The goal is to actively find the right balance between them, in an extremely dynamic environment. [99]

[98] W. H. Melody (2001). *Spectrum auctions and efficient resource allocation: learning from the 3G experiences in Europe*. Info, Vol. 3, Iss. 1, pp. 5–13. Available at: http://www.emeraldinsight.com/journals.htm?articleid=873900.

[99] J.-M. Chaduc, G. Pogorel (2008). *Op. cit.*, supra footnote 1.

4. Need for change

4.1. The "Mobile boom"

Radio frequencies have been historically employed in radio and television broadcasting and transmission of voice telephony. Progressive improvements in the processes and equipment used for transmitting and receiving signals have led to subsequent increase in the range of communications possible on each frequency band.[100]

The rapid growth of the ICT industry has given birth to a huge variety of new services and applications moving from traditional to Internet broadband services.[101] Hence, in recent years, demand for spectrum has tremendously increased and it has also changed its nature. Society is becoming more mobile, so more spectrum is required for the provision of mobile communication services.[102]

Liberalisation, deregulation and privatisation processes involving the telecommunication sector have favoured the implementation of a more competitive environment and encouraged the introduction of new services and technologies. In particular, increased competition has determined an unpredictably rapid diffusion of mobile telephony and then, of mobile Internet.

Mobile telephony is nearly the technology that has been adopted with the most rapid rate in history. Moreover, in developing countries it has been playing (and still plays) a major role in fostering progress, as it can enhance everyday life with many ICT applications in education, health, banking and other life aspects, shortening the existing gap with developed countries.[103]

Mobile networks are considered the solution for connecting developing countries and rural areas as they proved to be less costly and fast to develop rather than fixed-line communications.[104]

[100] W. H. Melody, W. Lemstra (2011). *Op. cit.*, supra footnote 33.

[101] International Telecommunication Union – ITU (2013). *Trends in Telecommunication Reform 2013. Transnational Aspects of Regulation on a Networked Society*. Geneva, Switzerland. Available at: http://www.itu.int/dms_pub/itu-d/opb/reg/D-REG-TTR.14-2013-SUM-PDF-E.pdf.

[102] M. Cave (2002). *Op. cit.*, supra footnote 21.

[103] International Telecommunication Union – ITU (2013). *The World in 2013. ICT Facts and Figures,* Geneva, Switzerland. Available at: http://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2013.pdf.

[104] E. Lie (2004). *Op. cit.*, supra footnote 28.

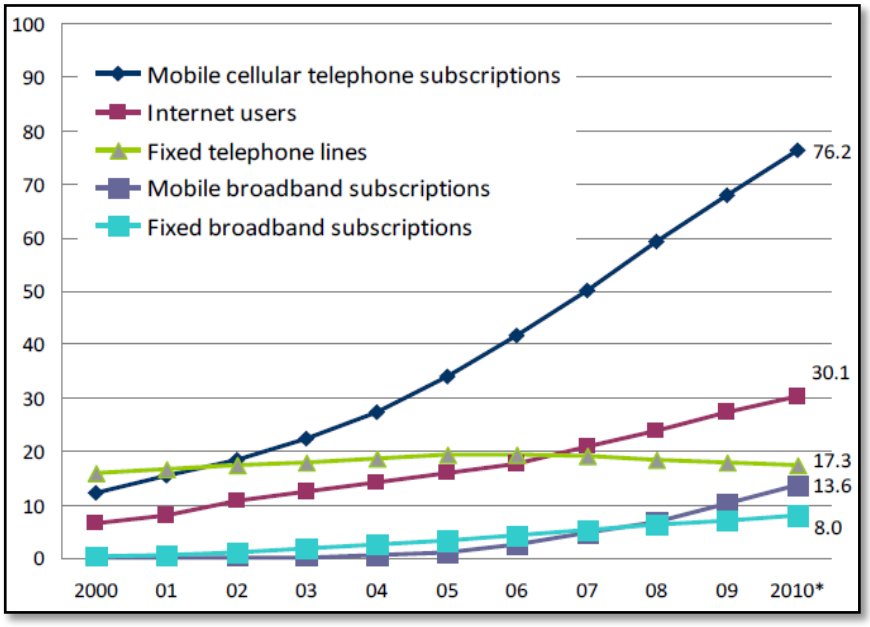

Figure 5. Global ICT developments, 2000-2010
Note: * Estimates
Source: World Bank, InfoDev, IFC, ITU (2011). *Telecommunications Regulation Handbook*, 10th edition (edited by C. Blackman & L. Srivastava). Available at: http://www.itu.int/dms_pub/itu-d/opb/reg/D-REG-TRH.01-2011-PDF-E.pdf.

In 2002 the total number of mobile subscribers in the world surpassed that of fixed customers. At the end of 2011, about 6 billion-mobile cellular subscriptions have been counted globally and they will reach an estimated 6.84 billion by the end of 2013.[105] Nowadays there is almost a mobile-cellular subscription per inhabitant worldwide and the number of mobile connections continues to grow rapidly, as it has been predicted there may be an additional 1 billion mobile connections worldwide within one year.[106]

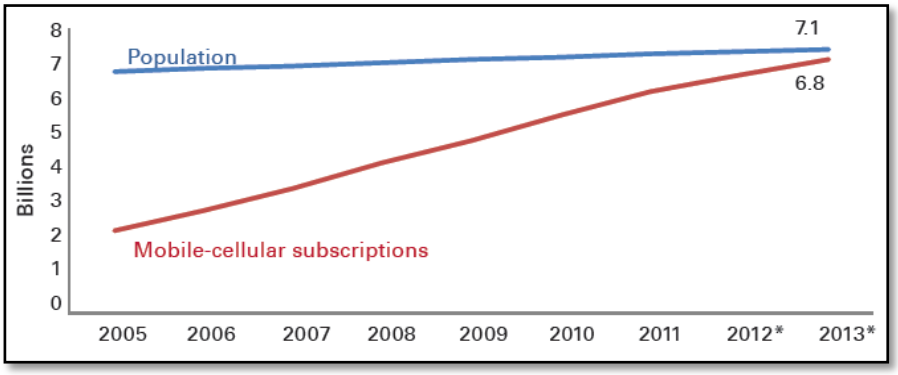

Figure 6. Mobile subscriptions
Note: * Estimates
Source: ITU (2013). *The World in 2013. ICT Facts and Figures*, Geneva, Switzerland. Available at: http://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2013.pdf.

[105] International Telecommunication Union – ITU (2013). *Op. cit.*, supra footnote 101.
[106] GSM Association – GSMA (2012). *Importance of the Digital Dividend* (accessed May 2013), http://www.gsma.com/spectrum/wp-content/uploads/DigitalDividend/DDtoolkit/digital-dividend-background.html.

The advent of the Internet has radically changed the world, revolutionizing all aspects of human life and giving outset to a series of radical innovations able to shorten distances and time between individuals worldwide.[107] Between 2005 and 2010, the number of Internet users has doubled. It has been estimated that by the end of 2013, 39% of the world's population, meaning over 2.7 billion people, will be using the Internet, about 13% more compared with 2009. In the developed world the percentage is quite high, 77%, compared to that of the developing world, 31%, but this is still increasing with high rate.[108]

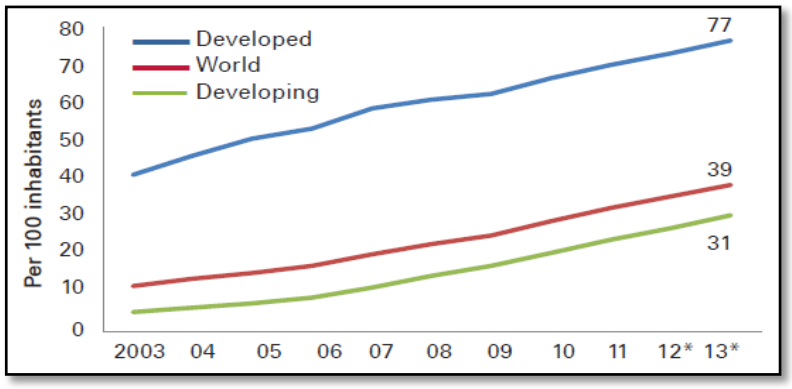

Figure 7. Internet subscriptions
Note: * Estimates
Source: ITU (2013). *The World in 2013. ICT Facts and Figures,* Geneva, Switzerland. Available at: http://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2013.pdf.

In 2008 mobile broadband subscriptions overtook fixed broadband subscribers, highlighting the potential of the mobile Internet. In 2011 mobile-broadband subscriptions have doubled fixed-broadband subscriptions and they will be jumping to an estimated 2.1 billion by the end of 2013, representing nearly three times the number of fixed-broadband subscriptions.[109]
Thanks to new types of devices, such as smartphones, tablets, e-book readers, gaming consoles, a wide range of services are delivered through the wireless broadband network and the number is growing at a fast pace.[110]

[107] International Telecommunication Union – ITU (2013). *Op. cit.*, supra footnote 101.
[108] International Telecommunication Union – ITU (2013). *Op. cit.*, supra footnote 103.
[109] International Telecommunication Union – ITU (2009). *The World in 2009. ICT Facts and Figures*, Geneva, Switzerland. Available at: http://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2009.pdf;
International Telecommunication Union – ITU (2010). *The World in 2010. ICT Facts and Figures*, Geneva, Switzerland. Available at: http://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2010.pdf;
International Telecommunication Union – ITU (2011). *The World in 2011. ICT Facts and Figures*, Geneva, Switzerland. Available at: http://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2011.pdf;
International Telecommunication Union – ITU (2013). *Op. cit.*, supra footnote 103.
[110] Radio Spectrum Policy Group – RSPG (2013). *Opinion on Strategic Challenges facing Europe in addressing the Growing Spectrum Demand for Wireless Broadband*. Available at: http://rspg-spectrum.eu/rspg_opinions/index_en.htm.

This turns out in an incredible growth of global traffic, in particular data, such as video streaming, file sharing, online gaming and VOIP (voice over IP) calling, while voice represents only a small portion of the traffic, once the primary element. [111]

Cisco estimates that between 2011 and 2016 global mobile traffic will increase 18 times.[112] LTE (Long Term Evolution), the new broadband mobile network technology, has already been developed in many countries and several others are working on it, as showed in the picture below.

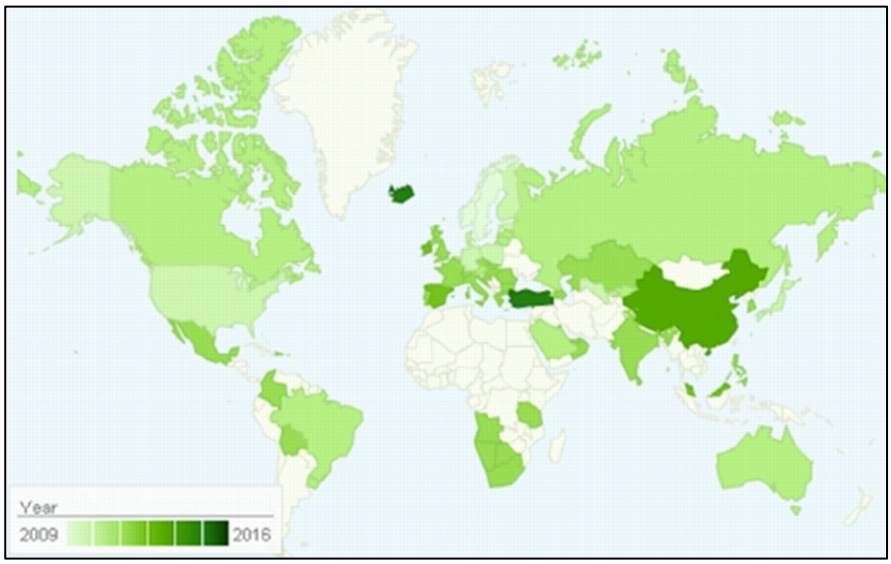

Figure 8. Global heatmap by year of LTE deployment
Source: The Cisco (2013). Cisco Visual Networking Index: *Global Mobile Data Traffic Forecast Update,* 2012–2017, 6 February 2013. Available at: http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-520862.html.

With its high data speeds, low latency, massive bandwidth and real-time capability, LTE services can deliver high definition video, music and multiplayer video gaming to consumers wherever they are and at any time.[113]

In developing countries, the number of mobile-broadband subscriptions is expected to be more than doubled from 2011 to 2013 (from 472 million to 1.16 billion). Interestingly, in developing countries mobile-broadband network is likely the primary, if not, the only form of connection, unlike developed countries where mobile and fixed connections are both present and accessible.[114]

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[111] International Telecommunication Union – ITU (2013). *Op. cit.*, supra footnote 101.

[112] GSM Association – GSMA (2012). *Importance of the Digital Dividend* (accessed May 2013), http://www.gsma.com/spectrum/wp-content/uploads/DigitalDividend/DDtoolkit/digital-dividend-background.html.

[113] European Commission – EC (2007). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions *Reaping the full benefits of the digital dividend in Europe: a common approach to the use of the spectrum released by the digital switchover*, {COM(2007) 700 }. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2007:0700:FIN:en:PDF.

[114] International Telecommunication Union – ITU (2009). *Op. cit.*, supra footnote 109;

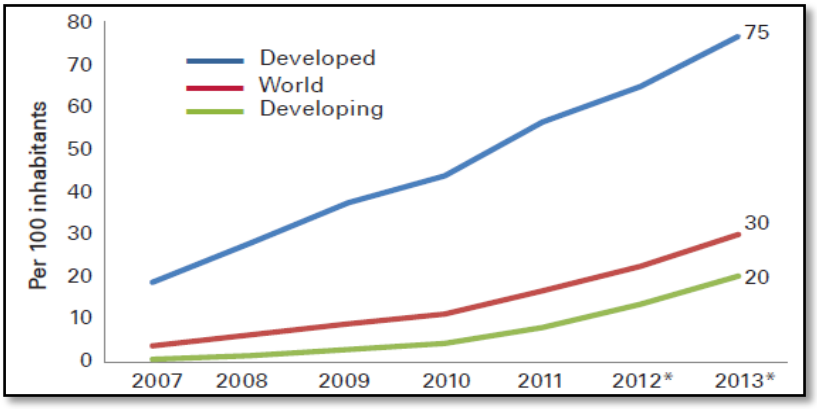

Figure 9. Mobile Internet
Note: * Estimates
Source: ITU (2013). *The World in 2013. ICT Facts and Figures*, Geneva, Switzerland. Available at: http://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2013.pdf.

Comparing all these results, it can be said that mobile-cellular subscriptions and active mobile-broadband subscriptions penetration rates have been growing fast between 2008 and 2013 compared with fixed telephone subscriptions and fixed-broadband subscriptions penetration rates, which have remained substantially constant or have decreased. This situation confirms the idea that individuals are asking for more mobile services and also for more applications based on the Internet, looking at the growing number of connected people.

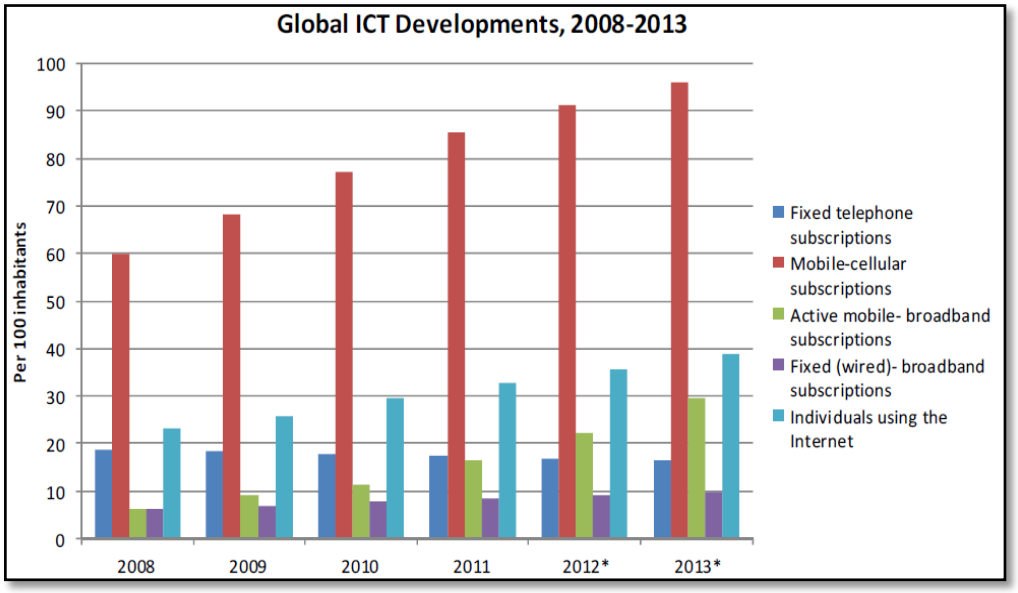

Figure 10. Global ICT trends and broadband penetration, 2008-2013
Note: * Estimates
Source: ITU (2013). *Trends in Telecommunication Reform 2013. Transnational Aspects of Regulation on a Networked Society*. Geneva, Switzerland. Available at: http://www.itu.int/dms_pub/itu-d/opb/reg/D-REG-TTR.14-2013-SUM-PDF-E.pdf.

International Telecommunication Union – ITU (2010). *Op. cit.*, supra footnote 109;
International Telecommunication Union – ITU (2011). *Op. cit.*, supra footnote 109;
International Telecommunication Union – ITU (2013). *Op. cit.*, supra footnote 103.

Not only new refined technologies but also existing services call for more spectrum, sharpening the already drastic condition of spectrum scarcity. The growing disproportion between the demand for radio frequencies and the amount of spectrum available is giving rise to the critical necessity of reconsidering how radio spectrum should be used.[115]

Furthermore, in the past, there was a clear demarcation between services, such as television, which used spectrum, and technologies like telephony, which did not. Instead, convergence between telecommunications, computing, entertainment and information is eroding the boundaries between services.[116] The resulting advent of hybrid services is making extremely difficult predicting what kind of technological development will happen, what kind of new and innovating service will succeed in the market and the related spectrum demand.[117]

Convergence between different technologies and services, globalization, a widespread use of the Internet, the increasing demand for broadband and mobile services and applications, and other phenomena are pushing regulators to properly design a new spectrum policy for a digital world.[118]

Regulators have to face a very arduous challenge in managing radio spectrum given the dynamic nature of the wireless communications environment. Flexibility is the key characteristic that should distinguish a renewed regulatory framework, in a way that it will not constrain future developments. Regulatory barriers should be removed, making easier the access to spectrum and foster the dynamic adaptation to technological and economic developments.[119]

4.2. How to improve spectrum assignment

The debate on introducing reforms in the spectrum management area is more than ever at its peak, given the incontrovertible necessity to overcome the weaknesses of the administrative regime that have contributed to artificial spectrum shortages. Technological developments and new services are struggling with the inefficiencies caused by a command-and-control regime that proved to be inadequate, at least in certain bands.

In recent years, several proposals have been developed. They can be distinguished in technology-driven approaches, based on technology innovation considerations, and market-driven methods, related to the introduction of economic criteria for achieving the highest-valued use of

[115] R. Struzak (2003). *Op. cit.*, supra footnote 1.

[116] E. Lie (2004). *Op. cit.*, supra footnote 28.

[117] M. Cave (2002). *Op. cit.*, supra footnote 21.

[118] International Telecommunication Union – ITU (2012). GSR Discussion Paper. *Spectrum Policy in a hyperconnected Digital Mobile world,* Geneva, Switzerland. Available at: http://www.itu.int/ITU-D/treg/Events/Seminars/GSR/GSR12/documents/GSR12_SpectrumPolicy_Horton_2.pdf.

[119] M. Cave (2002). *Op. cit.*, supra footnote 21.

spectrum.[120] Regulators are moving from a pure administrative model of assignment to more flexible approaches both dealing with the concept of unlicensed spectrum and relaying on more market oriented methods with the aim to supplement or even replace bureaucratic processes.[121]

4.2.1. Technology-driven improvements: spectrum commons

The development of ultra-modern technologies and the convergence of different services are introducing new technical parameters for communication, totally different from those that belong to the existing spectrum management, striving for a more open approach to spectrum management, away from exclusive rights.[122]

Moreover, the significant growth of spectrum demand for wireless technologies has unveiled the impossibility for the available spectrum to meet the needs of future technologies. This calls for a change in the spectrum management to create a dynamic and flexible use of spectrum.[123]

Thus, in recent years unlicensed spectrum models have drawn a lot of interest. Service-specific allocations and assignments would be not required, but considered unnecessarily restrictive. Spectrum would be treated as an asset available to all users complying with certain established technical standards and common rules governing the use, but with no right to protection from interference.[124] The spectrum commons model is based on licence-free or unlicensed users who received certain spectrum bands, used in common with others to provide services.[125]

With the common approach a higher level of efficiency can be gained, as there would be low barriers to entry, which is a source of competition, almost total certainty about band access, low lead times from innovation to market, less pressure on licensed portions of spectrum, creativity through information sharing and diversity. Moreover this model may be more compatible with international harmonisation and standardisation efforts as it offers a collaborative rather than competitive environment for equipment standards.[126]

The attracting proposal of a licence-exempt model leans on strong statements. Firstly, an unlicensed model is easily applied to short-range transmissions, where the density of users is low and there is a negligible probability that users interfere. Secondly, new and smarter technologies allow overcoming the

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[120] B. Wellenius, I. Neto (2006). *Op. cit.,* supra footnote 78.

[121] International Telecommunication Union – ITU (2012). *Op. cit.,* supra footnote 118.

[122] G. R. Faulhaber, D. Farber (2002). *Op. cit.,* supra footnote 81.

[123] A. Durantini, M. Martino (2013). *The spectrum policy reform paving the way to cognitive radio enabled spectrum sharing*. Telecommunications Policy, Vol. 37, Iss. 2–3: Elsevier Ltd, March–April 2013, pp. 87–95. Available at: http://www.sciencedirect.com/science/article/pii/S0308596112001814.

[124] E. Lie (2004). *Op. cit.,* supra footnote 28.

[125] International Telecommunication Union – ITU (2012). *Exploring the Value and Economic Valuation of Spectrum,* Geneva, Switzerland. Available at: http://www.itu.int/ITU-D/treg/broadband/ITU-BB-Reports_SpectrumValue.pdf.

[126] B. Freyens (2007). *Op. cit.,* supra footnote 89.

interference problem, eliminating the necessity of assigning channels to users, as more applications may be able to share the same spectrum band. Without going into specific details, spread spectrum technologies, ultra wide-band technology, smart antennae, software-defined radio, mesh networks are examples of technological developments that introduce great flexibility in the use of the spectrum bands which can be shared by users without causing harmful interference to each other.[127] Among other spectrum sharing technologies, Cognitive Radio systems are being developed, as they could introduce radical changes in the management of spectrum. Cognitive Radio systems may be able to continuously monitor and detect unused spectrum potions, dynamically use free parts of spectrum and timely release them when a primary user starts to transmit on those frequencies.[128]

Thirdly, the innovation process in the ICT sector may be strongly promoted, as the regulatory and financial requirements on users would be considerably reduced, lowering barriers and enhancing competition.[129]

Several countries have already been testing some forms of licence-exempt model, in particular in that part of the spectrum allocated to industrial, scientific and medical (ISM) applications.[130] However, a main concern is related to this model: in presence of a common resource that has limited availability, each player has the incentive to overuse that resource, causing excessive interference, if there are few or no restrictions, as each player reaps the benefits while bears only a fraction of the shared costs. If everybody acts in this way, the result will be the dissipation of the common resource, which will become unusable.[131]

4.2.2. Market-driven improvements

For the spectrum to be used efficiently, spectrum users should face an appropriate charge, explicit or implicit, which reflects the opportunity cost of their spectrum use. The opportunity cost is related to the fact that spectrum is a scarce and finite resource, so the use of the spectrum for one purpose precludes its use for another. Hence the opportunity cost can be defined as the value of output foregone when a spectrum portions is employed for one particular use rather than the next best alternative.[132]

The absence of incentives to use the spectrum resource in an efficient way artificially stimulates an irrational and extravagant use of spectrum, hoarding

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[127] B. Wellenius, I. Neto (2006). *Op. cit.,* supra footnote 78.

[128] A. Durantini, M. Martino (2013). *Op. cit.,* supra footnote 123.

[129] J. M. Bauer (2002). *Spectrum management: Private Property rights or Commons?,* in R. E. Mansell, R. A. Samarajiva, A. K. Mahan (eds.), Networking knowledge for information societies: institutions and intervention, The Netherlands: Delft University Press, pp. 118-126. Available at: http://lirne.net/resources/netknowledge/bauer.pdf.

[130] B. Wellenius, I. Neto (2006). *Op. cit.,* supra footnote 78.

[131] C. Veljanovski (2007). Economic Principles of Law. Ebook: Cambridge University Press.

[132] M. Cave (2002). *Op. cit.,* supra footnote 21.

frequencies for the future, creating spectrum shortages and misallocation. A spectrum management regime should always ensure continuing incentives for users towards more effective use of this resource.[133] The economy will benefit from individual users economising on their use of spectrum. Spectrum would not be wasted and this is undoubtedly a positive aspect, but mainly benefits derive from added dynamic efficiency. The introduction of market-based principles will foster innovation and greater competition, as new entrants and new technologies would win access to spectrum.

This principle of opportunity cost charging can be applied in a number of different ways: trading, auctions and pricing.[134] Hence, policy makers worldwide start working on spectrum reforms in order to replace the traditional centralised command-and-control regime with more market-based mechanisms, encouraging the thriving of well-advanced technologies and services.[135] Nevertheless, many regulators still continue to apply a command-and-control approach to assign spectrum licences, in particular in developing countries for example in the African continent.[136]

4.2.2.1. Spectrum markets: trading frequency licences

In the 1950s Ronald Coase was one of the first who declared the inefficiencies of the command-and-control regime, identifying the establishment of markets for spectrum as the best way to improve the accuracy of the assignment process and the efficiency in the utilisation of spectrum.[137]

In the traditional administrative approach, licensees cannot sell their frequencies, which must be used or returned. Instead, both the initial assignment of licences and the following exchanges between operators can be managed by a market approach, leaving the possibility to change not only the ownership but also the use of the spectrum by secondary trading.[138]

This flexibility, deriving from the tradability of frequencies, to determine who will use the spectrum and how, eliminates artificial market entry barriers and fosters innovation, enabling operators to rapidly introduce innovative services, while avoiding that a valuable resource, such as the spectrum, could be locked in allocations to obsolete technologies or inefficient uses.[139] Incumbent users will be encouraged to invest in more efficient use of spectrum in order to enhance profit, or release spectrum potentially available for other users which value it more highly. As stated in the Communication Commission on

[133] W. H. Melody, W. Lemstra (2011*). Op. cit.,* supra footnote 33.

[134] M. Cave (2002). *Op. cit.,* supra footnote 21.

[135] E. Lie (2004). *Op. cit.,* supra footnote 28.

[136] International Telecommunication Union – ITU (2012). *Op. cit.,* supra footnote 118.

[137] D. Hatfield, P. Weiser (2006). *Op. cit.,* supra footnote 8.

[138] McLean Foster & Co. in collaboration M. Cave, R. W. Jones (2007). *Op. cit.,* supra footnote 17.

[139] C. Cambini, N. Garelli (2011). *Evaluation of the Opportunity Cost of the Spectrum: Application to the Digital Dividend*, Telecommunications Policy, Vol. 35, Iss. 7: Elsevier Ltd, pp. 633-649. Available at: http://www.sciencedirect.com/science/article/pii/S0308596111001042.

"introducing a market-based approach to spectrum management in Europe", published in 2005, researches demonstrated that using a market-based approach would have had significant economic and social benefits. In particular it had been estimated that a net gain of €8-9 billion per year would have achieved with the introduction of spectrum trading combined with flexible usage rights, across Europe.[140]

Both the US and the EU embraced market-driven solutions, such as spectrum trading, however EU Member States turned out to be slower in allowing market trading in spectrum licences.[141] Only few EU countries introduced that practice since 2002 or later, such as the UK, which rolled out spectrum trading in December 2004.[142]

Spectrum assignments would consist of well-defined, legal rights of possession that could be bought, sold, subdivided and aggregated, at the discretion of the owner.[143] According to the mainstream microeconomic theory, market exchanges will lead to a higher level of efficiency in the use of the radio spectrum as, allowing the operators the flexibility to decide which technology or service to provide, radio spectrum will be allocated to its most valuable uses.[144] Each user is exposed to the opportunity cost of his spectrum use and he will have to consider if holding spectrum rights is worth more than selling them. If the existing holder considers the opportunity cost as greater than the value of the spectrum, he will be willing to sell his spectrum rights, which may be bought by another user.

There is general consensus that a more competitive environment can be created, ensuring that spectrum will be employed in the uses and by the users which bring the highest valued services to the economy.[145] Secondary trading is considered a key reform in the spectrum management field, as it may foster innovation, favouring the emerging of new technologies, eliminating artificial scarcities of spectrum.[146]

However, there are quite a few risks associated to spectrum markets, as they can reflect monopoly or oligopoly conditions. Competition may be restricted and innovation processes hampered if firms with financial means to buy the available spectrum will turn to anti-competitive practices such as taking advantage of their dominant position and preventing other incumbents from

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[140] European Commission – EC (2005). *Op. cit.,* supra footnote 88.

[141] R.B. Kelly, A. J. LaFrance – Squire Sanders (2012). *Spectrum Trading in the EU and the US - Shifting Ends and Means*. ICLG to: Telecommunication Laws and Regulations 2012. Available at: http://www.squiresanders.com/files/Publication/8ce3ed01-56b5-475a-af16-969ee634df4f/Presentation/PublicationAttachment/9ff7086b-589b-4fdd-bbc6-970717b5837b/Tel12_Squire%20Sanders_ver4.pdf.

[142] Ofcom – Office of Communications (2011). Trading Guidance Notes. Available at: http://stakeholders.ofcom.org.uk/spectrum/spectrum-trading/.

[143] International Telecommunication Union – ITU (2012). *Op. cit.,* supra footnote 79.

[144] E. Lie (2004). *Op. cit.,* supra footnote 28.

[145] M. Cave (2002). *Op. cit.,* supra footnote 21.

[146] McLean Foster & Co. in collaboration M. Cave, R. W. Jones (2007). *Op. cit.,* supra footnote 17.

obtaining additional spectrum or new entrants from entering the market.[147] Competition problems may arise when owners of spectrum don't make unused spectrum available, in particular if it can be bought by a competitor and thus used to provide competitive services. This risk of spectrum hoarding is one of the reason why trading do not take place despite being potentially Pareto-efficient.[148]

However, even considering these issues, many experts support the introduction of spectrum markets because they still may create significant improvement over an inefficient administrative system. But, at least for the moment, the market approach has not been universally accepted.[149]

4.2.2.2. Auctions

A step forward in the spectrum management field has been the introduction of auctions for assigning frequency licences to users that is now a well-established practice among several SMAs.[150] It eliminates the weaknesses of administrative assignments, characterised by subjective judgements of spectrum authorities, awarding licences on the basis of bidding among competing applicants. Auctions award licences to bidders who value them the most.[151] Spectrum auctions have been recognised as a more efficient, transparent, fairer and faster mechanism of assigning spectrum licences ensuring an economically efficient distribution of the resource, in particular when demand exceeds supply. They also represent a reliable way to ensure that licences will be put to their most productive uses as they are competitively assigned to users willing to pay the most and convinced of being able to manage the asset more efficiently.[152] However, by changing the frequency assignment method to auctions, spectrum authorities have introduced inefficiencies associated with the monopoly power of spectrum managers. Often bidders have overpaid for licences and price auctions simply have become a lucrative source of income for national governments.[153] Moreover

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[147] B. Wellenius, I. Neto (2006). *Op. cit.,* supra footnote 78;
European Regulators Group – ERG – Radio Spectrum Policy Group – RSPG (2009). *Report on radio spectrum competition issues. ERG-RSPG report on the management of radio spectrum in order to avoid anticompetitive hoarding*. Available at: http://rspg-spectrum.eu/_documents/documents/meeting/rspg19/rspg09_278_erg_rspg_report_on_radio_spectrum_competition_issues_090604.pdf.

[148] J. M. Bauer (2002). *Op. cit.,* supra footnote 86;
M. Cave (2009). *Anti-Competitive Behaviour in Spectrum Markets*. Paper prepared as an input into the ERG-RSPG Report on radio spectrum competition issues, (ERG (09) 22; RSPG09-278 Rev 2; June 2009), TPRC Conference, 25-27 September 2009. Available at: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1999846.

[149] W. H. Melody, W. Lemstra (2011*). Op. cit.,* supra footnote 33.

[150] European Commission - EC (2010). *Op. cit.,* supra footnote 18.

[151] International Telecommunication Union – ITU (2012). *Op. cit.,* supra footnote 79.

[152] E. Lie (2004). *Op. cit.,* supra footnote 28;
C. Cambini, N. Garelli (2011). *Op. cit.,* supra footnote 139.

[153] W. H. Melody, W. Lemstra (2011*). Op. cit.,* supra footnote 33.

using spectrum auctions, as in the case of spectrum markets, problems related to competition may arise. The emerging of firms in a dominant position or at least with market power may distort competition, shadowing small and weaker players.[154]

4.2.2.3. Administrative Incentive Pricing - AIP

Market mechanisms such as trading and auctions are broadly considered the most efficient approach to allocate spectrum and guarantee for its efficiency in the use. However, there are some parts of the spectrum that cannot be traded on the market, because of technical legacies, service coordination, safety or security issues and so on. In these kinds of situations, another strategy to boost efficiency in spectrum use is needed. It may consist of the adoption of specific regulatory instruments, such as spectrum fees.

A particular strategy has been experimenting recently: the Administrative Incentive Pricing (AIP) method. It is based on regulated fees imposed to public and private users, correlated to the opportunity cost of spectrum use and put into users' decision-making process.[155] It can be set within an administrative approach, but it can also be retained as a complementary market-based incentive mechanism, alongside the use of approaches such as auctions and trading.[156] Users, evaluating the spectrum quantity they use, may choose to get back some frequencies, which can be reassigned for different uses.[157] If spectrum users are not exposed to the opportunity cost of their spectrum, then they will generate inefficiencies and the opportunity cost of their usage will be carried by the State and ultimately by consumers. Typically, regulators set up a licence fees structure imposing charges on spectrum holders in order to recover direct and, in case, indirect costs, of spectrum management activity. Whereas, incentive based prices are not based on administrative costs, rather they somehow reflect the economic value of radio spectrum, still remaining settled by regulators.[158]

There exist different methodologies to simulate a market context and calculate the opportunity cost of spectrum use. Current and potential alternative spectrum uses should be identified for each frequency band and necessary cost calculation must be done to determine the proper incentive based price. Basically, incentive based prices that licence holders have to pay for the use of the radio spectrum are proxies for prices that would have been determined by market.[159]

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[154] International Telecommunication Union – ITU (2012). *Op. cit.,* supra footnote 79.

[155] C. Cambini, N. Garelli (2011). *Op. cit.,* supra footnote 139.

[156] Office of Communications – Ofcom (2009). Document for Information: *Policy evaluation report: AIP*. Available at: http://stakeholders.ofcom.org.uk/binaries/research/spectrum-research/evaluation_report_AIP.pdf.

[157] C. Cambini, N. Garelli (2011). *Op. cit.,* supra footnote 139.

[158] M. Cave (2002). *Op. cit.,* supra footnote 21.

[159] C. Doyle (2007). *The pricing of radio spectrum: using incentives mechanisms to achieve efficiency*. Paper prepared for the ITU Workshop "Market mechanisms for spectrum management", Geneva,

In fact, few countries have been using AIP approach based upon opportunity cost principles. Among them, the UK has been a forerunner in the field, introducing AIP in 1998. It has been proved that AIP is effectively helping to incentivise spectrum users to consider carefully the value of the spectrum and to use it in an optimal manner. For instance the police in Scotland have returned some portions of UHF spectrum, making them available for other services. In the case of radio astronomy service, the introduction of AIP has led to the decision of surrendering various spectrum bands, awarded to new and valuable services. In this case, AIP has satisfied the weaknesses of a potential market trading mechanism still immature to secure efficient reallocation. AIP mechanism can significantly contribute both to the allocation and the use of the radio spectrum, in terms of efficiency.[160]

The idea underlying this approach is that, in general, given a certain price for each input (fees are imposed as economic costs upon the users of the spectrum), producers will set up the production process at the level that ensures the minimisation of costs. The same goes for spectrum: imposing a licence fee related to the opportunity cost would incentivise the user to return the unused or less productive frequencies, if they will find that the fees cannot be economically justified,[161] in light of the goal of minimising the cost of the inputs used in their productive process, including spectrum.

Users may be also encouraged to use spectrum in a more efficient and rational manner, for example adopting spectrum-saving technologies, as this translates in lower fees. In such a way productive efficiency can be gained.

Even though the determination of the opportunity cost for a specific frequency band can be only approximated, the application of such a method should be considered a better solution than not to charge any price at all.[162] AIP is applicable and can work to promote more effective use of spectrum in both private and public sectors. In most countries, public sectors hold large amounts of valuable spectrum, 40-50% of the frequencies below 15 GHz, in many cases retaining more spectrum than necessary. Often old and inefficient equipment are used, even though new and more efficient technologies can be adopted. A more effective and rational use of radio spectrum by public users could increase the quality of public services provided and also more spectrum can be made available for commercial uses.[163] Instead, public users usually are not incentivised to use spectrum efficiently or to give back unused spectrum, denying benefits to society and obstructing the innovation process. Public users often consider spectrum assignment as permanent and without costs, so they

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Switzerland, 22-23 January 2007. Available at: https://www.itu.int/osg/spu/stn/spectrum/workshop_proceedings/Background_Papers_Final/Chris%20Doyle%20-%20Incentive%20based%20spectrum%20prices.pdf.

[160] Office of Communications – Ofcom (2009). *Op. cit.,* supra footnote 156.

[161] International Telecommunication Union – ITU (2012). *Op. cit.,* supra footnote 125.

[162] World Bank, InfoDev, IFC, ITU (2011). *Op. cit.,* supra footnote 77.

[163] European Commission - EC (2010). *Op. cit.,* supra footnote 18.

may hold more spectrum then necessary, causing spectrum hoarding and inefficient use. This situation is also tightened by the lack of transparency and information on spectrum allocation to public uses.
Incentives to enhance the efficiency with which public sector spectrum holdings are used can be introduced by AIP. From an economic point of view, the public sector should treat all inputs used in the production process equally, hence paying a price for spectrum use as it does for equipment, labour and the like. These fees represent the economic value of the spectrum portions used by public sector users, which cannot be readily quantifiable in market terms.[164] Fees have to be calculated accurately and have to be equal to those imposed to private users, as there would be any reason why they have to be treated differently.[165] Moreover, the regulator must be sure that the AIP are taking effect, ensuring that incentive based prices will not simply translate into increased budgets of public users. In other words if there is a mere internal transfer of money within State's accounts, AIP will not create any incentives to economise the use of the spectrum.[166]

4.2.3. Conclusions

Different approaches define different sets of rules governing the use of the spectrum, which in turn have implications for the evolution of the ICT industry. Each model has unique advantages and disadvantages and given the vast range of spectrum uses it is unlikely that one model will be wholly preferable. The different spectrum management approaches are not mutually exclusive.[167] For this reason, reaching a balanced mix of different spectrum management regimes could be the optimal way to manage radio spectrum, trying to capture the strengths and to avoid the weaknesses of each approach.[168] Moreover spectrum management methods should be continuously modified and updated, adopting different approaches in different spectrum bands over different periods of time. An efficient allocation established at a particular point in time, will become inappropriate when technological and market conditions and consumers' preferences change.[169]

4.3. Final Considerations

Policy makers and regulators have to face the hard challenge to find and adopt new dynamic regulatory tools able to perform effectively in an ever changing ICT environment.[170] It should be noted that national regulation is somehow

[164] International Telecommunication Union – ITU (2012). *Op. cit.*, supra footnote 125.
[165] C. Doyle (2007). *Op. cit.*, supra footnote 159.
[166] World Bank, InfoDev, IFC, ITU (2011). *Op. cit.*, supra footnote 77.
[167] B. Wellenius, I. Neto (2006). *Op. cit.*, supra footnote 78.
[168] J. M. Bauer (2002). *Op. cit.*, supra footnote 129.
[169] E. Lie (2004). *Op. cit.*, supra footnote 28.
[170] International Telecommunication Union – ITU (2013). *Op. cit.*, supra footnote 101.

chained. First of all, regulators must conform to international provision, where alongside the ITU, regional bodies have been acquiring more power in influencing national spectrum use.[171] They promote worldwide and regional harmonisation of spectrum, as it brings economies of scale in manufacturing equipment usable worldwide and facilitates the conclusion of cross-border agreements, which are necessary between neighbouring countries.[172] International cooperation and harmonisation is of course required by the very nature of these new broadband services, which are transnational, meaning they necessarily affects the interests of different countries. However spectrum management still remains anchored to national factors such as geography conformation, radiocommunication history, economic development, and social and geopolitical aspects.[173]

The advent of new technologies and market changes draw the features of the environment regulators must face, increasing both the demand for spectrum and the amount of spectrum accessible, once thought unusable. Optimum technical efficiency is extremely important to benefit from new and innovative technologies and expanding the amount of spectrum available for commercial uses will support their development.[174] Allocation of additional spectrum, re-farming existing allocation and assignment, opening up spectrum for unlicensed use are key policy tools to do so.[175] However, other objectives must be taken into account by regulators, as there are many stakeholders related to radio spectrum use, including equipment manufacturers, technology companies and the public sector users. It should be always pursued a rational and efficient spectrum use, balancing the interests of existing players with those of new entrants and minimising conflicts between all groups that have concerns on radio spectrum usage. The regulator will have to face the challenge of balancing the needs of all stakeholders with different and often competitive interests.[176]

In particular, radio spectrum is a vital resource for a wide range of public services such as national security, public safety and scientific research.[177] Regulators must achieve the extremely hard goal to develop an innovative radio spectrum policy that will favour the deployment of new and improved technologies and services driven by the private sector, such as wireless broadband technologies, while preserving the conditions for the optimal provision of services of public interests. A balance between different and often competitive objects must be found in order to derive maximum economic and social benefit, acting for the national interest. Regulators have to recognise that

[171] International Telecommunication Union – ITU (2012). *Op. cit.*, supra footnote 118.
[172] International Telecommunication Union – ITU (2012). *Op. cit.*, supra footnote 125.
[173] International Telecommunication Union – ITU (2007). *Op. cit.*, supra footnote 31.
[174] G. L. Rosston, J. S. Steinberg (1997). *Op. cit.*, supra footnote 22.
[175] International Telecommunication Union – ITU (2012). *Op. cit.*, supra footnote 118.
[176] R. Struzak (2003). *Op. cit.*, supra footnote 1.
[177] G. L. Rosston, J. S. Steinberg (1997). *Op. cit.*, supra footnote 22.

the introduction of market-based mechanisms in the spectrum assignment process for both the private and public sectors will foster innovation and ensure a more effective spectrum use. Licence-exempt models can also give the opportunity to take advantage of the qualities of new advanced technologies, which reduce the risk of harmful interference.

In this era of modern communications, access to the spectrum can be artificially restrained when spectrum regulations fail to keep pace with technology innovation and market changes. Spectrum management system need to be improved, moving away from unnecessary and obsolete rules and creating economic incentives for a more efficient and beneficial use of the spectrum.[178]

[178] National Telecommunications and Information Administration – NTIA (2004). *Spectrum Policy For The 21st Century – The President's Spectrum Policy Initiative: Report 2. Recommendations from State and Local Governments and Private Sector Responders*. Available at: http://www.ntia.doc.gov/files/ntia/publications/spct_pol_part_2_rl.pdf.

5. The digital dividend

5.1. What is the digital dividend?

Digital television (DTV) service, introduced in 1996 in Europe, is considered the most important development in television technology after the introduction of colour television in 1950s.[179] DTV can provide a higher number of programmes, increased coverage, a better picture and audio quality, interactive applications and new services as high definition television (HDTV).[180]

Several standard DTV channels of reasonable quality can be transmitted in the very same radiofrequencies previously used by a single analogue channel thanks to improved television technology, first of all digital compression techniques, which bring additional transmission capacity, and more efficient transmission technologies.[181] In those frequencies, up to six or even eight standard digital television channels can be transmitted, depending on the coding and modulation techniques.[182]

Indeed, DTT uses spectrum far more efficiently than analogue terrestrial television, carrying much more content within a given amount of spectrum. As a matter of fact, one radio-frequency channel of 6 MHz to 8 MHz spectrum bandwidth used to transmit a single analogue programme could now carry a multiplex of two to twelve digital programmes of equivalent quality. Besides most DTV standards permit the reuse of the same frequencies over much larger areas.[183] In general, four or five terrestrial analogue services are provided in each ITU Region, so their digitalization into a single digital television channel will considerably reduce the overall use of spectrum, with great potential benefits of a much better spectrum allocation.[184]

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[179] L. G. Kruger, P. F. Guerrero (2002). Preface to *Digital Television. An Overview,* Hauppauge, New York, USA: Novinka Books;
European Commission – EC (2003). Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions on *the transition from analogue to digital broadcasting (from digital 'switchover' to analogue 'switch-off'),* {COM(2003) 541}. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2003:0541:FIN:EN:PDF.

[180] J. Adda, M. Ottaviani (2005). *The transition to Digital Television,* Economic Policy January 2005, Great Britain: CEPR, CES, MSH, pp. 159–209. Available at: http://didattica.unibocconi.it/mypage/upload/48832_20111118_020512_THETRANSITIONTODIGITALTELEVISION.PDF.

[181] International Telecommunication Union – ITU (2010). ITU NEWS, *The digital dividend. Opportunities and challenges* (accessed May 2013), http://www.itu.int/net/itunews/issues/2010/01/27.aspx.

[182] McLean Foster & Co. in collaboration M. Cave, R. W. Jones (2007). *Op. cit.,* supra footnote 17.

[183] F. Rancy, E. Zilles, J. J. Guitot (2011). *Op. cit.,* supra footnote 39.

[184] International Telecommunication Union – ITU (2010). ITU NEWS, *The digital dividend. Opportunities and challenges* (accessed May 2013), http://www.itu.int/net/itunews/issues/2010/01/27.aspx.

For many years, great part of the radio spectrum below 1 GHz, meaning significant portions of the VHF (174-230 MHz) and UHF (470-862 MHz) bands, has been allocated on a primary basis to analogue terrestrial broadcasting, in many countries worldwide and in particular in Europe.[185] The digital switchover, meaning the migration process from analogue to digital broadcasting starting with the introduction of digital and ending with the switch-off of analogue transmissions[186], would have two major consequences on spectrum use. First of all, there would be an improvement in the quality and an expansion in the range of television services, as with digital technology television channels could be transmitted using less spectrum (25% or less) than before.[187] But also a significant part of the UHF and VHF bands will become free from traditional terrestrial broadcasting use and so released for other services, in particular for mobile services, leading to new applications, wider consumer choice and enhanced competition[188].

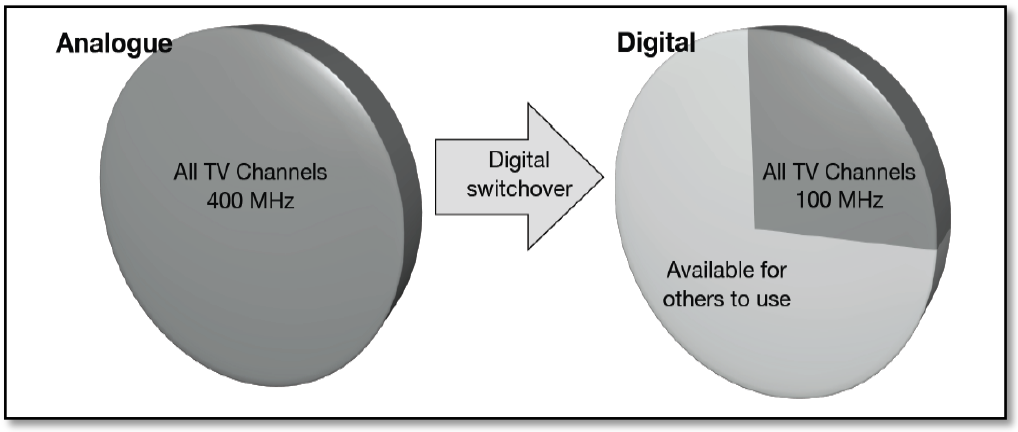

Figure 11. Digital Switchover: spectrum free from TV channels and available for other uses.
Source: S. Forge, C. Blackman, E. Bohlin – SCF Associates LTD (2007). The Mobile Provide. Economic impacts of Alternative Uses of the Digital Dividend, Public Report. Available at: http://camfordassociates.com/wp-content/uploads/2010/11/DD-Final-PUBLIC-Report-v10.1.pdf.

The amount of spectrum freed-up by the transition of terrestrial television broadcasting from analogue to digital, meaning the amount of spectrum in the VHF and UHF bands that is above that nominally required to accommodate existing analogue television services in a digital form, is defined as digital dividend.[189]

[185] F. Rancy, E. Zilles, J. J. Guitot (2011). *Op. cit.,* supra footnote 39.
[186] European Commission – EC (2003). *Op. cit.,* supra footnote 179.
[187] S. Forge, C. Blackman, E. Bohlin – SCF Associates LTD (2007). *The Mobile Provide. Economic impacts of Alternative Uses of the Digital Dividend,* Public Report. Available at: http://camfordassociates.com/wp-content/uploads/2010/11/DD-Final-PUBLIC-Report-v10.1.pdf.
[188] Office of Communications – Ofcom (2007). *Op. cit.,* supra footnote 66.
[189] International Telecommunication Union - ITU (2012). *Op. cit.,* supra footnote 32;
International Telecommunication Union – ITU (2010). ITU NEWS, *The digital dividend. Opportunities and challenges* (accessed May 2013), http://www.itu.int/net/itunews/issues/2010/01/27.aspx.

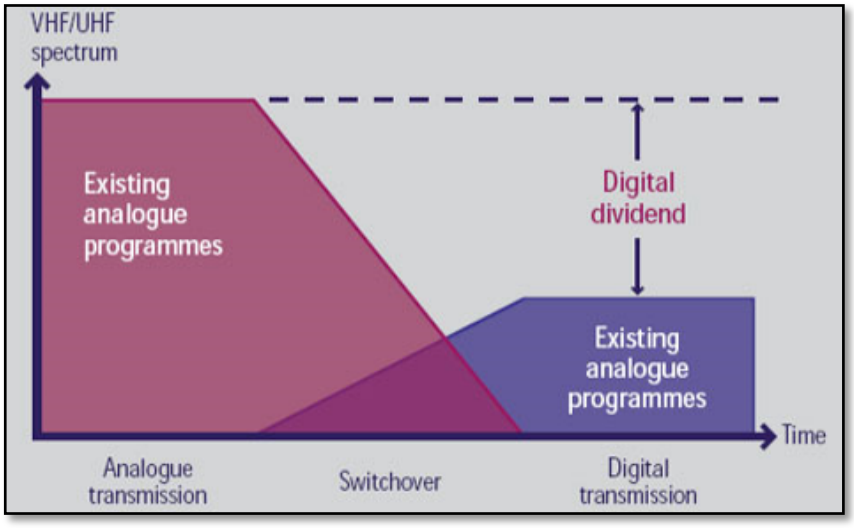

Figure 12. Digital dividend spectrum
Source: ITU (2010). ITU NEWS, *The digital dividend. Opportunities and challenges* (accessed May 2013), http://www.itu.int/net/itunews/issues/2010/01/27.aspx.

With the advent of digital television, terrestrial broadcasting has become the centre of world attention, as the switch-off of analogue television broadcasting and the resulting digital dividend represent a great opportunity for boosting the growth of the ICT sector by means of a more efficient use of the radio spectrum.[190] Reallocating part of the radio spectrum will give the possibility to meet new demands for services, fostering the innovation process and thus favouring the economic growth.[191] The provision of analogue television is no more justifiable in economic terms and the interest of both providers and viewers is therefore moving to a digital model.[192]

5.2. Size of the digital dividend

First of all, the size of the digital dividend is contingent on national peculiarities such as geography and topography, the degree of penetration of cable and/or satellite television services and the requirements for local television services. It may also be impacted by spectrum usage in neighbouring countries, as a result of the need to avoid or limit harmful interference. The amount also depends on the digital television technology being implemented to replace analogue services. The size of the digital dividend will increase as more advanced technologies become available. It also depends on the trade-offs underlying the choice of the basic parameters of digital transmissions, including: type of digital television reception, percentage of population served,

[190] International Telecommunication Union – ITU (2010). *Guidelines for the transition from analogue to digital broadcasting*, Geneva, Switzerland. Available at: http://www.itu.int/pub/D-HDB-GUIDELINES.01-2010/en.
[191] S. Forge, C. Blackman, E. Bohlin – SCF Associates LTD (2007). *Op. cit.*, supra footnote 187.
[192] International Telecommunication Union - ITU (2012). *Op. cit.*, supra footnote 32.

quality required and the like. Therefore, the size of the digital dividend will vary from ITU Region to ITU Region and from country to country due to the multiplicity of methods to plan spectrum for broadcasting.[193]

5.3. Potential uses of the digital dividend

In ITU Region 1 the UHF band at 470-862 MHz has been historically allocated to analogue television. However, the introduction of the digital television has reduced the spectrum needed by broadcasters, giving the possibility to allocate some of those UHF frequencies to other services, such as mobile services, while broadcasters would still have room to provide new programmes and other products.[194]

The range of innovative uses to which the digital dividend spectrum can be opened is wide and can become larger in the future. Given the rapid changes that characterise the ICT sector, new technologies and services and new uses for existing technologies may emerge, which will require the digital dividend to be used.[195] A non-exhaustive list may include digital television, as broadcasters can significantly expand their services launching new channels, more television programmes that can also be provided in high-definition, and new interactive television broadcasting, such as 3D television. A convergent service that can be promoted by broadcasters using the digital dividend is mobile television (MTV), which can allow users to receive and watch television using mobile devices. It could also be met the exponential demand for spectrum fuelled by mobile communications services for voice, data, video and multimedia applications. A relevant aspect here is the provision of wireless broadband services, either to fixed locations or to mobile terminals.[196]

As noted by the RSPG, the notion of broadband is continually evolving due to technological improvements and can be defined in myriad ways. In the RSPG Opinion on "Strategic Challenges facing Europe in addressing the Growing Spectrum Demand for Wireless Broadband" the term broadband is defined as the possibility of accessing a wide range of media rich services including web

[193] International Telecommunication Union – ITU (2010). ITU NEWS, *The digital dividend. Opportunities and challenges* (accessed May 2013), http://www.itu.int/net/itunews/issues/2010/01/27.aspx.

[194] GSM Association – GSMA (2012). Digital Dividend. Barriers: *Potential Barriers* (accessed May 2013), http://www.gsma.com/spectrum/wp-content/uploads/DigitalDividend/DDtoolkit/potential-barriers.html;

The use of the digital dividend in the VHF band is mostly foreseen for new broadcasting applications; this band is less attractive for mobile service applications due to its small size (F. Rancy, E. Zilles, J. J. Guitot (2011). *Op. cit.,* supra footnote 39; Radio Spectrum Policy Group – RSPG (2007). *Opinion on EU Spectrum Policy Implication of the Digital Dividend*. Available at: http://rspg-spectrum.eu/_documents/documents/opinions/rspg07_161_final_op_digdiv.pdf)

[195] Office of Communications – Ofcom (2007). *Op. cit.,* supra footnote 66.

[196] International Telecommunication Union – ITU (2010). ITU NEWS, *The digital dividend. Opportunities and challenges* (accessed May 2013), http://www.itu.int/net/itunews/issues/2010/01/27.aspx.

browsing, VOIP, and video services. Defining broadband in terms of functionality, meaning the services and applications that can be provided by a broadband network, is quite common, but it is not the only definition possible. This term broadband is also used to indicate the infrastructure used to deliver services to users. Technically, broadband refers to data transmission speed, that is the amount of data that can be transmitted across a network connection in one second, also known as the data transfer rate or throughput (measured in bit per second – bps).[197] Thus, broadband is related to a high-speed transmission of data, which allows users to access more advanced types of content, services and applications over the Internet and describes recent Internet connections which are faster than those provided by dial-up technologies.[198] Even though the first definition could be more subjective, the second one should be periodically updated to keep pace with technological developments in order to always indicate the highest data transmission speed available.[199] ITU has simply stated that the term broadband does not refer to either a certain speed or a specific service.[200] Nowadays, the term broadband is generally defined as a transmission capacity with sufficient bandwidth to provide simultaneously voice, data and video services of good quality.[201]

Broadband services can be delivered through both wired and wireless infrastructure. Sometimes they are seen as substitutes, competing with each other, but, in other cases, they are complementary. Trends show explosive growth of delivery of broadband services over these infrastructures and for wireless broadband in particular.[202] The achievement of the ambitious goal of ensuring Internet connectivity and access to information society to people all over the world, including remote and rural regions, through both fixed and wireless technologies is at stake and represents one of the key challenges highlighted in the Digital Agenda for Europe (DAE).[203]

Wireless broadband can be provided via either fixed, mobile or satellite platforms. A fixed wireless service provides wireless broadband to devices in

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[197] T. Kelly, C. M. Rossotto (2012). *Broadband strategies handbook*. Washington DC, USA: The World Bank. Available at: https://www.google.it/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CDEQFjAA&url=https%3A%2F%2Fopenknowledge.worldbank.org%2Fbitstream%2Fhandle%2F10986%2F6009%2F676200PUB0EPI0067882B09780821389454.pdf%3Fsequence%3D1&ei=XqUYUuHxBcKO4ATr_IDQCg&usg=AFQjCNEqGF499G__oLPdBpAcNc6343j7_w&bvm=bv.51156542,d.bGE.

[198] Federal Communication Commission – FCC, *Getting Broadband* (accessed May 2013), http://www.fcc.gov/guides/getting-broadband;
Infodev, *What is Broadband?* (accessed May 2013), http://broadbandtoolkit.org/1.2.

[199] T. Kelly, C. M. Rossotto (2012). *Op. cit.,* supra footnote 197.

[200] International Communication Union – ITU (2003). *The Birth of Broadband* (accessed May 2013), http://www.itu.int/osg/spu/publications/birthofbroadband/faq.html.

[201] Telecom ABC, *Broadband* (accessed May 2013), http://www.telecomabc.com/b/broadband.html.

[202] Radio Spectrum Policy Group – RSPG (2013). *Op. cit.,* supra footnote 110.

[203] International Telecommunication Union – ITU (2010). ITU NEWS, *The digital dividend. Opportunities and challenges* (accessed May 2013), http://www.itu.int/net/itunews/issues/2010/01/27.aspx.

permanent locations, such as homes and offices. A mobile broadband service (WiMAX, LTE) provides connectivity to users who may be in temporary locations, such as coffee shops and train stations. Depending on the characteristics of the satellite network, where the signal is up-linked to a satellite from which it then comes down to a satellite dish, satellite broadband can service either mobile or fixed broadband users or both.[204]

The digital dividend is suitable for additional DTT as it is within the range of frequencies already used for digital broadcasting. In particular, household receivers and aerials are already designed to pick up and decode signals at these frequencies or can be easily tuned to these frequencies. Households may not necessary need to get new equipment in the case of DTT in standard definition (SD) but this would be necessary in the case of DTT in high definition (HD) for decoding HDTV signals as HD DTT is expected to use a different encoding standard from the one currently in use. However there are a number of alternative means of delivering DTV services, including satellite, cable and the Internet.[205]

The availability of alternative platforms to distribute television services influences drastically the demand for television spectrum. In particular, the deployment of fixed broadband networks and the ever-increasing transmission speeds they offer, the digitalisation of cable networks and the spread of satellite television in emerging markets make television broadcasting feasible and attractive on such networks. For example, over-the-top (OTT) service providers deliver a television service bouquet directly over the Internet to consumers.[206] Terrestrial television is becoming less important and consequently related technology improvements are less beneficial, while consumers are focusing on satellite, cable and broadband platforms.[207]

Mobile operators find the digital dividend frequencies as an opportunity to respond to the growing demand for new mobile communication services for data, voice, video and multimedia applications.[208] The growing success of user-friendly smartphones and tablets has led to an exponential rise in data traffic, due to the explosive diffusion in particular of web traffic in the forms of accessing, searching and downloading Internet content; playing games online; listening to music online; video calling; watching video and television (i.e. YouTube); social networking (i.e. Facebook, Twitter, LinkedIn); messaging

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[204] M. Starks (2007). *Switching to Digital Television: UK Public Policy and the Market,* Bristol, UK: Intellect. Available at: http://www.scribd.com/doc/19159947/Switching-to-Digital-Television-UK-Public-Policy-and-the-Market;

Radio Spectrum Policy Group – RSPG (2013). *Op. cit.,* supra footnote 110.

[205] Office of Communications – Ofcom (2007). *Op. cit.,* supra footnote 66.

[206] International Telecommunication Union - ITU (2012). *Op. cit.,* supra footnote 32.

[207] B. Modlic, G. Sisul, M. Cvitkovic (2009). *Digital Dividend – Opportunities for New Mobile Services,* 51st International Symposium ELMAR-2009, Zadar, Croatia, 28-30 September 2009. Available at: http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=5342874&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D5342874.

[208] International Telecommunication Union - ITU (2012). *Op. cit.,* supra footnote 32.

(emails, instant messaging and the like) and uploading and sharing content.[209] Mobile phones have revolutionised human life in all its aspects and all over the world. By now, mobile telephony is affordable for about 6 billion consumers and they will become almost 7 billion by the end of 2013. The entire society is calling for a new allocation of spectrum to the mobile sector in order to obtain access to mobile broadband.[210]

The attractiveness of the digital dividend bands for the mobile industry is essentially related to the physical characteristics of waves with lower frequencies, such as the UHF frequencies, where the digital dividend is located, compared with waves with higher frequencies. The UHF frequencies allow for long-distance propagation and a deep penetration in obstacles such as walls, buildings and vegetation with negligible degradation.[211]

Hence, the UHF spectrum is useful to provide dependable mobile service in buildings, as it can ensure indoor coverage. It is also a cost-effective tool for delivering mobile broadband: a large service area can be covered at relatively low cost as fewer infrastructures would be required to provide wider coverage.[212]

Since the service area of a base station is in proportion to the square of the frequency, the number of base stations required to cover a given geographic area is approximately ten times greater at 2.6 GHz, frequencies already used by mobile service, than at 800 MHz. Less base stations translates in lower deployment costs.[213]

Telecommunications industry experts estimate that it is approximately 70% cheaper, in terms of infrastructure costs, to provide mobile broadband coverage using the 800 MHz band than using the radio frequencies (i.e. 2.1 GHz) currently used by Third Generation (3G) mobile technology (UMTS). The lower costs involved in rolling out such networks will make these investments more attractive for operators, which will be keen to improve the geographic coverage of wireless broadband services provided.[214]

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[209] Y. Zhang, A. Arvidsson (2012). *Understanding the Characteristics of Cellular Data Traffic*. Available at: http://conferences.sigcomm.org/sigcomm/2012/paper/cellnet/p13.pdf.

[210] Office of Communications – Ofcom (2007). *Op. cit.,* supra footnote 66.

[211] International Telecommunication Union - ITU (2012). *Op. cit.,* supra footnote 32.

[212] GSM Association – GSMA (2009). *Digital Dividend for Mobile: Bringing Broadband to All*. Available at: http://www.gsma.com/spectrum/wp-content/uploads/2012/03/gsmadigitaldividendformobile.pdf.

[213] International Telecommunication Union - ITU (2012). *Op. cit.,* supra footnote 32;
F. Rancy, E. Zilles, J. J. Guitot (2011). *Op. cit.,* supra footnote 39.

[214] Europa, Press Releases Database (2010). *Radio Spectrum: harmonised EU rules to foster high-speed wireless Internet services and avoid harmful interference* (accessed May 2013), http://europa.eu/rapid/press-release_IP-10-540_en.htm?locale=en.

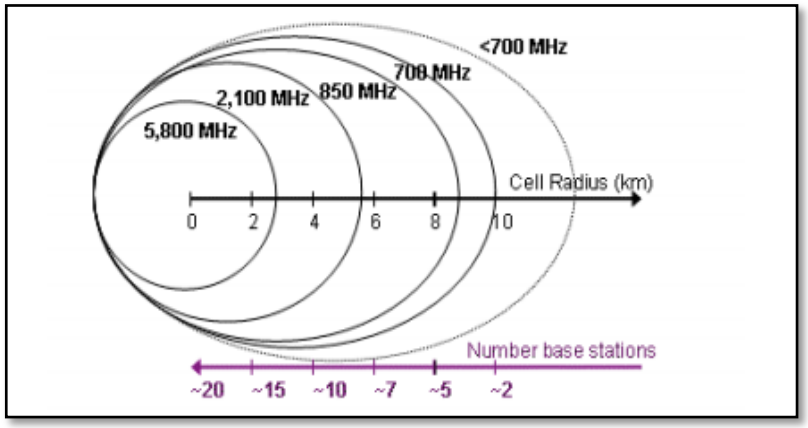

Figure 13. The propagation characteristics of spectrum
Source: S. Forge, C. Blackman, E. Bohlin – SCF Associates LTD (2007). *The Mobile Provide. Economic impacts of Alternative Uses of the Digital Dividend,* Public Report. Available at: http://camfordassociates.com/wp-content/uploads/2010/11/DD-Final-PUBLIC-Report-v10.1.pdf.

With a harmonised allocation of the digital dividend in all ITU Regions mobile industry could deliver cheaper mobile broadband services and Internet connectivity to people all over the world, in particular in areas not yet reached by landlines.[215] An affordable, equitable and widespread access to broadband is a political imperative for policy makers in both developed and developing countries.[216] In the developed world, mobile broadband represents an opportunity to increase Internet penetration enhancing the overall social welfare. In emerging markets, policy makers have understood that a broad Internet access plays a critical role in the deployment of empowering ICT applications in education, health, government, banking, social mobility, environment and business. These tools can significantly improve the overall quality of life of people fighting against poverty and underdevelopment. The digital divide is shrinking, particularly thanks to mobile telephony.[217] Although traditional broadband, for instance via ADSL or fibre, was available in 170 countries at the start of 2007, its broad availability remains a concern as it usually does not cover rural areas, in particular due to its insurmountable roll-out costs. Mobile broadband offers a genuine alternative to traditional broadband solutions, providing services and applications to homes and businesses that haven't had any access to broadband Internet. Mobile is easier, faster and cheaper to deploy than fixed technology, making mobile the only viable solution to closing the digital divide and to bringing affordable broadband access to all.[218]

[215] GSM Association – GSMA (2009). *Op. cit.,* supra footnote 212.
[216] GSM Association – GSMA (2012). Digital Dividend: *Introduction* (accessed May 2013), http://www.gsma.com/spectrum/wp-content/uploads/DigitalDividend/DDtoolkit/introduction.html.
[217] GSM Association – GSMA (2012). Digital Dividend: *The process* (accessed May 2013), http://www.gsma.com/spectrum/wp-content/uploads/DigitalDividend/DDtoolkit/the-process.html.
[218] GSM Association – GSMA (2009). *Op. cit.,* supra footnote 212.

The mobile service could use a frequency band shared with broadcasting (e. g. for short range mobile technologies, such as wireless microphones commonly used in theatres or in public events). But it may also operate in a distinct, harmonised frequency band. In this way it would be facilitated the provision of a ubiquitous service, favouring international roaming and the development of world markets equipment (e.g. for International Mobile Telecommunications – IMT). Moreover, there might also be the possibility for the provision of broadband services using the empty spaces between television channels.[219]

In CEPT Report 24 the expression "white spaces" is used to refer to a part of the spectrum, which is available for a radiocommunication application (service, system) at a given time in a given geographical area on a non-interfering/non-protected basis with regard to other services with a higher priority on a national basis.[220] In a few words, television broadcasting typically leaves some UHF frequencies idle at a particular time and location (broadcasting plans are not static) in order not to cause harmful interference. These broadcasting gaps, called white spaces, can be used for other services. However, it is worth noting that the white space concept can be applied to any band where the spectrum is not uniformly used.[221]

Mobile service is already using several spectrum bands, including 900 MHz, 1800 MHz, 2.1 GHz and 2.6 GHz bands. Higher frequencies bands are not suitable for rural and in-building coverage, unless incurring in uneconomic high deployment costs and consequently providing expensive services which rural areas could not afford. Among them, the 900 MHz band is the only one who presents characteristics similar to those of the 800 MHz band. Thus, it could be suitable for providing the above services. But the 900 MHz band is currently used by GSM technology, which is supposed to be replaced gradually by new technologies. So, allocating the 800 MHz band to advanced mobile

[219] International Telecommunication Union – ITU (2010). ITU NEWS, *The digital dividend. Opportunities and challenges* (accessed May 2013), http://www.itu.int/net/itunews/issues/2010/01/27.aspx.

[220] F. Ananasso - Director of Studies, Research and Education Agcom (2011). *White Spaces: Technological Context & International Outlook* (PowerPoint), Turin, Italy, October 2011. Available at: http://www.google.it/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CDEQFjAA&url=http%3A%2F%2Fwww.agcom.it%2FDefault.aspx%3Fmessage%3Ddownloaddocument%26DocID%3D7851&ei=VakHUoD-ONC4hAeo-IFY&usg=AFQjCNHwpHmNAm9MbPwncQJIZ5oa4bvsPw&bvm=bv.50500085,d.ZG4.

[221] GSM Association – GSMA (2013). *GSMA Public Policy Position on TV White Space*. Available at: http://www.gsma.com/spectrum/wp-content/uploads/2013/04/GSMA-Policy-Position-on-TV-white-space.pdf;

R. Beutler (2012). *The Digital Dividend of Terrestrial Broadcasting,* Chapter 7. New York, USA: Springer Science + Business Media LLC. Available at: http://link.springer.com/book/10.1007/978-1-4614-1569-5/page/1.

services appears as the right decision in order to provide additional capacity to be used by providers who do not currently have access to the 900 MHz band.[222]

5.3.1. The digital dividend to mobile service

Several analyses of the benefits that may be derived from different uses of the digital dividend have been conducted, in order to determine how these spectrum frequencies should be allocated. The objective is to reap the full advantages of the released spectrum. Basically, these studies have shown that the use of the freed-up UHF frequencies for mobile service would be much more advantageous than allocating the digital dividend to television broadcasting, in terms of global economic and social impact. By comparison, investments in the mobile sector rather than in television broadcasting services would generate more productivity and competitiveness, enhance job creation, further the innovation process and help reducing the digital divide.[223] Indeed allocating the digital dividend to television broadcasting is not more justifiable in economic terms also because with the deployment of cable, satellite and internet television, terrestrial television broadcasting has become less attractive and, in some cases, its share has fallen to 5% of the population.[224]

As early as 2008, it was estimated that in Europe, allocating up to 100 MHz of UHF spectrum to mobile would have generated between €63 billion and €165 billion in net present value (NPV), in addition to the estimated €2.5-5 trillion in NPV that mobile already generated for the European economy without the use of the UHF band. These frequencies represented less than 25% of the total spectrum in the UHF band usually used for the provision of television broadcasting services, so broadcasters would have still been able to operate occupying most of the band.[225]

According to a study commissioned by the EC in 2009, using the digital dividend for wireless broadband and other electronic communications services would generate between €17 billion and €44 billion over 15 years, depending on the actual future demand.[226] Estimates indicate an impact of an additional 0.6% GDP growth per year for the European economy by 2020, if the mobile service shares the spectrum with broadcasting television compared to the scenario where broadcasting television alone occupies the band. For many

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[222] Analysys Mason, Econ, Hogan and Hartson (2009). *Exploiting the digital dividend – a European approach*, Report for the European Commission. Available at: http://www.analysysmason.com/PageFiles/13825/Analysys%20Mason's%20final%20report%20'Exploiting%20the%20digital%20dividend%20-%20a%20European%20approach'%2020090814.pdf.

[223] S. Forge, C. Blackman, E. Bohlin – SCF Associates LTD (2007). *Op. cit.,* supra footnote 187.
GSM Association – GSMA (2009). *Op. cit.,* supra footnote 212.

[224] F. Rancy, E. Zilles, J. J. Guitot (2011). *Op. cit.,* supra footnote 39.

[225] Spectrum Value Partners (2008). *Getting the most out of the spectrum. Allocating UHF spectrum to maximise the benefits for European society*. Available at: http://www.valuepartners.com/downloads/PDF_Comunicati/Media%20e%20Eventi/2008/Spectrum-Getting-the-most-out-of-the-digita-dividend-2008.pdf.

[226] Analysys Mason, Econ, Hogan and Hartson (2009). *Op. cit.,* supra footnote 222.

emerging markets, the digital dividend represents a unique opportunity to leapfrog into the broadband world. Several studies have shown that a 10% increase in mobile penetration (i.e. the number of mobile phone users) leads to a 1.2% increase in GDP and mobile broadband is likely to have an even greater economic impact.[227] The World Bank analysis of 120 countries has estimated that for every 10% increase in the penetration of broadband services, there will be an increase in economic growth of 1.3%.[228]

5.3.2. A once-in-a-lifetime opportunity

The spectrum located between 200 MHz and 1 GHz, which comprises the digital dividend, is considered the most valuable part of the entire radio spectrum worldwide.[229] It offers an attractive balance between transmission capacity and geographic coverage, which makes it suitable for a wide range of different uses.[230] Keeping in mind this precious combination of key features, it can be easily understood why it is extremely rare to find unused UHF frequencies. Therefore, the digital dividend, which is a fairly large portion of the UHF spectrum, can be seen as a chance of a lifetime for the provision of innovative and useful services generating positive effects on the whole economy.[231]

The allocation of the digital dividend is without any doubt an international issue and worldwide frequency harmonisation should be considered a compulsory condition.[232] A fair and well-balanced reallocation of the spectrum between existing and new information and communication technologies is necessary to ensure that the society will reap the full social and economic benefits of the digital dividend.[233] Cross-border frequency coordination, preferably at regional level, where all countries within an ITU Region jointly agree on the same use, is a prerequisite that should be satisfied. Cross border interference problems between mobile and broadcasting services or other primary services such as aeronautical radionavigation and radio astronomy, will be avoided and economies of scale in equipment will be reached, ensuring lower costs for handsets and driving prices down. Spectrum harmonisation will

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[227] S. Forge, C. Blackman, E. Bohlin – SCF Associates LTD (2007). *Op. cit.,* supra footnote 187.
GSM Association – GSMA (2009). *Op. cit.,* supra footnote 212.

[228] GSM Association – GSMA, *Importance of the Digital Dividend* (accessed May 2013), http://www.gsma.com/spectrum/wp-content/uploads/DigitalDividend/DDtoolkit/digital-dividend-background.html.

[229] Office of Communications – Ofcom (2007). *Op. cit.,* supra footnote 66.

[230] International Telecommunication Union – ITU (2010). ITU NEWS, *The digital dividend. Opportunities and challenges* (accessed May 2013), http://www.itu.int/net/itunews/issues/2010/01/27.aspx.

[231] GSM Association – GSMA (2012), Digital Dividend. Barriers: *Overview* (accessed May 2013), http://www.gsma.com/spectrum/wp-content/uploads/DigitalDividend/DDtoolkit/barriers.html.

[232] GSM Association – GSMA (2009). *Op. cit.,* supra footnote 212.

[233] World Bank, InfoDev, IFC, ITU (2011). *Op. cit.,* supra footnote 77.

also contribute in reducing the complexity in equipment design and in allowing global roaming.[234]

As the digital dividend can only be made available for mobile service when analogue transmissions will be switched off due to interference problems with broadcasting services, the possibility of harmonisation depends primarily upon the timing and coordination of the analogue-to-digital switchover process set up by countries.[235] The analogue transmission should be switched off when digital broadcasting has achieved widespread penetration and few consumers remain for analogue broadcasting. Otherwise, there would be negative social and economic consequences, as people would be simply deprived of a service they want while providing a new service, the digital broadcasting, which consumers are not interested in.[236]

Since the beginning, the digital dividend has given rise to many concerns regarding its potential use, in particular television broadcasting on one hand and mobile services on the other, because of the extreme different spectrum management principles applied to the respective bands occupied.

For social and technical reasons, such as, respectively, the role of television as a means of freedom of expression and the large potential of interference terrestrial television transmissions can cause, television broadcasting has always been subject to a strict frequency planning in order to ensure equitable access to spectrum between neighbouring countries. Signing agreements, SMAs have the right to use the assigned frequencies and the obligation to avoid interference with transmissions in neighbouring countries. On the contrary, mobile service does not require such a rigid and well-planned regulatory structure as its frequency plan can be adjusted more easily given the necessity to adhere to some broad conditions.[237]

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[234] International Telecommunication Union – ITU (2010). ITU NEWS, *The digital dividend. Opportunities and challenges* (accessed May 2013), http://www.itu.int/net/itunews/issues/2010/01/27.aspx;

F. Rancy – Director, Radiocommunication Bureau ITU (2012). *Importance of Digital Dividend harmonization* (PowerPoint), May 2012, Barbados. Available at: http://www.itu.int/ITU-D/tech/events/2012/Broadcasting_CTU_CBU_Barbados_May12/Presentations/9_ImportanceOfDigitalDividendHarmonization_CGomez.pdf.

[235] International Telecommunication Union - ITU (2012). *Op. cit.,* supra footnote 32.

[236] European Commission – EC (2003). *Op. cit.,* supra footnote 179.

[237] F. Rancy, E. Zilles, J. J. Guitot (2011). *Op. cit.,* supra footnote 39.

6. International main events

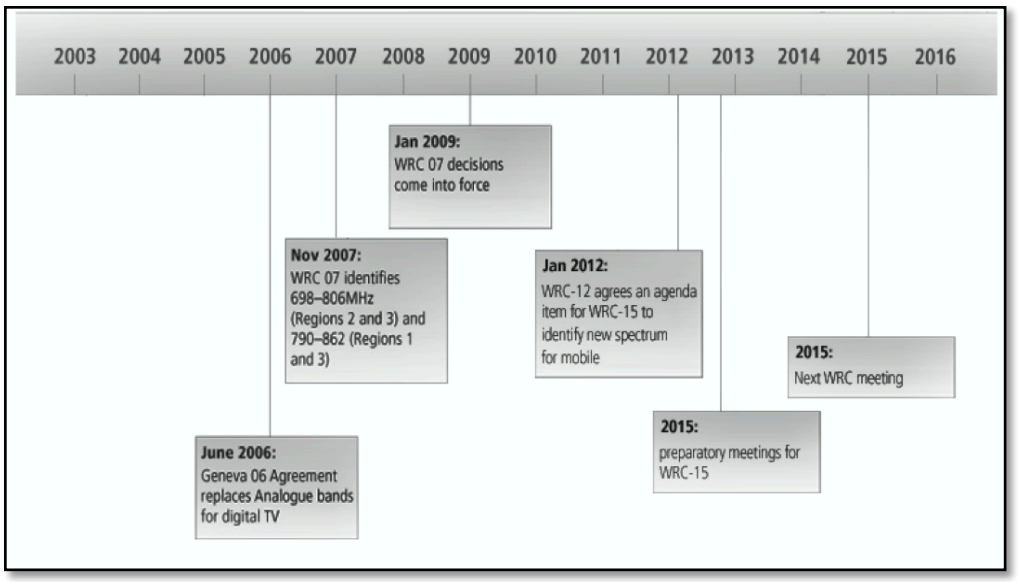

Figure 14. International main events
Source: GSMA (2012). Digital Dividend: The process, *ITU Processes* (accessed May 2013), http://www.gsma.com/spectrum/wp-content/uploads/DigitalDividend/DDtoolkit/the-process.html.

The above picture shows the main stages that have marked the evolution of the digital dividend issue. In 2006, countries from ITU Region 1 (all except for Mongolia) and the Islamic Republic of Iran adopt a new Agreement, commonly referred to as GE06 (Geneva-2006) Agreement, with which they decide for the transition from analogue to digital terrestrial broadcasting.
In 2007 ITU identify the upper part of the UHF band for International Mobile Telecommunication (IMT) services and allocate these frequencies to the mobile service on a co-primary basis with terrestrial television.
In 2012, ITU expand the digital dividend including the 694-790 MHz band, in ITU Region 1, which is identified for IMT and will host both television broadcasting and mobile service on a co-primary basis. This decision will enter into force in 2016, after the upcoming World Radiocommunication Conference that will be held in 2015. Several technical and regulatory issues need to be faced before the new allocation will become effective. ITU-R will conduct several studies, whose results will be discussed during this Conference in order to verify the viability of the proposal and take appropriate action.[238]

6.1. RRC-06

Considering the advantages of terrestrial digital broadcasting services, such as a wider range of programmes, higher video and audio quality and a more

[238] Office of Communications – Ofcom (2012). *UK Report of the ITU World Radio Conference (WRC) 2012*, Geneva, 23rd January – 17th February 2012. Available at: http://stakeholders.ofcom.org.uk/binaries/international/UK-ITU-R/UK_WRC12_Report.pdf.

efficient use of the spectrum previously used for analogue transmissions, ITU has undertaken several activities towards promoting the transition from analogue to digital broadcasting.[239] Successful transition to digital television requires the achievement of two simultaneous events: analogue switch-off and digital switchover. This process is costly and need to be planned carefully in order to avoid potential disruptive consequences, such as the unavailability of television service nationwide.[240] The final goal of digitalisation of broadcasting is to close the digital divide and provide a more equitable access to information society by all.

After many discussions, the ITU (Resolution 1224, 2003) decides to convene a Regional Radiocommunication Conference (RRC-06) for the planning of the digital terrestrial broadcasting frequencies scheme in ITU Region 1 (all except for Mongolia) and the Islamic Republic of Iran. The Conference is held in Geneva in the period 15 May–16 June 2006 and chaired by Mr Kavouss Arasteh of the Islamic Republic of Iran, unanimously elected the first day of the conference.[241] There are more than 1000 participants, representing 104 countries.

Actually, the RRC-06 is preceded by a first session in 2004 (RRC-04) during which technical bases for the new Plan are identified, including the broadcasting standards known as T-DAB (Terrestrial–Digital Audio Broadcasting) and DVB-T (Digital Video Broadcasting–Terrestrial).[242]

The RRC-06 is purely a broadcast conference, so it is organised for promoting the adoption of digital television technologies, ending up with analogue transmissions, while ensuring to minimise cross-border interference. Other services are not taken into consideration.[243] Moreover, the broad objective is to introduce the equitable access principle in the use of the spectrum by registering transmission rights on specific frequencies in specific locations or areas.[244]

Thus, after 6 years and a half of preparation, 118 countries from ITU Region 1 (all except for Mongolia) and the Islamic Republic of Iran adopt the GE06 Agreement. It replaces parts of the Stockholm Agreement for the European Broadcasting Area (1961) and parts of the Geneva Agreement for the African

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[239] International Telecommunication Union – ITU (2010). *Op. cit.,* supra footnote 189.

[240] F. Rancy, E. Zilles, J. J. Guitot (2011). *Op. cit.,* supra footnote 39.

[241] International Telecommunication Union – ITU (2006). *Digital broadcasting set to transform communication landscape by 2015* (accessed May 2013), http://www.itu.int/newsroom/press_releases/2006/11.html.

[242] T. O'Leary, E. Puigrefagut, W. Sami (2006). *GE06 - Overview of the second session (RRC-06) and the main features for broadcasters,* EBU Technical Review. Available at: http://www.ebu.ch/fr/technical/trev/trev_308-rrc-06.pdf.

[243] M. Sims (2006). *The Digital Dividend Dilemma* (accessed May 2013), PolicyTracker, The Spectrum Management Newsletter. Available at: https://www.policytracker.com/headlines/editorial-the-digital-dividend-dilemma?searchterm=the+digital+dilemma.

[244] F. Rancy, E. Zilles, J. J. Guitot (2011). *Op. cit.,* supra footnote 39.

Broadcasting Area (1989).[245] The GE06 Agreement enters into force on 17 June 2006. Many countries begin soon implementing the digital plan during the transition period and some of them have already finalized the transition to DTT broadcasting, ending up with the use of analogue transmissions.

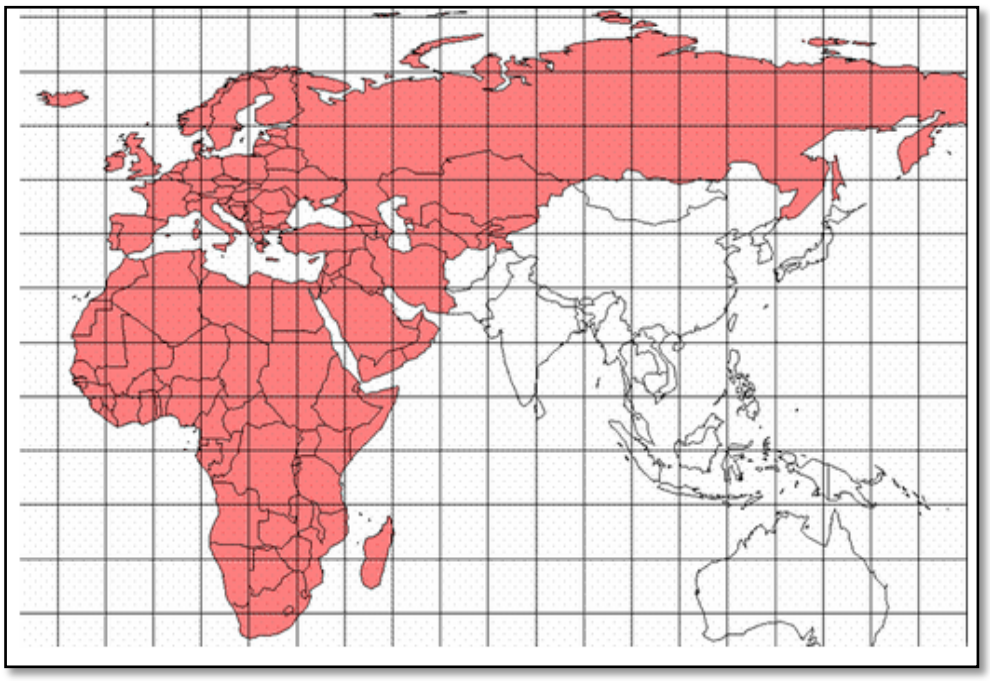

Figure 15. RRC-06 planning area - 119 countries of the GE06 Agreement
Source: ITU, Broadcasting Plans, *GE06 Agreement (accessed May 2013),* http://www.itu.int/ITU-R/terrestrial/broadcast/plans/ge06/.

Each country party to the Agreement is entitled to allocate the VHF and UHF (Bands III and IV/V) bands to television and sound broadcasting services.[246] To be precise, a frequency plan for digital broadcasting is established in Band III (174–230MHz) for the transmission of DVB-T and T-DAB services and in Band IV/V (470–862MHz) for the transmission of DVB-T services, along with agreed procedures which countries need to follow in order to introduce changes to the frequency plan and to ensure that frequency assignments are legitimate.[247] The UHF band (470-862 MHz) is divided into 49 channels, each

[245] European Commission – EC (2005). Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions: *EU spectrum policy priorities for the digital switchover in the context of the upcoming ITU Regional Radiocommunication Conference 2006 (RRC-06)*, {COM(2005) 461}. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2005:0461:FIN:EN:PDF;
GSM Association – GSMA (2012). State of play, *Geneva 06: Regional Radio Conference* (accessed May 2013), http://www.gsma.com/spectrum/wp-content/uploads/DigitalDividend/DDtoolkit/geneva-06.html.
[246] International Telecommunication Union - ITU (2012). *Op. cit.*, supra footnote 32;
International Telecommunication Union – ITU (2010). ITU NEWS, *The digital dividend. Opportunities and challenges* (accessed May 2013), http://www.itu.int/net/itunews/issues/2010/01/27.aspx.
[247] J.-J. Massima-Landji – ITU Representative (2012). *Digital Broadcasting Technologies* (PowerPoint). FTRA-2012, 18 June 2012, Libreville, Gabon. Available at: http://www.itu.int/ITU-D/afr/events/FTRA/2012/documents/Session1_Massima.pdf.

with 8 MHz bandwidth, while the VHF band (174-230 MHz) is divided into 7 or 8 channels with 8 or 7 MHz bandwidth, respectively, depending on the country.[248] Generally, countries have been allocated 3 T-DAB and 1 DVB-T multiplexes in the band III and 7-8 DVB-T multiplexes in bands IV/V.[249] Great flexibility is recognised to SMAs which can modify the digital frequency plan by agreements with neighbouring countries influenced by the proposed modifications.[250]

The GE06 Agreement also contains a provisional plan for the phasing-out of analogue television.[251] 17 June 2015 is set as the deadline for the transition period: until this date countries need to protect the analogue services of neighbouring countries; after that date analogue television transmissions in VHF and UHF bands will no longer be recognised and countries can start using the frequencies assigned to them by implementing the digital broadcasting plan. The deadline is postponed to 2020 for a small number of developing countries, but only for the VHF band (174-230 MHz).[252]

One of the hardest challenges faced by these countries was to find the right balance between analogue and digital transmissions, which have to cohabit during the transition period. As in some countries analogue broadcasting was still widely present at that time while other countries were moving faster towards digital, the risk of interference was seen as high.[253]

ITU put a lot of effort to make sure each country could succeed in the transition process from analogue to digital broadcasting, offering direct and indirect assistance by means of recommendations, guidelines, workshops, and seminars and satisfying potential specific needs.[254]

The RRC-06 does not focus on the potential benefits an allocation of the digital dividend to mobile services or in general to other services could offer, although countries, ensuring that there would not be interference with DTT services in

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[248] EBU – European Broadcasting Union (2009). *Accomodation of HDTV in the GE06 Plan*. Geneva, Switzerland. Available at: http://tech.ebu.ch/docs/tech/tech3334.pdf.

[249] Digital Terrestrial Television Action Group – DigiTAG (2008). *Analogue switch-off. Learning from experiences in Europe*. Geneva, Switzerland: DigiTAG. Available at: http://www.digitag.org/ASO/ASOHandbook.pdf.

[250] Digital Terrestrial Television Action Group – DigiTAG (2006). *Europe prepares for an all-digital future*. Geneva, Switzerland: DigiTAG. Available at: http://www.digitag.org/DTTResources/IBC06/Digital_future.pdf.

[251] J. Doeven - Chairman CEPT Working Group RRC-06 (2006). *Overview of the Geneva 2006 Agreement (GE06)*, PT Forum, 16 October 2006, Oslo, Norway. Available at: http://www.nettvett.no/ikbViewer/Content/Jan- Doeven-CEPT.pdf?documentID=50378.

[252] International Telecommunication Union – ITU (2010). ITU NEWS, *The digital dividend. Opportunities and challenges* (accessed May 2013), http://www.itu.int/net/itunews/issues/2010/01/27.aspx;
Digital Terrestrial Television Action Group – DigiTAG (2006). *Op. cit.,* supra footnote 250.

[253] M. Sims (2006). *RRC-06 agrees technical framework for draft digital plan* (accessed May 2013), PolicyTracker, The Spectrum Management Newsletter. Available at: https://www.policytracker.com/headlines/rrc-06-agrees-technical-framework-for-draft-digital-plan/?searchterm=RRC%2006.

[254] J.-J. Massima-Landji – ITU Representative (2012). *Op. cit.,* supra footnote 247.

neighbouring countries, are allowed to provide other services (Clause 42 of the GE06 final acts).[255]

It has been said that the GE06 digital plan has allocated the entire digital dividend to digital broadcasting favouring its development, but at the same time a sufficient level of flexibility has been accomplished, with the aim to adapt the digital plan when technical development will come up.[256] These developments refer to both broadcasting and non-broadcasting services so, it was early recognised the possibility for a reduction of the broadcasting usage of the spectrum in the long run.[257]

However, it was so difficult to reach agreement and so many compromises were needed that it seemed unlikely that individual countries would have really implemented other services than broadcasting. Even though there was broadly consensus on that point, the EC actually made a request for a different allocation of digital dividend frequencies, but it was beyond the scope of the RRC-06.[258]

6.2. WRCs preparatory work

Every three to four years a World Radiocommunication Conference (WRC) takes place to review, and, if necessary, revise the RR, the international treaty governing the use of the radio frequency spectrum and satellite orbits, with binding effect on all ITU members, promulgated by ITU. Each WRC is preceded by an extensive preparatory process, which involves entities at the international, regional and national level.

At global level, the preparation work, described in ITU-R Resolution 2, starts soon after the previous WRC, in the first Conference Preparatory Meeting (CPM) of the ITU-R, and continues until the following WRC. The CPM prepares a draft structure of a document called CPM report, based on WRC agenda, and places mandates on ITU-R study groups in order to conduct specific technical, operational and regulatory studies regarding spectrum usage to be finalised before the next WRC. The results of these studies are summarised in a section of the draft CPM report, which constitutes the starting point of WRC work. The draft WRC agenda is agreed at the previous WRC,

[255] Analysys Mason, Econ, Hogan and Hartson (2009). *Op. cit.*, supra footnote 222;
M. Thomas – Director ECO (2011). *International frequency coordination – further harmonisation in UHF?* (PowerPoint), Warsaw, Poland, 20 October 2011. Available at: http://www.google.it/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CDEQFjAA&url=http%3A%2F%2Fwww.cept.org%2Ffiles%2F1050%2FDeliverables%2FECO%2520presentations%2FWarsaw%2520Oct%25202011%2520with%2520speaking%2520notes.pptx&ei=pbIHUp_OIZGyhAe_t4Bo&usg=AFQjCNHqFK5BQbeIaNT8PHLoSPeo4sbFnQ&bvm=bv.50500085,d.ZG4.

[256] International Telecommunication Union – ITU (2006). *Digital broadcasting set to transform communication landscape by 2015* (accessed May 2013), http://www.itu.int/newsroom/press_releases/2006/11.html.

[257] T. O'Leary, E. Puigrefagut, W. Sami (2006). *Op. cit.*, supra footnote 242.

[258] Digital Terrestrial Television Action Group – DigiTAG (2006). *Op. cit.*, supra footnote 250.
M. Thomas – Director ECO (2011). *Op. cit.*, supra footnote 255.

formally determined by the ITU Council with the concurrence of a majority of ITU Member States and included in a specific resolution.[259]

The CPM normally meets nine months before the following WRC and adopts the final CPM report. The CPM report is the main basis for administrations to determine their positions for WRC and regional organisations since proposals are usually referring to CPM text options. ITU-R study groups also develop draft ITU-R recommendations containing the results of studies relevant for WRC agenda items. These recommendations may be referred to in the CPM text. Recommendations are normally adopted by the study groups and approved by ITU Member States. The work of these study groups has to be finalised about one year before WRC.[260]

Regional activities have become one of the key factors for the successful preparation of WRCs. At European (regional) level, the preparation phase of WRCs involves mainly the EC, the RSPG and the CEPT. CEPT preparation is carried out by a working group of the ECC, named Conference Preparatory Group (CPG). This group has the responsibility to develop and agree on European Common Proposals (ECPs) for WRCs, to prepare and approve CEPT-briefs for the members of CEPT national delegations and to coordinate CEPT actions during the course of the conference. The ECPs consist of proposals to modify the RR or to adopt new resolutions or modifications to existing resolutions and include the reasons justifying these proposals, while CEPT briefs are explanatory documents on agenda items.

At the first ECC meeting after a WRC, the ECC elects the CPG chairman for the next preparatory process. Once the chairman has been appointed, the CPG decides on the organisation of WRC preparations. In particular several project teams are established to address groups of agenda items under study with a chairman for each project team and a CEPT coordinator for each agenda item. The ECPs and CEPT-briefs are developed in the project teams. CEPT coordinators are essential in the development of the briefs and ECPs, as they gather all relevant information, including those from ITU-R activities, and investigate possible compromise amongst CEPT administrations.

During a WRC, the CEPT coordinator on a given agenda item also has the responsibility to present the relevant ECPs and negotiate on this agenda item. During CPG meetings draft ECPs and draft briefs are discussed and agreed. During WRCs, there are negotiations for each agenda item and also more global discussions. The CPG chairman and vice-chairmen lead the CEPT negotiation team during the conference. Discussions between regional

[259] T. Tjelta, A. L. Lillebø, E. O. Evenstad (2008). *Op. cit.*, supra footnote 60.

[260] Radio Spectrum Policy Group – RSPG (2009). *Opinion on the preparation of ITU World Radiocommunication Conferences*. Available at: http://rspg-spectrum.eu/_documents/documents/opinions/rspg09_294_preparation_itu_wrc.pdf.

organisations are regularly organised either bilaterally or under the umbrella of WRC chairman in order to help in solving the most difficult issues.[261]

6.3. WRC-07

The World Radiocommunication Conference in 2007 (WRC-07) address the worldwide use of the radio frequency spectrum, pursuing solutions on how to exploit this limited resource in the most rational and efficient way. The goal is to meet the global demand for spectrum generated by the rapid technological growth of ICTs, in particular by the development of wireless broadband.

WRC-07 is held in the period 22 October – 16 November 2007, in Geneva, and chaired by Mr François Rancy, from France. There are about 2800 participants, as either Member States representatives or observers.

The hottest issue of WRC-07, among many others, is Agenda Item 1.4 that requires WRC-07 to consider spectrum requirements and potential frequency ranges suitable for the future development of IMT. It was such a controversial topic, which required difficult and demanding negotiations that the achieved result was totally unexpected.[262]

First of all, WRC-07 decides to include both IMT–2000, the family of technologies for Third Generation (3G) mobile communications,[263] and IMT–Advanced, the technology family which refers to the next and higher-performing Fourth Generation (4G) of global wireless broadband communications, into a single category, called just IMT. In this way great flexibility in case of spectrum re-farming is ensured, as spectrum currently identified for 3G technologies can be easily freed up for the use of 4G technologies.[264]

In preparation for WRC-07 the Report ITU-R M.2078 is produced, which estimates that by 2020 the future spectrum bandwidth requirements for the development of IMT will be included in the range 1280-1720 MHz, depending on user demand, for each ITU Region.[265] A lot of spectrum will be necessary to satisfy IMT development requirements and finding unused and suitable spectrum portions represents a tough goal.

In this respect, the CPM identifies several bands, which are showed in Table 3, for advanced mobile services. These bands should be shared with other services already using them. The main idea is to give each national regulator

[261] Radio Spectrum Policy Group – RSPG (2009). *Op. cit.,* supra footnote 260.

[262] T. Tjelta, A. L. Lillebø, E. O. Evenstad (2008). *Op. cit.,* supra footnote 60.

[263] European Telecommunications Standards Institute - ETSI, *Harmonized Standards for IMT-2000* (accessed May 2013), http://www.etsi.org/technologies-clusters/technologies/mobile/imt-2000.

[264] T. Tjelta, A. L. Lillebø, E. O. Evenstad (2008). *Op. cit.,* supra footnote 60.

[265] International Telecommunication Union – ITU (2006). *Report ITU-R M. 2078 Estimated spectrum bandwidth requirements for the future development of IMT-2000 and IMT-Advanced,* Geneva, Switzerland. Available at: http://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2078-2006-PDF-E.pdf.

the freedom to choose which service or technology should use a specific band.[266]

Table 3. Candidate bands

Candidate band	Anticipated use
410 to 430 MHz	Bands which are attractive for the coverage extension of current IMT-2000 systems
450 to 470 MHz	
470 to 862 MHz	Coverage extension and possibly providing capacity requirements
2300 to 2400 MHz	Bands which are attractive for providing the capacity requirements for IMT-Advanced
2700 to 2900 MHz	
3400 to 3600 MHz	
3600 to 3800 MHz	
3800 to 4200 MHz	
4400 to 4990 MHz	

Source: Ofcom Statement (2007). *WRC-07 Agenda Item 1.4*. Available at: http://stakeholders.ofcom.org.uk/binaries/consultations/wrc07/statement/statement.pdf.

One of the candidate bands, the UHF band (470–862 MHz), of great interest for mobile services because of its attractive characteristics in terms of propagation and information-carrying capacity, raises wide disagreement, as it is allocated to the broadcasting service on a primary basis in all three ITU Regions. Therefore, during the RRC-06, that band has just been re-planned for ITU Region 1 and the Islamic Republic of Iran for the introduction of digital broadcasting.[267] The GE06 Agreement placed some constraints on other possible uses. They are not banned, but in order to be introduced, great organisational and economic efforts are required. For instance agreements with neighbouring countries need to be re-negotiated. Moreover, broadcasters would perceive such a change in the use as something detrimental to their interests.[268]
Nevertheless, even though some concerns, WRC-07 identifies the upper part of the UHF band for IMT services. Several countries expressed great support, in particular in ITU Region 2 and 3, where a low percentage of population relies on terrestrial, over-the-air broadcasting to receive video service, even after DTV transition.[269]
Many elements have determined the new allocation: the high suitability of these frequencies for mobile applications, which may be re-planned in short

[266] M. Sims (2008). *WRC-07 analysis: steps towards liberalization* (accessed May 2013), PolicyTracker, The Spectrum Management Newsletter. Available at: https://www.policytracker.com/headlines/wrc-07-analysis-steps-towards-liberalization.
[267] T. Tjelta, A. L. Lillebø, E. O. Evenstad (2008). *Op. cit.*, supra footnote 60.
[268] M. Sims (2006). *The Digital Dividend Dilemma* (accessed May 2013), PolicyTracker, The Spectrum Management Newsletter. Available at: https://www.policytracker.com/headlines/editorial-the-digital-dividend-dilemma?searchterm=the+digital+dilemma.
[269] J. Alden (2011). *The Digital Dividend. Challenges in implementing the Digital Transition to the Information Society*. Regional Seminar On Costs & Tariffs, Gaborone, Botswana, 17-18 May 2011. Available at: http://www.itu.int/ITU-D/finance/work-cost-tariffs/events/tariff-seminars/Gaborone-11/Documents/Session8Alden.pdf.

term; the growing need for spectrum by the mobile service, keeping in mind the irreplaceable role it has been playing and still plays in modern society as a buster for the economy worldwide; the higher cost of achieving coverage of low density population areas in the 2.1 GHz and 2.6 GHz bands, already identified for IMT. Thus, the upper part of the UHF spectrum bans is allocated, in each ITU Region, to the mobile service on a co-primary basis with terrestrial television as follows:

- 698-806 MHz band in ITU Region 2 and nine countries in ITU Region 3 (Bangladesh, China, Korea, India, Japan, New Zealand, Papua New Guinea, Philippines and Singapore);
- 790-862 MHz band in ITU Region 1 and ITU Region 3.[270]

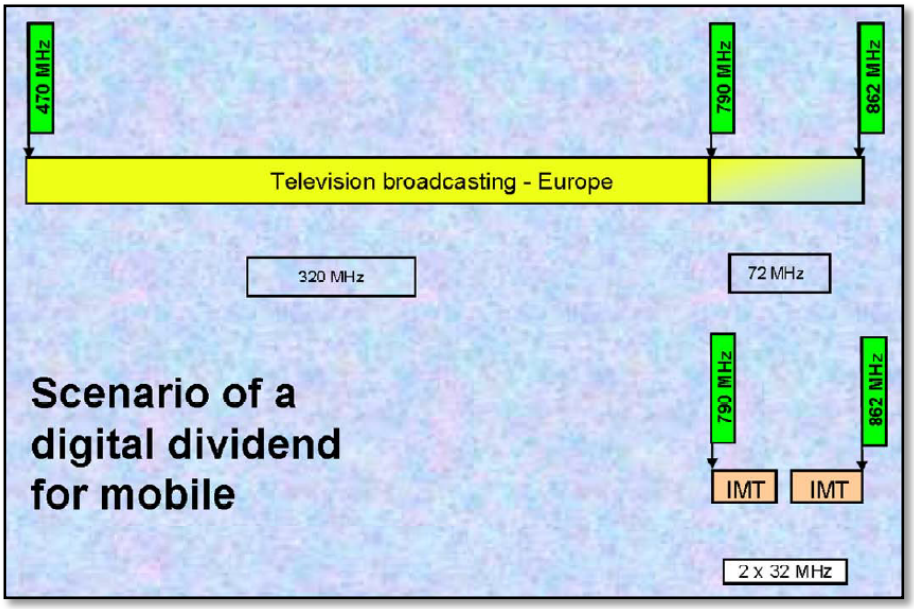

Figure 16. The digital dividend Band – ITU Region 1
Note: Between the frequencies used for uplink and downlink there have to be some frequency separation due to handsets design and cost[271]
Source: Modlic, B., Sisul, G., Cvitkovic, M. (2009). *Digital Dividend – Opportunities for New Mobile Services*, 51st International Symposium ELMAR-2009, Zadar, Croatia, 28-30 September 2009. Available at: http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=5342874&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D5342874.

Focusing on ITU Region 1, it should be said that the main part of the UHF band continues to be used for the provision of broadcasting services. WRC-07 has confirmed the validity of the GE06 Agreement in particular regarding the deadline, 17 June 2015, for the transition period from analogue to digital transmission. WRC-07 has selected the same date as the start for the effective allocation of mobile service in the 790-862 MHz band. However, countries in

[270] International Telecommunication Union – ITU (2010). *Towards the implementation of the digital dividend: ITU–R Joint Task Group 5–6 completes its studies* (accessed May 2013), www.itu.int/net/itunews/issues/2010/08/34.aspx.
[271] Radio Spectrum Policy Group – RSPG (2007). *Op. cit.*, supra footnote 194.

ITU Region 1 that have already completed the transition from analogue to digital television broadcasting are allowed to implement mobile services immediately, under certain conditions. These conditions include the protection of broadcasting services against harmful interference. Moreover, before putting mobile services into operation, agreements with neighbouring countries must be signed.[272]

Since WRC-07, SMAs have put a lot of effort in making the digital dividend available for the mobile service.[273] Many countries in ITU Region 1 soon started the process of converting traditional analogue terrestrial television broadcasting to digital television broadcasting, making the frequencies available for mobile services. By the end of 2008, five European countries have already realised the analogue switch-off migrating to digital television: the Netherlands, Luxemburg, Switzerland, Sweden and Finland.[274] To date twenty-two EU Member States are switched over to digital. Greece, Poland, Bulgaria, Hungary, the Former Yugoslav Republic of Macedonia, and Bosnia and Herzegovina should complete the process by the end of 2014; Albania, Romania, Russia, Montenegro and Turkey have planned to complete the process in 2015. This will ensure that the deadline of the GE06 Agreement will be met.[275]

With regard to the European position in WRC-07, the ECP recognised that the digital dividend could be allocated to mobile service and identified for IMT, but that it was too early to take concrete decisions, which were postponed to the next WRC-12. A small minority of EU Countries wanted to take a final decision at WRC-07. Moreover, the timing made it difficult for CEPT to consider developments on the digital dividend phenomenon, which happened just few months before WRC-07, and to reach consensus on a mobile allocation in the UHF band.[276]

Eventually, WRC-07 agrees on an agenda for the next WRC-12, in particular on Agenda Item 1.17 aimed at proposing a follow up of WRC-07 decision regarding the UHF band. Being aware of the potential for interference between the mobile service and other primary services in the band 790–862 MHz, WRC-07 in Resolution No. 749 decides that technical studies will be conducted in order to adequately protect from harmful interference the primary services that have already been using those frequencies. A dedicated Joint Task

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[272] International Telecommunication Union – ITU (2010). ITU NEWS, *The digital dividend. Opportunities and challenges* (accessed May 2013), http://www.itu.int/net/itunews/issues/2010/01/27.aspx.

[273] International Telecommunication Union – ITU (2013), *Mobile broadband and terrestrial television jostle for spectrum* (accessed May 2013), http://www.itu.int/net/newsroom/wrc/2012/features/digital_dividend.aspx.

[274] B. Modlic, G. Sisul, M. Cvitkovic (2009). *Op. cit.,* supra footnote 207.

[275] BKSTS, Motion Magazine (2013). *European Audiovisual Observatory Press Release* (accessed May 2013), http://bksts.com/BKSTSNews/european-audiovisual-observatory-press-release/.

[276] Radio Spectrum Policy Group – RSPG (2009). *Op. cit.,* supra footnote 265.

Group 5-6 (JTG 5-6) is commissioned to conduct studies on how mobile and other allocated services, such as broadcasting, aeronautical radionavigation and fixed services, can share that band, in particular in ITU Regions 1 and 3.[277] Recognising that there was a lot at stake with respect to the future of the digital dividend, all SMAs attached great importance to the results of those studies, completed in 2010, which have been reported to WRC-12, under Agenda Item 1.17.[278]

6.3.1. Considerations

When WRC-07 took the decision to allocate the upper part of the UHF spectrum for mobile services on a co-primary basis, the process of switching from analogue to digital broadcasting was under way in many countries and had been completed in some of them. In this respect, WRC-07 prompted national actions around the world to re-farm UHF frequencies for mobile service.[279]

Looking at the economic and social consequences, on one hand, the introduction of digital television is bringing many benefits to society. For instance broadcasters are keen to develop, improve and expand their services, providing more and higher-quality and/or interactive services existing and new consumers will benefit from. On the other hand the transition to digital television broadcasting and the consequent release of some frequencies in the UHF band are offering the unique opportunity to re-allocate part of the radio spectrum to other valuable uses and in this way enhancing its efficiency.[280]

WRC-07 did not suppress the existing UHF allocation to terrestrial broadcasting or other services, but left the choice to each country to choose if allocate those frequencies to the mobile service. However, WRC-07 decision for a co-primary allocation of the upper part of the UHF band to mobile service has indirectly set the direction national regulators should take in deciding the allocation of the digital dividend. SMAs can in principle ignore the identification for IMT expressed by the ITU. However, it is evident that as soon as neighbouring countries change spectrum allocation in favour of the mobile service it will start to become unattractive not to harmonise the spectrum usage.[281]

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[277] International Telecommunication Union – ITU (2010). *Towards the implementation of the digital dividend: ITU–R Joint Task Group 5–6 completes its studies* (accessed May 2013), www.itu.int/net/itunews/issues/2010/08/34.aspx.

[278] International Telecommunication Union – ITU (2010). ITU NEWS, *The digital dividend. Opportunities and challenges* (accessed May 2013), http://www.itu.int/net/itunews/issues/2010/01/27.aspx.

[279] International Telecommunication Union – ITU (2013), *Mobile broadband and terrestrial television jostle for spectrum* (accessed May 2013), http://www.itu.int/net/newsroom/wrc/2012/features/digital_dividend.aspx.

[280] International Telecommunication Union - ITU (2012). *Op. cit.,* supra footnote 32.

[281] R. Beutler (2012). *Op. cit.,* supra footnote 221.

Basically the ITU aims at identifying the means by which it could be possible to satisfy the needs of a society that is becoming more and more mobile-based, asking for a widespread broadband internet access and advanced mobile services.[282] Even though the re-planning of the digital dividend frequencies for mobile service, previously planned to be allocated to digital television, will ask and it is already asking for additional costs, the net benefit to the global economy can be broad, both for developed and developing countries.[283] Obviously, SMAs will have to face broadcasters' opposition. In fact, they would be deprived of some spectrum historically used for television broadcasting, while they are eager to broadcast more channels in digital form.[284] However, the current trend in convergence and mobility calls for a renewed use of the radio spectrum fitting for a mobile world.[285] Preserving the status quo would mean denying the progress made in the telecommunication sector and turning down the potential that advancements in mobile communication technologies can offer for a more efficient use of the spectrum and, thus, for the benefit of the whole society. According to GE06 Agreement, SMAs need to settle agreements with neighbouring countries in order to provide other services than digital broadcasting, while ensuring that interference problems will not arise. This negotiating process will profoundly modify the digital frequency plan, whose implementation started just few years ago, in 2006, when the GE06 Agreement entered into force.

6.4. WRC-12

The World Radiocommunication Conference 2012 (WRC-12) is held in Geneva and chaired by Mr Tariq Al Awadhi of the United Arab Emirates. The agenda for WRC-12 was agreed at the previous WRC-07 (Resolution No. 805) and formally established by the ITU Council with the concurrence of a majority of the Member States. More than three thousands participants,

[282] M. Sims (2007). *WRC-07: nobody has lost, everybody has gained* (accessed May 2013), PolicyTracker, The Spectrum Management Newsletter. Available at: https://www.policytracker.com/headlines/wrc-07-nobody-has-lost-everybody-has-gained?searchterm=nobody+has+lost.

[283] International Telecommunication Union – ITU (2013), *Mobile broadband and terrestrial television jostle for spectrum* (accessed May 2013), http://www.itu.int/net/newsroom/wrc/2012/features/digital_dividend.aspx.

[284] D. Sirat, D. Setiawan, M. F. Mirza (2010). *A Basic Framework Analysis on the Needs of Radio Frequency Spectrum Allocation at Ultra High Frequency (UHF) Band for Digital Terrestrial TV Broadcasting in Indonesia*, Computer Engineering and Applications (ICCEA), Second International Conference on, Vol. 2, pp. 73-77, 19-21 March 2010. Available at: http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=5445621&isnumber=5445587&url=http%3A%2F%2Fieeexplore.ieee.org%2Fstamp%2Fstamp.jsp%3Ftp%3D%26arnumber%3D5445621%26isnumber%3D5445587.

[285] O. U. Agwuncha (2011). *Digital Switchover for Future Broadcasting – Dividends and Challenges* in Electronics and Telecommunications, Research Seminar Series, 10th Workshop Proceedings, 13 April 2011, Prof. R.E. Sheriff (Editor), School of Engineering, Design and Technology, pp. 153-157.

including 165 ITU Member States and over 100 companies as observers from the private sector, attend the event, which lasts almost four weeks, from 23 January to 17 February 2012.[286] The CPM, after a period of preparatory work, adopts the CPM report, which will be the point of beginning for the Conference along with another document prepared by the RB: the report on the activities of the ITU-R. Great effort is put by SMAs, regional and international telecommunication organisations with the aim to reach as many results as possible from WRC-12.[287]

6.4.1. The 800 MHz band

At WRC-07 the 790-862 MHz band is allocated to the mobile service in ITU Region 1 and ITU Region 3 and identified for IMT worldwide.[288] Moreover, a dedicated Joint Task Group 5-6 (JTG 5-6) is commissioned by ITU-R to conduct some compatibility studies as concerns came up regarding potential harmful interference problems between mobile and other radiocommunication services, such as broadcasting and radionavigation services, already allocated on the 790-862 MHz band on a primary basis, mainly in Eastern Europe. Harmful interference may be caused by the presence on the same frequencies of different services in neighbouring countries.[289]

As stated in WRC-12 Agenda Item 1.17, during WRC-12 the results of those studies are discussed in detail. It is clarified that no additional regulatory measures, beyond those specified in the GE06 Agreement, need to be taken to ensure adequate protection to existing services already allocated on the 790-862 MHz band, as when a neighbouring country allocates the same frequencies to the mobile service there is no evidence of harmful interference, except for exceptional cases that can be managed by bilateral or multilateral agreements between neighbouring countries.[290]

6.4.2. The 700 MHz band

WRC-12 also decides to expand the digital dividend to include the 700 MHz band (694-790 MHz) in ITU Region 1, which will be allocated to the mobile

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[286] F. Leite – Deputy Director, ITU Radiocommunication Bureau (2012). *Outcomes of ITU WRC-12 for IMT & other mobile broadband* (Power Point). GSMA Mobile World Congress, Barcelona, Spain, 27 February – 01 March 2012. Available at: http://www.gsma.com/publicpolicy/wp-content/uploads/2012/03/gmf12presentationfabioleiteitu.pdf.

[287] International Telecommunication Union – ITU (2012). ITU NEWS, *World Radiocommunication Conference 2012* (accessed May 2013), https://itunews.itu.int/En/2061-World-Radiocommunication-Conference-2012.note.aspx.

[288] The 698-806 MHz band has been allocated to the mobile service in ITU Region 2 and nine countries in ITU Region 3.

[289] Office of Communications – Ofcom (2012). *Op. cit.,* supra footnote 242.

[290] GSM Association – GSMA (2012). *Agenda Item 1.17* (accessed May 2013), http://www.gsma.com/spectrum/wp-content/uploads/2012/03/briefpaper117optiv1oxford.pdf.

service (except for aeronautical mobile) and identified for IMT.[291] These frequencies are addressed as the second digital dividend. In this way the misalignment in the mobile allocations of the digital dividend spectrum between the three ITU Regions can be corrected, achieving a worldwide harmonisation of the 700 MHz, the 800 MHz and the 900 MHz bands for IMT.[292]

The proposal to allocate the 700 MHz band to mobile service comes from African and Arab countries, which are included in ITU Region 1 along with Europe. Some of these African and Arab countries have limited fixed line infrastructure, but extensive mobile systems in the 806-862 MHz band.[293] As they make little use of the 700 MHz band for television broadcasting, even though those frequencies are reserved to this service, they have seen the possibility to propel the use of that band for mobile service, satisfying their need for wireless broadband. This issue is not included in the WRC-12 agenda, as it is put forward at the start of the Conference. [294] In support of this proposal these countries state that the conclusions pulled out of the technical studies conducted by ITU-R on compatibility between mobile and television broadcasting services in the 790-862 MHz can potentially be applied to the 694-790 MHz band and that additional measures would not be required.[295]

The final decision to use the frequency band 694-790 MHz by the mobile service derives from a series of considerations that WRC-12 has synthetized in Resolution No. 232. Basically, it refers to the fact that some SMAs already intend to identify the 694-862 MHz band or part of it for IMT. It is highlighted the suitability of the frequencies below 1GHz for mobile service and the main role IMT has been playing and still plays in reducing the digital divide.[296]

However, given several technical and regulatory issues that need to be faced and the recognition that the spectrum needs of the current users of those frequencies deserve to be safeguarded, WRC-12 decides to insert this issue as a point of discussion at the WRC that will be held in 2015.[297]

Agenda Item 1.2 for WRC-15 is formulated. It states that the upcoming WRC will examine the results of the studies ITU-R is conducting in order to verify the viability of the proposal and take appropriate action in order for the new

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[291] International Telecommunication Union – ITU (2012). *World Radiocommunication Conference sets future course* (accessed May 2013) http://www.itu.int/net/pressoffice/press_releases/2012/10.aspx#.UadcgUB7LQp.

[292] International Telecommunication Union - ITU (2012). *Op. cit.,* supra footnote 32.

[293] Office of Communications – Ofcom (2012). *Op. cit.,* supra footnote 242.

[294] D. Wood – Deputy Director, EBU Technology and Development (2012). *Everything you ought to know about WRC-12?* In Digital Video Broadcasting Project – DVB website (accessed May 2013), http://www.dvb.org/news_events/news/everything-you-ought-to-k/index.xml.

[295] Office of Communications – Ofcom (2012). *Op. cit.,* supra footnote 242.

[296] International Telecommunication Union – ITU (2012). Resolution No. 232 [COM5/10] (WRC 12) *Use of the frequency band 694-790 MHz by the mobile, except aeronautical mobile, service in Region 1 and related studies,* Geneva, Switzerland. Available at: https://www.itu.int/oth/R0A0600004B/en.

[297] International Telecommunication Union - ITU (2012). *Op. cit.,* supra footnote 32.

allocation to become effective immediately after WRC-15. The CPM has established a specific Joint Task Group (JTG 4-5-6-7) to conduct these sharing studies, whose results will determine the technical and regulatory conditions to be applied.[298]

After WRC-15, the 700 MHz band will host both television broadcasting and mobile services, having equal status.[299] If this allocation comes into effect, negotiation with neighbouring countries will be required, as countries will need to internationally coordinate a new DTT frequency plan. Coordination will be also needed between the 700 MHz band and the 800 MHz band in order to maximise potential benefits that can be derived from a harmonised allocation within ITU Region 1 and globally.[300]

Postponing to 2015 the validity of the new allocation will give Europe time to consider carefully all the possible consequences of a new allocation. It would be really difficult for Europe to clear out the 700 MHz band as it is heavily used by television broadcasting, which has just recently left the 800 MHz band.[301] In many European countries, such us UK, Spain, France, Portugal and Italy, DTT is the main digital television viewing platform.[302] Moreover, television broadcasting is widely considered as a crucial instrument in society for providing information and promoting shared values.[303] Therefore, consumers and operators may be affected by the new reallocation due to, for example, disruption and loss of services and potential additional costs for re-tuning, respectively.[304] The consequences of the loss of these frequencies for

[298] Office of Communications – Ofcom (2012). *Op. cit.,* supra footnote 242.

[299] D. Wood – Deputy Director, EBU Technology and Development (2012). *Everything you ought to know about WRC-12?* In Digital Video Broadcasting Project – DVB website (accessed May 2013), http://www.dvb.org/news_events/news/everything-you-ought-to-k/index.xml;
International Telecommunication Union – ITU (2012). *Op. cit.,* supra footnote 296.

[300] GSM Association – GSMA, Digital Dividend: GSMA Viewpoint *Recommendations* (accessed May 2013), http://www.gsma.com/spectrum/wp-content/uploads/DigitalDividend/DDtoolkit/gsma-viewpoint.html;
Office of Communications – Ofcom (2012). *Op. cit.,* supra footnote 242.

[301] D. Standeford (2012). *WRC-12 edges towards agreement on mobile broadband* (accessed May 2013), PolicyTracker, The Spectrum Management Newsletter. Available at: https://www.policytracker.com/headlines/wrc-12-edges-towards-agreement-on-mobile-broadband/?searchterm=digital%252520dividend%252520in%252520wrc-12.

[302] J. Stewart – Analysys Mason (2012), *Implementing the second digital dividend: harmonisation is key – comment from World Radio Conference 2012* (accessed May 2013), http://www.analysysmason.com/About-Us/News/Insight/Implementing-the-second-digital-dividend--harmonisation-is-key/#.Ubmkovl7LQo.

[303] C. Cambini, N. Garelli (2011). *Op. cit.,* supra footnote 139.

[304] BHO Legal (2012), *European Broadcasting Union warns about WRC-12 risks to European Radio Spectrum Policy* (accessed May 2013), http://www.bho-legal.com/fr/aktuelles/nachricht/details/european-broadcasting-union-warns-about-wrc-12-risks-to-european-radio-spectrum-policy/.

broadcasting and the effect on the public should be clearly understood in order to make the right decision for the society overall.[305]

6.4.3. Additional spectrum

It is worth noting that the lower edge of the spectrum that would be allocated to the mobile service is not yet settled, meaning that other potential candidate frequencies will be investigated. Thus, another issue that has been included in WRC-15 agenda under Agenda Item 1.1 regards the wish to consider additional spectrum to be allocated for the mobile service, going lower than 700 MHz on the UHF spectrum in order to facilitate the development of terrestrial mobile broadband applications.[306]

As stated in WRC-12 Resolution No. 233, the Conference takes into consideration the exponential growth in demand for mobile broadband services and the raising number of users of IMT systems for mobile broadband applications. By now, IMT is playing a main role in bridging the digital divide, in particular in delivering universal broadband service, and in contributing to global economic and social development by providing a wide range of multimedia applications, such as mobile telemedicine, teleworking, distance learning and other applications. Resolution No. 233 also recalls attention to the peculiar characteristics of the frequency bands below 1 GHz, which can suit the necessities of IMT systems and to the need to continue exploiting technological developments to achieve the goal of a more and more efficient use of the spectrum.[307]

The need to identify additional frequencies to be allocated to the mobile services is putting pressure on many SMAs. It has been estimated that around 500 MHz will be required to accommodate the growing spectrum demand for wireless and mobile broadband over the next ten years. In order to identify this additional spectrum, being the spectrum in short supply, re-farming of frequencies already occupied by other services seems to be one of the most attractive solution, in particular regarding those bands reserved for government use. Of course this would have financial consequences that need to be considered upfront. Another possible measure that could be taken refers to the release of additional UHF frequencies, making life more difficult for

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[305] D. Wood – Deputy Director, EBU Technology and Development (2012). *Everything you ought to know about WRC-12?* In Digital Video Broadcasting Project – DVB website (accessed May 2013), http://www.dvb.org/news_events/news/everything-you-ought-to-k/index.xml.

[306] International Telecommunication Union – ITU (2012). *World Radiocommunication Conference sets future course* (accessed May 2013) http://www.itu.int/net/pressoffice/press_releases/2012/10.aspx#.UadcgUB7LQp.

[307] International Telecommunication Union – ITU (2012). Resolution No. 233 [COM6/8] (WRC 12) *Studies on frequency-related matters on International Mobile Telecommunications and other terrestrial mobile broadband applications,* Geneva, Switzerland. Available at: http://www.itu.int/oth/R0A0600004C/en.

broadcasters.[308] Maybe, the time has come to architect a new plan from the foundations for the allocation of the UHF band although such a drastic approach would carry a higher degree of uncertainty. In the years ahead the importance of the mobile service and in particular of mobile broadband will continue to growth along with hungry for spectrum frequencies. Technological progress is inevitable, which need to be backed in order to reap its benefits.[309]
It is still too early to predict how this extremely critical issue will end up. The final agreement resulting from WRC-15 will inevitably mark the future use of the radio spectrum and the technological development in particular of the mobile and the broadcast sector.

6.4.4. Considerations

After RRC-06, the UHF spectrum has been re-allocating twice due to WRC-07 and WRC-12 decisions. A new international framework has been created, which countries have to comply with. Within this framework, national regulators have the freedom to choose which service should use the upper part of the UHF band, under the condition of bilateral or multilateral agreements with neighbouring countries about the selected use, in order to manage interference problems. Even though the allocation of those frequencies to mobile service is not compulsory, the growing importance of mobile service for both developed and developing countries is self-evident, given the widespread use of mobile applications and their undeniable positive social and economic benefits. It could be claimed that the direction that countries are going to take goes in favour of the mobile service.[310]
Mobile services have shown such a rapid diffusion that additional frequencies are required to meet the future needs of wireless technologies, as the data traffic in mobile networks is even growing faster than predicted and will keep growing over the next years.[311] The increase in data traffic per user, which shows the change in the use of mobile devices, is a key driver for spectrum demand.[312]

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[308] International Telecommunication Union – ITU (2013), *Mobile broadband and terrestrial television jostle for spectrum* (accessed May 2013), http://www.itu.int/net/newsroom/wrc/2012/features/digital_dividend.aspx.
[309] R. Womersley (2012). *Laying the groundwork for future UHF success* (accessed May 2013), PolicyTracker, The Spectrum Management Newsletter. Available at: https://www.policytracker.com/blogs/richard-womersley/topics/Digital%20dividend.
[310] P. Defraigne - Cullen International (2011). *EU spectrum policy: Digital dividend* (PowerPoint), 33rd meeting of EPRA, Ohrid, Macedonia, 26-27 May 2011. Available at: http://www.google.it/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CDgQFjAA&url=http%3A%2F%2Fwww.cullen-international.com%2Fressource%2F366%2F0%2Forhid-may.pdf&ei=9eUUUuGRJKby4QTGnICwCA&usg=AFQjCNEssBa_3NHZQizk3YY2WZ_PIO6yYA&bvm=bv.50952593,d.bGE.
[311] A. Durantini, M. Martino (2013). *Op. cit.,* supra footnote 123.
[312] Data traffic can be technically measured by the number of petabytes per month. The petabyte is a multiple of the unit byte for digital information; 1 petabyte = 1015 bytes.

According to the latest Cisco forecast, global mobile data traffic grew 70% in 2012, reaching 885 petabytes per month at the end of 2012 (520 petabytes per month were reached at the end of 2011) and will increase 13-fold between 2012 and 2017 at a compound annual growth rate (CAGR) of 66%, reaching 11.2 exabytes (1 exabyte = 10^{18}bytes) per month by 2017. By the end of 2013 the number of mobile-connected devices will exceed the number of people on earth, and by 2017 there will be nearly 1.4 mobile devices per capita.[313]

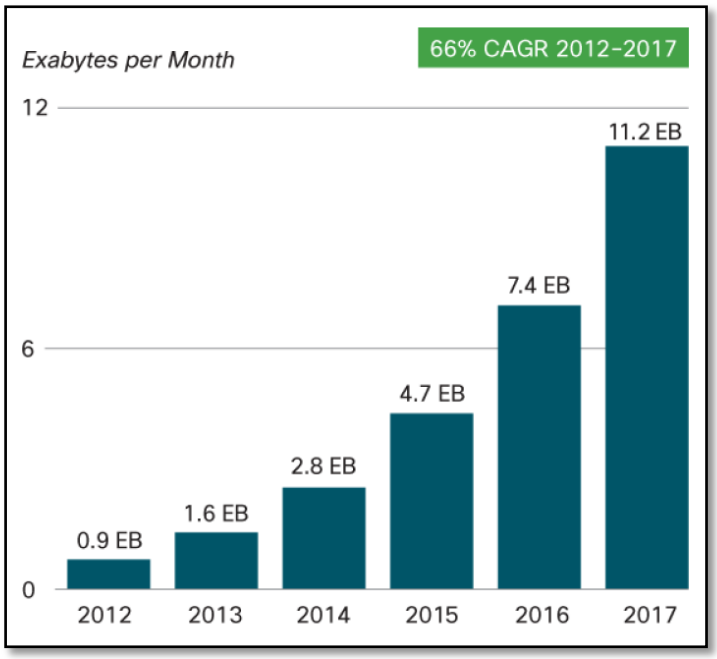

Figure 17. Cisco Forecasts 11.2 exabytes per month of mobile data traffic by 2017
Source: The Cisco (2013). Cisco Visual Networking Index: *Global Mobile Data Traffic Forecast Update 2012-2017*, 6 February 2013. Available at: http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-520862.html.

It is worth noting that demand for DTT and wireless broadband is likely to vary from country to country. It depends on several interrelated factors such as geography, population density, development of infrastructure for cable and fixed broadband networks and the legal framework, for example restrictions that may be present in some countries regarding new entrants.
From broadcasting perspective, realising the 700 MHz band would have a dramatic impact as many DTT systems have already been re-planned to free up the first digital dividend. A new planning would probably require a specific conference for terrestrial broadcasting and, inevitably, countries will incur in additional costs. Moreover, that band is seen as vital for the future development

[313] The Cisco (2013). Cisco Visual Networking Index: *Global Mobile Data Traffic Forecast Update 2012-2017*, 6 February 2013. Available at: http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-520862.html.

of digital broadcasting technologies, which would be prevented if more spectrum was released.[314]

Despite the availability of other platforms, such as the Internet, cable and satellite, DTT is the primary means of delivering television in many European countries and in most of them there is evidence of demand for additional DTT services.[315]

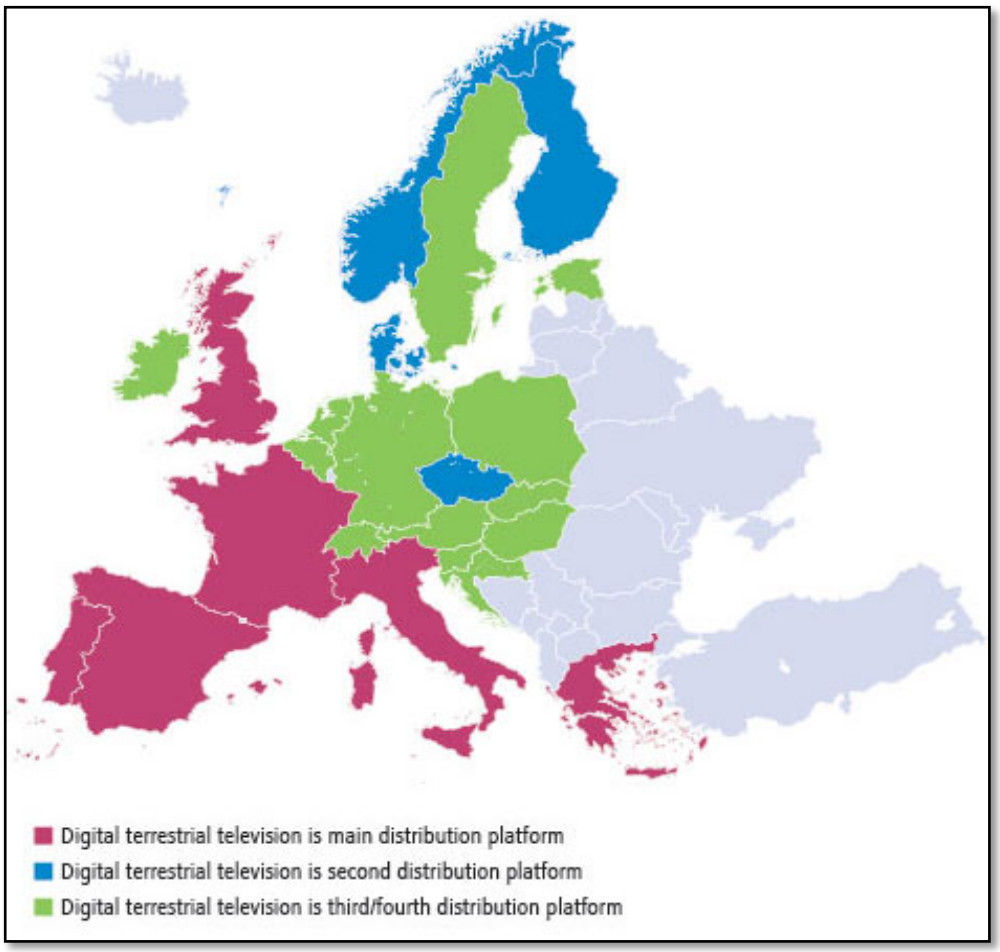

Figure 18. Position of the digital terrestrial television platform in selected European countries
Source: ITU (2013). *Mobile broadband and terrestrial television jostle for spectrum* (accessed May 2013), http://www.itu.int/net/newsroom/wrc/2012/features/digital_dividend.aspx.

Moreover, predicting the amount of spectrum that will be required to satisfy spectrum demand from different services is a very hard goal to achieve. Studies could be conducted, however they would require too much time to be formulated that their validity would be challenged by the rapid evolution characterising these technologies. They would appear too old, not corresponding to reality anymore. Moreover, the work at the international,

[314] R. Beutler (2012). *Op. cit.*, supra footnote 221.

[315] International Telecommunication Union – ITU (2013), *Mobile broadband and terrestrial television jostle for spectrum* (accessed May 2013), http://www.itu.int/net/newsroom/wrc/2012/features/digital_dividend.aspx.

regional and national level behind every allocation decision usually takes a lot of time, even years, not keeping abreast of technological advances, in particular of mobile sector.[316] However, the growing importance of mobile services worldwide is so outstanding that it cannot be ignored. Society is becoming more and more mobile, so more spectrum will be required to allow the mobile sector to grow.

[316] International Telecommunication Union - ITU (2012). *Op. cit.*, supra footnote 32.

7. European framework

7.1. The importance of European harmonisation

Spectrum harmonisation is a vital aspect of digital dividend allocation. Thus, it has been occurring on both regional and multiregional basis. Europe has been working hard to structure a harmonised regional plan on the digital dividend, promoting coordination in the management and use of the spectrum, to be followed by all EU Member States.

The aim is to put Europe in the condition to maximise the benefits that can be gained from coordinated pan-European services and markets. If spectrum harmonisation is not reached, Europe will have to face many negative consequences, such as cross-border interferences and impossibility for producers to build economies of scale due to fragmented national approaches, which will impede the development of a single European digital market.

A communication from the EC to the EP states that the total value of services that depend on the use of the radio spectrum in the EU exceeds €250 billion annually, which is about 2.2% of the annual European GDP. It has been estimated that, in Europe, the wireless electronic communications industry supports 3.5 million jobs and generates around €130 billion annually in tax revenues. Moreover, mobile services have a penetration rate of 124%, being used by 83% of the EU households, which have access to at least one mobile phone, while 24% of households do not have access to a fixed line, they just rely on mobile devices.[317]

In order to understand the social and economic impact of the potential uses that can be made of the digital dividend, the EU has been conducting a large-scale study, launched in 2008. According to this study, appropriate European coordination would increase the potential economic impact of the digital dividend by an additional €20 to €50 billion by 2015, as compared to individual EU Member States plans, depending mostly on the actual level of future demand for services such as advanced terrestrial broadcasting and wireless broadband services.

In the longer term, beyond 2015, further benefits of €30 billion could be realised through continued EU coordination. Evidence suggests that there would also be overall positive social benefits, albeit more difficult to quantify.[318]

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[317] GSM Association – GSMA (2012). *Importance of the Digital Dividend* (accessed June 2013). Available at: http://www.gsma.com/spectrum/wp-content/uploads/DigitalDividend/DDtoolkit/digital-dividend-background.html;
GSM Association – GSMA (2012). *The Digital Dividend in Europe* (accessed June 2013). Available at: http://www.gsma.com/spectrum/wp-content/uploads/2012/03/ddinfosheeteuroupdate1.pdf.

[318] European Commission – EC, Information Society and Media Directorate-General (2009). Consultation document *Transforming the digital dividend opportunity into social benefits and economic growth in Europe*. Available at:

7.2. European common approach to radio spectrum

The Radio Spectrum Decision (Decision No. 676/2002/EC) of the EP and of the Council of 7 March 2002 can be considered one of the first milestones in the development of a European common approach to radio spectrum. The objective of this decision is to establish a Community regulatory and policy framework to ensure that national radio spectrum policies are coordinated and, where appropriate, harmonised within the EU, with the aim to fulfil relevant Community purposes by institutionalising European spectrum policy.[319]

EU Member States negotiate in the ITU as independent members (European Union is a 'Sector Member', a status similar to industry organisations[320]), but in practice they choose to develop their technical positions together within CEPT before negotiating with the rest of the world. In turn, CEPT need to consider EU interests and objectives in negotiations.[321]

In this respect, the final objective of the Radio Spectrum Decision is to protect the interests of the European Community in international negotiations on the use of the spectrum, trying to merge EU Member States' interests in one common action.[322] EU Member States and the Community must closely cooperate during negotiation processes in order to safeguard the unity of the Community.[323]

This decision also introduces a cooperation mechanism for the decision making process with regard to spectrum management, which involves mainly EC, RSPG and CEPT.[324] RSPG provides opinions of the EU Member States to the EC, which, in turn, issues mandates to CEPT to provide technical conditions on the use of the spectrum. Then, these conditions are integrated by the EC into

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http://www.ilr.public.lu/services_frequences/cons_publiques/conspub160709/2009_0710_0904_digitaldividendconsultation.pdf.

[319] E. Bohlin (2011). *A Perspective on the Evolution of European Spectrum Policy* (PowerPoint), CEPS-ITS Seminar, Brussels, Belgium, 25 October 2011.

[320] European Commission - EC (2011). Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions *The European Union's policy approach to the ITU World Radiocommunication Conference 2012 (WRC-12),* {COM(2011) 180}. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0180:FIN:EN:PDF.

[321] GB Parliament: House of Commons: European Scrutiny Committee (2011). *Thirty-first Report of Session 2010-12*. Available at: http://books.google.it/books?id=-tETEzpl73kC&pg=PA51&lpg=PA51&dq=Thirty-first+Report+of+Session+2010-12&source=bl&ots=_dDbbLdz4z&sig=3J7qj4ytoo8b18tiKGgcGROAXp4&hl=it&sa=X&ei=Ou0UUuu3A4mm4ASv3YGQBQ&ved=0CDcQ6AEwAQ#v=onepage&q=Thirty-first%20Report%20of%20Session%202010-12&f=false.

[322] European Parliament – EP, Council of the European Union – the Council (2002). *Op. cit.,* supra footnote 64.

[323] European Commission – EC (2007). Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions *The ITU World Radiocommunication Conference 2007 (WRC-07),* {COM(2007) 371}. Available at: http://eur-lex.europa.eu/LexUriServ/site/en/com/2007/com2007_0371en01.pdf.

[324] E. Bohlin, C. Blackman, S. Forge, A. Renda (2007). *Op. cit.,* supra footnote 62.

recommendations or decisions, after consultation of the EU Member States. By means of recommendations, EC encourages the adoption of proposed technical conditions, which, instead, have binding effects if included in decisions.[325]
The following table contains all the RSPG Opinions adopted since this entity has been set up, as reported in the RSPG website.[326]

Table 4. RSPG Opinions

2004
• Opinion on Secondary Trading of Rights to use Radio Spectrum • Opinion on Spectrum Implications of Switchover to Digital Broadcasting
2005
• Opinion on Wireless Access Policy for Electronic Communications Services (WAPECS) • Opinion on the World Radio Conference 2007 (WRC-07)
2006
• Opinion on The Introduction of Multimedia Services in particular in the frequency bands allocated to the broadcasting services
2007
• Opinion on a Coordinated EU Spectrum Approach for Scientific Use of Radio Spectrum • Opinion on Spectrum Policy Implications of the Digital Dividend • Revised Opinion on WRC-07
2008
• Opinion on Spectrum Issues Concerning EU Borders • Opinion on Aspects of a European Approach to "Collective Use of Spectrum" • Opinion on Streamlining the Regulatory Environment for the use of Spectrum
2009
• Opinion on best practices Regarding the Use of Spectrum by Some Public Sectors • Opinion on the Digital Dividend • Opinion on the Preparation of ITU World Radiocommunication Conferences • Opinion on the Main Themes of WRC-12 of Interest for EU-wide support
2010
• Opinion on the Radio Spectrum Policy Programme
2011
• Opinion on Common Policy Objectives for WRC-12 • Opinion on Cognitive Technologies
2012
• Opinion on the process for EU assistance in bilateral negotiations with third countries and between EU countries • Opinion on Review of Spectrum Use
2013
• Opinion on Strategic Challenges facing Europe in adrressing the Growing Spectrum Demand for Wireless Broadband • Interim Opnion on the preparation of Common Policy Objectives for WRC-15

[325] F. Rancy, E. Zilles, J. J. Guitot (2011). *Op. cit.*, supra footnote 39.

[326] Radio Spectrum Policy Group – RSPG (2013). *RSPG Opinions* (accessed June 2013), http://rspg.ec.europa.eu/rspg_opinions/index_en.htm#opinions.

The EC placed three mandates to CEPT; each of them was part of the EU preparation process for a WRC.

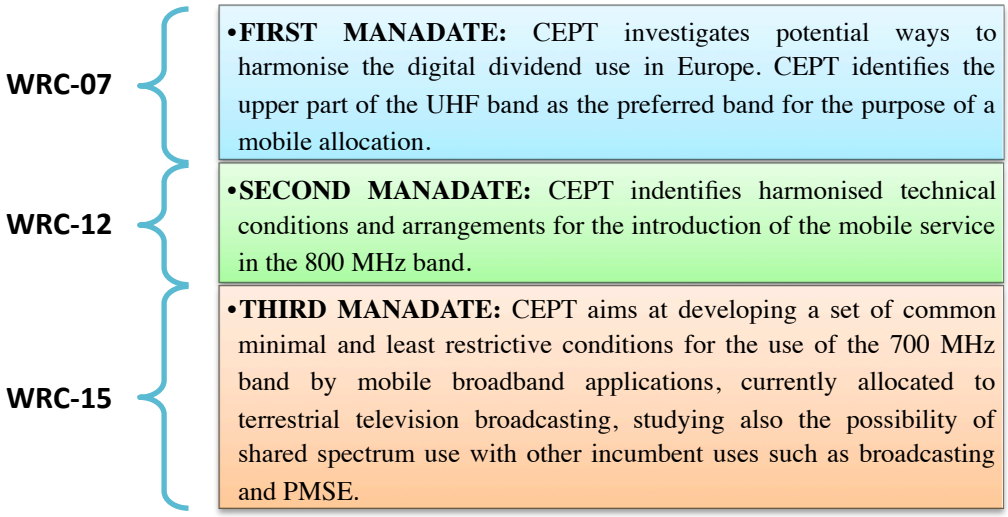

Figure 19. CEPT mandates

7.3. Europe and the digital switchover

Within Europe, active interest has always been shown in the development of digital television technologies, given the huge advantages that can be gained in terms of more efficient spectrum usage and increased transmission possibilities. In fact, the EC deeply analyses this issue in the Communications COM(2003) 541 and COM(2005) 204. The latter was published in light of the RSPG Opinion "on spectrum implications of the switchover to digital terrestrial broadcasting", released in 2004, which emphasizes the benefits of migrating to digital television, both at national and European level. Moreover, timing and duration of the switchover period are recognised as critical factors because of temporary constraints on spectrum capacity due to parallel simulcasting of both analogue and digital transmissions during the transition period. The shorter is the transition period the sooner countries and the Europe overall can benefit from the introduction of digital broadcasting. In particular the COM(2005) 204 calls for an acceleration of the switchover plans of EU Member States, which should be completed through a coordinated approach on a European scale.

The aim is to overcome a fragmented situation emerging among EU Member States, which could represent an obstacle for the provision of pan-European services and applications.[327] Although the switchover is a complex process

[327] European Commission – EC (2003). *Op. cit.*, supra footnote 179;
European Commission - EC (2005). Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions *on accelerating the transition from analogue to digital broadcasting*, {COM(2005) 204}. Available at: http://eur-lex.europa.eu/LexUriServ/site/en/com/2005/com2005_0204en01.pdf.

from a technical point of view, what can really affect its accomplishment is mostly related to political difficulties, such as absence of political commitment and economic obstacles, for instance lack of incentives to switch by analogue consumers. In this regard, coordination between EU Member States would facilitate a rapid switchover.[328]

7.4. Digital dividend taking centre stage

Already point of discussion in previous years, the digital dividend has started to occupy centre stage in Europe since 2005, when the EC identified the release of digital dividend frequencies resulting from digital switchover as a spectrum policy priority in the context of RRC-06, in its Communication COM(2005) 461. The Communication states that digital technologies uses spectrum more efficiently than analogue technologies. Thus, less spectrum will be used by DTT systems, releasing some frequencies for the provision of other services.[329] Spectrum harmonisation, firstly regarding the regulation of spectrum, is considered a key element for the completion of an open and competitive digital European market, which will continue to develop if regulatory constraints are maintained at the necessary minimum level.[330]

In the same year, during the EU preparation process for WRC-07, the RSPG adopted its Opinion on WRC-07, subsequently revised in February 2007. It states that all the issues that would be discussed during that Conference are of relevance to Europe. For this reason the European Community is encouraged to pursue with effort its policy priorities and objectives at the next Conference.[331] Following the RSPG Opinions on WRC-07, the EC provided political guidance for WRC-07 negotiation process, in particular by means of Communications to the EP and the Council.[332]

Over the years, several RSPG Opinions have been published, assisting the EC in the development of policies on spectrum use. One of the Opinions that marked the debate on the digital dividend was published in February 2007. It regards the EU spectrum policy implications of the digital dividend. It illustrates the basic characteristics of the digital dividend; its potential uses and

[328] Radio Spectrum Policy Group – RSPG (2004). Opinion on *spectrum implications of switchover to digital broadcasting*. Available at: http://rspg-spectrum.eu/_documents/documents/opinions/rspg04_55_op_dig_switch.pdf.

[329] Post & Telestyrelsen – PTS (2006). *The use of radio spectrum following the switch-off of analogue terrestrial television broadcasting*, Report on a Government assignment. Available at: http://www.pts.se/upload/Documents/EN/Use_of_radio_spectrum_2006_35.pdf.

[330] European Commission – EC (2007). *Op. cit.*, supra footnote 323;
Radio Spectrum Policy Group – RSPG (2010). Opinion on *the Radio Spectrum Policy Programme*. Available at: http://rspg-spectrum.eu/_documents/documents/opinions/rspg10_330_rspp_opinion.pdf.

[331] Radio Spectrum Policy Group – RSPG (2005). Opinion on *the World Radio Conference 2007 (WRC-07)*. Available at: http://rspg.ec.europa.eu/_documents/documents/opinions/rspg05_103_op_wrc07.pdf.

[332] Radio Spectrum Policy Group – RSPG (2009). Opinion on *the main themes of WRC-12 of interest for EU-wide support*. Available at: http://rspg-spectrum.eu/_documents/documents/opinions/rspg09_295_main_themes_wrc12.pdf.

calls for a mandate to be given to CEPT in order to study possible harmonisation measures for a sub-band of the UHF band for fixed and mobile networks.

In light of the upcoming WRC-07, the EC adopted the above RSPG Opinion and placed the first mandate to CEPT with the aim to investigate potential ways to harmonise the digital dividend use in Europe, managing potential interference issues. Five CEPT Reports have been released (No. 21, 22, 23, 24, 25). CEPT identifies the upper part of the UHF band as the preferred band for the purpose of a mobile allocation.[333] In particular CEPT Reports 22 and 23 conclude that such harmonisation of the 790-862 MHz band is feasible from a technical, regulatory and administrative point of view.[334] Therefore, Report 25 proposes technical options and scenarios to optimise the use of the digital dividend, including steps required during the transition period before analogue switch-off.[335]

Two important EC Communications were published in 2007, which have significant implications for the mobile service. In the COM(2007) 371 on WRC-07, the EC states that the spectrum bands released by switchover to digital broadcasting "should not be frozen by the present spectrum allocation situation but should be assessed in the light of the opportunities provided by new, efficient uses, keeping in mind general interest objectives". More flexibility should be introduced, reducing spectrum fragmentation, which would lead to suboptimal use of that scarce resource, and eliminating regulatory barriers to the provision of innovative services in the UHF band. Giving mobile services the same status as broadcasting services at the next WRC-07 has been addressed as the first step in the direction of more flexibility.[336] Based on the RSPG Opinion on WRC-07, the Communication COM(2007) 700 on "Reaping the full benefits of the digital dividend in Europe: a common approach to the use of the spectrum released by the digital switchover" was adopted. It describes the nature of the digital dividend and proposes coordinated action at the European level in order to ensure optimal use of the digital dividend, from both a social and economic perspective, by a wide range of potential applications, while taking into account that different situations may exist in each country. EU Member States are invited to facilitate the introduction of new services by working together and in collaboration with the EC in order to identify common spectrum bands in the digital dividend that

[333] International Telecommunication Union - ITU (2012). *Op. cit.,* supra footnote 32.

[334] H. R. Karimi, M. Fenton, G. Lapierre, E. Fournier (2010). *European Harmonized Technical Conditions and Band Plans for Broadband Wireless Access in the 790-862 MHz Digital Dividend Spectrum*, New Frontiers in Dynamic Spectrum, 2010 IEEE Symposium on, pp. 1-9, 6-9 April 2010. Available at: http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=5457848&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D5457848.

[335] R. Beutler (2012). *Op. cit.,* supra footnote 221.

[336] European Commission – EC (2007). *Op. cit.,* supra footnote 326.

can be optimised by creating "clusters" of services using similar type of communications network.[337]

In several EU Member States mobile services have already been playing an important role in the provision of broadband access: firstly, because of its cost effectiveness, which may exceed that of wired broadband, especially in areas with a low population density; secondly, because of the distinct value offered by mobility and wireless connectivity in general. However, in other countries mobile is regarded as complementary service to fixed networks. Thus, the diffusion of mobile services in providing broadband access will also depend on the roll-out of fixed broadband services. In turn, this will depend on the geography of the country and the population density, i.e. the size of rural and urban areas noting that there are substantial differences between urban and rural areas in most parts of Europe.[338]

Both the Council (Council Conclusion on 12 June 2008) and the EP (EP Resolution of 24 September 2008) recognised the validity of the main objectives proposed by the EC in the Communication COM(2007) 700, underlying the potential benefits of a coordinated approach to the use of the spectrum in the EU for electronic communication services other than broadcasting.[339] It has been said that "many potential uses of the digital dividend will simply not occur if access to spectrum is not better coordinated across Member States", meaning that a higher level of coordination and flexibility in the use of the spectrum can increase the overall capacity and range of uses and so the overall value of the digital dividend.

If EU Member States move together it will be possible to sustain a common approach to the digital dividend with which supporting technology development and innovation with a European dimension and strengthening the role Europe plays in the global marketplace with regard to the competitiveness of its ICT sector. It will also ensure that the digital dividend spectrum is tailored to European requirements, and not imposed from outside.[340]

7.5. The 800 MHz band to mobile service

In response to the outcome of WRC-07 and looking at the next WRC-12, in April 2008, the EC issued a second mandate to CEPT, whose results represent the harmonised technical conditions and arrangements for the introduction of the mobile service in the 790-862 MHz band across Europe.[341] Technical considerations regarding harmonisation options for the digital dividend in the EU are described in four CEPT Reports (No. 29, 30, 31, 32).

[337] European Commission – EC (2007). *Op. cit.,* supra footnote 113.

[338] Radio Spectrum Policy Group – RSPG (2013). *Op. cit.,* supra footnote 110.

[339] European Commission – EC, Information Society and Media Directorate-General (2009). *Op. cit.*, supra footnote 318.

[340] European Commission – EC (2007). Op. cit., supra footnote 113.

[341] R. Beutler (2012). *Op. cit.,* supra footnote 221.

Report 29 gives guidance on cross-border coordination issues that can rise when some countries may implement mobile services while other countries still provide broadcasting services. Report 30 identifies common and minimal technical conditions for 790-862 MHz band aimed at protecting broadcasting channels from harmful interference. Report 31 includes the preferred frequency arrangement for the digital dividend frequencies, adopted in the EC Decision No. 2010/267/EU which will be uncase later. [342]

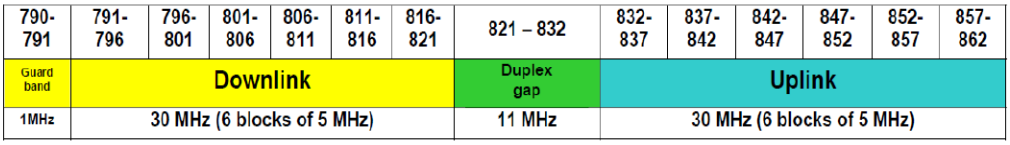

Figure 20. Preferred harmonised channelling arrangement for the 90-862 MHz band in EU
Source: International Telecommunication Union - ITU (2012). *Digital Dividend: Insights for Spectrum Decisions*, Geneva, Switzerland. Available at: http://www.itu.int/ITU-D/tech/digital_broadcasting/Reports/DigitalDividend.pdf.
Note: A guard band (the duplex gap), meaning unused frequencies, is needed between frequencies used for uplink and downlink transmissions in order to prevent interference.

Report 32 underlies the necessity to ensure the continuation of existing Program Making and Special Events (PMSE) services (i.e. wireless microphones and cordless cameras which support sport events and concerts) operating on the 470-862 MHz band. It also identifies a number of potential frequency bands and innovative technical developments as a solution to the current use of the 790-863 MHz band by these applications.[343]
While CEPT was working on WRC-12 Agenda, another RSPG Opinion on the Digital dividend was published in 2009. It seeks to provide a series of recommendations to the EC for the drawing of a coordinated approach within Europe to favour the availability of the 800 MHz band for other services than broadcasting. It highlights how lack of coordination would hamper the high potential of the digital dividend, while coordinating digital dividend planning across Europe would promote growth, competition and innovation.[344]
On the basis of the above CEPT response and RSPG Opinion, in October 2009, the EC Recommendation No. 2009/848/EC on "Facilitating the release of the digital dividend in the European Union" has been published. The EC recommends that the digital switchover should take place by 2012 and that the 790-862 MHz sub-band should be used for wireless broadband services.[345]
Between July and September 2009, the EC held a public consultation on the

[342] European Commission – EC (2010). *Commission Decision of 6 May 2010 on harmonised technical conditions of use in the 790-862 MHz frequency band for terrestrial systems capable of providing electronic communications services in the European Union,* Official Journal of the European Union. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:117:0095:0101:en:PDF.
[343] International Telecommunication Union - ITU (2012). *Op. cit.*, supra footnote 32.
[344] Radio Spectrum Policy Group – RSPG (2009). Opinion on *the Digital Dividend*. Available at: http://rspg-spectrum.eu/_documents/documents/opinions/rspg09_291_digitaldividend.pdf.
[345] P. Defraigne - Cullen International (2011). *Op. cit.*, supra footnote 310.

digital dividend, to obtain comments and views from all interested stakeholders on the use of the digital dividend.[346]

Making radio spectrum available for the development of broadband services is considered an "urgency" in particular given the goal to achieve 100% broadband coverage, including rural areas, which cannot be easily reached by wired infrastructure. It has also stated that many EU Member States have already started to consider the possibility to allocate the 790-862 MHz sub-bands to services other than terrestrial broadcasting.

The EC puts forward again the need to endorse a common approach for the establishment of a single European market, taking advantages of economies of scale, which would contribute to European economy. Consumers would get great benefits from European coordinated decisions on the digital dividend as they would have wider range of new and improved services, better quality and lower prices, due to economies of scale which drive down handset and equipment costs.[347]

RSPG Opinions regarding WRC-12 were published in 2009 and 2011, which identified several WRC-12 issues of most relevance to the EU policies.[348] In particular, the latter refers to the need to strengthen the role of the EU in international negotiations, by means of an adequate level of coordination between EU Member States. Moreover, Agenda Item 1.17 on the digital dividend is recognised as of particular importance for the European economy. In this respect, Member States are encouraged to follow a common objective: achieving a WRC-12 decision which would enable the deployment of electronic communication services other than broadcasting in the 790-862 MHz band.[349]

As for previous WRCs, in 2011 the EC has provided the EP and the Council with a Communication, COM(2011) 180, setting out the EU policy interests in certain WRC-12 items, based on the related RSPG Opinion. With regard to Agenda Item 1.17 the EU policy objective consists of supporting "regulatory provisions for the balanced coexistence between wireless broadband and the diminishing use of aeronautical radionavigation systems on its eastern border, with the aim of enabling wireless broadband to cover effectively the entire territory of the EU. All obligations to protect digital broadcasting under the GE06 agreement should remain in force and no further obligations should be

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[346] European Commission – EC (2013). Digital Agenda for Europe, *Delivering the digital dividend* (accessed June 2013), http://ec.europa.eu/digital-agenda/en/delivering-digital-dividend.

[347] European Commission – EC (2009), Commission Recommendation of 28 October 2009 *facilitating the release of the digital dividend in the European Union,* {2009/848/EC}, Official Journal of the European Union. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:308:0024:0026:EN:PDF.

[348] Radio Spectrum Policy Group – RSPG (2009). *Op. cit.,* supra footnote 332.

[349] Radio Spectrum Policy Group – RSPG (2011). Opinion on *Common Policy Objective for WRC-12*. Available at: http://rspg-spectrum.eu/_documents/documents/meeting/rspg24/rspg10_350_wrc_opinion.pdf.

added at the conference". The EC calls for a coordinated approach between Member States during the forthcoming WRC-12, which are asked to act on behalf of the EU.[350]

7.6. Decision No. 2010/267/EU

In the EC Communication COM(2009) 586 on "transforming the digital dividend into social benefits and economic growth", the EC outlines a set of proposals for a common approach to the digital dividend in Europe.[351] It has been anticipated what would have been contained in Decisions No. 2010/267/EU and No. 243/2012/EU. The EC has strongly advocated the necessity to introduce harmonised technical and strategic measures which would have been helpful to set up the desired EU common approach for the availability and efficient use of the 790-862 MHz band.

In this respect, in May 2010, the EC published the Decision (No. 2010/267/EU) on "harmonised technical conditions of the use in the 790-862 MHz frequency band for terrestrial systems capable of providing electronic communications services in the European Union".[352] Basically, the EC lays down a set of technical rules for EU Member States to follow if they decide to change the use of the 800 MHz band currently allocated to broadcasting for mobile broadband services. These technical requirements should minimise the potential for interference with broadcasting services in adjacent bands and lay the foundation for harmonisation and efficient use of the 800 MHz band. This will increase the potential economic benefits of the digital dividend and contribute to the deployment of high-speed wireless Internet services by avoiding harmful interference.[353]

Just in May 2010, Germany was the first country in Europe that completed the allocation process of the 800 MHz band. A market-based approach based on auction was implemented to allocate the digital dividend frequencies to the mobile operator community. As early as in 2005 the EC started encouraging the adoption of market-based approaches to replace administrative processes for the management of the spectrum. In the Communication COM(2005) 400 to the Council, the EP and the European Economic and Social Committee and the Committee of the Regions, the EC expresses its opinion in favour of the introduction of market mechanisms for the management of the spectrum, as

[350] European Commission - EC (2011). *Op. cit.*, supra footnote 320.

[351] European Commission - EC (2009). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions *Transforming the digital dividend into social benefits and economic growth*, {COM(2009) 586}. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0586:FIN:EN:PDF.

[352] International Telecommunication Union - ITU (2012). *Op. cit.*, supra footnote 32.

[353] Europa, Press Releases Database (2010). *Radio spectrum: harmonised EU rules to foster high-speed wireless internet services and avoid harmful interference* (accessed June 2013), http://europa.eu/rapid/press-release_IP-10-540_en.htm?locale=en.

they increase overall efficiency since the value of the spectrum is determined by market forces. In fact, other European countries followed Germany's lead. Giving just few examples, the Swedish auction of the digital dividend, set up with the aim to provide super-fast broadband to all the population, ended in March 2011. In July 2011, Spain auctioned the 800 MHz band, along with other frequency bands, followed by France in 2011.[354]

7.7. The first Radio Spectrum Policy Programme

Strategic measures to be applied by EU Member States for the efficient use of the 800 MHz band, mentioned in the Communication COM(2009) 586, have been summarised in a comprehensive framework provided by a five-year Radio Spectrum Policy Programme (RSPP). It was proposed by the EC in September 2010 in the Communication COM(2010) 471.[355]

In the Directive No. 2009/140/EC of the EP and of the Council it is said that "[…] where appropriate, legislative multiannual radio spectrum policy programmes should be established to set out the policy orientations and objectives for the strategic planning and harmonisation of the use of radio spectrum in the Community". The EC, "[…] taking utmost account of the opinion of the Radio Spectrum Policy Group […] may submit legislative proposals to the EP and the Council for establishing multiannual radio spectrum policy programmes.[356]

Thus, the EC formulates his proposal taking into account the RSPG Opinion on "the Radio Spectrum Policy Programme" requested by the EC itself and published in 2010. It recommends the EC on the key elements a RSPP for the period 2010-2015 should address and underlies the necessity of a common course of action during international negotiations shared by all EU Member States, successfully representing EU objectives and priorities. It also advises the EC that the best process for assessing the efficiency of spectrum use should

[354] European Commission – EC (2005). *Op. cit.*, supra footnote 88;
GSM Association – GSMA (2012). Digital Dividend Introduction: *Auctions Summary* (accessed June 2013), http://www.gsma.com/spectrum/wp-content/uploads/DigitalDividend/DDtoolkit/auctions-summary.html#italy;
GSM Association – GSMA (2012). Digital Dividend State of play: *Regulatory Perspective*, (accessed June 2013), http://www.gsma.com/spectrum/wp-content/uploads/DigitalDividend/DDtoolkit/regulatory-perspective.html.

[355] European Commission – EC (2012). Press Release database, Digital Agenda: *Commission welcomes step forward for wireless broadband with adoption of Radio Spectrum Policy Programme* (accessed June 2013). Available at: http://europa.eu/rapid/press-release_IP-12-141_en.htm.

[356] European Parliament – EP, Council of the European Union – the Council (2009). *Directive 2009/140/EC of the European Parliament and of the Council of 25 November 2009 amending Directives 2002/21/EC on a common regulatory framework for electronic communications networks and services, 2002/19/EC on access to, and interconnection of, electronic communications networks and associated facilities, and 2002/20/EC on the authorisation of electronic communications networks and services,* Official Journal of the European Union. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:337:0037:0069:EN:PDF.

take into account demand and technology trends and the relation between spectrum demand and supply. In this way it should be possible to identify potential available spectrum for emerging spectrum needs, always striving for maximum spectrum efficiency.

During the development of this RSPG Opinion, the EP and the EC co-organised the first EU Spectrum Summit in Brussels on 22-23 March 2010. The participants, representatives of the EP, the EC and the EC Member States, and stakeholders from the telecommunications industry and users, debated policy issues and objectives in preparation for the RSPP. They agreed on the importance of spectrum in supporting the most important EU policy objectives. Then the EC also conducted a public consultation in March-April 2010 in order to collect stakeholders' views. Eventually, the provision of the RSPG Opinion on the RSPP led to the EC proposal for a decision establishing the first RSPP.[357]

In 14 March 2012 the EP and the Council, with the Decision No. 243/2012/EU, approved the first five-year radio spectrum policy programme, which actually didn't receive a warm welcome by some Member States, being annoyed by a further intrusion into national control of spectrum policy.[358]

The RSPP has been set up for the strategic planning and harmonisation of the use of the spectrum to ensure the functioning of the internal market, with the aim to foster economic growth, to boost innovation and investment, and to promote and preserve competition. The goals of the EU will be supported, as delineated in the EC Communications of 3 March 2010 on the Europe 2020 Strategy and of 26 August 2010 on "A Digital Agenda for Europe", whose broad objective is to make Europe a smart, sustainable, inclusive information-based economy, ensuring universal broadband coverage for all EU citizens.

The RSPP aims at identifying best practices, information sharing, definition of common and/or converging technical conditions and application of flexible criteria for the use of the spectrum in order to remove rigidity in spectrum management and make easier access to spectrum. Service and technology neutrality principles are emphasized in order to favour the provision of all types of technology and services.[359] The RSPP incentivises the adoption of a renewed economic and social approach with regard to management, allocation and use of spectrum. The broad objective is to reach greater spectrum efficiency and convergence in spectrum use across Europe. It is recognised and highlighted the huge potential of wireless broadband services to promote a knowledge-based economy, to develop and assist sectors relying on

[357] Radio Spectrum Policy Group – RSPG (2012). Opinion on *Review of Spectrum Use*. Available at: https://circabc.europa.eu/sd/d/b3046fab-d648-4413-b6dd-89d4cb88fa21/RSPG12-408%20Final%20Opinion%20Spectrum%20Review.pdf;
European Commission – EC (2013). Digital Agenda for Europe, *RSPP: the roadmap for a wireless Europe* (accessed June 2013), https://ec.europa.eu/digital-agenda/en/rspp-roadmap-wireless-europe.

[358] K. Pearson, P. Marks (2012). *Op. cit.,* supra footnote 29.

[359] A. Durantini, M. Martino (2013). *Op. cit.,* supra footnote 123.

information and communications technologies and to overcome the digital divide. Wireless broadband can play and has been playing a main role in boosting economy given its sustainable costs comparing with wired broadband and the growing demand for speed and coverage.

In short, the RSPP aims at pursuing the following objectives:

- to make sufficient spectrum available to satisfy growing needs;
- to maximise flexibility in the use of the spectrum;
- to enhance the efficient use of spectrum;
- to promote competition between electronic communications services;
- to harmonise the internal market and develop transnational services;
- to avoid interference and disturbances;
- to protect human health.[360]

Member States are asked to ensure an efficient management and use of spectrum having as ultimate aim the identification of at least 1200 MHz (including spectrum already in use) of suitable spectrum for wireless broadband services such as high-speed 4G wireless broadband systems by 2015.

As stated in the DAE, Europe is striving for the establishment of ubiquitous broadband coverage at a speed of not less than 30 Mbps for all Union citizens by 2020 with at least 50% of EU households having access to broadband at a speed of at least 100 Mbps. With particular regard to the 800 MHz band, it is said that the accessibility of new consumer products and technologies should be fostered so as to secure consumer endorsement for the transition to digital technology and efficient use of the digital dividend.

In order to find the 1200 MHz of suitable spectrum in support of EU objectives, the Decision establishing the RSPP sets up a spectrum inventory of existing uses in the frequency range between 400 MHz and 6 GHz, which involves an analysis of technology and spectrum demand trends and future needs, in order to identify bands that can be harmonised and allocated to wireless broadband.[361]

In 2012, while this Decision was under negotiation, the RSPG released an Opinion on "Review of Spectrum Use" providing guidance to the EC on how a spectrum review need to be undertaken under the RSPP Decision. It describes methodologies that should be implemented in order to reach certain specified objectives. Carrying out a review of spectrum use across Europe is considered a complex and huge achievement, which needs a deep and detailed analysis of demand and technologies trends. It can help in developing a comprehensive strategic plan for the use of the radio spectrum by means of which improving spectrum efficiency matching potential available frequencies with new needs.

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[360] European Commission – EC (2010). *Proposal for a Decision of the European Parliament and of the Council establishing the first radio spectrum policy programme* {COM(2010) 471}. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:0471:FIN:EN:PDF.

[361] K. Pearson, P. Marks (2012). *Op. cit.*, supra footnote 29.

This Opinion depicts the main steps for the assessment of demand and supply of spectrum and discusses how the identification of frequency bands for future services and applications should be made.[362] A forward-looking approach on spectrum use is needed. The challenge is to predict the future development of DTT and wireless broadband services, while taking into account the possibility of their convergence on a common platform and assessing their value for the society in order to reach the best usage of the UHF spectrum.[363]

Moreover, the Decision No. 243/2012/EU sets 1 January 2013 as the deadline for the release of the digital dividend spectrum to be allocated to mobile broadband service. The EC shall grant specific derogations until 31 December 2015 for Member States in which exceptional circumstances or cross-border frequency coordination problems would prevent the availability of the band. After 2015, annual derogation can be granted if coordination problems still persist.[364] By 10 April 2014, the EC shall report to the EP and the Council on the activities developed and the measures adopted by EU Member States. Finally, by 31 December 2015, the EC will review the application of this Decision.[365]

7.8. EU policy on the 700 MHz band

The RSPG Opinion on "Strategic Challenges facing Europe in addressing the Growing Spectrum Demand for Wireless Broadband" has been requested by the EC in April 2012, asking for guidance in order to meet the future demand for wireless broadband services and achieve the goals of the DAE. It has been stated that the future development of wireless broadband services in Europe depends on the objectives pursued through the RSPP, together with the ITU and CEPT works.

The RSPG recommends the development of a strategic plan to make available the amount of spectrum needed to meet the future demand for wireless broadband services in the time frame 2013-2020, including the intermediate target in the RSPP of at least 1200 MHz of spectrum by 2015. In addition to the above, the RSPG recommends the development by the EC, in cooperation with the EU Member States, of a long-term strategic policy on the future use of

[362] Radio Spectrum Policy Group – RSPG (2012). *Op. cit.,* supra footnote 357.

[363] European Conference of Postal and Telecommunications Administrations – CEPT (2013). *Report from CEPT to the European Commission in response to the Mandate on inclusion of information on rights of use for all uses of spectrum between 400 MHz and 6 GHz,* 11 March 2013. Available at: http://www.erodocdb.dk/Docs/doc98/official/pdf/CEPTREP046.PDF.

[364] R. Niepold – Advisor Radio Spectrum Policy (2013). *EU Digital Dividend Strategy: The process and the state of play* (PowerPoint). Available at: http://readi.asean.org/readi.asean.org/media/files/READI_ASPF2_Haiphong_0413_Ruprecht%20Niepold.pdf.

[365] European Parliament – EP, Council of the European Union – the Council (2012). *Op. cit.,* supra footnote 21;

European Commission – EC (2013). Digital Agenda for Europe, *What is Radio Spectrum Policy?* (accessed June 2013), http://ec.europa.eu/digital-agenda/en/what-radio-spectrum-policy.

the UHF (470-790 MHz) band. Needs of existing users and possible future needs arising from convergent broadcasting-mobile platforms must be taken into account.

The total amount of spectrum already available in Europe for wireless broadband services is nominally 1701.50 MHz comprised of 990 MHz for terrestrial applications, 173 MHz for satellite-based broadband and 538.50 MHz for Wi-Fi-type applications. In order to meet the intermediate target in the RSPP, the RSPG has identified potential candidate bands, which also include the 700 MHz band.[366]

In March 2013, WRC-12 agreed on the allocation on a co-primary basis of the 700 MHz band to the mobile service in ITU Region 1. Recognising the burden of this challenge in terms of spectrum policy, the EC issued a mandate to CEPT. This mandate aims at developing a set of common and minimal conditions for the use of the 700 MHz band by mobile broadband applications, currently allocated to terrestrial television broadcasting, studying also the possibility of shared spectrum use with other incumbent uses such as broadcasting and PMSE. The development of harmonised technical conditions is an integral part of RSPP, whose policy objectives should be taken into high consideration by CEPT.

The RSPG states that reallocating the 700 MHz band for mobile service in ITU Region 1 will be significantly more disruptive to terrestrial broadcasters than it is in the 800 MHz band. In fact, terrestrial broadcasters would lose 96 MHz from a total of 320 MHz – 30% of the total remaining UHF television spectrum. Such a reallocation cannot be seen as a release of frequencies thanks to technology improvements but it is clearly a forced reduction of broadcasting capacity, which could only be partially balanced with the development of new television technologies, such as DVB-T2 (DVB-T second generation). This would lead to backlashes on consumers, which should buy new equipment without certainty in terms of benefits of enhanced television reception. Therefore, consumers could be reluctant to replace television receivers every time the technology changes. Moreover, it is not clear why development in the broadcasting sector that enable a more efficient use of the spectrum should necessarily translate in a reduction of the allocated spectrum to this type of service.

This is a difficult discussion and different outcomes can be obtained depending from which side the issue is observed. In addition significant planning and coordination among neighbouring countries will be needed in order to preserve equitable access to spectrum and control interference, as freeing up the 700 MHz band from television broadcasting will severely interfere with the rights individual countries acquired at the RRC-06. A new RRC would help SMAs in

[366] Radio Spectrum Policy Group – RSPG (2013), *Op. cit.,* supra footnote 110.

defining a new broadcasting plan and clearing equitable broadcasting rights below the 700 MHz band.

Moreover, the 700 MHz band is heavily used in Europe not only for terrestrial television but also for PMSE technologies, such as wireless microphones and other applications used in theatres, sporting and media events, which make use of the white spaces between television broadcasts. Obviously such use will not be possible in the 700 MHz band if it is used for mobile broadband. The problem is that there are a limited number of other frequencies that could be used by PMSE. Providing a solution for the continuation of PMSE services elsewhere in the UHF band or in other appropriate bands represents another concern for Europe in light of the goal to allocate the 700 MHz band to mobile broadband. CEPT is currently studying the possibility to implement PMSE in the 1492-1518 MHz band.

Bearing in mind WRC-12 decision to allocate the 700 MHz bands to IMT on a co-primary basis, it would be appropriate for Europe to develop a position in time for the upcoming WRC on the refinement of the lower band edge and on possible channelling arrangements for mobile services in the 700 MHz band. It may also be useful for Europe to take a longer-term view on the future use of the UHF band in order to develop a long-term strategy regarding its use, monitoring long-term developments of DTT and mobile broadband services, and possible convergent platforms. In any case, before taking any concrete decision, it is wise to wait WRC-15 results, given the implications the Conference may have in terms of frequencies allocated to mobile service.

In the Opinion on "Common Policy Objectives for WRC-15" the RSPG highlights the relevance of Agenda Item 1.1, which refers to the wish of identifying additional spectrum for the mobile service to facilitate the development of terrestrial mobile broadband applications. In line with RSPP, which requires the identification of at least 1200 MHz of suitable spectrum by 2015 to support growth in wireless data traffic, the EC Communication COM(2012) 478 on "Promoting the shared use of radio spectrum resources in the internal market" recognises the shared access to spectrum as the solution at the forefront to the problem of lack of available spectrum for new spectrum needs. The shared use of spectrum includes all situations in which two or more users or wireless applications are authorized to utilise the same frequencies on a non-exclusive basis in a defined sharing arrangement. A study conducted for the EC by SCF Associates Ltd shows that additional shared spectrum for wireless broadband could create significant net economic benefits for Europe. In this respect it is important to remove current regulatory constraints and actively facilitate shared use of spectrum. Finding possible spectrum-sharing opportunities is one of the goals pursued by the RSPP by means of the spectrum inventory process.

As matters stand, the challenge posed by the reallocation of the 700 MHz band cannot be underestimated. A lot of interests are at stake. On one side mobile

operators are starving for more spectrum, being the just released 800 MHz band not enough for the deployment of their services. On the other side, television broadcasters will find themselves in a situation extremely difficult to handle, with additional problems for consumers, which will suffer the consequences of decisions imposed from the top.

It is worth noting that in Europe DTT is the dominant delivery platform for television with over than 275 million people watching television over DTT. However, the role broadband services have been playing for the economy worldwide cannot be ignored, as well as the exponential increase in the volume of data traffic, which was not expected at all. As time passes, the true scale of the mobile phenomenon is becoming ever clearer. It will be interesting to see how SMAs, within the international and European frameworks, will be able to protect and guarantee other services, firstly, terrestrial television broadcasting.[367]

[367] European Conference of Postal and Telecommunications Administrations – CEPT (2013). *Op. cit.,* supra footnote 363;
Radio Spectrum Policy Group – RSPG (2013). *Op. cit.,* supra footnote 110.
Office of Communications – Ofcom (2013). Call for Inputs: *Future use of the 700 MHz band. Implementing Ofcom's UHF strategy*. Available at: http://stakeholders.ofcom.org.uk/binaries/consultations/700mhz-cfi/summary/UHF_SI_call_for_inputs.pdf;
D. Standeford (2013), *RSPG highlights difficulties of reallocating 700 MHz band* (accessed June 2013), PolicyTracker, The Spectrum Management Newsletter. Available at: https://www.policytracker.com/headlines/rspg-highlights-difficulties-of-reallocating-700-mhz-band;
J. Stewart – Analysys Mason (2012). *Harmonisation is key – comment from World Radio Conference 2012* (accessed June 2013). Available at: http://www.analysysmason.com/About-Us/News/Insight/Implementing-the-second-digital-dividend--harmonisation-is-key/#.Ubmkovl7LQo;
Radio Spectrum Policy Group - RSPG (2013). Interim Opinion on *Common Policy Objectives for WRC-15*. Available at: https://circabc.europa.eu/d/a/workspace/SpacesStore/989a9929-29b7-4ec2-855a-9ccd7e020393/RSPG-13-525-interim_opinion_WRC_15.pdf;
Digital Europe (2013). *Position on the 700 MHz band,* Brussels, Belgium. Available at: http://www.google.it/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0CDEQFjAB&url=http%3A%2F%2Fwww.digitaleurope.org%2FDocumentDownload.aspx%3FCommand%3DCore_Download%26EntryId%3D522&ei=2esVUo_EMojStAbO7oHgAQ&usg=AFQjCNHzMCs2KBJdJH-mDGvST_e8qzDmCg&bvm=bv.51156542,d.Yms.
European Commission - EC (2012). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the regions *Promoting the shared use of radio spectrum resources in the internal market,* {COM(2012) 478}. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2012:0478:FIN:EN:PDF.
S. Forge, C. Blackman, E. Bohlin – SCF Associates LTD (2007). *Op. cit.,* supra footnote 187.
Digi.TV (2012), *Guidelines on using the Digital Dividend* Project: South-East European Digital Television. Available at: http://www.see-digi.tv/shared_files/wp3/guidelinesonusingdigitaldividend-a-11.pdf;
R. Beutler (2012). *Op. cit.,* supra footnote 221.

8. National spectrum regulators

8.1. Introduction

Within the framework encompassing ITU's Radio Regulations, further bilateral or multilateral agreements with neighbouring countries and the rules set out at regional level, radio spectrum management is an ultimate responsibility of SMAs. They can be either a part of a government ministry or an independent agency, normally established by statute, with specified powers and responsibilities.[368] Since the beginning of the 20th century, SMAs have set national rules, publishing laws and regulations, in order to establish principles applicable to electronic communications.[369]

SMAs are responsible for the final allocation of frequency bands to specific types of services in their respective territories, defining a detailed national frequency allocation table, in accordance with international allocation agreements. Moreover they are in charge of the assignment process which is the activity of assigning radio frequencies or radio frequency channels within each allocated band under specified conditions to individual users by means of authorisations.

Within the context of an evolving international and regional regulatory environment, allocating the digital dividend falls within national prerogatives, meaning that EU Member States are entitled to manage the freed up spectrum according to their national interests.[370] Managing the spectrum always requires, among other things, an assessment of potential technological developments in order to balance future demands for spectrum.

In the current situation, introduction and uptake of new wireless services, most notably mobile broadband, are resulting in spectrum demand growth, which is increasing with high speed.[371] The UHF spectrum has been re-allocated twice due to WRC-07 and WRC-12 decisions, prompting national actions around the world to re-farm UHF band in support of the mobile service.[372]

Focusing on Europe, along with WRC-07 decision to allocate the 800 MHz band in ITU Region 1 to mobile service, WRC-12 also took the decision to expand the digital dividend to include the 700 MHz band. These decisions have created a new international framework, which countries have to comply with. Within this framework, SMAs have the freedom to choose which service should use the upper part of the UHF band, under the condition of bilateral or

[368] McLean Foster & Co. in collaboration M. Cave, R. W. Jones (2007). *Op. cit.,* supra footnote 17.

[369] J.-M. Chaduc, G. Pogorel (2008). *Op. cit.,* supra footnote 1.

[370] B. Modlic, G. Sisul, M. Cvitkovic (2009). *Op. cit.,* supra footnote 207.

[371] International Telecommunication Union - ITU (2012). *Op. cit.,* supra footnote 32.

[372] International Telecommunication Union – ITU (2013), *Mobile broadband and terrestrial television jostle for spectrum* (accessed May 2013), http://www.itu.int/net/newsroom/wrc/2012/features/digital_dividend.aspx.

multilateral agreements with neighbouring countries about the selected use in order to manage interference problems. However, even though the allocation of those frequencies to mobile service is not compulsory, the growing importance of mobile service for both developed and developing countries is self-evident, given the widespread use of mobile applications and their undeniable positive social and economic benefits. It could be claimed that the direction that countries are taking goes in favour of mobile service.[373]

Furthermore, Europe calls a holistic approach to be adopted by EU Member States regarding the use of the spectrum. Even though the goal of a harmonised spectrum management across countries so different from each other seems hard to achieve, ensuring that the same frequency bands are available for the same purpose in different countries will lead to pan-European services, taking advantage of economies of scale and lower equipment costs.[374]

With the aim to bring as many benefits as possible to society, decisions on how the freed-up spectrum should be used must be taken carefully by SMAs, as radio spectrum is a vital scarce resource for modern society. In fact, choices on digital dividend use will impact on the capability to maximise the benefits of a full exploitation of these frequencies.[375]

For several years, the digital dividend has been a hot issue extensively discussed by broadcasters and mobile service operators. There is a lot at stake for these industries and, therefore, for end-users. Regulators and governments may face obstacles in the process of clearing and awarding the 700 MHz and 800 MHz bands, given the necessity to find a balance between incumbents' and new users' needs. Thus, the crucial role of governmental bodies in this process is evident in order to create a clear and appropriate regulatory framework by means of which trying to gain the best for citizens.[376]

In this chapter, two cases studies are shown with the aim to briefly describe the different approach adopted in the UK and in Italy to face the digital dividend issue.

8.2. The United Kingdom

8.2.1. Ofcom

The Office of Communications (Ofcom) is the newly integrated regulator and competition authority for the whole UK communications sector, which encompasses broadcasting, telecommunications and wireless communications

[373] P. Defraigne - Cullen International (2011). *Op. cit.*, supra footnote 314.

[374] T. Tschentscher - Partner Freshfields, in association with Economist Intelligence Unit (2010). *Europe's Digital Dividend* Mobile Matters. Insights on telecoms, media and technology, Iss. 2, September 2010. Available at: http://www.mobile-matters.com/europes-digital-dividend.

[375] GSM Association – GSMA (2009). *Op. cit.*, supra footnote 212.

[376] International Telecommunication Union – ITU (2010). ITU NEWS, *The digital dividend. Opportunities and challenges* (accessed June 2013), http://www.itu.int/net/itunews/issues/2010/01/27.aspx.

services.[377] It was established as a body corporate by the Office of Communications Act 2002 and operates under the Communications Act 2003, an Act of Parliament that describes exactly rights and obligations, responsibilities and missions upon Ofcom.[378]

Ofcom is the result of the merger of five previous regulators (the Broadcasting Standards Commission, the Independent Television Commission, the Office for Telecommunications, the Radio Authority and the Radiocommunications Agency).[379] Among other tasks, Ofcom is the independent entity in charge of the management of the UK spectrum. As stated in the Communication Act 2003, Ofcom is responsible for the provision of regulations of electronic communications networks and services and of the use of the electro-magnetic spectrum.[380] Although independent of Government, Ofcom cooperates with the Department for Culture, Media and Sport and with the Department for Business, Innovation and Skills.[381]

8.2.2. Digital Terrestrial Television

In the UK, the Government White Paper on DTT is released as early as August 1995 and its proposals for the introduction of DTT services are incorporated into the Broadcasting Act of July 1996.[382] The act provides for the establishment of six multiplexes of 6 MHz each (same capacity as the existing analogue channels).[383]

DTT is formally launched in the UK on 15 November 1998. By 2003 digital television has penetrated around half the households in the UK, growing faster than almost any other electronic household good or service. It has transformed the whole television industry, giving impetus to technology convergence between broadcasting, telecommunications and computer sectors, and requiring changes to the statutory and regulatory framework.[384] There are now several

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[377] GB Parliament: House of Commons: Committee of Public Accounts (2011), *Ofcom: the effectiveness of converged regulation* Twentieth Report of Session 2010-11. Available at: http://www.publications.parliament.uk/pa/cm201011/cmselect/cmpubacc/688/688.pdf.

[378] Office of Communication – Ofcom, *What is Ofcom* (accessed June 2013), http://www.ofcom.org.uk/about/what-is-ofcom/.

[379] politics.co.uk (2012). *Ofcom* (accessed June 2013), http://www.politics.co.uk/reference/ofcom.

[380] UK Government (2003). *Communications Act 2003,* Chapter 21. Available at: http://www.legislation.gov.uk/ukpga/2003/21/contents.

[381] politics.co.uk (2012). *Ofcom* (accessed June 2013), http://www.politics.co.uk/reference/ofcom.

[382] A. D'Arma (2007). *Digital Switchover in Italy: An Analysis of Government Policy 1996-2006*. Paper presented to the 57th Annual International Communications Association (ICA) Conference 'Creating Communication: Content, Control, Critique', 24-28 May 2007, San Francisco, USA. Available at: http://citation.allacademic.com/meta/p_mla_apa_research_citation/1/7/0/5/8/pages170585/p170585-3.php.

[383] C. Colapinto, F. Papandrea (2007). *Digital TV policies in the UK, US, Australia and Italy* in F. Papandrea, M. Armstrong, Record of the Communications Policy & Research Forum 2007, Sydney, Australia: Network Insight Pty Ltd, pp. 40-56.

[384] M. Starks (2007). *Op. cit.,* supra footnote 204.

digital broadcasting platforms available in the UK: satellite, cable, broadband and DTT.[385]

Given the success of digital television adoption, in September 1999 the government announces for the first time its ambition to switch off the traditional analogue terrestrial television services and replace them fully with DTT since 2006, as stated at that time.[386]

As early as January 2003, before Ofcom comes into existence, the UK Government definitely decides to achieve the goal of switching to digital, reserving 256 MHz for the operators of the six existing DTT multiplexes, expanding the coverage and capacity of terrestrial broadcasting, and releasing a digital dividend of 112 MHz, freed up by the switchover from analogue to DTT systems, to be made available for new uses, including the provision of mobile services.[387]

On 15 September 2005, the Secretary of State for Culture, Media and Sport confirms that digital switchover will take place in the UK between 2008 and 2012.[388] Switching off the analogue signal would allow a reorganisation of all 368 MHz used by terrestrial television.[389]

A Digital TV Action Plan[390] is carried out, which envisages a transition process from analogue to digital broadcasting on a regionally phased basis starting with the England and Scotland Borders in 2008 and completing in Northern Ireland in 2012. On 21 September 2011 more than half of UK homes had switched to digital television and on 24 October 2012 the last remaining analogue channels were turned off in Northern Ireland, marking the completion of the UK's five-year switchover programme.

UK broadcasting services turned out to be totally digitalised, with 98.5% of homes receiving multi-channel DTT[391], marking the end of more than 70 years of analogue broadcasting, started with the first public television broadcasting service launched in 1936.

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[385] Office of Communications – Ofcom (2007). *Op. cit.,* supra footnote 66.

[386] M. Cave (2006). *The development of digital television in the UK,* M. Cave, K. Nakamura, Digital Broadcasting Policy and Practice in the Americas, Europe and Japan, Cheltenham, UK: Edward Elgar Publishing Limited; Northampton, Massachusetts, USA: Edward Elgar Publishing, Inc. pp. 105-119.

[387] Office of Communications – Ofcom (2009). Consultation: *Digital Dividend: clearing the 800 MHz band*. Available at: http://stakeholders.ofcom.org.uk/binaries/consultations/800mhz/statement/clearing.pdf.

[388] G. Berman, G. Danby, E. White (2006). *The Digital Switchover (Disclosure of Information) Bill*, Bill 3 of 2006-07, Research Paper 06/64, House of Commons Library. Available at: http://www.parliament.uk/briefing-papers/RP06-64.pdf.

[389] Office of Communications – Ofcom (2007). *Op. cit.,* supra footnote 66.

[390] BBC News (2009). *UK's digital action plan unveiled* (accessed June 2013), http://news.bbc.co.uk/2/hi/technology/7858495.stm.

[391] digitaluk (2012). *Digital TV switchover 2008-2012* Final Report. Available at: http://www.digitaluk.co.uk/__data/assets/pdf_file/0019/82324/DigitalUK_Switchoverfinal_report_Nov2012.pdf.

This process has seen the replacement of five national analogue TV channels with over 70 digital channels.[392]

This public policy decision has had a significant impact on broadcasting market and the wider UK economy, encouraging the deployment of DTT, also in under-served parts of the country and open the way for the development of new communications technologies by freeing up a large amount of potentially valuable radio spectrum.[393]

8.2.3. First digital dividend

The UK has been playing a leading role in the provision of digital television services and has been at the forefront within Europe in identifying and releasing a digital dividend to be used by services other than broadcasting. The UK identified 14 frequency channels of 8 MHz each, making a total of 112 MHz, in UHF Bands IV and V to be cleared of analogue terrestrial television.[394] It also stated that the interleaved capacity (white space) available within the 256 MHz reserved for the six DTT multiplexes could be used for additional services such as wireless microphones.[395]

The plan, developed at that time, comprised two bands of spectrum:

- a smaller, upper band of 48 MHz at 806-854 MHz (channels 63-68);
- a larger, lower band of 64 MHz at 550-630 MHz (channels 31-35, 37 and 39-40).

Since 2003, Ofcom have been acting to increase the size of the UK's digital dividend, clearing channel 36 from aeronautical radar during 2009 and channel 38 from radioastronomy during 2012, releasing additional 16 MHz. In this way the UK obtained a digital dividend of 128 MHz of high quality spectrum by the end of 2012.[396]

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[392] Office of Communications – Ofcom (2012). *End of an analogue era paves way for 4G mobile* (accessed June 2013), http://media.ofcom.org.uk/2012/10/24/end-of-an-analogue-era-paves-way-for-4g-mobile/.

[393] M. Starks (2007). *Op. cit.*, supra footnote 204;
Office of Communications – Ofcom (2004). *Driving digital switchover: a report to the Secretary of State*. Available at: http://stakeholders.ofcom.org.uk/binaries/research/tv-research/dso1.pdf.

[394] Aetha (2011). *Case studies for the award of the 700 MHz/800 MHz band: UK,* prepared for GSMA. Available at: http://www.gsma.com/spectrum/wp-content/uploads/2012/07/700MHz-800MHz-band-UK.pdf.

[395] Office of Communications – Ofcom (2007). *Op. cit.*, supra footnote 66.

[396] Office of Communications – Ofcom (2009). *Op. cit.*, supra footnote 387;
Office of Communication – Ofcom (2006). *Maximising the benefits of the digital dividend* (accessed June 2013), http://media.ofcom.org.uk/2006/12/19/maximising-the-benefits-of-the-digital-dividend/.

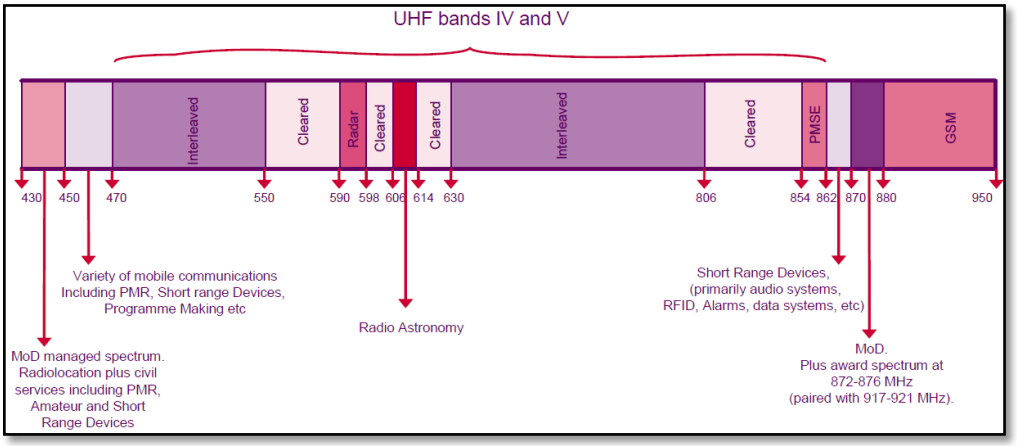

Figure 21. The digital dividend and adjacent spectrum use between 430 and 950 MHz
Source: Ofcom (2007). *Digital Dividend Review: a statement on our approach to awarding the digital dividend*. Available at: http://stakeholders.ofcom.org.uk/binaries/consultations/ddr/statement/statement.pdf.

A clear strategy was defined regarding the way in which this spectrum would be awarded, as set out in the Digital Dividend Review (DDR), conducted in the period 2005-2007 and concluded with the publication of a Statement in December 2007. The main decision regards the adoption of a market-led approach based on auctions, seen as the proper means to maximise the total value to society generated from the use of the spectrum. The tradability of licences would give users the flexibility to decide which technologies and services should have access the spectrum and to change the use in response to shifts in consumer demand and technology.[397] It would create stronger incentives for efficiency and increase opportunities to bring more competition and innovation into the communication sector. The principles of service and technology neutrality are introduced in order to reach great flexibility, imposing minimum restrictions on use of the spectrum necessary to prevent harmful interference and ensuring the awarding of frequencies to the uses with highest value.[398]

The UK approach to the digital switchover and, consequently, to the digital dividend has been characterised by several public consultations, which include cost-benefit analyses of the digital switchover and of the re-purposing of the digital dividend band. In July 2003, the UK estimates that the digital switchover would generate net benefits within the range of £1.5-2 billion in NPV (from 2010 to 2026). This assessment notes that released spectrum could be used for mobile telecommunications services, which would generate greater benefits using spectrum than television broadcasting. In February 2005, the UK government updates the above assessment. For the period 2010-2015, net

[397] Office of Communications – Ofcom (2008). *Delivering the digital dividend – bringing innovation to the airwaves* (accessed June 2013), http://media.ofcom.org.uk/2008/06/06/delivering-the-digital-dividend-bringing-innovation-to-the-airwaves/.
[398] Office of Communications – Ofcom (2009). *Op. cit.*, supra footnote 387.

benefits of £1.1-2.2 billion are identified, with a net benefit amounting £1.7 billion if switchover were completed in 2012. Again, the assessment notes the potential use of the released spectrum for non-broadcast television services (e.g. mobile), but, for the purposes of calculating the benefits, it is assumed that the spectrum would be used for two, additional standard-definition television multiplexes. In 2006, Ofcom estimates that the value of the digital dividend spectrum would lie within the range £5-10 billion in NPV, over 20 years, as included in the DDR. It is clear that the digital dividend would generate significant benefits for the UK economy.[399]

However, the UK is also aware of the fact that European and worldwide organisations are carrying out works on the 800 MHz band, which was not considered yet by the UK, and that much more advantages would have been gained, if spectrum use had been harmonised at European level[400]. It is noteworthy here that the EU itself is encouraging EU Member States to agree on common technical and strategic measures for the use of the 800 MHz band in order to reach its objective of high-speed broadband coverage of 100% of the EU population by the end of 2013.[401]

Thus, given CEPT outcome on a harmonised sub-band for mobile communications using channels 62-69 (798-862 MHz), WRC-07 decisions, which include a co-primary mobile allocation for 790-862 MHz (channels 61-69) and the increasing number of other European countries planning to release the 800 MHz band, Ofcom decides to align its strategy with the emerging European harmonised approach.[402]

Even though Ofcom was a pioneer in calling for the digital dividend allocation to mobile, being its strategy not in line with European vision and WRC-07 decisions, the UK is forced to undertake a significant and costly spectrum re-planning, which has led to its later adoption of the European strategy.[403]

In the Statement published on 30 June 2009 on clearing the 800 MHz band, Ofcom announces the intention to revise its plans to incorporate the 790-862 MHz band in the digital dividend. The UK has been the 8th European country to announce the release of the 800 MHz band as part of the digital dividend after Sweden (19 December 2007), Finland (19 June 2008), France (20 October

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[399] Aetha (2011). *Op. cit.*, supra footnote 394.
Office of Communications – Ofcom (2009). Statement: *Digital Dividend: clearing the 800 MHz band*. Available at: http://stakeholders.ofcom.org.uk/binaries/consultations/800mhz/statement/clearing.pdf.

[400] GSM Association – GSMA (2012). Barriers. Removing Barriers: *Country Case Studies* (accessed June 2013), http://www.gsma.com/spectrum/wp-content/uploads/DigitalDividend/DDtoolkit/dd-allocations.html.

[401] BBC News (2009). *Call to harmonise mobile airwaves* (accessed June 2013), http://news.bbc.co.uk/2/hi/technology/8329857.stm.

[402] Office of Communications – Ofcom (2009). *Op. cit.*, supra footnote 399.

[403] Aetha (2011). *Op. cit.*, supra footnote 394;
GSM Association – GSMA (2012). Digital Dividend, Analogue Switch-off *Country Analysis* (accessed June 2013), http://www.gsma.com/spectrum/wp-content/uploads/DigitalDividend/DDtoolkit/country-by-country-analysis.html.

2008), Switzerland (13 November 2008), Spain (2 June 2009), Germany (12 June 2009) and Denmark (22 June 2009).[404]

In 2009 a further analysis on the additional benefits/costs of adopting the 800MHz band in the UK is undertaken. It is included in the Consultation document containing the proposals to align the UK digital dividend with the European plans for the creation of the 800MHz band, which was published on 2 February 2009.[405] Ofcom states that substantial net benefits, estimated at that time at £2-3 billion in NPV over twenty years, could be gained by making the same spectrum available as other countries because better wireless services could be provided, particularly mobile broadband. Moreover, aligning the spectrum would generate benefits from international economies of scale in equipment manufacture which leads to lower cost services for consumers and from greater freedom in the use of the mobile service in UK and across Europe.[406] Ofcom recognises how increasing by 24 MHz the digital dividend would create greater value for citizens and consumers having the possibility to access new mobile broadband services. More operators would have the possibility to be present, thus enhancing competition, innovation and quality service.[407]

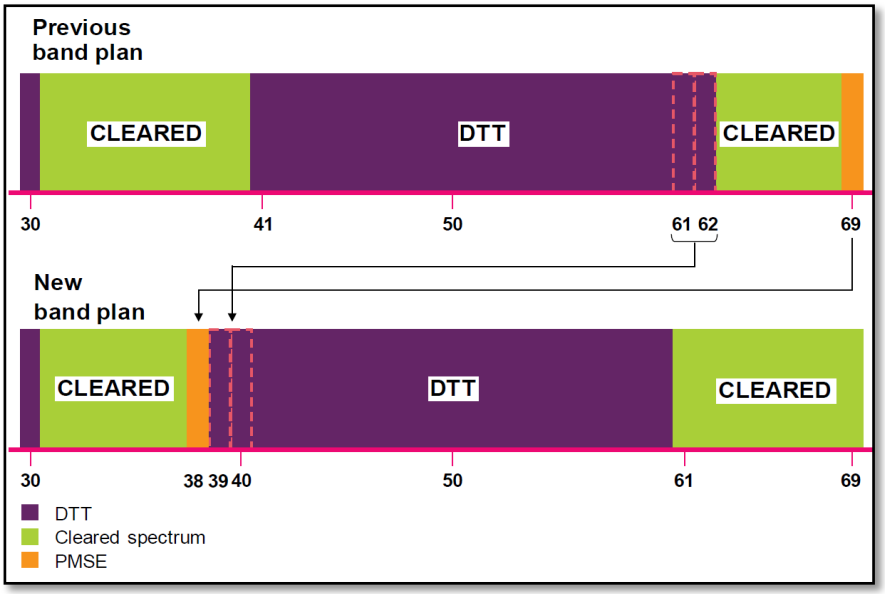

Figure 22. Changing the configuration of the UK's digital dividend
Source: Ofcom (2009). Statement: *Digital Dividend: clearing the 800 MHz band*. Available at: http://stakeholders.ofcom.org.uk/binaries/consultations/800mhz/statement/clearing.pdf.

[404] M. Conway (2012). *UK digital-dividend regulatory framework* (PowerPoint), DCKTN/UKTI Workshop on Mobile and Broadcast Innovation Opportunities in the Digital Dividend Spectrum, 21 June 2010;
Office of Communications – Ofcom (2009). *Op. cit.*, supra footnote 387.
[405] Aetha (2011). *Op. cit.*, supra footnote 394;
[406] Office of Communications – Ofcom (2009). *A better Digital Dividend for Britain* (accessed June 2013), http://media.ofcom.org.uk/2009/02/02/a-better-digital-dividend-for-britain/.
[407] Office of Communications – Ofcom (2009). *Op. cit.*, supra footnote 399.

As shown in the above picture, the creation of the 800MHz band have implied the clearance of channels 61 and 62 which were previously planned to be used by DTT (moved to channel 39 and 40) and channel 69 previously allocated to PMSE (moved to channel 38).

Some respondents to the Ofcom Consultation document mentioned above said that, without alignment with other European countries, the UK would have risked being a subscale market that manufacturers and service providers would either not have entered or only have been able to do so at an increased cost, which would ultimately have been borne by citizens and consumers.[408] The issue of the PMSE devices has been subject to extensive, detailed and repeated consultation, in particular in light of the upcoming Olympics Games hosted in London in 2012.[409] Ofcom guaranteed PMSE users the access to the 800 MHz band, as concerns raised regarding the necessity to have the spectrum available for the use for the Olympic Games.[410]

The UK government confirmed its commitment to fund the costs of clearing these channels, estimated to be first £85-185 million and then £115-250 million in NPV for channel 61 and 62 and £5-18 million in NPV for channel 69, considering them as modest compared to the expected benefits of clearing the 800MHz band.[411]

The 800 MHz band becomes totally available by the end of July 2013 as channel 69 has been cleared from PMSE at the end of 2012 and the clearance of channels 61 and 62 was completed on 31 July 2013.[412] The UK achieves its objective ahead of schedule (five months earlier than the original plan) and under budget.[413]

With regard to the renewed digital dividend plan including the 800 MHz band, the UK starts bilateral and multilateral negotiations with neighbouring

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[408] Office of Communications – Ofcom (2009). *Op. cit.*, supra footnote 387.

[409] BBC News (2009). *Digital dividend scheme switched* (accessed June 2013), http://news.bbc.co.uk/2/hi/technology/7870459.stm;
Aetha (2011). *Op. cit.*, supra footnote 394;

[410] GB Parliament: House of Commons: Business, Innovation and Skills Committee (2010). *Broadband* Fourth Report of Session 2009-10. Available at: http://www.publications.parliament.uk/pa/cm200910/cmselect/cmbis/72/72.pdf.

[411] N. Laflin (2009). *UK Broadcasters' perspective on the Digital Dividend* (PowerPoint), BBC Distribution, European Commission Hearings on the Digital Dividend, Brussels, Belgium, 6 March 2009. Available at: http://www.analysysmason.com/PageFiles/11730/UK%20Broadcasters%20Perspective%20on%20the%20Digital%20Dividend%20-%20BBC.pdf;
BBC News (2009). *Digital dividend scheme switched* (accessed June 2013), http://news.bbc.co.uk/2/hi/technology/7870459.stm;
Aetha (2011). *Op. cit.*, supra footnote 394.

[412] M. Conway (2012). *Op. cit.*, supra footnote 404;
Office of Communications – Ofcom (2013). *Notice of transitional restrictions on Mobile Networks in the 800 MHz band for protection of DTT in channels 61 and 62*. Available at: http://stakeholders.ofcom.org.uk/binaries/consultations/award-800mhz/statement/Annex_6.pdf.

[413] digitaluk (2013). *The channel 61 & 62 clearance project* (accessed September 2013), http://www.digitaluk.co.uk/industry/news/6162_clearance_engineering.

countries in order to efficiently clear and award those frequencies. Some changes have to be agreed and introduced in the GE06 Plan on the use of the UHF band, which has been designed to optimise the use of these frequencies for broadcasting, in order to ensure that new allocations are granted international recognition and protection.[414] In particular, the UK concludes bilateral agreements with France and Ireland and with Belgium and the Netherlands.[415]

In figure 23 the 800MHz band plan is shown, as it has been awarded in the UK. To be consistent with the EC view, it has a 1MHz guard band below the band (between the 800MHz band and DTT) and an 11MHz duplex gap.[416]

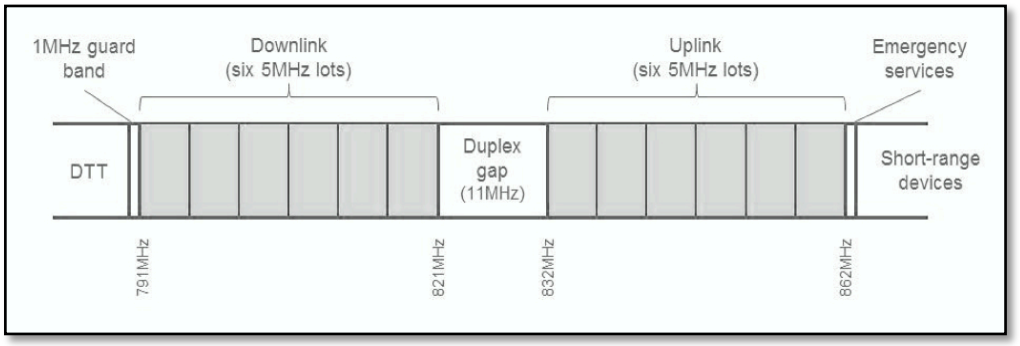

Figure 23. Proposed 800MHz band plan
Source: Aetha (2011). *Case studies for the award of the 700 MHz/800 MHz band: UK*, prepared for GSMA. Available at: http://www.gsma.com/spectrum/wp-content/uploads/2012/07/700MHz-800MHz-band-UK.pdf.

The Statement published on 24 July 2012, sets out Ofcom's decisions for the award of licences for the use of both the 800 MHz band (790-862 MHz) and the 2.6 GHz band (2500-269 MHz). It follows on from two Consultations taken in March 2011 and January 2012.[417]

Licences to use the 800 MHz and 2.6 GHz bands for mobile broadband services (4G) are granted on 1 March 2013 following the auction that starts on 23 January 2013.[418] On 20 February 2013, after five years of planning and more than 50 rounds of bidding during five-weeks of auction process, Ofcom announces which operators have won the right to deploy 4G mobile services in

[414] Office of Communications – Ofcom (2009). *Op. cit.*, supra footnote 387.
[415] Office of Communications – Ofcom, UK Digital Terrestrial Television: *International Coordination Agreements* (accessed June 2013), http://stakeholders.ofcom.org.uk/broadcasting/guidance/tech-guidance/agreements/.
[416] Aetha (2011). *Op. cit.*, supra footnote 394;
Ovum (2011). *Ofcom sets out plans for largest ever award of spectrum* (accessed June 2013), http://ovum.com/2011/03/29/ofcom-sets-out-plans-for-largest-ever-award-of-spectrum/.
[417] Office of Communications – Ofcom (2012). Statement: *Assessment of future mobile competition and award of 800 MHz and 2.6 GHz*. Available at: http://stakeholders.ofcom.org.uk/binaries/consultations/award-800mhz/statement/statement.pdf.
[418] Office of Communications – Ofcom, *800 MHz & 2.6 GHz Combined A*ward (accessed June 2013), http://stakeholders.ofcom.org.uk/spectrum/spectrum-awards/awards-archive/completed-awards/800mhz-2.6ghz/.

the UK. Seven bidders take part and five of them win licences to operate in the 800MHz and 2.6GHz bands[419]: Everything Everywhere Ltd, Hutchison 3G UK Ltd, Niche Spectrum Ventures Ltd (a subsidiary of BT Group plc), Telefónica UK Ltd and Vodafone Ltd. MLL Telecom and Hong Kong-based HKT were unsuccessful. Ofcom has attached a coverage obligation on Telefónica UK Ltd, which has the duty to provide a mobile broadband service for indoor reception to at least 98% of the UK population (expected to cover at least 99% when outdoors) and at least 95% of the population of each of the UK nations by the end of 2017 at the latest. Competing phone companies will soon start to deliver superfast mobile broadband (4G) services in the UK by late spring or summer 2013.[420] Almost £2.34 billion has been raised. This was £1.00 billion more than the reserve price, but £1.20 billion less than what was predicted by the government (£3.5billion).[421]

Table 5. UK 4G auction results

Licensee	Frequencies assigned	Base price	Additional prices	Licence fee paid
Everything Everywhere Limited	796 to 801 MHz and 837 to 842 MHz	£588,876,000	£0	£588,876,000
	2535 to 2570 MHz and 2655 to 2690 MHz		£0	
Hutchison 3G UK Limited	791 to 796 MHz and 832 to 837 MHz	£225,000,000	£0	£225,000,000
Niche Spectrum Ventures Limited	2520 to 2535 MHz and 2640 to 2655 MHz	£186,476,000	£15,061,179	£201,537,179
	2595 to 2620 MHz		£0	
Telefónica UK Limited	811 to 821 MHz and 852 to 862 MHz	£550,000,000	N/A	£550,000,000
Vodafone Limited	801 to 811 MHz and 842 to 852 MHz	£790,761,000	£8,060,020	£802,860,143
	2500 to 2520 MHz and 2620 to 2640 MHz		£4,039,123	
	2570 to 2595 MHz		£0	

Source: Ofcom, *4G auction results* (accessed June 2013), http://consumers.ofcom.org.uk/4g-auction/.8.2.4.

8.2.4. Second digital dividend

The increasing use of smartphones and tablets and related services is driving up data traffic rates with an exponential speed, determining the rapid growth in the demand for mobile broadband capacity. In a Consultation published in 2012, Ofcom has predicted that, under a mid-level growth scenario, mobile data capacity demand will experience an 80-fold increase between 2012 and 2030,

[419] Ovum (2013). *The hammer comes down on the UK's 4G auction* (accessed June 2013), http://ovum.com/2013/02/22/the-hammer-comes-down-on-the-uks-4g-auction/.

[420] Office of Communications – Ofcom, *4G auction results* (accessed June 2013), http://consumers.ofcom.org.uk/4g-auction/.

[421] Ovum (2013). *The hammer comes down on the UK's 4G auction* (accessed June 2013), http://ovum.com/2013/02/22/the-hammer-comes-down-on-the-uks-4g-auction/;
S. Kennedy – NetTek Ltd (2011), *UK Spectrum update*, (PowerPoint). Available at: http://www.uknof.org.uk/uknof21/Kennedy-Spectrum.pdf.

and a 300-fold increase under a high-growth scenario.[422] In order to meet this demand, more mobile spectrum is needed over the long term, together with new technologies to make mobile broadband more efficient.[423]

Ofcom has been sharply criticised for several delays that have characterised the awarding process of the first digital dividend, with the UK lagging behind other countries, which have already rolled out 4G services.[424] Among other things, Ofcom showed some difficulties when it had to decide whether and how the 800 MHz band had to be reserved or not for bidders other than O2 and Vodafone, in light of the objective to promote competition.[425]

However, Ofcom, aware of the emergency nature of the situation, starts soon working on the second digital dividend, the 700 MHz (694-790 MHz) band. These frequencies are currently used by DTT and other services on an interleaved basis. In fact, a consultation is taken from 29 March 2012 to 7 June 2012 on how best to use those frequencies. It is worth noting that this process is animated by WRC-12 results, which paved the way for a global allocation of the 700 MHz band for mobile broadband after the next WRC-15.

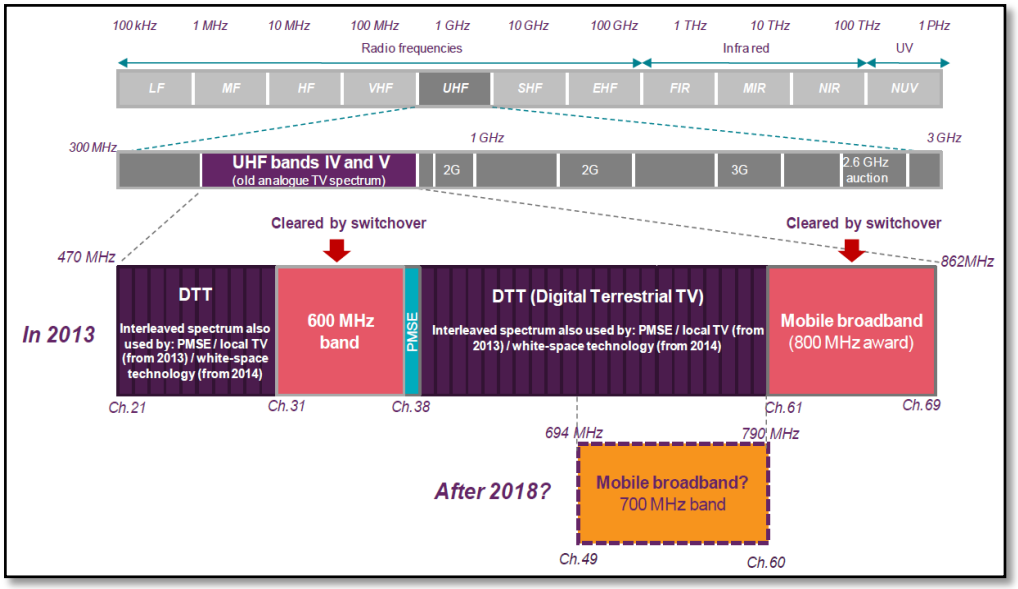

Figure 24. UHF bands IV and V and the 700 MHz band

Source: Ofcom Consultation (2012) *Securing long term benefits from scarce spectrum resources. A strategy for UHF bands IV and V*. Available at: http://stakeholders.ofcom.org.uk/binaries/consultations/uhf-strategy/summary/spectrum-condoc.pdf.

[422] Office of Communications – Ofcom (2012) Consultation: *Securing long term benefits from scarce spectrum resources. A strategy for UHF bands IV and V*. Available at: http://stakeholders.ofcom.org.uk/binaries/consultations/uhf-strategy/summary/spectrum-condoc.pdf.

[423] Office of Communications – Ofcom, *4G auction results* (accessed June 2013), http://consumers.ofcom.org.uk/4g-auction/.

[424] BBC News (2013), *Operators' 4G bidding war begins as Ofcom launches UK auction* (accessed June 2013), http://www.bbc.co.uk/news/technology-21160814.

[425] I. Walden (2012). *Telecommunications Law and Regulation*, Oxford, UK: Oxford University Press.

Ofcom believes that the DTT platform will remain attractive over the next decade so it is necessary to sustain the delivery of DTT, while enabling the use of the 700 MHz band for mobile broadband. A solution is needed to conciliate broadcasters' interests and mobile service's increasing demand for spectrum.[426] The idea is to move the broadcasting service on the 600 MHz (550-606 MHz) band and to allocate the 700 MHz band to mobile broadband. In this way it would be possible to benefit from economies of scale, widening the availability of handsets and reducing prices that a harmonised spectrum use for mobile broadband services can offer. The band could become available from 2018.
The 600 MHz band is the lowest band of the cleared digital dividend spectrum freed up for alternative uses other than broadcasting by the switch from analogue to digital television, along with the 800 MHz band.[427]

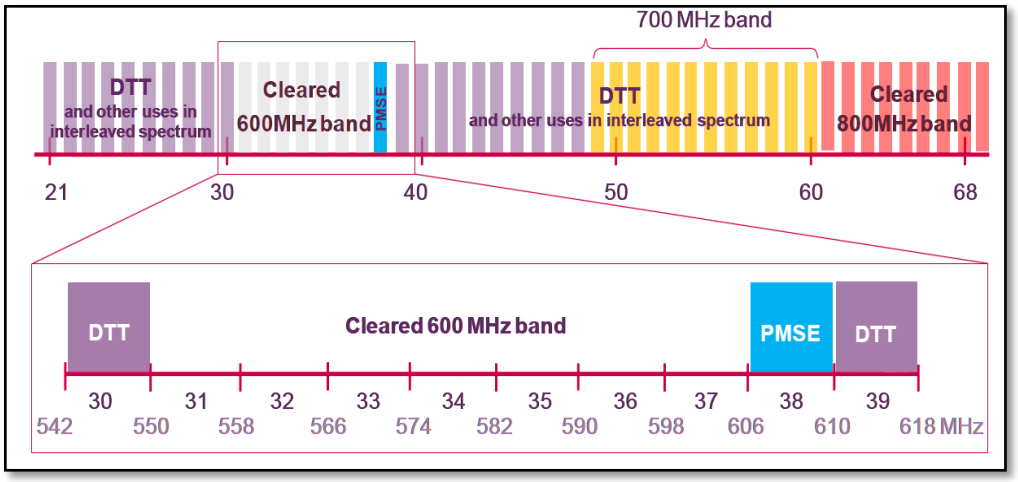

Figure 25. The available spectrum
Source: Ofcom Consultation (2013). *Award of the 600 MHz spectrum band. Including request to stakeholders to notify intention to apply*. Available at: http://stakeholders.ofcom.org.uk/binaries/consultations/600mhz-award/summary/condoc.pdf.

The regulator believes the 600 MHz band has the potential to be used by DTT, giving broadcasters the possibility to fulfil their objectives.[428] In 2009 and 2011 studies commissioned by Ofcom are conducted by Arqiva, a communications infrastructure and media services company leader in the UK.[429] These studies illustrate how the 600 MHz band could be used to provide two DTT multiplexes.[430]

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[426] Office of Communications – Ofcom (2012). *Op. cit.*, supra footnote 422.
[427] Office of Communications – Ofcom (2010). Interim Statement*: 600 MHz and geographic interleaved spectrum Summary of responses to consultation on potential uses and next steps*. Available at: http://stakeholders.ofcom.org.uk/consultations/600mhz_geographic/summary-of-responses/.
[428] Ovum (2012). *Ofcom starts planning the award of the second digital dividend* (accessed June 0213), http://ovum.com/2012/05/03/ofcom-starts-planning-the-award-of-the-second-digital-dividend/.
[429] Arqiva, *About us* (accessed June 2013), http://www.arqiva.com/corporate/about/.
[430] Office of Communications – Ofcom (2013). Consultation: *Award of the 600 MHz spectrum band. Including request to stakeholders to notify intention to apply*. Available at: http://stakeholders.ofcom.org.uk/binaries/consultations/600mhz-award/summary/condoc.pdf.

In the Statement published on 16 November 2012 on UHF strategy, Ofcom clearly displays its dual long term strategic objectives to release the 700 MHz band for mobile broadband, while protecting the provision of DTT, accommodating DTT in the 600 MHz band, for interim use.[431] A Consultation is published on 6 February 2012 in which Ofcom sets out its proposal for the award of a licence to establish temporary DTT multiplexes in the 600 MHz spectrum band. This band comprises seven channels of 8 MHz each (channel 31 to 37), but channel 36 (590-598 MHz) is excluded from this award, given a proposed Europe-wide signal propagation study on a temporary basis.

The current use of the 600 MHz band is for PMSE systems, which will be able to access the band after the deployment of DTT services, by using the interleaved spectrum. As the objective is to award this band as soon as possible, the above Consultation includes a form that should have been returned by stakeholders who intended to apply for the licence in this band by 4 April 2013, which was the closing date for responses. The period over which the 600 MHz band can be used on an interim basis is five years, from 2013 to 2018. Ofcom is aware of the fact that this is a very short period, but it is considered appropriate in light of the duty to ensure an optimal use of the spectrum.

Of course there are constraints regarding the use of the 600 MHz band, as problems may arise at international and local level. Firstly, in most European countries the 600 MHz band is used for television broadcasting, so there will be relatively high possibility of cross-border interference. Negotiations have been conducted with neighbouring countries on the basis of their use of the spectrum for broadcasting. At the national level, potential interference may arise between services occupying the 600 MHz band and services in the neighbouring bands, meaning DTT and PMSE, as shown in the above picture. However mechanisms to coordinate PMSE operations with DTT transmissions are well-established in other parts of the UHF bands, so coexistence problems may be easily solved.[432]

The proposal of moving DTT down to the 600 MHz band from the 700 MHz band, which will be free up for mobile broadband, would be of great benefit for the UK, given also the emergent international trend and the necessity to support the international process. WRC-12 results and the objectives of the upcoming WRC-15 are oriented towards the harmonisation of the 700 MHz band for the mobile service use.[433] Thus, any potential change of use of the 700 MHz band from broadcasting to mobile broadband in UK will be influenced by international developments and will be coordinated at the international level.

In this respect, as part of WRC-15 Agenda Item 1.1 preparation process, Ofcom is currently carrying out studies on the future spectrum requirements for

[431] Office of Communications – Ofcom (2012). *Op. cit.,* supra footnote 422.

[432] Office of Communications – Ofcom (2013). *Op. cit.*, supra footnote 430.

[433] I. Walden (2012). *Op. cit.,* supra footnote 425.

mobile broadband applications. These studies take into account the evolving needs, including user demand for IMT and other terrestrial mobile broadband applications.[434] If there is a change of use of the 700 MHz band, the DTT frequency plan currently in use will have to be modified. Hence, the UK will need to internationally co-ordinate a new DTT frequency plan with neighbouring countries. There could be also the possibility of a new RRC in order to revise the current GE06 Agreement. Inevitably, the conclusion of international agreements depends on many factors such as decisions taken by each country regarding the use of the frequencies, but, first of all, what will be decided at International and European level.[435]

8.3. Italy

8.3.1. Agcom

The Communications Regulatory Authority (Autorità per le Garanzie nelle Comunicazioni - Agcom) is the independent and autonomous regulator and competition authority for the communication industries, established by Law No. 249 of 31 July 1997. It supports the Italian liberalisation of the telecommunications market. It is one of the first authorities established under Law No. 481 of 14 November 1995, after the completion of the European Internal Market.[436] Agcom is defined as a "convergent" authority, since its competences cover the whole communications system, supervising both electronic communications and the provision of content.[437]

The Agcom replaced the former Radio and Publishing Guarantor, responsible for overseeing television and radio broadcasting, and the press, which showed lack of formal independence from the Parliament and the Government.[438] As for other authorities set up in the Italian system, the Parliament establishes its powers, defines its statutes and elects its members. Agcom is first and foremost a "guarantor": its main tasks, as described in the Law No. 249, are to ensure equitable access conditions for operators in order to safeguard and maintain a fair market competition, to guarantee the availability of agreed services to everybody and to protect fundamental rights of consumers.[439]

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[434] Office of Communications – Ofcom (2013). *Op. cit.,* supra footnote 430.

[435] Office of Communications – Ofcom (2013). *Op. cit.,* supra footnote 367.

[436] Treccani, L'Enciclopedia Italiana, *L'Agcom: nascita, struttura, funzioni* (accessed June 2013), http://www.treccani.it/webtv/videos/Int_Rino_Caiazzo_agcom.html.

[437] European Commission - EC (2012). *ITALY 2011 Telecommunication Market and Regulatory Developments* (accessed June 2013). Available at: http://ec.europa.eu/digital-agenda/sites/digital-agenda/files/IT_Country_Chapter_17th_Report_0.pdf.

[438] M. S. Tighettini, G. Nesti, C. Padovani (2013). *Italy* in H. Sousa; W. Trützschler, J. Fidalgo, M. Lameiras, *Media Regulators in Europe: A Cross-Country Comparative Analysis,* Braga, Portugal: CECS, University of Minho, pp. 100-113.

[439] Autorità per le Garanzie nelle Comunicazioni – Agcom, *Introduction to the Agcom* (accessed June 2013), http://www2.agcom.it/eng/eng_intro.htm.

Concerning spectrum management, Agcom shares responsibilities with the Ministry of Economic Development. Basically, the Ministry of Economic Development is responsible for the spectrum allocation (frequency allocation table), while Agcom is in charge of spectrum assignment process (both in telecommunications and broadcasting sectors). Moreover, the Ministry of Economic Development issues authorisations and rights of use of the spectrum, while Agcom sets up the rules for spectrum access, such as number of rights of use and geographical limitations.[440]

8.3.2. Italian television anomaly[441]

Since the '80s, the Italian television market has been characterised by a duopoly consisting of the state broadcaster Radiotelevisione Italiana (RAI) and the private broadcaster Mediaset. Digitalisation has not had significant impact on television ownership, being the duopoly constantly present.[442] The situation starts changing only with Sky coming into the Italian television market, which is gradually gaining market share. Moreover, it is worth noting the presence of a conflict of interests at the time when Silvio Berlusconi was Prime Minister, being his family holding company Fininvest the controller of Mediaset.[443]

While the initial government policies on DTT and digital switchover are formulated under the centre-left governments (1996-2001), their implementation is taken under the centre-right government led by Silvio Berlusconi (2001-2006). DTT is introduced in Italy with the adoption of the Decree-Law No. 5 of 20 January 2001, amended by Law No. 66 of 20 March 2001 (and the related Regulation No. 431/01/CONS), which provides for the switch-off of analogue networks and the switchover to digital terrestrial transmissions by 2006.[444]

In Italy, DTT starts in December 2003 when Mediaset begins broadcasting its services over a multiplex with five channels. RAI follows soon after on 3 January 2004 with transmissions over two multiplex.[445] Before 2000, little was done, while other countries had already started significant policy initiatives. Apart from any other considerations, the most important element, which has been preventing the government to achieve the goal of implementing DTT, is

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[440] M. Martino (2011). *Spectrum management and policy Issues in the EU and Italian framework* (PowerPoint), Agcom Seminar, 7 October 2011. Available at: http://www.agcom.it/Default.aspx?message=downloaddocument&DocID=7562.

[441] C. Occhino, E. Cywiak, *Case Study: Italy's television anomaly – ownership, influence and a challenge to journalistic standards*. Available at: http://www.aej-uk.org/AEJ-mediasurvey-ita.doc.

[442] M. T. García Leiva, (2008). *DTT in the UK and Spain: a comparative policy analysis (1998-2006),* info, Vol. 10, Iss. 3, pp. 39-50. Available at: http://www.emeraldinsight.com/journals.htm?articleid=1723322.

[443] M. Hibberd (2008). *The media in Italy,* Glasgow, UK: Bell and Bain Ltd, pp. 130-132.

[444] European Commission - EC (2004). *Italian Plan for Digital Switchover*. Available at: http://ec.europa.eu/information_society/policy/ecomm/doc/current/broadcasting/switchover/it_digital_sw_it_rev1_en.doc.

[445] C. Colapinto, F. Papandrea (2007). *Op. cit.,* supra footnote 383.

of a technical order. Differently from the situation in other countries, in Italy there was simply not enough spare capacity to be allocated to incumbent broadcasters and/or new entrants to start DTT services. Channel occupancy in Italy is very close to spectrum saturation, due to the proliferation of local private stations, which has led to an extremely chaotic situation. How to free up enough frequencies to allow for the launch of DTT was a problem with no immediate solution.[446]

On 3 May 2004, in response to complaints about the high concentration of ownership in the Italian television market[447], Law No. 112, known as the Gasparri Law is adopted, followed by the subsequent Consolidated Broadcasting Act of 2005. This should have included a practical solution to high concentration in the television market, providing means for promoting pluralism. [448] However, instead of opening up new spaces for other operators, the Gasparri Law helped preserve the old media concentration in a new legal framework, giving Silvio Berlusconi a solid legal basis to expand his media holdings. Someone could venture to say that the Gasparri Law was tailor-made for Silvio Berlusconi, because it has been adopted while Silvio Berlusconi was Prime Minister, so he had in his hands both political and broadcasting power.[449] This situation gave rise to suspicious concerns about the impartiality of the Government in regard to television broadcasting.[450] For sure the Gasparri Law contravened EU law.[451]

In fact, in July 2006 the EC decides to send a letter of formal notice to Italy requesting information about its broadcasting legislation's compatibility with EU rules on competition in the markets for electronic communications networks and services. On 18 July 2007, the EC follows up that letter with a reasoned opinion containing further criticisms, in particular of the plans for the digital switchover.[452] The EC found that the Gasparri Law, among other Italian Laws, was not compliant with the EU competition rules, as it precluded operators which were not active in analogue transmissions from experimenting with digital transmissions and from creating their own digital networks and introduced unjustified advantages for existing analogue broadcasters. That

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[446] A. D'Arma (2007). *Op. cit.,* supra footnote 382.

[447] C. Occhino; E. Cywiak. *Op. cit.,* supra footnote 441.

[448] M. Haraszti - The Representative on Freedom of the Media, Organization for Security and Co-operation in Europe (2005). *Visit to Italy: The Gasparri Law. Observations and Recommendations*. Available at: http://www.osce.org/fom/46497.

[449] S. Blatmann - Reporters sans Frontieres (2003). *Italy. A media Conflict of Interest: anomaly in Italy*. Available at: http://www.rsf.org/IMG/pdf/doc-2080.pdf.

[450] G. Mazzoleni, G. Vigevani, S. Splendore – Open Society Foundations (2011). *Mapping Digital Media Italy*, Country Report. Available at: http://www.opensocietyfoundations.org/sites/default/files/mapping-digital-media-italy-20130605.pdf.

[451] M. Hibberd (2008). *Op. cit.,* supra footnote 443.

[452] Autorità per le Garanzie nelle Comunicazioni – Agcom (2009). Resolution No. 181/09/CONS *Criteri per la completa digitalizzazione delle reti televisive terrestri*. Available at: http://www.agcom.it/default.aspx?DocID=2964.

letter was the first step of the infringement procedure under Article 226 of the EC Treaty started in December 2007.[453]

Moreover, in January 2008, the European Court of Justice rules that Italy has breached Community law by giving a television company a broadcasting licence but failing to give it a frequency allocation. That case involves another broadcasting operator, Centro Europa 7, against the Ministry of Communications and the regulator Agcom.[454] In June 2012, the European Court of Human Rights expresses its opinion on the same case, stating that the Italian authorities have failed to put in place an appropriated legislative and administrative framework regarding frequency allocation, violating Article 10 (freedom of expression and information) and Article 1 of Protocol No. 1 (protection of property) of the European Convention of Human rights at the expense of Centro Europa 7.[455]

In order to respond to the issue highlighted by the EC, the Italian Law No. 101 of 6 June 2008 is adopted in order to introduce a national plan setting out new criteria for allocating digital frequencies. EC expresses satisfaction with the statutory reforms introduced by Law No. 101/08.[456] However, it finds the assignment process as inadequate, as it doesn't allow new players to enter the market, perpetuating RAI and Mediaset hegemony.

In response to this further remark, in Resolution No. 181/09/CONS of 7 April 2009, transposed into primary legislation by the 2008 Community Law, Agcom sets the new rules for the full digitalisation of national terrestrial television in Italy.[457] Following the approval of Resolution No. 181/09/CONS the EC decides to suspend the infringement proceeding against Italy on 8 October

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[453] European Commission – EC (2006). Digital Agenda for Europe, *Competition: Commission requests Italy to comply with EU rules on electronic communications* (accessed June 2013), https://ec.europa.eu/digital-agenda/en/news/competition-commission-requests-italy-comply-eu-rules-electronic-communications;

Telecom Italia (2011). *Digital Frequencies and Switch Off* (accessed June 2013), http://www.telecomitaliamedia.it/it/node/362;

N. Matteucci (2008). *Multiplatform Competition and State Aid in EU Digital TV: A Comparative Assessment* Proceedings the 2008 EUCPR Conference, ITPS-JRC, Seville, Spain. Available at: http://works.bepress.com/nicola_matteucci/6/.

[454] M. Sims (2008). *Newsflash: Italian TV band allocations ruled unlawful,* PolicyTracker, The Spectrum Management Newsletter (accessed June 2013). Available at: https://www.policytracker.com/headlines/newsflash-italian-tv-band-allocations-ruled-unlawful/?searchterm=the%20European%20court%20of%20justice%20has%20ruled%20that%20Italy%20has%20breached%20community%20law%20by%20giving%20a%20TV%20company%20a%20broadcasting%20licence%20but%20failing%20to%20give%20it%20a%20frequency%20allocation.

[455] European Court of Human Rights (2012). *Italian authorities should have ensured that a licensed TV company had the frequencies enabling it to broadcast,* Press Release. Available at: http://www.medialaws.eu/wp-content/uploads/2012/06/Grand-Chamber-judgment-Centro-Europa-7-S.r.l.-and-Di-Stefano-v.-Italy-07.06.12.pdf.

[456] Europa, Press Releases Database (2009). *Commission ends legal action after Italy and Estonia comply with EU advertising rules* (accessed June 2013), http://europa.eu/rapid/press-release_IP-09-1492_en.htm?locale=en.

[457] Telecom Italia (2011). *Digital Frequencies and Switch Off* (accessed June 2013), http://www.telecomitaliamedia.it/it/node/362.

2009, reserving the right to resume it at any time while monitoring the implementation of the plan.[458]

Turning to the point of the digital switchover, the Gasparri Law confirmed 2006 as the deadline for the full transfer to DTT, as proposed by Agcom. As a matter of fact, the possibility to meet this deadline appeared to be too far for many reasons, including the early stage of government planning and the difficulty of coordination of hundreds of local broadcasters.[459] Then the target date of 31 December 2006 was postponed, initially to 31 December 2008 and subsequently to 31 December 2012.[460]

In accordance with Law No. 101/08, with decree of the Ministry of Economic Development of 10 September 2008 No. 33827 concerning "Definition of a calendar for the final transition to the DTT transmissions, with indication of the territorial areas concerned and of the corresponding deadlines", the calendar for the switch-off from analogue to digital television was defined, postponing the deadline of the transition until 2012, in line with European recommendations.[461] The Ministerial Decree divided the national territory into 16 technical macro-areas, largely coinciding with regions.[462]

The process started in Sardinia in July 2008 and was completed on 4 July 2012 with the shutdown of the last analogue transmitters in Sicily. The transition involved 10 national channels, more than 550 local channels and over 24.200 transmissions sites.[463] In addition, the introduction of DTT has led to an increase of free-to-air national television channels from 10 to about 75.[464]

8.3.3. First digital dividend

On 15 June 2010 with Resolution No. 300/10/CONS, Agcom approves the new National Digital Frequency Assignment Plan, in accordance with the GE06 Agreement. On the basis of this Plan, the 800 MHz band is assigned to local broadcasters, even though WRC-07 decision to allocate the 800 MHz band to mobile service on a co-primary basis with terrestrial television prompted

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[458] G. Mazzoleni, G. Vigevani, S. Splendore – Open Society Foundations (2011). *Op. cit.,* supra footnote 450.

[459] A. D'Arma (2007). *Op. cit.,* supra footnote 382.

[460] C. Colapinto, F. Papandrea (2007). *Op. cit.,* supra footnote 383.

[461] Autorità per le Garanzie nelle Comunicazioni – Agcom (2009). *Annual Report 2009 sull'attività svolta e sui programmi di lavoro*. Available at: http://www.agcom.it/Default.aspx?message=viewrelazioneannuale&idRelazione=18.

[462] A. Barbadoro (2011). *La transizione della televisione dall'analogico al digitale. Il processo – la pianificazione – le attività in corso* (PowerPoint), Agcom Seminar, 4 November 2011. Available at: http://www.agcom.it/default.aspx?DocID=7286.

[463] Federazione Radio Televisioni – FRT, settimanale di informazione sul settore radiotelevisivo della Federazione Radio Televisioni (2012), Year 19, No. 24, Rome, Italy. Available at: http://www.frt.it/allegati/newsletter/FRT%20Radio%20&%20Tv%20notizie%2024_2012%20-%2009%20luglio%202012.pdf.

[464] Telecompaper (2012). *Italy completes digital TV switch-over* (accessed June 2013), http://www.telecompaper.com/news/italy-completes-digital-tv-switch-over--882950.

national actions all over the world to re-farm UHF frequencies for mobile service.

Thus, for some time, Italy supports the idea of returning the spectrum to broadcasters after analogue switchover. Complex negotiations are carried out to this end with the French and Austrian regulators in order to minimise the interference between Italy's legacy broadcasting allocation and the new digital dividend allocations to mobile in neighbouring countries. However, backed by Europe and given the general orientation for a mobile allocation, Italy's position shifts.[465]

Probably, the Italian Government already knew at the time of the initial allocation, that they would have asked local broadcasters to clear the 800 MHz band in the near future, but allocating the 800 MHz band to broadcasting service appeared to be an easy decision to implement with minimum effort.[466]

On 13 December 2010, Law No. 220, known as "Stability Law for 2011", is adopted. It states, among other things, that the 790-863 MHz band (channel 61-69) has to be allocated to mobile service since 1 January 2013, aligning Italian actions with European recommendations and other EU Member States strategies.[467] It is also taken the decision to launch a public auction to allocate those frequencies. As the digital dividend was initially assigned to local television broadcasters, the law in question requires local operators to be compensated using 10% of the proceeds of the auction, subject to a cup of €240 million (10% of the estimated income of €2.4 billion).[468]

The amount of the compensation is seen as inadequate and unfair by local broadcasters, which will have to incur in huge investments in new digital equipment and have seen a drastic reduction of their frequencies. Moreover local broadcasters are concerned because Italy remains a country that relies heavily on terrestrial broadcasting to receive television services. Cable and satellite are less popular in Italy than in other European territories. So, there has to be enough spectrum available to allow broadcasting operators to provide services their customers expect. Erosion of broadcasting spectrum means that viewers in territories such as Italy would starts to see degradation in the services being offered.[469]

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[465] GSM Association – GSMA (2012). Barriers. Removing Barriers: *Country Case Studies* (accessed June 2013), http://www.gsma.com/spectrum/wp-content/uploads/DigitalDividend/DDtoolkit/dd-allocations.html.

[466] Federazione Radio Televisioni – FRT, settimanale di informazione sul settore radiotelevisivo della Federazione Radio Televisioni (2010), Year 17, No. 44, Rome, Italy. Available at: http://www.frt.it/allegati/newsletter/FRT%20Radio%20&%20Tv%20notizie%2044_2010%20-%2020%20dicembre%202010.pdf.

[467] A. Barbadoro (2011). *Op. cit.*, supra footnote 462.

[468] Telecom Italia (2011). *Digital Frequencies and Switch Off* (accessed June 2013), http://www.telecomitaliamedia.it/it/node/362.

[469] D. Standeford (2012). *Italy ditches DTT spectrum beauty contest* (accessed June 2013), PolicyTracker, The Spectrum Management Newsletter. Available at: https://www.policytracker.com/headlines/italy-ditches-dtt-spectrum-beauty-contest/?searchterm=italy.

On 18 May 2011 Resolution No. 282/11/CONS is adopted, integrated by Resolution No. 370/11/CONS of 23 June 2011 afterwards. It concerns procedures and rules for assignment and use of frequencies available for broadband wireless electronic communication services in the 800 MHz, 1800 MHz, 2.1 GHz and 2.6 GHz bands.[470] As envisaged by the Stability Law, Italy's telecommunications regulator, within 15 days from the adoption of the Stability Law, holds a multiband auction of 255 MHz of spectrum in four different bands, based on simultaneous multiple rounds.[471] There are blocks in both the 800 MHz and the 2.6 GHz bands, which several other countries have grouped together for a 4G auction, as well as in the 1800 MHz and 2.1 GHz bands.[472] Coverage obligations are associated to these bands, with different requirements for each block of frequencies.[473]

With regard to the 800 MHz band, consistently with European Decision No. 2010/267/EC of 6 May 2010, Italy follows the frequency arrangement for the digital dividend frequencies as shown hereunder:

790 - 791	791 - 796	796 - 801	801 - 806	806 - 811	811 - 816	816 - 821	821 - 832	832 - 837	837 - 842	842 - 847	847 - 852	852 – 857	857 - 862
Guard band	Downlink						Duplex gap	Uplink					
1 MHz	30 MHz (6 blocks of 5 MHz)						11 MHz	30 MHz (6 blocks of 5 MHz)					

Figure 26. 800MHz band plan
Source: Agcom (2011). *Resolution No. 282/11/CONS*. Available at: http://www.agcom.it/Default.aspx?message=visualizzadocument&DocID=6447.

The auction officially starts on 30 August 2011, when the Ministry of Economic Development discloses the starting bids in a public session. Initial bids amounts to €2.3 billion. The confirmed qualified bidders in the auction are the four incumbent mobile operators (although five companies submitted applications): Telecom Italia (TIM), Vodafone Italia, Wind and H3G. The

[470] Federazione Radio Televisioni – FRT, settimanale di informazione sul settore radiotelevisivo della Federazione Radio Televisioni (2011), Year 18, No. 22, Rome, Italy. http://www.frt.it/allegati/newsletter/FRT%20Radio%20&%20Tv%20notizie%2022_2011%20-%2020%20giugno%202011.pdf.

[471] European Commission - EC (2012). *Op. cit.*, supra footnote 437.

[472] M. Newlands (2012) *Italy 800 MHz, 1800 MHz, 2.1 GHz, 2.6 GHz* (accessed June 2013), PolicyTracker, The Spectrum Management Newsletter. Available at: https://www.policytracker.com/consultations/draft-regulations-for-auction-of-lte-suitable-spectrum/proposed-rules-for-combined-spectrum-auction/?searchterm=italy.

[473] Autorità per le Garanzie nelle Comunicazioni – Agcom (2011). *Asta frequenze: al via la consultazione pubblica sulle procedure e sulle regole di gara*, Press Release 24 March 2011. Available at: http://www.agcom.it/default.aspx?DocID=5973;
Autorità per le Garanzie nelle Comunicazioni – Agcom (2011). *Asta frequenze: al via le procedure e le regole di gara,* Press Release 18 May 2011. Available at: http://www.agcom.it/default.aspx?DocID=6350.

structure of the auction, with a series of bidding rounds, allows the participants to raise their bids by a minimum of 3%.[474]
The frequencies being auctioned are as follows:

Table 6. Italy: frequencies auctioned

Band	Spectrum available	TDD or FDD	Reserve price (€)
800 MHz	6 lots of 2 x 5 MHz	FDD	353.3 million
1800 MHz	3 lots of 2 x 5 MHz	FDD	155.9 million
2 GHz	1 lot of 15 MHz	TDD	77.9 million
2.6 GHz	12 lots of 2 x 5 MHz	FDD	30.7 million
2.6 GHz	2 lots of 15 MHz	TDD	36.8 million
Total	**255 MHz**		**654.6 million**

Source: Watson, J. (2011). *Italian spectrum auction gets under way* (accessed June 2013), PolicyTracker, The Spectrum Management Newsletter. Available at: https://www.policytracker.com/headlines/italian-spectrum-auction-gets-under-way/?searchterm=GETS%20UNDER%20WAY.
Note: TDD (Time Division Duplex) and FDD (Frequency Division Duplex) are two different duplexing schemes.

On 29 September 2011, after 469 bidding rounds lasting 22 days, the 4G auction is concluded.[475] The country's four national mobile operators all win sizeable portions of spectrum, with TIM and Vodafone Italia spending the most at €1.26 billion for a total of 2x30 MHz each: two blocks of 800 MHz band, one block of 1800 MHz band and three blocks of 1.6 GHz band. The 800 MHz band is the most expensive band, raising alone €2.96 billion, which is split between TIM (€992.200.000 for 2x10 MHz) Vodafone (€992.400.000 for 2x10 MHz) and Wind (€977.900.000 for 2x10 MHz). Wind pays €1.12 billion to obtain two blocks of 800 MHz and four blocks of 2.6 GHz. Moreover, Wind wins the lowest-priced block of 5 MHz in that band, the only one without coverage obligations.[476] H3G implements a quite different strategy acquiring

[474] J. Watson (2011). *Italian spectrum auction gets under way* (accessed June 2013), PolicyTracker, The Spectrum Management Newsletter. Available at: https://www.policytracker.com/headlines/italian-spectrum-auction-gets-under-way/?searchterm=GETS%20UNDER%20WAY;
M. Newlands (2011). *Italy holds Europe's most successful 4G auction to date* (accessed June 2013), PolicyTracker, The Spectrum Management Newsletter. Available at: https://www.policytracker.com/headlines/italy-holds-europe2019s-most-successful-4g-auction-to-date/?searchterm=italy%20holds.

[475] M. Martino (2011). *Il futuro dei servizi mobili passa dal digital dividend*, Ecoscienza No. 5/6, Year 2011. Available at: http://www.arpa.emr.it/cms3/documenti/_cerca_doc/ecoscienza/ecoscienza2011_5e6/martino_es5e6_2011.pdf.

[476] GSM Association – GSMA (2012). Digital Dividend Introduction: *Auctions Summary* (accessed June 2013), http://www.gsma.com/spectrum/wp-content/uploads/DigitalDividend/DDtoolkit/auctions-summary.html#italy.

the entire available spectrum in the 2.6 GHz band for €74 million.[477] The licences on offer will last until 31 December 2029.
Over €3.9 billion has been raised, more than double the reserve price of €1.7 billion, significantly exceeding Italy's expectations. The Italian result can be considered a great success, also in comparison with those of other European countries.[478] The Italian government said it would direct digital dividend revenues to the development of the telecom sector.[479] The assignment results and total payments for each operator are shown in the table below:

Table 7. Spectrum blocks gained by operator and relative payment

	TIM	Vodafone	Wind	H3G	Total
800 MHz	2 x 10	2 x 10	2 x 10		2 x 30
1800 MHz	2 x 5	2 x 5		2 x 5	2 x 15
2.6 GHz	2 x 15	2 x 15	2 x 20	2 x 10	2 x 60
2.6 GHz TDD				30	30
Total MHz	60	60	60	60	240
Total €	1.260.320.000	1.259.680.000	1.119.920.000	305.375.100	3.945.295.100

Source: Ministero dello Sviluppo Economico (2011). *Procedura per l'assegnazione di diritti d'uso delle frequenze nelle bande 800, 1800, 2000 e 2600 MHz Fase dei miglioramenti competitivi*. Available at: http://www.sviluppoeconomico.gov.it/images/stories/documenti/SGUS_t469.pdf.
Note: TDD: Time Division Duplex.

The 15 MHz block in the 2.1 GHz band has remained unassigned at the end of August.[480] The 800 MHz and 1800 MHz bands will be used for the deployment of LTE, while 2.5 GHz appears to be attractive for Wimax.[481]
The Italian government has gone through several obstacles which caused delays in the decision making process to allocate the digital dividend to mobile

[477] M. Newlands (2011). *Italy holds Europe's most successful 4G auction to date* (accessed June 2013), PolicyTracker, The Spectrum Management Newsletter. Available at: https://www.policytracker.com/headlines/italy-holds-europe2019s-most-successful-4g-auction-to-date/?searchterm=italy%20holds.
[478] J. Watson (2011). *Italian spectrum auction gets under way* (accessed June 2013), PolicyTracker, The Spectrum Management Newsletter. Available at: https://www.policytracker.com/headlines/italian-spectrum-auction-gets-under-way/?searchterm=GETS%20UNDER%20WAY;
GSM Association – GSMA (2012). Introduction: *Auctions Summary* (accessed June 2013), http://www.gsma.com/spectrum/wp-content/uploads/DigitalDividend/DDtoolkit/auctions-summary.html#italy;
[479] Country & Industry Forecasting: IHS Global Insight (2011). *Italian Digital Dividend Auction Complete, Raises USD 5.4 Bil*. (accessed June 2013), http://www.ihs.com/products/global-insight/industry-economic-report.aspx?id=1065930401.
[480] M. Newlands (2011). *Italy holds Europe's most successful 4G auction to date* (accessed June 2013), PolicyTracker, The Spectrum Management Newsletter. Available at: https://www.policytracker.com/headlines/italy-holds-europe2019s-most-successful-4g-auction-to-date/?searchterm=italy%20holds.
[481] Il sole24ore – Italian daily newspaper (2010), *Incognita sui tempi: sprint per fine 2011* (accessed June 2013), http://www.ilsole24ore.com/art/notizie/2010-10-26/incognita-tempi-sprint-fine-063806.shtml?uuid=AY2dbDeC.

broadband and to auction those frequencies. The main obstruction, which the Italian government was struggling with, regarded the Italian market for regional broadcasting.[482]

Italy had 150/180 local television broadcasters in the digital dividend band, which have been allocated 10% of the auction proceeds as compensation for freeing spectrum frequencies.[483] Local broadcasters soon started complaining with the exiguity of the compensation and had to face up to a reality as of exhausting bureaucracy and inefficient institutions, which made almost impossible to defend their own rights.[484] They denounced a great disparity of treatment between them and national broadcasters.[485] Several negotiations between Agcom and the association representing Italy´s regional broadcasters were protracted and hindered progress on the digital dividend issue.[486]

The Italian government was asked to double the compensation from €240, required by the Stability Law No. 2011, to €480 million, meaning from 10% to 20% of the estimated income.[487] This request was never accepted, but the idea to eliminate the cup of €240 million came up. Given the results of the 4G auction, local broadcasters should have been compensated with €400 million, 10% of the effective revenue. But then, on 14 November 2011, a new Stability Law for year 2012 was adopted, which re-established the initial condition regarding the compensation amount.

Eventually, the Minister of Economic Development decided to reduce the compensation from €240 to €174.6 million, which would have been distributed among local broadcasters on the basis of certain specified criteria.[488]

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[482] J. Watson (2011). *Italian spectrum auction gets under way* (accessed June 2013), PolicyTracker, The Spectrum Management Newsletter. Available at: https://www.policytracker.com/headlines/italian-spectrum-auction-gets-under-way/?searchterm=GETS%20UNDER%20WAY.

[483] Federazione Radio Televisioni – FRT, settimanale di informazione sul settore radiotelevisivo della Federazione Radio Televisioni (2011), Year 18, No. 12, Rome, Italy. Available at: http://www.frt.it/allegati/newsletter/FRT%20Radio%20&%20Tv%20notizie%2012_2011%20-%2004%20aprile%202011.pdf.

[484] Federazione Radio Televisioni – FRT, settimanale di informazione sul settore radiotelevisivo della Federazione Radio Televisioni (2012), Year 19, No. 16, Rome, Italy. Available at: http://www.frt.it/allegati/newsletter/FRT%20Radio%20&%20Tv%20notizie%2016_2012%20-%2007%20maggio%202012.pdf.

[485] Federazione Radio Televisioni – FRT, settimanale di informazione sul settore radiotelevisivo della Federazione Radio Televisioni (2012), Year 19, No. 35, Rome, Italy. Available at: http://www.frt.it/allegati/newsletter/FRT%20Radio%20&%20Tv%20notizie%2035_2012%20-%2029%20ottobre%202012.pdf.

[486] GSM Association – GSMA (2012). Barriers. Removing Barriers: *Country Case Studies* (accessed June 2013), http://www.gsma.com/spectrum/wp-content/uploads/DigitalDividend/DDtoolkit/dd-allocations.html.

[487] Federazione Radio Televisioni – FRT, settimanale di informazione sul settore radiotelevisivo della Federazione Radio Televisioni (2011), Year 18, No. 24 Rome, Italy. Available at: http://www.frt.it/allegati/newsletter/FRT%20Radio%20&%20Tv%20notizie%2024_2011%20-%2004%20luglio%202011.pdf.

[488] Federazione Radio Televisioni – FRT, settimanale di informazione sul settore radiotelevisivo della Federazione Radio Televisioni (2011), Year 18, No. 43, Rome, Italy. Available at:

Thus, local broadcasters have been struggling for a fairer and more balanced compensation, but their efforts were paid back with less than what stated in the beginning.

Moreover, the Italian auction procedure was described as chaotic by Fitch Ratings Agency, which claimed that there was widespread confusion over how the process have worked.[489] However, Italy has been one of the first European countries to proceed with the auction of the 800 MHz band, following those of Germany, Sweden and Spain.[490] It has been completed ahead of schedule and been a great attainment, which put Italy at the forefront in Europe.[491]

8.3.4. Second digital dividend

Under the government of Prime Minister Silvio Berlusconi, the 700 MHz band is to be assigned free of charge to national TV broadcasters. On 8 July 2011 the final regulations on the procedure for assigning the 700 MHz band is published in No. 80 of the Official Gazzette (Resolution No. 497/10/CONS).

A beauty contest has to be held to allocate six digital terrestrial multiplexes to network operators for the purpose of establishing six national digital television networks. These six multiplexes have become available following analogue switch-off and are divided into three subsets named A, B and C, which included 3 (A1, A2 and A3), 2 (B1 and B2), and 1 (C1) multiplexes, respectively.[492] The choice of a beauty contest has been seen as the right solution to the infringement procedure set by EU.[493]

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http://www.frt.it/allegati/newsletter/FRT%20Radio%20&%20Tv%20notizie%2043_2011%20-%2019%20dicembre%202011.pdf.

[489] M. Newlands (2011). *"Chaotic" Italian super auction set to end by September 30* (accessed June 2013), PolicyTracker, The Spectrum Management Newsletter. Available at: https://www.policytracker.com/headlines/201cchaotic201d-italian-super-auction-set-to-end-by-september-30/?searchterm=chaotic

[490] M. Martino (2011). *Op. cit.,* supra footnote 477.

[491] M. Newlands (2011). *Italy holds Europe's most successful 4G auction to date* (accessed June 2013), PolicyTracker, The Spectrum Management Newsletter. Available at: https://www.policytracker.com/headlines/italy-holds-europe2019s-most-successful-4g-auction-to-date/?searchterm=italy%20holds;

Ministero dello Sviluppo Economico (2011). *Frequenze: chiusa gara 4G, incasso a 3,9 mld euro. Romani: "Risultato straordinario"* (accessed June 2013), http://www.sviluppoeconomico.gov.it/index.php?option=com_content&view=article&viewType=1&idarea1=593&idarea2=0&idarea3=0&idarea4=0&andor=AND&sectionid=0&andorcat=AND&partebassaType=0&idareaCalendario1=0&MvediT=1&showMenu=1&showCat=1&showArchiveNewsBotton=0&idmenu=2263&id=2020729.

[492] Autorità per le Garanzie nelle Comunicazioni – Agcom (2011). *Annual Report 2011 sull'attivita` svolta e sui programmi di lavoro* (accessed June 2013). Available at: http://www.agcom.it/Default.aspx?message=viewrelazioneannuale&idRelazione=27##;

Autorità per le Garanzie nelle Comunicazioni – Agcom (2010). *Attached A to Resolution No. 497/10/CONS Procedure per l'assegnazione delle frequenze disponibili in banda televisiva per sistemi di radiodiffusione digitale terrestre e misure atte a garantire condizioni di effettiva concorrenza*. Available at: http://www.agcom.it/Default.aspx?message=downloaddocument&DocID=5222.

[493] M. Mele (2011). *Frequenze tv, «serve più tempo»,* Il sole24ore – Italian daily newspaper (accessed June 2013), http://www.ilsole24ore.com/art/economia/2011-12-24/frequenze-serve-tempo-081420.shtml?uuid=Aaw0cMXE

Unlike auctions, participants are not ranked on the basis of the financial value of their tenders but on the basis of other criteria, such as technical infrastructure plan, marketing plan for broadcast services, company structure and experience in the field of e-communications.[494] Three different ranking are drafted, one for each subset.[495] An assignment free of charge is chosen in order to foster pluralism in the Italian television market.[496]

Eight out of the ten operators that submit applications before the 6 September 2011 deadline are accepted. They are Canale Italia srl, Telecom Italia Media Broadcasting srl, Elettronica Industriale spa (part of Mediaset group), Sky Italia Network srl, Prima Tv spa, Europa Way srl, 3lettronica Industriale spa and Radiotelevisione Italiana spa. Tivuitalia e Dbox are excluded.[497]

Later on, Sky Italia announces its decision to withdraw the request of participating to the contest. It states that the procedure is too slow to allow the participants to plan their investments in the long term. Moreover, it considers the rules of the procedure as unfair, arguing that they favour incumbent operators. In fact, on the basis of the criteria used, the best frequencies, those part of the 700 MHz band and contained in subset B, appears to be pre-assigned to the state-owned public broadcaster RAI and Silvio Berlusconi's Mediaset broadcasting company.[498]

The next administration of Prime Minister Mario Monti criticises the plan for once again benefitting incumbent broadcasters and the decision to assign without charge a scarce valuable public good as frequencies are.[499] A deep assessment of the beauty contest procedure is seen as a matter of urgency, given also Sky Italia's withdrawal from the contest, its objections and the

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[494] International Law Office Media & Entertainment (2011). *Italy Final regulations on the digital dividend beauty contest*. Available at: http://www.internationallawoffice.com/Account/Login.aspx?ReturnUrl=http%3a%2f%2fwww.internationallawoffice.com%2fnewsletters%2fdetail.aspx%3fg%3d815ed3de-c851-4d03-9f32-cecedffcd581.

[495] Autorità per le Garanzie nelle Comunicazioni – Agcom (2011). *Op. cit*., supra footnote 492.

[496] Federazione Radio Televisioni – FRT, settimanale di informazione sul settore radiotelevisivo della Federazione Radio Televisioni (2011), Year 18, No. 25 Rome, Italy. Available at: http://www.frt.it/allegati/newsletter/FRT%20Radio%20&%20Tv%20notizie%2025_2011%20-%2011%20luglio%202011.pdf.

[497] Federazione Radio Televisioni – FRT, settimanale di informazione sul settore radiotelevisivo della Federazione Radio Televisioni (2011), Year 18, No. 34, Rome, Italy. Available at: http://www.frt.it/allegati/newsletter/FRT%20Radio%20&%20Tv%20notizie%2034_2011%20-%2017%20ottobre%202011.pdf.

[498] Federazione Radio Televisioni – FRT, settimanale di informazione sul settore radiotelevisivo della Federazione Radio Televisioni (2011), Year 18, No. 41, Rome, Italy. Available at: http://www.frt.it/allegati/newsletter/FRT%20Radio%20&%20Tv%20notizie%2041_2011%20-%2005%20dicembre%202011.pdf;

D. Standeford (2012). *Italy ditches DTT spectrum beauty contest* (accessed June 2013), PolicyTracker, The Spectrum Management Newsletter. Available at: https://www.policytracker.com/headlines/italy-ditches-dtt-spectrum-beauty-contest/?searchterm=italy.

[499] TM News (2012). *Tv/Monti: Frequenze non possono essere date senza corrispettivo* (accessed June 2013), http://www.tmnews.it/web/sezioni/news/PN_20120120_00296.shtml.

international developments for the use of the 700 MHz band and the general adoption of auction procedure for the assignment process.[500]

Prime Minister Mario Monti states he would prefer to allocate spectrum by auction, but legislation sitting up the beauty contest has already been adopted and there is little time to make changes. Therefore, the administration suspends the assignment process via beauty contest shortly before its finalisation, which is eventually annulled. Agcom is asked to come up with auction rules to be applied.

The decision to auction the spectrum has been driven by WRC-12 decision for a co-primary allocation of the 700 MHz band to mobile service along with television broadcasting since 2016, and the related need to avoid rigid decisions that could affect any future use of the 700 MHz band. In this regard Italy considers worthwhile to associate rights of use lasting 5 years to the 700 MHz frequencies, while rights of use of 20 years are recognised for the other frequencies.

Moreover, Italy is in the spotlight in the context of the unending infringement proceeding opened by the EC against Italy, strongly criticised for its tendency to protect broadcasting incumbents' interests, to the detriment of a competitive environment.[501] Europe aims at opening the relatively closed structure of Italian television broadcasting sector for new entrants and smaller existing operators while ensuring the efficient use of spectrum. On 31 October 2012 the EC sends a letter to Agcom defining the solution Italy should implement in order to put an end to the infringement procedure started in 2006. Among other measures, Italy is asked to lay down an auction procedure.[502]

On 11 April 2013, Agcom in a press release states that the rules for the auction of the frequencies ex beauty contest have been unanimously approved and contained in Resolution No. 277/13/CONS.[503] With the aim to secure a more efficient use of the spectrum, to enhance competition in the television market and to leave room for future developments of the mobile service in accordance with international agreements, Agcom decides not to auction three out of the

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[500] M. Mele (2012). *Frequenze tv congelate, Mediaset attacca*, Il sole24ore – Italian daily newspaper (accessed June 2013), http://www.ilsole24ore.com/art/economia/2012-01-21/frequenze-congelate-mediaset-attacca-081320.shtml?uuid=AaKqCmgE.

[501] Corriere delle Comunicazioni.it (2013). *Maurizio Dècina: Riordino dello spettro radio* (accessed June 2013), http://www.corrierecomunicazioni.it/tlc/19013_maurizio-decina-riordino-dello-spettro-radio.htm; D. Standeford (2012). *Italy ditches DTT spectrum beauty contest* (accessed June 2013), PolicyTracker, The Spectrum Management Newsletter. Available at: https://www.policytracker.com/headlines/italy-ditches-dtt-spectrum-beauty-contest/?searchterm=italy.

[502] Autorità per le Garanzie nelle Comunicazioni – Agcom (2012). Resolution No. 550/12/CONS *Consultazione Pubblica sullo schema di provvedimento recante "procedura per l'assegnazione delle frequenze disponibili in banda televisiva per sistemi di radiodiffusione digitale terrestre e misure atte a garantire condizioni di effettiva concorrenza e a tutela del pluralismo ai sensi dell'art. 3-quinquies del Decreto-Legge 2 Marzo 2012, n. 16, convertito, con modificazioni, dalla Legge No. 44 del 26 Aprile 2012*. Available at: http://www.agcom.it/Default.aspx?message=downloaddocument&DocID=9716.

[503] Autorità per le Garanzie nelle Comunicazioni – Agcom, *Via libera alle regole per l'asta delle frequenze tv,* Press Release 11 April 2013. Available at: http://www.agcom.it/default.aspx?DocID=10898.

six multiplexes embraced by the previous beauty contest procedure. The multiplexes in question are those included in the 700 MHz band (channels 54, 55, 58 in the group U). To be clear, in Resolution No. 550/12/CONS the initial subsets (A, B and C) are reorganised in six new subsets subdivided in two groups, L which comprises frequencies under 700 MHz band and U which embraces frequencies within 700 MHz band.

Table 8. Six new subsets subdivided in groups L and U.

	Subsets	Channels
Group L Frequencies < 700 MHz	L1	Channels 6 – 7
	L2	Channel 25
	L3	Channels 23 – 24 – 28
Group U Frequencies > 700 MHz	U1	Channel 54
	U2	Channel 55
	U2	Channel 58

Source: Agcom (2012). Resolution No. 550/12/CONS Available at: http://www.agcom.it/Default.aspx?message=downloaddocument&DocID=9716.

The broad goal Agcom wants to achieve consists of defining a roadmap to re-farm the 700 MHz band, in order to make possible the auction of the upper part of the 700 MHz band (channels 57-60) for LTE services in the short term and to allow definite use of the lower part (channels 49-56) for television broadcasting services in the long term.
Moreover, Agcom will make temporary use of the digital dividend frequencies previously planned for DTT that are not included in the current procedure, for other purposes. In particular these frequencies will be necessary to improve the overall television system in particular the public service provided by RAI, with a view to the release of channels 57-60 by 2016 and to the planning and assignment of the remaining channels of the 700 MHz band by 2020.[504] Group L has been reorganised as shown in the underlying table:

[504] Autorità per le Garanzie nelle Comunicazioni – Agcom (2013). Resolution No. 277/13/CONS: *Procedura per l'assegnazione delle frequenze disponibili in banda televisiva per sistemi di radiodiffusione digitale terrestre e misure atte a garantire condizioni di effettiva concorrenza e a tutela del pluralism ai sensi dell'art. 3- quinquies del decreto-legge 2 Marzo 2012, No. 16, convertito, con modificazioni, dalla Legge No. 44 del 26 Aprile 2012*. Available at: http://www.agcom.it/Default.aspx?message=visualizzadocument&DocID=10903.

Table 9. Reorganization of Group L

Group L	
L1	Channels 6 - 23
L2	Channels 7 - 11
L3	Channels 25 – 59*

Note: Channel 59 will be substituted by another channel by 2016
Source: Agcom (2013). Resolution No. 277/13/CONS. Available at: http://www.agcom.it/Default.aspx?message=visualizzadocument&DocID=10903.

The reorganisation of the subsets has been designed to solve some issues emerged with the digital switchover. First of all international interference problems with neighbouring countries have to be faced, as Malta, Croatia, France and Slovenia have been complaining about signal disturbance. Other issues are related to interference problems between LTE services and television broadcasting using adjoining bands and there is also the necessity to improve national coverage by each of the subsets to be auctioned.
As a result of this decision, Italian television frequency plan will be adjusted on 22, instead of the previous 25, national television channels. Unlike the 800 MHz band auction, in this case not only local but also national broadcasters will suffer from a reduction in the amount of spectrum available for their services. Probably they will be forced to implement new technologies, such as DVB-T2 (DVB-T second generation), to provide the same services, which will require more investments. The extra cost involved will obviously be passed on to television users, which will need to buy new equipment in order to continue watching their favourite programs.
In response to the necessity to guarantee more competition and pluralism in the provision of contents, as also requested by the EC, the measures adopted regarding the auction allow only new entrants and small operators to access three blocks, while the other operators which already have two multiplexes, can access two blocks. Access to one multiplex is recognised to integrated operators, active on other platforms with a market share above 50% of pay-tv (e.g. Sky Italia). Operators that have three or more multiplexes are excluded. Thus, RAI, Mediaset and Ti Media do not have the requisites to join the auction. For this and other reasons both RAI and Mediaset showed their opposition against the auction rules and started legal actions right after Agcom had published the draft of the procedure.[505]

[505] Autorità per le Garanzie nelle Comunicazioni – Agcom (2013). *Op. cit.,* supra footnote 504;
P. Anastasio (2013). *Frequenze Tv, pronto il bando di gara*, Corriere delle Comunicazioni.it (accessed June 2013). Available at: http://www.corrierecomunicazioni.it/tlc/21370_frequenze-tv-pronto-il-bando-di-gara.htm;

The digital switchover is offering Italy the possibility of making more efficient use of its spectrum. The finalisation of the auction procedure, in view of this objective, is a step needed to complete the reorganisation of broadcasting spectrum.[506] Italy needs to seize this opportunity in order to fill a normative gap that has been characterising Italian television broadcasting sector for years. However, radical changes seem extremely difficult to happen. Television broadcasters do not want to pay for something they were getting for free. The opposition of operators like Mediaset could jeopardise the feasibility of the auction.[507]

Waiting for further developments and the achievement of a satisfying end, more comprehensive and exhaustive considerations will be developed in another place, taking into consideration the international trends in light of the upcoming WRC-15.

8.4. The UK and Italy: a comparison

8.1. Introduction

The purpose of this last section is to summarise the key findings outlined in the sections above, trying to highlight the main differences in the approach adopted by the UK and Italy, respectively, with regard to the digital dividend issue.

Il sole24ore – Italian daily newspaper (2013), *Non perdere tempo sulle frequenze* (accessed June 2013), http://www.ilsole24ore.com/art/commenti-e-idee/2013-04-12/perdere-tempo-frequenze-063952.shtml?uuid=Abt3TSmH;

Aeranti-Corallo, Teleradiofax, newspaper (2013), No. 8, 20 April 2013. Available at: http://www.aeranti.it/images/stories/teleradiofax/2013/TRFAX2013-08.pdf;

Federazione Radio Televisioni – FRT, settimanale di informazione sul settore radiotelevisivo della Federazione Radio Televisioni (2013), Year 20, No. 19, Rome, Italy. Available at: http://www.frt.it/allegati/newsletter/FRT%20Radio%20&%20Tv%20notizie%2019_2013%20-%2003%20giugno%202013.pdf;

Federazione Radio Televisioni – FRT, settimanale di informazione sul settore radiotelevisivo della Federazione Radio Televisioni (2013), Year 20, No. 4, Rome, Italy. Available at: http://www.frt.it/allegati/newsletter/FRT%20Radio%20&%20Tv%20notizie%2004_2013%20-%2028%20gennaio%202013.pdf;

Federazione Radio Televisioni – FRT, settimanale di informazione sul settore radiotelevisivo della Federazione Radio Televisioni (2013), Year 20, No. 2, Rome, Italy. Available at: http://www.frt.it/allegati/newsletter/FRT%20Radio%20&%20Tv%20notizie%2002_2013%20-%2014%20gennaio%202013.pdf;

Federazione Radio Televisioni – FRT, settimanale di informazione sul settore radiotelevisivo della Federazione Radio Televisioni (2012), Year 19, No. 7, Rome, Italy. Available at: http://www.frt.it/allegati/newsletter/FRT%20Radio%20&%20Tv%20notizie%2007_2012%20-%2020%20febbraio%202012.pdf.

[506] European Commission - EC (2012). *Op. cit.*, supra footnote 437.

[507] D. Standeford (2012). *Italy ditches DTT spectrum beauty contest* (accessed June 2013), PolicyTracker, The Spectrum Management Newsletter. Available at: https://www.policytracker.com/headlines/italy-ditches-dtt-spectrum-beauty-contest/?searchterm=italy.

8.2. Digital Terrestrial Television

Both the UK and Italy rely heavily on terrestrial broadcasting to receive television services, first using analogue and then digital technologies. Television services have traditionally been universally available in those countries, which can be considered as pioneers in introducing DTT services.[508]

Since the development of digital television, the UK has been playing a leading role within Europe, launching its own DTT services in 1998. Moreover, all the different digital broadcasting platforms have been developed: satellite, cable, the Internet and DTT. By the end of 2012, 98% of households started to receive digital television over any platforms, which makes the UK one of the countries in the world with the highest digital television penetration. However, 75% of households actually rely on digital terrestrial broadcasting.[509] These data highlight the role DTT platform will continue to play for television viewers in the UK at least in the middle-term, even though it might change in a more distant future.[510]

As early as 1999 the UK government announces its aim to fully abandon traditional analogue terrestrial television broadcasting in favour of DTT broadcasting to be realised since 2006. In 2005 the starting date of the switch-off is postponed until 2008 and, in accordance with the new plan set, the last analogue channels are turned off in 2012. The transition process is set on a regionally phased basis, similar to the one adopted by Italy. Even though the UK is well prepared, having conducted several studies and analyses, it cannot avoid the impacts of disagreements among sector players, political matters and unexpected events. For example in 2009/2010 delays are caused by a change of government. [511]

In Italy, DTT is introduced in 2001.[512] Digital terrestrial transmissions start in December 2003 when Mediaset begins broadcasting its services, followed soon after by RAI.[513] First attempts to transmit digital television via cable and satellite go back to 1994 and 1996 respectively, which however still have

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[508] D. Standeford (2012). *Italy ditches DTT spectrum beauty contest* (accessed June 2013), PolicyTracker, The Spectrum Management Newsletter. Available at: https://www.policytracker.com/headlines/italy-ditches-dtt-spectrum-beauty-contest/?searchterm=italy;
M. T. García Leiva (2008). *Op. cit.,* supra footnote 442.

[509] Office of Communications – Ofcom (2013). *Digital Television Update* (PowerPoint). Available at: http://stakeholders.ofcom.org.uk/binaries/research/tv-research/tv-data/dig-tv-updates/2012Q4.pdf.

[510] M. Newlands (2012). *Ofcom proposes 600 MHz for TV and 700 MHz for broadband* (accessed June 2013), PolicyTracker, The Spectrum Management Newsletter. Available at: https://www.policytracker.com/headlines/ofcom-proposes-600-mhz-for-tv-and-700-mhz-for-broadband?searchterm=ofcom+proposes+600+.

[511] Aetha (2011). *Op. cit.,* supra footnote 394.

[512] European Commission - EC (2004). *Op. cit.,* supra footnote 444.

[513] C. Colapinto, F. Papandrea (2007). *Op. cit.,* supra footnote 383.

limited penetration in Italy.[514] Just in recent years, Sky Italia, a satellite platform, has been increasing in viewing and shares.[515]

Looking at the digital switchover process, the Gasparri Law confirms 2006 as the deadline for the full transfer to DTT. However, as in the UK, also in Italy some delays occur, but finally the process starts in Sardinia in July 2008 and is completed on 4 July 2012 with the shutdown of the last analogue transmitters in Sicily.

In order to understand the different path traced by the UK and Italy, it is suffice to consider that the transition process in Italy involved more than 550 local channels.[516] While the UK does not have a well-developed regional television sector,[517] in Italy there is an extensive presence of local broadcasters, which has been favoured by a scarce regulation of the radio spectrum. In fact, proliferation of local private stations, which has led to an extremely chaotic situation, represents one of the main difficulties that slowed the adoption of DTT in Italy.[518]

As regards the regulator, in both countries a convergent and independent entity has been established for the regulation of communications industries. Ofcom, the UK regulator, is recognised for its independent and autonomous actions, highly coordinated with the European level. The UK authority approach to the digital switchover and, consequently, to the digital dividend has been characterised by several public consultations with the aim to reach consensus among stakeholders and make broadly agreed decisions. The interplay between authority and stakeholders is perceived as necessary in order to create the right conditions that would enable the achievement of long-term objectives.

Overall, the UK regulation appears minimalist and coherent, the Italian one chaotic and confused.[519] In this respect, Agcom, the Italian regulator, has been criticised for a certain degree of dependence from political power and lack of transparency in its decisions.[520] Moreover, in spite of active involvement by European regulators, Italian authority has often acted separately, in particular with regard to the evolution of the Italian television industry. In the plan for the launch of DTT services, while Community authorities have repeatedly acted

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[514] F. Colombo (2005). *Il digitale terrestre in Italia e la diffusione dell'innovazione,* Camera di Commercio di Milano, Impresa & Stato, la rivista nel 2005, Indice No. 70/2005. Available at: http://www.mi.camcom.it/il-digitale-terrestre-in-italia-e-la-diffusione-dell-innovazione.

[515] Fondazione Rosselli - Istituto di Economia e Media (2011). *L'industria comunicazione in Italia. Tredicesimo Rapporto IEM Gli investimenti pubblici nell'industrial culturale e delle telecomunicazioni*. Available at: http://culturaincifre.istat.it/sito/varie/2011_XIII_rapporto_IEM.pdf.

[516] Federazione Radio Televisioni – FRT, settimanale di informazione sul settore radiotelevisivo della Federazione Radio Televisioni (2012), Year 19, No. 24, Rome, Italy. Available at: http://www.frt.it/allegati/newsletter/FRT%20Radio%20&%20Tv%20notizie%2024_2012%20-%2009%20luglio%202012.pdf.

[517] M. T. García Leiva (2008). *Op. cit.,* supra footnote 442.

[518] A. D'Arma (2007). *Op. cit.,* supra footnote 382.

[519] M. T. García Leiva, (2008). *Op. cit.,* supra footnote 442.

[520] A. Di Corinto, A. Gilioli (2010). *I nemici della rete*. Milan, Italy: Biblioteca Universitaria Rizzoli.

against extension of market power by incumbent analogue operators into the digital television market, the initial Italian transition process was planned in a way that assigned privileged role to RAI and Mediaset, the two companies that have dominated the Italian television landscape for decades. Several regulatory attempts to enhance competition and break the existing duopoly have been circumvented by implementation delays and lax enforcement.[521] The infringement procedure, started in December 2007 by the EC, which found Italy legislative and administrative framework regarding television market not compliant with EU competition rules, is still on going. In all Europe, there are no other cases in any countries even comparable with the Italian television market. It is extremely closed and incumbents have always been safeguarded from a possible competitive environment, which could erode their dominant positions.[522]

8.3. First digital dividend

While the entire world was moving towards an allocation of the digital dividend to mobile service, Italy was keeping going straight ahead against the flow. Rules and regulations regarding the digital dividend have been introduced without a consistent strategy, systematically altered and for this reason developed in a fragmented way. The Italian Government has extensively influenced the management of the digital switchover, the allocation of the digital dividend and finally the assignment of frequencies. Decisions were often conditioned by political aims and mostly guided by short-term objectives. In this respect a clear case was the adoption of the National Digital Frequency Assignment Plan on June 2010 with Resolution No. 300/10/CONS. Even though WRC-07 conclusion to allocate the 800 MHz band to mobile service on a co-primary basis prompted national actions to re-farm UHF frequencies for mobile service, in Italy, the 800 MHz band was re-assigned to local broadcasters, supporting the idea of returning the spectrum to broadcasters after analogue switchover. This is a clear expression of a natural instinct to preserve the existing incumbents' hegemony.[523] With hindsight, allocating the 800 MHz band to broadcasting service was probably the fruit of a tendency to adopt provisional solutions easy to implement with no effort, avoiding the burden of defining a long-term and effective strategy.[524]

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[521] A. Brown, R. G. Picard (2008). *Digital Terrestrial Television in Europe*. New Jersey, USA: Lawrence Erlbaum Associates, pp. 317-334.

[522] L. Giacomello (2012). *Far West digitale: il paradosso delle tv locali* (Thesis, Ca' Foscari University, Venice, Italy). Available at: http://dspace.unive.it/bitstream/handle/10579/1550/816892-1163214.pdf?sequence=2.

[523] M. T. García Leiva, (2008). *Op. cit.,* supra footnote 442.

[524] Federazione Radio Televisioni – FRT, settimanale di informazione sul settore radiotelevisivo della Federazione Radio Televisioni (2010), Year 17, No. 44, Rome, Italy. Available at: http://www.frt.it/allegati/newsletter/FRT%20Radio%20&%20Tv%20notizie%2044_2010%20-%2020%20dicembre%202010.pdf.

Unlikely Italy, the UK was the first European country to identify and release a digital dividend to be used by services other than broadcasting. As early as 2003, the UK government identified the scope for 112 MHz to be made available for new uses, including the provision of mobile services.[525] The fact that the UK has started extremely early studying the issue of the digital dividend has caused some delays in the adoption of the approach emerging at European level. However, aware of the benefits that would have been gained from a European coordinated strategy, the UK revised its plans to incorporate the 800 MHz band. All the policies adopted were driven by objectives such as spectrum efficiency, maximisation of economic and social benefits for the society, promotion of a competitive environment. In fact, among other things, one of the reasons that delayed the auction procedure of the 800 MHz band was the difficulty Ofcom showed in deciding if the band should have been reserved or not for bidders other than O2 and Vodafone, the incumbents, in light of the objective to promote competition. Paradoxically, this sort of situation would have never been occurred in Italy, where delays were caused exactly by the opposite reason, meaning the strong tendency to protect broadcasting incumbents' interests by the government. Only because of the watchful eye of the EC, Italy forced itself to open the national television market up to new operators.

Moreover, in the UK a clear strategy was defined regarding the digital dividend, in particular in respect to the way in which this spectrum had to be awarded. The decision to adopt a market-based approach was emphasised very strongly since the beginning, seen as the mechanism proper for maximising the total value to society generated from the use of the spectrum. During the years before the auction of the 800 MHz band, Ofcom have been publishing an extensive number of detailed technical studies and cost-benefit analyses in order to determine the economic value of the digital dividend frequencies.

In Italy, there was and there still is no clear understanding of the value of this scarce and irreplaceable resource and of the negative effects of an inefficient use of it.[526] Moreover, there is no tradition of auctioning procedures and the previous UMTS and WiMax auctions didn't set the precedent for changing the approach towards radio spectrum. With regard to the 800 MHz band, Italy was convinced that these frequencies had to be returned to broadcasters after analogue switch-off, even though the entire world around it was moving towards an allocation to mobile service. Starting to feel the pressure from Europe, the Stability Law for 2011 was adopted, which included the decision to launch a public auction to allocate the 800 MHz band for mobile service. And actually Italy has been one of the first European countries to proceed with the

[525] Aetha (2011). *Op. cit.*, supra footnote 394.

[526] T. Valletti (2009). *Se lo Stato non vuole incassare il dividendo digitale* (accessed June 2013), http://archivio.lavoce.info/binary/la_voce/articoli/cache_pdf/SE-LO-STATO-NON-VUOLE-INCASSARE-IL-DIVIDENDO-DIGITALE-1001077.pdf.

auction, which has been a great success, exceeding Italian government's expectations in terms of revenues. The 800 MHz band was the most expensive among the auctioned bands and this result testifies how mobile operators were eager to bag some of these frequencies to deploy their services.

8.4. Second digital dividend

With regard to the second digital dividend, Italy showed again its lack of insight into the economic value of the radio spectrum, and its tendency to suit the interests of incumbent broadcasters, with the decision to assign the 700 MHz band free of charge by means of a beauty contest procedure whose rules were favouring incumbent operators. In fact, on the basis of the criteria used, the 700 MHz band appeared to be pre-assigned to the state-owned public broadcaster RAI and Silvio Berlusconi's Mediaset broadcasting company. This is one of the reasons that led Sky Italia to announce its withdrawal from the contest. It is worth noting that the decision for a beauty contest was taken under government of Prime Minister Silvio Berlusconi. Then, he severely criticised the decision of the next administration of Prime Minister Mario Monti to annul the assignment process via beauty contest and apply auction rules. Again, Italy has been scolded by Europe, which recommended vigorously the adoption of an auction procedure. Only in this way it was possible to put an end to the infringement procedure started because of the excessive closed structure of Italian television broadcasting and open the way to new entrants. Eventually, Agcom decided not to auction the 700 MHz band. It will be reserved for mobile service, in light of the international trend and the policies adopted at European level.

The Italian approach is a clear demonstration of the ingrain passive attitude of Italian government to keep going ahead on its direction, ignoring the developments at international and European level, until it cannot do otherwise. National decision policymaking process was often driven by interests other than those relating to spectrum efficiency, innovation and development of a competitive environment. In pursuing short-term objectives, Italian government sometimes seemed to ignore the consequences of its actions. The 700 MHz frequencies will be taken from broadcasters to be allocated to mobile service, but not quite enough attention has been paid on how the effects of this measure will impact on television operators. The struggle of regional broadcasting operators, which characterised the first digital dividend, did not teach any lesson.

If anything, Ofcom is at the forefront again on the second digital dividend issue, already working on a solution to conciliate broadcasters' and mobile operators' interests.[527] It seems that Ofcom has already in its hands the right

[527] M. Newlands (2012). *Ofcom proposes 600 MHz for TV and 700 MHz for broadband* (accessed June 2013), PolicyTracker, The Spectrum Management Newsletter. Available at:

answer to the tough question put by WRC-12 and which will require a clear response at the upcoming WRC-15.

Simply, in order to clear the 700 MHz band, which will be allocated on a co-primary basis to mobile service since 2016, Ofcom is studying the possibility to move the broadcasting service on the 600 MHz band, making possible the allocation of the 700 MHz band to mobile broadband. In a recent article published by PolicyTracker, the newsletter devoted to spectrum management and policy, it can be read that broadcasters seem to agree with moving from the 700 MHz band to the 600 MHz, looking at this possible re-allocation as a crucial change needed to keep pace with the development of the ICT sector.[528] Aware of the fact that constraints on the use of the 600 MHz band at the international and national level must be faced, Ofcom is already carrying out studies and negotiating agreements in order to make the DTT transition feasible.

On the contrary, in Italy broadcasting operators are showing strong opposition. They cannot accept the fact that technological progress is changing the rules of the society and that in the new mobile-driven environment their position cannot be preserved unchanged.

8.4. Conclusions

While there is wide agreement on the need for more spectrum for the development of wireless technologies, Europe will have to face many obstacles in pursuing its objective of a harmonised spectrum usage across its territory. As the cases of the UK and Italy can show, EU Member States differ from each other in terms of internal specific conditions, such as geography configuration, political situation and spectrum management history. Europe's common policy must balance the needs of developing mobile broadband services and, at the same time, the interests of existing spectrum users in a fragmented and uneven context.

The UK is working actively towards international harmonisation and release of the 700 MHz band for mobile broadband, while safeguarding the future of DTT by making available the 600 MHz band. However, disagreements are arsing in particular in the broadcasting sector. The BBC considers releasing the 700 MHz band as a hasty decision. It asserted that the current mobile consumption does not require additional spectrum to be released for mobile services, whose deployment on the 800 MHz band has not even started. Moreover, the transition of broadcasting services from the 700 MHz band to the 800 MHz band will impose extra cost to end-users forced to buy new

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https://www.policytracker.com/headlines/ofcom-proposes-600-mhz-for-tv-and-700-mhz-for-broadband?searchterm=ofcom+proposes+600+.

[528] T. Telep (2013). *TV makers seem unconcerned about move from 700 MHz* (accessed June 2013), PolicyTracker, The Spectrum Management Newsletter. Available at: https://www.policytracker.com/headlines/tv-manufacturers-not-concerned-about-move-from-700-mhz?searchterm=tv+makers+seem.

equipment. A more detailed and careful analysis is trumpeted in order to secure the achievement of a win-win solution. However, the 700 MHz issue is still on-going. It is considered one of the toughest challenges in the spectrum management field of recent years, which will have disruptive effects on radio spectrum usage and technological development trends. Europe should accurately arm itself for the forthcoming WRC-15, enhancing its role in order to ensure that all EU Member States, including those more reluctant such as Italy, will share European longer-term view on the future use of the spectrum.[529]

[529] J. Watson (2013). *PolicyTracker Monthly edition: July 2013* (accessed June 2013), PolicyTracker, The Spectrum Management Newsletter. Available at: https://www.policytracker.com/headlines/the-policytracker-monthly-edition-july-2013/?searchterm=July%202013.

9. Implications for future research

It should be quite clear that radio spectrum is an extremely valuable scarce resource for which demand is growing quickly along with the rise of innovative services, such as mobile broadband.

Mobile Internet is considered a disruptive technology, given its potential to transform life, business and the global economy, giving rise to new ways of understand, perceive and interact with and within the world. Mobile Internet technologies are rapidly advancing and experiencing everyday breakthroughs.

Even though the use of the Internet is already widespread, its scope of impact is even broader and not yet realised. However the economic and social benefits of mobile Internet usage may not be fully reached if sufficient spectrum capacity cannot be made available. [530]

The allocation of the first digital dividend to mobile service has been one of the most relevant events that has revolutionised spectrum management worldwide.[531] Nowadays, countries included in ITU Region 1 are setting the stage to face another challenge: that of the reallocation of the second digital dividend. Moreover, the international wish is to identify additional spectrum to be allocated for the mobile service, in order to facilitate the development of terrestrial mobile broadband applications. The question now arising is: how can additional spectrum be freed up for mobile services?

The Federal Communication Commission (FCC), the US telecommunications regulatory agency, which regulates interstate and international communications by radio, television, wire, satellite and cable, recognises incentive auctions as an innovative means to face the problem of spectrum need for mobile services.[532]

An incentive auction is a market-based mechanism to clear incumbent spectrum licensees and assign new licences. The idea underlying this type of auction is encouraging existing broadcast television licensees to give up spectrum usage rights on a voluntary basis in exchange for a share of the proceeds from an auction of new licences to use the freed-up spectrum.

The auction is seen as a significant financial opportunity for many broadcasters, which could thereby have the means to invest in the development of new television technologies for a more efficient use of the spectrum. At the

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[530] McKinsey Global Institute (2013), *Disruptive technologies: Advances that will transform life, business, and the global economy*, McKinsey and Company. Available at: http://www.mckinsey.com/insights/business_technology/disruptive_technologies.

[531] J. L. G. Barroso, A. Mochon, Y. Saez, C. Feijo (2012). *Simulating digital dividend auctions: Service neutrality versus dedicated licences*. Telematics and Informatics, Vol. 29, Iss. 1, February 2012, pp. 11–25. Available at: http://www.sciencedirect.com/science/article/pii/S0736585311000426.

[532] Federal Communications Commission – FCC, *Incentive Auctions* (accessed July 2013), http://www.fcc.gov/incentiveauctions.

same time the released spectrum could be used for deploying mobile broadband.

The FCC structured the incentive auction in three interdependent parts:

- a "reverse auction" by means of which broadcasters decide their prices to voluntarily relinquish spectrum rights in exchange for payments;
- a "repacking" of the broadcast television bands, which involves reorganising and assigning channels to the remaining broadcast television stations still on the air in order to release frequencies in the UHF spectrum to be allocated to the mobile service;
- a "forward" auction of the amount of spectrum made available as a result of the two previous sections where potential users can compete for new initial licences.

The US is a pioneer in this field as its broadcast television spectrum incentive auction has been the first attempt worldwide, whose proceeding was launched by the FCC in October 2012. Moreover, its unprecedented structure makes the above incentive auction the first two-sided spectrum incentive auction in the entire world.

The uniqueness and complexity of this process instill several doubt regarding its feasibility and success. For instance, the number of broadcasters that will participate and the amount of spectrum that will be freed-up are uncertain. Moreover there are concerns related to the auction methodology and the impact on existing broadcasting stations which will choose not to take part in the auction, for example in terms of interference problems and reduction of coverage areas and population served. The way the released spectrum will be valued and the broadcasters' compensations will be determined are difficult to determine as well.

It will be interesting to follow the development of this process, which must be concluded by 2022 by Statute.[533] Therefore, it would be quite challenging to investigate the possibility of an incentive auction in Europe, bearing in mind that, among other issues, in contrast to the US, in many European countries, DTT is the primary means of delivering television and there is evidence of demand for additional DTT services despite the availability of other platforms, such as the Internet, cable and satellite.

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[533] Federal Communications Commission – FCC, Stuff Summary, *The broadcast television spectrum incentive auction* (accessed July 2013), http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-318455A1.pdf;

Federal Communications Commission – FCC (2012). Commission document: *Broadcast Television Spectrum Incentive Auction NPRM* (accessed July 2013), http://www.fcc.gov/document/broadcast-television-spectrum-incentive-auction-nprm;

Federal Communications Bar Association – FCBA (2013). *Panel on the FCC Incentive Auction Proceeding at T-Mobile NYC on June 5 2013* (accessed July 2013), http://www.youtube.com/watch?v=tKJeL2AYZjE.

In order to meet the increasing demand for mobile broadband, the FCC is also working on spectrum sharing models.[534] The same path is followed by Europe. In fact, the recent mandate issued to CEPT by the EC also aims at studying the possibility of shared spectrum use between mobile broadband and other incumbent uses. The considerable growth of spectrum demand for mobile broadband has unveiled the impossibility for the available spectrum to meet the needs of future technologies. This calls for a change in the spectrum management to create a dynamic and flexible use of the spectrum. In this respect, spectrum sharing offers a potential solution to addressing the problem of spectrum scarcity, maximising the use of under-utilised bands.[535]

New and smarter technologies allow overcoming the interference problem, eliminating the necessity of assigning channels to specific users, as more applications may be able to share the same spectrum band. For instance, Cognitive Radio (CR) systems may be able to continuously monitor and detect unused spectrum potions, dynamically use free parts of spectrum and timely release them when a primary user starts to transmit on those frequencies. Therefore, spectrum policy reforms need to be implemented in order to introduce new forms of spectrum sharing, in particular in terms of usage rights.

There is a lot of scepticism regarding the effective potential of spectrum sharing, as related technologies still exist in embryonic form, which makes their performances uncertain, and long-term investments are required for governments and industries.[536] Moreover, more coordination will be needed between services. However, given the fact that spectrum demand for mobile services is expected to grow in the future (under a mid-level growth scenario, mobile data capacity demand will experience an 80 fold increase between 2012 and 2030, and a 300 fold increase under a high-growth scenario), implementing dynamic spectrum sharing approaches could be seen as a successful long-term strategy.

An ambitious goal would be answering the question why dynamic spectrum management is a promising and viable solution to the spectrum scarcity problem and how spectrum management can be reformed in order to promote the adoption of dynamic spectrum sharing technologies.

In the figures 27 and 28 here below the reasoning underlying the above research questions is summarised.

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[534] Federal Communications Commission – FCC (2012). Commission document: *Enabling Innovative Small Cell Use in 3.5 GHZ Band NPRM & Order* (accessed July 2013), http://www.fcc.gov/document/enabling-innovative-small-cell-use-35-ghz-band-nprm-order.

[535] InterDigital (2012). White Paper: Dynamic Spectrum Management. *Spectrum harvesting through the allocation and aggregation of contiguous and non-contiguous licensed, unlicensed, and TV white space frequency channels*. Available at: http://www.interdigital.com/wp-content/uploads/2012/10/InterDigital-DSM-White-Paper_Oct2012.pdf.

[536] Rysavy Research (2012). Spectrum Sharing. *The promise and the reality*. Available at: http://www.rysavy.com/Articles/2012_07_Spectrum_Sharing.pdf.

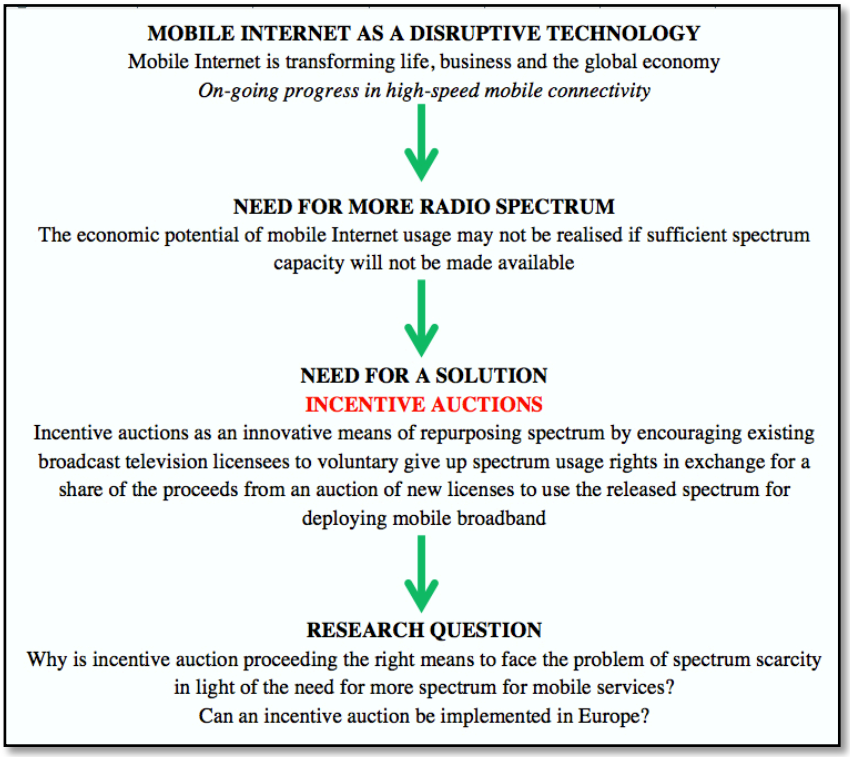

Figure 27. Research question: incentive auction

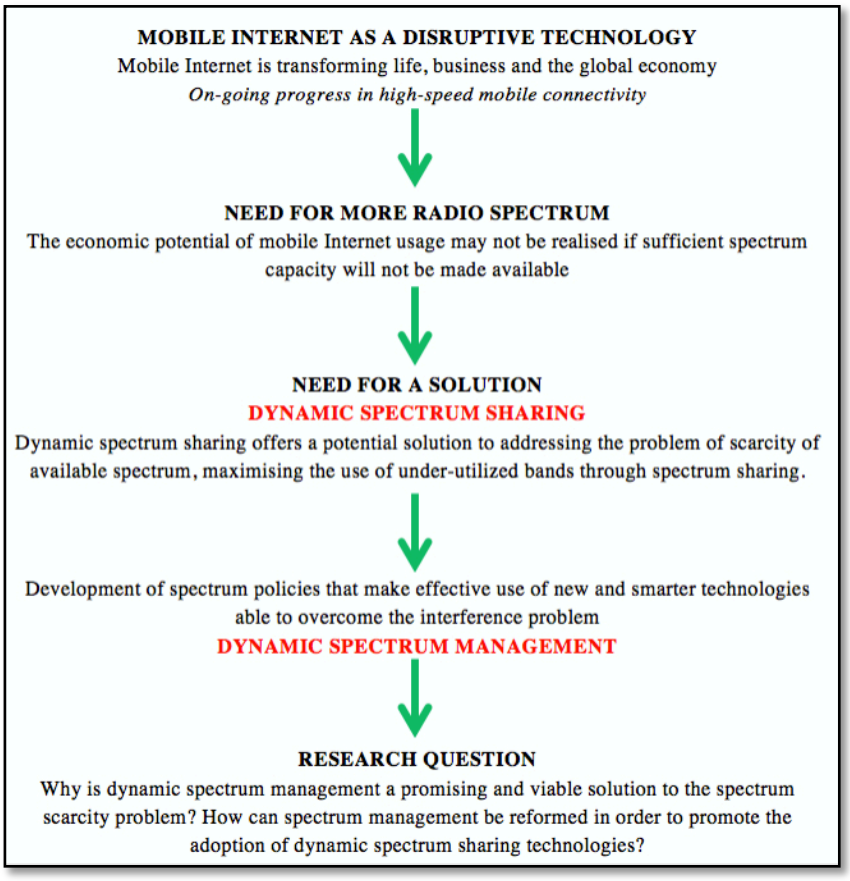

Figure 28. Research question: dynamic spectrum sharing

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