IESE Business School
University of Navarra

Public-Private Sector
Research Center

Occasional Paper
OP-259-E
Rev. 4/2014

REALLOCATING THE 700 MHz BAND: SHOULD WE DO IT?

Juan Delgado

IESE Occasional Papers seek to present topics of general interest to a wide audience.

IESE Business School – University of Navarra
Av. Pearson, 21 – 08034 Barcelona, Spain. Phone: (+34) 93 253 42 00 Fax: (+34) 93 253 43 43
Camino del Cerro del Águila, 3 (Ctra. de Castilla, km 5,180) – 28023 Madrid, Spain. Phone: (+34) 91 357 08 09 Fax: (+34) 91 357 29 13

The Public-Private Sector Research Center is a Research Center based at IESE Business School. Its mission is to develop research that analyzes the relationships between the private and public sectors primarily in the following areas: regulation and competition, innovation, regional economy and industrial politics and health economics.

Research results are disseminated through publications, conferences and colloquia. These activities are aimed to foster cooperation between the private sector and public administrations, as well as the exchange of ideas and initiatives.

The sponsors of the Public-Private Sector Research Center are the following:

- Ajuntament de Barcelona
- Departament d' Economia i Coneixement de la Generalitat de Catalunya
- Departament d' Empresa i Ocupació de la Generalitat de Catalunya
- Diputació de Barcelona
- Fundació AGBAR
- Institut Català de les Empreses Culturals (ICEC)
- PricewaterhouseCoopers
- Sanofi
- FGC

REALLOCATING THE 700 MHz BAND: SHOULD WE DO IT?

Juan Delgado[1]

Abstract

The proposal to evaluate the reallocation of the 700 MHz spectrum band in Europe, Africa and the Middle East from broadcasting services to mobile communications, presented during the last World Radiocommunication Conference in 2012, aimed to respond to the increasing demand for mobile broadband and the need to harmonize spectrum use across the world. The final decision is still subject to subsequent analysis and future potential adoption by national governments and the European Union. As this paper shows, this decision requires a careful analysis since, first, the amount of spectrum required for mobile broadband and, most importantly, the timing of the demand are uncertain and, second, the reallocation is not without costs since the 700 MHz band is currently being used in several countries for digital terrestrial television and other services. Assigning too much spectrum to mobile broadband too early at a high cost would lead to an inefficient outcome. A truly efficient allocation of the spectrum would require a more accurate picture of the current use, the exploration of alternative policy and technology options and the promotion of secondary markets for spectrum trading.

[1] Founder and director of R&P Economics and former chief economist for the Spanish Antitrust Agency, CNC. Financial support from Abertis is gratefully acknowledged. The author thanks Lluís Borrell for his comments and suggestions and Jaime Pingarrón for his research assistance. The ideas and opinions in this paper, as well as any errors, are exclusively of the author.

REALLOCATING THE 700 MHz BAND: SHOULD WE DO IT?

Executive Summary

Discussions have started about the so-called "second digital dividend," the reallocation of the 700 MHz band (694-790 MHz), which is primarily assigned to broadcasting, to mobile broadband (MBB). The last World Radiocommunication Conference (WRC) in 2012 decided to initiate the technical assessment to allocate the 700 MHz band for mobile services in Europe, Africa and the Middle East. Harmonization work at the international and European levels is under way, but several uncertainties remain.

In order to assure that the final decision regarding the "second digital dividend" contributes to a more efficient spectrum use, it is essential to consider the three issues at stake:

1. **The future spectrum demand for MBB is uncertain**: It is not certain what the future evolution and magnitude of spectrum demand for MBB will be. The projections differ depending on the source and, in some cases, they have been revised substantially. The increasing use of alternative wireless technologies such as Wi-Fi and the more efficient use of the existing spectrum makes spectrum demand for MBB difficult to predict and, more importantly, increases uncertainty making it riskier (and probably unnecessary) to adopt early decisions about changing the 700 MHz band allocation.

2. **The current role of DTT and the future needs for spectrum differ across countries**: The 700 MHz band is partly being used in some countries for terrestrial digital broadcasting, so reallocating it to mobile services would require finding extra spectrum for DTT to keep the platform competitive and to deliver a universal TV service. Otherwise, the broadcasting of existing TV channels and the development of new TV formats such as HDTV would be at risk.

3. **There is little information about the level of efficiency and current use of the spectrum**: There is hardly any data about actual spectrum use. Once the spectrum is allocated, there is limited or no effective monitoring on whether the spectrum is being used efficiently (i.e., degree of usage). Ex-post efficiency cannot be verified by regulators and policy makers.

The release of the 700 MHz band for MBB communications is proposed under the assumption that the reallocation of underutilized frequencies to MBB, where demand is increasing, and the harmonized use of such band will increase global welfare.[1] However, the analysis of the impact on welfare is not trivial since, first, the magnitude of MBB demand increase is uncertain and, second, UHF frequencies play an important role in DTT broadcasting and in the future development of HDTV. Moreover, since there is not a clear picture of the current usage of

[1] See "WRC-12: Allocating terrestrial frequencies to mobile services," DigiTAG Web Letter, February 2012. Available at http://www.digitag.org/WebLetters/2012/External-Feb2012.html.

the spectrum, policy makers do not have sufficient information to carry out a reallocation of the spectrum that guarantees a positive contribution to global efficiency and welfare. Under this setting, adopting early decisions on the reallocation of the 700 MHz band might not necessarily lead to a more efficient outcome.

Policy Recommendations

Given the existing trade-offs involved in the decision to reallocate the 700 MHz band for MBB and the difficulties in assessing them with a sufficient level of accuracy, assigning too much spectrum to mobile broadband too early at a high cost would lead to an inefficient outcome. A truly efficient allocation of the spectrum would require a more accurate picture of the current use of the spectrum, the exploration of alternative policy and technology options and the promotion of secondary markets for spectrum trading.

1. **Assess the efficiency of current spectrum usage:** Further development in the EU inventory of existing uses of spectrum should be made in order to identify how the spectrum is actually being used and whether the allocated spectrum is used efficiently. This will expand the policy options and will allow policy makers to relax existing trade-offs contributing to increasing welfare.

2. **Explore the possibilities of unlocking underutilized parts of the spectrum:** Governments can start by releasing non-commercial spectrum (such as the military spectrum), which is kept for public purposes but not used efficiently. Also, efficiency in usage of spectrum could be improved by regulating white spaces, which are kept deliberately empty by TV operators in order to avoid interferences.

3. **Promotion of new technologies that make a more efficient use of the spectrum:** Governments should support new technologies to make better use of the existing spectrum and to free up frequencies, such as full duplex signals that allow radio devices to transmit and receive signals in the same frequency, and spectrum sharing and pooling technologies that allow for the use of the same spectrum by several users through allocation mechanisms.

4. **Favor market solutions:** Spectrum allocation mechanisms can guarantee efficient allocation at a specific moment in time but do not guarantee that such efficient allocation holds if there are changes in technology or in supply and demand conditions. Secondary markets complement initial allocation mechanisms and guarantee the efficient use of spectrum through trading, as they allow the change of usage of the spectrum following the forces of supply and demand.

I. Introduction

The discussion about the so-called "second digital dividend" has started at the European and world level. The second digital dividend refers to the harmonization and reallocation of the 700 MHz spectrum band (694-790 MHz) within the known and valuable UHF band, which was primarily assigned to broadcasting, to mobile broadband (MBB).[2] Harmonization work at the international and European levels is under way but several uncertainties remain. First, the amount of spectrum required for MBB[3] and the timing of spectrum demand are uncertain, and second, the reallocation is not without costs since the 700 MHz band is currently being used in several countries for digital terrestrial television (DTT) and other uses such as program-making and special events. There exists the risk of assigning too much spectrum and too early to MBB at a high cost leading to an inefficient outcome. Such risk is even higher given the lack of knowledge of the current usage of the spectrum. This paper analyses the trade-offs involved in the reallocation of the 700 MHz band and proposes several measures to guarantee that any further reallocation of the spectrum leads to an increase in global efficiency.

The European Commission required all European Union member states to make the 800 MHz band (790-862 MHz) available for mobile broadband services by January 1, 2013.[4] The so-called "first digital dividend" was justified under the argument that the switchover from analogue to DTT freed up a very large amount of radio spectrum that could therefore be reallocated for mobile communications, where demand for spectrum was increasing.

According to the Commission, the spectrum used to broadcast analogue television "is particularly attractive because it is part of the 'best' spectrum located between 200 MHz and 1 GHz, offering an optimal balance between transmission capacity and distance coverage."[5] The reality proved not to be without costs because part of the freed frequencies had already been assigned for other uses, such as digital broadcasting, and the switchover involved a previous reallocation of the spectrum. The transition was then not so straightforward. Acknowledging such realities, the European Commission has recently granted a number of extensions to several Member States in order to reorganize their spectrum to materialize the benefits.[6] The first digital dividend was therefore not absent of costs but the global balance was likely to be positive for social welfare due to a more efficient use of the spectrum and to a harmonized use across countries.

---

[2] Although the term "second digital dividend" is commonly used as opposed to the "first digital dividend," they are different in nature: while the benefits from the so-called "first digital dividend" arose from the harmonization and more efficient use, due to the use of digital transmission technologies, of the 800 MHz (790-862 MHz) band, the benefits from the second dividend would only come from harmonization.

[3] For the purposes of this paper, we will use the term wireless broadband (WBB) to refer to all wireless broadband technologies (xDSL, Wi-Fi, satellite, etc.) and the term mobile broadband (MBB) to denote only mobile services with licensed spectrum.

[4] Decision 243/2012/EU of the European Parliament and of the Council establishing a multi-annual radio spectrum policy program (RSPP).

[5] European Commission (2007), p. 4.

[6] In particular, Spain, Cyprus, Lithuania, Hungary, Malta, Austria, Poland, Romania and Finland. See EC Press Release "Europeans suffering because most Member States are too slow delivering 4G mobile broadband spectrum." Brussels, July 23, 2013.

Discussions have started about the so-called "second digital dividend" related to the reallocation of the 700 MHz band (694-790 MHz) to MBB. The last World Radiocommunication Conference (WRC) in 2012 decided to initiate the technical assessment to allocate the 700 MHz band for mobile services (on a co-primary basis alongside broadcasting) in Region 1 (Europe, Africa and the Middle East). In the next WRC in 2015, the technical feasibility of the reallocation will be analyzed and, following the results of such analysis, a proposal to reallocate (or not) such spectrum band and the relevant technical conditions will be formulated. Then, national governments (or the EU in the case of an EU harmonized decision for EU countries) would have subsequently to decide whether or not to adopt and implement the WRC decision.

In March 2013 the European Commission issued a mandate to the European Conference of Postal and Telecommunications Administrations (CEPT) to develop a set of common conditions for use of the 700 MHz band by mobile broadband.[7]

In the case of the reallocation of the 700 MHz band the trade-offs are stronger than in the "first digital dividend": on the one hand, the reallocation costs are higher especially in those countries such as Spain, France, the United Kingdom and Italy where DTT plays a major role and is currently using the 700 MHz spectrum. In such countries, the release of such spectrum might not only limit the number of TV channels but might also put at risk the development of better definition TV formats such as high and ultra high definition television (HDTV and UHDTV, respectively), which initially require more spectrum.[8]

On the other hand, the benefits are uncertain since future demand for MBB and the timing of such demand are uncertain. There is industry consensus on the fact that that demand will be increasing but not on the magnitude of such increase or its split between mobile spectrum (below 1 GHz) and other wireless technologies spectrum (above 1 GHz). Moreover, Cisco's recent substantial downward revision of its mobile data traffic estimates,[9] especially for Europe, shows that uncertainty about future demand is still significant.[10] Cisco's revision responds to more accurate estimates regarding the determinants of mobile data traffic such as the evolution of next-generation Wi-Fi, the evolution of compression technologies and the relative pricing of wire vs. wireless communications.

Given the likely high costs and the uncertain benefits, this paper analyzes whether the evidence available provides a solid base to reallocate efficiently the 700 MHz band after 2015 and provides policy recommendations for a more efficient spectrum use and allocation over time.

---

[7] European Commission, Radio Spectrum Committee, Working Document RSCOM12-37rev3, Feb 20, 2013, "Mandate to CEPT to develop harmonized technical conditions for the 694-790 MHz ('700 MHz') frequency band in the EU for the provision of wireless broadband electronic communications services and other uses in support of EU spectrum policy priorities."

[8] According to Brugger and Gbenga-Ilori (2009), the digital transmission capacity needed to deliver HDTV depends on a number of factors among which are: the type of compression used; the degree to which picture impairments are acceptable and whether the HDTV signal is part of a statistical multiplex. Advances in the compression technology might reduce spectrum requirements in the medium term.

[9] See Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2012–2017, at http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-520862.html.

[10] See "CISCO slashes its mobile data forecasts, but the numbers still look far too high," Analysys Mason, February 15, 2013. Posted at http://www.analysysmason.com/About-Us/News/Insight/Cisco-mobile-data-forecasts-Feb2013/#.UjTvSWT-Ihc.

The paper assesses the trade-offs involved in the potential decision about the so-called second digital dividend, i.e., the release of 700 MHz band for MBB services, given the current state of play and the future demand for TV and MBB services. Based on the analysis of such trade-offs, the paper provides policy recommendations for a more efficient allocation and use of the spectrum.

The paper starts by presenting the current state of play of the spectrum allocation and the future uncertainties about spectrum demand for different usages – mainly broadcasting, mobile and Wi-Fi. The next section evaluates the trade-offs involved in the decision about the release of the 700 MHz band for MBB. Finally, the final section provides policy recommendations in view of the evidence analyzed.

II. Facts

To analyze the policy options available and to make sure that any decision regarding the allocation of the spectrum contributes to national, European and global efficiency, it is essential to have a clear picture of the current allocation and usage of the spectrum and of the future demand across usages. In particular, for the reallocation of the 700 MHz band in Europe the relevant factors at stake are:

1. **The future spectrum demand for MBB is uncertain:** It is not certain what the future evolution and magnitude of spectrum demand for MBB will be. The projections differ depending on the source and, in some cases, they have been revised substantially. The increasing use of alternative wireless technologies such as Wi-Fi and the more efficient use of existing spectrum makes spectrum demand for MBB difficult to predict and, most importantly, increases uncertainty making it riskier (and probably unnecessary) to adopt early decisions about changing the 700 MHz band allocation.

2. **The current role of DTT and the future needs for spectrum differ across countries:** The 700 MHz band is being used in all Region 1 countries for terrestrial digital broadcasting, so reallocating it to mobile services would require finding extra spectrum for DTT to keep the platform competitive and delivering a universal TV service. Otherwise, the broadcasting of existing TV channels and the development of new TV formats such as HDTV would be at risk.

3. **There is little information about the level of efficiency and current use of the spectrum:** There is hardly any data about actual spectrum use. Once the spectrum is allocated, there is limited or no effective monitoring on whether the spectrum is being used efficiently (i.e., degree of usage). Ex-post efficiency cannot be verified by regulators and policy makers.

The following subsections analyze each of these elements in detail:

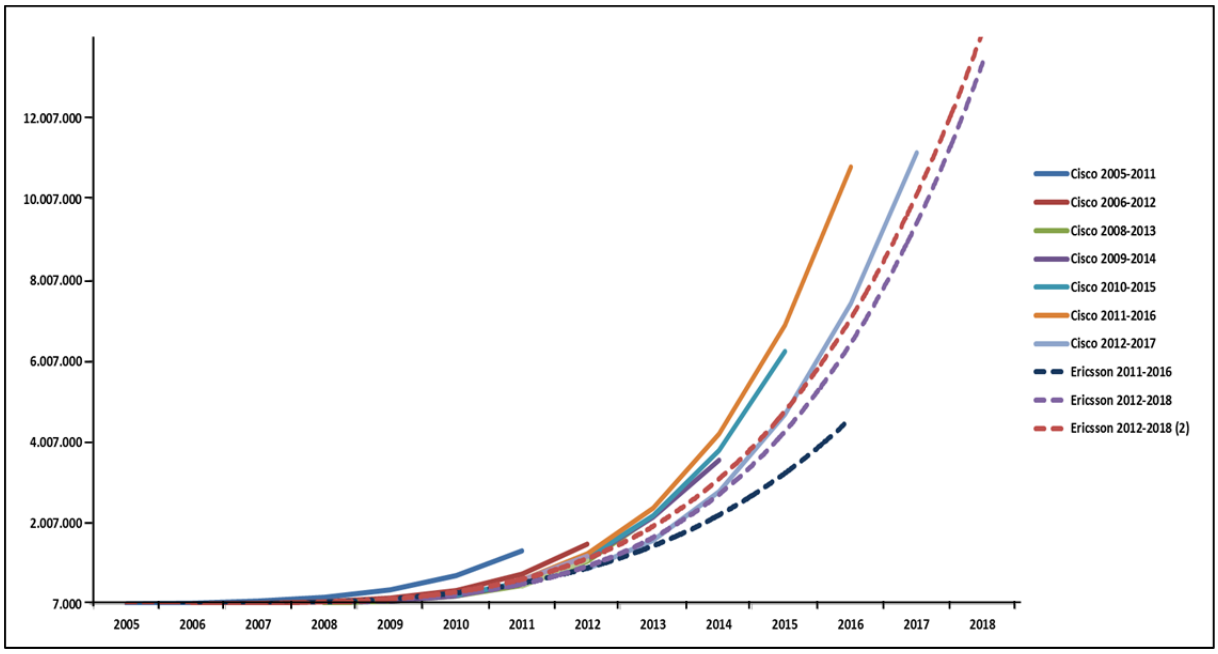
1. The Future Spectrum Demand for MBB is Uncertain

The main argument for the reallocation of the 700 MHz band is the need for spectrum for MBB. However, the evolution of MBB demand is uncertain. On the one hand, demand estimates differ substantially depending on the industry source. On the other hand, demand estimates have been recently revised downwardly. For example, the most recent global demand estimates for 2016 are

7.43 million TB/month according to Cisco, whereas they are 4.6 million TB/month according to Ericsson (see Figure 1). Discrepancies are large and there is no reliable official data to validate industry estimates.[11] Demand estimates have changed year after year. Traditionally, they have been corrected upwardly. For example, Cisco's estimates for 2014 were 3.5 million TB/month in 2009, 3.8 million TB/month in 2010 and 4.2 million TB/month in 2011 (see Figure 1). However, in February 2013 Cisco corrected its estimates dramatically: the new estimate for 2014 was 2.8 million TB/month, which implied a reduction of one-third with respect to the previous year's estimate.

Cisco's new estimates are now closer to Ericsson's, which were initially much more pessimistic (see Figure 1). Cisco's correction responds to the increasing lack of correlation between mobile devices demand and demand for spectrum for MBB. The increasing use of Wi-Fi connectivity by mobile devices has broken such correlation. Nowadays, 70% of Internet traffic from mobile devices is directed through Wi-Fi networks (see Figure 2). This figure is even higher (around 80%) in developed countries. The increasing capacity required by new content and the development of new, more powerful technologies such as WiMax reduce the expected need for mobile spectrum and therefore cast some doubts about the magnitude of future MBB services demand.[12]

Figure 1
Global mobile data forecast (TB per month)

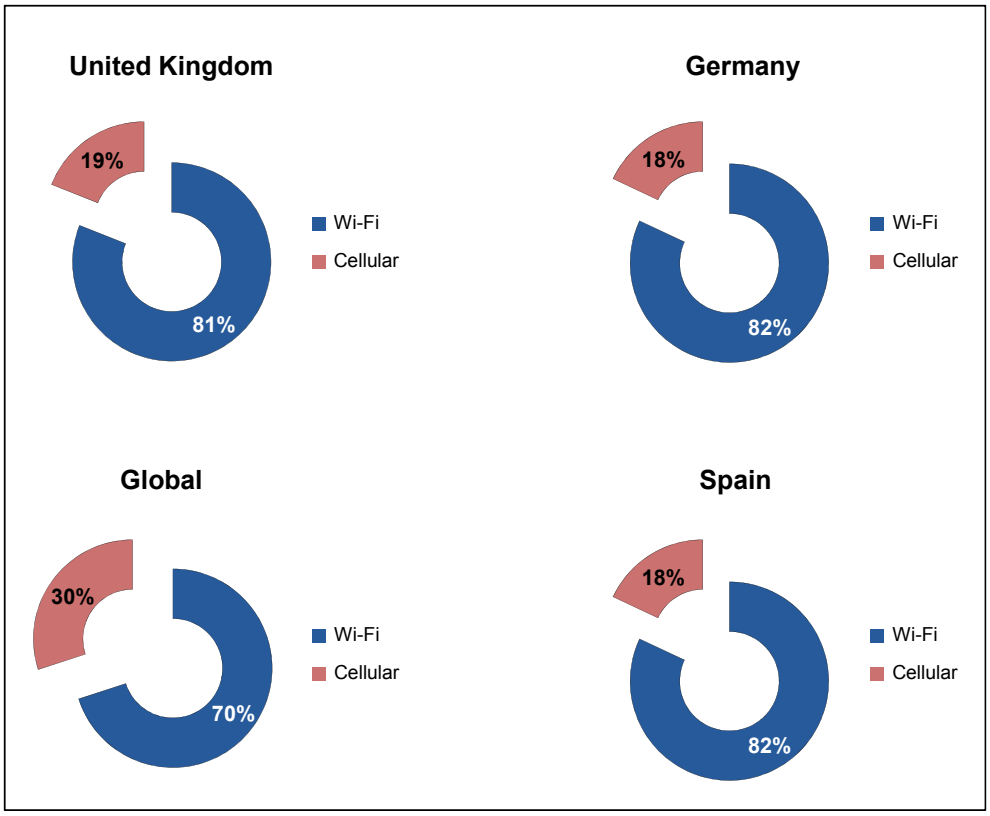


[11] Some countries have elaborated their own estimates. See, for example, the comprehensive report commissioned by Industry Canada (2010). National initiatives in this direction would be desirable to be able to adopt informed decisions. See, for example, Ofcom's consultation of March 2013 on "Future demand for mobile broadband spectrum and consideration of potential candidate bands" available at http://stakeholders.ofcom.org.uk/consultations/cfi-mobile-bb/.

[12] The ITU has developed a tool called "SPECULATOR" for estimating the spectrum requirements for the future development. The tool has been criticized on several grounds. ESOA, the European Satellite Operators' Association, considers that the estimates from this tool (contained in the report ITU-R M.2290) "are at least two orders of magnitude (a factor of 100 or more) too high." (http://www.esoa.net/upload/files/news/R12-JTG4567-C-0573-Satindustry-on-IMT-requirements.docx). Tim Farrar, president of Telecom, Media, and Finance Associates: "the data that informs this debate (allocating more spectrum to wireless service at the WRC15) is deeply flawed and overestimates the demand by as much as 1,200 times" (http://gigaom.com/2014/02/22/note-to-the-telecom-industry-beware-of-false-models/).

Data source: Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update. Years 2008-2013, Ericsson Mobility Report 2012, 2013; Ericsson Traffic and Market Data Report 2011.

Figure 2
Smartphone-originated data traffic distribution



Data source: "Understanding Today's Smartphone User: Demystifying data usage trends on cellular & Wi-Fi Networks," white paper, Informa Telecoms & Media, 2012.

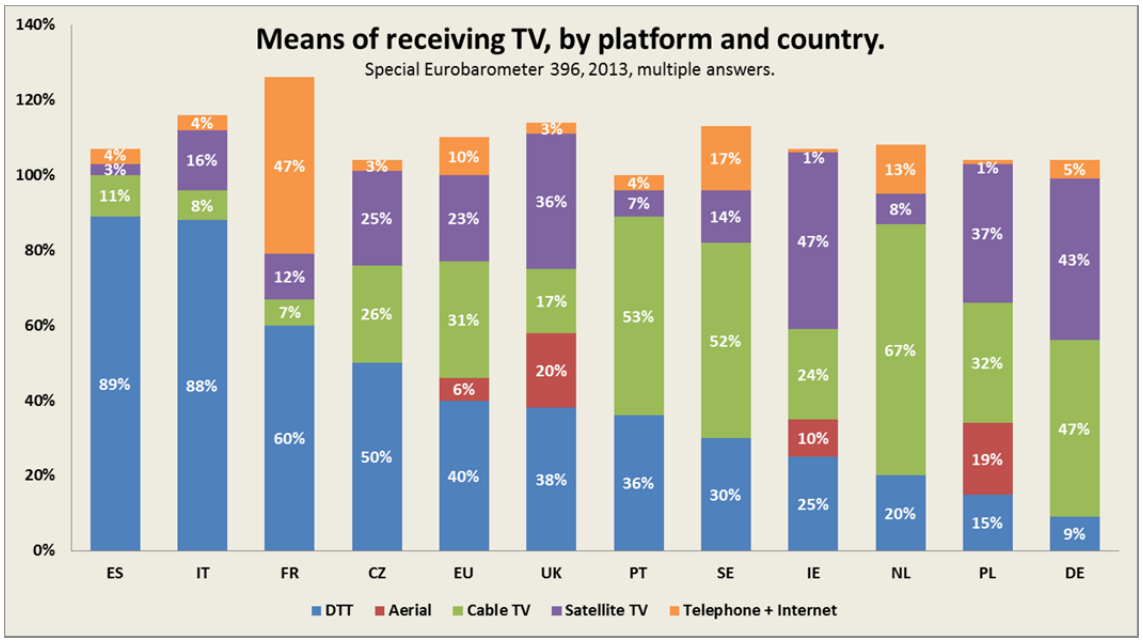
2. The Current Use of the 700 MHz Band Differs Across Countries

DTT networks now deliver nearly 2,000 TV channels and it is the main TV platform for about 50% of European households (approx. 275 million viewers).[13] Forty percent of EU households access TV broadcasts through DTT (see Figure 3). Terrestrial TV broadcasting plays different roles in different European countries. In Spain, Italy, the United Kingdom and France DTT broadcasting is the main platform for digital TV broadcasting (see Figure 3). In particular, in Spain, almost 90% of households use DTT as a platform for digital TV broadcasting. The 700 MHz band is currently used for DTT broadcasting among other uses (such as microphones, local TV and PMSE). More importantly, the development of new TV formats such as HDTV and UHDTV will require additional frequencies at least in the initial stages of their development. In the past, digital broadcasting technologies have evolved increasing the compression of the signal and being able to provide more channels using the same amount of spectrum. HDTV and UHDTV technologies

[13] See "Digital Terrestrial Television: A spectacular success story," November 28, 2013, by Broadcast Network Europe, available at http://www.broadcast-networks.eu/wp-content/uploads/2013/12/Digital-Terrestrial-Television-A-Spectacular-Success-Story.pdf.

will require additional frequencies in the short term, although improvement in compression technologies in the future will likely allow for freeing up part of those additional frequencies later on.[14, 15]

Figure 3
Take-up of DTV, by platform and country (2013)*



* The total might be above 100% because some households may make use of several platforms.

Data source: Special Eurobarometer 396, E-Communications household survey, August 2013. Available at http://www.digitag.org/SpecialEurobarometer-E.pdf.

3. There is Little Information About the Level of Efficiency and Current Use of the Spectrum

There is little evidence about the efficiency and actual use of the spectrum across main services like mobile and Wi-Fi. There are recent initiatives in this direction but they are not generalized.[16] The lack of monitoring and the non-existence of a secondary market in most countries make it difficult to improve the efficiency in the current use of the spectrum and to free up unused or underutilized parts of the spectrum. Once the spectrum is allocated, most governments do not monitor whether this is being used efficiently or not. Moreover, governments do not even have a clear picture of the use of the spectrum reserved for public use and defense, which is not commercially available.

---

[14] See footnote 8.

[15] A recent study (see Communications Chambers, 2014) analyzes the economic and social importance of DTT evidencing DTT's vital role in supporting broadcasting, driving innovation and investment in program-making while keeping consumer costs down and showing that DTT delivers more value per unit of spectrum than mobile broadband. http://www.digitaluk.co.uk/__data/assets/pdf_file/0015/87000/The_Value_of_DTT_in_an_era_of_increasing_demand_for_spectrum_20-1-14.pdf.

[16] Wik Consult (2012) is a first step in the elaboration of a spectrum map for Europe. CSMAC (2010) suggests indicators to measure spectrum efficiency. There are also reports analyzing the efficiency of parts of the spectrum. For example, Deloitte (2007) is a study commissioned by the BBC on the analysis of its own spectrum effective use and Rysavy Research (2011) assesses the efficiency of the spectrum assigned to U.S. mobile operators.

The existence of secondary markets for spectrum would provide incentives to efficiently use the spectrum. If firms could sell the unused parts of their allocated spectrum, they would have incentives to use it more efficiently. In addition, firms that value the spectrum more than incumbents would have a chance to enter the market contributing to increased global efficiency. In most European countries, such an option is not available. Spectrum users can always return their frequencies but they will not get their money back, so they'd be better off keeping it and finding alternative uses even if they are inefficient.

The European Radio Spectrum Policy Programme (RSPP)[17] established the need for an EU inventory of existing uses of spectrum, for both commercial and public purposes. The spectrum inventory will allow further development of the digital dividend policy. Wik Consult's recent report "Inventory and review of spectrum use: Assessment of the EU potential for improving spectrum efficiency"[18] commissioned by the European Commission is the first step in the process of building such inventory. The object of the report was "to develop a methodology for the analysis of technology trends, future needs and demand for spectrum." The Spectrum Inventory merged the information available in pre-existing data sources such as the ECO Frequency Information System (and the information gathered from the authorities that manage the spectrum in each member state). With this database, and the use of technical and socioeconomic indicators of spectrum efficiency, the report provides a general overview of the spectrum efficiency among EU member states. This report does not, however, provide a definitive measure of spectrum efficiency, since full information about spectrum usage was not available or was not provided by some member states. Further work at the national level and the elaboration of indicators about actual spectrum use and the level of efficiency are necessary in order to complete the full picture.

III. Trade-offs Involved in the Release of the 700 MHz Frequencies to MBB Services

The trade-offs involved in the decision regarding the second digital dividend are more complex than the ones involved in the first digital dividend. While the first digital dividend arose from a more effective use of the spectrum through the introduction of digital broadcasting, the second implies additional trade-offs that have to be carefully analyzed as it effectively means reducing the spectrum available for DTT (which was not the case with the first digital dividend).

The release of the 700 MHz band for MBB communications is proposed under the assumption that the reallocation of underutilized frequencies to MBB, where demand is increasing, and the harmonized use of such band will increase global welfare.[19] However, as mentioned in the previous sections, the analysis of the impact on welfare is not trivial since first, the magnitude of the increase in the demand for MBB is uncertain, and second, such frequencies play an important role in DTT broadcasting and in the future development of HDTV. Moreover, since there is not a clear picture of the current usage of the spectrum, policy makers do not have sufficient information to carry on a reallocation of the spectrum that guarantees a positive

[17] European Parliament and Council (2012).

[18] Wik Consult (2012).

[19] See "WRC-12: allocating terrestrial frequencies to mobile services," DigiTAG Web Letter, February 2012. Available at http://www.digitag.org/WebLetters/2012/External-Feb2012.html.

contribution to global efficiency and welfare. Under this setting, adopting early decisions on the reallocation of the spectrum might not necessarily lead to a more efficient outcome.

First, the benefits from such decision are not trivial. Industry estimates agree that mobile operators will need more spectrum in the future but there is no agreement on how much more (see Figure 1). The amount of spectrum needed will be driven not only by the demand for mobile devices but also by the mobile and other wireless use of mobile devices (which will also be affected by the evolution of next-generation Wi-Fi), the evolution of data transmission technologies (e.g., video compression technologies, 5G or LTE) and the relative pricing strategies of mobile and landline operators. While demand for mobile devices can be estimated somehow accurately, the impact of the remaining factors is uncertain. In fact, as mentioned in the previous section, industry estimates vary substantially and Cisco has recently made a significant downward correction to its estimates.

Allocating additional spectrum to MBB without more accurate estimates about the future evolution of demand could lead to an inefficient outcome since if too much spectrum is transferred to mobile operators such spectrum will be underutilized.

This misallocation is not absent of costs. As mentioned in the previous section, the 700 MHz band is currently being used for DTT broadcasting. The European Commission has actively promoted the digitalization of terrestrial television within its digital agenda for Europe.[20] DTT broadcasting currently makes use of the 800 Mhz and 700 MHz frequency bands.

The release of such frequencies to MBB would have a significant effect on the deployment of digital television[21] and, most importantly, on the development of new TV formats such as HDTV and UHDTV. First, unless alternative frequencies are made available, such a release might imply a reduction in the number of TV channels and, in any case, it will imply high costs for re-tuning existing networks. Second, the implementation of HDTV requires access to additional UHF spectrum, at least during the first stages of its deployment.[22] Thus, the release of such spectrum for MBB might prevent the development of HDTV.[23] TV stations might have to choose between reducing their number of channels or halting their plans to develop HDTV, unless alternative spectrum is made available to them.

Thus, the benefits from reallocating the spectrum are uncertain and the costs are likely to be high. Any decision to reallocate the spectrum should carefully analyze the trade-offs involved. The magnitude and timing of such trade-offs are not the same in all European countries. In those countries where DTT broadcasting is the main digital television viewing platform, the trade-off already exists at present, since the release of the UHF band to MBB would be made at the expense of other uses. In those countries where the role of DTT broadcasting is minor (e.g., the Netherlands, Poland, Germany or Sweden) the misallocation of the spectrum might have arguably a more limited negative effect on the current development of digital television but still

---

[20] See "Delivering the digital dividend" at http://ec.europa.eu/digital-agenda/en/delivering-digital-dividend.

[21] Not only reducing the spectrum available but also adding further costs to consumers that may require additional equipment, to re-tune device or to reorient aerials in order to continue receiving the service. This might put the DTT platform at a competitive disadvantage, inducing consumers to switch to other alternatives such as Internet television, cable or satellite putting.

[22] See footnote 5.

[23] See Indepen Consulting (2007) for an analysis of the impact of the first digital dividend on the development of HDTV by the BBC.

would jeopardize the DTT platform and would also have an effect on other future potential uses of the 700 MHz band. Such misallocation might irreversibly block the spectrum for future alternative uses and might restrict technological development. In any case, what is clear is that a one-size-fits-all European policy does not seem appropriate given the different existing trade-offs in different countries.

Before adopting any decision regarding the reallocation of the 700 MHz band, policy makers have to evaluate current and future trade-offs and explore other policy alternatives that would allow response to the spectrum needs of MBB while allowing for the development of digital television. The evaluation of such trade-offs is not trivial, however, given the uncertainty about the future needs for spectrum for MBB and the future evolution of technology. In any case, in order to analyze policy alternatives, it is necessary to have a detailed picture of the current usage of the spectrum and an assessment of its efficiency. Such analysis will enlarge the map of policy options and will likely relax the trade-offs identified.

Policy makers should make sure that their decisions contribute to increasing welfare. Thus, they should incorporate all the elements at stake to evaluate the net impact of the different policy alternatives on welfare.

IV. Policy Recommendations

In the debate on the 700 MHz spectrum band reassignment, radio spectrum policy faces the challenge of enabling the release of additional spectrum for MBB services in response to the increasing (but uncertain) demand for mobile data capacity while securing the benefits provided by DTT and other current uses of the 700 MHz band.

Given the existing trade-offs involved in the decision to reallocate the 700 MHz band for MBB and the difficulties to assess them with a sufficient level of accuracy, an early reallocation of the spectrum might be likely to lead to an inefficient outcome reducing social welfare.

Such decision should be adopted once the level of uncertainty has been reduced and the trade-offs have been carefully analyzed and should be accompanied by reassigning new spectrum to DTT to avoid any disruption in the development of HDTV. A sequential approach to the decision-making process will avoid the adoption of irreversible costly decisions.

Thus, **the decision to reallocate the 700 MHz band should not be adopted until policy makers are able to guarantee that it will lead to an efficient outcome.** The reallocation of the 700 MHz band requires some preliminary steps in order to guarantee such efficient outcome. Those preliminary policy steps should be directed to analyze the efficiency of the current use of the spectrum and enlarge the scope of policy options by freeing the currently underutilized parts of the spectrum, exploring new technologies and allowing a better spectrum management through market solutions.

1. **Assess the efficiency of the current spectrum usage and produce more accurate forecasts on future uses**: While lots of effort has been put into designing mechanisms to allocate the spectrum, not much has been done to evaluate whether the current allocation within and across usages is optimal and whether the actual use is efficient. The European RSPP establishes an EU inventory of existing uses of spectrum, both for commercial and public purposes. A further development of this instrument especially at the national level

will allow identification of how the spectrum is actually being used and whether the allocated spectrum is used efficiently. This will expand the policy options and will allow policy makers to relax existing trade-offs contributing to increased welfare.

2. **Explore the possibilities of unlocking underutilized parts of the spectrum**: Once the actual use of the spectrum has been analyzed, measures should be adopted to unlock underutilized parts of the spectrum. Governments can start by releasing the non-commercial spectrum, which is kept for public purposes but not used efficiently. For example, in December 2012 the U.K. Ministry of Defence announced its intention to auction around 200 MHz of spectrum, which had been previously been allocated to military purposes, in the first semester of 2014.[24] The U.K. government had also announced its intention to free up at least 500 MHz of public spectrum by 2020.[25] This extra spectrum can be used both to support the provision of 4G mobile services and to provide wireless access to fixed-line broadband services. Such initiative will not only allow for a more efficient use of the spectrum but will also allow for increasing public revenues. Similarly, the U.S. Department of Defense announced in July 2013 the release of the frequencies from 1755 MHz to 1780 MHz,[26] within a broader plan to open 500 MHz of public spectrum for private use in the following 10 years.[27] The restructuring of such frequencies will have an estimated cost of $12 billion, which the Department of Defense plans to finance by auctioning the frequencies.

   Regulating white space for unlicensed uses will also improve the efficiency in the use of the spectrum. White space is made up of the frequencies that TV license holders are not using.[28] They are kept deliberately empty by TV operators in order to avoid interference between different TV stations placed in geographically separated areas or that may have been freed up because of the digital dividend. The U.K. Telecoms regulator Ofcom launched in 2012 a consultation on the standardization of devices using white space.[29] In the United States, the FCC established a set of rules in 2010 to allow unlicensed radio transmitters to operate in white space. A remarkable initiative is Google's White Spaces Spectrum Database,[30] whose purpose is the so-called "Dynamic Spectrum Sharing," i.e., to allow spectrum to be used by another party when not in use or needed by the primary user. Google has started a trial project in South Africa using TV white space to provide wireless broadband to 10 schools.[31]

3. **Promotion of new technologies that make a more efficient use of the spectrum**: Governments should support new technologies to make better use of the existing spectrum and to free up frequencies, such as full duplex signals that allow radio devices

---

[24] "Ministry Of Defence to auction off radio spectrum," U.K. Ministry of Defence press release, December 17, 2012. Available at https://www.gov.uk/government/news/mod-to-auction-off-radio-spectrum.

[25] U.K. Department for Culture, Media and Sport (2011).

[26] "In switch, U.S. military offers to share airwaves with industry," *Reuters*, July 23, 2013. Available at http://www.reuters.com/article/2013/07/23/usa-defense-spectrum-idUSL1N0FT0KG20130723.

[27] The White House (2010).

[28] See FCC webpage on white space at http://www.fcc.gov/topic/white-space.

[29] "TV white spaces. A consultation on white space device requirements," November 22, 2012.

[30] "White Spaces Spectrum Database" at http://www.google.org/spectrum/whitespace/index.html.

[31] "TV white spaces trial in South Africa," Google Blog, March 25, 2013, http://blog.google.org/2013/03/tv-white-spaces-trial-launches-in-south.html.

to transmit and receive signals in the same frequency (instead of two frequencies),[32] and spectrum sharing[33] and pooling technologies[34] that allow the use of the same spectrum by several users through allocation mechanisms.

In general, technologies that imply a shared use of the spectrum, such as TVWS, Wi-Fi, RDIF and Bluetooth, improve the efficiency in the use of the spectrum. The European Commission is already promoting sharing solutions such as ASA or LSA, which do not imply locking the spectrum for a specific use (as is the case of MBB where the use of the spectrum is assigned exclusively to the license holders).

4. **Favor market solutions by introducing flexible tradable mechanisms that allow the change of usage of the spectrum following the forces of supply and demand:** Secondary spectrum markets allow improvement in efficiency through trading. Secondary trading implies the possibility that spectrum licensees sell their unused assigned spectrum. If incumbents can make a profit from unused frequencies, they will have incentives to improve the efficiency in the use of their frequencies and resell the unused bits.

   Well-functioning secondary markets can help ensure that in response to demand and supply changes (such as technology changes or new uses of the spectrum) spectrum will migrate to more efficient uses, allowing parties outside of the initial allocation to enter the market.[35] Spectrum allocation mechanisms (such as spectrum auctions or "beauty contests") can guarantee efficient allocation at a specific moment in time but do not guarantee that such efficient allocation holds if there are changes in technology or in supply and demand conditions. Some spectrum holders might require additional frequencies while others might hold more frequencies than they want. Secondary markets complement initial allocation mechanisms and guarantee that efficiency holds at any point in time no matter the initial allocation.[36]

   Secondary markets would allow, for example, TV license holders to free up frequencies as they use their spectrum more efficiently or as technology evolves and allows them to offer the same number of channels or new TV formats such as HDTV making use of fewer frequencies.

   The effectiveness of secondary trading requires transparency in market design, low transaction and administrative costs and the close monitoring of competition to avoid spectrum monopolization.

   Secondary spectrum markets have been developed in the last decade in several countries such as the United States, Australia, Canada, New Zealand[37] and some countries in

---

[32] Hua et al (2012).

[33] See National Telecommunications and Information Administration (2013). Spectrum sharing is currently being considered by some regulators. See, for example, "Ofcom explores spectrum sharing to meet mobile data demands," Fierce Wireless Europe, August 9, 2013, http://www.fiercewireless.com/europe/story/ofcom-explores-spectrum-sharing-meet-mobile-data-demands/2013-08-09.

[34] Weiss and Jondral (2004).

[35] See Mayo and Wallsten (2010) for an overview of the efficiency properties of secondary spectrum markets and their use in the United States.

[36] See OECD (2005) for the benefits from spectrum trading.

[37] New Zealand was the first country to introduce spectrum trading in 1989.

Central America (such us Guatemala and El Salvador). In Europe, they are not very common and only the United Kingdom plans to develop them.[38]

In the United States, for example, secondary markets have developed rapidly in the last decade following the adoption of several measures by the FCC to facilitate their development. The first steps towards a more flexible use of spectrum were adopted in the early 2000s,[39] when the FCC produced a series of guidelines aiming at the elimination of barriers to the development of secondary markets, by simplifying the transfers and leases of wireless services. More recently, in 2012 the FCC established rules[40] to allow TV license holders to "relinquish rights in spectrum assignments to other parties or to the FCC." TV license holders decide voluntarily to participate and whether they want to go off-air or stay on-air by using other frequencies.

[38] See Ofcom's Spectrum Management Strategy Report. Available at http://stakeholders.ofcom.org.uk/consultations/spectrum-management-strategy/.

[39] See FCC (2003).

[40] See FCC (2012) and FCC (2013) for the design of incentive auctions for broadcast television spectrum.

Bibliography

Brugger, R., and A. Gbenga-Ilori (2009). "Spectrum usage and requirements for future terrestrial broadcast applications." EBU Technical Review Q4 (2009).

Commerce Spectrum Management Advisory Committee, CSMAC (2008). "Definitions of efficiency in spectrum use." Available at http://www.ntia.doc.gov/files/ntia/publications/spectral_efficiency_final.pdf.

Communications Chambers (2014). "The value of Digital Terrestrial Television in an era of increasing demand for spectrum." Report commissioned by Digital UK. Available at http://www.digitaluk.co.uk/__data/assets/pdf_file/0015/87000/The_Value_of_DTT_in_an_era_of_increasing_demand_for_spectrum_20-1-14.pdf.

Deloitte (2007). "The BBC's efficient and effective use of spectrum." Report commissioned by the BBC Trust's Finance and Strategy Committee. Available at http://www.bbc.co.uk/bbctrust/assets/files/pdf/review_report_research/vfm/dt_spectrum.pdf.

European Commission (2007). Communication from the Commission: reaping the full benefits of the digital dividend in Europe: a common approach to the use of the spectrum released by the digital switchover. Brussels, November 13, 2007.

European Parliament and Council (2012). Decision 243/2012/EU of the European Parliament and of the Council of March 14, 2012, establishing a multi-annual radio spectrum policy programme (RSPP).

Federal Communications Commission, FCC (2003). "Promoting efficient use of spectrum through elimination of barriers to the development of secondary markets. Report and order and further notice of proposed rulemaking." REPORT AND ORDER AND FURTHER NOTICE OF PROPOSED RULEMAKING on 10/06/2003. FCC Docket 03-113.

Federal Communications Commission, FCC (2012). "Expanding the economic and innovation opportunities of spectrum through incentive auctions." A Proposed Rule by the Federal Communications Commission on December 12, 2012. FCC Docket 12-118.

Federal Communications Commission, FCC (2013). "The broadcast television spectrum incentive auction: a staff summary." Available at http://www.fcc.gov/document/broadcast-television-spectrum-incentive-auction-staff-summary.

Hua, Y., P. Liang, Y. Ma, A.C. Cirik and O. Gao (2012). "A method for broadband full-duplex MIMO radio." IEEE Signal Processing Letters 19 (2012) No. 12, p.p. 793-796.

Indepen Consulting Ltd. (2007). "Intervening to secure UHF spectrum for HD PSB." Review of Ofcom's Impact Assessment. BBC response to Ofcom's consultation on the Digital Dividend Review. Available at http://stakeholders.ofcom.org.uk/binaries/consultations/ddr/responses/bbcannex.pdf.

Industry Canada (2010). "Study of future demand for radio spectrum in Canada 2011-2015." Report by Red Mobile Consulting.

Mayo, J. and S. Wallsten (2010). "Enabling efficient wireless communications: The role of secondary spectrum markets." *Information Economics and Policy* 22 (2010) p.p. 61-72.

National Telecommunications and Information Administration, NTIA (2013). "The Spectrum Sharing Innovation. Test-Bed Pilot Program FY 2012 Progress Report." United States Department of Commerce.

OECD (2005). "Secondary Markets for Spectrum: Policy Issues." Working Party on Telecommunication and Information Services Policies. Directorate for Science, Technology and Industry.

Rysavy Research (2011). "Efficient use of spectrum." Report commissioned by CTIA – The Wireless Association. Available at http://www.rysavy.com/Articles/2011_05_Rysavy_Efficient_Use_Spectrum.pdf.

UK Department for Culture, Media and Sport, DCMS (2011). "Enabling UK Growth. Releasing public spectrum. Making 500 MHz of Spectrum available by 2020." March 2011.

Weiss, T.A. and F.K. Jondral (2004). "Spectrum Pooling: An Innovative Strategy for the Spectrum Efficiency." *Communications Magazine* 42 (2004) p.p. 8-14.

The White House (2010). "Unleashing the Wireless Broadband Revolution." Presidential Memorandum, June 28, 2010.

Wik Consult (2012). "Inventory and review of spectrum use: Assessment of the EU potential for improving spectrum efficiency." Study for the European Commission.