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International Telecommunication Union

GSR 2010 Discussion Paper

Spectrum in Transition: The Digital Dividend

Work in progress, for discussion purposes

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1.1 Introduction

1.1.1 Purpose of This Paper

This paper aims to inform policy makers and regulators about spectrum management issues related to the digital switchover and the Digital Dividend. The paper includes a summary of policies, best practices and progress being made in implementing change in regions around the globe. Among other things, the paper serves to demonstrate and recommend current and possibly new pathways for resolving outstanding issues related to the Digital Dividend.

The fundamental reason why the Digital Dividend spectrum is so important is its physical characteristics: an exceptionally attractive combination of capacity (bandwidth) and coverage. The Digital Dividend can be used for a very wide range of potential new services. These include additional television services delivered through Digital Terrestrial Television (DTT) (whether in standard definition (SD) or high definition (HD)), local television, new types of mobile broadband, mobile television, wireless home networks, to name just a few. There are many new technologies exploiting the capabilities of the Internet: ranging from fixed to mobile devices that are capable of receiving audiovisual content such as movies, TV, and games. Technology is not the only thing changing, however. Viewing behaviour of individuals and whole segments of society are changing, and the lines between television viewing, radio listening, and media access (with mobile device options) are becoming increasingly blurred.

1.1.2 Outline of The Paper

The paper begins with an explanation and description of Digital Switchover and the Digital Dividend, and provides a perspective on important historical developments and circumstances leading up to the Digital Switchover. The frequency bands affected, the issues involved, and estimates of the size and value the Digital Dividend are explored. Section 1.3 provides an overview of the policy options. Section 1.4 reviews international best practices; section 1.5 further illustrates these international best practices by discussing regional examples. This paper concludes with a brief discussion of remaining issues and reflection on what steps are needed to complete the digital switchover and allocate the Digital Dividend spectrum.

1.2 Digital Switchover (DSO) and the Digital Dividend

Digital Switchover and Digital Dividend are two related concepts. The Digital Dividend is a consequence of the Digital Switchover having taken place. This section begins with an interpretation and commentary on these two concepts and provides policy makers and regulators (including spectrum, broadcast and telecom/ICT regulators) with an overview of the Digital Dividend (in terms of freed up spectrum).

1.2.1 Defining the concepts: Digital Switchover and the Digital Dividend

1.2.1.1 Digital Switchover

Digital Switchover occurs when analogue television broadcasting signals are converted to and replaced by digital television services. Sometimes this occurs abruptly and is referred to as Analogue Shut-off whereas in other circumstances, analogue and digital signals coexist for a period of time during the transition.

While digital signals are not necessarily better than analogue signals for recording or broadcasting in terms of frequency response, signal-to-noise ratio, or dynamic range, transmission of digital signals is much more efficient. Moreover, new broadcast services such as distinct simulcast programming can be offered using digital multiplexing. Typically, there is a trade-off between energy and bandwidth when using spectrum. To move more data further, transmitters must either increase bandwidth or energy, or both. Thus, much of the early effort in developing broadcast and wireless communications was dedicated to studying and improving ways to combine efficient energy transmission and spectrum use. The advent of digital transmission technologies made a third solution available: the use of standard processor chips loaded with various functional algorithms. Dramatic and exponential improvements in processing complexity drove down costs while significantly reducing transmission error. With modern coded modulation, processing complexity is now the cheapest way to improve transmission as compared to increasing energy or bandwidth.[1] Given that the technological challenge of making transmission more efficient has been largely resolved, the most important questions concerning the Digital Switchover are when and how it will occur. These questions will be further explored when examining the best practices and regional trends (see Sections 1.4 and 1.5 below).

How and when Digital Switchover occurs can vary and depends very much on how local broadcast markets evolve and how broadcast services are delivered to consumers. For example, in the US, one of the several early large-scale markets to have already switched-off, consumers were provided with incentives in the form of a coupon (subsidy) or reduced-cost set-top boxes. In Germany, another early adopter, most consumers were already using cable television subscriptions and so only a small number of households needed new equipment to access multi-channel digital services. In a number of other countries in all regions, however, the transition is likely to take much longer.

How to use the Digital Dividend and how to reallocate the released spectrum are the subjects of ongoing intense debate involving consumers, legislators, regulators, and operators involved in broadcast, telecommunications, and ICTs (in particular broadband). The modality of new services is discussed in Section 1.2.3

1.2.1.2 Defining the Digital Dividend

Generally speaking, the Digital Dividend resides in the range of broadcast spectrum – VHF (30 MHz – 300 MHz) and UHF (300 MHz – 3.0 GHz). There are several definitions of the Digital Dividend. The most common definition is the amount of spectrum in the VHF and UHF bands that is above that amount nominally required to accommodate existing analogue TV programmes and that might be potentially freed up in the switchover from analogue to digital television. Spectrum is freed-up since digitally transmitted broadcast services require less spectrum than the amount needed to accommodate existing analogue transmissions (principally, television).

Another interpretation suggests that additional services can be packed into the same spectrum, hence resulting in a digital dividend:

> *More digital programmes and associated services (including interactive multimedia ones) than the existing number of analogue programmes can likely be carried in the spectrum that is presently occupied by analogue programme services* (although this may not be the case for High Definition Services)[2].

In either case, broadcast services are transitioning to digital transmission techniques resulting in several options for ICT and broadcast regulators to consider.

1.2.2 Spectrum in Transition

This section highlights major evolutionary steps in the use of broadcast spectrum, the size of the Digital Dividend, the bands affected, and important international decisions affecting the timing and implementation of the Digital Switchover. Recent trends relating to the transition model are illustrated using country experiences from all regions.

1.2.2.1 Major Trends in the use of VHF and UHF Spectrum

The early developments in wireless communications began in the mid-nineteenth century with key discoveries and innovation occurring around the globe and involving individuals such as Maxwell, Edison, Hertz, Tesla, Popov, Rutherford, Marconi and Baviera. Early radio manufacturing pioneers included the British Marconi, the German Telefunken and the American Westinghouse. The first AM broadcast took place on Christmas Eve, 1906 from Brant Rock, Massachusetts. FM broadcasting would not occur until 1933, and was first piloted in several US east coast stations throughout 1939.

Commercial broadcast radio grew in popularity until the late 1940s, when television first appeared and soon overtook radio as the main source of in-home entertainment. Radio took 38 years to reach an audience of 50 million compared to 13 years for television and four years for the Internet.[3] Meanwhile, radio and television continue to be amongst the most popular ICT devices in the home with worldwide penetration rates still on the increase. In OECD households, with the exception of four countries, television penetration rates exceed 90 per cent (see Figure 1.1).This is quite high compared to the Internet which had a global penetration rate of 28.7 per cent in 2009.[4] However, Internet is growing very rapidly, having grown by 44.8 per cent since 2000.[5] In 2010, the three most popular media channels are television, Internet and radio. Internet only surpassed radio in 2004.[6]

1.2.2.2 Trends in Media Usage

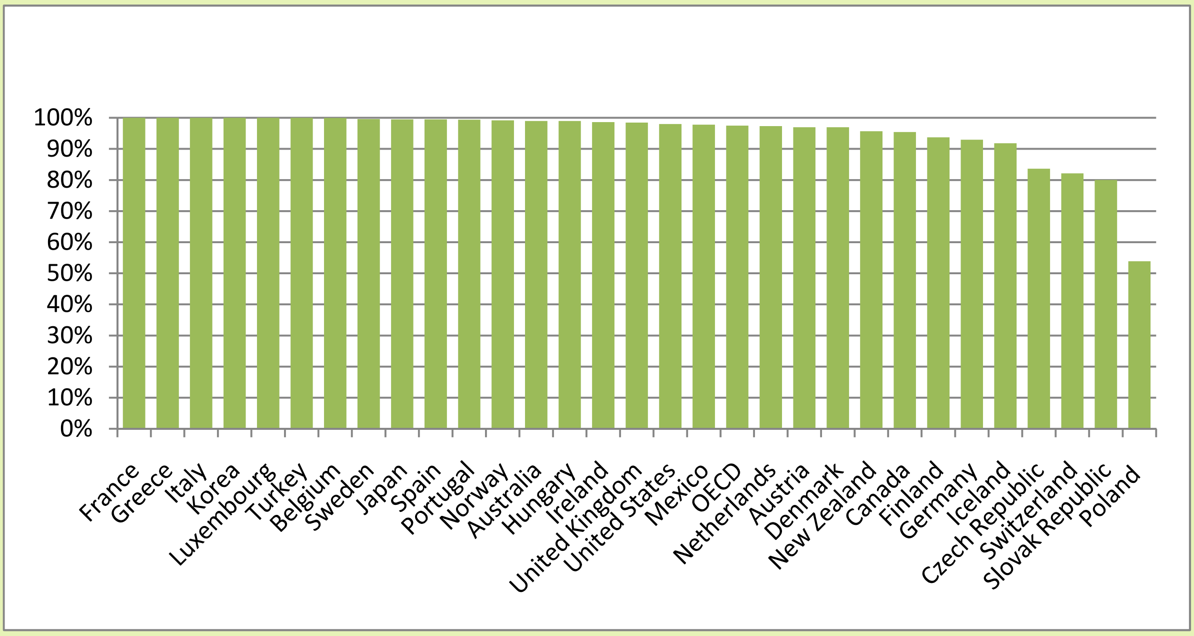
Viewing behaviour is changing with increasing use of the Internet, especially amongst younger audiences. Viewers now use a range of devices capable of receiving audio-visual content such as movies, TV, games, and so forth. The lines between television viewing and radio listening and between PC and mobile device options are now blurred. These trends have been reported in several instances, particularly in developed countries such as in the Republic of Korea and in the UK, but also increasingly in developing countries. In 2008, Ofcom's Communications Market Study[7] revealed that:

- Television is of declining interest to many 16-24 year olds; on average they watch television for one hour less per day than the average television viewer.
- Instead, the Internet plays a central role in daily life; more than 70 per cent of 16-24 year old Internet users use social networking websites (compared to 41 per cent of all UK Internet users).
- DAB[8] digital radio continues to grow in importance. In 2005, sales of Digital Audio Broadcast portable radios outstripped sales of analogue portable radios for the first time, accounting for 54 per cent of sales, up from 45 per cent in 2004. Overall digital listening (including radio channels via digital television) accounted for 11 per cent of all listening hours in 2005, compared to only 6 per cent in 2004.
- However, TV and radio continue to be the main source of news and entertainment for the elderly and underprivileged.

In 2010, Ofcom reported an important reversal in trends in TV viewing for British audiences[9]:

- Despite the growing choice in technology and services available, watching TV remains the activity that most adults would miss the most. Compared to 2007, a growing number of 16-24s (8 percentage points) and over 55s (7 percentage points) say that watching TV is the activity they would miss the most.

Figure 1.1: Percentage of households with a television, 2007



Source: OECD, ITU, EAO

- However, from 2003 to 2008, UK TV revenue as a whole contracted for the first time since 2003, down by 0.4 per cent in 2008 to £11.1bn. Net TV advertising revenue also declined by 9.6 per cent to £3.1 billion, which is the biggest fall since 2003.

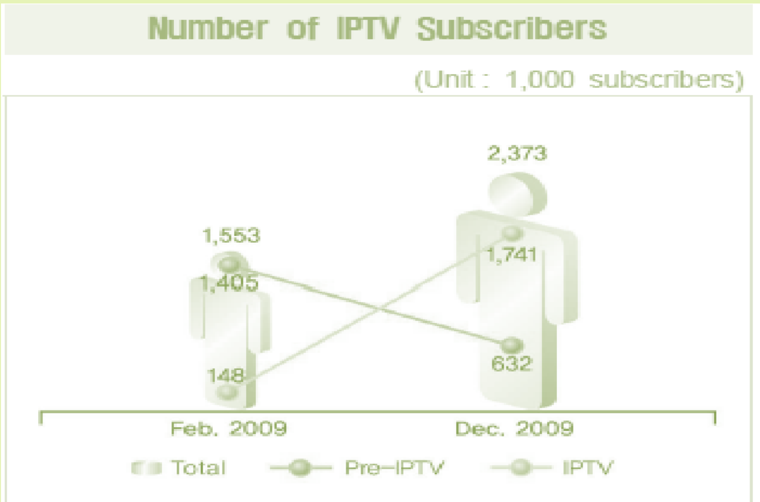
In 2009, the Korean Communications Commission (KCC) reported observing significant new trends. The number of IPTV subscribers in Korea is rising sharply while other forms of subscription television access are declining (see figure 1.2 below).

Services like Terrestrial Digital Multimedia Broadcasting (T-DMB) are also making viewers move away from traditional television services. T-DMB first came on the air in 2005 in Korea and is a free service supported by advertisers. T-DMB had nealry 22 million subscriber in 2009. Today T-DMB is in operation or in trials in a number of countries including Mexico, Germany, Norway, Indonesia, and Malaysia.

1.2.2.3 Trends in Media Delivery

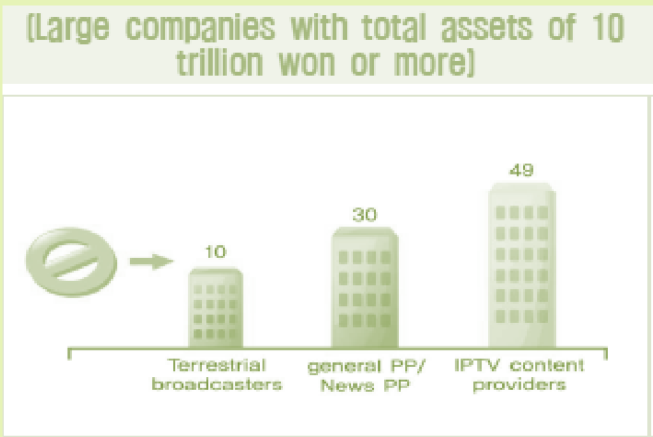
As viewing behaviour changes, businesses that provide services change the way that services are organized and delivered. These changes cause shifts in market power and changes in old alliances between networks and advertisers. In the Republic of Korea, for the IPTV example illustrated above (see Figure 1.2 above), there are now more companies providing IPTV services than television and newspaper companies combined (see figure 1.3 below).

Figure 1.2: Republic of Korea, IPTV Subscribers



Source: KCC Annual Report , 2009.

Figure 1.3: Growth in IPTV Companies in the Republic of Korea, 2009



Source: KCC Annual Report , 2009.

Box 1.1: Global media trends

Overall global trends in media are clearly evident with some different regional tendencies:

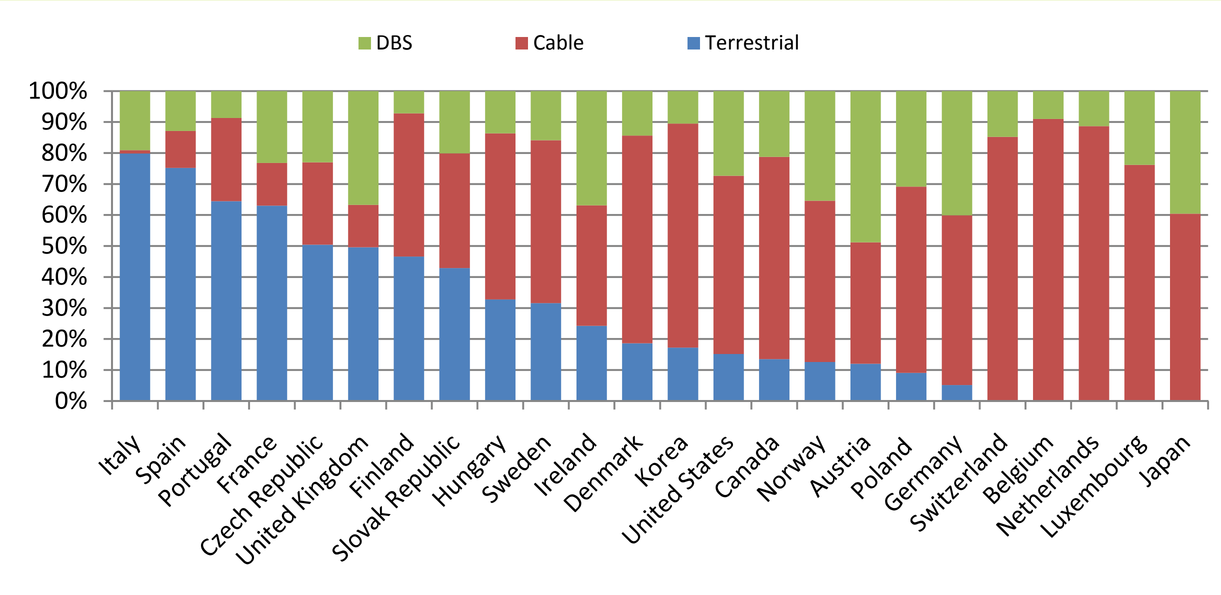
- The global media market, valued at USD 1.3 trillion in 2009, is forecast to grow at an annual average rate of 2.7 per cent to reach USD 1.6 trillion by 2013.
- Terrestrial TV advertising is expected to decline while global multichannel TV will grow and increase according to industry reports, with advertising expenditures growing 1.4 per cent in 2009 to hit USD 19.2 billion in spite of a slowing economy.
- The global trend in growth masks some sharp regional contrasts. The multichannel TV advertising market is expected to shrink 0.9 per cent in North America, but is forecast to grow 0.6 per cent in Western Europe and 15.3 per cent in Eastern Europe and the Middle East.
- A milestone was reached in the UK in 2009. For the first time, advertisers spent more on Internet advertising than on television advertising, with a record £1.75bn online spending recorded in the first six months of that year.

Source: Informa Telecoms & Media (2009).

Viewing behaviours and attendant revenues are not the only things changing. Methods for accessing television are changing, too. Generally, fewer people are accessing television broadcast through over-the-air means.[10] Triple play take-up is on the rise as well, with more consumers moving toward converged service packages offered by telcos. In several OECD countries (Belgium, Luxembourg, Netherlands, and Switzerland), traditional over-the-air analogue broadcast transmission was, for the most part, already eliminated by 2007.

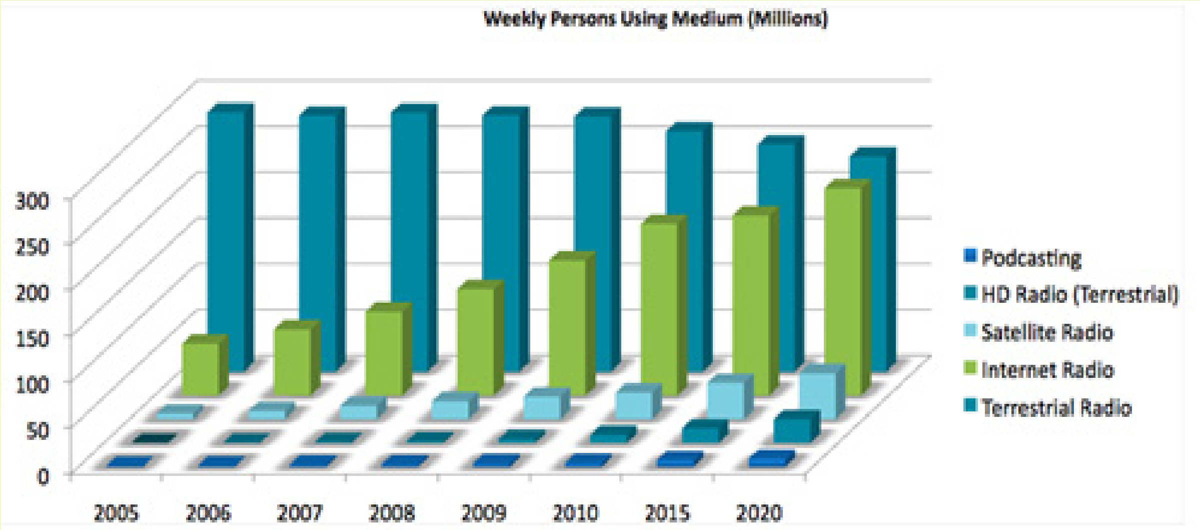
The trend away from accessing television through terrestrial means will likely continue in developed countries but less so in developing countries. In developed economies, new services such as Digital Mobile TV access represent an emerging market with possibly as great a potential as Internet Radio. The projections shown in Figure 1.5 illustrate the trend in the US. According to these projections, terrestrial radio will remain an important means of media access, showing some decline in total listening while substantial growth occurs in two services, namely Internet Radio and potentially radio over mobile phone (similar to T-DMB in the Republic of Korea). In developing countries, sales of traditional terrestrial radio receivers can be expected to show continued robust growth.

Figure 1.4: Breakdown of television access by distribution type in the OECD – 2007



Source: OECD Communications Outlook, 2008.

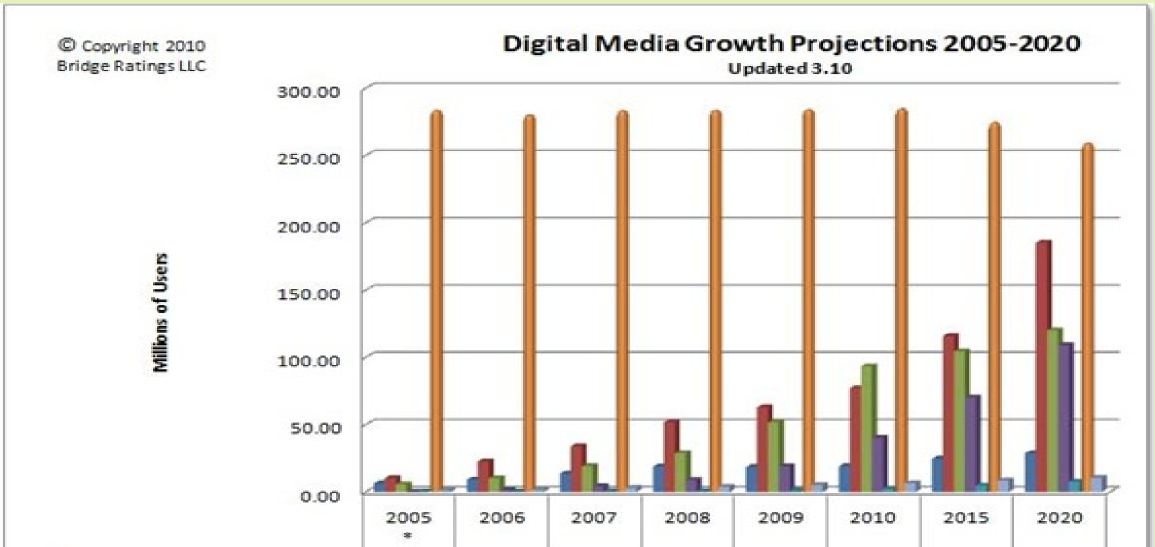
Figure 1.5: Growth in Internet Radio



Source: Bridge Ratings LLC, 2010.

Figure 1.6 illustrates the trends in digital media growth in the US for the period 2005 to 2010 with projections to 2020. Several trends are worth noting. Terrestrial radio is expected to continue as the leading means of accessing digital content throughout the period, with Internet Radio showing a dramatic rise from its inception in the early 2000's. Internet Radio appears to be on track to overtake terrestrial radio sometime in the future.

Figure 1.6: Digital Media Growth



	2005 *	2006	2007	2008	2009	2010	2015	2020
Sirius XM Merged	6.30	9.10	13.61	18.88	18.51	19.27	24.75	28.80
Internet Radio	10.15	22.60	34.00	51.80	62.90	77.20	115.80	185.28
Wireless Internet Penetration	5.67	10.10	19.19	28.79	51.81	93.26	104.46	120.12
Mobile phone Audio Listeners	0.00	1.475	4.14	8.69	19.13	40.17	70.29	108.95
HD Radio	0.100	0.27	0.38	0.50	0.90	2.34	4.67	7.57
Terrestrial Radio Wkly Cume	283.10	279.65	282.84	283.02	283.49	284.19	274.13	258.57
Podcasting/Netcasting**	1.01	1.49	2.94	3.68	5.07	6.34	8.43	10.54

Sources: Bridge Ratings LLC, 2010.

1.2.2.4 Digital Dividend Spectrum Bands

The previous section makes clear that digital technology has transformed markets. Services have evolved and new demands have emerged while digital media access is becoming ubiquitous. These changes have altered the map for both new and existing service providers in many ways. The traditional terrestrial form of television broadcast competes with and in some cases has been replaced by other wired and wireless means of access that may now have the upper hand. Terrestrial digital radio broadcast continues to hold its own against new forms of access in developed markets such as the US and is likely to grow in developing markets. Changes in consumer demand are not uniform across all markets, and the technologies used by different consumer groups are not the same. With the release of the Digital Dividend spectrum, new opportunities open for expanding existing services and introducing new services for end users. In this section, the different bands affected by the Digital Dividend and their potential new uses are described.

The International Telecommunication Union (ITU) has been leading global spectrum allocation efforts over the past decades. Analogue broadcast services traditionally occupied several frequency ranges in the UHF and VHF bands. The band plans and technical standards vary across the three regions of the ITU. Because markets are different and the bands and technologies used vary, different timelines for Digital Switchover have evolved (see Figure 1.8 and Table 1.1 below).

Table 1.1 illustrates the spectrum bands typically used for radio and TV services.

For ease of reference, the regions defined by the ITU Radio Regulation appear in Figure.1.7.

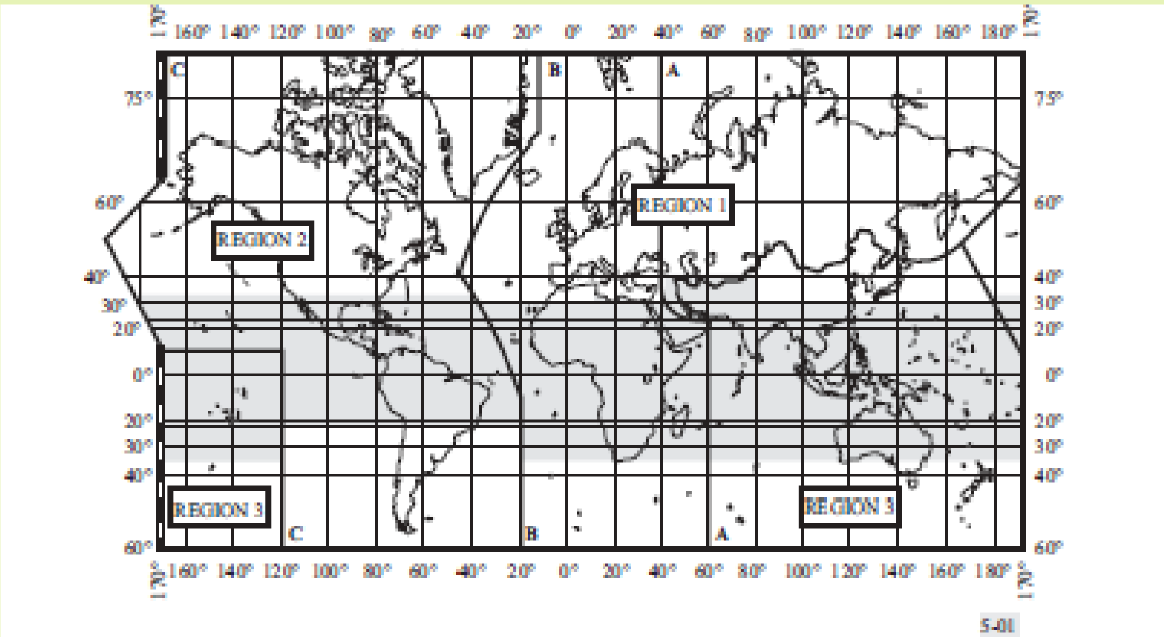
Table 1.1: Typical Spectrum Bands for Radio and Television Broadcast

Band	Region 1	Region 2	Region 3
LF and MH 3 kHz – 3000 kHz			
AM Radio	148.5-283.5 kHz 526.5-1606.5 kHz	– 525-1705 kHz	– 526.5-1606.5 kHz
HF 3.0 MHz – 30 MHz			
Short-wave Radio	Various	Various	Various
VHF 30 MHz – 300 MHz			
FM Radio	87.9-107.9 MHz	87.9-107.9 MHz	87.5-107.9 MHz 76-90 MHz (Japan only)
Television	Western Europe: 40-88 and 174-230 MHz Eastern Europe: 48-100 and 174-230 MHz	North and South America: 54-88 and 174-216 MHz	Asia: PRC – 48-92 and 166-223 MHz Japan – 90-108 and 170-222 MHz Australia/New Zealand – 54-88 and 174-230 MHz
UHF 300 MHz – 3.0 GHz			
Television	Europe: PAL[11] 470-890 MHz France: Secam[12] Africa: PAL and SECAM 470-862 MHz	North America: NTSC[13] 470-608, 624-890 MHz South America: NTSC and PAL 470-890 MHz	Asia: NTSC, PAL, SECAM PRC 470-862 MHz Japan 470-890 MHz

Note: For a detailed description of spectrum bands 460-890 and the current allocation to services, see the ITU Radio Regulations 2006 (RR5-54). For reference notes also refer to the ITU RRs.

Source: McLean Foster & Co., based on the ITU Radio Regulations 2006.

Figure 1.7: ITU Regions



Source: ITU Radio Regulations 2006 (RR5-01).

1.2.2.5 The Size of the Digital Dividend

The Digital Dividend arises from digital technological advances leading to efficiencies in the way in which TV signals are transmitted. Digital compression systems for digital television allow the transmission of several (up to six, depending on the coding and modulation techniques) standard digital television channels of acceptable quality in the radio-frequency spectrum previously used by a single analogue channel.[14] Simply put, more content can be carried for a given amount of spectrum, and this trend is expected to continue. New technologies are likely to increase the capacity of the current DTT multiplexes (by at least 20 per cent) and hence allow more services to be provided without using additional spectrum that is in high demand for other uses.

Digital audio has benefitted in the same way, although unlike the case of digital television, there has been no coordinated effort to harvest a digital dividend. The particular bands used for radio, the amounts of spectrum involved, and the social and cultural constraints associated with radio broadcast make it difficult to determine at this stage whether there will be a Digital Dividend in the radio broadcast bands.

The amount of spectrum vacated by television broadcasting services and making way for DTT according to the Final Acts of WRC-07 varies by region. Table 1.2 shows the size of the Digital Dividend resulting from Digital Switchover by ITU Region.

1.2.2.6 Categories of Digital Dividend Spectrum – Cleared and Interleaved (whitespaces)

There are two categories of Digital Dividend Spectrum:

- **Cleared spectrum** refers to the broadcast spectrum that will become available once Digital Switchover occurs and appears in Table 1.2 as Digital Dividend.
- **Interleaved spectrum (whitespace)** is additional capacity available within the spectrum that will be used in digital broadcast based on how digital terrestrial television (DTT) networks are deployed. The interleaved spectrum is so called because it can be used at a local level by different users on a shared (interleaved) basis with terrestrial television.[15] For a more detailed explanation of DTT and the technologies involved see Section 1.2.3.3 – Digital Terrestrial TV.

Table 1.2: The Digital Dividend by ITU Region

Band	Region 1	Region 2	Region 3
698 - 806 MHz		698 - 806 MHz (2)(3)	
806 - 862 MHz		806 - 862 MHz (2)(4)	
698 - 790 MHz			698 - 790 MHz (5)
790 - 862 MHz	790 - 862 MHz (1)(6)(7)		790 - 862 MHz
Digital Dividend Spectrum	72 MHz (8)	164 MHz	164 MHz

Notes:

(1) Identified for IMT services on a primary basis past 17 June 2015.

(2) Identified for IMT services on a co-primary basis. Effective now with various dates set for DSO (USA, 2009; Canada, 2011; Mexico, 2022).

(3) Brazil has opted to allocate 698 - 806 MHz for IMT on a secondary basis.

(4) The USA had decided earlier in 2003 to vacate broadcast services from the 700 MHz band.

(5) China, India, Japan, New Zealand and Singapore opted to identify the 698-790 MHz band, in addition to the 790-862 MHz band, which was accepted by all countries in the region.

(6) The European Commission adopted the policy of analogue shut-off for 790-862 MHz to take place 1 January 2012. COM(700)2007.

(7) The EC approved harmonized technical rules for the use of the 800 MHz band (790-862 MHz) for mobile broadband 2010/EU/267.

(8) In 2003 Ofcom allocated 112 MHz of spectrum for the Digital Dividend resulting from DSO..

Source: McLean Foster & Co., based on the ITU Radio Regulations 2006.

1.2.2.7 International Regulation and the Digital Dividend

Different allocations and standards for television took many years to evolve and were firmly in place when policy makers, regulators and the ITU first embarked on a course leading to the Digital Dividend.

Since the 1990s, the ITU's Radiocommunication Sector (ITU–R) has made a number of recommendations dealing with coding, compression and modulation techniques for digital terrestrial television broadcasting. These recommendations have contributed to the process that is finally yielding the Digital Dividend. For example, the pioneering Recommendation ITU–R BT.798 published 1 January 1994 stipulates "that digital television terrestrial broadcasting should fit in the channels (6, 7 and 8 MHz) intended for analogue television emission in the VHF/UHF bands". This Recommendation prohibited the bandwidth used for digital programmes to go beyond the analogue channel bandwidth and thus paved the way for the development of sophisticated digital compression techniques.

The Geneva 2006 Frequency Plan 2006 (GE06)

The Geneva 2006 Frequency Plan (GE06) Agreement resulted from the work of Regional Radio Conferences 2004 and 2006 and replaced the Stockholm Plan of 1961 (ST61) that established the broadcast frequency plan for Europe, Africa and many parts of Asia[16]. The GE06 Plan sets 17 June 2015 as the date when participating countries will no longer protect the analogue services of neighbouring countries and can then begin to use frequencies assigned to them in the GE06 Plan for transmission of domestic digital services. Implementation of the GE06 digital plan can occur during the transition period (between 17 June 2006 and 17 June 2015) but requires prior agreement of neighbouring countries that may be affected.

The GE06 Agreement has the binding force of a treaty and addresses 72,761 country requirements for the transmission of DVB-T and T-DAB services in frequency Band III (174-230 MHz) and DVB-T services in frequency Bands IV/V (470-862 MHz). Generally, countries have been allocated 3 T-DAB and 1 DVB-T "coverage layers" in the Band III and 7-8 DVB-T layers in Bands IV/V.

WRC-07: World Radio Conference Allocations

The World Radiocommunications Conference (WRC-07), held in November 2007, allocated the 790-862 MHz sub-band in Region 1 (covering the European Broadcasting Area and Africa) to the Mobile Service for IMT technologies such as 3G, 4G, WiMAX on a primary basis, except for aeronautical mobile, and on shared basis with the broadcasting service until 17 June 2015. Prior to WRC-07, the frequency band 790-862 MHz was allocated in Regions 1 and 3 to the broadcasting service and the fixed service on a primary basis and in Region 3 to the mobile service on a primary basis and, additionally, in nineteen countries of Region 1, to the aeronautical radionavigation service (ARNS) on a primary basis (RR No. 5.312).

WRC-12

Resolution 749 (WRC-07) and Agenda item 1.17 of WRC-12[17] tasks the ITU-R Sector "to conduct sharing studies for Regions 1 and 3 in the band 790-862 MHz between the mobile service and other services in order to ensure adequate *protection* of services allocated to the band and to take appropriate action."

In view of the complexity and importance of WRC-12 Agenda item 1.17 issues, a dedicated Joint Task Group 5-6 (JTG 5-6) was established to study how mobile service can share the band 790-862 MHz band with:

- the Broadcasting service (Issue A);
- the Aeronautical radionavigation service (Issue B); and
- the Fixed service (Issue C).

These issues were further sub-divided by cases according to either an ITU-R Region[18] (for Issue B and Issue C) or to whether the countries were or were not Contracting Members of the GE06 Agreement (Issue A). Appropriate methods have been proposed for each issue and case.

The work of the Joint Task Group in providing the text for the draft CPM Report addressing the results of sharing studies for fixed, mobile and broadcasting services in the band 790-862 MHz in Regions 1 and 3 was completed in May 2010 and indicates that there is a need to protect certain other primary terrestrial services from the newly allocated mobile service in Region 1. Of particular significance is ensuring coordination and interference avoidance between mobile services and aeronautical radionavigation services (ARNS) in those countries where ARNS has a primary allocation.[19]

Coordination between GE06 Contracting and Non-Contracting member states requires careful consideration of the spectrum sharing studies. Sharing options are outlined in the Annexes attached to the report. However, a number of interference issues are not yet resolved, suggesting that further study of interference issues is necessary. In some cases, a consensus could not be reached around a single option. The implication is that digital switchover will occur at different times over the period leading up to analogue shut-off.

Box 1.2: ITU-R Resolution 749

Resolution 749 (WRC-07) is referenced within RR No. **5.317A** and resolves:

1. to invite ITU-R to conduct sharing studies for Regions 1 and 3 in the band 790-862 MHz between the mobile service and other services in order to *protect* the services to which the frequency band is currently allocated;
2. to invite ITU-R to report the results of the studies referred to in *resolves* 1 for consideration by WRC-12 to take appropriate action."

Studies to be carried out

CPM 11-1 decided that JTG 5-6 is to conduct sharing studies for Regions 1 and 3 in the band 790-862 MHz between the mobile service and other services in order to protect the services to which the frequency band is currently allocated (see Annex 1-1).

Source: ITU-R Resolution 749 "Studies on the use of the band 790-862 MHz by mobile applications and by other services", at: www.itu.int/dms_pub/itu-r/oth/0C/04/R0C040000070001PDFE.pdf

1.2.3 How to use the Digital Dividend?

How the Digital Dividend is used varies from one country to another, owing to national circumstances such as the country's geographical position, size and topography, penetration of satellite/cable services, and spectrum usage in adjacent countries (see Regional Experiences in Section 1.4).

The issues of regulatory approaches, allocation and assignment, economic considerations such as economies of scale achieved through harmonization, and technical considerations such as interference, sharing and migration from analogue to digital broadcast are discussed in Section 1.2.4 – Issues.

This section begins with an overview of the main uses of and technologies involved in the Digital Dividend.

1.2.3.1 New Services and Technologies

The main uses for the Digital Dividend spectrum include both broadcasting and fixed telecommunication services, as well as a mix of both over mobile platforms:

- Digital Terrestrial TV – DTT;
- Broadcast Mobile TV;
- Commercial Wireless Broadband; and
- Commercial Wireless Broadband and Public Protection and Disaster Relief.

These services are described in more detail below.

1.2.3.2 Digital Terrestrial TV – DTT

DTT can be viewed either through free-to-air service or by subscription. DTT offers standard or high-definition channels on a national, regional, or local basis and uses much of the existing customer premise equipment (CPE) such as aerials, set-top boxes, and existing television transmitter equipment. The European Broadcast Union (EBU) claims that the UHF band (470-862 MHz) is the only band that can be used for widespread development of DTT services and argues that mobile telecommunications services, including wireless broadband services (e.g. WiMAX), can be deployed in several other frequency bands.[20] With respect to options such as Satellite, the EBU notes that restrictions on deploying dishes and issues with weather prevent Satellite from being a preferred technology of choice over DTT.

An issue related to DTT involves the choice between MPEG-2 and MPEG-4 compression techniques for countries that have yet to deploy DDT.[21] Early adopters had less choice in this matter; many early adopters opted for MPEG-2. The choice can now be made based on equipment cost and availability, with the cost of upgrading CPE to enable MPEG-4 thought to be low.

The size of the Digital Dividend will not be known until the choices are finalized and migration from MPEG – 2 to MPEG – 4 is more complete. A four-phase development is forecast to take place in many countries:

- conversion from analogue to SDTV (using MPEG-2);
- conversion from MPEG-2 to MPEG-4 AVC;
- choice between single frequency networks (SFN's) and multi-frequency networks (MFN's)[22]; and
- transition from SDTV to HDTV.

Whereas the first and second switchover phases will probably reduce spectrum consumption, the third one will require additional spectrum.[23]

1.2.3.3 Broadcast Mobile TV

Broadcast mobile TV is a very efficient multicast service that allows users with a mobile device to watch multiple TV channels in way similar to DTT. Broadcast mobile TV services are available in several countries including Austria, Finland, Italy, the Netherlands and the USA, using several technologies based on standards such as:

- Digital Video Broadcast – Terrestrial (DVB-T);
- Digital Video Broadcast – Handhelds (DVB-H);
- Digital Multimedia Broadcast (DMB);
- Advanced Television System Committee – Mobile/Handheld (ATSC M/H);
- Integrated Services Digital Broadcasting – Terrestrial 1 seg (ISDB-T 1seg); and
- China Mobile Multimedia Broadcast (CMMB);

The 470-862 MHz band is preferred by mobile operators for simultaneous use of broadcast mobile TV and GSM/3G services. Other bands could be used for broadcast mobile TV such as the VHF television band.

1.2.3.4 Commercial Wireless Broadband

Figure 1.9 shows the rapid growth in mobile cellular and mobile broadband subscriptions compared to the much slower growth in older technologies.

Not surprisingly, many ICT players hope that the Digital Dividend spectrum will be used for fixed or mobile wireless broadband services, especially to extend coverage in rural areas because of excellent propagation characteristics. Mobile broadband subscriptions are on the increase using two main technologies:

- UMTS/LTE: UMTS is widely deployed, especially throughout Europe, and plans are being made to deploy next generation technologies such as LTE.[24] European operators are moving towards LTE and coordination on spectrum pairs will be critical for Europe-wide deployments.
- Mobile WiMAX (802.16M) is being deployed in a number of countries, especially across Asia and the Americas, and is able to offer similar data rates using either Frequency Division Duplex (FDD) or Time Division Duplex (TDD) profiles. Mobile WiMAX will most likely be deployed using TDD.

The 470-862 band can be used for wireless broadband, however, it will be very important to coordinate and harmonize frequencies to achieve economies of scale and to achieve regional wide deployments. The US has already decided to deploy advanced wireless services in the 700 MHz band.[25] There are other bands that can be used for mobile broadband, especially those bands currently used for GSM services that will eventually be phased out.

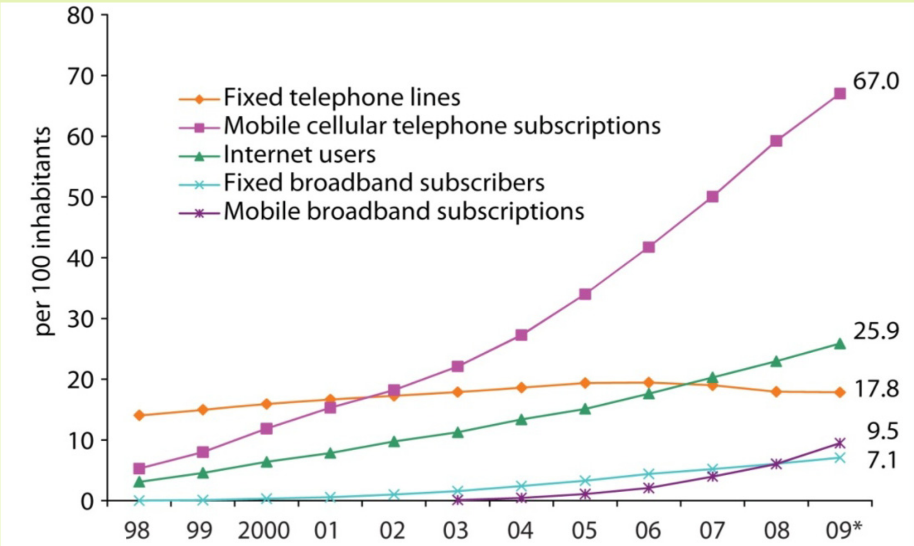
1.2.3.5 Public Protection and Disaster Relief

Frontline Public Protection and Disaster Relief (PPDR) agencies need to be able to communicate reliably and effectively with first responders and emergency services in order to coordinate responses to disasters. Traditionally, this coordination has occurred using telephony-based, voice communication. Existing standards for public protection and disaster relief services support voice and narrowband networks. There is increasing demand for broadband applications and services, however. Spectrum below 1 GHz is viewed with interest as being the most suitable for a range of new capabilities.

1.2.4 Issues

Decision-making processes for digital switchover and potential uses of the Digital Dividend, along with spectrum re-allocation decisions, have been driven essentially by political considerations. In some cases, these decision-making processes have pitted one set of interests (telecommunication operators and service providers) against other influential and powerful interests such as consumers[26] and stakeholders such as government departments and broadcasters (e.g., the European Broadcast Union). This section discusses some issues related to using the Digital Dividend and changes that may be required to leverage the Digital Dividend.

Figure 1.9: Mobile Subscriptions to Reach 5 Billion in 2010



*Source: ITU World Telecommunication/ICT Indicators Database * Estimate.*

1.2.4.1 Regulatory Frameworks Differ

This section provides an overview of international, regional and national regulatory frameworks. In addition, regional political institutions such as the European Commission significantly influence the nature, extent and timing of re-allocation decisions and the technical rules that affect the size and scope of the Digital Dividend.

As discussed in section 1.2.2.7 above, the ITU acts to harmonize the efficient use of the spectrum resource on a global basis on behalf of governments. Ultimately the implementation – how and when recommendations and regulations are implemented – rests with national governments. Allocations of radio spectrum are agreed upon at the ITU World Radiocommunication Conferences (WRC) for each ITU Region, and the Radio Regulations are then revised. Agreements on changes to allocations made at WRCs have treaty status, and international harmonization and coordination of spectrum allocation are essential for many public sector services such as transport.

Practices across regions vary and decisions made about spectrum allocation vary across the three ITU regions. Region 1 has multiple sovereign markets and attempts a unified approach. Region 2 is dominated by the US and often reflects a single market approach whereas there multiple sovereign markets and no real unified approach across Region 3 encompassing Asia-Pacific and Oceania.

In Europe, common positions in relation to WRC agenda items are developed by the European Conference of Postal and Telecommunications Administrations (CEPT); the CEPT includes 48 European member states. The European Union presents a particularly situation since broad policy in terms of goals, direction and timelines is set on a pan-national basis while the detailed implementation of policy is left with individual countries.

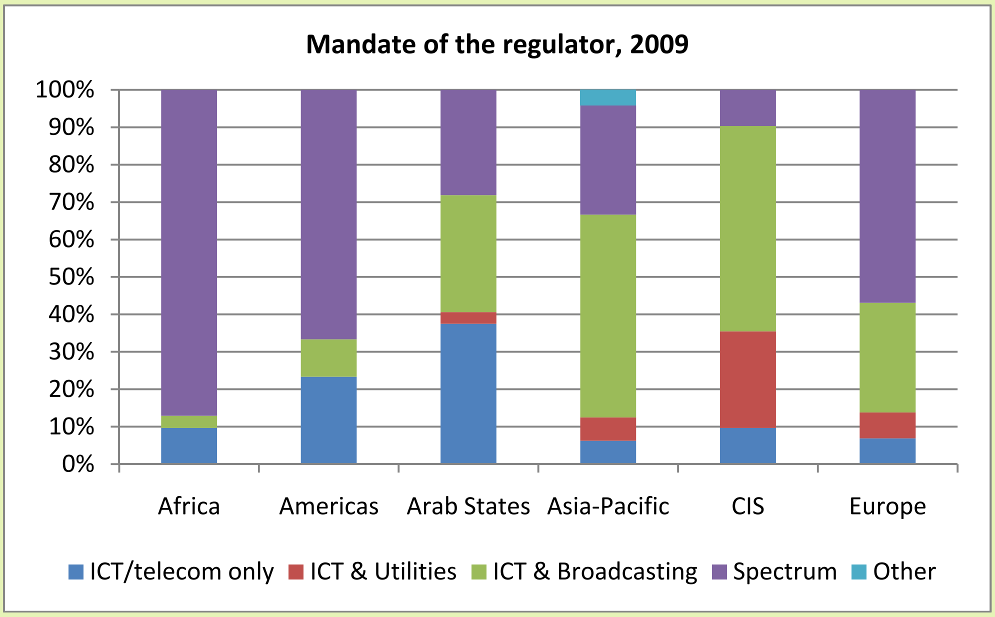
Much like North and South America, outside of the GE06 agreement, there is no formal process for setting a common agenda in Asia to coordinate and harmonize spectrum use and the Digital Dividend.

At the national level, the regulatory framework for broadcast and telecommunications is characteristically diverse:

- in some cases, there is one regulator for both broadcast and telecommunications, and
- in other cases, the regulation of these services is divided between separate regulators.

Figure 1.10 illustrates the issue by showing that there is no consistent pattern in regulatory mandate and function across the regions of the globe.

Figure 1.10: Regulatory Functions



Note: Those regulators dealing with more than one area (i.e., ICTs & broadcasting and spectrum) are counted twice.

Source: ITU World Telecommunication Regulatory Database.

At the policy and standards level, the same diversity is evident. For example, for television systems, different standards apply to various regions around the world. As previously noted, there are three dominant analogue television standards: NTSC, PAL and SECAM. There have been some intensive efforts made to achieve cooperation at the regional and trans-regional level to smooth out the process and simplify the inherent diversity. The Geneva Frequency Plan referred to as GE06 is a prime example.

1.2.4.2 Allocation and Assignment

Two topics are explored in this section. The first involves contrasting public and private goods and considering how the differences influence the debate on how to use the Digital Dividend. The second topic involves a discussion of how certain services, say public broadcast, strongly influence the allocation and assignment process and the choice between administrative and market-based methods.

How are public goods defined? Publicness is a technical term that refers to the impact of one more user of a particular service on the consumption opportunities of other users. The “pure public good” is one where the addition of one more user has no effect at all on how much anyone else can consume -- an additional viewer of a national news broadcast, for example. On the other hand, there is the “pure private good" case where consumption by one person leaves nothing for anyone else, such as high power transmitters blocking out other transmitters.

Across various regions and in many countries, broadcast activities may be found at many points along the spectrum that runs from pure public goods to pure private goods, making pure comparisons of public-value and market-value a difficult task. An important feature of public goods is that they are often strongly defended by those who benefit the most from their availability.

In choosing how much spectrum to allocate and for whom, regulators not only place emphasis on market valuations and economic efficiencies but also on social, development and cultural goals. Market mechanisms do not necessarily or easily take public policy priorities into account, and so in the case of broadcast governments often intervene in allocation decisions to ensure that public-value broadcast content is available.

Public value is therefore strongly defended and yet it is hard to quantify because it is difficult to measure in terms of incremental spectrum assignments. Administered Incentive Prices (AIP) and the measurement of marginal benefits is one approach being used in a range of countries that can help in determining where the balance lies between broadcast and other services such as mobile services.

1.2.4.3 Reserving Spectrum for Future Use

Along with the discussion on current uses of the Digital Dividend spectrum, spectrum regulators are also faced with issues related to future use. Should some of the Digital Dividend be reserved for future use? The central issues are the uncertainty over the best use of the reserved spectrum both now and in the future and the lack of information available, as well as the potential for regulatory decisions to have undesirable effects on the incentives for spectrum efficiency. Ofcom in the UK conducted an assessment of the potential significance of regulatory failures. It determined that regulatory decisions to reserve the Digital Dividend for potential uses are prone to regulatory failure (see Box 1.3).

Box 1.3: Reserving the Digital Dividend for potential future uses: the view of the UK regulator

In Ofcom's view, a market-led approach to determining the uses for the Digital Dividend is superior because:

- Where there is considerable uncertainty over the highest value future use, market mechanisms can help to ensure that the spectrum is used by those who value it the most. Markets allow the superior information held by participants to be revealed and combined in order to identify those who have the highest value.
- Market mechanisms also help to resolve uncertainty because markets help to reveal information about how much a resource is worth to others.
- Finally information about value and flexibility of use give users strong incentives to get the most out of the spectrum they own and hence to ensure efficient use in the longer term and promote innovation. The ability to make these changes and to be flexible in responding to unforeseen changes quickly is particularly important for promoting efficient spectrum use in the longer term.

Source: Ofcom UK, Digital Dividend Review 2007.

1.2.4.4 Interference

Interference issues are never simple. In the case of the analogue switch-off and the Digital Dividend, interference issues are complicated by the scale of the change in terms of regions and countries and the range of potential options, including fixed, mobile, broadcast and the presence of new and evolving technologies.

Two main types of interference likely to occur:

- adjacent channel interference, which occurs between radio systems operating in neighbouring frequencies, and
- co-channel interference, which occurs between radio systems sharing the same frequency.

In the UHF spectrum, for example, several interference problems are likely between DTT and wireless broadband base station receivers, mobile and aeronautical radionavigation systems, and similar systems in border areas or where high-power transmitters are being used.

Solutions to interference issues involve well-established international coordination steps for border areas as well the creation of band plans providing sufficient guard bands between services. As mentioned earlier, the ITU Joint Task Group 5-6 created at WRC-10 was mandated to conduct sharing studies to help resolve potential interference issues. The results of the work done will be considered at WRC-12. Some interference issues will likely require further consideration.

The European Broadcast Union states that deploying two-way mobile communications services and wireless broadband services alongside broadcasting could result in unacceptable interference to broadcasting caused by mobile terminals.[27] This type of interference from portable transmitters is very difficult to predict and prevent. In particular, where channels 61 to 69 (i.e. 790-862 MHz) are used by mobile services, broadcasting services using adjacent channels (i.e. channel 60 and below) will experience interference unless specific technical limitations are imposed to mobile services. These technical limitations could include power limitations, restrictive spectrum masks, and guard bands, for example.

1.2.4.5 Migration

It is generally accepted that it is in the public interest to ensure that the exploitation of the Digital Dividend is managed as efficiently and effectively as possible, that results satisfy the maximum demand for spectrum, and that obstacles to efficient use are removed by policy makers and regulators. This should be a fundamental goal of spectrum policy and should be a general guide to the main proposals coming out of coordination efforts by policy makers and regulators. If the Digital Dividend is properly organized and if the results are coordinated and harmonized, then a wide range of uses is possible, as virtually all common wireless applications could make use of this part of the spectrum.

If we are to achieve the goal of efficient and effective use of the Digital Dividend, an important issue centres on who should lead the migration process. Is it the policy maker, the broadcast regulator, the telecommunication regulator or the spectrum agency?

Ultimately, irrespective of whether the debate on the Digital Switchover and the Digital Dividend is initiated within a ministry, regulator or by a private sector interest, the decision to switch-off analogue broadcast services is very much a political one. This decision involves trade-offs between cultural, social, and economic objectives and the decision is strongly coloured by historical considerations and, quite likely, security concerns. Successful switchover strategies depend on effective communication with the public, as well as, in some cases, some form of incentive or subsidy, generally funded through public revenues, to equipment suppliers service providers and consumers. (See the experience of the US and South Africa in Section 1.4.)

The political decision is then followed by decisions that should directly support the goal of efficient and effective exploitation of the Digital Dividend. Who makes these decisions will depend on the legislated powers and roles of various authorities within the regulatory framework.

Table 1.3 matches decisions with stakeholders.

The ITU has recently prepared Guidelines for the Transition from Analogue to Digital Broadcasting to facilitate the Digital Switchover and to leverage the Digital Dividend spectrum. These guidelines identify and distinguish many technical considerations, such as the main DTTB or MTV network elements.[28]

Table 1.3: Digital Dividend Decisions and Stakeholders

Required Decision	Entity/Stakeholders
Analogue Shut-off	Essentially a political decision taken by the political authority (the legislature), likely led by a ministry or a regulator
Digital Dividend – Size and Allocations	A complex set of issues combining economic, social, and technical considerations with a critical need to coordinate and harmonize results ensuring maximum benefits. The process and decisions are best suited for entities primarily responsible for policy assessment and policy setting, aided by technocracy and user input (through public consultation processes, etc.).
Technical Standards	Requires decisions and collaboration amongst regulatory agencies.
Interference Management	Best suited to the spectrum management agency.

Source: McLean Foster & Co.

Box 1.4: Technical Considerations in Implementing DTT

1. Television presentation formats: for DTTB platforms either Standard Definition Television (SDTV) and/or High Definition Television (HDTV) and for MTV platforms a minimum bit rate per service;
2. Transmission standard: for DTTB platforms e.g. DVB-T or ATSC and for MTV platforms DVB-H or T-DMB;
3. Compression technology: for DTTB platforms MPEG2 or MPEG4 and for MTV platforms e.g. H264/MPEG-4 AVC or open;
4. Conditional Access (CA) systems and Digital Rights Management (DRM): interoperability between deployed systems for respectively DTTB and MTV platforms;
5. Application Programming Interface (API) for additional and interactive services: for DTTB platforms e.g. MHP or proprietary and for MTV platforms specific technical requirements to support integration between broadcast TV and 3G mobile TV networks.

Source: ITU, Guidelines or the Transition from Analogue to Digital Broadcasting, May, 2010, www.itu.int/publ/D-HDB-GUIDELINES.01-2010/en.

Section 1.5 – Regional Examples provides an overview of national experiences in migrating from analogue to digital radio and television broadcasting. As well, a summary of best practices based on existing models and internationally adopted policies appears in Section 1.4 – Best Practices.

1.2.5 Economic Value

1.2.5.1 Valuing the Digital Dividend

Europe has lead the way in studying the value of the Digital Dividend in member economies, believing that harmonization efforts at a National and European level can help to achieve significant benefits.

> *"As a result of the switchover from analogue to digital TV, tremendous spectrum resources will become available for other uses, especially for wireless broadband. The incremental value of using the Digital Dividend spectrum for wireless broadband across the EU is estimated to be between EUR 150 – EUR 200 billion. The Digital Dividend could allow Europe to extend its leadership in electronic communications services, creating growth and jobs, increasing productivity and giving greater access to broadband services for all Europeans."*[29]

The European Commission refers to an estimate in the value of the Digital Dividend that exceeds EUR 150 billion, which is about 2.2 per cent of the annual European GDP for the total value of electronic communications services that depend on use of radio spectrum in the EU. Radio spectrum has an essential role as an enabler for growth, as was pointed out in the i2010 initiative.

There are many complex steps and skills (which often go beyond the capabilities of regulators in developing countries) that are involved in determining a measurement of the value of Digital Dividend spectrum. Measuring this value requires the development and assessment of economic, financial, and infrastructure models; a deep understanding of local markets and sectors such as education, banking and manufacturing and an understanding of the interaction of the sectors with new technologies; assumptions about technology choices; and the impact of the Digital Dividend on incomes, employment, investment in new technology, growth in productivity, etc. Development of robust models and determination of reliable estimates play a central role in deciding how best to use the Digital Dividend.

Significant estimates of the economic value of the Digital Dividend in the EU have been made and are provided below in Table 1.4.

An excellent example of the value of Digital Dividend spectrum determined by market based methods is the 700 MHz Digital Dividend spectrum auction completed by the FCC in 2008 which raised over USD 15 billion. The auction determined a spectrum price for the spectrum. It did not determine the value of Digital Dividend spectrum in terms of overall benefits to the economy such as the range of estimates depicted above in Table 1.4.

1.2.5.2 Harmonization

When regulators set standards for services, they aim to achieve interoperability to gain economies of scale. Careful consideration is needed in setting standards in order to balance the pros and cons affecting local market dynamics.

At present, there are two basic models for harmonizing standards in an efficient manner:

- Mandating single technologies and standards: this model delivers full harmonization and most potential for reaping the benefits of economies of scale and interoperability, or
- Letting the market decide how services will develop; this approach ensures maximum choice for consumers.

There is strong pressure to adopt both models in some capacity since both of the above models have a downside:

1. Mandating of technologies and standards – picking a winner by regulation – involves the risk that the wrong standard will be selected, which would have serious consequences such as hampering innovation, impairing service roll out, and and reducing technology take-up. Unfortunately, this problem has occurred often enough to consider this is a high risk.

Table 1.4: Estimates in Value for the Digital Dividend

Use	Assumptions	Valuation
Digital Terrestrial Television	Six DTT multiplexes in each Member State requiring 48 MHz when using National SFN's (8 MHz channels per SFN) and 384 MHz when using MFN's (64 MHz spectrum channels per multiplex).	Between EUR 130 Billion and EUR 370 Billion discounted over 15 yrs.
Mobile Television	One multiplex using either 8 MHz per SFN or approximately 48 MHz for an MFN.	Between EUR 2.5 Billion and EUR 25 Billion discounted over 15 yrs.
Wireless Broadband	Use of a 72 Mhz sub-band within the 470-862 MHz band for wireless broadband services.	Between EUR 50 Billion and EUR 190 Billion discounted over 15 yrs.
Total		Between EUR 182.5 Billion and EUR 585 Billion discounted over 15 yrs.

Source: Exploiting the Digital Dividend – a European Approach, Analysis Mason, DotEcon, Hogan & Hartson, 2009.

2. A lack of harmonized standards increases the risk of favouring first-movers (e.g. those acquiring a licence first) and technology-led market power. Once such market power is established, regulation can be imposed only by bearing high costs (e.g. for expropriating investors). Moreover, absence of harmonization leads to fragmented markets, especially for small home markets.

The Guidelines for the Transition from Analogue to Digital Broadcasting developed by the ITU are helpful in providing guidance on the extent to which standard definitions should be flexible, demonstrating the balance between prescribing standards and allowing the market to determine them (see box 1.5 below).

With respect to standards, the Guidelines offer useful references to technology regulation best practices in countries where the Digital Switchover has already taken place or is imminent. Table 1.5 illustrates the similarity of choices made by regulators in various countries.

It is worth noting that with respect to compression technology, MPEG2 or MPEG4, there is complete agreement on an approach that remains neutral and that does not require the adoption of one or the other compression technology. However, it should be noted that, as time goes on, this issue will become increasingly moot as the assumption of HDTV television formats become widely accepted.

Box 1.5: Harmonization principles in migrating to DTT

It can be concluded that, in most cases, the Regulators seek to strike a balance by not prescribing or recommending technologies/standards for all system/network elements but only for selected elements.

- For example, the Regulator prescribes the transmission standard (e.g. DVB-T) but leaves the television presentation format (either SDTV or HDTV) for the market to decide, defining a minimum set of standards and leaving room for entrepreneurship in developing new services.
- The Regulator does not lay down standards for all multiplexes but only for a selected number of multiplexes. For example, the Regulator prescribes one multiplex to be operated on the basis of the DVB-H transmissions standard (for the provision of a MTV service) and leaves the rest of the available multiplexes technology neutral.[30]

Source: ITU, Guidelines or the Transition from Analogue to Digital Broadcasting, May, 2010, www.itu.int/publ/D-HDB-GUIDELINES.01-2010/en.

Table 1.5: Choices in Technology Regulation

Country	TV Presentation Format	Transmission Standard	Compression Technology	Additional Services
Belgium	Neutral	S	Neutral	Neutral
Denmark	R	S	Neutral	Neutral
Finland	Neutral	S	Neutral	Neutral
France	S	S	S	Neutral
Germany	Neutral	S	Neutral	Neutral
Rep. of Korea	S	S	S	Neutral
UK	Neutral	S	Neutral	Neutral
US	S	S	Neutral	Neutral

R=Recommended

S=Stipulated

Source: ITU – Guidelines or the Transition from Analogue to Digital Broadcasting, p. 17[31]

1.3 Policy Options Related to the Digital Dividend

Policies to promote ICT access and innovation and to contribute to development are commonly shared by ITU Member States. This section describes important policy considerations. How these goals and objectives translate into practical approaches to handling the Digital Switchover and the Digital Dividend can differ due to varying geographical, cultural, social and economic features of each country.

1.3.1 Market-Led or Regulatory Intervention?

Several approaches exist to determine how many services and what technology options should be chosen for the use of the Digital Dividend. Regulators can choose between market-led approaches and regulatory intervention. Even in highly liberalized markets that allow for more flexibility through service and technology neutral licensing, policy makers and regulators usually consider social, cultural and developmental objectives. Simply put, there are trade-offs between economic and value considerations and access to broad forms of media and content.

Under a market-led approach, the national spectrum manager releases the spectrum in a way that permits the widest possible range of technologies and services to be deployed. It is left to the market to determine how the Digital Dividend should be used. This allows more flexibility for users to change the use of spectrum over time, reflecting changes in technology and the preferences of citizens and consumers.

The interventionist approach, by contrast, places regulatory limits on the way that the Digital Dividend spectrum can be used. This approach selects particular uses or users by reserving spectrum for them and/or excluding others from gaining access.

Spectrum has traditionally been managed in an administrative way with regulations detailing who can use spectrum, for what, and how. As scarcity of spectrum has increased with the advent of new technologies and services (see section 1.2.2 above), approaches to spectrum management have been changing. This is now more emphasis on market mechanisms and flexibility for users and less resort to regulation.

Choosing a market- led approach to the Digital Dividend reflects a wider strategy for spectrum management that involves reducing regulation and making more use of market mechanisms. However, there is increased risk of market failure: the risk that markets might not deliver the best outcome for citizens and consumers in all circumstances. One key concern in considering the risk of market failure is coordination of the demands of a large number of small users, i.e. individuals and local broadcasters in a market test of one service versus another or in gaining access to spectrum. Measuring social value is another concern since some services may provide greater opportunities for growing participation in civil society. The assessment of the approaches comes with cautionary guidance: a decision to not intervene because the economic value of the Digital Dividend exceeds broader social value does not mean that the presence of broader social values are unimportant.

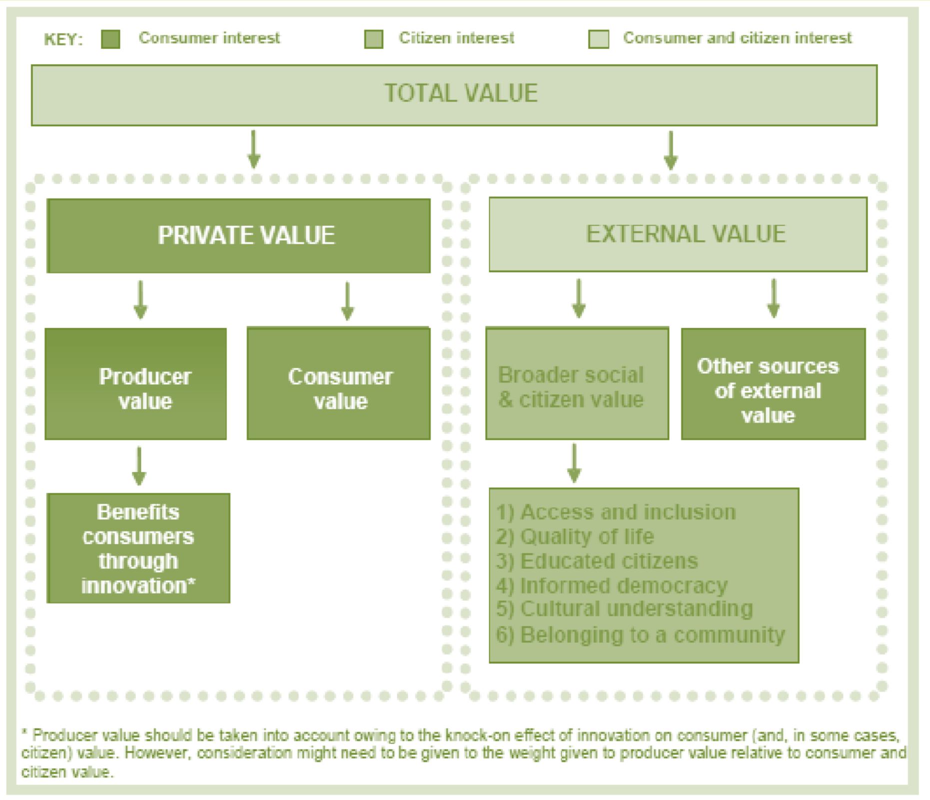
If a decision to intervene is made to set aside spectrum, what potential value is lost? For example, such a decision may result in the loss of the opportunity of universal access to mobile broadband services. To answer this question and to address concerns properly requires a clear analytical framework where the potential benefits and the potential costs of intervening are considered and measured. The framework should include opportunities for consultation with stakeholders and consumers. An example of framework used by one regulator appears in Figure 1.11.

The key question for the allocation of the Digital Dividend appears to be what is the best way of maximising the total value to society and what are the trade-offs. Assessing the trade-offs is important in considering whether to intervene or allow markets to determine how the Digital Dividend is to be used. The UK regulator, Ofcom, has suggested a framework for helping with assessing the two approaches. The Ofcom framework appears in Figure 1.12 below.

1.3.2 Universal Access

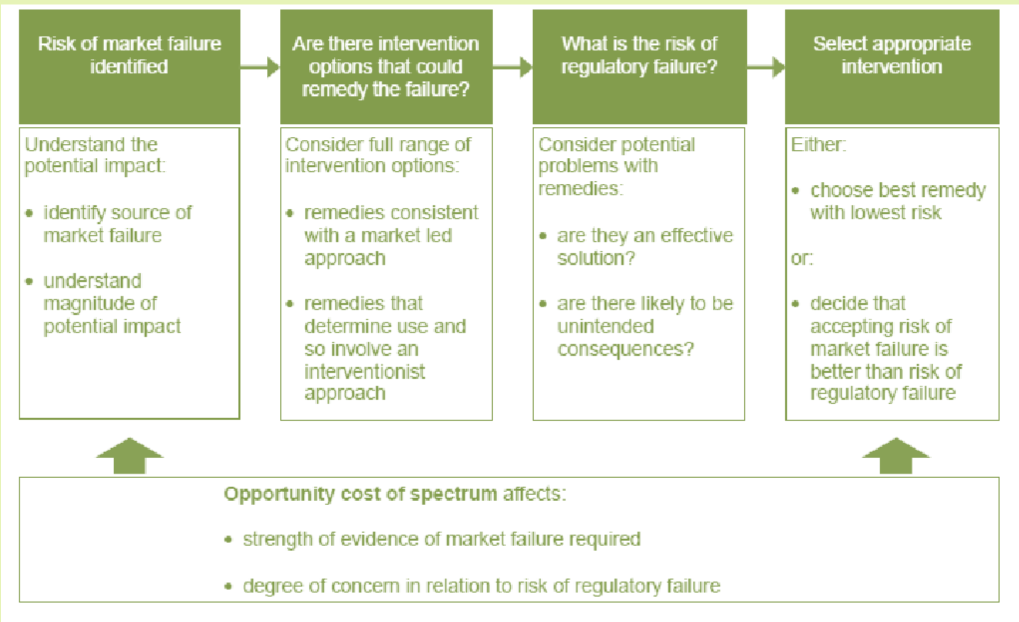
Universal access is a widely accepted core policy goal that contributes to sustainable growth by ensuring access to key services at a low cost to as many as possible. Education and healthcare are two chief areas of social inclusion. Universal access to ICTs helps in developing digital skills necessary in a modernizing economy and brings modern effective healthcare to isolated regions and communities. Universal access has traditionally meant access to telecommunications and broadcast services, sometimes in the form of public security and emergency broadcast. Access to broadband has entering the equation of universal access only recently.

Figure 1.11: Total Value Framework



Source: Ofcom 2007, Digital Dividend Review.

Figure 1.12: Approach to Trading Off Market Led and Interventionist Approaches



Source: Ofcom 2007, Digital Dividend Review.

The use of Digital Dividend spectrum to meet universal access goals such as access to wireless broadband is an important policy consideration. However, the likely importance of terrestrial TV in developing countries as an inexpensive means to distribute news, culture and entertainment to the broad public cannot be overlooked.

The 2002 European Commission Universal Service Directive requires national governments to periodically review which services are to be included in the bundle of universal access services. Countries such as the Republic of Korea and Canada[32], as well as a number of developing countries as varied as Kazakhstan, Malaysia, Nigeria and Sri Lanka,[33] have either mandated or are considering altering the conventional policy view of universal access and including access to broadband services.

1.3.3 Growth, Innovation and Competition

The benefits of increased spectrum efficiency are widely accepted to include promoting growth, innovation, and competition derived from liberalized and more flexible spectrum use. In general, improvements are gained because:

- existing users are motivated to make better use of their spectrum;
- the true value of spectrum is revealed;
- new entrants stimulate competition in downstream markets; and
- new services are adopted more quickly and cheaply through innovation.

Keeping these considerations in mind is important when determining how to use the Digital Dividend. A case can be made that a balanced approach to promoting growth, competition and innovation, as suggested by the European Commission, should be sought between the two highest value uses, namely DTT and wireless broadband.[34] The 2008 European Economic Recovery Plan published by the European Commission at the height of the financial crises identifies high-speed Internet connections as powerful means of promoting rapid technology diffusion that in turn creates demand for innovative products and services.[35]

The European Broadcast Union has steadfastly promoted the idea that preservation of TV channel provisioning is needed to support DTT becoming a viable competing platform.

> *The terrestrial broadcasting platform represents a unique combination of elements such as technical excellence and efficiency, favourable coverage and service characteristics, flexibility, market success and wide support across the industry as well as by the public in most European countries. It serves equally well public service broadcasters and commercial broadcasters as well as many other players in the value chain. As a result the terrestrial broadcasting platform generates significant social and economic benefits. It would be very difficult to replicate such a powerful mixture on another platform*[36]*.*

The Total Value Framework illustrated in Figure 1.11 shows how economic and social considerations can be combined to facilitate the analysis needed to determine which approach is best suited to deciding how to use the Digital Dividend in the most effective and efficient way. Section 1.2.5 – Economic Value outlines how economic tools can be used to determine the comparative value of spectrum in different uses in order to help answer the fundamental question for regulators: how to maximize the benefits to society from the use of the Digital Dividend spectrum.

1.3.4 Public Safety Requirements

Taking a co-ordinated approach to communications standards and interoperability is necessary to ensure efficient future use of government resources and reliable communications under adverse conditions. Decisions to use spectrum for public protection and disaster relief purposes (PPDR) usually take place at the national level and comprise values more akin to public goods than commercial or private goods (although not exclusively public). The benefits of a coordinated approach are seen as:

- ensuring that the technological, operational, and organizational benefits of collaborative operation can be maximized by all PPDR agencies in central and local governments, and
- the strengthening of effectiveness and the improvement of the resilience and reliability of the systems deployed.

In Europe an effort has been made through the European Conference of Postal and Telecommunications Administrations (CEPT) to harmonize an approach for a public safety allocation in the 470-862 MHz band. In this case, as in others, even if a public safety network is considered valuable it is important to consider the opportunity cost of displacing other services.

1.3.5 Economies of Scale and Interoperability

It is generally accepted that economies of scale in ICT equipment manufacturing and interoperability translate into lower costs to consumers leading to universality of service access. Economies of scale are aided by common radio frequency allocations and common technical standards. Strong linkages exist between increased usage and penetration and economic growth.

The policy concern revolves around several service and allocation options or scenarios that may be considered for DTT, broadband or other services. For example, of three options considered by the EC, the option creating the highest probable value involves broadband in the 790-862 MHz sub-band and DTT in the remainder of the 460-790 MHz band. The recommendation for policy makers is to carefully consider various options while weighing consumer value and economies of scale.

1.3.6 Using Interleaved (whitespace) Spectrum

The first step in determining whether it is feasible to use whitespace spectrum involves knowing the extent to which whitespace spectrum exists in a geographic area. There are several options for the use of whitespace spectrum:

- Allowing the use of unlicensed devices;
- Assigning whitespace spectrum to local broadcast;
- Allowing existing users to share the spectrum;
- Assigning whitespace spectrum to a band manager who manages the spectrum for users; and
- Choosing between market based or administrative assignments.

Study will be necessary and consultation with stakeholders should be done in every case to communicate how technology may affect whitespace spectrum in certain locations and to obtain input into decisions on appropriate options and strategies.[37]

The experience of some European countries is summarized in Box 1.6 below.

1.4 Regional Experiences

In this section, examples from each of the three regions of the ITU are given with respect to how the digital switchover has taken place or is planned; examples of the tools and mechanisms adopted in each of the three regions to facilitate the transition and use of the Digital Dividend are also provided.

1.4.1. Region 1

1.4.1.1 European Union

In Europe, a crowded place, the nature of terrestrial broadcasting signals requires careful planning of frequencies. The ITU Regional Radiocommunication Conference (GE06) establishes detailed allotments for each country based on the prospect of digital transmission replacing the analogue television regime adopted in 1960. Within the European Union, the latest date for analogue switch-off is 2012. GE06 leaves significant scope for flexibility in implementing the plan. First, there is a high degree of flexibility regarding the location of transmitters within the service area and interference envelope in the plan. Secondly, a declaration was signed that permits services other than broadcasting, provided they do not cause interference to allotted broadcast frequencies and will not receive any protection from interference beyond what would be granted for broadcasting use.

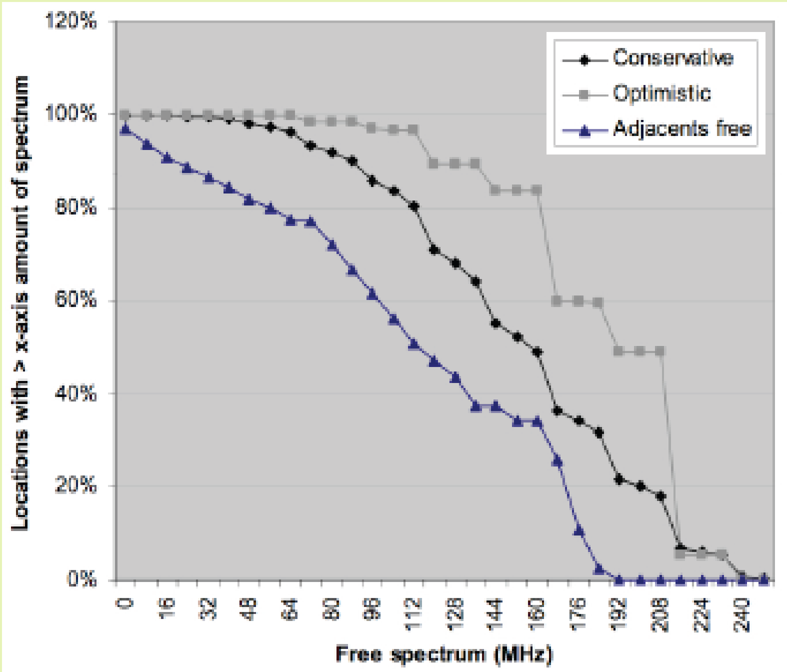
The view of the European Commission is that the spectrum making up the Digital Dividend is currently highly fragmented into relatively narrow bands, scattered over many frequencies, and intertwined with digital broadcasting channels.

> *These circumstances are a consequence of regional spectrum planning options adopted at the ITU Regional Radiocommunication Conference, which produced an international plan, the Geneva 2006 agreement, on the basis of traditional broadcasting use. Some flexibility is provided in the Geneva agreement to open up the spectrum to other uses. However, this flexibility is limited under the existing technical conditions and, in practice, the current situation is not conducive to the allocation of this spectrum to more efficient alternative uses.*[38]

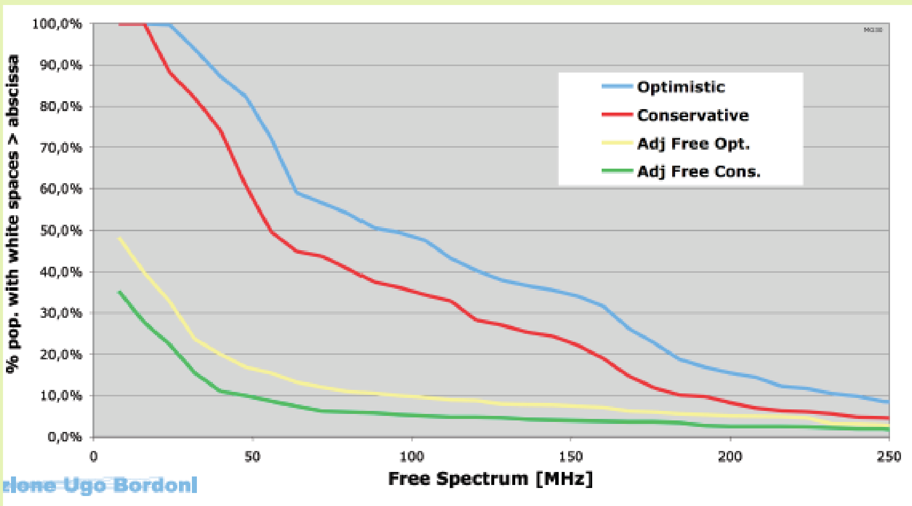
Box 1.6: Amount of free interleaved spectrum in the US, UK and Italy

In the US, a recent study concludes that urban and sub-urban areas in addition to rural areas could derive substantial benefit from whitespace spectrum. They conclude that overall, the opportunity provided by TV whitespaces is "potentially of same order as the recent release of "beachfront" 62 MHz of 700 MHz spectrum for wireless data service". In an era and in a country stretched for spectrum, this is a sizeable market opportunity and one which industry is keen to exploit.

After the Digital Switchover in the UK, interleaved spectrum exists at 248 MHz. But the amount of interleaved spectrum in any given location depends on whether both adjacent channels are required to be free.



Similar estimates have been produced for Italy, where switchover has already been completed, by population density, with both conservative and optimistic projections.



Source: How much white space capacity is there? Harrison et al, 2010, IEEE DySPAN 2010; Guido Riva, Ugo Bordoni Foundation.

In 2007, the European Commission adopted a Communication COM(2007)700 that describes the nature and opportunities of the Digital Dividend and that demonstrates the added value that can be derived from a common approach at EU level. Within Europe, France, Sweden, Finland, Germany, and Switzerland have already decided to use the sub-band for Mobile Services. Those countries have already started very intensive coordination meetings to liberate the 790-862 MHz sub-band from broadcasting services. In other countries like Austria, Czech Republic, and Ireland, spectrum regulators have opened consultations, and decisions will be taken very soon.

1.4.1.2 United Kingdom

The UK Government decided in 2003 to create a Digital Dividend of 112 MHz from 368 MHz of spectrum used by analogue terrestrial broadcast leaving 256 MHz for transition to DTT. The Digital Switchover began in 2008 and will be completed by 2012.

In 2007, Ofcom concluded a Digital Dividend Review[39] that included a consultation with stakeholders on how to allocate and award the Digital Dividend. Digital Dividend spectrum is to be assigned using auctions and packaged in such a way as to permit the maximum number of uses. It was not reserved for mobile or broadband uses. Ofcom also decided to continue permitting the use of interleaved spectrum (the frequencies used by terrestrial television and shared by low-power application) for programme-making and special events (PMSE). Channel 69 was assigned on a national licensed basis for PMSE.

In 2008 and 2009, Ofcom determined that, since an increasing number of European countries were identifying a Digital Dividend in the 800 MHz band (which is different from the UK), it was important to align with the European approach. In Ofcom's view, such an alignment would allow the UK to derive benefits from international economies of scale in equipment manufacture and from having fewer restrictions on how the spectrum could be used, particularly for the next generation mobile broadband services. However, refarming the 800 MHz band and clearing it of existing and planned authorized users (a significant number of digital terrestrial television transmitters and an overwhelming majority of wireless microphones) were necessary. The costs and benefits of clearing the 800 MHz band were examined and a consultation document was published in February 2009.[40] It was determined that significant net benefits, conservatively estimated at £2-3 billion in net present value, would result. Accordingly, in 2009, Ofcom decided to clear the 800 MHz band. In August 2010, it issued a statement that the UK Government had decided to provide new spectrum licences in another band and partial equipment replacement funding to Channel 69 programme-making and special event licensees using a formula that, on average, provides 55 per cent of the replacement cost for new equipment.[41]

1.4.1.3 Germany

The analogue shut-off of terrestrial broadcasting in Germany was completed nationally at the end of 2008. In July 2009, broadcast radio spectrum for fixed and mobile services in the frequency range for the Digital Dividend (790-862 MHz) was released by amending the frequency allocation ordinance with the agreement of the federal states. Bundesnetzagentur (BNetzA), the German regulator, conducted a large mobile frequency auction, including Digital Dividend frequencies, in May 2010. Existing mobile operators, as well as new parties such as cable network operators, infrastructure operators and wholesalers were involved to participate in the bidding. The frequency package generating the most interest was a block of 60 MHz of so-called Digital Dividend spectrum in the 800 MHz range, which was divided into six blocks of 2x5 MHz each.

1.4.1.4 France

Whereas Germany completed analogue shut-off in 2008, France continues to phase in the Digital Switchover with the deployment of Digital terrestrial TV (DTTV). By January 2010, it covered 89 per cent of the population of Metropolitan France.[42] National free-to-air broadcasters are required by law to cover 95 per cent of the population by November 2011. Furthermore, in those départements where the coverage will be lower than 91 per cent of the population, CSA requested that the broadcasters ensure operation of all the sites that cover at least 500 inhabitants. Analogue terrestrial TV is planned to be switched off as of 30 November 2011.

Independent of each other, France and Germany announced strategic orientations for the future use of the Digital Dividend, in particular with the aim of opening up the upper part of the Digital Dividend (the 800 MHz band) for wireless broadband and advanced electronic communication services.

1.4.1.5 Africa

Very few African countries have taken steps to begin planning the launch of digital terrestrial TV (DTTV) platforms because there is limited consumer demand for the service. Not many consumers have the necessary disposable income to afford a subscription to

DTTV, and many prefer other ICT services such as mobile phones.

It has been suggested by some that a better priority for African regulators would be to focus on access to broadband services given that the macro-economic effects are relatively well understood and can be anticipated. It might make more sense for many African countries to use any excess spectrum for the deployment of mobile broadband networks since spectrum below 900MHz is very well suited for rural networks because the favourable propagation characteristics of the band lead to reduced costs for wireless broadband roll-out. In other words, spectrum below 900MHz requires fewer base stations to connect more people.

1.4.1.6 South Africa

The switch-on date for DTT broadcasting occurred towards the end of 2008 whereas switchover dates for analogue broadcast occurred in stages in an effort to minimize the costs of digital migration. Fifty per cent of the population was to have coverage quickly; 80 per cent of the population was to have coverage by 2010; and 100 per cent was to have coverage by 1 November 2011.[43] However, The Independent Communications Authority of South Africa (ICASA) has recently indicated that South Africa's switch over to digital terrestrial television (DTT) will be delayed until at least 2013. ICASA cites lack of availability of locally manufactured set-top boxes and delays in promulgating regulations as the reasons for the postponement of the full Digital Switchover.

As a means to achieve universal service and access to DTT, government policy established that basic set top box prices would be set low and they would be sourced from South African suppliers. The price for the set-top boxes will be in the region of R800 each, and Government is set to subsidize poor households to the tune of R2.45-billion.

In July 2009, ICASA issued a statement indicating that processes (including consultations) for freeing spectrum in the 790-862 MHZ range, which is required for broadband purposes, would begin.

1.4.1.7 Kenya

Of the three possible approaches to digital switchover (national switchover, phased in switchover and partial switchover), the Government of Kenya has chosen a phased in approach, with analogue switch-off taking place on a region by region basis. The Communications Commission of Kenya (CCK) believes that the phased in approach has several benefits in the Kenyan context:

- Firstly, the lessons that are learned in one region can be applied in other regions to improve the process;
- Secondly, the released frequencies can be re-used in a neighbouring region in order to increase its digital coverage and expand the digital service offering; and
- Thirdly, this approach allows the cost and effort of migration over time.

Digital TV broadcasting will occur the 470-806 MHz frequency band. The CCK has adopted the DVB-T standard for digital television broadcasting in accordance with the decisions taken at RRC- 06. The introduction of DVB-T standard for television broadcasting service in Kenya is to be facilitated through licensed signal distributors.

The key dates are:

- Switch on of DTT and commencement of the simulcast phase commencing 30 August 2009;
- Simulcast phase continues to 30 June 2012; and
- Analogue shut-off occurs on 1 July 2012.

1.4.2 Region 2

1.4.2.1 United States

In the United States, the Federal Communications Commission (FCC) has been heavily involved with managing the transition from analogue to digital television. Commencing with an FCC order in 2003, analogue television broadcasters in channels 52-69 were directed to vacate the 698-806 MHz band and only operate DTV in channels 2-51 (500-600 MHz). The switchover was originally scheduled for 17 February 2009 and provided for an analogue-to-digital converter box subsidy. However, the switchover was then delayed by the US Congress through the DTV Delay Act since it was estimated that a large number of households – about two million households – would be cut-off from television because they were either unprepared for the transition or no new signal would be available to them. The legislation permits television stations to retain their analogue authorization beyond the switchover date in markets where household penetration of DTV reception equipment is less than 85 per cent.

Nevertheless, to date about half of the UHF spectrum was released by broadcasters after the switch-off of analogue and was reserved as a Digital Dividend for redistribution to new services, mainly via technology-neutral auctions completed in March of 2008. In addition, regulatory plans are being considered to allow "intelligent" devices to use the so-called "white space" of unutilized spectrum in broadcast coverage areas.

The FCC concluded the Digital Dividend auction of the 700 MHz band on 18 March 2008; it issued 261 licences for a total value of just over USD 19 billion. The auction also included 10 MHz of spectrum designated as the D Block (public service spectrum) intended to provide sufficient bandwidth for a national broadband public safety network. This spectrum was not auctioned since bids failed to meet the minimum reserve prices.

Another important feature of the US regulatory framework is the Commercial Spectrum Enhancement Act, which was signed into law in 2004 (CSEA, Title II of P.L. 108-494). This Act created a centralized and streamlined Spectrum Relocation Fund (SRF). The SRF provides funding through which Federal agencies can recover the costs associated with relocating their radio communications systems from certain spectrum bands where these frequencies were authorized to be auctioned for commercial purposes. The SRF provides the regulator with a powerful tool to facilitate reallocation of certain services and users. The CSEA appropriates such sums as are required for relocation costs, which are financed by auction proceeds. In 2007, the CSEA appropriated USD 1.008 billion from the Advanced Wireless Spectrum (AWS) auction proceeds of USD 13.7 billion and these funds were allocated across 27 government departments and agencies. An annual report to Congress on the status of the fund, including appropriations and distributions, is submitted by the US Office of Management and Budget.

On 23 September 2010, as part of its National Broadband Strategy, the FCC approved a proposal that will enable mobile device manufactures to use whitespace portions of the television broadcasting spectrum for unlicensed mobile broadband operations. The whitespace signal spectrum spaces were freed up as part of the United States' transition from analog to digital television broadcasting.[44]

1.4.2.2 Canada

In 2001, Canada began in earnest to study the Digital Switchover and began to coordinate plans, especially with respect to cross-border public safety uses with the United States, for use of frequencies in the 746-806 MHz range (Television Broadcasting Channels 60-69) once switchover takes place. Whereas the United States adopted a cut-over date of 2009, Canada has adopted a more "wait and see" approach and decided on a switchover date of 31 August 2011.

There were several factors influencing the decision to adopt a "wait and see" approach:

1. Broadband penetration is lagging in Canada. Broadband got off to a flying start early on, due in part to the presence of two sectors – telecommunications and cable TV – that were both eager to enter each other's markets. These sectors had been prevented from directly competing with each other up to that point due to restrictions on cross-ownership; there was therefore pent-up demand for broadband. However, penetration has stalled at 65 per cent and ranks in bottom quartile of OECD countries.
2. Spectrum supply seems to be adequate. Some suggest that robust intra-modal competition is lacking because there is little scope or incentive for new entrants in either fixed-line telecommunications or cable TV since in most geographic areas a cable TV provider and an incumbent telecom operator already exist. Foreign ownership restrictions are often cited as another impediment to increased competition.
3. Similarly, some unfortunate choices concerning regional licences, tariff structure, standards, and spectrum have meant that the mobile sector has been poorly equipped and slow to move to 3G. The Advanced Wireless Services Auction concluding in July 2008 raised USD 4.26 billion for 105 megahertz (MHz) of radio spectrum in the 2,1 GHz band for IMT services. As of 2010, most of that spectrum remains underutilized. In other words, operators are not being pressured to obtain additional spectrum. This is in contrast with the United States where the AWS Auction in 2008 released 90 MHz which is highly used.
4. Regulatory processes are following the United States that did complete an auction in 2008 of 60 MHz of Digital Dividend spectrum in 746-806 MHz band in connection with the original switch-off date of 17 February 2009. Canada has yet to determine firm dates for the auctioning of 700 MHz spectrum.

1.4.3 Region 3[45]

The situation in Asia (Region 3) is quite different than in other regions. Some countries have concluded their plans for the analogue switch-off, while others are only considering the possibility for switchover. There are several technical constraints in Asia. Though digital terrestrial television services have been introduced in some countries of the region, the services are based on different standards (DVB-T, ATSC, ISDB-T, DMB-T), and all use different channels (6, 7 and 8 MHz). In contrast, in most cases a single standard (DVB-T) exists for GE06 countries.[46] Another constraint is that broadcasting channels are scattered on a non-contiguous basis across the whole UHF band.

However, in an effort to harmonize the use of the Digital Dividend across the region, China, Japan, New Zealand, India and Singapore along four other countries in the region have identified the 698-862 MHz band for IMT, aligning with Region 2. China is to wait until 2015 for the implementation of the analogue shut-off and the realization of the Digital Dividend.

1.4.3.1 India

In August 2010, the Telecom Regulatory Authority of India (TRAI) released a plan to implement the Digital Switchover in phases, beginning in 2011 and concluding by the end of 2013. There are four phases with each involving fiscal incentives to operators such as tax holidays and duty exemptions. The phases are as follows:

- Phase I: commencing in 2011 with the four metro areas of Delhi, Mumbai, Kolkata and Bangalore;
- Phase II: cities with a population of one million;
- Phase III: covering all remaining urban areas in the country; and
- Phase IV: the rest of the country completed by 2013 December in the fourth phase.

India, along with China and others has identified the 698-862 MHz band for IMT.

1.4.3.2 Republic of Korea

The Korean Communications Commission (KCC) completed its action plan in 2009 to begin accelerating the progress towards DTV transition, which is set for 2012. The KCC plan includes steps to conduct public information campaigns and to conduct pilot projects to test elements of the transition strategy and hopefully to reduce errors occurring in the transition itself. Some of the key steps in transition include new legislation and regulatory changes:

- IPTV Act (2008) related regulations, and
- Special Law on DTV Transition and related regulations.

1.5 Best Practices

In June 2010, there were just over 45 countries planning for Digital Switchover and 15 countries that have already completed the switchover. This provides a rich source of experience to review and from which lessons may be drawn.

In this section, we review some of the best practices used by spectrum managers when implementing change. It is important to note that, based on experience, the best practices outlined below are not consistently applied.

1.5.1 Spectrum Planning

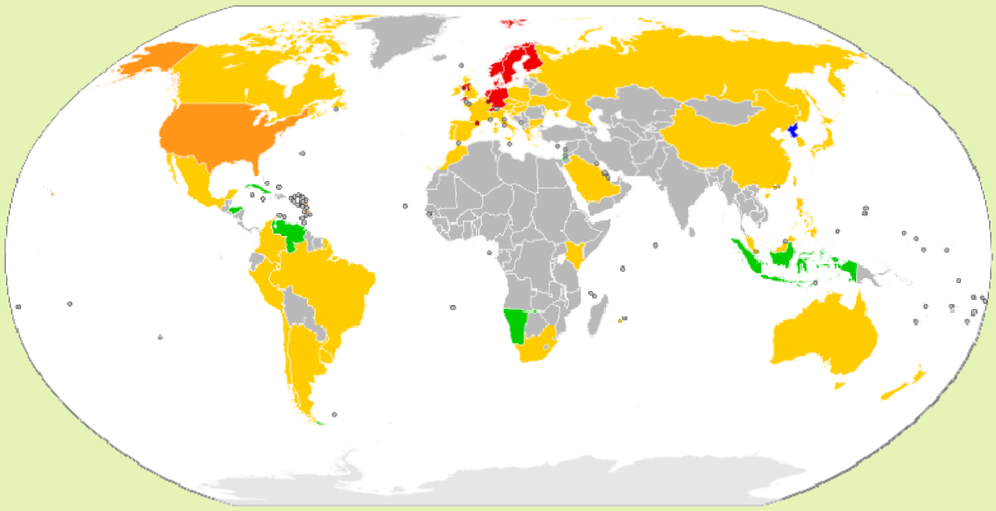
Spectrum planning has been at the centre of the Digital Switchover and Digital Dividend. Few countries have sectors robust enough to afford market adjustments that result in market failure. Some level of planning is required to ensure that at least the goals of harmonized allocations and standards can be achieved. The speed at which plans can be implemented depends very much on the homogeneity of markets and the resolve of policy makers to move with determination. Clearly, the stakes differ by country. Some countries are compelled by the desire to lead technology development and market development while others can only afford to adopt a wait and see approach.

1.5.2 Reallocation – Refarming Processes (are they up to the task?)

The need for reallocation, often known as refarming, can arise in several ways:

- It may be that the international table of frequency allocations has changed, as in the case of WRC-07, resulting in the realignment of national table of frequency allocations;
- Demand for radio services may be changing and there may be more demand for mobile broadband and less demand for traditional terrestrial TV; and
- sometimes, new spectrum-efficient technologies allow spectrum to be freed up, as in the case of the Digital Dividend

Figure 1.14: Status of Digital Switchover



Legend: Status of DSO Transition

- Transition completed, all analog signals terminated
- Transition completed for full power stations, not yet completed for low power stations
- Transition in progress, broadcasting both analog and digital signals
- Transition not yet started, broadcasting analog signals only
- Does not intend to transition, broadcasting analog signals only
- No information available

Various approaches exist for re-farming. For example, in some cases featuring administrative approaches, regulators address the issues; in other cases featuring market-driven approaches, users determine the timing and price. Some approaches simply require the user to absorb the cost. In other cases, the beneficiaries of the change are either invited or required to reimburse all or part of the transition costs of the incumbent user.

Reallocation and refarming of spectrum are activities in many spectrum management organizations that continue to pose challenging issues with respect to establishing policy and procedures for governments, regulators, and users alike. Key issues include deciding who pays and the amount that must be paid for reallocation and refarming of spectrum. These issues trigger all sorts of conflicts, some of which that escalate to legal challenges.

Several tools exist and have proven to be effective including: Spectrum Refarming Funds (e.g., France and the US); dispute resolution techniques; and, in some cases, methods for spectrum valuation to determine compensation. Nevertheless, policies and tools often do not provide clear paths to solutions for reallocation problems.[47]

1.5.3 Migration

Analogue shut-off is feasible. If properly managed, new services can be introduced and existing services migrated to new spectrum. The migration process begins with a political decision about the dates to shut-off analogue services. This is followed by regulatory decisions concerning standards and bands. Roles and responsibilities for decision makers can be defined and allocated at various stages of the switchover process. (See Table 1.3.) The transition process has taken place in enough countries to date to provide sufficient guidance on what decisions should be mandated and what decisions are best left in the hands of the market-place. Furthermore, there are comprehensive guidelines available to regulators interested in an in-depth discussion of the topic.[48] Finally some countries have used pilot studies to test migration strategies. (See Section 1.4.3.2, the Republic of Korea and the 2009 Annual Report of the Korean Communications Commission.)

1.5.4 Consultation and assessment of the value of the Digital Dividend

The means of achieving greater spectrum efficiency in order to contribute to policy goals such as economic growth and competition lead to many debates on the economic value of the Digital Dividend spectrum in existing uses such as television or in new uses such as wireless broadband. As a result, many regulators and spectrum managers are beginning to conduct user surveys and studies to evaluate the demand for spectrum and to estimate the value of spectrum in various uses, including both new and existing uses. These are important tools to help frame the question of and to take a decision on how to best use the Digital Dividend. Example of recent studies and evaluations include:

- The European Union – Transforming the Digital Dividend opportunity into social benefits and economic growth in Europe, July 2009, http://ec.europa.eu/information_society/policy/ecomm/radio_spectrum/_document_storage/consultations/2009_digitaldividend/2009_0710_0904_digitaldividendconsultation.pdf, and
- Sweden – The use of radio spectrum following the switch-off of analogue terrestrial television broadcasting, www.pts.se/upload/Documents/EN/Use_of_radio_spectrum_2006_35.pdf

1.6. Lessons Learned

Setting the targets for analogue shut-off is a political decision and requires political leadership and political unity. If properly managed, analogue shut-off is feasible. The pace of the transition process is accelerated where political leadership is strongly evident. Likewise, political unity across a region contributes to accelerated implementation. Uniform and geographically separated large states have been able to move more quickly. The EU has made significant progress given the size, number, distinct differences between the member states, and the explicit desire to allow for flexibility in implementation. The flexible approach has consequences. In Europe a harmonized approach on how to use the Digital Dividend is lacking. Powerful interests (telecom operators and broadcasters) argue for different approaches and outcomes. These views and interests are pursued through separate telecommunication and broadcast processes. Eventually, the regulatory framework will need to be adjusted to reflect converged markets.

Where there has been progress in completing the switchover quickly, it has occurred primarily due to liberalized markets that are underpinned by economic considerations and focussed policy. Additional urgency is often tied to economic and commercial strategies to achieve or maintain technology leadership. For developing countries, the switchover urgency is a less compelling argument due to the continuing importance of broadcast as media access technology. Early adoption places the burden of high cost of conversion on consumers. For regulators, choosing standards early in the game can pose risks for the market and consumers. Delay presents a viable option when considering economies of scale and strategies to promote local industry.

Implementation of the Digital Dividend spans nearly two decades. The initial discussions amongst regulators on topics such as spectrum supply and demand and technology change were pressing issues in the mid-1990s. Countless resources have been expended in the effort. It is not yet complete, as major challenges such as interference management and harmonization of standards and allocations are unresolved. Still, recent statements and pronouncements presage even more effort and time to obtain new spectrum to meet demands and so the work will continue. There are pressing requirements for new regulatory tools based on more flexible and adaptive mechanisms in order to facilitate more rapid change.

Services are converging and in some countries telecommunication and broadcast companies are merging capabilities. In both developed countries and developing countries people are accessing content using a variety of means. Regulators need to be careful in choosing technical standards so that they do not become obstacles to change. Interference, especially in relation to service neutral licensing, is an enormous problem. In deciding what services should use the Digital Dividend spectrum, market and economic factors – growth, innovation and efficiency – should be paramount while not ignoring social and development objectives. Tools such as spectrum prices, spectrum valuation, and market-based assignments that incorporate market drivers are needed to resolve issues.

1 There are two very notable exceptions: fibre-optic cable [but fiber optic can also be digital, right? Maybe clarify here] and lasers are two commonly used analogue systems which continue to decline in cost.

2 European Broadcast Union, Technical Review – Spectrum Management, October 2006, p.17.

3 UN Millennium Report 1999.

4 ITU World Telecommunication Regulatory Database.

5 Google Analytics.

6 Forrester, 2005.

7 OFCOM, Communications Market Studies, 2008.

8 Digital Audio Broadcasting.

9 OFCOM, Communications Market Studies, 2008.

10 Of course there are exceptions. In Germany where cable prices are high, cable subscriptions declined while Free to Air (FTA) user increased in number.

11 PAL is the analogue television system used primarily in Europe. It was developed largely to improve upon deficiencies observed in using NTSC for colour TV and in conjunction with the standard European 50 Hertz TV design.

12 SECAM is the analogue television used in France, Russia and former CIS countries and in parts of West Africa

13 NTSC is the analogue television system used in most of North America, most countries in South America, Myanmar, Republic of Korea, Japan, Philippines, and some Pacific island nations and territories (see map). The National Television System Committee is the name of the U.S. standardization body that developed this broadcast standard.

14 ITU-D Q11/2 (2006-2010 study period).

15 The size of spectrum whitespace has been estimated to be as large as 100 MHz based on deployment of six DTT multiplexes. This will vary depending on geography.

16 African nations signed the ST61 agreement in 1989.

17 www.itu.int/ITU-R/index.asp?category=study-groups&rlink=rcpm-wrc-12-studies&lang=en

18 See RR provision No. 5.2.

19 See RR provision No. 5.312.

20 European Broadcast Union, Using the Digital Dividend, 2009.

21 Acceptable quality can be offered if one 8 MHz channel accommodates five or six standard definition digital television (SDTV) services (using the MPEG-2 compression system) or two or three digital high-definition television (HDTV) services (using MPEG-4 AVC). Most SDTV transmissions today are based on MPEG-2.

22 MFN's refer to multi-frequencies networks which have typically been used in the past with analogue broadcast although they are occasionally used in national DTT networks. Single frequency networks (SFN's) are most often associated with spectrally efficient and lower powered regional and local DDT network dedicated to providing identical content over the network on a particular channel.

23 European Commission, Exploiting the Digital Dividend – a European Approach, Analysis Mason, DotEcon and Hogan & Hartson LLC, August, 2009.

24 LTE – Long Term Evolution is a further evolution capable of data rates up to 14.4Mbit/s using either Frequency Division Duplex (FDD) or Time Division Duplex (TDD) profiles.

25 In 2008, the 700 MHz band auction in the US was the largest in its history collecting over USD13 billion.

[26] Consumer interests stem from the fact that the costs borne by consumers in replacing existing devices may not be trivial.

[27] Please add reference.

[28] ITU, Guidelines or the Transition from Analogue to Digital Broadcasting, May 2010.

[29] Please add reference.

[30] ITU, Guidelines or the Transition from Analogue to Digital Broadcasting, May 2010, p.15.

[31] The footnotes appearing in Table 2.1.1 of the Guidelines refer to the regulatory documents containing national decisions on various DTTB technical standards and have not been reflected in Table. 5.0.

[32] Canada has launched in 2010 a program – Broadband Canada: Connecting Rural Canadians with targeted commitments to achieving broadband access.

[33] ITU Telecommunication/ICT Regulatory Database.

[34] European Commission, Exploiting the Digital Dividend – a European Approach, Analysis Mason, DotEcon and Hogan & Hartson LLC, August 2009.

[35] European Commission, COM(2008), A European Economic Recovery Plan, November 2008, p.16.

[36] European Broadcast Union.

[37] Ofcom, 2010 – Digital dividend: consultation on potential uses of the 600 MHz band and geographic interleaved spectrum.

[38] The European Commission, COM(2007) 700 Final – Reaping the full benefits of the Digital Dividend in Europe.

[39] Ofcom 2007, Digital Dividend Review.

[40] Ofcom: Digital Dividend: clearing the 800 MHz band, Consultation, 2 February 2009. www.ofcom.org.uk/consult/condocs/800mhz/800mhz.pdf.

[41] Ofcom: Clearing the 800 MHz band Funding for moving programme-making and special events from channel 69, Statement, 5 July 2010.

[42] European Commission: COM(2010)253 final/3,15th Progress Report on the Single European Electronic Communications Market, 2009.

[43] In March of this year, Sentech, a SA manufacturer of set-top boxes, foreast that it would achieve 56% DTT population coverage by 31 March 2011

[44] www.fcc.gov/Daily_Releases/Daily_Business/2010/db0923/FCC-10-174A1.pdf.

[45] The ITU has financed a project being conducted by the Korean Communication Commission for the implementation of the DTT in Asia Pacific and in Africa.

[46] Although some countries have chosen to implement other standards, i.e., South-Africa selected ISDT-T.

[47] The revised ITU-D Resolution 9 is expected to deal with the question of appropriate pathways to re-allocation solutions.

[48] See e.g., ITU, Guidelines for the Transition from Analogue to Digital Broadcasting.