



# ECC Report 224

Long Term Vision for the UHF broadcasting band

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## 0 EXECUTIVE SUMMARY

Traditionally, broadcasting and broadband communication services have their own regulations, market structure and dedicated network infrastructure (e.g. high power / high tower versus dense networks) in order to provide their respective set of services. The future development of services and terminals has the potential to blur the border between the two “worlds” for the end user and may require innovative approaches to deliver content to end users in the most efficient way from a technical, economic and social perspective.

The studies contained in this Report identify and analyse possible scenarios for the development of the band 470-694 MHz in the long term starting from the existing situation and recognizing the ongoing studies in the 700 MHz band in Europe, and short to medium term developments (e.g. AI 1.2 of WRC-15 and the response to the European Commission Mandate on the 700 MHz band). The current situation is dealt with in the Report by describing the current role of the terrestrial broadcast platform including issues such as supporting Free to Air, social inclusion and providing information in times of emergencies. In addition, the regulatory framework for the provision of audiovisual media services, the duration of currently assigned TV Rights of Use and current consumption of audiovisual content is also explored in the Report.

The Report addresses the trends in the evolution of services and consumer behaviour, as well as the networks and technologies that offer the potential to deliver these services in the band. It includes consideration of the way in which audio visual content consumption habits may be changing. The most important developments in relation to the evolution of delivery of broadcast services in fixed and mobile environments are also identified.

The studies contained in this Report are based on anticipated developments for the various current platforms and technologies under consideration and linked to the demand and supply of the envisaged services. Thus, it was necessary to develop relevant indicators in order to monitor the assumptions that align with anticipated developments used for the construction of the future scenarios. These indicators are described in Chapter 5 and are considered suitable for monitoring developments in the future services expected to use the UHF band. Further consideration is required on the measurement and the monitoring of these indicators.

In relation to the evolution of delivery of broadcast services in fixed and mobile environments the following important developments are expected to continue:

- Broadcasting services will continue to evolve by improvements in picture quality and user experience through the introduction of HDTV, UHDTV, 3DTV, etc;
- Linear viewing will remain the main way of viewing TV content for the foreseeable future;
- Time-shifted and on-demand (non-linear) AV content viewing will continue to grow, driven by services such as YouTube, Netflix, BBC iPlayer and Boox TV;
- Currently the majority of TV viewing, both linear and non-linear (catch-up), occurs in the home;
- On mobile devices, viewing of video content outside the home represents about 40% of total viewing on these devices;
- Most TV viewing will remain on the large screen, while viewing on handheld devices will increase. In the home, the latter is currently driven by the availability of WiFi;
- Migration of services from SDTV to HDTV, and the introduction of UHDTV services as well addition of interactive services complementing the main stream;
- In many European countries, HDTV programmes are already offered on the DTT platform and satellite, and this could be expected to become the norm in the short to medium term. In order to allow these services to be delivered efficiently to viewers, DTT networks need to continue to evolve and have access to a sufficient amount of spectrum;
- Hybrid broadcast-broadband services will become commonplace, possibly including a wireless broadband element, to allow increased access to non-linear as well as linear content;
- Evolutions in DTT technology will support larger SFNs therefore increasing efficient use of spectrum;
- European Digital Agenda (DAE) objectives will lead to improved broadband capacity supporting improved availability of IPTV;
- LTE through its Broadcast and eMBMS applications will be able to deliver broadcast and multicast content;
- New mobile devices, tablets and smartphones, facilitate better user experience for mobile AV content;

- In order to service this evolution in content offering on all platforms the program production industry will require sufficient interference free PMSE spectrum to be provided in a timely manner;
- Mobile broadband services are undergoing growing demand which is causing a significant increase data traffic. The largest and fastest growing traffic type is on-demand video but consumers also rely on mobile broadband for a wide variety of other mobile applications.

This Report discusses and analyses in Chapter 6 the general classes of scenarios considered by CEPT in defining the long term vision for the band 470-694 MHz. ANNEX 2: provides a detailed description and the assessment of all the scenarios studied by CEPT. CEPT considers that the following four classes of scenarios could cover the developments in the band 470-694 MHz in the long term:

- **Class A:** Primary usage of the band by existing and future DVB terrestrial networks  
This class of scenarios assumes a natural evolution of the DTT platform based on HPHT networks possibly complemented with LPLT sites, taking into account the ongoing technological and service developments, and assuming a stable regulatory environment and access to the spectrum.
- **Class B:** Hybrid usage of the band by downlink LTE and/or DVB terrestrial networks  
This class of scenarios assumes that broadcast and mobile broadband services in the UHF band would in the future be delivered via LTE SDL/eMBMS (downlink only), with or without the DTT platform, based on HPHT and/or LPLT networks. The scenarios of this class generally provide additional unicast downlink capacity and flexibility in the use of capacity.
- **Class C:** Hybrid usage of the band by conventional two-way (uplink and downlink) LTE mobile broadband and/or DVB terrestrial networks  
This class of scenarios assumes that broadcast and full, bi-directional mobile broadband services operate in the UHF band, with or without the DTT platform, based on HPHT and/or LPLT networks. This class corresponds to scenarios where conventional two-way LTE mobile broadband services (i.e. operating with separate uplink and downlink channels in the UHF band), to support unicast multimedia content as well as all other types of mobile broadband data traffic, are introduced in the band.
- **Class D:** Usage of the band by future communication technologies  
This class assumes that broadcast and mobile broadband services in the UHF band would in the future be delivered via evolved or via completely new, as not yet existing, communication technologies resulting in connectivity anytime anywhere through any available network.

Cross-border frequency coordination and coexistence is one element of the assessment and is addressed in Chapter 6 of the Report based on the above mentioned classes.

Audiovisual media services, which could be traditionally seen as typical broadcast platform “content”, and other audiovisual content (user generated content, video clips, etc.) are also available on the internet and distributed via cable, optical fibre or wireless broadband access. The usage and acceptance of all distribution platforms differs substantially from country to country, but linear services are mainly delivered over the traditional broadcast distribution platforms whilst the on-demand services are primarily delivered over broadband networks. On the other hand, broadcast services are more and more heading for using return channels or additional parallel channels to allow the user more flexibility and access to additional information. **A cooperation between radiocommunication services is expected in the long term.**

Traffic expectations for broadcast service and broadband access, including wireless, assume the increasing delivery of audiovisual content in improved quality to an increasing number of users. This will result in a higher asymmetry between upstream and downstream traffic.

Due to its propagation characteristics, the band 470-694 MHz can be efficiently used for the distribution of audiovisual services. These services may be linear or non-linear. The number of receiving users served by a content provider can vary from one to up to several million users. This is depending on the different types of content, user density, the specific social and economic situation, and technology. **Therefore, the long term usage of the band 470-694 MHz is mainly foreseen for downstream audiovisual content distribution.**

The scenarios listed in ANNEX 2: and classified in Chapter 6 describe possible long term future deployments in the band 470-694 MHz. Each of these scenarios has a certain potential to occur.

With the current state-of-the-art of the radiocommunication technologies there are incompatibilities between some scenarios, as studied in this Report. The compatibility between scenarios has to be taken into account. As assessed today and for the coming years, coexistence is feasible between broadcast and mobile downlink networks whereas the coexistence between mobile uplink and broadcasting or mobile downlink is difficult and challenging. However, the situation as of today may change in the long term.

The variety of scenarios considered in this report should be understood as an indication for different needs/requirements in different countries regarding the future use of the band 470-694 MHz.

**In order to facilitate different scenarios considered by the CEPT for the usage of the band 470-694 MHz, it could be necessary to introduce more flexibility in the regulatory environment governing the use of this band** to respond to different needs and requirements in different countries. This will also allow taking into account, inter alia, the possible advances in radiocommunication technologies.

There could be different measures to provide for the regulatory flexibility in the band 470-694 MHz, if so required. It should be pointed out that any modification of the Radio Regulations to implement flexibility has to be discussed in the framework of ITU, taking into account the inherent flexibility of the Radio Regulations and the GE06 Agreement.

**The consideration of the following non-binding elements, may assist administrations within the context of the national legal and regulatory framework, when deciding on a particular scenario for the usage of the band 470-694 MHz:**

- the current national general interest objectives;
- the implications of a given scenario on the audiovisual industry, content creation and user expectations;
- monitoring of the market and technological developments, including by means of the key indicators as defined in Chapter 5;
- a cost/benefit analysis with a focus on the impact on consumers;
- assessment criteria such as but not limited to those that were used in the assessment of the scenarios listed in ANNEX 2.;
- a realistic time frame for the transition towards a new scenario, taking into account duration of the existing rights of use and the spectrum needs during the transition period as well as the need for continuation of the service (in the context of this report);
- the coexistence feasibility between different classes and the necessity for cross-border frequency coordination.

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## LIST OF ABBREVIATIONS

| <b>Abbreviation</b> | <b>Explanation</b>   |
|---------------------|--|
| <b>3G</b>           | Third Generation of mobile telecommunication technology              |
| <b>3GPP</b>         | Third Generation Partnership Project                                 |
| <b>ACS</b>          | Adjacent Channel Selectivity   |
| <b>AIPN</b>         | All-IP Networks  |
| <b>ARIB</b>         | Association of Radio Industries and Businesses , in Japan            |
| <b>ASO</b>          | analogue switch-off (terrestrial TV)                                 |
| <b>ATSC</b>         | Advanced Television Systems Committee, in the US                     |
| <b>AV</b>           | Audiovisual  |
| <b>CEPT</b>         | European Conference of Postal and Telecommunications Administrations |
| <b>CPG</b>          | Conference Preparatory Group of the ECC                              |
| <b>D2D</b>          | Device to Device   |
| <b>DAE</b>          | European Digital Agenda  |
| <b>DASH</b>         | Dynamic Adaptive Streaming over HTTP                                 |
| <b>DCF</b>          | Discounted Cash Flow   |
| <b>DL</b>           | Down-link  |
| <b>DTT</b>          | Digital Terrestrial Television                                       |
| <b>DTTB</b>         | Digital Terrestrial Television Broadcasting                          |
| <b>DTV</b>          | Digital Television   |
| <b>DVB-T</b>        | Digital Video Broadcasting - Terrestrial                             |
| <b>DVB-T2</b>       | Digital Video Broadcasting –2 <sup>nd</sup> Generation Terrestrial   |
| <b>DVD</b>          | Digital Video Disc   |
| <b>EC</b>           | European Commission  |
| <b>ECC</b>          | Electronic Communications Committee                                  |
| <b>eMBMS</b>        | evolved Multimedia Broadcast and Multicast Services                  |
| <b>EPG</b>          | Electronic Programme Guide   |
| <b>EU</b>           | European Union   |
| <b>FFT</b>          | Fast Fourier Transform   |
| <b>FoBTV</b>        | Future of Broadcast Television Initiative                            |
| <b>FTA</b>          | Free-to-Air  |
| <b>GE06</b>         | Geneva 06 Agreement  |
| <b>HbbTV</b>        | Hybrid Broadcast Broadband TV  |
| <b>HD</b>           | High Definition  |
| <b>HDTV</b>         | High Definition Television   |
| <b>HEVC</b>         | High Efficiency Video Coding   |
| <b>HPHT</b>         | High-Power High-Tower  |
| <b>HSPA</b>         | High Speed Packet data Access  |
| <b>HTTP</b>         | Hypertext Transfer Protocol  |
| <b>IEM</b>          | In-ear monitoring  |
| <b>IMT</b>          | International Mobile Telecommunications                              |
| <b>IPTV</b>         | Internet Protocol Television   |

|                    |   |
|--------------------|---|
| <b>ISD</b>         | Inter-site distance   |
| <b>ITU</b>         | International Telecommunication Union                             |
| <b>ITU-D</b>       | ITU Telecommunication Development Sector                          |
| <b>ITU-R</b>       | ITU Radiocommunication Sector                                     |
| <b>LPLT</b>        | Low-Power Low-Tower   |
| <b>LTE</b>         | Long Term Evolution   |
| <b>Ma02revCo07</b> | Maastricht 2002 Special Arrangement, as revised in Constanța 2007 |
| <b>MBB</b>         | Mobile broadband  |
| <b>MBSFN</b>       | Multicast Broadcast over Single Frequency Network                 |
| <b>MFCN</b>        | Mobile Fixed Communication Network                                |
| <b>MT</b>          | Mobile Telecommunications   |
| <b>OFDM</b>        | Orthogonal Frequency Division Multiplex                           |
| <b>PMSE</b>        | Programme Making and Special Events                               |
| <b>PPDR</b>        | Public Protection and Disaster Relief                             |
| <b>PSB</b>         | Public Service Broadcasting                                       |
| <b>PSM</b>         | Public Service Media  |
| <b>PVR</b>         | Personal Video Recorder   |
| <b>QoS</b>         | Quality of Service  |
| <b>RAS</b>         | Radio Astronomy Service   |
| <b>RoU</b>         | Right of Use  |
| <b>RR</b>          | ITU Radio Regulations   |
| <b>RSPG</b>        | Radio Spectrum Policy Group                                       |
| <b>RSPP</b>        | Radio Spectrum Policy Programme                                   |
| <b>SAB</b>         | Services Ancillary to Broadcasting                                |
| <b>SAP</b>         | Services Ancillary to Programme Making                            |
| <b>SD</b>          | Standard Definition   |
| <b>SDL</b>         | Supplementary DL  |
| <b>SDTV</b>        | Standard Definition Television                                    |
| <b>SFN</b>         | Single Frequency Network  |
| <b>SMS</b>         | Short Message Service   |
| <b>TDD</b>         | Time Division Duplex  |
| <b>TTA</b>         | Telecommunications Technology Association                         |
| <b>TG6</b>         | Task Group 6 of the ECC   |
| <b>UE</b>          | User equipment  |
| <b>UHF</b>         | Ultra High Frequency  |
| <b>UHDTV</b>       | Ultra High Definition Television                                  |
| <b>UMTS</b>        | Universal Mobile Telecommunications System                        |
| <b>VOD</b>         | Video on Demand   |
| <b>WRC</b>         | World Radiocommunication Conference                               |

## 1 INTRODUCTION

Traditionally, broadcasting and broadband communication services have their own regulations, market structure and dedicated network infrastructure (e.g. high power / high tower versus dense networks) in order to provide their respective set of services. The future development of services and terminals has the potential to blur the border between the two “worlds” for the end user and may require innovative approaches to deliver content to end users in the most efficient way from a technical, economic and social perspective. This may imply cooperation or even convergence of networks. Therefore, the studies carried out in TG6 on the future use of the UHF band sought to take into account the following, among others:

- The different market position of terrestrial TV compared to other platforms in different countries;
- The different licensing regimes and durations for the incumbent services;
- The need to provide certainty for each sector;
- The flexibility required to address different situations in different CEPT countries with regard to content regulation;
- Cross-border frequency coordination issues between different network topologies and the impact on equitable access taking into account the GE06 Agreement;
- Various reception environments (e.g. indoor/outdoor, fixed, portable, ) and coverage requirements (e.g. country-wide, regional and local);
- Coexistence with PMSE-applications;
- The technologies available (e.g., OFDM based systems such as DVB-T / T2, LTE), their evolution and their possible convergence;
- The possibility of “hybrid” networks and the related issue of transition, economic models, and the possibility of convergent/cooperative services ); and
- Possible introduction of cognitive techniques (e.g. use of white space by applications other than PMSE).

The 33rd ECC meeting (March 2013) decided to launch an activity in order to:

- frame the studies to support the development of a long-term vision for the UHF-band in Europe focusing primarily on technical issues, but addressing also economic, social and regulatory aspects and
- formulate key questions which have to be answered by the group which will be responsible for these studies, taking into account the need to collect data on the existing situation in each CEPT country.

Finally, the 34th ECC meeting (June 2013) agreed to establish a new ECC Task Group (TG6) to address the studies aiming at the development of a long term vision for the UHF broadcasting band (focusing on the band 470-694 MHz) in Europe. The main issues addressed in this report cover the following key questions:

- Identify and analyse possible scenarios for the development of the band in the long term starting from the existing situation and recognizing ongoing studies in the 700 MHz band in Europe and the short/medium term developments (e.g. AI 1.2 of WRC-15 and the response to the EC Mandate on the UHF band);
- The flexibility of individual CEPT administrations in addressing the future use of the band;
- How to ensure equitable access to the band by those CEPT administrations wishing to operate broadcasting services; and
- How to provide certainty that there will be a stable environment for future investment by the services envisaged in the band (including PMSE and AV content production).

## 2 DEFINITIONS

| <b>Term</b>   | <b>Definition</b>  |
|---|--|
| <b>Scenario</b>   | A combination of the following elements: service, terminal/user device, usage environment and delivery.  |
| <b>Service</b>  | Content/information and/or functions provided to/from a user (e.g. audio/video linear, audio/video non-linear, interactive/on-demand services, data, PMSE, etc)  |
| <b>Terminal/user device</b>   | Receiving/transmitting equipment for the above service (e.g. large flat screen, portable TV sets, PC, laptop, smartphone, game console, tablets, etc);   |
| <b>Usage environment</b>  | Description of the radio propagation environment (e.g. rural, dense urban) as well as the receiving mode (fixed, portable/mobile) and location (e.g. at home, in public places, and vehicles)  |
| <b>Delivery</b>   | The means to provide the service (e.g. technology used, network architecture, etc)   |
| <b>Audio-visual (AV) content<sup>1</sup></b>                            | Data, which is intended and coded to be presented as video and/or sound, .   |
| <b>Data content<sup>1</sup></b>   | Any data which is not intended to be recognized by persons as video or sound (i.e. which is not audiovisual content).  |
| <b>Audio visual media service</b>                                       | As defined in AVMS Directive   |
| <b>AV linear service<sup>1</sup></b>                                    | Services providing AV content for which the service provider decides which content is offered and at which particular time. The user cannot influence the sequence of content.   |
| <b>AV non-linear service<sup>1</sup></b>                                | Services providing AV content for which the user chooses the time to access and view the content based on a list of programme content supplied by the service provider.  |
| <b>User devices with embedded antenna</b>                               | Devices with an integrated antenna (such as smartphones, tablets, laptops, TV sets, etc.) <sup>2</sup>   |
| <b>User devices connected to an external (but not roof top) antenna</b> | Devices connected to an external antenna but not at roof top level (such as portable receivers, mainly used as secondary devices) but also receivers in vehicles   |
| <b>User devices connected to roof top antenna</b>                       | Devices connected to an external roof top antenna (such as TV sets or desktop PC's) <sup>2</sup>   |
| <b>AV content production</b>  | An industry using the necessary tools (including PMSE), in order to establish AV content with a quality that lives up to consumers' expectations and meets the quality requirements of the AV content distribution industry  |
| <b>Event production</b>   | Whilst the term "Event" can be used for almost any production it is normally referring to a live show primarily designed for an audience within a stadium or specific area with live performers, examples include Rolling Stones and outdoor festivals such as Glastonbury (UK). The size of the venue requires a different approach to a relative small indoor studio. All the radio devices and systems described Audio Video Media production will be in use but feeding vast audio amplification systems often coupled to large screens. Such Events are often broadcast via a visiting Outside Broadcast team (or teams). |

<sup>1</sup> regardless of the delivery mechanism

<sup>2</sup> The devices in brackets might switch categories due to different usage conditions (e.g. smartphone connected to a hands-free equipment with external antenna).

## 3 BACKGROUND

### 3.1 SCOPE

The UHF band is the core band for terrestrial television and audio PMSE (e.g. radio microphones and IEM). However, the market penetration of different TV platforms is country dependent<sup>3</sup>.

In addition, there is a trend towards mobile consumption for audiovisual content (including audiovisual media services) creating the necessity to consider how broadcasting and mobile services could complement each other in the delivery of audiovisual (both linear and non-linear) content to mobile terminals.

In light of various developments including implementation of mobile services in the 800 MHz band, discussions underway on the 700 MHz band, the continuing interest globally in exploiting the UHF band 470-790 MHz for digital terrestrial television (DTT), wireless broadband (WBB) and other services, the ECC established Task Group 6 with the aim of developing a long term vision for the use of the band 470-694 MHz. A key objective in doing so was to provide clarity and certainty to all stakeholders on a stable environment for future investment by the services envisaged in the band, including PMSE in support of AV content production.

TG6 was requested to identify and analyse possible scenarios for the development of the band in the long term starting from the existing situation and recognizing ongoing studies in the 700 MHz band in Europe, and short to medium term developments (e.g. AI 1.2 of WRC-15 and the response to the European Commission Mandate on the 700 MHz band). The task group was also required to take account of the differences in the requirements that individual countries in Europe may have for the various current and potential uses of the band and provide advice on how to ensure equitable access to the band by those administrations wishing to continue to operate broadcasting services.

A vision of the future framework for the management of the UHF band, including the appropriate level of harmonisation at the European level, taking into account cross-border coordination, would provide certainty to all stakeholders. This vision should reflect on how the growing European AV content production industry can be protected and supported within the framework.

### 3.2 THE SPECTRUM CONTEXT

#### ▪ GE06

The ITU Regional Radiocommunication Conference in 2006 in Geneva established an Agreement (GE06) [1] which covers use of the bands 174-230 MHz (Band III) and 470-862 MHz (Bands IV and V) for terrestrial digital broadcasting services (T-DAB and DVB-T) in the CEPT area and beyond. A key feature of GE06 is that it allows for flexible implementation, facilitating other services, besides broadcasting, in the band on condition that the spectral power density of an alternative use does not exceed the associated plan entry and requires no more protection than the associated plan entry.

#### ▪ RSPP

The Radio Spectrum Policy Programme [2], adopted in March 2012 by the European Parliament and the Council (Decision No 243/2012/EU), is intended to facilitate the development of strategies to enhance the efficiency and flexibility of spectrum use and promoting competition. This first RSPP addresses the frequency range 400 MHz to 6 GHz, sets out general regulatory principles, policy objectives and priorities aimed at using spectrum to contribute to the political objectives of the European Union from 2011 to 2015.

Key elements of the RSPP include the identification by 2015 of at least 1200 MHz of spectrum suitable for wireless data traffic (including frequencies already in use), an inventory of spectrum use with the objective of

<sup>3</sup> Some CEPT administrations consider that the terrestrial TV platform may at some point in the future no longer be relevant in their country while other administrations have stated that terrestrial TV services will need to be maintained for the foreseeable future.

analysing the efficiency of spectrum use, in particular in the 400 MHz to 6 GHz range, finding appropriate spectrum for wireless microphones and cameras (PMSE), and allowing spectrum trading throughout the EU in all harmonised bands where flexible use has already been introduced.

In Article 7 of the Decision, the RSPD also calls for sufficient spectrum to be made available for the terrestrial delivery of audiovisual services.

In Article 8 of the Decision, the RSPD also seeks to ensure sufficient spectrum is made available for Public Protection and Disaster Relief (PPDR).

Since the adoption of the RSPD the EC has taken a number of initiatives including development of a spectrum inventory of use by Member States of all frequency bands in the range 400 MHz to 6 GHz issuing a mandate to CEPT on the 700 MHz band [3].

#### ▪ **WRC-15 (AI 1.1 and 1.2)**

The agenda for the forthcoming World Radiocommunication Conference in 2015 (WRC-15) contains two items of direct interest to the future use of the UHF band. They are under study by CEPT Conference Preparatory Group (CPG) and previously were under study by ITU Joint Task Group 4-5-6-7<sup>4</sup>.

Agenda item 1.1<sup>5</sup> is aimed at identifying frequency bands for allocation to the mobile service and possible designation of these bands for use by IMT. Amongst the bands under consideration is 470-694 MHz.

Agenda item 1.2<sup>6</sup> is intended, inter alia, to confirm the lower limit of the frequency allocation to the Mobile service, except aeronautical mobile, in the band 694-790 MHz. CEPT favours 694 MHz as the lower limit of the allocation. Other issues to be developed include appropriate frequency plans for the band to facilitate mobile services and the need to ensure that digital terrestrial television in the UHF band below 694 MHz, in particular broadcasting channel 48 (686-694 MHz), is protected. Solutions should also be studied for accommodating applications ancillary to broadcasting (SAB/SAP<sup>7</sup>) requirements.

#### ▪ **EC Mandate 700 MHz**

In February 2013 the EC issued a mandate to CEPT, via the Radio Spectrum Committee, to develop harmonised technical conditions for the 694-790 MHz (700 MHz) band for the provision of wireless broadband and other uses in support of EU spectrum policy objectives. The mandate [3] requires CEPT to develop a preferred channelling arrangement for the band and identify common and minimal (least restrictive) technical conditions, suitable for electronic communications services as well for PPDR, to ensure protection of broadcasting services and PMSE below the lower band edge. It also requires CEPT to consider the accommodation of PMSE (in particular wireless microphones) in the band.

The EC mandate states that the results of this mandate should constitute a technical input to the EU-level political process through a timely provision of the technical parameters for any strategic scenarios. The exploitation of the results of this mandate does not necessarily entail the development of a technical implementation measure under the Radio Spectrum Decision. Any common regulatory action at EU-level should be guided by an EU-level political agreement on the long-term use of the 700 MHz band.

Part A of the response to the EC Mandate is contained in CEPT Report 53 [16].

### **3.3 CURRENT SITUATION**

#### **3.3.1 The current role of the terrestrial broadcast platform**

In many CEPT countries the terrestrial broadcast platform is the primary means of delivering broadcast services. The terrestrial broadcast coverage often exceeds 98% of the population and free-to-air access to

<sup>4</sup> The final meeting of ITU Joint Task Group 4-5-6-7 was in July 2014.

<sup>5</sup> 1.1 to consider additional spectrum allocations to the mobile service on a primary basis and identification of additional frequency bands for International Mobile Telecommunications (IMT) and related regulatory provisions, to facilitate the development of terrestrial mobile broadband applications, in accordance with Resolution 233 (WRC-12).

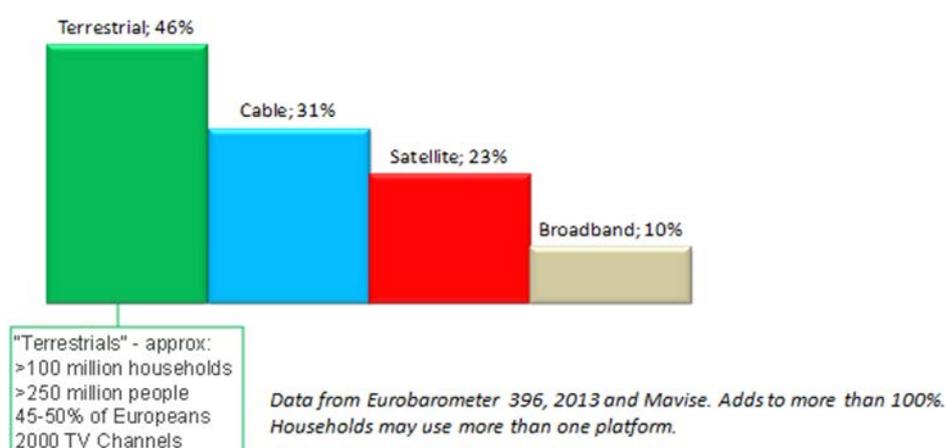
<sup>6</sup> 1.2 to examine the results of ITU-R studies, in accordance with Resolution 232 (WRC-12), on the use of the frequency band 694-790 MHz by the mobile, except aeronautical mobile, service in Region 1 and take the appropriate measures.

<sup>7</sup> The term 'SAB/SAP' used in the ITU relates to PMSE, See [9].

Public Service Broadcasting is mandatory. Indeed, in many countries there is a deep-rooted expectation by the members of the public that free-to-air broadcast services are universally available via terrestrial networks.

Even in countries where cable, satellite or broadband platforms hold a significant market share, terrestrial broadcasting is regarded, alongside these other platforms, as an essential, flexible, reliable and cost-effective way of delivering broadcast content to a mass audience. This is facilitated by the fact that most European households are suitably equipped to receive free-to-air radio and television services without any subscription. The terrestrial platform has the largest base of installed receivers and is the principal broadcast platform for free-to-air services and with a potentially universal reach. According to the Eurobarometer 396<sup>8</sup> around 46% of the EU households in 2013 rely on the terrestrial broadcast networks for receiving TV services. Any large-scale migration to another distribution platform would result in costs for the public and these cost implications must be addressed if such migration is to be considered.

### TV Reception, EU28 Households



**Figure 1: TV reception EU28 households**

Additional information on the terrestrial distribution in households for TV delivery can be found in ANNEX 3:

Terrestrial TV services in European countries are subject to audiovisual media regulation and normally require individual authorisation. This gives the national media authorities an important tool for the implementation of general interest, social and cultural policy objectives thereby providing an essential outlet for national creative content. On other platforms the major content providers and market players often come from abroad, even from outside Europe.

Free-to-air access, near universal availability of DTT and broadband connections are also the key enablers of connected TV services to be provided to all citizens without discrimination.

The broader benefits of a free-to-air platform such as DTT are that it can afford a range of other content, (i.e. non PSB), that offers diversity and choice and sustains platform innovation and ultimately competition.

As a result, the terrestrial broadcasting platform generates significant social and economic benefits<sup>9</sup> which cannot be replicated on any other platform without investments and complex migration of DTT households. Although other platforms are already in use which deliver significant economic value (such as cable/broadband and satellite), it is in the interest of both the broadcasting industry and society as a whole that the terrestrial broadcasting platform remains attractive for viewers and listeners and a viable alternative to other delivery platforms.

<sup>8</sup> Special Eurobarometer 396 - e-Communications Household Survey, August 2013 (<http://ec.europa.eu/digital-agenda/en/news/special-eurobarometer-396-e-communications-household-survey>)

<sup>9</sup> See also <http://tech.ebu.ch/docs/r/r131.pdf>

DTT networks are optimised for the simultaneous delivery of linear audiovisual content and supplementary pushed data services, to very large audiences. They are designed to achieve a specific coverage with pre-defined and sustained Quality of Service (QoS) and a particular reception mode (e.g. roof-top fixed, mobile, portable indoor, handheld as defined in GE 06).

DTT is a scalable and flexible delivery platform as it is capable of:

- adjusting the transmission parameters according to a desired reception mode (including handheld reception by adopting denser networks topologies);
- adjusting coverage to the desired service area (nationwide but regional or local coverage is also possible), based on the editorial, legal, political or commercial requirements;
- offering a range of services and quality levels (e.g. SDTV, HDTV, eventually also UHD TV);
- supporting a variety of business models, both free-to-air and based on conditional access.

The DTT networks in Europe are based on the DVB family of standards. DVB-T2 is currently the state-of-the-art broadcast technology. Frequency arrangements and cross-border coordination issues are specified in the GE06 Agreement and the associated Plan. Transmission networks are implemented according to national specifications.

Terrestrial reception is available for free for the public, largely because many households are equipped with suitable receiving antennas or master antenna systems.

### 3.3.2 Benefits of terrestrial broadcasting

#### 3.3.2.1 Available distribution platforms for public service broadcasting

It should be noted that in most countries DTT is the only free-to-air platform and therefore it is essential for PSB services. ANNEX 4: shows the current information on the availability of PSB distribution platforms in 26 European countries.

Noting that in some countries penetration of satellite or cable TV distribution is similar or higher than DTT, consideration could be given to the possibility of these other TV platforms taking the place of DTT. In this regard the following important factors need to be taken into account:

1. Provision of Free-to-Air (FTA) services on alternative platforms;
2. Provision of Public Service Broadcasting (PSB) services on alternative platforms;
3. Provision of local and regional TV services;
4. Provision of complementary commercial programmes;
5. "Universal" availability;
6. Competition between TV distribution platforms;
7. Legal requirements regarding national provision of infrastructure;
8. Migration of DTT audiences to another platform.

Taken together, these elements often represent severe impediments to replacing DTT by alternative platforms. Further information is provided in ANNEX 5:.

#### 3.3.2.2 The role of terrestrial broadcasting in supporting social inclusion

The terrestrial broadcast platform undertakes a key role in many European countries to support social inclusion. In order to understand better how the terrestrial broadcasting service in Europe enables digital inclusion and the impact on society of any potential future displacement of services it is important that household viewing by age and demographic status are monitored.

DTT is easy-to-use and in some CEPT countries households have been equipped to receive free-to-air television for decades (with roof-top antennas). This facilitates access of all citizens, especially without age discrimination.

### 3.3.2.3 The role of terrestrial broadcasting in providing information in times of emergencies

The terrestrial broadcast platforms (TV, Radio, ...) are critically important for information dissemination to the public in times of emergencies, including natural and man-made disasters. The intrinsic one-to-many broadcast architecture and the geographic diversity of terrestrial broadcast transmission facilities provide high service reliability during crises of all types.

In many regions, radio and television broadcasters and government authorities collaborate in ensuring highly reliable services during emergencies, via the availability of back-up equipment and supplies, as well as standardised procedures and checklists intended to ensure a high degree of emergency preparedness and continued information flow to the public. In times of crisis and disaster, or wherever mass dissemination of information is required instantaneously, radio and television broadcasting is very effective at reaching affected populations with relevant information-rich media content.

### 3.3.3 Audiovisual policy and regulatory framework for the provision of audiovisual media services

Terrestrial TV in the UHF band is currently essential in fulfilling the national and European audiovisual policy objectives such as social cohesion, media pluralism and cultural diversity. This is achieved in particular through the free-to-air model that supports a dual system where Public Service Broadcasting co-exists with commercial TV providers.

These fundamental European policy objectives are well formulated by the Council of Europe in the Recommendation Rec(2003)9 [4] *on measures to promote the democratic and social contribution of digital broadcasting* and the Declaration [5] *on the allocation of the digital dividend and the public interest*.

Audiovisual media services are normally subject to two different sets of rules at the European level: the regulatory framework for audiovisual content, i.e. the Audiovisual Media Services Directive 2010/13/EU [6] and the regulatory framework for electronic communications networks and services, i.e. the Telecom Package Directives, in particular the Framework Directive [7] and the Universal Service Directive [8]. Furthermore, the Radio Spectrum Policy Programme [2] defines the current spectrum priorities in the EU whilst the Geneva'06 Agreement [1] governs the use of the UHF band for digital terrestrial TV services in the ITU Region 1.

Even though the regulation of transmission and the regulation of content are separate they both aim to guarantee media pluralism, cultural diversity and consumer protection. Moreover, the Telecom Package Directives are without prejudice to measures taken at European or national level to pursue general interest objectives, in particular relating to content regulation and audiovisual policy.

Further details can be found in ANNEX 1:.

Some of the scenarios listed in ANNEX 2: may be incompatible with the existing legal framework in some countries. For example the Portuguese Constitution and French law establish that the State shall ensure a free-to-air television (linear content) public service. In these circumstances, to fulfil this Constitutional rule, a nationwide platform shall be available with free access for the population. Therefore, the potential compatibility of any scenario with this legal requirement would have to be considered on a national level to assess the practicability of this scenario even in the "long term".

At a national level specific regulation has been put in place to ensure the efficient use of the spectrum in accordance with specific circumstances and to ensure that national audiovisual policy objectives are achieved. Specific obligations for Public Service Media (e.g. the number of TV channels, the type and amount of programmes, the primary distribution mechanism, availability and coverage) are generally defined in the Law and are normally valid for the entire licence period. The high-level technical framework such as the choice of the transmission system and compression standard (e.g. DVB-T or DVB-T2, MPEG-2 or MPEG-4) may also be subject to political decisions. Details are normally specified by the licensing authorities.

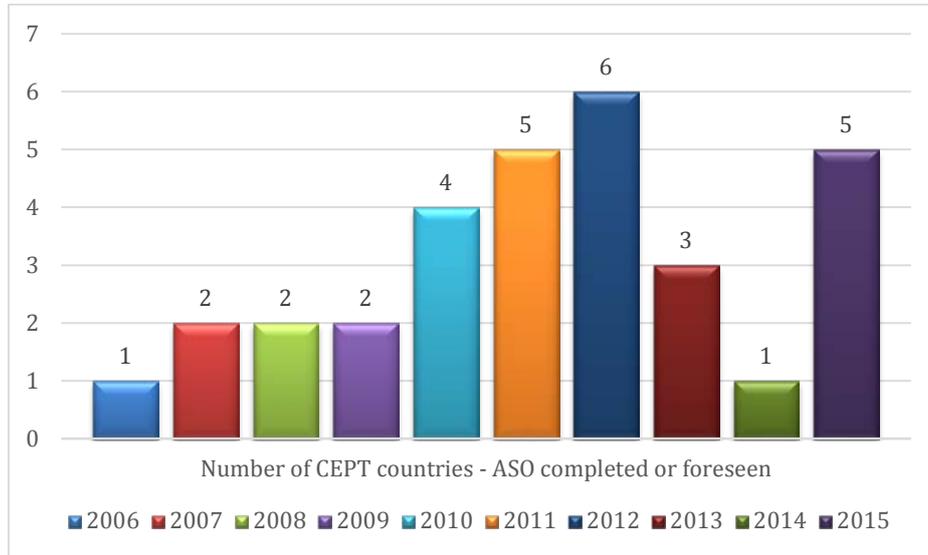
### 3.3.4 The duration of the TV Rights of Use (RoU) currently assigned

The UHF broadcasting band (470-862 MHz) was in the past primarily intended for the provision of analogue terrestrial broadcasting television (TV) in CEPT countries. The development of digital broadcasting

technologies in the last 15 years allowed the introduction of DTT in many CEPT countries. Therefore, most countries have already switched off analogue TV whereas some other countries have started or are starting this process. The information given in this section provides more details in this respect.

As of November 2014, almost all CEPT countries have already finalized the analogue switch-off (ASO) based on the information provided in ANNEX 6:.

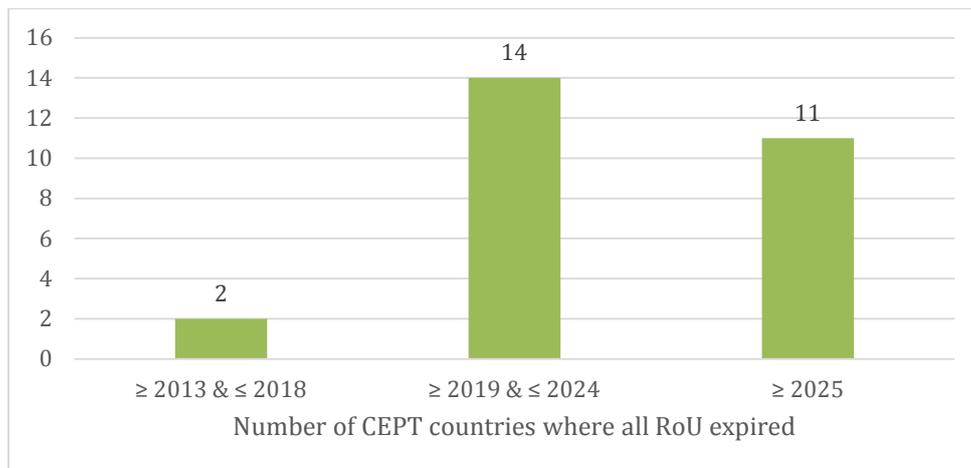
Figure 2 illustrates the number of CEPT countries that completed ASO and those that foresee its completion from 2006 to 2015.



**Figure 2: ASO completed per CEPT country/year (based on data available in 31 CEPT countries)**

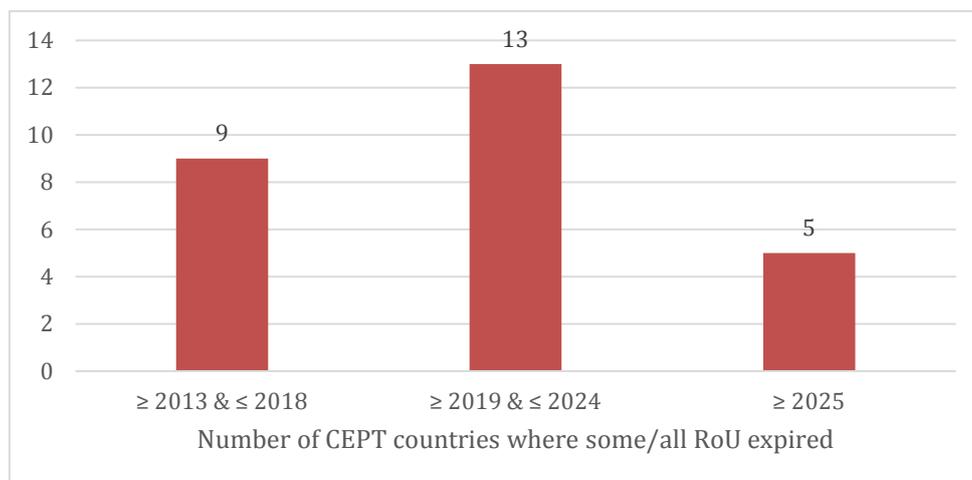
From the data provided in ANNEX 6:, and as expected, the implementation of terrestrial TV platforms differ from country to country, including the number of TV networks available, the type of coverage (national, regional/local) and the date of implementation. This leads to a situation where it could be difficult to get a full picture of the duration of the corresponding RoU. Even for a specific CEPT country with several RoU granted, the duration of each RoU could be different.

Figure 3 illustrates the expiry dates of the longest existing RoU and the number of CEPT countries in which these apply.



**Figure 3: Expiry dates of the longest existing RoU and the number of CEPT countries in which these apply (based on data available in 27 CEPT countries)**

In addition, Figure 4 illustrates the number of countries where **at least** one RoU will expire within the same time frame. This means that in those CEPT countries RoU for terrestrial TV transmissions could still be assigned to other terrestrial TV networks.



**Figure 4: Number of CEPT countries where some/all TV RoU expire (based on data available in 27 countries)**

It should be noted that there are RoU without an expiry date which are not illustrated in Figure 3 and Figure 4.

### 3.3.5 Current consumption of audiovisual content

For the purpose of the Report, three ways of viewing audiovisual content are considered:

- Linear, live viewing;
- Linear delivered, but time-shifted viewing (e.g. by means of a Personal Video Recorder(PVR));
- Non-linear viewing (all AV content, including catch-up TV, YouTube, Netflix, BBC iPlayer, BooxTV, etc.).

Linear viewing remains the main way to consume television services. 93% of TV in Europe is watched live. In 2012 this accounted for 233 minutes per person per day. An additional 5% is recorded watching (e.g. PVR) which is also delivered in a linear way.

In addition, there is a small but growing demand for nonlinear (on-demand) services. Globally, IP video traffic represents 66 percent of the total IP traffic in 2013. Mobile video traffic exceeded 50 percent of the total mobile traffic for the first time in 2012 and over two-thirds of the world's mobile data traffic is expected to be video by 2018.<sup>10</sup>

However, linear and non-linear services do not always correspond to the same content: In 2012 in Europe about 2% of the total TV viewing was true on-demand, although there are large differences across EU national markets.

The growth of the demand for nonlinear services so far, has not had an eroding effect on linear TV viewing. On the contrary, linear and non-linear viewing seem to be complementary.

Data related to the extent of linear and of non-linear viewing within CEPT countries is provided in ANNEX 3:.

### 3.3.6 Current situation for PMSE in the band

The UHF TV band (470 to 862 MHz) has been used for many decades to provide terrestrial TV and it is also the core spectrum for audio PMSE (radio microphones and IEM) due to technical characteristics [9]. PMSE

<sup>10</sup> Cisco Virtual Network Index and Cisco mobile Virtual Network Index.

uses the same frequency range but operates in the interleaved spectrum between the TV transmitters. This is an example of a successful implementation which improves the efficiency of spectrum sharing.

Since the 1940s PMSE was used by public broadcast productions. Later other productions started to use these RF-tools as well and today almost every kind of event is produced successfully with extensive use of PMSE equipment (not limited to 470-862MHz). Moreover these events are often based on the functionality and options provided by PMSE services which provide artistic freedom. The use of PMSE is widespread in society and that the vast majority of events are broadcast (live) and deliver a high socio-economic benefit to society through:

- Direct sales of equipment;
- Direct ticket sales of concerts, sport events and other venues;
- Direct revenues of rental companies from the equipment;
- Advertising coming from all the events;
- Secondary revenue streams of these events (such as tourism, hotels, taxis, restaurant and catering industry);
- Indirect revenues from SMS services linked to events (Eurovision Song Contest, "The voice of..." etc.);
- Indirect revenues of IMT providers from the traffic during such events; and
- Indirect revenues (sometimes lasting more than 10 years after the event) of recorded material of the events (DVD, Blue Ray, You Tube, film industry, etc)
- Ability of the hearing impaired to enjoy live events.

The symbiosis between broadcasting and PMSE has been and still is very successful. It also provides the required spectrum quality for interference-free operation of the PMSE equipment. Consumers will not accept that the quality of audiovisual content will fall back to the level of 30 years ago, restricting the artistic freedom of designers and producers by use of wired systems. Daily productions require the operation of 60-90 channels in parallel (using 96MHz of interleaved spectrum for radio microphones, audio links and in-ear monitors) and multiple productions are sometimes in close physical proximity (e.g. London West End, Hamburg Reeperbahn, Paris city centre, etc.). Large productions, such as political summits, elections, sports events etc., often require more than 270 MHz of interleaved spectrum in order to fulfil the consumer demands.

Additional information on spectrum use and future requirements for PMSE is available in ECC Report 204 [9]. Specifically, Annex 1 of ECC Report 204 focusses on audio links, as used in the UHF band and Annex 4 of ECC Report 204 describes the economic and social values of PMSE.

### 3.3.7 Other uses /allocations of the band

According to the Radio Regulations [10], the allocation to the broadcasting service in the frequency range 470-790 MHz in ITU Region 1 is accompanied by several footnotes, some of which are of particular interest for CEPT.

In Germany, Austria, Denmark, Estonia, Finland, Liechtenstein, Norway, Netherlands, the Czech Republic and Switzerland, the band 470-494 MHz is also allocated to the radiolocation service on a secondary basis, limited to the operation of wind profiler radars (see RR 5.291A).

In Region 1, except in the African Broadcasting Area, the band 608-614 MHz is also allocated to the Radio Astronomy Service (RAS) on a secondary basis (see RR 5.306) and according to RR 5.149 administrations are urged to take all practicable steps to protect the RAS from harmful interference, when making assignments to stations of other services to which the band 608-614 MHz is allocated.

Furthermore, in Armenia, Azerbaijan, Belarus, the Russian Federation, Georgia, Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan, Turkmenistan and Ukraine, the band 645-862 MHz, in Bulgaria the bands 646-686 MHz, 726-758 MHz, 766-814 MHz and 822-862 MHz, in Romania the band 830-862 MHz, and in Poland, the band 830-860 MHz until 31 December 2012 and the band 860-862 MHz until 31 December 2017, are allocated to the aeronautical radionavigation service on a primary basis (see RR 5.312).

### 3.3.8 Case Study: Example of Existing Usage of the band 470-790 MHz by the Broadcasting Service and PMSE in Austria

To illustrate the likely spectrum complexities involved, the example of Austria is considered.

In July 2010 the Austrian Government decided to allocate the frequency band 790-862 MHz to next generation mobile networks. The same decision clarified that the frequency band 470-790 MHz will be used only for the future development of broadcasting services (HDTV) including new technologies like DVB-T2 while facilitating PMSE applications in TV white spaces.

Based on that decision, in 2013 three nationwide DVB-T2 multiplexes were issued in addition to the existing two nationwide DVB-T multiplexes and several regional and local multiplexes. A large number of channels are located in the 700 MHz band with license duration of 10 years, i.e. until 2023. Existing DVB-T licences expire in 2016 and will be re-issued as DVB-T2 licences for a further 10 years.

The three DVB-T multiplexes (MUX A, B, C) use 38 transmitters and the three DVB-T2 multiplexes (MUX D, E, F) use 32 transmitters in the frequency range 694-790 MHz. The effective radiated power of more than 20 of these transmitters is within the range 10 kW to 125 kW.

Within the framework of the GE06 Agreement, Austria has to coordinate with up to 13 neighbouring/affected countries<sup>11</sup>. Re-planning of the UHF band, as a consequence of developments in the 700 MHz band, appears to be a very tricky task which may take many years and the switch-over of 700 MHz channels will require the synchronisation with these countries.

Concerning PMSE in Austria about 18,000 Licences (Light Licensing) for wireless microphones are issued, using all of the available broadcasting spectrum in UHF from 470-790 MHz. A very special situation occurs in Austria when the great open air festivals near the border (Bregenz, Salzburg and St. Margarethen/Mörbisch) take place during summer time, where the lack of spectrum is more visible than in other locations, because of bi- or multilateral country cases and the less available spectrum due to usage on basis of GE06. This tense situation in these "Hot Spots" will become even more difficult, if the available UHF spectrum for PMSE would be further reduced.

In order to make sustainable investment decisions and to guarantee the business models it will be crucial that a sufficient (i.e. competitive) amount of the UHF spectrum will be available for the broadcasting service and PMSE for the longer term.

## 3.4 ECONOMIC VALUE OF SPECTRUM

While this section of the Report addresses approaches to determining the economic value of spectrum it should also be kept in mind that, when arriving at a value for spectrum, other factors need to be taken into account including social and cultural values such as the benefits to society of the availability of free-to-air services including public service broadcasting (PSB), as well as services such a broadband and other services [15] offering vital support to the general public<sup>12</sup>.

### 3.4.1 General principles

Radio frequencies are a finite, reusable resource of significant value for the public and the market. It is therefore in society's interests that the radio spectrum is managed as efficiently as possible as well as from a socio-economic perspective.<sup>13</sup> In radio spectrum management, the spectrum authorities continuously make choices and prioritises how the spectrum resource should best be used, even when the alternatives have many uncertain effects and with no obvious price tags. The choices are rarely easy, but a structured impact assessment/cost-benefit analysis produces a better-supported decision, thereby increasing the likelihood that the finite, reusable spectrum resource is used effectively for the benefit of the whole of the society.

<sup>11</sup> CZE, D, HNG, I, LIE, SUI, SVK, SVN / BIH, F, HRV, POL, SRB.

<sup>12</sup> [www.lse.ac.uk/businessAndConsultancy/LSEEnterprise/pdf/tetraReport.pdf](http://www.lse.ac.uk/businessAndConsultancy/LSEEnterprise/pdf/tetraReport.pdf)

<sup>13</sup> DIRECTIVE 2009/140/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 25 November 2009 amending Directives 2002/21/EC on a common regulatory framework for electronic communications networks and services, 2002/19/EC on access to, and interconnection of, electronic communications networks and associated facilities, and 2002/20/EC on the authorisation of electronic communications networks and services: recital 24.

A cost-benefit analysis and assessment of how demand and needs develop in the future can serve as guidance in general spectrum planning, as the spectrum authority makes decisions on what sorts of spectrum uses should be facilitated or prevented in a specific frequency band, through for example ITU-R allocation, harmonisation decisions, choice of access rights and licence conditions.

A cost-benefit analysis is an important tool in quantifying the key costs and benefits of particular policy actions.

Cost-benefit analysis, together with needs assessment can guide the assignment of spectrum in overall spectrum planning, and in the assignment of spectrum for public goods, certain cases of transnational services, and in order to achieve certain political objectives.

### 3.4.2 Assessing the spectrum value

The ITU-D Report, “Exploring the Value and Economic Valuation of Spectrum” [11], indicates the main factors that can influence the value of spectrum as summarized in Table 1.

**Table 1: Factors in assessing spectrum value**

| Type of factor                   | Factor   |
|----------------------------------|--|
| Intrinsic                        | <ul style="list-style-type: none"> <li>• Propagation characteristics</li> <li>• Sharing capacity</li> <li>• Profusion of uses</li> <li>• Global and regional harmonization</li> <li>• International constraints</li> </ul>   |
| Extrinsic: Physical factors      | <ul style="list-style-type: none"> <li>• Geography</li> <li>• Climate</li> </ul>   |
| Extrinsic: Socioeconomic factors | <ul style="list-style-type: none"> <li>• Demographics</li> <li>• Population density</li> <li>• Income distribution</li> <li>• Economic growth rate</li> <li>• Political stability</li> <li>• Absence of corruption</li> <li>• Rule of law</li> </ul>   |
| Extrinsic: Policy and Regulation | <ul style="list-style-type: none"> <li>• Favourable investment and customs laws</li> <li>• Independent regulatory agency</li> <li>• Competition policy</li> <li>• Infrastructure sharing</li> <li>• Rules of protection of the public against electromagnetic waves</li> <li>• Open access rules</li> <li>• Technology neutrality</li> <li>• Limitation of and protection against interference</li> <li>• Coverage obligations</li> <li>• Spectrum caps</li> <li>• Auction rules and bidding credits/set-asides</li> <li>• Transparency</li> <li>• Licensing framework</li> <li>• Dispute-resolution mechanisms</li> </ul> |

According to the ITU-D Report “Digital Dividend: insights for spectrum decisions”, approved in August 2012 [12], the economic value of the spectrum can be stated as the value generated by a service from using spectrum in the 470-862 MHz band over and above the value that would be realised if the service was provided by alternative means (i.e. the next best alternative).

In practical terms, this value cannot be easily defined or estimated due to several reasons, including:

- Difficulty in determining what a next-best-alternative is with comparable services and/or levels;
- High speed of technological innovation;
- Existence of alternatives in the same spectrum band (470-862 MHz).

An alternative valuation approach is a straightforward discounted cash flow (DCF) method. However, such models also suffer some of the same disadvantages as the incremental models. For example, technological innovation may result in unforeseen competition and hence market shares or churn figures in the model are too optimistic. These models also require a profound and detailed knowledge of the business (e.g. service packages, prices, Capex, Opex).

The difficulties associated with an assessment of each of the subjects pointed out above are detailed in the Report "Exploring the Value and Economic Valuation of Spectrum" [11].

The complexity of evaluating the economic value of the spectrum is also illustrated by the different techniques involved in such valuation. According to [13], there are generally three valuation techniques commonly used by economists and financial analysts: Market Comparables, discounted cash flow, and Econometric:

- In the Market Comparable approach, analysts use previous sales of similar items or otherwise known values of assets, and adjust the value to account for differences in the item being valued;
- DCF analysis estimates the value of an asset by forecasting a stream of future cash flows, or profits, based on expected revenues, and capital and operating costs. A discount rate is then used to translate this flow of income into a single (present) value. This approach is commonly used in financial valuations of business models;
- An econometric analysis statistically estimates the relationship between any number of explanatory variables and the values of a sample of assets similar to the one being valued. Once this statistical relationship is identified, it is applied to the target band to estimate its value.

## 4 EVOLUTION OF SERVICES, TECHNOLOGY AND NETWORKS

This section of the Report addresses the trends in the evolution of services (broadcast, mobile and converged services to consumers) as well as the networks and technologies with the potential to deliver these services in the band. It includes consideration of the way in which audiovisual content consumption habits may be changing.

Broadcast technology has been optimised for the delivery of linear broadcast services to a very large number of simultaneous viewers, primarily on large TV screens, with a guaranteed QoS, universal coverage and in a cost efficient way.

LTE is optimised for unicast communication services and coverage targeting handheld devices. The eMBMS standard is an option of the LTE standard which is designed for the delivery of nonlinear and linear broadcast services to a large number of simultaneous viewers.

The concept of convergence/cooperation between technologies and services is not a new topic. One simple perspective on cooperation might be the connecting of different services via a single, dual platform device, e.g. a connected TV receiver will provide linear service via the broadcast stream and on-demand services via a fixed or mobile broadband network platform. This scenario would typically take the best of both technologies to offer an enhanced service to the consumer and hence an established technology or an established mode of use can be enhanced. Convergence however is the amalgamation of separate services onto a single technology platform. When practicable this represents savings for the consumer through lower cost of devices. It has yet to be seen if LTE and its further enhancements or DVB-T and its further enhancements or both could play the role of the converged platform.

### 4.1 EVOLUTION OF SERVICES

#### 4.1.1 Linear TV

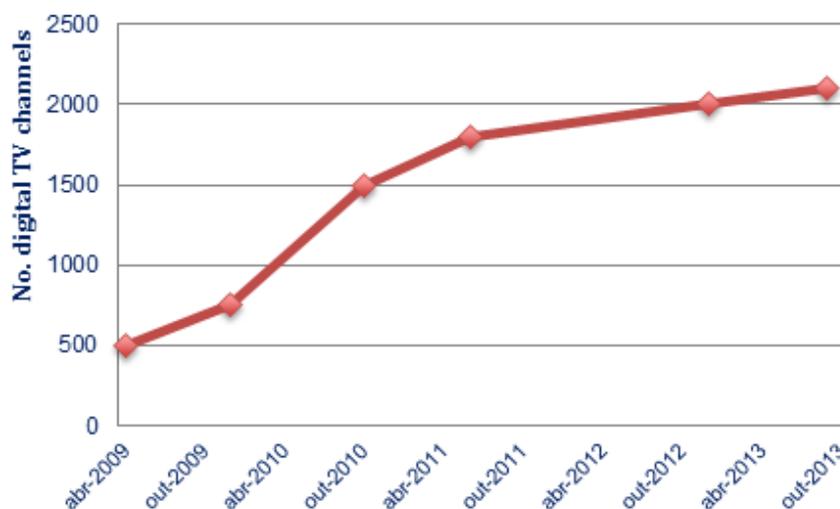
Linear TV services have evolved dramatically over the last ten years offering a wide range of high quality content, both in Standard Definition and High Definition resolution, to a large number of European users. FTA channels are unencrypted and hence free at the point of consumption.

##### 4.1.1.1 Increased content choice

While consumption of linear content remains stable at typically 4 hours per day per European consumer<sup>14</sup>, this value does not distinguish between the platforms used. The choice and availability of TV content has increased significantly in recent years. According to the European Audiovisual Observatory<sup>15</sup> there are currently more than 10,000 TV programme services and more than 3,000 on-demand audiovisual programme services in Europe. More than 2,000 TV channels across Europe are provided on DTT networks including national, regional and local services (these figures indicate the extent of PMSE use). Figure 5 reflects the growth of the DTT content offering which largely coincides with the digital switch-over across Europe.

<sup>14</sup> Ofcom UK: The Communications Market Report: International (2013)  
[http://stakeholders.ofcom.org.uk/binaries/research/cmr/cmr13/icmr/3\\_tv.pdf](http://stakeholders.ofcom.org.uk/binaries/research/cmr/cmr13/icmr/3_tv.pdf)

<sup>15</sup> The MAVISE TV Database (<http://mavise.obs.coe.int/>) is maintained by the European Audiovisual Observatory.



**Figure 5: Programme services on Terrestrial broadcast networks across the EU area  
(Based on data from the MAVISE TV database)**

Approximately 50% of TV programme services are national services with the remainder being a mix of regional or local programme services. In a number of countries, though not all, there is a latent market demand for additional channels but further growth is constrained by the available capacity on the national DTT platforms.

#### 4.1.1.2 Evolution in picture quality

Most of the TV content currently provided is in standard definition (SDTV) format. However, an increasing number of channels are already available in high definition quality (HDTV) which is fast becoming the standard for audio visual content delivery.

Furthermore, it is expected that typical TV screen sizes will continue to increase<sup>16</sup> and the capabilities of consumer devices will further evolve, leading to the demand for even higher picture quality, such as Ultra HDTV (or UHD TV) and 3DTV.

#### 4.1.1.3 Evolution of Consumer Behaviour

Consumers are increasingly investing in TV sets with larger and larger screens, resulting in higher requirements on picture quality. In addition to the traditional audio-visual content, new consumer demands and behaviours are suggesting a need for more program services with different and dedicated content, also offering regional and local content, as well as on-demand content available and accessible anytime-anywhere. Linear consumption continues to dominate TV content with on-demand TV consumption being complementary and extending the total amount viewing time.

Mobile and nomadic use of linear and non-linear TV content on smart phones and tablets has increased on top of voice, text and data use. Access to these highly personalised and convenient devices often in the hands of the younger generation is seen as attractive by the TV content providers. Furthermore, mobile devices inherently come with a reverse channel allowing for interaction. As these devices typically feature cameras, microphones, touch screens with keyboards, etc., new TV formats with live texting, audio and even video interaction of consumers can be provided. Also, new mobile applications enable the consumption of TV content in a personalised way (like time-shifted viewing) on smartphones and tablets.

It is estimated<sup>17</sup> that there will be increasing consumer demand for video delivered to mobile devices. Currently 72% of consumers that own a smartphone, PC or a tablet use these devices for video viewing and 42% do so also outside of the home.

<sup>16</sup> <http://stakeholders.ofcom.org.uk/market-data-research/market-data/communications-market-reports/cmr13/tv-audio-visual/>

<sup>17</sup> Ericsson Mobile Lab, CISCO mobile Virtual network Index

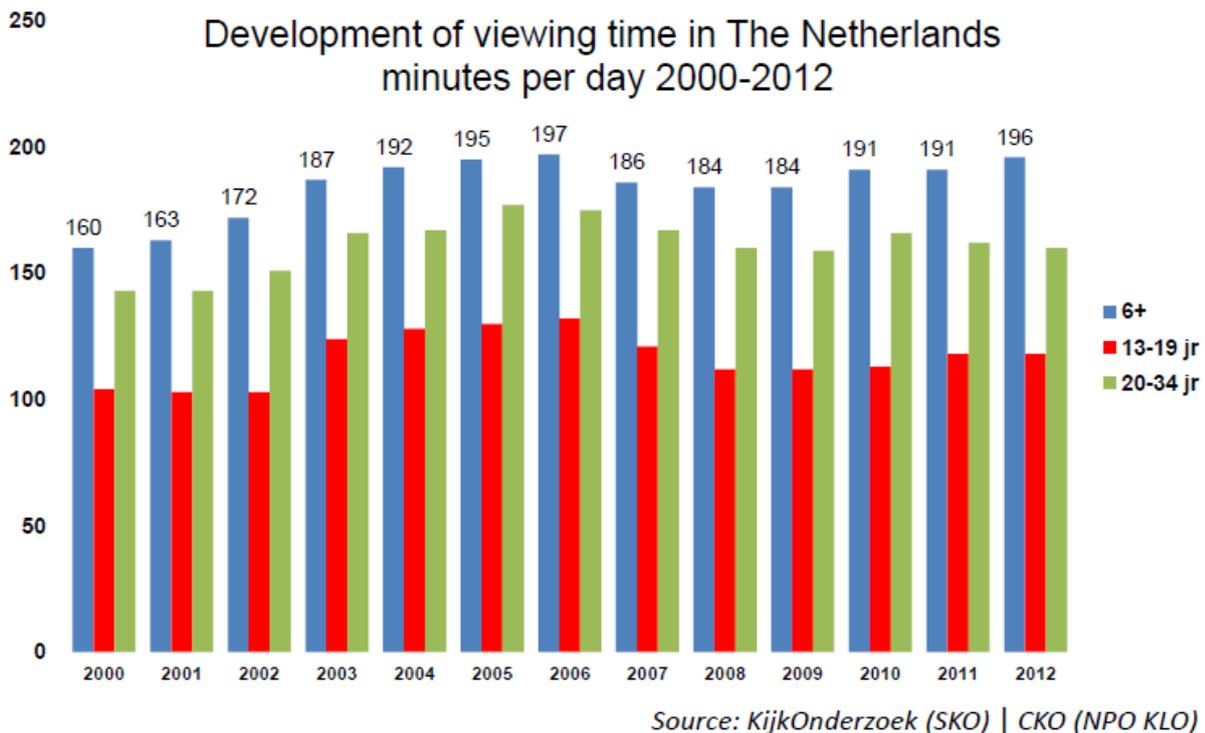
It is difficult to compare consumption for non-linear content and for linear TV services as currently the content format delivered are typically different and the metrics to measure the respective market are also different. Usually, consumer behaviour for non-linear content is quantified in terms of sessions per user whereas consumer behaviour of linear TV is measured in terms of time spent per user. Currently, in terms of the viewing time reported to the overall population, video on mobile device represents a rather small portion of the total viewing time, whereas individual viewing time are not negligible (See ANNEX 3:).

Audiovisual consumption through on-demand streaming platforms is rising fast (see section 4.1.2) both for user generated and professionally produced content (e.g. Youtube, Netflix, etc). Such platforms dominate the video consumption on mobile devices.

Non-linear audiovisual consumption and linear TV consumption seem to address complementary demands:

- Non-linear content is largely consumed, on devices other than large screen, (with the exceptions of e.g. Netflix), with content obtained through delivery platforms other than Linear TV , in particular by the younger generation;
- Linear TV consumption dominates viewing, on large screens at home.

The study of AV consumption by the younger generation may give insight into forecasting future AV consumption patterns. For example, in a cohort study in the Netherlands, summarised in Figure 6 below, it can be seen that those in the age range 13-19 watch less TV than those in the age range 20-34. What can also be noted is that those who were teenagers at the beginning of the study are by the end of the study all in the older age range and viewing time for the 20-34 age range does not decrease but stays relatively stable. This shows that viewing consumption patterns change as people move into different phases of their lives.



**Figure 6: Development of AV viewing time in the Netherlands**

#### 4.1.1.4 Linear TV vs. non-linear TV viewing

Linear viewing remains the dominant form of TV content consumption. The average viewing time of linear TV content on a large screen is approximately 4 hours (see Figure 7 below). 93% of TV in Europe is watched live. Additionally, 5% is recorded viewing (e.g. PVR) which is also delivered via linear means.

In addition, there is a small but growing demand for nonlinear TV content. In 2012, on average in Europe, 2% of the total TV viewing was true on-demand<sup>18 19</sup>, with large differences between national markets. One of the reasons for the small percentage is that a part of the population does not have access to the nonlinear service.

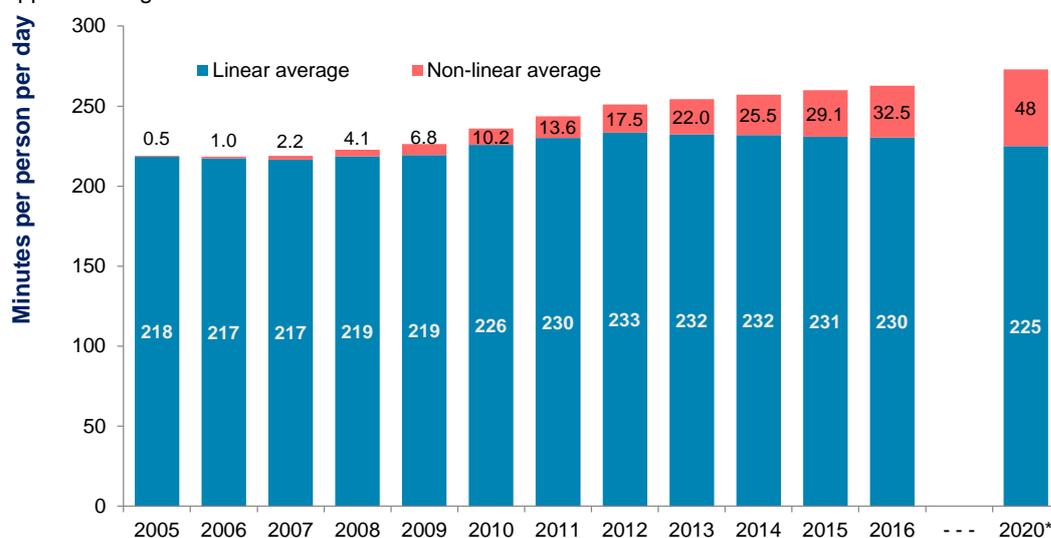
Consumption patterns of non-linear TV content vary also across user groups, with more consumption of TV content over the internet among the young generation<sup>20</sup>.

Whilst non-linear TV viewing has become popular, it accounts only for a few percent of the total viewing share. Figure 7 provides recent projections on the proportion of linear and non-linear TV consumption on large screen for the EU 'Big 5' countries (i.e. France, Germany, Italy, Spain, UK).

## Evolution of linear and non-linear TV viewing

Minutes per person per day – Average in the EU 'Big 5'

Applies to "big screens"



Source: IHS – ScreenDigest: Cross-platform Television Viewing Time FY 2012  
Note: Forecast from 2012 / \* 2020 forecast by EBU

**Figure 7: Screen Digest forecast of linear and on-demand TV viewing for the EU 'Big 5' countries (France, Germany, Italy, Spain, UK) (applicable to big screens)**

It is expected that linear TV will continue to have a key role in providing audiovisual content like daily news, sport events and other live events that are interesting at the moment they happen. It is also expected that linear TV will also continue to seek for exclusive content such as TV series, documentaries, movies. TV channels may also want to make these exclusive contents available in non-linear ways after first linear broadcasting. Linear TV fulfils an essential social function, stimulating debate, conversation and interaction among people. Additionally, non-linear viewing complements linear TV as people can catch up and watch a programme they might have missed when it was aired linearly. Linear TV viewing currently seems to serve as the main entry point for the majority of viewers who access time shifted and on-demand TV services (this is not the case for generic on-demand audio-visual services), thus complementing each other.

<sup>18</sup> [http://www.mediametrie.fr/internet/communiqués/l-audience-de-la-video-sur-internet-en-janvier-2014.php?id=1031#.U3lY5vl\\_v-U](http://www.mediametrie.fr/internet/communiqués/l-audience-de-la-video-sur-internet-en-janvier-2014.php?id=1031#.U3lY5vl_v-U).

<sup>19</sup> Ofcom Communications Market Report, August 2013, page 152 note 3Reasons research which indicates that 2.5% viewing was via VOD

<sup>20</sup> Ofcom UK: The Communications Market Report: International (2013)  
[http://stakeholders.ofcom.org.uk/market-data-research/market-data/communications-market-reports/cmr13/international/?utm\\_source=updates&utm\\_medium=email&utm\\_campaign=icmr-13](http://stakeholders.ofcom.org.uk/market-data-research/market-data/communications-market-reports/cmr13/international/?utm_source=updates&utm_medium=email&utm_campaign=icmr-13)

#### 4.1.1.5 Reception of TV content on mobile and portable devices

On smartphones and tablets TV content consumption is based on wireless broadband connections, in particular WiFi which currently serves around 80% of TV content viewing on these devices. So far, the market take-up of consumption via nomadic DVB-T/T2 systems, e.g. laptop and cars remains modest across Europe.

As the processing capability and the screen resolution of mobile and portable devices continue to increase this fuels user expectations in terms of service quality and availability. It is therefore important to ensure that all audiovisual content services can be delivered affordably in a sufficiently high quality and with adequate reliability in order to satisfy the user experience.

#### 4.1.1.6 Hybrid TV services and second-screen application

Another notable trend is the rise of second-screen applications, which allow viewers to interact with the linear programme or access additional services and information via their PCs, smartphones or tablets simultaneously with watching the main linear content on the large screen.

Linear viewing in combination with internet access is also driving a new phenomenon called 'social TV' that includes interaction between viewers over social media while simultaneously watching TV content.

A recent study for Ofcom in the UK concludes "that we often use the phone or social media to talk to each other about television. Arguably, this social tendency has contributed to the continued attraction of watching programmes live, in order to be a part of conversations about television."<sup>21</sup>

Furthermore, there is significant growth of hybrid TV services (also known as 'connected TV') that leverage the combined advantages of broadcast and broadband delivery. Linear audiovisual content and the necessary signalling are delivered over either a broadcast network or the broadband network whilst additional content and data services are provided over a broadband connection. This enables the viewers to enjoy through a single access point a variety of media services including video on demand (VoD), catch-up TV, interactive and personalised services, voting, games and social networking in addition to the commonly available enhanced digital text and Electronic Programme Guide (EPG).

The ability to access VOD services over broadband networks has gradually been established over the last years and the consumption of VOD services has increased. But no obvious transition in consumer behaviour from linear content consumption via broadcast networks to on-demand services seems to be underway.

Further information on the evolution of broadcast services can be found in the EBU Technical Report 13.<sup>22</sup>

### 4.1.2 Rise of non-linear AudioVisual consumption

Non-linear viewing allows the user to decide how, when and by which device to watch TV content and video. Personal video recorders and new cloud based applications (like Netflix, BooxTV, Hulu, BBC iPlayer, etc.) enable users to control and, where appropriate, record and watch audiovisual content and movies. This has been made possible by the increased availability of good value, high quality broadband that is able to support the demands of video content.

Audio-Visual usage behaviour, especially of the younger generation (~age 15-25), may currently be changing in respect of how, when and by which device they watch TV content and video. For example, there is a statement<sup>23</sup> that only 1 in 3 under the age of 35 with broadband access gets all of their TV in the traditional way. 1 in 8 under the age of 35 gets all their TV and movie content online. However, more studies are needed on this issue.

Some statistics from YouTube, as of February 2014, provide an indication of the extent of the consumption of video content, the discrepancy in consumption between generations, and the consumption on different terminals than large screens (See: <http://www.youtube.com/yt/press/statistics.html>)

<sup>21</sup> Ofcom Communications Market Report, August 2013, Ofcom, pp. 150.

<sup>22</sup> <https://tech.ebu.ch/docs/techreports/tr013.pdf>

<sup>23</sup> Are Young People Watching Less TV? (Dec 9th, 2013), <http://www.marketingcharts.com/wp/television/are-young-people-watching-less-tv-24817/>

and <http://expandedramblings.com/index.php/youtube-statistics/> for further details and statistics). Netflix Statistics reinforce this notion. (See: <http://www.statisticbrain.com/netflix-statistics/> for further details and statistics).

## 4.2 EVOLUTION OF NETWORKS AND TECHNOLOGIES

Networks and technologies will develop in order to meet the expected evolution of services and user requirements. In delivering audiovisual content to the general public, the efficient use of the radio frequency spectrum is an essential aspect and is of great concern to national regulators. This section considers how the existing technologies and networks are expected to evolve to support these requirements.

However, recognizing the high speed of technical development, new, possibly more converging, technologies supporting enhanced flexibility of spectrum usage and different services may be available in the long term. This would improve further the efficiency of service offering and frequency usage.

### 4.2.1 Future developments of DTT technology

Some key attributes of the DTT technology are summarized below:

- High availability and reliability of service;
- The capability to deliver local and regional content;
- National coverage beyond just high population density areas;
- QoS independent of the number of simultaneous viewers;
- Ease of reception via portable or existing roof mounted aerials;
- Supports both Free-to-Air channels that are free at the point of consumption and encrypted channels.

The development of DTT technology in the future is expected to support these requirements.

The transmission standard DVB-T2<sup>24</sup> is a state-of-the-art broadcast specification. It uses the OFDM modulation scheme and a number of advanced modulation and coding techniques allowing very efficient spectrum utilisation (up to 6 bits/s/Hz).

As its predecessor DVB-T, DVB-T2 has been developed by the European DVB Project<sup>25</sup> and standardised by ETSI. It is based on the same elements as the DVB-based standards for other broadcast delivery platforms, e.g. DVB-C/C2 and DVB-S/S2. This creates several advantages in terms of chip integration, further improvements of standards, license costs and, in general, economies of scale. Many countries worldwide have introduced or will introduce DVB-T2, and ATSC is considering it now as a potential basis for ATSC3.0.

DVB-T2 networks are currently implemented using the H.264/AVC video compression format. Introducing the next generation of video compression format, H.265/HEVC, would further increase the channel capacity of DVB-T2 multiplexes. Investigations carried out by the EBU have shown that the improvement in coding technology (migrating from MPEG2 to H.264/AVC) and in modulation technology (migrating from DVB-T to DVB-T2) would facilitate the possibility of upgrading all current programme services from SDTV to HDTV. However, choosing to upgrade all programme services from SDTV to HDTV will limit the available capacity for additional services (see estimation of gains provided by enhanced technologies in EBU Technical Report 15<sup>26</sup>).

In addition, the DVB-T2 feature known as *Multiple Physical Layer Pipes* allows independent adjustment of parameters for each delivered programme service within a channel multiplex to meet the required reception conditions (for example outdoor or roof-top antenna). It also allows DTT receivers to save power by decoding only a single program service rather than the whole multiplex of services.

<sup>24</sup> Further information on DVB-T2 including the latest specification can be found at <http://www.dvb.org/standards/dvb-t2>.

<sup>25</sup> Digital Video Broadcasting Project (DVB) [www.dvb.org](http://www.dvb.org)

<sup>26</sup> <http://tech.ebu.ch/docs/techreports/tr015.pdf>

The DVB-T2 standard allows networks to be configured to deliver programme service content to mobile and handheld devices<sup>27</sup>. This feature of DVB-T2 networks could complement mobile broadband networks and be used to offload a significant amount of traffic reducing costs (both for the consumer and mobile broadband network operators) and offering improved QoS.

Other innovative ways of using the DVB-T2 technology are being investigated, (such as the Tower Overlay approach) which may enable cooperative use of DVB-T2 and LTE technologies.

Standardisation of the Ultra HDTV (UHDTV) format has been largely completed which takes the quality of audiovisual media services to a whole new level of viewing experience, beyond HD. Equipment capable of supporting UHDTV content is already coming to the market, test transmissions are being carried out whilst commercial services are expected to be offered as early as 2015.

High value complementary and support systems coexist in the same spectrum used by DTT services, e.g. PMSE and AV content production.

Convergence or cooperation between technologies and services is not a new subject and the DTT service continues to adapt to satisfy developments in consumption behaviour.

One such recent development is TV and set-top boxes including a broadband receiver thereby giving access to on-demand content and catch-up services such as Youview in the UK.

In addition the HbbTV standard<sup>28</sup> enables the provision of hybrid TV services over the existing broadcast and broadband infrastructure. This is another recent example of a European TV standardisation initiative which is gaining momentum globally.

Furthermore, hybrid broadcast-broadband services may also be proposed based on the MHP standard<sup>29</sup> (MHP 1.1.3). The adoption of this DVB's platform for HBB services is increasingly spreading in important markets.

New systems or technologies need to be introduced in parallel with the existing ones to give consumers the opportunity to invest in new equipment or services according to their wishes, while the existing services are maintained during a transition period with simulcast transmissions. New services provide increased value to audiences and motivate them to invest in new equipment providing a stimulus for the adoption of new technology (e.g. H.265/HEVC on DVB-T2 networks) which in turn enables the users to receive a wider service proposition and new services / formats such as 3DTV and UHDTV.

DTT technology and services are expected to further develop in the future, thus creating recurrent needs for technological upgrades (for both consumers and broadcasters) and hence scope for simulcast of new and existing services. New technical specifications are continually being developed, e.g. within the DVB Project.

#### **4.2.2 Evolution of cellular networks**

The data based traffic over mobile broadband networks is rapidly increasing especially due to mobile multimedia usage. It should also be remembered that broadband-based delivery has offered significant benefits in terms of diversity and choice, and lowering the barriers to the distribution of content. However, consumers and businesses also rely on mobile broadband networks for a wide variety of different applications ranging from simple voice, email, web surfing and social media to banking, health tools, mGovernment and increasingly machine-to-machine based connectivity for everything from smart utilities to connected vehicles. There are several efforts currently underway aiming at further enhancing the performance of 3G and 4G technologies in delivering higher capacity, data rates, user experience and in delivering efficiently mobile multimedia services (e.g. UMTS/HSPA 3GPP specification Release 9 and beyond, LTE-Advanced 3GPP specification Release 10 and beyond). In particular, LTE (3GPP specification Release 9 and beyond) already includes evolved Multimedia Broadcast and Multicast Services (eMBMS) capabilities which enable the delivery of rich mobile multimedia content to users and allows the mobile

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<sup>27</sup> A relevant sub-set of the DVB-T2 specification has been published as a T2-Lite transmission profile.

<sup>28</sup> See <http://www.hbbtv.org>.

<sup>29</sup> ETSI TS 102 812 v1.3.1

broadband network to switch dynamically from a unicast to a broadcasting mode on a cell-by-cell basis to address users demand for live or on-demand content and other multimedia services.

Beyond technological improvements to spectrum efficiency or other factors, e.g. increasing the capacity of mobile networks is dependent on accessing additional spectrum. Such is the importance of additional spectrum to meeting growing data requirements that the ITU has made the consideration of new mobile allocations an agenda item at WRC-15.

Furthermore, cellular networks are evolving towards all-IP networks. IP Networks have been adopted as a vehicle for the convergence platforms for fixed networks. IP networks can leverage very large ecosystems and can benefit from internet-related developments.

#### 4.2.2.1 LTE Broadcast Technology

Today, LTE eMBMS is an adjunct to the LTE standard and has limited broadcast capabilities. The short cyclic prefix, the limits on the proportion of the downlink channel that can be assigned to broadcast and the need to operate in parallel an uplink channel effectively limit LTE eMBMS to providing broadcast services to areas with high network density, e.g. city coverage and football stadia.

A future evolution as an extension to the LTE standard, yet to be agreed, is referred to in this report as LTE Broadcast. It is assumed that LTE Broadcast differs from LTE eMBMS through the use of longer cyclic prefixes, a dedicated downlink channel and no limit on the proportion of the channel that can be dedicated to broadcast. For further details on the standard modification required see Table 7 in A2.7.2.2.

In the context of this report LTE eMBMS will be used to refer to the broadcast capability of LTE as described in revisions up to and including Release 12 of the 3GPP LTE specification. The proposed new system will be referred to as LTE Broadcast.

LTE (and by extension LTE Broadcast) are all-IP Networks (AIPN) by definition, providing the following two benefits:

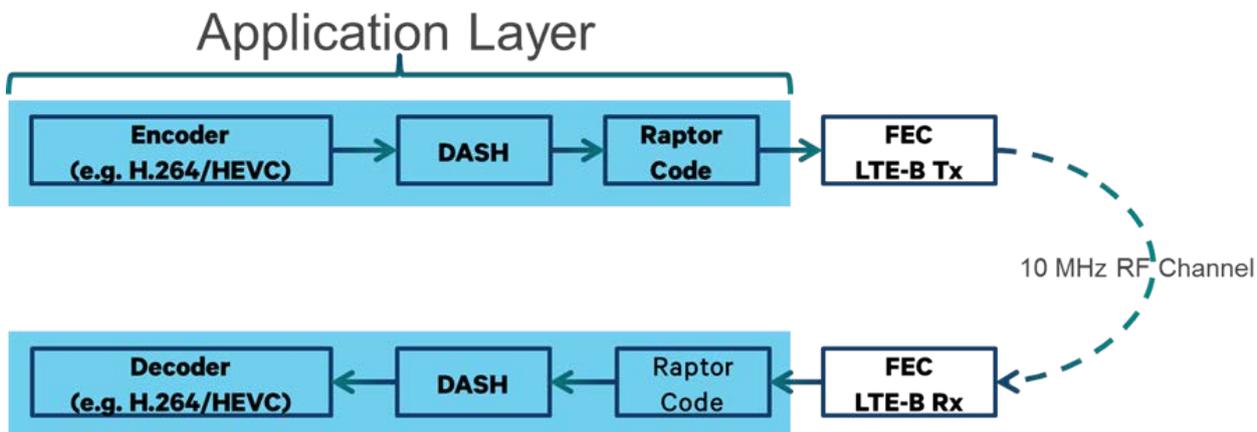
- they can seamlessly integrate future evolutions of delivery mechanisms;
- they benefit from economies of scale and large support, both on device and network sides.

#### 4.2.2.2 LTE as an Integrated Unicast/Broadcast Platform

LTE supports both unicast delivery and multicast/broadcast delivery (through LTE eMBMS). There are multiple benefits to supporting both delivery methods in parallel, in the context of so-called hybrid delivery scenario, i.e. scenarios where part of the content is delivered over unicast and part of the content is delivered over broadcast. In practice, a hybrid delivery scenario can be deployed by leveraging the functionality of Dynamic Adaptive Streaming over HTTP (DASH) on top of LTE Broadcast.

LTE-DASH based hybrid delivery solutions are able to support the following features:

- Delivery of certain components/media streams/representations/segments over broadcast and other components over unicast with synchronization at the client;
- Seamless transition of a broadcast-delivery into a time-shift mode, such that the same content is available for later consumption in the cloud;
- Dynamic resource allocation between unicast and broadcast.



**Figure 8: Typical LTE-Broadcast encoding/decoding chain**

### 4.2.3 Evolution of PMSE

The PMSE industry has instigated, with the backing of the German Administration and subsequently an ETSI STF a Cognitive PMSE<sup>30</sup> project which has publically demonstrated in 2013 an experimental six channel systems which would monitor the local spectrum and automatically change the frequency of the transmitters in line with any local interference.

PMSE has a fundamental problem in that latency must be minimised below 4ms, thus technologies such as LTE are not viable.

An issue which will also need addressing is how the licencing regime will enable these systems to operate.

Further information available in ECC Report 204 [9].

In case of simulcast phase, when introducing new terrestrial transmission systems a side effect of simulcasting is reduction of the availability of spectrum for PMSE and AV content production.

### 4.3 ITU QUESTIONNAIRE ON SPECTRUM REQUIREMENTS FOR BROADCASTING

In 2012, as part of its preparations for submission of material to the ITU-R Joint Task Group preparing for WRC-15, the ITU WP6A prepared and distributed a questionnaire on spectrum requirements for broadcasting in the GE06 planning area (Region 1 and Iran).

An ITU-R Report BT-2302 [14] detailing and analysing all the responses was published in April 2014.

It has to be noted, that responses to the ITU Questionnaire may not necessarily represent the current position of all administrations. Administrations are encouraged to keep their responses to the questionnaire up-to-date. Updated responses should be made to the BR at the email address given in the [questionnaire](#).

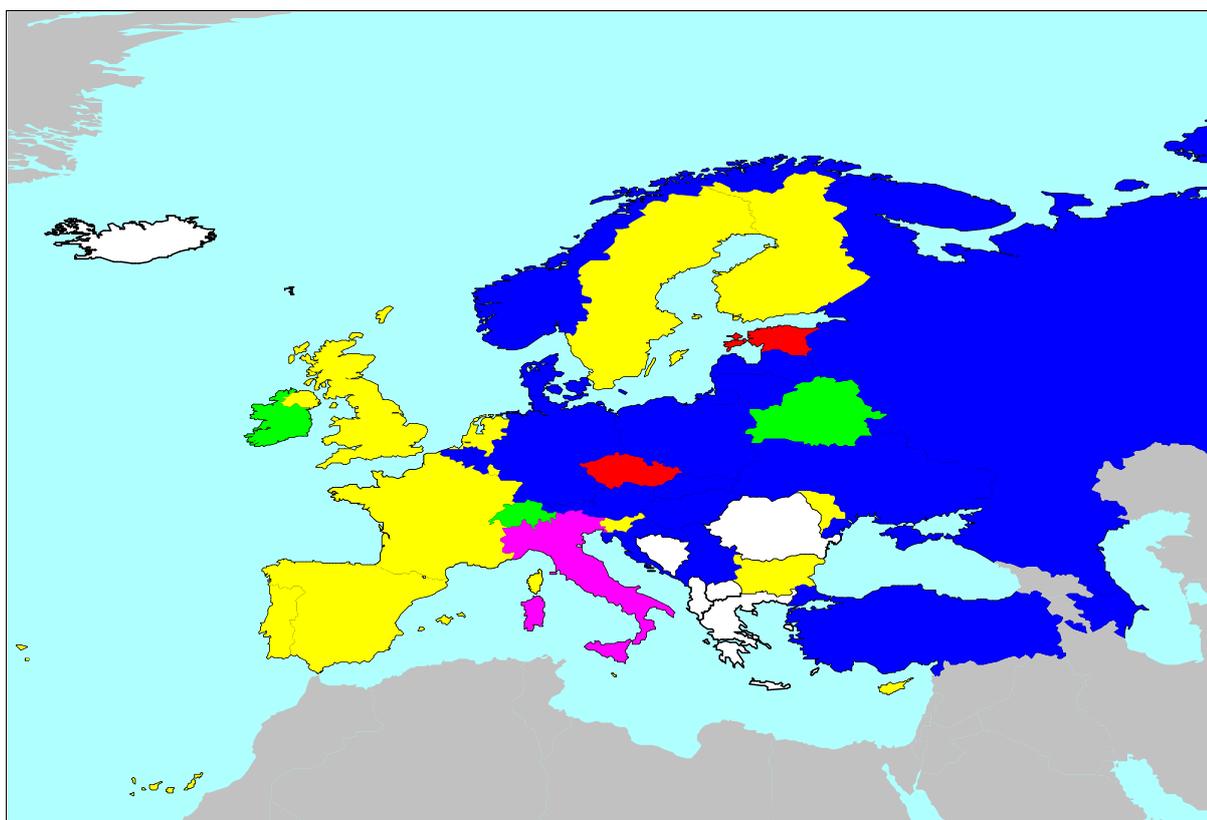
In April 2014, 23 of 36 responses from 48 CEPT member states have been able to make definitive responses to a question about “the amount of spectrum you foresee that will be required for terrestrial television broadcasting” in the band 470-862 MHz.

<sup>30</sup> <http://cpmse.research-project.de/index.php/en/>

This is summarised in Table 2 and Figure 9.

**Table 2: Required amount of spectrum in the band 470-862 MHz for DTT**

| Map Colour | Required amount of spectrum in the band 470-862 MHz for DTT | No of Countries |
|------------|---|-----------------|
| Red        | 224 MHz   | 2               |
| Green      | Between 224 and 320 MHz                                     | 4               |
| Blue       | 320 MHz   | 16              |
| Magenta    | >320 MHz  | 1               |
| Yellow     | To be determined  | 13              |



**Figure 9: Required amount of spectrum in the band 470-862 MHz for DTT, based on ITU-R Report BT-2302-0 (April 2014)**

#### 4.4 FUTURE DELIVERY OF HIGH RESOLUTION AV CONTENT

Existing mobile radio technologies are not well suited to the mass audience broadcast of high resolution content such as HD and in the future UHD. 3G and 4G technologies are optimised for unicast operation and their broadcast modes (MBMS and eMBMS), due to the current limitations in the technical standard, are not efficient broadcast delivery mechanisms. However, DVB-T and in particular DVB-T2 are very efficient at delivering high data rate, high resolution video and hence any future system for audiovisual content provision should as a minimum be as capable as DVB-T2.

There is already recognition that current standards will benefit from enhancements by higher performing standards in due course, some examples of such developments are summarised below.

#### 4.4.1 FoBTV

In 2011, 13 leading television broadcast organizations founded the Future of Broadcast Television Initiative (FoBTV), which is a not-for-profit association aimed at developing technologies for next-generation terrestrial broadcasting systems and making recommendations to standardization organizations around the world. Its members represent broadcasters, manufacturers, network operators, standardisation organisations, research institutes and others in more than 20 countries all over the world.

The FoBTV goals are as follows:

- Develop future ecosystem models for terrestrial broadcasting taking into account business, regulatory and technical environments;
- Develop requirements for next generation terrestrial broadcast systems;
- Foster collaboration in DTV development, laboratories;
- Recommend major technologies to be used as the basis for new standards;
- Request standardisation of selected technologies by appropriate standards development organisations (ATSC, DVB, ARIB, TTA, etc.).

#### 4.4.2 5G

Technical developments that are now under consideration are focused on the next generation of mobile standards. These developments will probably focus on the efficient delivery of several classes of services, including video delivery.

#### 4.4.3 Artemis

This is a proprietary technology under development in the USA; it uses a dense network of small radio access points and distribution of the signal for each user across the network in an optimum way, using information about the performance of the RF channels in the network. The performance optimisation of the network is carried out in a (cloud-based) data centre. It effectively attempts to provide, independent virtual channels for each user, thus avoiding spectrum congestion of existing technologies.

### 4.5 SUMMARY ON EVOLUTION OF SERVICES, TECHNOLOGY AND NETWORKS

The following important developments are expected to continue:

- Broadcasting services will continue to evolve by improvements in picture quality and user experience through the introduction of HDTV, UHD TV, 3DTV, etc;
- Linear viewing will remain the main way of viewing TV content for the foreseeable future.
- Time-shifted and on-demand (non-linear) AV content viewing will continue to grow, driven by services such as YouTube, Netflix, BBC iPlayer and Boox TV;
- Currently the majority of TV viewing, both linear and non-linear (catch-up), occurs in the home;
- On mobile devices, viewing of video content outside the home represents about 40% of total viewing<sup>31</sup> on these devices;
- Most TV viewing will remain on the large screen, while viewing on handheld devices will increase. In the home, the latter is currently driven by the availability of WiFi;
- Migration of services from SDTV to HDTV, and the introduction of UHD TV services as well addition of interactive services complementing the main stream;
- In many European countries, HDTV programmes are already offered on the DTT platform and satellite, and this could be expected to become the norm in the short to medium term. In order to allow these services to be delivered efficiently to viewers, DTT networks need to continue to evolve and have access to a sufficient amount of spectrum;
- Hybrid broadcast-broadband services will become commonplace, possibly including a wireless broadband element, to allow increased access to non-linear as well as linear content;
- Evolutions in DTT technology will support larger SFNs therefore increasing efficient use of spectrum;
- European Digital Agenda (DAE) objectives will lead to improved broadband capacity supporting improved availability of IPTV;

<sup>31</sup> <http://aframe.com/blog/2013/06/top-10-mobile-video-statistics/>

- LTE through its Broadcast and eMBMS applications will be able to deliver broadcast and multicast content;
- New mobile devices, tablets and smartphones, facilitate better user experience for mobile AV content.
- In order to service this evolution in content offering on all platforms the program production industry will require sufficient interference free PMSE spectrum to be provided in a timely manner;
- Mobile broadband services are undergoing growing demand which is causing a significant increase data traffic. The largest and fastest growing traffic type is on-demand video but consumers also rely on mobile broadband for a wide variety of other mobile applications.

## 5 INDICATORS FOR THE MONITORING OF EXPECTED DEVELOPMENTS

The studies contained in the draft Report are based on assumptions made on expected developments for the various current platforms and technologies under consideration and on the demand and supply of the envisaged services.

However, the future might be completely different with the development of new not as yet existing, communication technologies resulting, for example, in connectivity anytime anywhere through any available network.

Thus, it is felt appropriate to develop relevant indicators in order to monitor the assumptions that align with the anticipated developments used for the construction of the scenarios.

The following indicators are suggested as suitable for monitoring developments in the services expected to use the UHF band. Availability of data may limit the applicability of the indicator to a subset of CEPT countries.

**Table 3: Summary of indicators**

| Indicator                                      | Measurement  | Rationale  |
|--|--|--|
| Role of DTT in delivery of audiovisual content | Comparative penetration of -and availability of Free To Air content on-DTT, Cable, Satellite and IP-TV per households by country, across CEPT. May need to distinguish between primary and secondary sets. If possible, provide break-down by age and demographic categories | The extent of use of DTT is a key driver to the costs of migrating to an alternative delivery platform and effective use of the UHF band |
| Extent of linear audio-visual consumption      | Amount of linear audiovisual usage, by country, across CEPT. If possible, provide break-down by age and demographic categories by platform and by device (including smartphones and tablets)   |  |
| Extent of non-linear audio-visual consumption  | Amount of nonlinear audiovisual usage, by country, across CEPT. If possible, provide break-down by age and demographic categories, and by platform and by device   |  |
| Devices used for television / AV viewing       | Number / share of different devices (TV sets, smartphones, tablets, PC's) used for television / AV content viewing   | Describes the change in the viewing habits of the consumers  |
| Linear/non linear consumption per device       | For each viewing device, provides the ratio between linear and non linear content  | Evaluate the need to include broadcast tuners in mobile devices or to include broadcast mode in mobile networks                          |
| User environment of AV content consumption     | Proportion of content which is consumed in home vs out of home   |  |
| Broadband Network to                           | Proportion of AV content which is  |  |

| Indicator   | Measurement  | Rationale   |
|---|--|---|
| deliver AV content                                      | consumed over mobile networks vs over WIFI networks  |   |
| Demand for higher resolution AV content                 | Percentage of TV sets and other video viewing devices (e.g. PC, Tablet, Smartphones) sold by size and resolution over time | To consider consumer behaviour towards screen size and how this may influence demand for higher resolution images               |
| Time shifted viewing patterns                           | Proportion of content which is delivered linearly and stored locally for consumption at a later date                       | Understand the extent to which local storage and scheduled content capture enables time-shifted content 'on the go'             |
| Lifecycle of TV sets                                    | Lifecycle and rate of renewal of TV sets, by country, across CEPT  |   |
| Lifecycle of mobile equipment                           | Lifecycle and rate of renewal of handsets and tablets across CEPT  |   |
| Lifecycle of audio PMSE equipment                       | Lifecycle and rate of renewal PMSE audio equipment across CEPT, and beyond   | Describes the impact of a change in frequency allocation, alternative spectrum/technologies and impact on AV budget and content |
| Development of new technologies/network infrastructures | Penetration/use of new technologies and deployment of new network infrastructure   | Implications for incumbents in both financial and equipment supply  |
| Cost of spectrum  | E.g. Cost / MHz or Cost / MHz/ per capita  | Cost of the spectrum may have impact to the business cases including DTT. .   |

Further consideration is required on the measurement and the monitoring of these indicators.

## 6 LONG TERM VISION ISSUES

This chapter discusses the general classes of scenarios considered by CEPT in defining the long term vision for the band 470-694 MHz. ANNEX 2: provides a detailed description and the assessment of all the scenarios studied by CEPT.

### 6.1 GENERAL CLASSES OF SCENARIOS

CEPT considers that the following four classes of scenarios could cover the developments in the band 470-694 MHz on a long term:

- **Class A:** Primary usage of the band by existing and future DVB terrestrial networks;
- **Class B:** Hybrid usage of the band by downlink LTE and/or DVB terrestrial networks;
- **Class C:** Hybrid usage of the band by conventional two-way (uplink and downlink ) LTE mobile broadband and/or DVB terrestrial networks;
- **Class D:** Usage of the band by future communication technologies.

Though most scenarios described herein are derived and based on today's DTTB and mobile technologies it is envisaged, that new, more flexible and possibly convergent technologies, will be developed and implemented in future for the transmission/distribution of audiovisual content in the UHF band.

ANNEX 2:provides a detailed description and assessment of all the scenarios considered in the CEPT studies on defining the long term vision for the band 470-694 MHz. Table 4 provides the correspondence between the general classes of scenarios described above and the scenarios listed in ANNEX 2:.

**Table 4: Correspondence between the general classes of scenarios and the scenarios listed in Annex 2**

| General Class | Scenarios in Annex 2 |
|---------------|----------------------|
| A             | 1, 2, 3, 4           |
| B             | 5, 6, 8, 9           |
| C             | 7, 10                |
| D             | 11                   |

Scenario 12 (as described in ANNEX 2:) is supposed to occur in combination with any of the scenarios of Classes A, B, C, and D.

It should be also noted that wind profiler radars, currently used in some European countries in the band 470-494 MHz (see RR 5.291A) and the Radio Astronomy Service in the band 608-614 MHz (see RR 5.149), may be still operational in the future and will need to be taken into account by all scenarios foreseen in the band 470-694 MHz.

### 6.2 CLASS A: PRIMARY USAGE OF THE BAND BY EXISTING AND FUTURE DVB TERRESTRIAL NETWORKS

This class of scenarios assumes a natural evolution of the DTT platform based on HPHT networks possibly complemented with LPLT sites, taking into account the ongoing technological and service developments, and assuming a stable regulatory environment and access to the spectrum.

This class assumes the provision of ubiquitous DTT coverage at a moderate cost per area unit. It is therefore particularly suitable for coverage of large areas (including rural), generally nationwide, targeting fixed rooftop for large TV screens and vehicular reception modes.

Regional TV services are easily introduced and come with little additional spectrum requirements.

The evolution of the existing DTT platform, supplemented with additional sites, enables improved portable, mobile, and potentially indoor reception in some areas of interest. This also enables different devices to be connected to the DTT platform provided that they are equipped with DTT tuners.

The cost of the evolved network increases depending on the number of additional sites needed.

Taking into account cross-border planning considerations, the available throughput ranges from about 200 to 240Mbps with DVB-T2 utilising the band 470-694MHz and fixed rooftop reception with a nearly universal coverage. This capacity may be increased with next generation broadcasting technologies in the long term (beyond 2020).

Also, complementary use such as pushed machine and smart-cities related communication is enabled by the DVB-T2 specification.

Additionally, interleaved spectrum (white spaces) usage, including the highly valued continuation of PMSE, is possible with this class.

The existing DTT networks, broadcasting technologies and regulatory framework ensure that this class of scenarios is already available.

From a cross-border frequency coordination perspective, scenarios in this class can coexist in general with scenarios belonging to classes A and B (see also §6.6).

### **6.3 CLASS B: HYBRID USAGE OF THE BAND BY DOWNLINK LTE AND/OR DVB TERRESTRIAL NETWORKS**

This class of scenarios assumes that broadcast and mobile broadband services in the UHF band would in the future be delivered via LTE SDL/eMBMS (downlink only), with or without the DTT platform, based on HPHT and/or LPLT networks.

The scenarios of this class generally provide additional unicast downlink capacity and flexibility in the use of capacity.

If cellular downlink networks and technologies are used as an alternative to the broadcasting networks:

- Broadcast throughput between 1 and 2 b/s/Hz would be theoretically possible. The cost per area unit for maintaining the delivery of TV services is mainly determined by the network topology and the possibility to reuse an existing network. In particular, the network requires more sites for the same coverage (estimated to at least ten times more) than the current DTT network.
- Indoor reception of the broadcast service is possible in areas with high site densities (e.g. in dense urban areas). Coverage over large areas would be only delivered for fixed rooftop reception. The borders between two SFNs represent challenging zones to ensure service delivery. It is to be noted that IMT technologies are not mature yet for large scale broadcasting and some modifications of the standards are needed.
- LTE is optimised for unicast communication services and coverage targeting handheld devices. The eMBMS standard is an option of the LTE standard which is designed for the delivery of nonlinear and linear broadcast services to a large number of simultaneous viewers.
- This situation corresponds to a new network for the TV content distribution. When introducing new systems / technologies they need to be introduced in parallel with the existing ones to give consumers the opportunity to invest in new equipment / services according to their wishes, while the existing services are maintained during a transition period with simulcast transmissions. Therefore, the elements associated with a transition process (cost, antenna orientation, simulcast period, receivers, ...) will need to be taken into consideration.

If cellular downlink networks are used alongside broadcasting networks within the band 470-694 MHz:

- Universal and large scale broadcast service targeting fixed rooftop reception mode is still possible.
- The spectrum available to DTT will be reduced, i.e. this option may be of interest only if a small amount of TV content needs to be broadcast by DTT.
- If a new network is introduced in the band, the transition process implies that inter-network interference should be dealt with on a national basis. The need for guard bands would reduce the amount of usable spectrum.

Additionally and for both cases, interleaved spectrum usage, including the continuation of PMSE, is severely hindered with this class. Should this affect the AV content production, it would lead to the consumer dissatisfaction with the AV content experience, if alternative spectrum is not identified.

From a cross-border perspective, scenarios in this class can coexist in general with scenarios belonging to classes A and B (see also §6.6).

#### **6.4 CLASS C: HYBRID USAGE OF THE BAND BY CONVENTIONAL TWO-WAY (UPLINK AND DOWNLINK) LTE MOBILE BROADBAND AND/OR DVB TERRESTRIAL NETWORKS**

This class of scenarios assumes that broadcast and full, bi-directional mobile broadband services operate in the UHF band, with or without the DTT platform, based on HPHT and/or LPLT networks. This class corresponds to scenarios where conventional two-way LTE mobile broadband services (i.e. operating with separate uplink and downlink channels in the UHF band), to support unicast multimedia content as well as all other types of mobile broadband data traffic, are introduced in the band.

If cellular networks and technologies are used as an alternative to the broadcasting networks:

- Broadcast throughput between 1 and 2 b/s/Hz would be theoretically possible. The cost per area unit for maintaining the delivery of TV services is mainly determined by the network topology and the possibility to reuse an existing network. In particular, the network requires more sites for the same coverage (estimated to at least ten times more) than the current DTT network, which therefore increases costs.
- Indoor reception of the broadcast service is possible in areas with high site densities (e.g. in dense urban areas). Coverage over large areas would be only delivered for fixed rooftop reception. The borders between two SFNs represent challenging zones to ensure service delivery. It is to be noted that IMT technologies are not mature yet for large scale broadcasting and some modifications of the standards are needed.
- This situation corresponds to a new network for the TV content distribution. When introducing new systems / technologies they need to be introduced in parallel with the existing ones to give consumers the opportunity to invest in new equipment / services according to their wishes, while the existing services are maintained during a transition period with simulcast transmissions. Therefore, the elements associated with a transition process (cost, antenna orientation, simulcast period, receivers, ) will need to be taken into consideration.
- Two way mobile broadband services could use the UHF band to support all types of data traffic not necessarily offering linear TV content. The propagation properties of the UHF band facilitate expansion of mobile network capacity especially in rural areas and inside buildings.

If cellular networks are used alongside broadcasting networks:

- Universal and large scale broadcast service targeting fixed rooftop reception mode is still possible.
- The spectrum available to DTT will be reduced, i.e. this option may be of interest only if little amount of TV content needs to be broadcast by DTT.
- As for this situation a new network is introduced in the band, the transition process implies that inter-network interference should be dealt with on a national basis. The situation is further complicated in view of the need to accommodate the uplink frequencies within the country.
- Two way mobile broadband services could use the UHF band to support all types of data traffic not necessarily offering linear TV content. The propagation properties of the UHF band facilitate expansion of mobile network capacity especially in rural areas and inside buildings.

Additionally and for both cases, interleaved spectrum usage, including the continuation of PMSE, is severely hindered with this class. Should this affect the AV content production, it would lead to the consumer dissatisfaction with the AV content experience, if alternative spectrum is not identified.

From a cross-border perspective, scenarios in this class can only coexist with scenarios belonging to the same class C and in that case, harmonisation of the UL band according to an agreed timescale is required across countries (see also §6.6).

## **6.5 CLASS D: USAGE OF THE BAND BY FUTURE COMMUNICATION TECHNOLOGIES**

This class of scenarios assumes that broadcast and mobile broadband services in the UHF band would in the future be delivered via evolved or via completely new, as not yet existing, communication technologies resulting in connectivity anytime anywhere through any available network.

## **6.6 COMPATIBILITY BETWEEN CLASSES OF SCENARIOS**

It is anticipated that different administrations may prefer different scenarios for which different spectrum management options are possible. It is therefore necessary to analyse the possibility of coexistence offered by these options.

The analysis assumes that the telecommunication technologies work in a similar way as they do today, notably it is assumed that broadband technologies are used. Also the network architectures for both the broadcasting and the cellular networks are assumed to be similar to what is implemented nowadays (i.e. typical inter-site distances, transmitted power, sensitivity thresholds, antenna heights are unchanged).

The coexistence issue is twofold:

Criteria 1: first, from a technical point of view, it is necessary to assess whether two different options can be used in two neighbouring countries. The coexistence studies show, in most cases, that some degree of coordination will be needed between the involved administrations.

Criteria 2: second, the likelihood of success of the coordination must be evaluated. These evaluations, although subjective, find their roots in the past experience as well as in technical considerations and expressed needs of the administrations.

Table 5 summarises the coexistence analysis, conclusions of which need to be fulfilled at any point in time, e.g. during the transition period or the final situation. Regarding Class D, because the technologies are unknown for the time being, the coexistence issues would be assessed in due time. The rationale behind the evaluations is given in the subsequent text in §6.7.

**Table 5: Summary of the coexistence analysis**

|         | Class A   | Class B  | Class C |
|---------|---|--|---------|
| Class A |   |  |         |
| Class B |   |  |         |
| Class C |   |  |         |
|         | Criteria 1: Technically feasible with similar technologies and network architectures as currently available.<br>Criteria 2: similar bilateral coordination issues already dealt with.           | Criteria 1: Technically feasible with similar technologies and network architectures as currently available.<br>Criteria 2: new bilateral coordination methodology need to be developed. |         |
|         | Criteria 1: Technically feasible with similar technologies and network architectures as currently available.<br>Criteria 2: requires a Region-wide harmonization (frequency plan and schedule). | Criteria 1: Technically difficult and challenging assuming similar technologies and network architectures as they are nowadays   |         |

**6.7 CROSS-BORDER FREQUENCY COORDINATION AND COEXISTENCE**

Co-channel coexistence is investigated below as adjacent channel compatibility can be achieved using appropriate guard bands and tuning range in the devices.

- The coexistence between **two broadcast networks** (HPHT) (class A) corresponds to the current situation and is therefore possible. It requires extensive but well known cross-border coordination procedures.
- Coexistence between **two cellular downlink networks** is possible. Coordination issues correspond to existing situations in IMT bands except that uplink is not relevant in this case.
- In the case of two different network topologies for downlink purposes on both sides of the border (i.e. **cellular downlink network and a HPHT broadcast network**), interference will occur over a few tens of kilometres within the area between both networks and detailed cross-border coordination (at bilateral/multilateral level) will be essential. This includes appropriate methodologies agreed by involved parties and realistic parameters to investigate the problems as well as appropriate frequency plans in order to cover those areas which are potentially interfered. A common channelling plan for DTT and cellular networks would facilitate the work.
- Coexistence between **a cellular uplink and a broadcast or cellular downlink network** is challenging with similar network architectures as encountered nowadays. The studies conclude that there is a need for a separation distance of hundreds of kilometres.
- Coexistence between **two cellular bidirectional networks** is possible and currently little coordination is required in IMT-bands for this type of coexistence, providing a harmonized frequency plan and synchronized migration schedules are used.

It is to be noted that because a loss of a broadcast TV service cannot be alleviated by the use of an alternative band, it is expected that extensive cross-border coordination work would be necessary even for those cases where TV services are delivered on cellular networks.

Because coexistence between cellular uplink and broadcasting or cellular downlink is difficult and challenging, any spectrum option that introduces an uplink in the band requires a consensus among all the involved administrations and Region-wide synchronisation, including during transition periods. This could require Region-wide agreements because the use of this frequency band in one country is (partly) determined and has impact on the neighbouring countries (sometime called the domino effect). Noting the diversity of needs and situations encountered across the CEPT countries it might be challenging to agree on the minimum amount of downlink capacity and the specification of the uplink part.

## 7 RECOMMENDATIONS

The consideration of the following non-binding elements, may assist administrations within the context of the national legal and regulatory framework, when deciding on a particular scenario for the usage of the band 470-694 MHz:

- the current national general interest objectives;
- the implications of a given scenario on the audiovisual industry, content creation and user expectations;
- monitoring of the market and technological developments, including by means of the key indicators as defined in Chapter 5;
- a cost/benefit analysis with a focus on the impact on consumers;
- assessment criteria such as but not limited to those that were used in the assessment of the scenarios listed in ANNEX 2.;
- a realistic time frame for the transition towards a new scenario, taking into account duration of the existing rights of use and the spectrum needs during the transition period as well as the need for continuation of the service (in the context of this report);
- the coexistence feasibility between different classes and the necessity for cross-border frequency coordination.

## 8 CONCLUSIONS

TG6 was requested to identify and analyse possible scenarios for the development of the band 470-694 MHz in the long term starting from the existing situation and recognizing the ongoing studies in the 700 MHz band in Europe, and short to medium term developments (e.g. AI 1.2 of WRC-15 and the response to the European Commission Mandate on the 700 MHz band). The Task Group was also required to take account of the differences in the requirements that individual countries in Europe may have for the various current and potential uses of the band and provide advice on how to ensure equitable access to the band by those administrations wishing to continue operating broadcasting services.

The current situation is dealt with in the Report by describing the current role of the terrestrial broadcast platform including issues such as supporting Free to Air, social inclusion and providing information in times of emergencies. In addition, the regulatory framework for the provision of audiovisual media services, the duration of currently assigned TV Rights of Use and current consumption of audiovisual content is also explored in the Report.

The Report addresses the trends in the evolution of services and consumer behaviour, as well as the networks and technologies that offer the potential to deliver these services in the band. It includes consideration of the way in which audio visual content consumption habits may be changing.

In relation to the evolution of delivery of broadcast services in fixed and mobile environments the following important developments are expected to continue:

- Broadcasting services will continue to evolve by improvements in picture quality and user experience through the introduction of HDTV, UHD TV, 3DTV, etc;
- Linear viewing will remain the main way of viewing TV content for the foreseeable future.
- Time-shifted and on-demand (non-linear) AV content viewing will continue to grow, driven by services such as YouTube, Netflix, BBC iPlayer and Boox TV;
- Currently the majority of TV viewing, both linear and non-linear (catch-up), occurs in the home;
- On mobile devices, viewing of video content outside the home represents about 40% of total viewing on these devices;
- Most TV viewing will remain on the large screen, while viewing on handheld devices will increase. In the home, the latter is currently driven by the availability of WiFi;
- Migration of services from SDTV to HDTV, and the introduction of UHD TV services as well addition of interactive services complementing the main stream;
- In many European countries, HDTV programmes are already offered on the DTT platform and satellite, and this could be expected to become the norm in the short to medium term. In order to allow these services to be delivered efficiently to viewers, DTT networks need to continue to evolve and have access to a sufficient amount of spectrum;
- Hybrid broadcast-broadband services will become commonplace, possibly including a wireless broadband element, to allow increased access to non-linear as well as linear content;
- Evolutions in DTT technology will support larger SFNs therefore increasing efficient use of spectrum;
- European Digital Agenda (DAE) objectives will lead to improved broadband capacity supporting improved availability of IPTV;
- LTE through its Broadcast and eMBMS applications will be able to deliver broadcast and multicast content;
- New mobile devices, tablets and smartphones, facilitate better user experience for mobile AV content.
- In order to service this evolution in content offering on all platforms the program production industry will require sufficient interference free PMSE spectrum to be provided in a timely manner;
- Mobile broadband services are undergoing growing demand which is causing a significant increase data traffic. The largest and fastest growing traffic type is on-demand video but consumers also rely on mobile broadband for a wide variety of other mobile applications;

The studies contained in this Report are based on anticipated developments for the various current platforms and technologies under consideration and linked to the demand and supply of the envisaged services. Thus, it was necessary to develop relevant indicators in order to monitor the assumptions that align with anticipated developments used for the construction of the future scenarios. These indicators are described in Chapter 5

and are considered suitable for monitoring developments in the future services expected to use the UHF band. Further consideration is required on the measurement and the monitoring of these indicators.

This Report discusses and analyses in Chapter 6 the general classes of scenarios considered by CEPT in defining the long term vision for the band 470-694 MHz. ANNEX 2: provides a detailed description and the assessment of all the scenarios studied by CEPT. CEPT considers that the following four classes of scenarios could cover the developments in the band 470-694 MHz in the long term:

- **Class A:** Primary usage of the band by existing and future DVB terrestrial networks

This class of scenarios assumes a natural evolution of the DTT platform based on HPHT networks possibly complemented with LPLT sites, taking into account the ongoing technological and service developments, and assuming a stable regulatory environment and access to the spectrum.

- **Class B:** Hybrid usage of the band by downlink LTE and/or DVB terrestrial networks

This class of scenarios assumes that broadcast and mobile broadband services in the UHF band would in the future be delivered via LTE SDL/eMBMS (downlink only), with or without the DTT platform, based on HPHT and/or LPLT networks. The scenarios of this class generally provide additional unicast downlink capacity and flexibility in the use of capacity.

- **Class C:** Hybrid usage of the band by conventional two-way (uplink and downlink) LTE mobile broadband and/or DVB terrestrial networks

This class of scenarios assumes that broadcast and full, bi-directional mobile broadband services operate in the UHF band, with or without the DTT platform, based on HPHT and/or LPLT networks. This class corresponds to scenarios where conventional two-way LTE mobile broadband services (i.e. operating with separate uplink and downlink channels in the UHF band), to support unicast multimedia content as well as all other types of mobile broadband data traffic, are introduced in the band.

- **Class D:** Usage of the band by future communication technologies

This class assumes that broadcast and mobile broadband services in the UHF band would in the future be delivered via evolved or via completely new, as not yet existing, communication technologies resulting in connectivity anytime anywhere through any available network.

Audiovisual media services, which could be traditionally seen as typical broadcast platform “content”, and other audiovisual content (user generated content, video clips, etc.) are also available on the internet and distributed via cable, optical fibre or wireless broadband access. The usage and acceptance of all distribution platforms differs substantially from country to country, but linear services are mainly delivered over the traditional broadcast distribution platforms whilst the on-demand services are primarily delivered over broadband networks. On the other hand, broadcast services are more and more heading for using return channels or additional parallel channels to allow the user more flexibility and access to additional information.

**A cooperation between radiocommunication services is expected in the long term.**

Traffic expectations for broadcast service and broadband access, including wireless, assume the increasing delivery of audiovisual content in improved quality to an increasing number of users. This will result in a higher asymmetry between upstream and downstream traffic.

Due to its propagation characteristics, the band 470-694 MHz can be efficiently used for the distribution of audiovisual services. These services may be linear or non-linear. The number of receiving users served by a content provider can vary from one to up to several million users. This is depending on the different types of content, user density, the specific social and economic situation, and technology. **Therefore, the long term usage of the band 470-694 MHz is mainly foreseen for downstream audiovisual content distribution.**

The scenarios listed in ANNEX 2: and classified in Chapter 6 describe possible long term future deployments in the band 470-694 MHz. Each of these scenarios has a certain potential to occur.

With the current state-of-the-art of the radiocommunication technologies there are incompatibilities between some scenarios, as studied in this Report. The compatibility between scenarios has to be taken into account. As assessed today and for the coming years, coexistence is feasible between broadcast and mobile downlink networks whereas the coexistence between mobile uplink and broadcasting or mobile downlink is difficult and challenging. However, the situation as of today may change in the long term.

The variety of scenarios considered in this report should be understood as an indication for different needs/requirements in different countries regarding the future use of the band 470-694 MHz.

**In order to facilitate different scenarios considered by the CEPT for the usage of the band 470-694 MHz, it could be necessary to introduce more flexibility in the regulatory environment governing the use of this band** to respond to different needs and requirements in different countries. This will also allow taking into account, inter alia, the possible advances in radiocommunication technologies.

There could be different measures to provide for the regulatory flexibility in the band 470-694 MHz, if so required. It should be pointed out that any modification of the Radio Regulations to implement flexibility has to be discussed in the framework of ITU, taking into account the inherent flexibility of the Radio Regulations and the GE06 Agreement.

## **ANNEX 1: REGULATORY FRAMEWORK FOR THE PROVISION OF AUDIOVISUAL MEDIA SERVICES**

Audiovisual media services are normally subject to two different sets of rules at the European level: the regulatory framework for audiovisual content, i.e. the Audiovisual Media Services Directive 2010/13/EU [6], and the regulatory framework for electronic communications networks and services, i.e. the Telecom Package Directives, in particular the Framework Directive [7] and the Universal Service Directive [8]. Furthermore, the Radio Spectrum Policy Programme [2] defines the current spectrum priorities in the EU whilst the Geneva'06 Agreement [1] governs the use of the UHF band for digital terrestrial TV services in the ITU Region 1.

Even though the regulation of transmission and the regulation of content are separate they both aim to guarantee media pluralism, cultural diversity and consumer protection. Moreover, the Telecom Package Directives are without prejudice to measures taken at European or national level to pursue general interest objectives, in particular relating to content regulation and audio-visual policy.

### **A1.1 AUDIOVISUAL MEDIA SERVICES DIRECTIVE**

The Audiovisual Media Services Directive (AVMSD) 2010/13/EU lays down a minimum set of rules which govern EU-wide coordination of national legislation in the particular areas related to audiovisual media. Provisions of the AVMSD cover all services with audiovisual content irrespective of the technology used to deliver the content. However taking into account the degree of choice and user control over services, the AVMSD makes a distinction between linear (television broadcasts) and non-linear (on-demand) services.

The AVMSD recognises that 'Audiovisual media services are as much cultural services as they are economic services. Their growing importance for societies, democracy — in particular by ensuring freedom of information, diversity of opinion and media pluralism — education and culture justifies the application of specific rules to these services.' (Recital 5).

### **A1.2 FRAMEWORK DIRECTIVE**

The Framework Directive forms part of the 'Telecom Package' that also includes the Authorisation Directive, the Access Directive, the Universal Service Directive and the e-Privacy Directive.

The objective of this Directive is to establish a harmonised framework for the regulation of electronic communications networks and services. This framework is not limited to telecommunications networks and services but covers all electronic communications networks and services. On the other hand, the content of services delivered over electronic communications networks, such as broadcasting content, is excluded.

The following provisions of the Framework Directive are particularly relevant for audiovisual media services:

#### **Recital 5**

The convergence of the telecommunications, media and information technology sectors means all transmission networks and services should be covered by a single regulatory framework. [...]

It is necessary to separate the regulation of transmission from the regulation of content. [...]

The separation between the regulation of transmission and the regulation of content does not prejudice the taking into account of the links existing between them, in particular in order to guarantee media pluralism, cultural diversity and consumer protection.

#### **Recital 6**

Audiovisual policy and content regulation are undertaken in pursuit of general interest objectives, such as freedom of expression, media pluralism, impartiality, cultural and linguistic diversity, social inclusion, consumer protection and the protection of minors. [...]

In Recital 19

Radio frequencies are an essential input for radio-based electronic communications services and, in so far as they relate to such services, should therefore be allocated and assigned by national regulatory authorities according to a set of harmonised objectives and principles governing their action as well as to objective, transparent and non-discriminatory criteria, taking into account the democratic, social, linguistic and cultural interests related to the use of frequency. [...] Transfer of radio frequencies can be an effective means of increasing efficient use of spectrum, as long as there are sufficient safeguards in place to protect the public interest,

Article 1 (3)

This Directive as well as the Specific Directives are without prejudice to measures taken at Community or national level, in compliance with Community law, to pursue general interest objectives, in particular relating to content regulation and audio-visual policy.

Article 8 (4, a)

The national regulatory authorities shall promote the interests of the citizens of the European Union by inter alia:

(a) ensuring all citizens have access to a universal service specified in Directive 2002/22/EC (Universal Service Directive) [...]

Article 8a (1)

Member States shall cooperate with each other and with the Commission in the strategic planning, coordination and harmonisation of the use of radio spectrum in the European Community. To this end, they shall take into consideration, inter alia, the economic, safety, health, public interest, freedom of expression, cultural, scientific, social and technical aspects of EU policies as well as the various interests of radio spectrum user communities with the aim of optimising the use of radio spectrum and avoiding harmful interference.

### **A1.3 UNIVERSAL SERVICE DIRECTIVE**

This Directive defines universal service as the “minimum set of services of specified quality to which all end-users have access, at an affordable price in the light of specific national conditions, without distorting competition”.

Member States must ensure that the electronic communications services detailed in the Directive are made available to all users in their territory, regardless of their geographical location, at a specified quality level and an affordable price.

The most relevant provision for broadcast services is in Article 31 (1):

'Member States may impose reasonable “must-carry” obligations, for the transmission of specified radio and television broadcast channels and complementary services, particularly accessibility services to enable appropriate access for disabled end-users, on undertakings under their jurisdiction providing electronic communications networks used for the distribution of radio or television broadcast channels to the public where a significant number of end-users of such networks use them as their principal means to receive radio and television broadcast channels. Such obligations shall only be imposed where they are necessary to meet general interest objectives as clearly defined by each Member State and shall be proportionate and transparent.'

#### **A1.4 RADIO SPECTRUM POLICY PROGRAMME**

The Radio Spectrum Policy Programme (RSPP), established by Decision No 243/2012/EU, defines the roadmap for how Europe can translate political priorities into strategic policy objectives for radio spectrum use. The following provisions in this Decision are relevant for the audiovisual media services:

##### Article 1 (1)

'This Decision establishes a multiannual radio spectrum policy programme for the strategic planning and harmonisation of the use of spectrum to ensure the functioning of the internal market in the Union policy areas involving the use of spectrum, such as electronic communications, research, technological development and space, transport, energy and audiovisual policies.'

##### Article 1 (3)

This Decision is without prejudice to measures taken at national level in full compliance with Union law, which pursue objectives of general interest, in particular those relating to content regulation and audiovisual policy.

##### Article 7

In order to support the further development of innovative audiovisual media and other services to Union citizens, taking into account the economic and social benefits of a single digital market, Member States shall, in cooperation with the Commission, aim at ensuring there is sufficient spectrum available for satellite and terrestrial provision of such services, if the need is clearly substantiated.

#### **A1.5 GENEVA AGREEMENT 2006 (GE06)**

The GE06 Agreement is an international treaty that governs the use of the UHF band for terrestrial TV and other services in parts of ITU Regions 1 and 3. In particular, the GE06 Agreement defines frequency arrangements and the cross-border coordination procedure for the UHF band. The associated frequency plan contains the internationally coordinated spectrum rights in the form of TV assignments and allotments, based on 8 MHz channels.

Flexibility of the GE06 Agreement is reflected in the spectrum mask concept which allows any technology to be implemented on the basis of an assignment or an allotment, provided that it does not cause more interference nor require better protection than the corresponding entry in the Plan.

#### **A1.6 NATIONAL REGULATION**

In most European countries specific national regulation has been put in place to ensure the efficient use of the spectrum in accordance with the specific national circumstances and to ensure that audiovisual policy objectives are achieved.

Specific obligations for Public Service Media (e.g. number of TV channels, the type and amount of programmes, the primary distribution mechanism, availability and coverage) are generally defined in the Law. These obligations normally remain valid for the entire license period. PSM obligations are subject to periodic reviews which sometimes involve public debate.

The high-level technical framework such as the choice of the transmission system and compression standard (e.g. DVB-T or T2, MPEG-2 or MPEG-4) may also be subject to political decisions. Details are normally specified by the licensing authorities.

## ANNEX 2: LONG TERM SCENARIOS FOR DELIVERY IN THE BAND 470-694 MHZ

Chapter 6 discusses the general classes of scenarios considered by CEPT in defining the long term vision for the band 470-694 MHz. This Annex provides a detailed description and assessment of all the scenarios studied by CEPT.

### A2.1 GENERAL DESCRIPTION OF SCENARIOS

Table 6 lists the scenarios considered by CEPT for the development in the band 470-694 MHz in the long term. These scenarios may occur either as a standalone scenario or in combination with each other. It needs to be noted, however, that the migration towards these scenarios will start from the current situation in the band, which is described in § 3.3.

**Table 6: Long term scenarios for delivery in the band 470-694 MHz**

| No                          | Service                               | Terminal/<br>user device                | Usage environment                                 | Delivery   |               | §     |
|-----------------------------|---------------------------------------|---|---|--|---------------|-------|
|                             |                                       |   |   | Technology   | Network       |       |
| <b>Standalone scenarios</b> |                                       |   |   |  |               |       |
| 1                           | AV linear,<br>AV non-linear           | Large screen,<br>small<br>screen/tablet | Stationary, portable<br>outdoor/indoor            | DTT <sup>1</sup>   | HPHT          | A2.2  |
| 2                           | AV linear,<br>AV non-linear           | Large screen,<br>small<br>screen/tablet | Stationary, portable<br>outdoor/indoor            | DTT <sup>1</sup>   | LPLT          | A2.3  |
| 3                           | AV linear,<br>AV non-linear           | Large screen,<br>small<br>screen/tablet | Stationary, portable<br>outdoor/indoor            | DTT <sup>1</sup> (outdoor),<br>WiFi (indoor) <sup>2</sup>  | HPHT/<br>LPLT | A2.4  |
| 4                           | AV linear,<br>AV non-linear           | Large screen,<br>small<br>screen/tablet | Stationary, portable<br>outdoor/indoor            | DTT <sup>1</sup> (outdoor),<br>WiFi (indoor) <sup>2</sup> ,<br>DTT <sup>1</sup> chips<br>inside UE | HPHT/<br>LPLT | A2.5  |
| 5                           | AV linear,<br>AV non-linear           | Large screen,<br>small<br>screen/tablet | Stationary, portable<br>outdoor/indoor            | LTE Broadcast  | HPHT          | A2.6  |
| 6                           | AV linear,<br>AV non-linear           | Large screen,<br>small<br>screen/tablet | Stationary, portable<br>outdoor/indoor,<br>mobile | LTE Broadcast  | LPLT          | A2.7  |
| 7                           | AV linear,<br>AV non-<br>linear, Data | Large screen,<br>small<br>screen/tablet | Stationary, portable<br>outdoor/indoor, mobile    | LTE Broadcast  | LPLT          | A2.8  |
| 8                           | AV linear,<br>AV non-linear<br>Data   | Large screen,<br>small<br>screen/tablet | Stationary, portable<br>outdoor/indoor, mobile    | DTT <sup>1</sup> , LTE <sup>3</sup>  | HPHT/<br>LPLT | A2.9  |
| 9                           | AV linear,<br>AV non-linear<br>Data   | Large screen,<br>small<br>screen/tablet | Stationary, portable<br>outdoor/indoor, mobile    | LTE <sup>3</sup> ,<br>LTE Broadcast  | HPHT/<br>LPLT | A2.10 |
| 10                          | AV linear,<br>AV non-linear<br>Data   | Small<br>screen/tablet                  | Stationary, portable<br>outdoor/indoor, mobile    | LTE <sup>4</sup>   | LPLT          | A2.11 |

| No  | Service                    | Terminal/<br>user device | Usage environment                           | Delivery                        |                 | §     |
|---|----------------------------|--------------------------|---|---------------------------------|-----------------|-------|
|   |                            |                          |   | Technology                      | Network         |       |
| 11  | Smart data quantities      | Smart communication unit | Stationary, portable outdoor/indoor, mobile | Dynamic cognitive communication | HPHT/LPLT       | A2.12 |
| <b>Scenario to occur in combination with Scenarios 1-11</b> |                            |                          |   |                                 |                 |       |
| 12  | PMSE AV content production | PMSE equipment           | Portable, mobile                            | Digital/Analogue                | Low power links | A2.13 |

<sup>1</sup> DTT refers to the DVB family of terrestrial broadcasting standards.

<sup>2</sup> Using the frequencies outside the band 470-694 MHz.

<sup>3</sup> The uplink will be implemented outside the band 470-694 MHz.

<sup>4</sup> Frequency arrangements will include the uplink in the band 470-694 MHz.

It needs to be noted that wind profiler radars, currently used in some European countries in the band 470-494 MHz (see RR 5.291A) and the Radio Astronomy Service in the band 608-614 MHz (see RR 5.149), may be still operational in the future and will need to be taken into account by all scenarios foreseen in the band 470-694 MHz.

## A2.2 SCENARIO 1

In this scenario DTT remains the primary technology for the delivery of broadcast services in the band 470-694 MHz using DVB standards.

This scenario assumes a natural evolution of the DTT platform taking into account the ongoing technological and service developments, and assuming a stable regulatory environment and access to the spectrum.

### A2.2.1 Description

#### Services

- Linear and non-linear TV services, as they evolve over time;
- Migration of these TV services, from SDTV to HDTV and, eventually, UHD TV;
- Progressive introduction of hybrid TV services, integration of the mainstream linear TV services delivered over DTT with catch-up and on-demand services delivered via broadband networks;
- Machines could also rely on DTT to get access to a wide range of pushed 'machine' communications, such as software updates (already 'on air'), information delivered for the functioning of smart-cities (energy and environment, etc.), of public transportation, public safety, etc. This means that beyond traditional audiovisual media services (linear or on-demand via push mechanisms), a small but sufficient part of the whole DTT capacity may be reserved for these services;
- The interleaved spectrum (white spaces) would continue to be used for secondary services such as, for example, PMSE.

#### Terminal / user devices

- TV receivers as they evolve over time;
- Other devices, including portable and mobile terminals capable of receiving via terrestrial broadcast networks;
- Machines capable of receiving a DTT signal.

#### Usage environment

- Primarily the home environment including in urban, sub-urban and rural areas;
- Public places and vehicles provided that the networks are designed to ensure the required coverage.

#### Delivery

The DTT networks would remain a mix of high-power-high-tower (HPHT) and low-power-low-tower (LPLT) transmitters, as well as a mix of MFN and SFN configurations.

Transmission technology would be upgraded, including:

- migration from DVB-T towards DVB-T2 and beyond;
- migration from MPEG-2 to MPEG-4 and, eventually, HEVC.

### **A2.2.2 Assessment**

This scenario foresees a natural development and evolution of DTT in a stable regulatory environment and in response to the market demand of an almost universally accessible, free to view high quality broadcast platform. It represents continuation of the current use of the UHF band, preserves the economic social and cultural benefits currently provided via the terrestrial broadcast platform, and requires minimum or no regulatory intervention.

#### *A2.2.2.1 Technical/feasibility studies*

In this scenario QoS for large audiences and the integrity of broadcast services are ensured. Further technical developments and standardisation of DTT technology are ongoing in the DVB-Project. In addition, there are global harmonisations efforts within FoBTv<sup>32</sup> with a goal to develop future ecosystem models for terrestrial broadcasting taking into account business, regulatory and technical environments.

In Europe most countries have switched off the analogue terrestrial TV transmissions. DVB-T has been widely rolled out across Europe and constitutes the de-facto standard of terrestrial TV delivery. Some countries in Europe have already started to operate DVB-T2 thereby being able to offer more programmes including HDTV.

Under this scenario DTT would increasingly be integrated into the hybrid delivery ecosystem that enables provision of the whole range of linear and nonlinear audiovisual media services.

This scenario is therefore technically feasible, provided that enough spectrum is available to sustain a viable platform and its development.

#### *A2.2.2.2 Cross-border frequency coordination and coexistence*

Cross-border coordination is governed by the provisions of the GE06 Agreement. Co-existence with PMSE could continue. In addition, cognitive devices could be introduced in the white spaces.

#### *A2.2.2.3 Economic, social and cultural issues*

##### *Social and Cultural Benefits*

The economic, social and cultural benefits currently delivered by DTT would be preserved and possibly further amplified. Audiovisual media policy objectives associated with DTT would continue to be met (see also section 3.3).

User expectations would be met in terms of

- almost universal availability of TV services;
- increasing QoS, e.g. SD to HD and beyond, at an affordable cost; and
- minimum or no interruption caused by the technological upgrades.

##### *Economic – Costs & Benefits*

The existing broadcast network infrastructure would continue to be used. This holds also for other services sharing the same sites and sometimes even the same optical fibre cables. The impact of this scenario on other users of the UHF band would be minimal, i.e. PMSE and other white space users would continue to have access to the spectrum.

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<sup>32</sup> The Future of Broadcast Television Initiative (FoBTv) <http://www.nercdtv.org/FoBTv2012/en/aboutus.html>

Furthermore, the existing business models, in particular the free-to-air model supporting co-existence of public and commercial services, are expected to continue to evolve.

#### *A2.2.2.4 Regulatory impact*

Minimum or no change to the current regulation would be required as the GE06 Agreement and the relevant national regulatory regimes would remain in place.

The possible regulatory impact of using the broadcasting platform for pushed machine communications purposes should be studied taking into account national regulatory frameworks.

#### *A2.2.2.5 Migration issues*

For this scenario, as it is based on a natural evolution of the platform, the migration issues are the same as those experienced previously on the platform, e.g. when moving from analogue to digital. Migration will include technological upgrade from one variant of DTT to another, which normally implies replacement of hardware both on the network side as well as on the side of receivers, which is to be expected.

Upgrading from one DTT variant to another calls for more or less extended simulcast phases. To this end, the spectrum used during simulcasting would be used after a switch-over to offer more or higher quality content.

In this scenario the risk of audience erosion on the terrestrial platform is relatively small.

### **A2.3 SCENARIO 2**

In this scenario DTT remains the primary technology for the delivery of broadcast services in the band 470-694 MHz (Scenario 1) and DTT network topology evolves towards low-power-low-tower configuration.

This scenario assumes a natural evolution of the DTT platform taking into account the ongoing technological and service developments, and assuming a stable regulatory environment and access to the spectrum.

#### **A2.3.1 Description**

##### **Services**

- Linear and non-linear TV services, as they evolve over time;
- Migration of these TV services, both linear, from SDTV to HDTV and, eventually, UHD TV;
- Progressive introduction of hybrid TV services, integration of the mainstream linear TV services delivered over DTT with catch-up and on-demand services delivered via broadband networks;
- Machines could also rely on DTT to get access to a wide range of pushed 'machine' communications, such as software updates (already 'on air'), information delivered for the functioning of smart-cities (energy and environment, etc.), of public transportation, public safety, etc. This means that beyond traditional audiovisual media services (linear or on-demand via push mechanisms), a small but sufficient part of the whole DTT capacity may be reserved for these services;
- The interleaved spectrum (white spaces) would continue to be used for secondary services such as, for example, PMSE.

##### **Terminal / user devices**

- TV receivers as they evolve over time,
- Other devices, including portable and mobile terminals capable of receiving via terrestrial broadcast networks.
- Machines equipped with DTT tuners.

##### **Usage environment**

- Primarily the home environment including in urban, sub-urban and rural areas;
- Public places and vehicles provided that the networks are designed to ensure the required coverage.

## Delivery

The DTT network configuration would evolve from the current mix of high-power-high-tower (HPHT) and low-power-low-tower (LPLT) transmitters towards LPLT topology. Synergies with the cellular network infrastructure should be sought.

Transmission technology would be upgraded, including:

- migration from DVB-T towards DVB-T2 and beyond;
- migration from MPEG-2 to MPEG-4 and, eventually, HEVC.

### A2.3.2 Assessment

In addition to the evolution assumed in the Scenario 1 the DTT networks would migrate towards LPLT configuration. It should be noted that most DTT networks already today include a mix of high, medium and low power transmitters where the latter mainly serve as gap fillers to ensure continuous network coverage.

The main advantages of this scenario include:

- The interference range of DTT networks can be reduced, which would facilitate cross-border coordination, in particular easier co-channel operation;
- Improved coverage for mobile and handheld reception of DTT signals;
- Potential synergies between DTT and existing cellular sites and network infrastructure in terms of site sharing.

The main constraints are related to:

- Increased network costs, both capex and opex;
- The users relying on fixed reception would need to re-align their roof top aerial towards the nearest transmitter to ensure a robust and stable signal.

Non-ionising radiation limits that may prohibit site sharing with cellular networks or transmitting the required DTT power in some cases.

#### *A2.3.2.1 Technical/feasibility studies*

This scenario is technically feasible as both DVB-T and DVB-T2 allow for a dense network configuration. In some countries an average inter-site distance in a DTT network already is as low as 10km, in particular in mountainous areas.

Utilising part of the existing cellular sites network would be one possible way of increasing the density of DTT networks.

Contribution requirements for bringing content to DTT transmitters should be investigated as it could be more difficult than in the case of HPHT configuration.

#### *A2.3.2.2 Cross-border frequency coordination and coexistence*

As in the Scenario 1, cross-border frequency coordination is governed by the GE06 Agreement. Co-existence with PMSE could continue. In addition, cognitive devices could be introduced in the white spaces.

Furthermore, this scenario allows easier cross-border coordination because the DTT transmitting power would be lower than in HPHT configuration.

Site sharing between DTT and mobile networks would facilitate the co-existence between the two services as it helps to minimise the impact of adjacent channel interference. However, the scope for site sharing may be limited because of non-ionising radiation limits.

### *A2.3.2.3 Economic, social and cultural issues*

#### Social and Cultural Benefits

The social and cultural benefits currently delivered by DTT would be preserved and possibly further amplified. Audiovisual media policy objectives would continue to be met by DTT (see also section 3.3).

User expectations would be met in terms of:

- almost universal availability of TV services;
- ever increasing QoS, e.g. SD to HD and beyond, at an affordable cost; and
- minimum or no interruption caused by the technological upgrades.

The impact on other users of the UHF band would be minimal, i.e. PMSE and other white space users would continue to have access to the spectrum.

#### Economic – Costs & Benefits

Many viewers would need to make changes to their antenna installation and a significant number of them would need assistance.

Furthermore, existing business models, in particular the free-to-air model supporting co-existence of public and commercial services, would continue to evolve. New market models might emerge, in particular in relation to synergies between DTT and the cellular network infrastructure.

Investments would be required to increase the density of the DTT networks, which would also impact on the operational costs.

Long term return on investments made into HPHT network infrastructure would be lost because the HPHT networks would be abandoned before the end of the depreciation period. The impact on other services, such as radio, data and cellular services, currently sharing the same infrastructure would need to be taken into account.

In totality, the benefits of this scenario, taking account of the associated costs, should be compared with Scenario 1. This scenario can be considered for the future only if it can deliver overall benefits that are equal or higher than those delivered in Scenario 1.

### *A2.3.2.4 Regulatory impact*

Minimum or no change to the current regulation would be required as the GE06 Agreement and the relevant national regulatory regimes would remain in place.

Additional regulations may be required to enable the introduction of LPLT DTT networks by means of access to cellular sites and site sharing.

The possible regulatory impact of using the broadcasting platform for pushed machine communications purposes should be studied taking into account national regulatory frameworks.

### *A2.3.2.5 Migration issues*

In this scenario migration refers to a substantial re-planning and changes to the DTT networks including additional transmission sites. Proper funding would be required to cover all associated costs.

No change to the transmission system nor to the use of the spectrum, in terms of allotments, would be required.

Many viewers using fixed reception would need to re-align their roof top aerial and a large number of them may need assistance.

Some efforts might be required regarding the co-siting the broadcasting and mobile transmitters.

In cases where migration will include an upgrade of DTT technology, a more or less extended simulcast phase would be required during which both the old and the new transmission system would be in operation. The spectrum used during simulcasting would be used after a switch-over to offer more or higher quality content.

## **A2.4 SCENARIO 3**

In this scenario DTT remains the primary technology for the delivery of broadcast services in the band 470-694 MHz (Scenario1) and DTT networks are designed for fixed reception and coupled with other means (e.g. using WiFi) for indoor, and outdoor public places and reception in vehicles.

This scenario assumes a natural evolution of the DTT platform taking into account the ongoing technological and service developments, and assuming a stable regulatory environment and access to the spectrum.

### **A2.4.1 Description**

#### **Services**

- Linear and non-linear TV services, as they evolve over time. This assumes that the DTT technology will evolve such that the non-linear TV services will be enabled in the band;
- Migration of TV services, both linear and non-linear, from SDTV to HDTV and, eventually, UHDTV;
- Progressive introduction of hybrid TV services, integration of the mainstream linear TV services delivered over DTT with catch-up and on-demand services delivered via broadband networks;
- In cases where migration will include an upgrade of DTT technology, a more or less extended simulcast phase would be required during which both the old and the new transmission system would be in operation.. The spectrum used during simulcasting would be used after a switch-over to offer more or higher quality content;
- The interleaved spectrum (white spaces) would continue to be used for secondary services such as, for example, PMSE.
- Machines could also rely on DTT to get access to a wide range of pushed 'machine' communications, such as software updates (already 'on air'), information delivered for the functioning of smart-cities (energy and environment, etc.), of public transportation, public safety, etc. This means that beyond traditional audiovisual media services (linear or on-demand via push mechanisms), a small but sufficient part of the whole DTT capacity may be reserved for these services

#### **Terminal / user devices**

- TV receivers as they evolve over time, with a focus on the on large flat screens;
- Other devices, including portable and mobile terminals capable of receiving via terrestrial broadcast networks;
- Machines equipped with DTT tuners.
- Any indoor device or outdoor mobile terminals that can be connected to the complementary technology to DTT (e.g. WiFi).

#### **Usage environment**

- Primarily the home environment including in urban, sub-urban and rural areas;
- Enhanced indoor coverage would be provided through a complementary technology (e.g. WiFi);
- Public places and vehicles, provided that the networks are designed to ensure the required coverage or would be provided through a complementary technology (e.g. WiFi).

#### **Delivery**

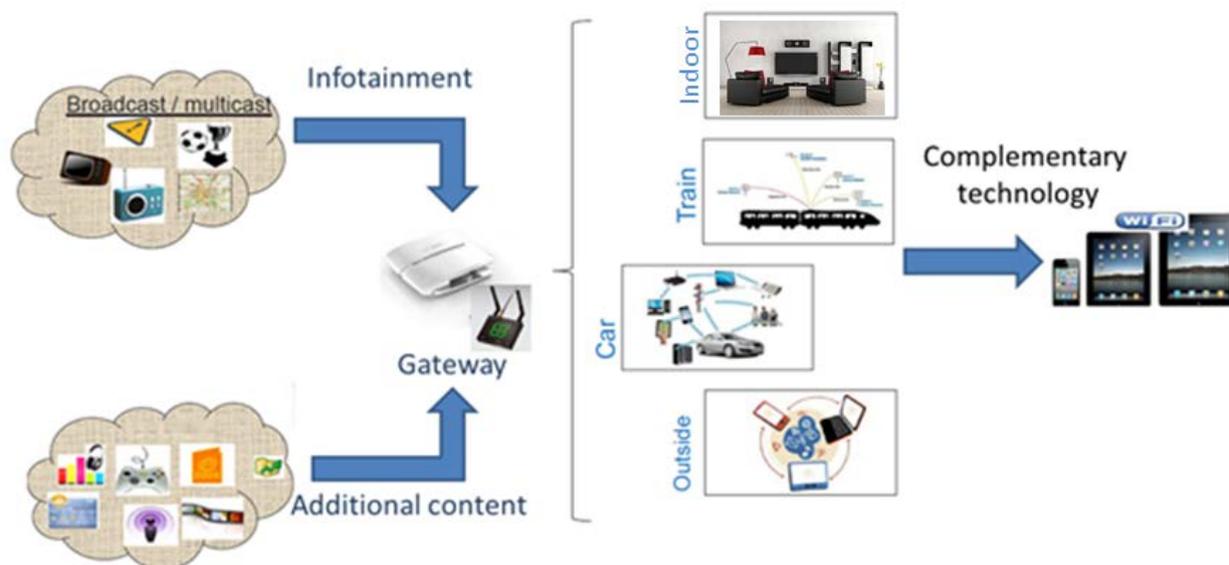
The DTT networks are designed for outdoor coverage (both fixed and mobile) and combined with other means to ensure indoor coverage and inside transportation systems (e.g. transcoding to WiFi).

The network configuration could remain a mix of high-power-high-tower (HPHT) and low-power-low-tower (LPLT) transmitters (as in Scenario 1) or could evolve towards LPLT (as in Scenario 2).

Transmission technology would be upgraded, including:

- migration from DVB-T towards DVB-T2 and beyond;
- migration from MPEG-2 to MPEG-4 and, eventually, HEVC.

The principle of delivery to transportation systems and public places by a complementary technology is illustrated in Figure 10 **Error! Reference source not found.**below:



**Figure 10: Delivery by a complementary technology**

The additional content could be supported by a cellular network, in a downlink mode, using appropriate frequency bands.

#### A2.4.2 Assessment

This scenario is a possible complement to the *Scenario 1* or *Scenario 2* above. In most countries in Europe DTT networks are planned for near-universal coverage for fixed reception. Even in those countries which target portable and mobile DTT reception the networks would ensure fixed reception also.

An increasing number of households are already equipped with a WiFi access point and therefore familiar with this technology. Most user devices, including new TV sets, are already capable of receiving WiFi signals, therefore can be targeted immediately.

In this scenario indoor coverage of DTT services would be provided by receiving DTT signals via roof-top antennas and re-distributing the content inside the buildings by means of WiFi. As a consequence, there would be no need to implement DTT networks providing indoor coverage. Furthermore, in-home distribution of services would have no impact on the use of the UHF spectrum.

Some services currently delivered over broadband connections could be offloaded onto DTT networks.

##### A2.4.2.1 Technical/feasibility studies

Broadcast-to-WiFi converters are already available on the market. However, further technical developments and standardisation would be required to address QoS and interoperability issues in order to facilitate mass market adoption.

In some cases bandwidth limits, especially in multi-dwelling units, may occur. QoS and integrity of DTT services after the conversion to WiFi would need to be ensured.

#### *A2.4.2.2 Cross-border frequency coordination and coexistence*

As in the Scenario 1 and Scenario 2, cross-border coordination is governed by the provisions of the GE06 Agreement. DTT networks would need to be coordinated only for fixed reception.

Co-existence with PMSE could continue. In addition, cognitive devices could be introduced in the white spaces.

#### *A2.4.2.3 Economic, social and cultural issues*

##### Social and Cultural Benefits

The social and cultural benefits currently delivered by DTT would be preserved and possibly further amplified. Audiovisual media policy objectives would continue to be met by DTT (see also section 3.3).

User expectations would be met in terms of

- availability of TV services, including indoors and on personal devices such as tablets and smartphones provided the DTT-WiFi converter is acquired (if not already embedded in the DTT receiving equipment);
- increasing QoS at an affordable cost; and
- minimum or no interruption caused by the technological upgrades.

The impact on other users of the UHF band would be minimal, i.e. PMSE and other white space users would continue to have access to the spectrum.

##### Economic – Costs & Benefits

The existing business models, in particular the free-to-air model supporting co-existence of public and commercial services, is expected to continue to evolve. New market models might emerge, in particular in terms of cooperation between DTT and broadband service providers. Investments would be required to ensure a wide adoption of the required devices and services.

By focusing on outdoor or fixed rooftop coverage the DTT networks could be operated in a cost efficient manner.

In totality, the benefits of this scenario, taking into account the associated costs, should be compared with Scenario 1. This scenario can be considered for the future only if it can deliver overall benefits that are equal or higher than those delivered in Scenario 1.

#### *A2.4.2.4 Regulatory impact*

Minimum or no change to the current regulation would be required as the GE06 Agreement and the relevant national regulatory regimes would remain in place.

The possible regulatory impact of using the broadcasting platform for pushed machine communications purposes should be studied taking into account national regulatory frameworks.

#### *A2.4.2.5 Migration issues*

In this scenario no significant migration issues have been identified beyond those associated with the Scenario 1. DTT-to-WiFi converters would be installed and used at the discretion of the user without involvement of the network operators.

## **A2.5 SCENARIO 4**

In this scenario DTT remains the primary technology for the delivery of broadcast services in the band 470-694 MHz (Scenario 1) and DTT receivers are included in mobile devices.

This scenario assumes a natural evolution of the DTT platform taking into account the ongoing technological and service developments, and assuming a stable regulatory environment and access to the spectrum.

### A2.5.1 Description

#### Services

- Linear and non-linear TV services, as they evolve over time;
- Migration of these TV services, from SDTV to HDTV and, eventually, UHDTV;
- Progressive introduction of hybrid TV services, integration of the mainstream linear TV services delivered over DTT with catch-up and on-demand services delivered via broadband networks;
- Machines could also rely on DTT to get access to a wide range of pushed 'machine' communications, such as software updates (already 'on air'), information delivered for the functioning of smart-cities (energy and environment, etc.), of public transportation, public safety, etc. This means that beyond traditional audiovisual media services (linear or on-demand via push mechanisms), a small but sufficient part of the whole DTT capacity may be reserved for these services. The remaining interleaved spectrum (white spaces) would continue to be used for secondary services such as, for example, PMSE.

As all user devices would eventually be capable of connecting to both broadcast as well as broadband networks, including wireless broadband in another frequency band (e.g. via LTE, or WiFi) this would offer additional possibilities, such as:

- a readily available return channel for interactive and on-demand broadcast services;
- traffic off-loading from mobile broadband networks onto DTT (e.g. for linear services, large file downloads, software and application upgrades).

#### Terminal / user devices

- TV receivers as they evolve over time;
- DTT receiving capabilities would be included in other devices, including portable and mobile terminals in order to make them capable of receiving via terrestrial broadcast networks in the UHF band;
- Machines equipped with DTT tuners.

#### Usage environment

- Primarily the home environment including in urban, sub-urban and rural areas;
- Enhanced indoor coverage would be provided through a complementary technology (e.g. WiFi);
- Public places and vehicles, provided that the networks are designed to ensure the required coverage.

#### Delivery

The DTT network configuration could remain a mix of high-power-high-tower (HPHT) and low-power-low-tower (LPLT) transmitters (as in Scenario 1) or could evolve towards LPLT (as in Scenario 2). The broadcast networks could be designed for any reception mode, including fixed roof-top, portable and mobile) or could be combined with complementary means for indoor coverage (as in Scenario 3).

Transmission technology would be upgraded, including:

- migration from DVB-T towards DVB-T2 and beyond;
- migration from MPEG-2 to MPEG-4 and, eventually, HEVC.

### A2.5.2 Assessment

This scenario is a possible complement to the *Scenario 1* or *Scenario 2* above provided that the networks are built for mobile or portable coverage. The networks that currently provide only fixed reception would need to be upgraded and the associated costs taken into consideration.

Personal devices such as smartphones and tablets are increasingly popular and the users expect them to be able to access any kind of audiovisual content or service, including linear broadcast programmes. In this scenario they would be capable of receiving directly via DTT networks, in a free to view manner.

TV services that are available on the DTT platform would not need to be delivered over mobile broadband networks. Other services currently delivered over broadband connections could be offloaded onto DTT networks (e.g. software updates, push services). Consequently, this traffic offloading via DTT may help to cope with increasing traffic on mobile broadband networks.

QoS for large audiences and integrity of TV services would be ensured, provided adequate coverage is ensured.

#### *A2.5.2.1 Technical/feasibility studies*

Portable and mobile devices with an integrated broadcast receiver are already available on the market, in particular in Japan, South Korea and the USA. Therefore, this scenario can be considered technically feasible.

DTT networks would need to be implemented for portable and mobile reception.

#### *A2.5.2.2 Cross-border frequency coordination and coexistence*

As in the Scenario 1 and Scenario 2, cross-border coordination is governed by the provisions of the GE06 Agreement. DTT networks would need to be coordinated for portable and mobile reception entailing higher demand for spectrum compared to fixed reception only.

Co-existence with PMSE could continue. In addition, cognitive devices could be introduced in the white spaces.

#### *A2.5.2.3 Economic, social and cultural issues*

##### Social and Cultural Benefits

The social and cultural benefits currently delivered by DTT would be preserved and possibly further amplified. Audiovisual media policy objectives would continue to be met by DTT (see also section 3.3).

User expectations would be met in terms of

- availability of TV services, including on personal devices such as tablets and smartphones;
- increasing QoS; and
- minimum or no interruption caused by the technological upgrades.

The impact on other users of the UHF band would be minimal, i.e. PMSE and other white space users would continue to have access to the spectrum.

##### Economic – Costs & Benefits

The existing business models, in particular the free-to-air model supporting co-existence of public and commercial services, is likely to continue to evolve. New market models might emerge, in particular in terms of cooperation between DTT and broadband service providers. Investments would be required to upgrade the DTT networks for portable and mobile reception.

So far, integration of DTT receivers in mobile devices has been marginal to non-existent in Europe but have been successful in other parts of the world (e.g. Japan, Korea,). A viable business model and/or preferably support by an MNO would be required as the integration of DTT receivers in terminals is a net cost for terminal vendors.

In totality, the benefits of this scenario, taking account the associated costs, should be compared with Scenario 1. This scenario can be considered for the future only if it can deliver overall benefits that are equal or higher than those delivered in Scenario 1.

#### *A2.5.2.4 Regulatory impact*

Minimum or no change to the current regulation would be required as the GE06 Agreement and the relevant national regulatory regimes would remain in place.

The possible regulatory impact of using the broadcasting platform for pushed machine communications purposes should be studied taking into account national regulatory frameworks.

#### *A2.5.2.5 Migration issues*

In this scenario migration issues are related to the required upgrade of DTT networks to enable portable and mobile reception. This may require additional frequency coordination unless it is combined with a migration of DTT to LPLT configuration as outlined in the Scenario 2.

In addition, the manufacturers of smartphones and tablets would need to produce and bring to the market the devices with integrated DTT receivers.

### **A2.6 SCENARIO 5**

In this scenario linear and non-linear broadcast services are delivered based on the LTE Broadcast with high-power-high-tower (HPHT) topology.

This scenario assumes that the broadcast services in the UHF band would in the future be delivered via LTE Broadcast HPHT networks. Service requirements, the types of user devices and usage environments are assumed to be similar as in the scenarios 1, 2, 3, and 4 described above.

#### **A2.6.1 Description**

##### **Services**

- Linear and non-linear TV services, as they evolve over time;
- Migration of these TV services, from SDTV to HDTV and, eventually, UHDTV;
- Progressive introduction of hybrid TV services, integration of the mainstream linear TV services with catch-up and on-demand services;
- The interleaved spectrum (white spaces) would continue to be used for secondary services such as, for example, PMSE.

##### **Terminal / user devices**

- TV receivers as they evolve over time, with a focus on large flat screens, capable of receiving LTE Broadcast;
- Other devices, including portable and mobile terminals capable of receiving LTE Broadcast.

##### **Usage environment**

- Primarily the home environment including in urban, sub-urban and rural areas;
- Public places and vehicles, provided that the networks are designed to ensure the required coverage.

##### **Delivery**

The LTE Broadcast networks would be deployed on the basis of a high-power-high-tower (HPHT) architecture utilising the current DTT network infrastructure to minimise changes required to the consumer's fixed aerial installations. The networks would be built for fixed roof-top reception, or could be extended to provide a stable robust signal indoors for stationary devices and outdoor coverage for mobile devices.

The UHF band would be used only for LTE Broadcast (downlink-only) while bi-directional (unicast) mobile broadband traffic would be carried in another spectrum (i.e. IMT frequency bands).

Near universal population coverage would be required and free-to-air reception would need to be possible in order to support general interest audiovisual policy objectives, including provision of public service media content, and to meet user expectations.

### **A2.6.2 Assessment**

The main advantage of this scenario stems from the fact that a single global standard such as LTE would be used for all services, including linear and nonlinear media services, utilising the existing base of mobile user devices (smart phones and tablets etc) and the associated economies of scale. However, typical broadcast receivers (e.g. TV sets, Set Top Boxes etc.) would need to be equipped for LTE access.

The main concerns are:

- The current LTE eMBMS specification does not allow for HPHT deployment and appropriate modifications of 3GPP specifications of LTE eMBMS would be required in order to allow for SFNs with larger inter-site distances;
- Significant investments would be required to roll-out LTE Broadcast networks with a coverage equivalent to the current DTT networks. These investments should be compared to the costs of upgrading the current DTT networks to be able to provide equivalent level of service to that of LTE Broadcast, e.g. migration from DVB-T to DVB-T2 and beyond;
- It is unclear whether LTE Broadcast networks could deliver the QoS comparable to that of DTT;
- There is currently no business model for eMBMS deployment that would ensure free-to-air delivery, which is a core value for public service media and the consumers;
- The current DTT services and audience would need to migrate to the new platform. Such migration would incur costs for the content providers and the consumers;
- This would require LTE Broadcast to support 8 MHz channel plan

There would be a risk of service interruption and erosion of audiences on the terrestrial platform.

#### *A2.6.2.1 Technical/feasibility studies*

An extension of the LTE eMBMS specification would be required to make a HPHT deployment possible (e.g. dedicated carrier, extended cyclic prefix).

The capability of LTE eMBMS is yet to be verified in terms of:

- the provision of linear TV services to large audiences, while meeting the coverage and quality requirements for broadcast services;
- free-to-air delivery of linear and nonlinear audiovisual services;
- seamless access to broadcast programmes across different networks.

LTE Broadcast is to be deployed within the current DTT channelling arrangement meaning 8 MHz variant would be required.

#### *A2.6.2.2 Cross-border frequency coordination and coexistence*

This scenario could be introduced under the Article 5.1.3. of the GE06 Agreement if an 8 MHz variant of LTE Broadcast were available. Doing so would not provide any advantage in terms of cross-border coordination efforts nor in terms of the interference levels to be expected, compared to a DVB-T network with similar coverage and capacity.

Co-existence with PMSE could continue. In addition, cognitive devices could be introduced in the white spaces.

No spectrum savings can be expected if the same transmission capacity is assumed as in Scenario 1. Depending on specific regulatory and technical requirements, more spectrum may be needed to provide the same level of service as in Scenario 1.

### *A2.6.2.3 Economic, social and cultural issues*

#### Social and Cultural Benefits

The social and cultural benefits currently delivered by the DTT platform could be preserved in this scenario if the same service requirements are to be applied on HPHT LTE Broadcast platform as is currently the case for DTT. If so, audiovisual media policy objectives would continue to be fulfilled (see also section 3.3).

User expectations would be met in terms of availability of TV services, including on personal devices such as tablets and smartphones.

#### Economic – Costs & Benefits

Investments would be required to implement HPHT LTE Broadcast networks with a coverage and capacity equivalent to the current DTT networks. These investments may be lower if the current DTT network infrastructure were to be reused. The HPHT LTE Broadcast networks could be deployed by e.g. the current DTT network operators or the mobile network operators, or both. However, viable business models for network deployment would need to be found.

Users would need to invest in new TV receivers that are LTE Broadcast enabled. External LTE tuners would be required for existing TV-receivers, e.g. integrated in set-top boxes or 'dongles'.

Costs associated with de-commissioning of the DTT platform, including early licence termination and knock-on costs to remaining users on HPHT sites (e.g. radio broadcasters) would need to be taken into account.

It would be essential to ensure that the free-to-air delivery model is retained, supporting co-existence of public and commercial services.

In totality, the benefits of this scenario, taking account the associated costs, should be compared with Scenario 1. This scenario can be considered for the future only if it can deliver overall benefits that are equal or higher than those delivered in Scenario 1.

### *A2.6.2.4 Regulatory impact*

Implementation of this scenario could take place within the framework of the GE06 Agreement, by application of the spectrum mask concept as defined in Article 5.1.3 provided that an 8 MHz variant of LTE becomes available. In this scenario LTE Broadcast may be seen as a Broadcasting Service.

Alternatively, if LTE would not support the 8 MHz channel raster the following elements could be studied:

- a) Consequences to the GE06 Agreement including the potential need to amend or abrogate this Agreement.
- b) Need to update bi- and multilateral coordination outside the scope of the GE06 Agreement, based on the principle of equitable access to the spectrum.

Regulatory conditions for a free-to-air provision of audiovisual services over LTE Broadcast networks must be established, including the appropriate coverage and quality obligations. In particular, the regulatory framework for free to air currently requires that audiovisual service providers such as public service media organisations need to have legally secured access to the delivery capacity, bearing the associated costs, while the end-user can receive content without additional charges.

### *A2.6.2.5 Migration issues*

Migration issues are caused by the substitution of DVB technology with LTE. The impact would be significant across the DVB ecosystem, including transmission equipment manufacturers, network and multiplex operators, broadcasters and the consumers.

It can be expected that an extended transitional period would be required, including simultaneous provision of services on both DVB-T/T2 and LTE Broadcast platforms, in order to minimise the adverse impact on the

viewers and interruptions of services. During this period the amount of the required spectrum would effectively be doubled.

An agreed road map for the migration and coordinated efforts by all relevant stakeholders would be required. Cost implications of the migration would need to be foreseen and compensated.

## A2.7 SCENARIO 6<sup>33</sup>

This scenario assumes that linear and non-linear broadcast services in the UHF band would in the future be delivered via LTE Broadcast LPLT networks using one or more dedicated downlink carriers. The scenario can be summarised as follows:

- The platform would deliver terrestrial broadcasting services and could also be used to deliver multicast/unicast data provided an external uplink/return channel is available;
- The receiving equipment targeted would include large flat screen TVs, portable TV sets and any other LTE capable devices including tablets and smartphones. The platform would provide wide area (national) fixed rooftop reception and mobile reception in areas where cell site density is sufficiently high, e.g. urban areas, along transportation corridors and areas of specific interest;
- The platform would leverage the existing cellular infrastructure through the addition of LTE Broadcast capability in 470-694 MHz on existing cellular transmission sites. Some additional sites might be required;
- For linear broadcast content, the network would operate as an SFN (on national, regional or sub-regional level, as required by the editorial definition of the service area) delivering 2 bps/Hz
- The borders between two SFNs represent challenging zones to ensure service delivery as discussed in Section A2.7.2.1;
- The overall platform would be IP-based, ensuring flexibility for the introduction of new technology (e.g. new codecs) and providing opportunities for convergence of linear and non-linear services.

### A2.7.1 Description

#### Services

Linear and non-linear TV services, including free-to-air, as they evolve over time (SDTV, HDTV and, eventually, UHD TV).

For terminals with unicast connection (e.g. an external LTE connection):

- Non-Linear TV and other AV services;
- Hybrid TV services, integration of the mainstream linear TV services with catch-up and on-demand services;
- Typical LTE functionalities such as access control, billing, emergency calls.

#### Terminal / user devices

- TV receivers capable of receiving LTE Broadcast, as they evolve over time;
- Other devices, including portable and mobile terminals capable of receiving LTE Broadcast.

<sup>33</sup> LTE eMBMS as an adjunct to the LTE standard has limited broadcast capabilities because of the need to meet the primary requirements of the LTE system - mobile unicast. The short cyclic prefix, limits on the proportion of the downlink channel that can be assigned to broadcast, plus the need to pair with a dedicated uplink channel effectively limit LTE eMBMS to providing niche broadcast services to areas with high network density, e.g. city coverage and football stadia. Use of LTE eMBMS, as presently specified, to provide broadcast services over a wide area, as a replacement for existing terrestrial television services, would be spectrally inefficient and would require a dense cellular network, similar to that found in urban environments, across the entire service area.

Scenario 6 & 7 are based on a proposal for new, yet to be agreed, extensions to the LTE standard referred to in this report as LTE Broadcast. It is assumed that LTE Broadcast differs from LTE eMBMS through the use of longer cyclic prefixes, a dedicated downlink channel and no limit on the proportion of the channel that can be dedicated to broadcast. For further details on the standard modification required in order to support scenario 6 and 7, see Table 7 in A2.7.2.2

In the context of this report LTE eMBMS will be used to refer to the broadcast capability of LTE as described in revisions up to and including R12 of the 3GPP LTE specification. The proposed new system will be referred to as LTE Broadcast.

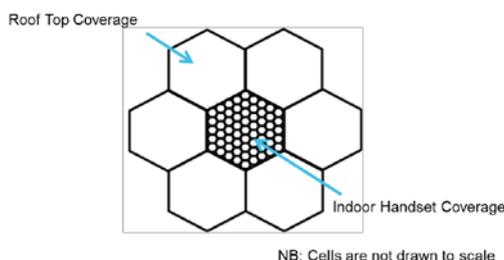
To receive services other than linear broadcast, such as non-linear broadcast, hybrid, catch-up, video on demand, mobile data, etc. the receiving device will also need to have a unicast capability.

### Usage environment

- Home environment including in urban, sub-urban and rural areas through fixed rooftop reception;
- Reception on mobile devices (e.g. smartphones and tablets) in nomadic and mobile conditions such as indoor, outdoor, public places and in vehicles in areas where networks provide the required coverage. Reception on mobile devices requires higher network deployment density and may therefore be restricted to areas of interest for the operator of the network. Such areas of interest may include for example, main cities and main freeways.

In order to support both usage environments, the network would operate as an SFN (possibly nationwide, see Section A2.7.2.1 for delivery of linear broadcast content). The network would be designed for 'Mixed Service', i.e. the delivery of mobile coverage in areas of interest, while providing fixed rooftop reception across the network, as illustrated in Figure 11. In areas where fixed roof top reception is adequate the LTE Broadcast network would require a transmission site density lower or equal to that of existing cellular networks (10 km cell range) in order to ensure that an initial deployment could be achieved by simply reusing existing cellular sites (no network densification). Existing cellular networks are 'naturally' denser in high density population areas and therefore offer the possibility to adopt mobile coverage in these areas without requiring new sites.

The adoption of a coverage mode (ranging from true mobile to fixed rooftop) for a given area would not impact the band plan or the harmonisation giving countries greater freedom to meet their requirements.



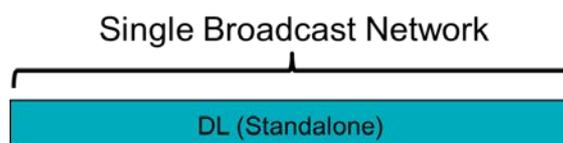
**Figure 11: Mixed Service SFN**

### Delivery

In this scenario, the LTE Broadcast network would be deployed in a low-power-low-tower (LPLT) configuration using an architecture similar to existing cellular networks.

The LTE Broadcast platform would deliver its services over a Downlink (DL) standalone channel, and a single network would deliver content to all users from any particular site. There is a single LTE Broadcast infrastructure.

Near universal population coverage would be required and free-to-air reception would need to be possible in order to support general interest audiovisual policy objectives, including provision of public service media content, and to meet user expectations.

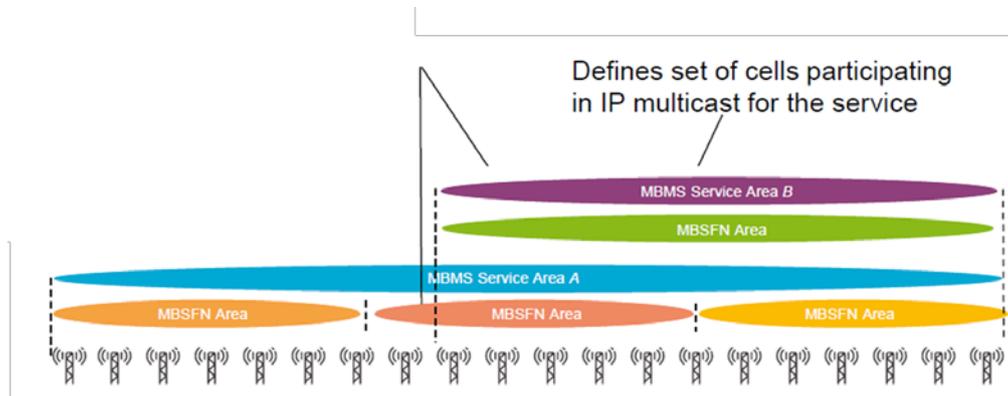


**Figure 12: Adaptive LTE-Broadcast platform (excluding UL) scenario**

If necessary, i.e. should the platform deliver multicast and unicast data on top of broadcast data, the uplink will be implemented in another LTE frequency band.

### A2.7.1.1 LTE Broadcast Service Area/MBSFN

While the scenario targets nationwide SFN for the delivery of national linear TV channels, there is in many countries a need to support delivery of local content. LTE Broadcast supports overlap between MBSFN areas in order to enable local, regional, and national services. One cell can belong to several MBSFN areas (up to 8), as illustrated in Figure 13.



**Figure 13: LTE-Broadcast supports multiple MBMS Service area and MBSFN areas**

### A2.7.2 Assessment

One of the main advantage of this scenario stems from the fact that the broadcast service would reach mobile user devices (e.g. smartphones and tablets) in areas where a dense network is deployed. LTE terminals conforming to LTE Broadcast would be able to receive the envisaged broadcast service.

The main concerns are:

- Whether it is possible to maintain services in the borders between SFN (see Section A2.7.2.1);
- Investment would be required to roll-out LPLT LTE Broadcast networks with a coverage equivalent to the current broadcast networks;
- Existing broadcast receivers (e.g. TV sets, Set Top Boxes etc.) would either need to be equipped with an LTE Broadcast receiver or replaced;
- Some fixed roof top antenna would need to be realigned;
- The current services would need to adopt the new standard, with the same constraint as when a new broadcast technology is introduced (e.g. migration from DVB-T to DVB-T2);
- This scenario implies that PMSE and white space devices access to the UHF band would be limited and that they would require separate spectrum;
- Under this scenario, wide area (national) fixed rooftop reception and mobile reception in areas where cell site density is high would be provided. Should there be the need to fulfil national objectives for (near-) universal portable/mobile coverage further network densification would be required. Predictable / guaranteed quality of service should be possible for broadcast services.

### *A2.7.2.1 SFN Coverage, frequency reuse and borders between SFNs*

One of the central proposals of this scenario is to move towards SFNs with nationwide coverage and frequency reuse of 1 within the same country in order to increase the spectrum efficiency. While a frequency reuse of 1 and 2bps/Hz is recognised as being achievable within a single SFN coverage, the borders between two such SFNs represent challenging zones to ensure service delivery.

Stakeholders agree that further work is required to estimate the extent of these borders areas and identify whether solutions could be found.

It should be stressed that such border areas occur between geographical areas where different content is broadcast. For national content borders between countries are the challenging areas, for regional and local content, such border areas would occur within a country.

Finally, some users living in border areas currently use two different rooftop antennas in order to receive content from multiple countries or regions. This possibility would no longer be available in the future.

### *A2.7.2.2 Technical/feasibility studies*

Simulation results of LTE Broadcast demonstrate that, where there are no borders, assuming a 100  $\mu$ sec CP, cell radius of 9 km for fixed rooftop reception and 2 km for indoor reception on mobile devices can be achieved for a target spectrum efficiency of 2 bps/Hz. Increasing the cyclic prefix to 200  $\mu$ sec would enable support of cell radius ranging from 10 to 15 km (corresponding to an ISD of 17km to 26km).

An assessment of the modifications to the LTE standard that would be required to support this scenario is given in the following paragraphs.

#### Longer Cyclic Prefix for Wide Area SFN

The current LTE carrier design uses large inter-carrier frequency separation to support high speed mobility in high frequency bands (e.g. 2.5 GHz). The LTE cyclic prefix is currently limited to 16.6  $\mu$ s - 33.3  $\mu$ s is not yet fully standardized. The cyclic pre-fix imposes limits on the inter-site distance (ISD) in a SFN network, the ISD typically being limited to between 20% ~ 30% of the cyclic prefix. In the case of a 33.3  $\mu$ s cyclic prefix this limits the ISD to 2 ~ 3 km.

In order to support wide area SFN with large cell range, it is necessary to extend the cyclic prefix. To ensure that the modified standard can be implemented in a straightforward manner, the following requirements should be maintained:

- Cyclic prefix should remain limited to maximum 20% of the symbol length;
- 12.5% of pilot symbols should be kept to support mobile reception;
- Performance (Bit and packet error rate, sensitivity, etc...) should remain similar to existing LTE eMBMS modes;
- The symbol and frame design should maintain integer hierarchy relative to existing LTE modes in time and frequency spacing;
- The air interface should support mobile reception in 470-694 MHz band without interference cancellation;
- The FFT transform size should not become excessive.

#### Dedicated carrier

As LTE eMBMS was developed as an incremental revision to current LTE networks, there was no necessity to deploy a separate carrier to achieve broadcast/multicast delivery. For these so called mixed mode LTE eMBMS carriers the broadcast/multicast information can occupy a maximum of 60% of the total available bandwidth in an FDD format carrier. A maximum of 6 of the 10 subframes of an LTE FDD frame may be allocated to MBSFN. This leads to limits on the throughput of individual channels and combined with the need for pairing with an uplink channel, which would be lightly used during broadcast sessions, is a spectrally inefficient means of broadcasting.

Therefore, the scenario requires a modification of the standard to support a dedicated carrier. A dedicated carrier is an LTE carrier where all subframes can be used for broadcast.

Service without user registration

In most CEPT countries, there are currently regulatory requirements for free-to-air service. If such requirements exist in these countries in the future then the LTE Broadcast service would need to be available without user registration.

Mobile networks already support Limited Service Mode (i.e. access to limited service without SIM registration), e.g. for emergency call. Limited standard modification would be required in order to explicitly enable access to LTE Broadcast service in Limited Service Mode, in order to satisfy specific national requirements for broadcast delivery (e.g. free-to-air).

**Table 7: Some required LTE standard modifications enabling Scenario 6**

| Name                                | Modification             | Justification   |
|-------------------------------------|--------------------------|---|
| Longer Cyclic Prefix for Mobile SFN | CP = 100/200/400 $\mu$ s | Required to enable country wide SFN with fixed rooftop reception                                |
| Dedicated carrier                   | 100% eMBMS frame         | Required for the delivery of linear terrestrial TV  |
| Shared Resource                     | Protocols                | To allow interoperability between broadcast and unicast services – convergence of the platforms |
| Service without user registration   | Extend LMS to eMBMS      | Required to support Free-to-air   |

**A2.7.2.3 Cross-border frequency coordination and coexistence**

LTE-Broadcast network vs LTE-Broadcast network

Considerations are provided in Section A2.7.2.1.

High power high tower network impacting LTE-Broadcast network

One of the aims of the proposed scenario is to achieve higher average received signal strength in the coverage area than is currently delivered by high power high tower networks. Should this goal be achieved, the limiting case should remain the interference from LTE Broadcast to high power high tower network.

**A2.7.2.4 Economic, social and cultural issues**

Social and Cultural Benefits

Assuming that the LTE Broadcast platform will be subject to the same coverage and quality requirements as the current DTT networks, the social and cultural benefits currently delivered by the terrestrial broadcasting platform are not only preserved in this scenario but potentially increased, due to the availability of the service on mobile devices in this scenario. Audiovisual media policy objectives would continue to be fulfilled.

User expectations would be met in terms of availability of TV services, including on personal devices such as tablets and smartphones, enhanced by offering a service availability in a mobile environment, where the network density is high enough, via a converged platform.

Economic – Costs & Benefits

Under the assumption that LTE Broadcast networks would be deployed with the reuse factor 1 (see Section A2.7.2.1.) and that the whole UHF band would be used, the PMSE users and white space devices would no

longer have access to the spectrum. A possible exception would be a 'safe harbour', if any, where dedicated spectrum is set aside for PMSE.

Investments would be required to implement LPLT LTE Broadcast networks with a coverage and capacity equivalent to the current DTT networks.

Users would need to invest in new TV receivers that are LTE Broadcast enabled. External LTE Broadcast tuners would be required for existing TV-receivers, e.g. integrated in set-top boxes or 'dongles'.

Suitable market models for free-to-air delivery of broadcast services over LTE Broadcast networks would need to be established.

#### *A2.7.2.5 Regulatory impact*

Implementation of this scenario could take place within the framework of the GE06 Agreement, by application of the spectrum mask concept as defined in Article 5.1.3 provided that an 8 MHz variant of LTE becomes available. In this scenario LTE Broadcast may be seen as a Broadcasting Service.

Alternatively, if LTE would not support the 8 MHz channel raster the following elements could be studied:

- a) Consequences to the GE06 Agreement including the potential need to amend or abrogate this Agreement.
- b) Need to update bi- and multilateral coordination outside the scope of the GE06 Agreement, based on the principle of equitable access to the spectrum.

Regulatory conditions for a free-to-air provision of audiovisual services over LTE Broadcast networks must be established, including the appropriate coverage and quality obligations. In particular, the regulatory framework for free to air currently requires that Audiovisual service providers such as public service media organisations need to have legally secured access to the delivery capacity, bearing the associated costs, while the end-user can receive content without additional charges.

#### *A2.7.2.6 Migration issues*

Migration issues are caused by effectively replacing the current DVB technology with LTE. The impact would be significant across the DVB ecosystem, including transmission equipment manufacturers and may extend to some network and multiplex operators.

The transition would need to be organised, e.g. in terms of modification of the receiver configuration, exactly as transition between two broadcasting technologies are organised. All citizen consumers using the terrestrial television platform will have to obtain new receiving equipment, LTE Broadcast or an alternative such as satellite. If they choose LTE Broadcast they may need to change their receiver aerial. Solutions for PMSE users would need to be found either through identification of a part of the UHF band reserved for PMSE, or outside of the UHF spectrum.

## **A2.8 SCENARIO 7<sup>34</sup>**

In this scenario LTE Broadcast is a service to deliver broadcast and multicast content over LTE cellular networks. It differs from Scenario 6 in that an uplink frequency range is proposed in the 470-694 MHz frequency range.

The scenario can be summarised as follows:

- The platform delivers terrestrial broadcasting services. The platform being an IP platform can deliver multicast, unicast, non-linear, interactive/on-demand services. In general, the platform provides a large IP downlink channel that can deliver any data to users;
- The receiving equipment includes the current terrestrial broadcasting receivers (e.g. large flat screen, portable TV sets) but also extends to any LTE capable device (including tablets and smartphones);

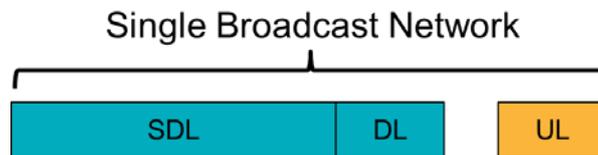
<sup>34</sup> See Footnote 3 to Scenario 6.

- The platform provides wide area fixed rooftop reception nationally and mobile reception in areas where cell site density is high, e.g. urban areas, along transportation corridors and areas of specific interest;
- The platform leverages the existing cellular infrastructure through the addition of LTE Broadcast capability in 470-694 MHz on existing cellular transmission sites;
- For linear broadcast content, the network would operate as an SFN (on national, regional or sub-regional level, as required by the editorial definition of the service area) delivering 2 bps/Hz. The situation at the border between countries is discussed in Section A2.7.2.1;
- The overall platform is IP based, ensuring flexibility for the introduction of new technology (e.g. new codecs) and providing opportunities for convergence of linear and non-linear services.

## A2.8.1 Description

### A2.8.1.1 DL delivery platform supporting interactivity

In this scenario, the LTE Broadcast platform delivers most services over a large Supplemental Downlink (SDL) channel operated as a Secondary Component Carrier (SCC). A small FDD band provides the Primary Component Carrier (PCC). A single network delivers content to all users.



**Figure 14: LTE-Broadcast platform (including UL) scenario**

The network can broadcast content free-to-air, but can also multicast and unicast content. When/if required, the Primary Component Carrier can support all typical LTE functionalities such as access control, billing, emergency calls.

The exact band plan would need to take a number of elements into account, including the spectrum requirement of other services (e.g. RAS, PMSE). Further studies are required to determine an appropriate band plan, should this option be selected, but in general the FDD sub-band is significantly smaller than the SDL sub-band, i.e. the platform remains a DL dominated platform.

### A2.8.1.2 Dynamic broadcast/unicast

The proposed platform is a large downlink pipe that can deliver broadcast or unicast content. The platform could allocate the required bandwidth to the broadcast of linear content and leverage any additional capacity for the delivery of unicast data. As such, the platform could adapt to the national broadcast requirements while maintaining harmonization at CEPT level.

For services requiring user registration, the network can monitor the number of terminals accessing the service in a cell and dynamically operate either in broadcast, multicast or unicast mode.

### A2.8.1.3 Mixed Service SFN and LTE Broadcast Service Area/MBSFN

The characteristics described in A2.7.1 (Usage environment) and A2.7.1.1 apply to both scenario 6 and scenario 7.

## A2.8.2 Assessment

### A2.8.2.1 Technical/feasibility studies

At the physical layer level, the LTE-Broadcast portion of scenario 7 is perfectly equivalent to Scenario 6. As such, the assessment from Section A2.7.2.2 applies. External pairing with the FDD component, as implemented for other SDL frequency bands, is assumed.

### A2.8.2.2 Cross-border frequency coordination and coexistence

The cross-border/coexistence considerations from Section A2.7.2.3 apply here.

In addition, the FDD part of the band would need to be harmonised, at least at European level.

### A2.8.2.3 Economic, social and cultural issues

Assuming that the LTE Broadcast platform will be subject to the same coverage and quality requirements as the current DTT networks, the social and cultural benefits currently delivered by the terrestrial broadcasting platform would be further increased in this scenario, compared to scenario 6, by enabling interactive services, e.g. VOD. This scenario would provide the opportunity for broadcast services to be complemented by interactive services over the terrestrial platform.

Suitable market models for free-to-air delivery of broadcast services over LTE Broadcast networks would need to be established.

### A2.8.2.4 Regulatory impact

The considerations from Section A2.7.2.5 apply here. In addition it is necessary to study the need of a co-primary allocation to the Mobile Service.

Additionally, should the platform deliver interactive services, a review of the regulatory regimes applicable respectively to broadcast and data services may be required. A number of requirements applicable to MNOs are currently not enforced on broadcast networks. The conditions under which such broadcast platform may support data services must be compatible with the regulatory framework applicable to broadband delivery. Obvious examples are Net Neutrality, which is obviously currently not applicable to broadcast networks, and spectrum fees, for which the regulation of broadcast and mobile networks is not aligned.

In some countries audiovisual service providers such as public service media organisations may need to have legally secured access to the delivery capacity, bearing the associated costs, while the end-user can receive content fully free of charge. An alternative regulatory option would be to extend the current *Must Carry* rules to cover also the LTE networks used for the delivery of public service media.

### A2.8.2.5 Migration issues

The considerations in Section A2.7.2.6 apply.

## A2.9 SCENARIO 8

### A2.9.1 Description

This scenario is based on the assumption that the demand for DTT is decreasing in the long term and at least part of the band could be used for other services. The released part could be licensed to Mobile Broadband (MBB) downlink (DL) that is more compatible with DTT (compared to MBB FDD or TDD). MBB DL can be used for 'traditional' MBB services as supplementary DL (SDL) or eMBMS based on market demand.

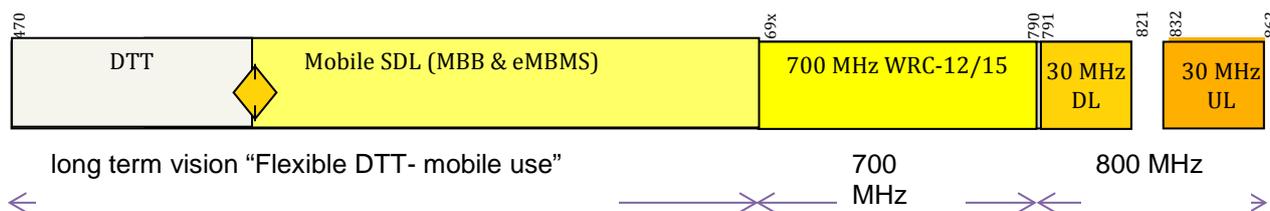


Figure 15: Mobile broadband SDL scenario

## Services

- Linear and non-linear TV services including free to air. Linear services over the DTT or MBB (using eMBMS if needed) network. Non-linear unicast (downlink) connection over the MBB network;
- Downlink data delivery with MBB over SDL;
- Hybrid TV services combining the DTT linear delivery and MBB for additional data (with the UL being in another band);
- PMSE and white spaces can continue to be used (for the time being) as both DTT and SDL will be initially based on the GE06 Plan entries with a gradual migration towards the situation shown in **Error! Reference source not found.** However, an increased size of SFNs, smaller re-use distances between allotments and higher interfering field strength will reduce the PMSE and white space spectrum availability.

## Terminal/ user devices

TV receivers as they evolve over time, retaining the DTT receiver and adding LTE-functionality for eMBMS/MBB SDL.

Tablets, smartphones and other mobile devices capable of interfacing with LTE eMBMS/MBB SDL.

## Usage environment

DTT and hybrid DTT/MBB cases primarily in the home environment through fixed rooftop reception in urban, sub-urban and rural areas. Depending on the DTT network also indoor and mobile reception is possible.

MBB/eMBMS everywhere within the network coverage. Depending on the network design this can include indoor, outdoor, public places and vehicles.

## Delivery

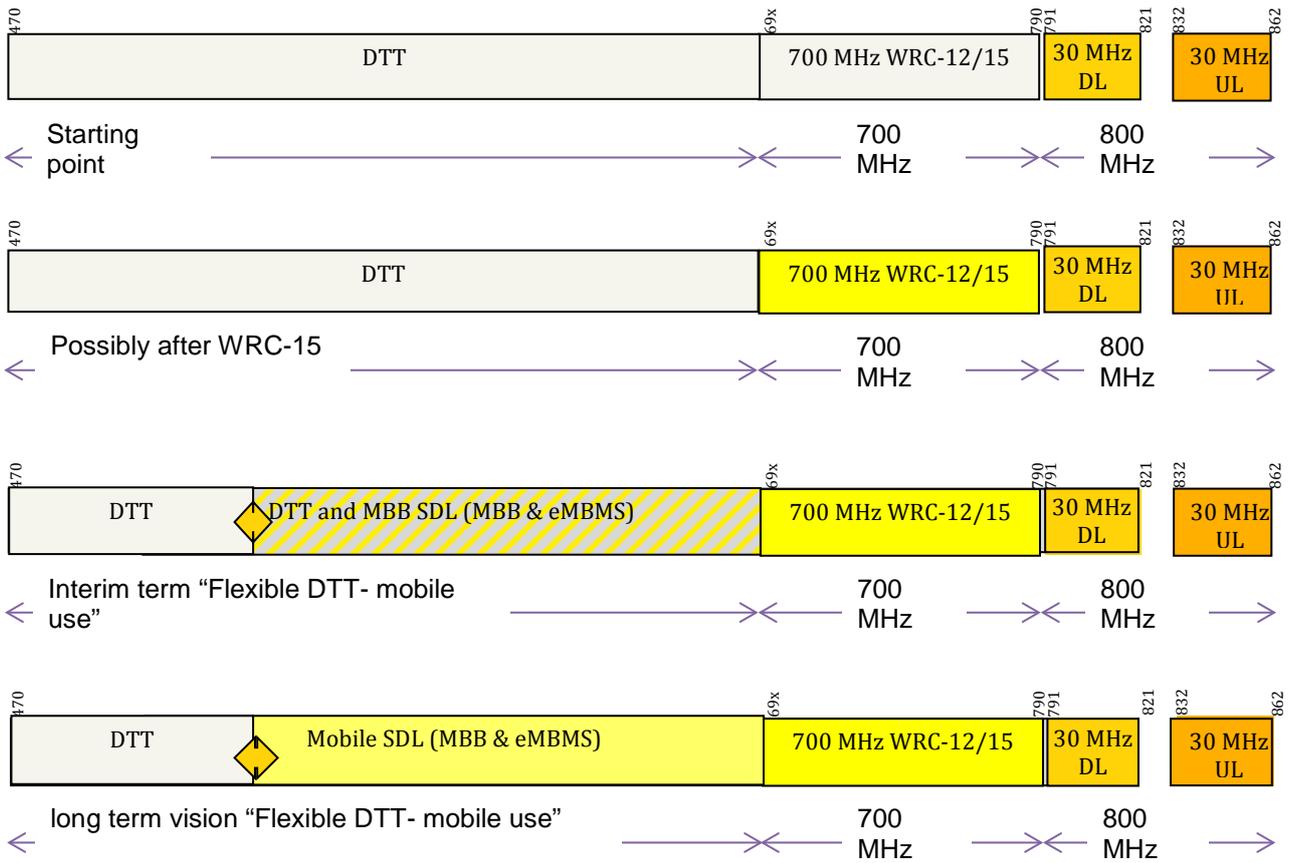
DTT networks would continue to be a mix of high-power-high-tower (HTHP) and low-tower-low-power (LTLP) networks as they are today. Transmission technology would migrate from DVB-T towards DVB-T2 and beyond. The networks should be converted from MFN to SFN as much as possible taking advantage of the DVB-T2 technology. Video coding would evolve from MPEG-2 towards MPEG-4 and HEVC.

MBB LTE SDL networks are LPLT SFN networks and can be implemented in the released DTT channels using the spectrum mask principle based on GE06 framework. Depending on market demand, content type and network optimisation LTE SDL can be used for 'traditional' MBB services or for LTE broadcast using eMBMS.

### A2.9.2 Assessment

Regulators may gradually reform the released frequencies for Mobile Broadband use, while the rest of frequency range can continue to be used for DTT. It is assumed that most of DTT will be evolved to DVB-T2 technology.

The freed channels could be used by Supplemental Downlink (SDL) (combined with other MBB bands via LTE Advanced carrier aggregation (CA)), as SDL is more compatible with the remaining DTT use than FDD or TDD networks. SDL would then facilitate both 'traditional' MBB DL and also LTE Broadcast (eMBMS), based on market demand. Additionally, SDL use would also support the trend that the future MBB traffic is asymmetric biased towards the downlink direction. Already today, in some networks the average asymmetry is about 8:1 towards downlink and the traffic is expected to be more downlink oriented in spite of increasing video etc uploading with smart phones (as usually the uploaded content will be downloaded many times, still supporting downlink oriented traffic).



**Figure 16: Phased approach to MBB SDL scenario**

**A2.9.2.1 Technical/feasibility studies**

LTE SDL implementation can be started in the released DTT channels utilising the GE06 framework. In principle, 5 MHz LTE SDL fits in an 8MHz channel without additional interference to remaining DTT network, utilizing/taking benefit of the GE06 feature of allowing flexible implementation, facilitating other services, besides broadcasting, on condition that the spectral power density of the alternative use does not exceed the associated plan entry and requires no more protection than the associated plan entry. Where DTT uses SFN, SDL can be again implemented in the unused DTT channels. LTE includes the LTE broadcast mode (eMBMS), which can be implemented in the LTE SDL, based on market demand.

To be able to use the GE06 Plan entries for LTE SDL the LTE channelling arrangements would have to be aligned with the 8 MHz channelling used in the GE06.

LTE technology will also evolve to respond to possible new requirements for the optimum use of this band, e.g. carrier aggregation (CA) facilitates that an uplink can be used from other LTE bands. Today's LTE capability can be used as a reference but the future capabilities of LTE are not limited to what is available today.

**A2.9.2.2 Cross-border frequency coordination and coexistence**

Cross-border issues do not change, while LTE SDL is implemented within GE06 framework. If a wider block is agreed to be moved from DTT to MBB, a common band plan and new coordination agreements need to be considered.

### *A2.9.2.3 Economic, social and cultural issues*

Allowing MBB LTE SDL in 470-694 MHz facilitates a dynamic spectrum usage change responding to the user behaviour change (if and when it happens). The band 470-694MHz is beneficial for MBB due to good propagation characteristics thus facilitating good wide area coverage. [

The social and cultural value of broadcasting is the TV content, not the delivery mechanism. DTT together with MBB LTE SDL ensures that citizens have easy access to the TV content they want and when they want it.

The impact of this scenario on the DTT ecosystem and PMSE, in particular on the issues described in §3.3 should be assessed.

### *A2.9.2.4 Regulatory impact*

Implementation of this scenario could take place within the framework of the GE06 Agreement, by application of the spectrum mask concept as defined in Article 5.1.3 provided that an 8 MHz variant of LTE becomes available.

Alternatively, if LTE would not support the 8 MHz channel raster the following elements could be studied:

- a) Consequences to the GE06 Agreement including the potential need to amend or abrogate this Agreement.
- b) Need to update bi- and multilateral coordination outside the scope of the GE06 Agreement, based on the principle of equitable access to the spectrum.
- c) The need of co-primary allocation to the Mobile Service

### *A2.9.2.5 Migration issues*

LTE already contains many of the capabilities that are needed for this flexible implementation of LTE SDL. The technology will evolve more based on the requirements of using this band. This band is attractive from mobile usage point of view and this motivates the required developments of the technology

This scenario will not deliver sufficient spectrum to cover AV content production and may lead to consumer dissatisfaction on AV content experience.

## **A2.10 SCENARIO 9**

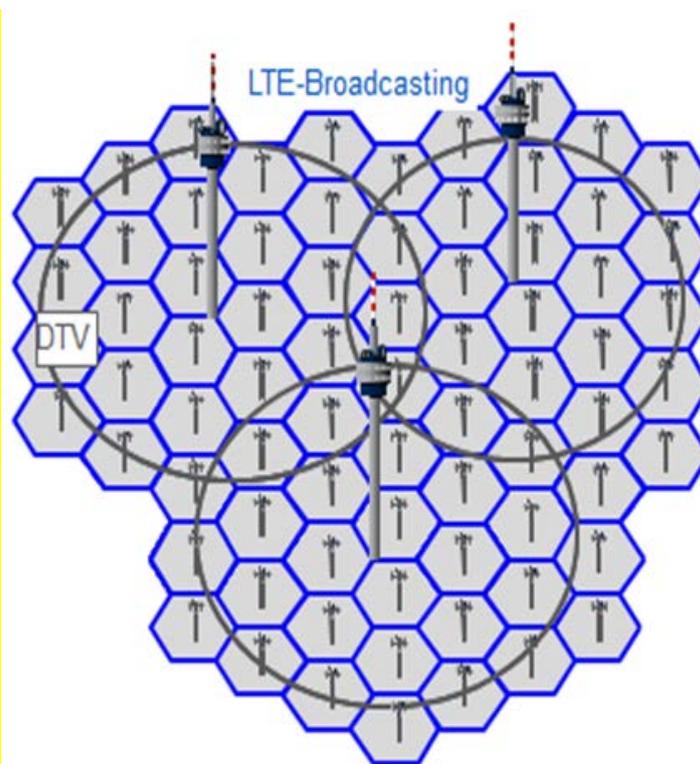
Current linear television distribution networks and LTE networks are complementary and can be used in cooperation very effectively in order to support the evolving consumer demands, thus paving the way towards more complete convergence and synergism in the future (win-win strategies). The combination of the two modes of delivery enables the easy introduction of new advanced services and applications and supports successful convergent offerings between digital television, broadcast providers, and mobile broadband service providers.

LTE Broadcast could be used in a “underlay” cellular structure using elements from specification of the evolved Multimedia Broadcast Multicast Service (eMBMS) while also considering the need for further enhancements.

The LTE Broadcast network could provide a broadcasting and/or unicasting service as well as traditional mobile broadband services. Any need for uplink interaction would be handled via another frequency band, typically used by current and/or future mobile broadband networks. The “underlay” and “overlay” structures are depicted in Figure 17 below. The underlay LPLT network uses unoccupied DTT channels where available.

This scheme in general may need to be accompanied by mitigation techniques in order to avoid interference and guarantee QoS. Certain requirements would be needed for all kinds of receivers, especially with respect to receiver adjacent channel selectivity (ACS). . Impact of this type of implementation on the existing PMSE services in the interleaved spectrum would need to be assessed.

Furthermore, it is to be noted that LTE and DVB-T/T2 are currently based on different coding schemes (both optimized/ideal for certain purposes) and that – according to information from industry – it would be very difficult to integrate both in a single chip. Therefore, both chips would need to be integrated in every device.



**Figure 17: LTE- Broadcast using a macro cellular structure on adjacent channels to DTT channels “under” the current DTT “overlay” network**

#### A2.10.1 Description

Broadcasting offers an effective way of distributing traditional linear programming to large populations in real time and with the use of recording devices the delayed consumption and archival of programming by users may also be possible. However, there are also the consumers’ increasing demands to access programming “a la carte” anywhere, anytime. In recent years linear television has been complemented by some form of video on-demand, be it IPTV based movie stores or web-based video clip services<sup>35</sup>. Indeed, the web sites of broadcasters, which are among the largest and with most traffic at national levels, offer proof of the growing popularity of innovative, streamed media services. Users employ a variety of devices to access such programming “a la carte”, ranging among Internet-enabled television sets, desktops, laptops, tablets, c-boards, and smartphones, among others that continue to proliferate.

Mobile broadband user terminal devices, such as smartphones and tablets, are increasingly important for access to media content and services. Innovative media services are among the main drivers of broadband take-up. Mobile broadband is becoming a significant delivery platform for broadcasters and it also enables more dynamic and interactive access of content.

However, the full potential of mobile broadband for the delivery of broadcasting content and services to large audiences is still not fully exploited.

<sup>35</sup> For a description of linear and non-linear television see, for example: <http://www.hans-bredow-institut.de/de/forschung/linear-and-non-linear-television-viewers%E2%80%99-perspective>

## A2.10.2 Assessment

The purpose of this scenario is to explore some developments and results with regard to relevant items related to convergence of applications, such as:

- types of services and applications, and
- available technology choices including support for possible convergent offerings between digital television; broadcast providers and mobile broadband service providers.

This scenario presents a view on current trends in multimedia distribution in general and television in particular. Access to radio and television based content over broadband networks is becoming an essential element of future IP based media services. The opportunity that LTE networks offer as a complement to the current terrestrial broadcasting technologies with the aim of improving the consumer experience has been investigated.

In addition to the demands of media consumers, mobile broadband networks also provide interesting opportunities for programme development in the domain of ENG/OB. LTE networks enable transmission of high definition (HD) video streams from live cameras with the low latency and high quality required for studio feeds.

Specifically, an overview of the LTE Multimedia Broadcast/Multicast Service (MBMS) has been presented as a solution for mass multimedia distribution over LTE. The spectrum requirements to provide roof-top reception television service using a cellular network deployment and MBMS has also been investigated. The spectral efficiency of MBMS for this application has been determined by simulations.

### *A2.10.2.1 Examples of IP-based media services*

New IP-based media services are currently being developed, refined and made accessible over mobile broadband networks. Traditional as well as a new variety of content is developing, including social media, texting and chatting that is engaging and entertaining a growing audience. In particular the younger and middle-aged audience groups are establishing these new behaviours where media content, in addition to the living room based television set, is also consumed on desktops, laptops, tablets and smartphones [19] [20]. Whatever the case may be in terms of future consumption, access to radio and television based content over broadband networks is becoming an essential element of future IP-based media services.

While still covering a significant consumer base, as well as large geographical areas, the current analogue or digital terrestrial broadcasting technologies are the primary, or the only, means of delivering television services to a living-room based television set using a fixed antenna, in numerous countries. It would be exceptionally demanding to substitute these technologies for the purpose of modernization and adaption to the new behaviour of consumers and the new variety of content provisions. The reality is that both forms of access will coexist and evolve in their own ways for a long time and win-win solutions need to be developed for the cooperation and convergence between Broadcasting and Mobile Services; hence it is expected that the current terrestrial broadcasting technologies will remain in use for years to come. In some countries, the availability of terrestrial television program channels and television viewing time is still on the increase. However, in other countries the increase of viewing time is now levelling out, or even having a somewhat downward trend with regard to linear television viewing [19], particularly with regard to the younger television audience.

Television viewing now is becoming a social event as people are using social media to discuss what they are watching. Indeed, the referred study [19] shows “Social television: sixty-two percent of people use social networking sites and forums while watching television on a weekly basis and this number is growing. Of these people, forty percent will be discussing what they are currently watching on television over social networks.”

Notably, studies have shown that consumer behaviour is changing in terms of freedom of location, time and choice when accessing content, as well as improved quality, quantity and interaction. One other significant change in behaviour is the growth of non-linear content. Accordingly, a trend is emerging with broadcasting focusing on live events whereas stored content will increasingly be made available by streaming.

An essential question to consider when satisfying the new demands of media consumers is how to provide access to linear and non-linear content while using different devices and different sized screens. Broadcasting networks are suitable for linear content, and television receivers are now being equipped with broadband access. Mobile broadband networks are well suited for non-linear content with interactive use, and the devices primarily used on those networks are highly flexible with regard to usage and mobility.

In February 2010, the Canadian Radio-television Telecommunications Commission (CRTC) released a report entitled “Navigating Convergence: Charting Canadian Communications Change and Regulatory Implications”, an analysis of many of the trends, opportunities and challenges that faced the industry at that time. Since the document was published, many of the trends it identified have not only continued, but also accelerated. The 2011 follow-up report entitled “Navigating Convergence II: Charting Canadian Communications Change and Regulatory Implications” [17] describes an environment characterized by greater-than-anticipated consumption of content from Internet sources, further consolidation within the communications industry, substitutability of services, a proliferation of communications devices, and network traffic growth for both fixed and wireless networks. The report focuses on the evolution of wired and wireless networks, media-consumption trends and consumer-related issues.

Furthermore, in the 2012 annual “Communications Monitoring Report”, which provides an overview of the Canadian communications sector, it is shown that Canadians are consuming more content, both traditional television and radio broadcasts and digital media content [18]. On a weekly basis, they watched an average of 28.5 hours of television, up from 28 hours in 2010, and listened to an average of 17.7 hours of radio, up from 17.6 hours the previous year. Canadians also actively consumed digital media content. Typical users watched 2.8 hours of Internet television per week, an increase from 2.4 hours in 2010. Four per cent of Canadians report only was watching television programming online, while 4 % watched programming on a smartphone and 3 % on a tablet. Additionally, Canadians also stream the signal of an AM or FM station over the Internet.

Traditional linear television distribution networks and LTE networks are regarded as being complementary and can be used in cooperation very effectively in order to support the evolving consumer demands. The combination of the two modes of delivery enables the easy introduction of new advanced services and applications and supports successful convergent offerings between digital television, broadcast providers, and mobile broadband service providers.

Currently mobile operators almost certainly have sufficient capacity for the additional traffic generated by the discussed new service offerings; however, further studies are needed. The future rapid increase in the traffic volume, certainly calls for additional capacity and new solutions.

#### *A2.10.2.2 Technical/feasibility studies*

Subject to further consideration

#### *A2.10.2.3 Cross-border frequency coordination and coexistence*

Subject to further consideration

#### *A2.10.2.4 Economic, social and cultural issues*

Subject to further consideration

#### *A2.10.2.5 Regulatory impact*

Implementation of this scenario could take place within the framework of the GE06 Agreement, by application of the spectrum mask concept as defined in Article 5.1.3 provided that an 8 MHz variant of LTE becomes available.

Alternatively, if LTE would not support the 8 MHz channel raster the following elements could be studied:

- a) Consequences to the GE06 Agreement including the potential need to amend or abrogate this Agreement.

- b) Need to update bi- and multilateral coordination outside the scope of the GE06 Agreement, based on the principle of equitable access to the spectrum.
- c) The need of co-primary allocation to the Mobile Service

**A2.10.2.6 Migration issues**

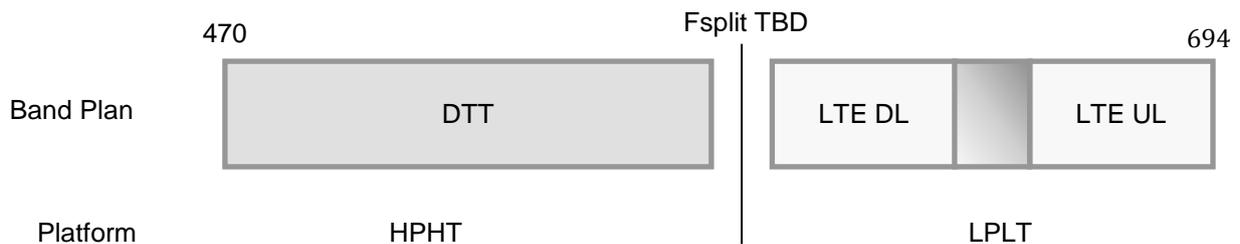
This scenario will not deliver sufficient spectrum to cover AV content production and will lead to consumer dissatisfaction on AV content experience.

**A2.11 SCENARIO 10**

This scenario is based on the principle that existing UHF spectrum is split into 2 sub bands: one remaining for broadcast use with existing HPHT platform, including PMSE in “white spaces” (although very limited), and the other sub-band structured in a traditional duplex FDD mode for broadband mobile services with a LTE LPLT platform to be deployed.

**A2.11.1 Description**

Under this scenario part of the spectrum resource below 694 MHz is dedicated to a traditional mobile broadband service such as LTE, with both uplink and downlink spectrum. The assumption is made that the mobile part of the band is deployed in a reverse duplex FDD arrangement, to ensure better compatibility with mobile services above 694 MHz. The LTE UL and DL elements are used by consumers for IP type data services. The remainder of the spectrum (below “Fsplit”) is used for DTT type technology for wide area broadcasting of audiovisual content.



**Figure 18: Mobile broadband FDD scenario**

No specific value is proposed at this early stage of analysis for the frequency “Fsplit” dividing the 2 parts of spectrum. This should rather be addressed in a further element of work on a long term vision for the UHF Band. This so far “generic” approach embraces both:

- medium sub-scenarios, such as for example a “50/50” approach where Fsplit=582 MHz ( i.e. 112 MHz for each of the 2 kinds of services);
- other scenarios, such as a “0/100” approach where Fsplit=470 MHz (i.e. no more spectrum for BC-MC) or a “100/0” approach where Fsplit=694 MHz (i.e. no change to the current situation).

Neither the use of Duplex Gap within LTE spectrum nor the opportunity of guard bands around Fsplit are discussed in this early step of the analysis.

**Service(s)**

DTT services and broadband mobile/LTE in Broadband spectrum part.

**Terminal / user device(s)**

DTT receivers including large flat screens. Smartphones, tablets, PCs / laptops for mobile services.

**Usage environment(s)**

DTT environnements and mobile environnements.

**Delivery**

DTT technologies (i.e. DVB-T/T2).

LTE/LTE-A 5G in LTE.

**A2.11.2 Assessment***A2.11.2.1 Technical/feasibility studies*

Parts of the UHF TV band have in the past been used for mobile services. For example the use of the band 790 – 862 MHz following WRC-07. It is therefore believed that with appropriate cross border coordination agreements that this scenario is feasible.

*A2.11.2.2 Cross-border frequency coordination and coexistence*

There are a range of possible mitigation measures available to reduce interference from IMT/LTE transmitters into a neighbouring system, including pointing antennas away from the border, downtilting of antennas, reduced antenna heights and/or transmit powers, etc.

Cross-border agreements / co-ordination can be used where necessary to manage / avoid cross-border interference between neighbouring countries.

*A2.11.2.3 Economic, social and cultural issues*

The benefit of this scenario is that it offers flexibility to administrations as to how they wish to use the valuable spectrum resource below 694 MHz. It may be that in some countries not all the spectrum from 470-694 MHz is required for broadcasting. Even if such a requirement exists today it may change overtime. It has been seen in some countries that the extra capacity afforded by the migration to DTT, cannot be used. That is there may not be a sustainable business model for the capacity of all multiplexes. This may be due to the availability of alternative platforms, or changing viewer habits (such as moving away from linear content).

In this case then, administrations have the flexibility to make the best use of the scarce spectrum resource, and to meet evolving demand in the future.

Calculating social and cultural benefits is complex. Previous studies have suggested that both mobile/LTE and DTT offer such benefits. However calculating a difference between the two is not trivial.

The impact of this scenario on the DTT ecosystem and PMSE, in particular on the issues described in §3.3 should be assessed.

*A2.11.2.4 Regulatory impact*

There are a number of regulatory issues that would need to be addressed under such a scenario. These could be split into two types:

1. National policy and obligations;
2. Cross border frequency coordination and interference control.

Issue 1: is not addressed here and is for national administrations.

Issue 2: This has a number of dimensions such as GE06, and possibly bi- or multi-lateral country agreements. One issue that would be of use to address is the possibility of modifying the ITU Radio Regulations at the forthcoming WRC-15. One option might be to establish a co-primary "MOBILE" allocation for the whole of the band 470 – 694 MHz. This would help facilitate the implementation of this option. It would

allow administrations to decide where an appropriate split between mobile and broadcasting should be and to change this overtime.

#### *A2.11.2.5 Migration issues*

Due to the need to benefit from economies of scale for mobile/IMT devices it is important that as many countries as possible use the same band plan and other technical conditions. This implies that “Fsplit” should be determined by agreement with a number of administrations. This also implies that “Fsplit” should only be modified with agreement of a number of administrations.

This scenario will not deliver sufficient spectrum to cover AV content production, and will lead to consumer dissatisfaction on AV content experience, if alternative spectrum is not identified..

## **A2.12 SCENARIO 11**

### **A2.12.1 Description**

#### **Service**

In this scenario the content/information/function are *smart data quantities*. These smart data quantities are being stored in data storage or produced in a data production or generated in data function generators which are all placed in one *generic smart communication unit*. They are transmitted in the most appropriate manner from the source unit to the destination unit. The source and the destination unit have same functionalities – their role is defined by the user and it changes depending on the type of communication. According to that concept, this scenario assumes that in the future broadcast and mobile broadband services in the UHF band would be delivered via accordingly evolved or completely new, as not yet existing, communication technologies.

#### **Terminal/user device**

The generic smart communication unit can store, produce, generate, transmit and receive smart data quantities.

The generic smart communication unit “knows” everything about the smart data quantities: when, where and how data is to be transmitted/received. The generic smart communication unit “knows” all about its geographical position and it can continuously update the information on the terrain and clutter on the way to the transmitting/receiving unit. Furthermore it “knows” what kind of radio networks that are accessible and also what radio frequencies are available for the specific transmission that is to be established. It is designed in a way that it can switch between transmitting and receiving mode.

For personal use the generic smart communication unit is a smart electronic personal companion that allows one to interface with all communication needs and media units such as large flat screens, portable TV sets, PCs, laptops, smartphones, game consoles, and tablets.

#### **Usage Environment**

The usage environment may be urban or rural: the smart communication units are designed to sense its environment both when they are in the transmitter and in the receiver mode. They can be used as fixed, portable or mobile units, at home or in public places or vehicles.

#### **Delivery**

As described above the generic smart communication unit “knows” everything about the smart data quantities to be delivered as well as about its geographical position. It can constantly update the information on the terrain and clutter on the way to the receiving unit. Most importantly, the generic smart communication unit “knows” what kind of radio networks and what frequencies that may be available for the specific transmission that is to be established. The radio networks of different kinds enable communication between communication units by co-operating with each other.

The technology used for delivery of the smart data quantities is based on the dynamic cognitive communication where the generic smart communication unit analyses its task. By knowing the radio and infrastructural environment the generic smart communication unit chooses in co-operation with the radio network the best suited transmission path, frequency and infrastructure.

## **A2.12.2 Assessment**

### *A2.12.2.1 Technical/feasibility studies*

The terminal/user device in this scenario is called generic smart data communication unit. The scenario is based on the intelligence of the communication unit that “knows” how to use the networks in the most appropriate way. On the other hand the radio networks of different kinds “know” how to co-operate with each other in order to enable communication. We can call this dynamic cognitive communication: by having insight into the radio and infrastructural environment the generic smart communication unit chooses, in co-operation with the radio network, to establish the best suited transmission path, frequency and infrastructure.

Many simple versions of generic smart data communication units are available and used all over the world. Smart phones for example can be used to receive, to transmit, to store and to generate audiovisual data/other data by using different frequency ranges and different networks – which co-operate with each other. Smart TV sets can also be seen as one version of the generic smart communication unit. There are a number of different wireless communication sets that people are carrying around and using for different purposes. Considering that the co-operation of highly developed broadcast and mobile broadband networks is an important, widely recognised and common interest for stake holders and regulators today then it seems possible to realise such a scenario based on dynamic cognitive communication in the year 2035.

### *A2.12.2.2 Cross-border frequency coordination and coexistence*

Cross-border frequency co-ordination should be based on cross-border agreements / co-ordination where necessary to manage / avoid cross-border interference between neighbouring countries, not excluding the possibility of applying some elements of GE06 Agreement, if necessary. At the moment it not possible to predict what the spectrum needs for the implementation of the co-operative networks will look like. However even if the communication in this scenario is cognitive and initiated by intelligent terminals the issue of co-existence will have to be carefully explored. The vision of this scenario is that 20 years from now spectrum sharing would be based on the logical, not on the physical level. That would also imply a completely new regulatory approach.

### *A2.12.2.3 Economic, social and cultural issues*

#### Social and Cultural Benefits

The individual person and their need for communication is the focus of this scenario. The social and cultural benefits of this scenario are expected to be high because the possibilities for individually created communication are bounded by technological and economical limitations. However, some financial implications should be encountered.

#### Economic – Costs & Benefits

This scenario implies new communication technologies which are used by a consumer who is in position to make their own choice all the way to the content. The consumers' needs and benefits are in focus. The existing business models have to be adjusted or transformed in order to meet this change. The free-to-air model, for example, is probably transformed by using the advantages of the different co-operative networks. Line borders between markets of today are redrawn or wiped away.

Obviously there is a need for large investments to realise that scenario. However it should be noted that a large portion of these investments will be a self-evident part of the technological development. Such investments will be required for stake holders in order to come into the market or to survive.

Long term return on investments made into HPHT network infrastructure would be lost because many HPHT networks would be abandoned before the end of the depreciation period. The impact on other services currently sharing the same infrastructure would need to be taken into account.

**A2.12.2.4 Regulatory impact**

On the RR level additional co-allocations might be required to enable all kinds of communication in the UHF band. On the CEPT level a harmonisation decision would be needed to make the band CEPT widely available. Cross-border frequency agreements / co-ordination can be used where necessary to manage / avoid cross-border interference between neighbouring countries.

**A2.12.2.5 Migration issues**

As this scenario is looking at the year 2035 there is a significant probability that the migration from the existing situation will not be direct and instant. Some migrations are carried out in planned and directed manner, but others happen gradually and spontaneously. Most probably the migration from the existing situation to this scenario will be carried out in a planned manner but it will gain a lot from the spontaneous changes in the communication environment. That is why the migration issues should be identified and analysed as soon as the communication environment indicates that this scenario is becoming a reality.

This scenario will not deliver sufficient spectrum to cover AV content production and will lead to consumer dissatisfaction on AV content experience.

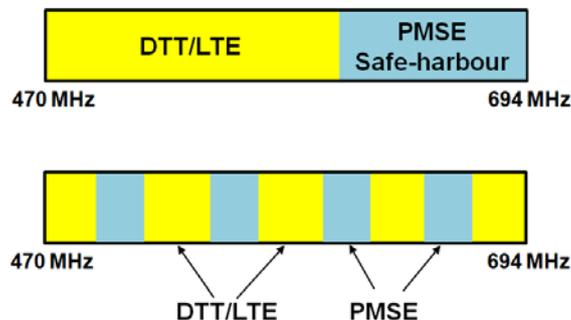
**A2.13 SCENARIO 12**

In this scenario, event and content production using PMSE systems, in particular, audio PMSE operate in dedicated spectrum. PMSE systems have always existed in a sharing scenario. If spectrum sharing with existing and new technologies is no longer possible dedicated spectrum might be one option to satisfy further justified demand in the UHF band.

It should be noted that because of body absorption of electromagnetic waves the UHF TV band is the core band for audio PMSE. These applications depend for their coverage on the properties of the band.

**A2.13.1 Description**

This scenario assumes that some spectrum in the band 470-790 MHz is reserved for exclusive PMSE usage. This dedicated spectrum can be either contiguous (single block) or formed through multiple blocks. The figures below provide illustrative examples of contiguous and multiple blocks of spectrum dedicated/reserved for PMSE usage in the band 470-694 MHz. This approach is sometimes called "safe-harbour". The possible ways to operate such a "safe harbour" are described in ECC Report 159. In addition to a potentially dedicated spectrum for PMSE there is a need for a continued access to interleaved spectrum.



**Figure 19: Examples for "safe harbour" channels used by PMSE**

The amount of dedicated/reserved spectrum needs to be defined on the basis of spectrum requirements for audio PMSE systems. It should be noted that, in the case of use of interleaved UHF TV spectrum by PMSE,

these spectrum requirements can be found in ECC Report 204, which indicates a local need of between 10 MHz for small events up to 270 MHz for large events.

## Services

- Event and AV content production based on PMSE production tools;
- Radio microphone Handheld or body worn microphone with integrated or body worn transmitter;
- In-ear monitor Body-worn miniature receiver with earpieces for personal monitoring of single or dual channel sound track;
- Portable audio link Body worn transmitter used with one or more microphones, with a longer operating range capabilities than that of radio microphones;
- Mobile audio link Audio transmission system employing radio transmitter mounted in/on motorcycles, pedal cycles, cars, racing cars, boats, etc. One or both link terminals may be used while moving.

## Terminal / user devices

- Audio PMSE for event and content production (e.g. Radio microphones, IEM, Talk-Back Systems, Audio links).

## Usage environment

- Fixed and mobile installations confined in space and time for e.g. AV content and event production;
- Typical usage includes studio production, theatre/concerts, political/social events, exceptional events and regular large events;
- Temporary audio PMSE applications, such as wireless microphones, in ear monitoring systems are used in a broad number of applications, including airborne and marine.

## Delivery

There are a large number of different delivery mechanisms

- Live audio content to the production facilities (e.g. broadcast studios, news teams);
- Live audio to the auditorium;
- Live audio to live streaming facilities; e.g. the Internet;
- Real time In-Ear-Monitor Systems (IEM);
- Live audio to recording units to provide long-term event reproduction;
- Talk back systems to control the event production environment.

## A2.13.2 Assessment

### *A2.13.2.1 Technical/feasibility studies*

It should be noted that PMSE can operate in the broadcast bands with TV and DAB transmissions which are “high tower high power systems” remote from audio PMSE installations and which are relatively well understood and rarely change their position or technical characters. The new allocations in comparison are for mobile use comprising of base stations and terminal units (phones or dongles) which will be located anywhere in the country and as such bring their transmissions physically closer to audio PMSE receivers which makes it impossible to use the interleaved spectrum as is the case with broadcasting stations. A combination of physical location, adjacent spectrum and modulation scheme are likely to provide a potential for interference to audio PMSE systems.

### *A2.13.2.2 Cross-border frequency coordination and coexistence*

Subject to further consideration

### *A2.13.2.3 Economic, social and cultural issues*

It is difficult to clearly identify the specific financial and social advantages of PMSE in a dedicated spectrum. From a general point of view, PMSE can be seen as an enabling technology allowing other activities to take place. Current society trends will have a significant impact on the development of different PMSE sectors which include changes in:

- programming style and definition for TV;
- coverage style (i.e. multiple camera angles) and priorities for TV sport;
- musical theatre and all other forms of theatre and entertainment;
- production budgets and staffing levels.

PMSE is dynamic: producers continually seek new experiences for audiences, with consequential changes in demand for spectrum. Such requests need to be considered and balanced against the benefits to society and needs of other services including other PMSE applications.

### SOCIAL & CULTURAL VALUE

PMSE equipment is an “enabler” allowing artistic expression which has not been available to earlier generations of artists and musicians at both professional and amateur level. In addition to the “artistic” use many other aspects of the social infrastructure rely heavily on the use of PMSE equipment, a few examples are:

- The ability in residential homes, hotels and village halls to provide announcements and entertainment;
- Use in schools to enhance the lives of hearing impaired children;
- Sports coaching using audio and video PMSE (more detailed information can be found in ECCREP204 Annex4).

### *A2.13.2.4Regulatory impact*

Consideration of the impact of cognitive PMSE systems on current licencing regimes to enable the systems to operate.

### *A2.13.2.5Migration issues*

Identification of sustainable spectrum for PMSE is required as there is a time lag of some 18 months or more in developing new equipment and also considering that a long term stability of spectrum availability is required in order to enable the users to maintain and expand their activities and industries.

### ANNEX 3: COLLECTION OF NATIONAL INPUTS WITH REGARD TO TV DELIVERY AND AUDIO-VISUAL CONSUMPTION

#### A3.1 TV DELIVERY

The following table provides information on the existing use of the terrestrial broadcast platform (digital or analogue) for TV delivery in households in various European countries, where:

- Primary sets are those using the terrestrial platform for TV delivery on their main set;
- Secondary sets are those which are not the "main" set (kitchens, bedrooms etc) that use the terrestrial platform for TV delivery;
- Total use is the proportion of households that use terrestrial distribution on one device somewhere in the house.

**Table 8: Terrestrial distribution in households for TV delivery**

| Country        | Primary Sets using terrestrial distribution | Secondary Sets using terrestrial distribution | Total use of terrestrial distribution | Observations   |
|----------------|---|---|---------------------------------------|--|
| United Kingdom | 39.1%                                       | Not Publically Available                      | 70.4%                                 | BARB Establishment survey Q1 2014.   |
| Finland        | 47%   | 23%   | 49%                                   |  |
| France         | 52.4%                                       | NA  | 59.7%                                 |  |
| Italy          | 70.7%                                       | 26.0%   | 96.7%                                 | Source Auditel 2012. Figures about primary sets refer to households who only rely on DTT sets for TV reception, whereas figures for secondary sets refer to households with both DTT and satellite reception sets; in this latter case, satellite is assumed to be the distribution platform for primary sets. |
| Austria        | 5%  | 6%  | 10.7%                                 |  |
| Czech Republic | 46%   | 55%   | 61.7%                                 |  |
| Hungary        | 19%   | 3%  | 22%                                   |  |
| Latvia         | NA  | NA  | 25.8%                                 | Source TNS 2012. Individual reception.   |
| Croatia        | 54.7%                                       | NA  | NA                                    |  |
| Estonia        |   |   | 26.5%                                 | DVB-T (pay) 9.6% and DVB-T (FTA) 16.9%   |
| Norway         | 14%   | 16%   | 30%                                   | 14% of Norwegian households use DTT as primary distribution platform.<br>16% of Norwegian households are dependent of DTT as secondary distribution platform, either on TV nr 2 etc. at home, or at cottages, caravans, boats etc. (source: Survey conducted by Ipsos MMI).                                    |
| Ireland        | 10%   | 31%   | 41%                                   | These figures represent a minimum estimate. Data from September 2014.<br>Source <a href="http://www.tamireland.ie/tv/universes">http://www.tamireland.ie/tv/universes</a>  |

| Country                     | Primary Sets using terrestrial distribution | Secondary Sets using terrestrial distribution | Total use of terrestrial distribution | Observations  |
|-----------------------------|---|---|---------------------------------------|---|
| Portugal                    | 21.8%                                       | NA  | NA                                    | Source: TNS, April/May 2013<br>Figures about primary sets refer to households (in continental territory of Portugal) who only rely on DTT sets for TV reception without pay-TV. |
| Belgium (Flemish Community) | NA  | NA  | 5.1 %                                 | Source Digimeter 2013, aug-sept.<br>Adoption and Usage of Media & ICT in Flanders, iMinds   |
| EU28                        | NA  | NA  | 46%                                   | NA  |

### A3.2 AUDIO VISUAL CONSUMPTION

The following table provides information on the extent of linear viewing of audiovisual content within CEPT countries.

**Table 9: linear viewing of audiovisual content**

| Country/Source | Source&Period                           | Linear (including live and time-shifted) Duration (hh:mm) | Observations  |
|----------------|---|---|---|
| France         | Médiamétrie, 2013                       | 3h46  | This value corresponds to the averaged value over the whole population studied, including those who don't watch linear. 4h37 is the Average viewing duration for these individuals who watch linear content (47 out of 59 MM) |
| UK             | Ofcom Communications Market Report 2014 | 3h:39mins   | Average time spent on watched activities per day, figure 2.20.  |
| Italy          | RAI-Auditel, 2013                       | 5h17  |   |
| Sweden         | MMS Årsrapport, 2013                    | 2h39  |   |
| Czech Republic | ATS, 2013                               | 3h38  |   |
| Finland        | Finnpanel TV Audience Measurement 2013  | 3h02  |   |
| Hungary        | Nielsen: TV Market                      | 5:11  |   |

| Country/Source                 | Source&Period   | Linear<br>(including live and<br>time-shifted)<br>Duration (hh:mm)   | Observations   |
|--------------------------------|---|--|--|
|                                | Snapshot 2014<br>Q1   |  |  |
| Latvia                         | TNS, Aug 2014   | 4h48   |  |
| Croatia                        | AGB Nielsen<br>Media Research,<br>2012  | 4h23   |  |
| Estonia                        |   | 3h16   |  |
| Norway                         | TNS Gallup –<br>TV-meter (2014<br>Q1 and Q2)  | 2h57 (total)<br>1h04 minutes (only NRK<br>– public service)  | Incl. 21 days time-shifted.  |
| Austria                        | Mediaresearch,<br>2013  | 2h48   | This value corresponds to the<br>averaged value over the whole<br>population studied, including those<br>who don't watch linear.<br>4h27 is the Average viewing duration<br>for these individuals who watch linear<br>content. |
| Ireland                        | TAM<br>Ireland, <a href="#">2013 TV<br/>Viewing Ireland</a>   | 3h28m per day  | 91% (3hrs 10 mins) of this viewing<br>was live with the other 9% (18 mins<br>per day) time shifted.  |
| Portugal                       | ECSI 2013   | > 1h00<br>(90% of the inquired<br>people)<br>> 3h00<br>(38% of the inquired<br>people)<br>> 2h00 & < 3h00<br>(26% of the inquired<br>people)<br>< 1h00<br>(7.7% of the inquired<br>people) | These values respect only people that<br>have a subscription television service.   |
| Belgium (Flemish<br>Community) | Source Digimeter<br>2013, aug-sept.<br>Adoption and<br>Usage of Media<br>& ICT in<br>Flanders, iMinds | 1 ..3 h  | Watched by vast majority of tv<br>viewers. More than half of those<br>watching TV content, watches one to<br>three hours a day.  |

It has to be remarked that figures in the table above are derived from various sources, which may employ different assumptions or methodologies for their statistical analyses.

The following table provides information on the extent of non-linear viewing of audiovisual content within CEPT countries.

**Table 10: Non-linear viewing.**

| Country/Source              | Source&Period  | Non Linear<br>(including live and<br>time-shifted)<br>Duration (hh:mm) | Comments  |
|-----------------------------|--|--|---|
| France                      | Netratings, 2013   | 5.46min  | This value corresponds to the averaged value over the whole population studied, including those who don't watch nonlinear.<br>32mn is the average viewing duration for these individuals who watch nonlinear content (11.1 out of 65 MM)  |
| UK                          | OFCOM<br>Communications<br>Market Report 2014  | 37 mins  | Average time spent on selected watched activities per day figure 2.20 (including DVD / Blu-Ray / VHS)   |
| Italy (Note 1)              | ISTAT, 2012  |  | 7.5 MM out of a population of 55MM are watching non linear content. These figures for Italy are derived considering consumption of TV contents on the web, for population over 6  |
| Sweden                      | Nordicom, 2013   | No data  | 6% of the population are watching nonlinear content   |
| Czech Republic              |  | No data  |   |
| Latvia                      |  | No data  |   |
| Croatia                     |  | No data  |   |
| Estonia                     |  |  | Non linear TV service is available for about 15% of DVB-C and 100% IPTV users. But the exact consumption is unknown   |
| Norway                      | NRK, 2014  | 1.5 minute (only NRK – public service)                                 | Data only available for Internet distribution of NRK content. No data available for other content   |
| Ireland                     |  | No data  |   |
| Portugal                    | NA   | NA   |   |
| Belgium (Flemish Community) | Source Digimeter 2013, aug-sept. Adoption and Usage of Media & ICT in Flanders, iMinds | NA   | Digital tv makes it possible to watch tv content in different ways. 55.8 % of the digital tv owners watch linear tv daily. Other figures on a daily basis are as follows: 17.8 % watch tv content slightly delayed, 25.4% watch tv content delayed, 1.9 % watch tv content on demand, 12.4 % watch tv via streaming websites and 3.1 % using TV apps. |

It should be noted that in the US, for non-linear viewers, AV daily consumption is at 40minutes/person [6]. This figure is not comparable with figures for linear viewing which are expressed as an average viewing figure person per day for the whole population.

#### ANNEX 4: AVAILABILITY OF PSB PROGRAMMES ON TV DISTRIBUTION PLATFORMS

The Table below shows the current information on the availability of PSB distribution platforms in different European countries.

FTA (Free-to-air) refers to a delivery model where PSB services are available to all viewers and listeners without recurring charges.

**Table 11: Availability of PSB distribution platforms in different European countries.**

| Country        | DTT | Satellite  | Cable  | IPTV                | Comments  |
|----------------|-----|--|--|---------------------|---|
| Austria        | FTA | FTA  | Mixture of FTA and No FTA  | No FTA              | DTT: PSB-services are FTA. Only simulcast transmitted HD-content via DVB-T2 is encrypted and a free of charge registration is necessary.<br>Cable: At present PSB services are partly FTA because of voluntary rules set up by some operators.<br>Satellite: PSB services are encrypted for content rights reasons. Free-to-air is possible with access cards |
| Belgium        | FTA | No FTA   | Subscription is required. The generalist PSBs are "must carry" and available in all pay packages | No FTA              | A joint programme between VRT and the Dutch NPO, called BVN (het Beste van Vlaanderen en Nederland) is FTA on satellite. The channel is satellite-only, not available on any other platform   |
| Bulgaria       | FTA | Only the International channel is FTA  | No FTA   | No FTA              |   |
| Croatia        | FTA | PSB services are encrypted; the viewers must obtain a viewing card. The card is free if they have no DVB-T reception on their location | No FTA.  | No FTA              |   |
| Czech Republic | FTA | No FTA, PSB services are encrypted, subject to a small subscription fee  | Some programmes FTA  | Some programmes FTA |   |

| Country | DTT | Satellite  | Cable   | IPTV  | Comments   |
|---------|-----|--|---|---|--|
| Denmark | FTA | No FTA. No must carry rules. Encrypted services include PSB, but they are only available with subscription   | Limited must carry rules, operator entitled to charge, no regulation of price for viewers   | No FTA, no must carry rules, operator entitled to charge  | Satellite FTA not possible due to rights issues.<br>Cable, satellite and IPTV are all re-distribution, i.e. performed by another entity than the PSB |
| Estonia | FTA | No FTA   | No FTA  | No FTA  |  |
| Finland | FTA | PSB service available FTA only outside DTT coverage areas.   | FTA (Must Carry).<br>Re-transmission of DTT   | FTA<br>Re-transmission of DTT   |  |
| France  | FTA | PSB services are encrypted for rights reasons, but with either free or one-off payment for a viewing card.<br>Not all sub-local services are available | "Must carry", minimum subscription €28/pm for triple play (no extra charge for DTT channels). <75% of HH have access.<br>Not all sub-local services are available | "Must carry", minimum subscription €30/pm for triple play (no extra charge for DTT channels). Not all sub-local services available. | Must carry is free for PSBs.<br>Cable & IPTV carriage must be on FRAND basis for commercial FTA DTT broadcasters                                     |
| Georgia | FTA | FTA  | No FTA  | No FTA  | No DTT. Analogue terrestrial   |
| Germany | FTA | FTA  | Subscription required (for single family at least 17 € per month, depending on local CATV operator – may be less for a flat in an apartment block                 | Subscription required (normally bundled with Internet and phone connection, from about 39 € per month)                              | HDTV by satellite is FTA for PSBs.   |
| Hungary | FTA | PSB services are encrypted; the viewers must obtain a viewing card   | No FTA  | No FTA  |  |
| Iceland | FTA | PSB services are encrypted for   | Not available   | PSB included in a TV  | The future of satellite distribution is unclear.   |

| Country     | DTT | Satellite  | Cable  | IPTV   | Comments  |
|-------------|-----|--|--|--|---|
|             |     | rights reasons, but with one-off payment for a viewing card. Local services are available  |  | package bundled with Internet connection and STB lease   |   |
| Ireland     | FTA | FTA (on Ka Band spot beam) and via subscription on Ku Band   | Must carry - Subscription required   | Must carry – Subscription required   |   |
| Italy       | FTA | 1. FTA. Encrypted for rights reasons, but with one-off payment for viewing card.<br>2. Pay TV. PBS programmes are available in simulcast in basic bouquet, although some programmes are not transmitted for rights reasons | N/A  | <1% use<br>PBS programmes are available on all IPTV platforms                                    | The Italian Public Broadcaster offers its contents over all platforms, including a catch-up TV service on its website, and has its own channels on You tube   |
| Latvia      | FTA | PSB services are encrypted for rights reasons. Subscription required   | "Must carry" - subscription required   | "Must carry" - subscription required   |   |
| Netherlands | FTA | PSB encrypted with one-off payment for viewing card. This service will terminate in August 2014. After that date PSB will be available on only within pay-TV packages  | Subscription is required. The generalist PSBs are "must carry" and available in all pay packages | Subscription is required. The generalist PSBs are "must carry" and available in all pay packages | According to the Dutch Media law the PSB channels (as well as the Flemish channel 1 and 2) are 'must carry' for every distributor with 100.000 subscribers or more, and in every available subscription package. The number of PSB channels and the quality differ per platform. On DTT there are 3 generalist TV channels in SD, on satellite the same channels are in HD and SD + 4 thematic channels in SD. On cable the 3 main TV channels (analogue, SD and HD digital) and 8 thematic channels (but only 1 in the basic package, 7 in plus packages). On IPTV the 3 main TV channels (SD and HD) and 8 thematic TV channels). A joint programme between VRT and the Dutch NPO, called BVN (het Beste van Vlaanderen en Nederland) is FTA on satellite. The channel is satellite-only, not |

| Country  | DTT | Satellite  | Cable   | IPTV   | Comments  |
|----------|-----|--|---|--|---|
|          |     |  |   |  | available on any other platform   |
| Norway   | FTA | Encrypted. Available outside DTT coverage areas with free access card. Not available in many areas where reception is blocked by the terrain   | Must carry. Operator entitled to charge. Not available in many rural areas                | Must carry. Operator entitled to charge. Not available in many rural areas                 | An extra DTT network is deployed in rural areas where satellite distribution is blocked by the terrain(590 transmitters; PSB only)  |
| Poland   | FTA | TVP's own platform on Astra 1Kr: encrypted/FTA depending on the programme.<br>Third parties platforms: selected programmes – FTA / must-carry obligation, some programmes might be encrypted | Third parties' networks: some programmes FTA under must-carry obligation / some encrypted | Selected programmes only   | 9 (of 14) programmes distributed via DTT  |
| Portugal | FTA | The DTT content is encrypted for rights reasons with one-off payment for a viewing card  | No FTA  | No FTA   | Only two PSB programmes are FTA in DTT together with two commercials channels and the Parliament channel. Outside the DTT coverage area, one can buy (at special price) a satellite receiver kit, to receive from Hispasat the same content as in DTT. In Cable and IPTV there is no FTA, you must always pay, unless specific agreements are made (e.g. between a town council and the cable operator) |
| Romania  | FTA | Mixture of FTA and No FTA  | "Must carry" subscription approx. €10/pm (relating to the base package of programmes)     | N/A  |   |
| Serbia   | FTA | No FTA   | No FTA  | No FTA   |   |
| Slovakia | FTA | PSB encrypted for geo-blocking (rights) reasons, subscription or so-called services charges min. €1,20/pm (CZE and SVK programmes)   | "Must carry" subscription approx. €10/pm (relating to the base package of                 | "Must carry", subscription (usual depend on the TV programme + internet package) or/and an |   |

| Country     | DTT | Satellite   | Cable   | IPTV   | Comments  |
|-------------|-----|---|---|--|---|
|             |     |   | programmes)<br>Generally not available in the rural areas   | activation fee.<br>Availability of service depend on local internet infrastructure |   |
| Spain       | FTA | PSB encrypted, two main PSB programmes included in pay TV packages                    | No FTA, two main PSB programmes included in pay TV packages | No FTA, PSB encrypted, two main PSB programmes included in the pay TV packages     | Satellite used to provide services where there is no DTT coverage. In these areas satellite decoder is provided free of charge  |
| Sweden      | FTA | No FTA service  | Must carry, but charged                                     | Must carry, but charged.   |   |
| Switzerland | FTA | PSB encrypted and limited to the Swiss audience with one-off payment for viewing card | Minimum subscription required                               | Subscription required (normally bundled with Internet and phone connection)        |   |
| UK          | FTA | FTA   | Minimum subscription £13/pm                                 | Subscription required  | DCable minimum subscription includes all public service channels. All platforms also have pay options. IPTV has FTA through DTT (YouView), but other content is subject to a subscription |

Source: EBU Members, compiled in March 2014.

## **ANNEX 5: CONSIDERATIONS IN REGARD TO A REPLACEMENT OF DTT BY OTHER TV PLATFORMS**

In the event that a replacement of DTT by other TV distribution platforms is considered (e.g. satellite, cable or IPTV) the following important factors need to be taken into account:

1. Provision of Free-to-Air<sup>36</sup> (FTA) services on alternative platforms;
2. Provision of Public Service Broadcasters' (PSB) services on alternative platforms;
3. Provision of local and regional TV services;
4. Provision of complementary commercial programmes;
5. Lack of "universal" availability;
6. Competition between TV distribution platforms;
7. Legal requirements regarding national provision of infrastructure;
8. Migration of DTT audiences to another platform.

Taken together, these elements often represent severe impediments to replacing DTT by alternative platforms.

### **A5.1 PROVISION OF FREE-TO-AIR SERVICES ON ALTERNATIVE PLATFORMS**

In many countries, DTT is the only distribution platform offering FTA television services.

All alternatives to FTA are either only available to subscribers as part of a paid package or via "Free to View" access cards.

Subscriptions clearly represent a hurdle to those who cannot afford, or do not wish to pay for, a commercial package (whether just TV, or a combination package including broadband or triple play).

The use of access cards represents an extra burden and costs on either broadcasters or platform providers, i.e. to manage databases of eligible households, handle the cards, and provide user support. Experience shows that platform operators whose core proposition provide pay-TV packages are reluctant to provide Free-to-view cards and the corresponding user equipment.

### **A5.2 PROVISION OF PSB SERVICES ON ALTERNATIVE PLATFORMS**

In some countries, public-service broadcasters' content is available on DTT, but not on any or all alternative platforms, for technical, regulatory or commercial reasons. Unless these reasons are addressed the alternative platforms cannot replace DTT for provision of PSB services.

### **A5.3 PROVISION OF LOCAL AND REGIONAL TV SERVICES**

DTT is convenient for the provision of local TV services as the network coverage can be adjusted to the regulatory and commercial requirements.

In many countries local TV services are only available on DTT and it may not be viable to provide them on other platforms, in particular where alternative platforms are not available or where the costs would be prohibitive.

### **A5.4 PROVISION OF COMPLEMENTARY COMMERCIAL PROGRAMMES**

In addition to PSB services on the DTT platform, there is generally a wide range of non-PSB content available to complement the PSBs. These services are highly-valued by their viewers and add a significant

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<sup>36</sup> Free-to-air (FTA) refers to a delivery model where broadcast services, both PSB and commercial, are available to all viewers and listeners without recurring charges.

value to the DTT platform. For many commercial services the DTT platform constitutes the preferred means of distribution under given technical, regulatory and economic conditions.

#### **A5.5 LACK OF “UNIVERSAL” AVAILABILITY**

DTT is a very cost efficient means to provide near-universal coverage. In many countries, there is a legal or licensing obligation for DTT to be available to a large proportion of the population (e.g. more than 98%). Not all alternative platforms can match this, which is in particular the case for cable and IPTV networks.

#### **A5.6 COMPETITION BETWEEN TV DISTRIBUTION PLATFORMS**

The existence of DTT in a given country is important even in those countries where satellite or cable are the main delivery platforms because it provides a competitive alternative for the benefit of viewers. If DTT was not available, viewers would have to move to satellite, cable or IPTV platforms which in many countries would require subscription to a pay package. In addition, in many places only one of these options (e.g. satellite) would be available.

#### **A5.7 LEGAL REQUIREMENTS REGARDING NATIONAL PROVISION OF INFRASTRUCTURE**

In some countries, there is a legal requirement for critical infrastructure, including PSB transmission facilities, to operate independently of foreign-owned companies, including satellite providers or even GPS signals. Furthermore, some DTT networks are considered to be part of “public safety” infrastructure to provide local information to population in case of emergency.

#### **A5.8 MIGRATION OF DTT AUDIENCES TO ANOTHER PLATFORM**

In countries where a significant part of the population relies on the DTT platform migration to alternative platforms would require large investments, either borne by individual households or governments. The latter may be impossible due to platform neutrality considerations.

## ANNEX 6: TV ROU DURATION, ASO AND TECHNOLOGY IN USE FOR TV BROADCASTING

The information available in Table 12 took as basis the following sources:

- Responses to the RSPG questionnaire on the long term spectrum requirements for television broadcasting in the European Union including the number of TV services, HDTV, interactive services, mobility requirements and the possible introduction of Ultra High Definition Television ([http://www.rspg-spectrum.eu/consultations/responses\\_questionnaire\\_dtt/dtt\\_questionnaire\\_responses.zip](http://www.rspg-spectrum.eu/consultations/responses_questionnaire_dtt/dtt_questionnaire_responses.zip));
- Preliminary draft new Report ITU-R on "Spectrum requirements for terrestrial television broadcasting in the frequency band 694-790 MHz in Region 1 and the Islamic Republic of Iran", available at Annex 10 to Document 6A/264.

**Table 12: TV RoU duration, ASO and technology in use for TV broadcasting in CEPT countries**

| CEPT Country | ASO in the band 470 – 862 MHz        | Technology in use for TV broadcasting | RoU expiry date  | RoU conditions/renewal  |
|--------------|--------------------------------------|---------------------------------------|--|---|
| Albania      |                                      |                                       |  |   |
| Andorra      |                                      |                                       |  |   |
| Austria      | Finished in 2011                     | DVB-T and DVB-T2                      | 3 Multiplexes DVB-T2 until 2023<br>2 Multiplexes DVB-T expire in 2016 and will be renewed as DVB-T2 Multiplexes until 2026   | License period is 10 years  |
| Azerbaijan   | Finished in 2013                     | DVB-T                                 |  |   |
| Belarus      | Started (ASO completion in 2015)     | DVB-T and DVB-T2                      |  |   |
| Belgium      | Finished in 2008 (Flemish Community) | DVB-T and DVB-T2                      | <u>Flemish Community</u> : expires in June 2024 for the television broadcast network operator.<br><br>At this moment no expiration date for the public broadcaster..<br><br><u>French Community</u> :<br><br><u>German-speaking Community</u> : No expiration time for public broadcaster. | <u>Flemish Community</u> : possibility of prolongation by 15 years for the licence of the television broadcast network operator<br><br><u>French Community</u> : The management contract of the public broadcaster is renewable every 5 years.<br><br><u>German-speaking Community</u> : The legally foreseen licenses are for nine years and prolongable for the |

| CEPT Country           | ASO in the band 470 – 862 MHz | Technology in use for TV broadcasting | RoU expiry date   | RoU conditions/renewal  |
|------------------------|-------------------------------|---------------------------------------|---|---|
|                        |                               |                                       |   | same duration.  |
| Bosnia and Herzegovina |                               |                                       |   |   |
| Bulgaria               | Finished in 2013              | DVB-T                                 | One of the licenses expires in 2015, all the other existing licenses expire in 2025   |   |
| Croatia                | Finished in 2010              | DVB-T and DVB-T2                      | 2019 (2 MUXes), 2020 (1 MUX), 2021 (2 MUXes)  |   |
| Cyprus                 |                               | DVB-T                                 | 2025  |   |
| Czech Republic         | Finished in 2012              | DVB-T                                 | Existing commercial countrywide DTT licenses expire between 2021-2024. Local DTT transmitters are authorized only until 31 <sup>st</sup> December 2017  |   |
| Denmark                | Finished in 2009              | DVB-T and DVB-T2                      |   |   |
| Estonia                | Finished in 2010              | DVB-T and DVB-T2                      | In Estonia the existing DTT frequency licenses are issued for 1 year and then need prolongation every year after payment of annual spectrum fee   |   |
| Finland                | Finished in 2007              | DVB-T and DVB-T2                      | 2016, except one multiplex in UHF expiring in 2026  |   |
| France                 | Finished in 2011              | DVB-T                                 | The time duration of the public service TV channels authorization is set by the government. For other existing national authorizations (i.e. other free-to-air TV channels and pay-TV channels), the license expiry date is currently between 2015 and 2022 | The French audiovisual media Law gives the possibility to the broadcasting regulator to award one extension of 5 years, under certain conditions. |
| Georgia                |                               |                                       |   |   |

| CEPT Country                              | ASO in the band 470 – 862 MHz | Technology in use for TV broadcasting | RoU expiry date  | RoU conditions/renewal   |
|---|-------------------------------|---------------------------------------|--|--|
| Germany                                   | Finished in 2008              | DVB-T                                 | End of 2025  |  |
| Greece                                    |                               |                                       |  |  |
| Hungary                                   | Finished in 2013              | DVB-T                                 | 2020   |  |
| Iceland                                   |                               |                                       |  |  |
| Ireland                                   | Finished in 2012              | DVB-T                                 | December 2019  | There are no broadcasting policy plans to terminate these PSB services, and the broadcasting legislation provides that, at the request of the PSB, spectrum licences shall be issued again for the PSB multiplexes |
| Italy                                     | Finished in 2012              | DVB-T and DVB-T2                      | All Italian DTT Licenses will last until 2032  |  |
| Latvia                                    | Finished in 2010              | DVB-T                                 | 31 December 2021   |  |
| Liechtenstein                             |                               |                                       |  |  |
| Lithuania                                 | Finished in 2012              | DVB-T                                 | The vast majority of licences are valid until 2022 and one multiplex is licensed until 2031  |  |
| Luxembourg                                | Finished in 2006              | DVB-T                                 | In the year 2020   |  |
| The Former Yugoslav Republic of Macedonia |                               |                                       |  |  |
| Malta                                     | Finished in 2011              | DVB-T                                 | There are two active DTT licences.<br>a) One licence issued to the commercial operator for the deployment of the Pay-TV service expires in 15 May 2021.<br>b) One licence issued to the General Interest Operator to operate the Free-to-Air TV service is an indefinite licence but may be terminated |  |

| CEPT Country       | ASO in the band 470 – 862 MHz        | Technology in use for TV broadcasting | RoU expiry date  | RoU conditions/renewal   |
|--------------------|--------------------------------------|---------------------------------------|--|--|
|                    |                                      |                                       | by the Government  |  |
| Moldova            | Not started (ASO completion in 2015) | DVB-T                                 |  |  |
| Monaco             |                                      |                                       |  |  |
| Montenegro         |                                      |                                       |  |  |
| Netherlands        | Finished in 2011                     | DVB-T                                 | All licenses expire on 31 January 2017   |  |
| Norway             | Finished in 2009                     | DVB-T                                 | 2 June 2021  |  |
| Poland             | Finished in 2013                     | DVB-T                                 | commercial 2020, 2021, PSB without time-limit  |  |
| Portugal           | Finished in 2012                     | DVB-T                                 | expires in 9 December 2023   | The right of use for DTT frequencies was granted for a 15-year period and can be renewed |
| Romania            | ASO to be complete in 17.06.2015     | DVB-T2                                | 2025   |  |
| Russian Federation | Started (ASO completion in 2015)     | DVB-T, DVB-T2 and DVB-H               |  |  |
| San Marino         |                                      |                                       |  |  |
| Serbia             | Started                              | DVB-T2                                |  |  |
| Slovak Republic    | Finished in 2012                     | DVB-T, DVB-T2 and DVB-H               | Licences issued for nationwide multiplexes shall expire on 09.09.2029  | Licenses for local multiplexes are issued for 7 years                                    |
| Slovenia           | Finished in 2011                     | DVB-T                                 | National: 2018, 2026; Local 2022   |  |
| Spain              | Finished in 2010                     | DVB-T                                 | National and regional multiplexes have been licensed until 2025, while local multiplexes have been licensed until 2020 |  |
| Sweden             | Finished in 2007                     | DVB-T and DVB-T2                      | Existing DTT license in Sweden expires in March 2014   |  |
| Switzerland        | Finished                             | DVB-T                                 | The license of the national Swiss broadcaster will end by 31.12.2017.  | There are discussions to prolong the license until 31.12.2023                            |

| CEPT Country   | ASO in the band 470 – 862 MHz    | Technology in use for TV broadcasting | RoU expiry date   | RoU conditions/renewal                             |
|----------------|----------------------------------|---------------------------------------|---|--|
|                |                                  |                                       | The licenses of the local operators will end by 31.12.2013  |  |
| Turkey         |                                  |                                       |   |  |
| Ukraine        | Started (ASO completion in 2015) | DVB-T2                                |   |  |
| United Kingdom | Finished in 2012                 | DVB-T and DVB-T2                      | The BBC A is not subject to a defined licence term.<br>BBC B: 2026<br>Digital 3&4: 2022<br>SDN: 2022<br>Arqiva A: 2026<br>Arqiva B: 2026<br>Arqiva C (DVB-T2): 2026<br>The Northern Ireland multiplex licence expires in 2024 | Arqiva C scope for early termination from Dec 2018 |
| Vatican        | Finished                         | DVB-T                                 |   |  |

## ANNEX 7: LIST OF REFERENCES

- [1] Geneva 06 Agreement: Regional Agreement Relating to the planning of the digital terrestrial broadcasting service in Region 1 (parts of Region 1 situated to the west of meridian 170° E and to the north of parallel 40 S, except the territory of Mongolia) and in the Islamic Republic of Iran, in the frequency bands 174 230 MHz and 470-862 MHz (<http://www.itu.int/ITU-R/terrestrial/broadcast/plans/ge06>)
- [2] Radio Spectrum Policy Programme: Decision No 243/2012/EU of the European Parliament and of the Council of 14 March 2012 establishing a multiannual radio spectrum policy programme.
- [3] EC Mandate on 700 MHz : Mandate to CEPT to develop harmonised technical conditions for the 694-790 MHz ('700 MHz') frequency band in the EU for the provision of wireless broadband and other uses in support of EU spectrum policy objectives.
- [4] Recommendation Rec(2003)9 of the Committee of Ministers to Member States on measures to promote the democratic and social contribution of digital broadcasting <https://wcd.coe.int/ViewDoc.jsp?id=38043&Site=CM>
- [5] Declaration of the Committee of Ministers on the allocation and management of the digital dividend and the public interest (<https://wcd.coe.int/ViewDoc.jsp?id=1252459>)
- [6] Directive 2010/13/EU, of 10 March 2010, on the coordination of certain provisions laid down by law, regulation or administrative action in Member States concerning the provision of audiovisual media services (Audiovisual Media Services Directive ([http://ec.europa.eu/avpolicy/reg/tvwf/index\\_en.htm](http://ec.europa.eu/avpolicy/reg/tvwf/index_en.htm)))
- [7] Directive 2002/21/ EC, of 7 March 2002, on a common regulatory framework for electronic communications networks and services, as amended by Directive 2009/140/EC and Regulation 544/2009 ([http://europa.eu/legislation\\_summaries/information\\_society/legislative\\_framework/l24216a\\_en.htm](http://europa.eu/legislation_summaries/information_society/legislative_framework/l24216a_en.htm))
- [8] Directive 2002/22/EC, of 7 March 2002, on universal service and users' rights relating to electronic communications networks and services, as amended by the Directive 2009/136/EC ([http://europa.eu/legislation\\_summaries/information\\_society/legislative\\_framework/l24108h\\_en.htm](http://europa.eu/legislation_summaries/information_society/legislative_framework/l24108h_en.htm))
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- [14] ITU-R Report BT.2302: Spectrum requirements for terrestrial television broadcasting in the UHF frequency band in Region 1 and the Islamic Republic of Iran. Available at <http://www.itu.int/pub/R-REP-BT.2302>
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