## ECC(14)021 Annex 1

**ECC(14)XXX Annex1**

ECC Report <No>

Working document towards ECC Report on  
Long Term Vision for the UHF broadcasting band

**Approved DD Month YYYY (Arial 9pt bold)**

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# Executive summary

Body text (style: ECC Paragraph)

(advice: the Executive Summary should provide a short and concise explanation on the purpose of the respective ECC Report and should clearly indicate the covered subjects to which it applies. In addition, it should clearly explain the application of the document.)

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**LIST OF ABBREVIATIONS**

|  |  |
| --- | --- |
| **Abbreviation** | **Explanation (style: Arial 10pt bold red (colour values RGB: 210, 35, 42)** |
| **CEPT** | European Conference of Postal and Telecommunications Administrations |
| **ECC** | Electronic Communications Committee |
| **AV** | Audiovisual |
| **HPHT** | High-power high-tower |
| **LPLT** | Low-power low-tower |
| **UE** | User equipment |
| **MBB** | Mobile broadband |
| **RAS** | Radio astronomy service |
| **<abbr>** | <explanation – edit the table as necessary> |
|  |  |
|  |  |
|  |  |
|  |  |

# Introduction

Traditionally, broadcasting and broadband communication services have their own regulations, market structure and typical 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 is blurring the border between the two “worlds” for the end user and may require innovative approaches to deliver content to the end users in the most efficient way from technical, economical and social perspective. This may imply using cooperation or even convergence of networks and more efficient use of spectrum resources. Therefore, the studies carried out in TG6 on the future use of the UHF band sought to take into account among others:

* 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 to each sector;
* The flexibility required to address different situations in different CEPT countries with regard to content regulation;
* Cross-border coordination issues between different network topologies and impact on equitable access taking into account the GE-06 Agreement;
* Various reception environments (e.g. indoor/outdoor, fixed, portable, etc.) 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, etc.), their evolution and their possible convergence;
* The possibility of “hybrid” networks (to be defined) and the related issue of transition, economical models, and the possibility of convergent/cooperative services (to be defined)
* Possible introduction of cognitive techniques (e.g. use of white space by applications other than PMSE).

During the 33rd ECC meeting (March 2013), it has been 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 economical, 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 existing situation in each CEPT country.

Finally, the 34th ECC meeting (June 2013), has agreed to set up 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 EC Mandate);
* 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;
* How to provide a certainty that there will be a stable environment for future investment by the services envisaged in the band (including PMSE).

[May need to address what is long term?]

# Definitions

|  |  |
| --- | --- |
| **Term** | **Definition (style: Arial 10pt bold red (colour values RGB: 210, 35, 42)** |
| **<Term 1>** | <Definition 1> |
| **<Term 2>** | <Definition 2> |
| **Data** | [Definition is required] |
| **Scenario** | A combination of the following elements: service, terminal/user device, usage environment and delivery. |
| **Service** | 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) |
| **Terminal/user device** | Receiving/transmitting equipment for the above service (e.g. large flat screen, portable TV sets, PC, laptop, smartphone, game console, tablets, etc); |
| **Usage environment** | 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) |
| **Delivery** | The means to provide the service (e.g. technology used, network architecture, etc) |
| **AV linear** | *[input from DG is expected]* |
| **AV non-linear** | *[input from DG is expected]* |
| **Data** | *[input from DG is expected]* |
|  | [From Doc. 10, D]  [Ed. note: the definitions below will need to be addressed later]  [Ed. note: if the classification proposed in Doc. 13, DTAG is accepted then the terminology in Table 1 needs to be updated] |
| **Large screen terminal**  [Doc. 13, DTAG]  **[Stationary TV set]** | …  A TV set (big screen) which is designed for reception of TV content in an stationary environment, including complementary set top boxes. Usually needs a permanent stationary power supply. |
| **Small screen terminal**  [Doc. 13, DTAG]  **[Mobile TV set]** | …  A small stand-alone or built in (e.g. in cars) mobile device being capable to receive linear TV programs using terrestrial TV standards in a mobile environment. Usually can be operated with batteries. |
| **Tablet terminal**  [Doc. 13, DTAG]  **[Mobile terminal]** | …  A mobile device such as a tablet PC or a smartphone connected to mobile networks using one or more of the mobile broadband technologies such as like UMTS or LTE or their evolutions. Usually is not equipped with a DTT receiver and can be operated with batteries. |
|  | [From Doc. 20, F] |
| **Broadcast content – multicast content (BC-MC)** | A content aimed at a few to many users, and encompasses diverse kind of contents, e.g. audio-visual linear or any pushed and stored data (on-demand audio-visual media services, videos, etc.), news, software updates, etc. |
| **Cellular broadband content (cBB)** | Electronic communication content aimed at one single user. It encompasses for example diverse sort of contents, e.g. web browsing, streaming, apps data, phone and messaging, etc. The direction is either downlink (cBB DL) or uplink (cBB UL). |

[Editorial’s note: the following definitions related to linear and non-linear are provided in the Audiovisual Media Services Directive (2010/13/EU)

‘television broadcasting’ or ‘television broadcast’ (i.e. a linear audiovisual media service) means an audiovisual media service provided by a media service provider for simultaneous viewing of programmes on the basis of a programme schedule;

‘on-demand audiovisual media service’ (i.e. a non-linear audiovisual media service) means an audiovisual media service provided by a media service provider for the viewing of programmes at the moment chosen by the user and at his individual request on the basis of a catalogue of programmes selected by the media service provider;

From ITU-T

Term: linear television (linear TV)

Definition: A television service in which a continuous stream flows in real time from the service provider to the terminal device and where the user cannot control the temporal order in which contents are viewed.

]

# BaCKGround

## SCOPE

The UHF band is the core band for terrestrial television. However, the market penetration of different TV platforms is highly country dependent. 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 will need to be maintained for the foreseeable future.

[In addition, there is a trend for mobile consumption for audiovisual content which makes necessary to think how broadcasting and mobile services could complement each other in the delivery of audiovisual linear and non-linear content to mobile terminals.[Editor’s note: text agreeable in principle but may be moved to another location]

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. The terms of reference for TG6 are in ANNEX 1.

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 operate broadcasting services.

A vision of the future framework for the management of the UHF band, including the right level of harmonisation at the European level and taking into account cross-border coordination, would provide certainty to all stakeholders.

## 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 particular in the CEPT area. A key feature of GE-06 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, e.g., mobile or fixed, 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 Council, 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 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, the RSPP also calls for sufficient spectrum to be made available for the terrestrial delivery of audiovisual services.

In Article 8, the RSPP also calls for seek to find appropriate spectrum for PPDR.

Since the adoption of the RSPP 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 frequency arrangements etc for the 700 MHz band.

* **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.

Agenda item 1.1[[1]](#footnote-1) is aimed at identifying frequency bands for allocation to the mobile service and designation of further bands for use by IMT. Amongst the bands under consideration is 470-694 MHz. This agenda item is under study by CEPT Conference Preparatory Group (CPG) and by ITU Joint Task Group 4-5-6-7.

Agenda item 1.2[[2]](#footnote-2) 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. CPG and JTG 4-5-6-7 are also studying this agenda item.

* **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 to ensure protection of broadcasting services and PMSE below the lower band edge. It also requires CEPT to consider use of the band by PPDR and 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.

## CURRENT SITUATION

### 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 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, i.e. 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[[3]](#footnote-3) 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 significant costs for the public and these cost implications must be addressed if such migration is to be considered.

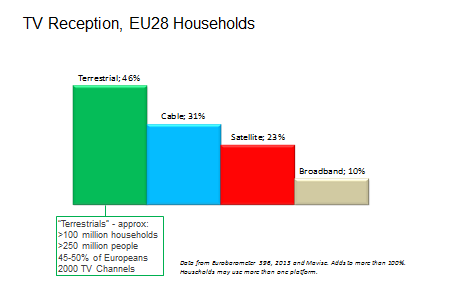


Figure 1: TV reception EU28 households

[Action point: to verify and include Figure concerning TV reception in CEPT countries]

The following table provides information on the DTT use in households for TV delivery, where:

* DTT Primary sets are those using DTT for TV delivery on their main set;
* DTT Secondary sets are those which are not the "main" set (kitchens, bedrooms etc) that use DTT for TV delivery, irrespective of the platform serving the primary set;
* Total DTT use: proportion of households that use DTT on at least one device somewhere in the house:

Table 1: DTT use in households for TV delivery

| **Country** | **DTT Primary Sets use** | **DTT Secondary Sets use** | **Total DTT Use** |
| --- | --- | --- | --- |
|
| United Kingdom | [40.5% | 35.5% | 75%] |
| [Others] |  |  |  |
| EU28 |  |  | 46% |
| Total CEPT |  |  |  |

[Note: Similar data for other countries is sought and should be added to the following table:]

Terrestrial TV services in Europe 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 whereby providing an essential outlet for the European creative content. On other platforms the major content providers and market players often come from outside Europe.

Free-to-air access and near universal availability of DTT are also the key enablers of connected TV services to be provided to all European citizens without discrimination. This is essential to avoid another digital divide - a digital TV divide.

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 enhanced diversity and choice and sustains platform innovation and ultimately competition.

As a result, the terrestrial broadcasting platform generates significant social and economic benefits[[4]](#footnote-4) which cannot be replicated on any other platform without very large investments and complex, expensive and disruptive migration of DTT households. It is therefore 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.

Digital terrestrial TV (DTT) networks are optimised for the simultaneous delivery of audiovisual content and supplementary data services, to very large audiences. They are designed to achieve a specific coverage with pre-defined and sustained quality of service and a particular reception mode (e.g. roof-top fixed, mobile, portable indoor, handheld).

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

* adjusting the transmission parameters according to a desired reception mode;
* adjusting coverage to the desired service area (nationwide but also regional or local coverage), based on the editorial, legal, political or commercial requirements;
* offering a range of services and quality levels (e.g. SDTV, HDTV, eventually also UHDTV);
* 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 GE-06 Agreement and the associated Plan. Transmission networks are implemented according to national specifications.

Terrestrial reception is cost efficient also for the public, largely because many European households are equipped with suitable receiving antennas.

### 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 and bridge the digital divide. In order to understand better how the terrestrial broadcast 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.

### 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 on measures to promote the democratic and social contribution of digital broadcasting[[5]](#footnote-5) and the Declaration on the allocation of the digital dividend and the public interest[[6]](#footnote-6).*

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[[7]](#footnote-7), and the regulatory framework for electronic communications networks and services, i.e. the Telecom Package Directives, in particular the Framework Directive[[8]](#footnote-8) and the Universal Service Directive[[9]](#footnote-9). 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.

Further details can be found in ANNEX 2.

Some of the scenarios listed in Chapter 5 may be incompatible with the existing legal framework in some countries. For example the Portuguese Constitution establishes that the State shall ensure a free-to-air television (linear content) public service. In these circumstances, to fulfill this Constitution rule, it shall be available a nationwide platform with free access for the population. Therefore, the potential compatibility of any scenario with this legal requirement would have to be considered 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 license period. 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.

### 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 (eg. Personal Video Recorder)
* Non-linear viewing (all AV content, including YouTube, Netflix, iPlayer 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. 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. In 2012 in Europe about 2% of the total TV viewing was true on-demand, although there are large differences across EU national markets. However, the growth of the demand for nonlinear services generally does not have an eroding effect on linear TV viewing. On the contrary, the linear viewing serves as the main entry point for the majority of users who access time shifted and on-demand services, thus reinforcing each other.

[

Data from Thinkbox in the UK shows that broadcast TV is consumed as follows. Data from other countries/broadcasters is also sought.

Table 2: ways of viewing audiovisual content

| **Country/Source** | **Source&Period** | **Linear (including live and time-shifted)** | **Non-linear** |
| --- | --- | --- | --- |
|
| UK | Thinkbox, 2012 | 98.8% | 1.2% |
| [Others] |  |  |  |

]

[Further details may be provided in section 4, in particular addressing the evolution (see documents 24 from EBU and 37 from BNE).]

### Current situation for PMSE in the band

Since decades the UHF TV band (470 to 862 MHz) is used for terrestrial TV. PMSE uses the same frequency range operating in the interleaved spectrum between the TV transmitters. This is an example of a successful implementation of highly efficient spectrum sharing.

In the beginning (more than 60 years ago) PMSE was used by public broadcast productions only. Later other productions started to use these RF-tools as well and today almost any kind of event is produced successfully with PMSE equipment. Moreover these events are based on the functionality and options provided by PMSE services. One must understand that PMSE is widely spread in the society and that a vast majority of events are broadcasted (live) and deliver a high socio economic benefit to the society:

* Direct sales of equipment;
* Direct ticket sales of concerts, sport events and other venues;
* Direct revenues of rental companies on the equipment;
* The advertising coming from all the events;
* The secondary revenue streams of these events (like tourism, hotels, taxis, restaurant and catering industry);
* Indirect revenues from SMS services linked to events (European Song Contest, ”The voice of…”);
* Indirect revenues of IMT providers from the traffic during such events;
* Indirect revenues (sometimes lasting even more than 10 years after the event) of recorded material of the events (DVD, Blue Ray, You Tube, Film Industry, etcetera).

The symbiosis between broadcast and PMSE has been and still is very successful. It also provides the required spectrum quality for interference free operation of the PMSE units. Consumers will and can NOT accept that the quality of the broadcast productions will fall back to the level of 30 years ago. Daily productions require the operation of 60-90 channels in parallel (using 96MHz of interleaved spectrum for both radio microphones, audio links and in ear monitors) and multiple productions are sometimes in close proximity (e.g. London West End, Hamburg Reeperbahn, Paris city centre, …). Large productions, like political summits and elections, sports events etc. often require the entire UHF TV band of more than 270 MHz of interleaved spectrum in order to fulfil the consumer demands in quality coverage. Regarding the political events the newsgathering and reporting of the diversity of opinions would be at risk.

[Editorial’s note: taken from parts of document 42. To be reviewed]

### Other uses of the band

According to the Radio Regulations, the allocation to the broadcasting service in the frequency range 470-790 MHz in ITU Region 1 is accompanied by several footnotes, whereas some of them 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 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 radio astronomy service from harmful interference, when making assignments to stations of other services to which the band 608-614 MHz is allocated.

Further RR 5.312 allocates in addition 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, to the aeronautical radionavigation service on a primary basis.

### Example for Existing Usage of the band 470 - 790 MHz for the Broadcasting Service and PMSE in Austria

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 in addition to the existing there were issued 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. till 2023. Existing DVB-T licences expire in 2016 and will be re-issued as DVB-T2 licences for further 10 years.

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 mainly with up to 13 neighbouring/affected countries: CZE, D, HNG, I, LIE, SUI, SVK, SVN / BIH, F, HRV, POL, SRB. 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 requires the synchronisation of timescales with these countries.

Concerning PMSE in Austria about 18,000 Licences (Light Licensing) for wireless microphones are issued, using actual the whole 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 situation in these “Hot Spots” will further increase, if the available UHF spectrum for PMSE is 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 in the long run.

### Other subsections to be identified

## ECONOMIC VALUE OF SPECTRUM

[A study conducted in the UK for the DTT broadcasters shows that the incremental value of spectrum is greater for DTT than for mobile data use. It concluded that the value per MHz of spectrum for DTT use is GBP 0.47bn, compared with less than GBP 0.19bn for mobile data. In particular, it noted that mobile data growth is being driven primarily by increases in video consumption, which (per unit of capacity) is less valuable to the consumer than other mobile data applications such as email.]

[Editorial’s note: text to be reviewed. Scope of the study to be clarified. If appropriate, information from alternative studies to be provided]

# TECHNOLOGY, SERVICE AND NETWORK EVOLUTION

This section of the Report addresses the trends in the evolution of technologies, services and networks delivering or with the potential to deliver broadcast, mobile and converged services to consumers in the UHF band (470-694 MHz). It includes consideration of the way in which consumer habits in consuming audio visual content are changing.

## Broadcasting [video resolution, coding, modulation/systems, receiving modes, coverage requirements]

The Digital Terrestrial Television (DTT) service platforms in Europe are the major source of audio-visual content consumption for 250 million European Citizens. The DTT platforms are fundamental to social and political cohesion within Europe and underpin investment in European originated content. BNE notes that the aspects being put forward in this document should be considered when developing the long-term strategy for the UHF spectrum on which the DTT platforms depend. Without long-term certainty of access to this spectrum there is considerable risk that there will be reluctance to commit to further investments and hence the effectiveness of the DTT service to innovate and compete will be reduced.

The DTT platform has evolved dramatically over the last ten years to become fully digital offering a wide range of high quality content, both in Standard Definition and High Definition resolution, to a large number of European users. Some key facts are summarised as follows:

* The DTT service is characterised by;
  + High availability and reliability of service
  + The capability to deliver local and regional content
  + National coverage beyond just high population density areas
  + Service quality independent of number of simultaneous users
  + Ease of reception via existing roof mounted aerials
  + Free-to-Air channels are unencrypted and hence free at the point of consumption
* Linear content consumption continues to dominate with on demand consumption being complementary and extending the viewing window;
* DTT already delivers vastly more data to European citizens than even envisaged in the high mobile data growth forecasts; and
* High value complementary systems coexist with DTT services, e.g. PMSE.

In addition to the traditional audio-visual content, delivered over the current analogue and digital terrestrial television Broadcasting networks, new consumer demands and behaviors are suggesting a need for more program channels with different and dedicated content, also offering regional and local content, as well as on-demand content available and accessible anytime-anywhere.

### Future developments of DTT technology

The European transmission standard DVB-T2[[10]](#footnote-10) is the state-of-the-art broadcast specification. It uses the OFDM modulation scheme and a number of advanced modulation and coding techniques allowing very efficient usage of spectrum (up to 6 bits/s/Hz).

DVB-T2 networks are currently implemented using the H.264/AVC. Introducing H.265/HEVC would further increase the channel capacity of DVB-T2 multiplexes. Investigations carried out by EBU have shown that the improvement in coding technology (going from MPEG2 to H.264/AVC) and in modulation technology (going from DVB-T to DVB-T2) would allow all services to be upgraded from SDTV to HDTV, but would not offer capacity for additional services (see estimation of gains provided by enhanced technologies in EBU Technical Report 15[[11]](#footnote-11)).

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

DVB-T2 networks can be configured for delivery to mobile and handheld devices[[12]](#footnote-12). This capability could be used to offload a significant amount of traffic from mobile broadband networks, whilst reducing costs and improving the quality of service.

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.

The HbbTV standard[[13]](#footnote-13) enables the provision of hybrid TV services over the existing broadcast and broadband infrastructure. This is another recent example of a successful pan-European TV initiative and is now gaining a global momentum.

Standardisation of the Ultra HDTV (UHDTV) format has been largely completed which takes the quality of audiovisual media services to a whole new level, 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.

New technologies need to be introduced in parallel with the existing ones to give consumers the chance to invest in new equipment 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. This provides a vehicle for the introduction 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 such as 3DTV and UHDTV. Without such incentives, there would be no reason for the public to upgrade to more advanced receiver technologies. This is generally true for any technology migration.

DTT technology and services are expected to further develop in the future, thus creating recurrent needs for upgrades and simulcast of new and existing services. New technical specifications are already being developed, e.g. within the DVB Project.

### LTE-Broadcasting (current forecasts, growth in data demand)

LTE Broadcast is a service to deliver broadcast and multicast content over LTE cellular networks. The service is delivered over a technology standardised by 3GPP as eMBMS.

## LTE Broadcast is an all IP Network

IP Networks have been adopted as a convergence platform for fixed network. Many proprietary solutions are being replaced by IP Networks. IP networks can leverage very large ecosystem and benefits seamlessly from internet related developments.

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

* LTE and LTE Broadcast can integrate seamlessly future evolutions delivery mechanisms
* LTE and LTE Broadcast benefit from economies of scale and large support, both on device and network sides.

LTE-Broadcasting, with its expected flexible unicasting and broadcasting capabilities, could be responding to [several of these requirements] by offering a viable technical distribution platform to provide the complementary audio-visual services and applications in the future media landscape.

In delivering audio-visual content to the general public of consumers, the efficient use of the radio frequency spectrum is an essential aspect and is of great concern to national regulators. The observations are that audio-visual content delivered over the current LTE networks is increasingly significant to the consumers, with measured demands for these services and application reaching a level of the order of 60 %, or more of the total downlink traffic.

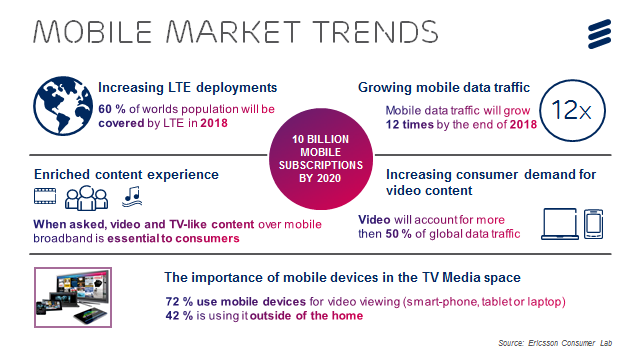


Figure 2: Relevant trends on the mobile market in relation to media and audio-visual content

## Other services/applications (e.g. PMSE, PPDR, etc.)

### ****Shared Spectrum Use – DTT enables PMSE []****

Joint or shared use of frequencies is already a well-established and successful practice between DTT and wireless production equipment such as wireless microphones (PMSE). Several studies have also been carried out within the framework of the ITU that show coexistence of mobile broadband (LTE) and DTT on shared frequencies is impossible. Some possibilities for coexistence between DTT are under development and may enable a potentially high value complementary use of the spectrum alongside the existing uses. [add ref to ECC Report 204]

### ****Broad Band Public Protection and Disaster Relief (PPDR)****

PPDR is identified as one of the priority areas of EU spectrum policy, and the need for additional spectrum for the provision of broadband PPDR services is also widely recognized in CEPT.

The growing demand for broad band PPDR services which could be satisfied within the new mobile allocation in the 700 MHz range right after WRC-15 and further envisaged beyond 2020 can be found in ECC Report 199.

Here at least 2 x 10 MHz is calculated as a minimum spectrum amount for wide area networks which would fulfill the mobile broad band needs of European PPDR organisations. Additional spectrum may be needed for catering for voice communications and other special PPDR applications, such as Air-Ground-Air (AGA) and Direct Mode (DMO). However, the Report also recognizes the fact that national needs for broadband PPDR may vary.(ECC Report 199 includes an Excel™ based calculator designed for translating PPDR Scenarios/Incidents into the corresponding spectrum amount needed, based on the assumption of the LTE technology) The follow-up ECC Report (“B”) which is currently under development in CEPT suggests a roadmap containing the timeframes and the associated steps towards evolution from current narrow- and wide-band Mission Critical services provided by TETRA and Tetrapol networks towards the broadband LTE future of PPDR communications.

In both reports mentioned above, a special attention is paid to the requirement of interoperability and economies of scale which could only be achieved by aligning the European frequency arrangements for broadband PPDR with those in the rest of the world. Sparked by the EU Commission’s Mandate to CEPT on the development of the least restrictive technical conditions for ensuring co-existence of mobile broadband services in the band 694 – 790 MHz with the broadcasting service, the CEPT identified this spectrum range 694 – 790 MHz as the most widely supported candidate range within which European regulators would be able to find the required spectrum for their national broad band PPDR needs.

The response to the Commission Mandate is currently being elaborated within CEPT including a possible accommodation of mobile broad band services for PPDR. At the time of writing the new frequency band plan for the mobile service in the 700 MHz has not been finalized. As one of the options under discussion, a PPDR frequency arrangement starting no lower than 698 MHz is considered so as to ensure that PPDR terminals do not interfere with TV reception in broadcast channel 48 (686 – 694 MHz). In the future addressed here, with the evolutionary outlook to a gradual decrease of the consumption of broadcasting services ‘over the air’ in Europe, further extension of the mobile allocation down towards the current broadcasting spectrum could be envisaged, and under this scenario countries may consider additional designation of spectrum for PPDR applications, subject to national needs.]

Add new section on White Space Devices

## DYNAMIC BROADCASTING AND Network cooperation concepts

### LTE-Broadcasting and DTV in a complementary media landscape

The use of LTE-Broadcasting in the range 470 – 694 MHz could be rolled out 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 network design could use LTE-Broadcasting in a macro cellular structure on adjacent channels to the DTV channels “under” the current DTV “overlay” network. The LTE-Broadcasting operations should be ensured under licensed conditions and be planned in relation to an existing DTV plan while using downlink-only as to avoid transmitting devices in e.g. home environments close to television receivers; notably, the downlink-only scheme might need to be accompanied by complementary means of mitigations techniques. The LTE-Broadcasting network could be providing a “true” broadcasting service and/or unicasting as well as be providing traditional mobile broadband services, any need for uplink interaction, would be handled via any other band, typically used by current and future mobile broadband networks. The “underlay” and “overlay” structures are depicted in Figure 3.

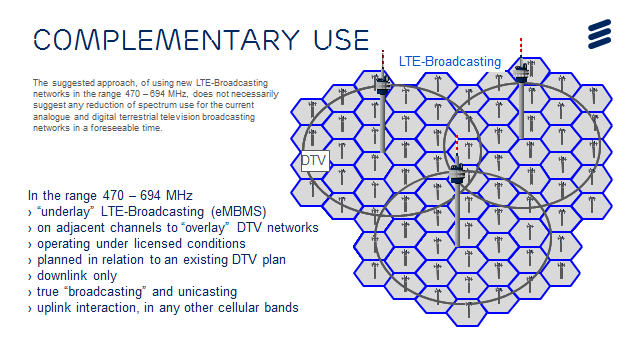


Figure 3: LTE-Broadcasting a macro cellular structure on adjacent channels to the DTV channels “under” the current DTV “overlay” network

### Generic transport layer + application layer implementation

A typical encoding/decoding LTE-Broadcast chain is illustrated in Figure 4.

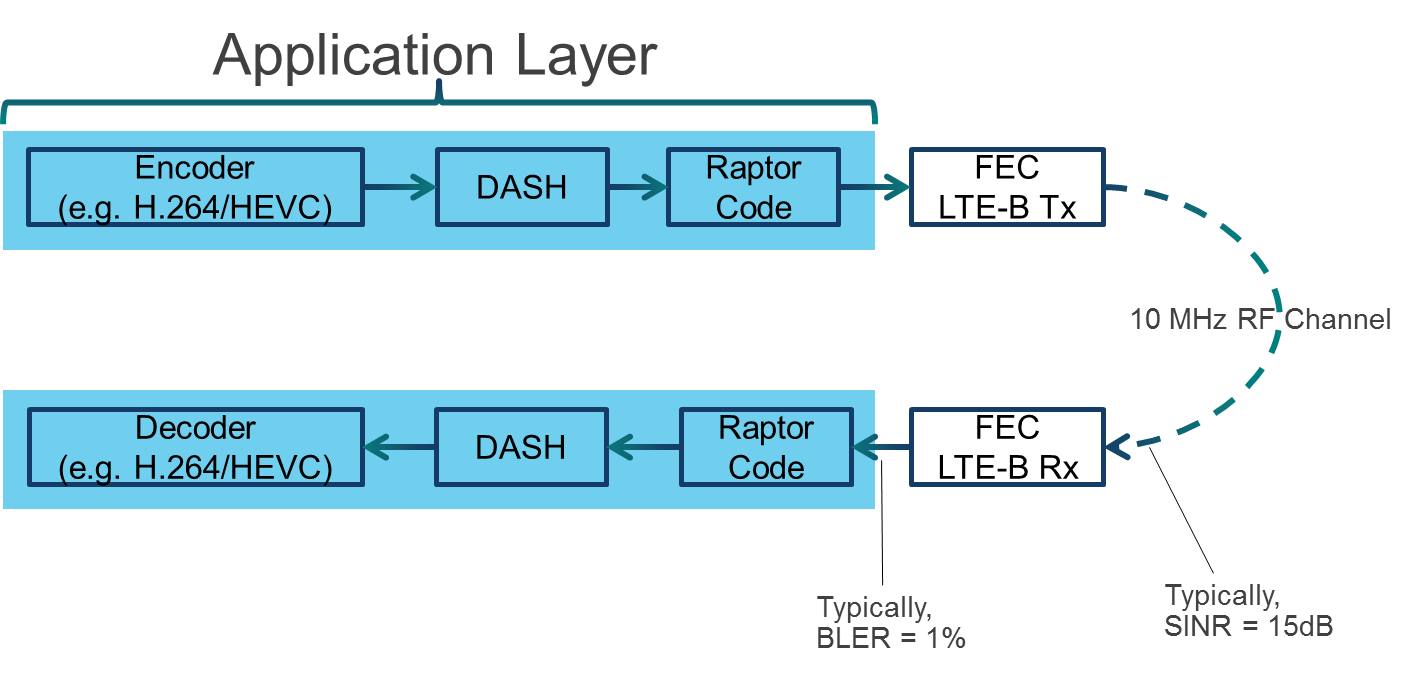


Figure 4: Typical LTE-Broadcast encoding/decoding chain

While the LTE FEC is integrated in LTE Broadcast itself, outter block coding (i.e. Raptor code), encapsulation (DASH) and source encoding/decoding (e.g. HEVC) are performed at application layer.

This provides a number of benefits, the most important being the ability of the delivery network to integrate seamlessly the latest standards of video-delivery.

### LTE as an Integrated Unicast/Broadcast Platform

LTE supports both unicast delivery and multicast/broadcast delivery (through LTE Broadcast). 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, hybrid delivery scenario can be deployed by leveraging the functionality of Dynamic Adaptive Streaming over HTTP (DASH) on top of LTE Broadcast.

**Figure 2: Hybrid delivery scenario**

Hybrid delivery scenarios (LTE based) support the following features:

* Delivery of certain components/media streams/representations/segments over broadcast and other components over unicast with synchronization at the client
* Use of unicast to improve user experience, for example for reducing channel-change times unicast may be used to enable an immediate switch until sufficient broadcast data is available to seamlessly switch back to the broadcast delivered representation
* Seamless transition of a broadcast-delivery into a time-shift mode, such that the same content is available for later consumption in the cloud
* supplementary coverage of the LTE broadcast networks
* Dynamic unicast/broadcast

## Future usage patterns (formats, contents, etc..)

### 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. A summary of all responses was presented as part of TG6(13)Info 02. Fuller details of individual responses are available in the table in [Appendix 1 of TG6(13)Info 02], and all the original responses are available on the WP6A Sharepoint site[[14]](#footnote-14) (TIES login required).

[more text on conclusions from ITU Questionnaire]

### Changes to Consumer Behaviour - Linear TV vs. non-linear viewing

Convergence between technologies and services is not a new subject and it can be concluded that an established technology or an established mode of use is not always replaced by newer ones.

The ability to order video services (VOD – Video-On-Demand or sometimes called Play Services) over broadband and IP networks has gradually been established over the last 10-15 years and the consumption of VOD services has increased relatively slowly. But any "transition" from linear services of established broadcast networks to VOD over broadband does not seem to be underway. Still today VOD services represent only a few percent of the total viewing time. It is simple and convenient to speak of a "transition", but the evidence from consumption patterns does not support this perspective. As has been recently confirmed by a study from Médiamétrie, linear Broadcast Television is still the killer application in the distribution of audiovisual [television] content, especially in Europe. In 2012 the average European consumed 3 hours and 55 minutes per day of scheduled linear television content, 7 minutes more than in 2011[[15]](#footnote-15)

Whilst, VOD and Play services from the major TV channels have become popular these account for only a few percent of the total viewing share. VOD and Play services are used mostly to watch programs shown on linear TV usually only one or a few days earlier. Demand for play services is thus driven in large part by what has previously been shown on linear TV.

It is also worth noting that linear TV is driving much of the content of newspapers and magazines. You write about what's going on and what's been on TV and it is often a daily topic of conversation. Linear TV fulfils an essential function by creating a common framework for conversation and interaction between people. This is not the case with VOD.

[]

Figure 5illustrates the points made above showing recent projections from Screen Digest on the proportion of linear and non-linear TV consumption for the EU ‘Big 5’ countries [for large screen viewing].

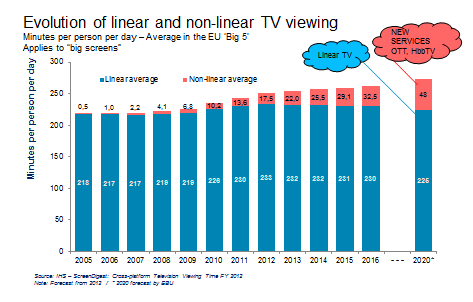


Figure 5 Screen Digest forecast of linear and on-demand TV viewing for the EU ‘Big 5’ countries

To date the spectrum discussion has been primarily focussed on the needs of the wireless broadband and IMT sector with little account taken of the consequences to existing licensed and commercially attractive services in the Broadcast UHF band 470 – 790 MHz. Whilst we recognise that there is significant growth in wireless broadband data traffic we believe that it is important to note that this growth in traffic is already being served by a combination of technology solutions, i.e. Fixed, Wi-Fi , terrestrial IMT and Satellite broadband networks, which will be further augmented by the new 800 MHz and 2.6 GHz wireless networks being rolled out.

DTT networks already exist and provide an efficient means of delivering very large volumes of data traffic, see Figure 6 which depicts the amount of data consumed via one multiplex across Europe predominantly Audiovisual Content. For this purpose the DTT platforms are cost efficient, spectrum efficient and extremely reliable. Hence, DTT has become an essential part of the Audiovisual Ecosystem representing a key pillar of European content creation, enabling freedom of choice, cultural diversity and political cohesion.

Finally, Digital Terrestrial Television has proven to be what consumers want: an easy and immediate means of accessing a multitude of TV and radio channels, complemented by a rapidly developing range of hybrid interactive services. Therefore any future long term strategy for the UHF band should recognise the value brought by DTT to European citizens and the consequences of a shift to a long term strategy centred on access to ultrafast broadband without DTT would most likely end up with counterproductive effects, i.e. higher costs for consumers, reduced access to European audio-visual content, lower quality and diversity of free to air TV on offer and reduced competition.

[We envisage a bright future for DTT in Europe with continued investment and innovation to support the migration to HDTV and to accommodate 3D and UHDTV in the future using the next generation of technology DVB-T2/HEVC. However, this will only be possible if the platform is afforded the appropriate certainty over long term access to spectrum. Furthermore, we believe that the Market and Consumers should be allowed to choose their preferred platforms for broadband services and media distribution.]



Figure 6 Data traffic comparison: DTT networks vs. Cisco Mobile Traffic Forecast

### Linear vs. non-linear viewing

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[[16]](#footnote-16). 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. In 2012 in Europe about 2% of the total TV viewing was true on-demand, although there are large differences across EU national markets. However, the growth of the demand for nonlinear services generally does not have an eroding effect on linear TV viewing. On the contrary, the linear viewing serves as the main entry point for the majority of users who access time shifted and on-demand services, thus reinforcing each other.

Figure 7 shows the evolution of linear and nonlinear viewing on the large TV screen in major European markets.

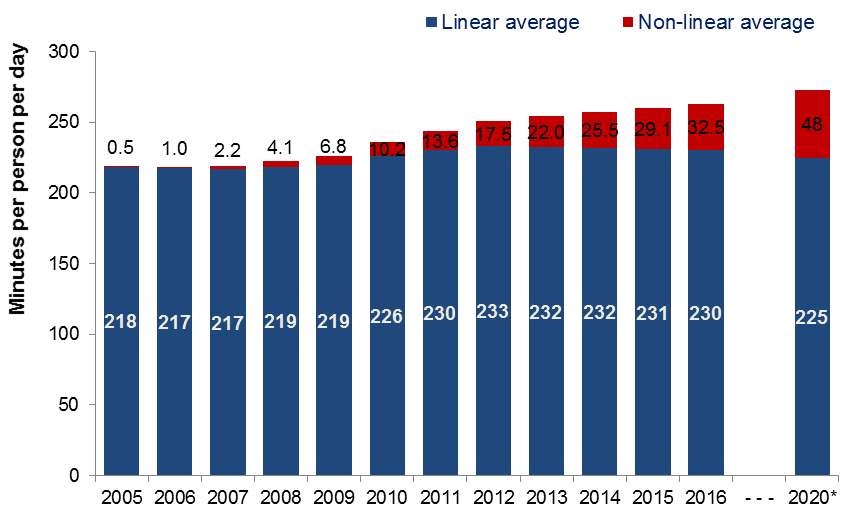


Figure 7: Evolution of TV viewing in Germany, France, Italy, Spain and the UK  
Source: IHS - Screen Digest: Cross-platform Television Viewing Time FY 2012  
\* Forecast for 2020 by EBU

Furthermore, the viewers are active on social networks while watching the programme which further strengthens the linear viewing habits.

## The services/applications involved

### Increased content choice

While linear viewing remains relatively stable the choice of TV programmes has considerably increased in the recent years. According to the European Audiovisual Observatory[[17]](#footnote-17) there are currently more than 10000 TV channels and more than 3000 on-demand audiovisual services in Europe. More than 2000 TV channels are provided on DTT networks including national, regional and local services.

Figure 8 reflects the growth of DTT content offer which largely coincides with the digital switch-over.

Figure 8: Channels on DTT networks across the EU area  
Based on data from the MAVISE TV database

Approximately 50% of TV channels are national channels, the others are regional or local. In a number of countries, though not all, there is a latent market demand for additional channels but further growth is constrained by the limited capacity of the DTT platform.

### Evolution in picture quality

Consumers are increasingly investing in TV sets with larger and larger screens, resulting in higher requirements on picture quality. Most of the TV services are currently provided in standard definition (SDTV) format. However, an increasing number of channels are already available in high definition quality (HDTV) which is becoming the standard for television delivery.

Furthermore, it is expected that typical TV screen sizes will continue to increase and the capabilities of consumer devices will further evolve, leading to the demand for even higher picture quality, such as Ultra HDTV (or UHDTV) and 3DTV. All relevant TV distribution platforms, including DTT, will then need to be able to support these emerging technologies.

### Reception on mobile and portable devices

The majority of TV viewing occurs in the home and the large TV screen remains the most widely used device. In addition, user devices such as smartphones and tablets are increasingly popular for access to media services both in the home and on the move. The majority of media usage both linear and non-linear takes place in the home environment and this is not likely to change with the growing adoption of innovative media services nor with the increasing use of personal receiving devices.

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 broadcast services can be delivered affordably and in a sufficiently high quality.

### 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.

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 a broadcast 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 catch-up TV, video on demand (VoD), interactive and personalised services, voting, games and social networking in addition to the commonly available enhanced digital text and Electronic Programme Guide (EPG).

Further information on the evolution of broadcast services can be found in the EBU Technical Report 13[[18]](#footnote-18).

### Summary on evolution of broadcast services

The following important developments are expected to continue:

* Linear viewing will remain the main way of viewing TV content. Time-shifted and on-demand viewing will continue to grow;
* Migration of services from SDTV to HDTV, and the introduction of additional HDTV services; The content offering will continue to increase.
* Introduction of Ultra-HDTV and possibly also 3DTV in the medium to longer term;
* Growing importance of viewing on portable and mobile devices, whilst most of the TV viewing will remain on the large screen.
* Majority of the TV viewing, both linear and non-linear, occurs in the home. This will not significantly change with the increased usage of portable and mobile devices, nor with the growing adoption of innovative media services.
* Hybrid broadcast-broadband services will become commonplace, possibly including wireless broadband, to allow increase of non-linear as well as linear content.

In many European countries, HDTV programmes are already offered on the DTT platform, and this is expected to become the norm in the short to medium term. In order to allow the above described services to be delivered to the viewers efficiently the DTT networks need to continue to evolve and have access to a sufficient amount spectrum.

# 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 platforms under consideration and on the demand and supply of the envisaged services.

Thus, it is felt appropriate to develop relevant indicators in order to monitor the assumptions made on expected developments.

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.

[Note: the table of indicators is very preliminary and should be further discussed]

Table 3: Summary of indicatorsTitle (style: Caption)

| **Indicator** | **Measurement** | **Rationale** |
| --- | --- | --- |
|
| Role of DTT in delivery of Linear audiovisual content | Comparative penetration of DTT, Cable, Satellite and IP-TV per households by country, across EU28 and wider CEPT. May need to distinguish between primary and secondary sets. If possible, provide repartition by age and demographic category | The extent of use of DTT is a key driver to the costs of migrating to an alternative delivery platform. |
| Extent of linear audio-visual consumption | Amount of linear audio visual usage, by country, across EU 28 and wider CEPT. If possible, provide repartition by age and demographic category |  |
| Extent of non-linear audio-visual consumption | Amount of nonlinear audio visual usage, by country, across EU 28 and wider CEPT. If possible, provide repartition by age and demographic category |  |
| Lifecycle of TV sets | Lifecycle and rate of renewal of TV sets, by country, across EU28 and wider CEPT. |  |
| Lifecycle of mobile equipment | Lifecycle and rate of renewal of handsets and tablets, across EU28 and wider CEPT. |  |
| etc |  |  |

# Long term vision issues

*[Ed note: To put a text that covers the descriptions of the scenarios as well as their assessment]*

## GENERAL DESCRIPTION OF SCENARIOS

CEPT considers the scenarios listed in Table 1 for the development in the band 470-694 MHz in a long term. These scenarios may occur either as standalone 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 4: Long term scenarios for delivery in the band 470-694 MHz

| **No** | **Service** | **Terminal/ user device** | **Usage environment** | **Delivery** | | **Source** | **§** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Technology** | **Network** |
|  | Standalone scenarios | | | | | | |
| 1 | AV linear,  AV non-linear | Large screen, small screen/tablet | Stationary, portable outdoor/indoor | DTT1 | HPHT | Doc. 25 (EBU) | [6.2](#_SCENARIO_1_[from) |
| 2 | AV linear, AV non-linear | Large screen, small screen/tablet | Stationary, portable outdoor/indoor | DTT1 | LPLT | Doc. 25 (EBU) | [6.3](#_SCENARIO_2_[from) |
| 3 | AV linear, AV non-linear | Large screen, small screen/tablet | Stationary, portable outdoor/indoor | DTT1 (outdoor),  WiFi (indoor)2 | HPHT/ LPLT | Doc. 25 (EBU) | [6.4](#_SCENARIO_3_[from) |
| 4 | AV linear, AV non-linear | Large screen, small screen/tablet | Stationary, portable outdoor/indoor | DTT1 (outdoor),  WiFi (indoor) 2, DTT1 chips inside UE | HPHT/ LPLT | Doc. 25 (EBU) | [6.5](#_SCENARIO_4_[from) |
| 5 | AV linear, AV non-linear | Large screen, small screen/tablet | Stationary, portable outdoor/indoor | LTE Broadcast | HPHT | Doc. 25 (EBU) | [6.6](#_SCENARIO_5_[from) |
| 6 | AV linear, AV non-linear | Large screen, small screen/tablet | Stationary, portable outdoor/indoor, mobile | LTE Broadcast | LPLT | Doc. 25 (EBU), Doc. 38 (Qualcomm) | [6.7](#_SCENARIO_6_[from) |
| 7 | AV linear, AV non-linear,Data | Large screen, small screen/tablet | Stationary, portable outdoor/indoor, mobile | LTE Broadcast | LPLT | Doc. 38 (Qualcomm) | [6.8](#_SCENARIO_7_[from) |
| 8 | AV linear, AV non-linear,  Data | Large screen, small screen/tablet | Stationary, portable outdoor/indoor, mobile | DTT1, LTE4 | HPHT/ LPLT | Doc. 35 (NSN, Nokia) | [6.9](#_SCENARIO_8_[from) |
| 9 | AV linear, AV non-linear,  Data | Large screen, small screen/tablet | Stationary, portable outdoor/indoor, mobile | LTE4,  LTE Broadcast | HPHT/ LPLT | Docs. 7, 40 (Ericsson) | [6.10](#_SCENARIO_9_[from) |
| 10 | AV linear, AV non-linear,  Data | Small screen/tablet | Stationary, portable outdoor/indoor, mobile | LTE5 | LPLT | Doc. (14)04 (GSMA) | [6.11](#_SCENARIO_2_[from_1) |
| 11 | Smart data quantities | Smart communication unit | Stationary, portable outdoor/indoor, mobile | Dynamic cognitive communication | HPHT/ LPLT | Doc. 34 (S) | [6.12](#_SCENARIO_11_[from_1) |
|  | Scenarios to occur in combination with Scenarios 1-11 | | | | | | |
| 12 | PMSE AV content production | PMSE equipment | Portable, mobile | Digital/ Analogue | Low power links | Doc. 47 (SUI) Doc. (14)16 (APWPT) | [6.13](#_SCENARIO_10_[from) |
| 13 | Public safety | Voice and data, remote video camera | Handheld portable, vehicle mounted, stationary | LTE6 | LPLT | Doc. 19 (VF) | [6.14](#_SCENARIO_13_[from) |

1 DTT refers to the DVB family of terrestrial broadcasting standards.

2 Using the frequencies outside the band 470-694 MHz.

3 May require the uplink in the band 470-694 MHz.

4 The uplink will be implemented outside the band 470-694 MHz.

5 Frequency arrangements will include the uplink in the band 470-694 MHz.

6 [This spectrum might be within the 470-694MHz band, overlapping the 694MHz boundary, or above 694MHz].[Ed. note: VF will provide a revised text]

[Ed. note: the definition of “portable” and “mobile” will need to be clarified]

[Ed.note: Further thoughts on the terms used to describe “Terminal/User device” are required]

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 that 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.

## SCENARIO 1 [from Doc. 25, EBU]

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.

### Description

**Services**

* Linear and non-linear TV services, as they evolve over time;
* 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;
* 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.

**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 configuration.

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

### Assessment

This scenario foresees a natural development and evolution of DTT in a stable regulatory environment and in response to the market demand of a 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.

#### Technical/feasibility studies

In this scenario quality of service 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[[19]](#footnote-19) with a goal to develop future ecosystem models for terrestrial broadcasting taking into account business, regulatory and technical environments.

In Europe most countries switched off 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 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.

#### Cross-border 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.]

#### 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 above).

User expectations would be met in terms of

* universal availability of TV services;
* ever increasing quality of services, e.g. SD to HD, 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.

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.

[Furthermore, the existing business models, in particular the free-to-air model supporting co-existence of public and commercial services, would continue to evolve.][Ed. note: clarification is required regarding the business models used for DTT delivery]

#### 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.

#### Migration issues

For this scenario, as it is based on natural evolution of the platform, there are no real migration issues. 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.

## SCENARIO 2 [from Doc. 25, EBU]

In this scenario DTT remains the primary technology for the delivery of broadcast services in the band 470-694 MHz (Scenario 1) + 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.

### Description

**Services**

* Linear and non-linear TV services, as they evolve over time;
* 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;
* 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 the on large flat screens;
* Other devices, including portable and mobile terminals capable of receiving via terrestrial broadcast networks.

**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.

### Assessment

[Ed. note: The text in yellow has been agreed between EBU and F] 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 constrains 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 the site sharing with cellular networks or transmitting the required DTT power in some cases.

#### 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 would be one possible ways of densifying 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.

#### Cross-border coordination and coexistence

As in the Scenario 1, cross-border 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 an 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.

#### 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 above).

User expectations would be met in terms of:

* universal availability of TV services;
* ever increasing quality of services, e.g. SD to HD, 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.] [Ed. note: The impact of this scenario on the spectrum available for other users (PMSE and other white space users) will need to be further assessed]

*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.][Ed. note: clarification is required regarding the business models used for DTT delivery]

Investments would be required to densify the DTT networks, which would also impact 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.

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.

#### 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 regulation may be required to enable introduction of LPLT DTT networks by means of access to cellular sites and site sharing.

#### 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.

## SCENARIO 3 [from Doc. 25, EBU]

In this scenario DTT remains the primary technology for the delivery of broadcast services in the band 470-694 MHz (Scenario1) + DTT networks are designed for fixed reception and coupled with other means (e.g. using WiFi) for indoor [coverage] and reception in public places and 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]. [Ed. note: Some elaborated text will need to be provided in order to clarify the original intention for the last part of the sentence]

### 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;][Ed. note: further clarification is required on provision of non-linear TV services in the band 470-694 MHz]
* 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;
* 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 the on large flat screens;
* Other devices, including portable and mobile terminals capable of receiving via terrestrial broadcast networks;
* 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 the delivery for transportation systems and public places by a complementary technology is illustrated in the figure below [Ed. note: the figures needs to include the indoor situation, the case of plane needs to be removed]:

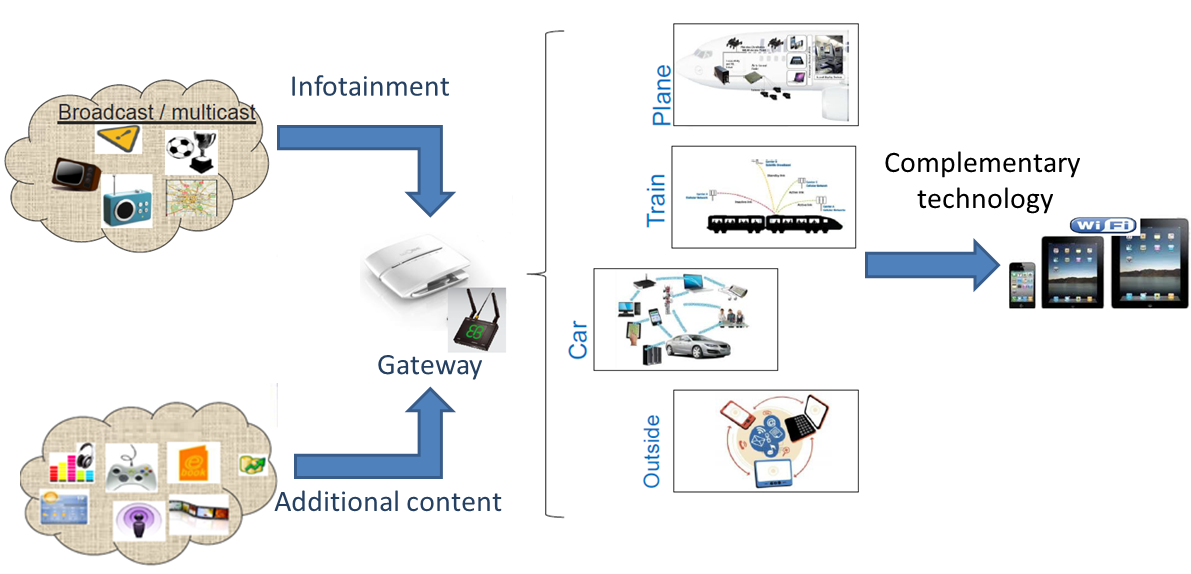


Figure 9: Title

[It is well understood that the complementary technology supporting the Additional Content is not the main topic to be addressed by TG6 but it is worth mentioning it as it could play the same major role as the broadband network connection in the home hybrid solution. Obviously it will be supported by a cellular link paired with the broadcast link. This cellular link, most probably an LTE one, could be located in any suitable frequency bands.][Ed. note: consider the removal of the above paragraph].

### 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 and fixed reception. Even in those countries which target portable and mobile DTT reception the networks would ensure fixed reception, too.

An increasing number of households is already equipped with a WiFi access points 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, thus optimising the spectrum use. Furthermore, in-home distribution of services would have no impact on the use of the UHF spectrum.

Furthermore, some services currently delivered over broadband connections could be offloaded onto DTT networks.

#### 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. Quality of service and integrity of DTT services after the conversion to WiFi would need to be ensured.

#### Cross-border 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.]

#### 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 above).

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);
* ever increasing quality of service 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.][Ed. note: The impact of this scenario on the spectrum available for other users (PMSE and other white space users) will need to be further assessed]

*Economic – Costs & Benefits*

[The 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 terms of cooperation between DTT and broadband service providers.][Ed. note: clarification is required regarding the business models used for DTT delivery]

Investments would be required to ensure a wide adoption of the required devices and services.

By focusing on outdoor coverage the DTT networks could be operated more cost efficiently.

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.

#### 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.

#### Migration issues

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

## SCENARIO 4 [from Doc. 25, EBU]

In this scenario DTT remains the primary technology for the delivery of broadcast services in the band 470-694 MHz (Scenario 1) + 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.

### Description

**Services**

* Linear and non-linear TV services, as they evolve over time;
* 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;
* The interleaved spectrum (white spaces) would continue to be used for secondary services such as PMSE and, potentially, white space devices, possibly under LSA regime.

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, with a focus on the on large flat screens;
* 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.

**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

### Assessment

[Ed. note: The text in § 5.5.2 was not considered by the meeting]

[Ed. note: The text in yellow has been agreed between EBU and F] This scenario is a possible compliment 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, i.e. without prior authentication on a broadband network.

TV services that are available on the DTT platform would not need to be delivered over mobile broadband networks. In addition, other services currently delivered over broadband connections could be offloaded onto DTT networks (e.g. software updates, push services). Consequently, the overall mobile traffic load and the required amount of spectrum would be reduced.

Quality of service for large audiences and integrity of TV services would be ensured.

#### 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.

#### Cross-border 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.]

#### 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 above).

User expectations would be met in terms of

* universal availability of TV services, including on personal devices such as tablets and smartphones;
* ever increasing quality of service 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.][Ed. note: The impact of this scenario on the spectrum available for other users (PMSE and other white space users) will need to be further assessed]

*Economic – Costs & Benefits*

[The 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 terms of cooperation between DTT and broadband service providers.][Ed. note: clarification is required regarding the business models used for DTT delivery]

Investments would be required to upgrade the DTT networks for portable and mobile reception.

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.

#### 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.

#### 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.

[Ed. note: The above text was not considered by the meeting]

## SCENARIO 5 [from Doc. 25, EBU]

In this scenario linear and non-linear broadcast services are delivered using the LTE eMBMS specification 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 eMBMS HPHT networks. Service requirements, the types of user devices and usage environments are assumed to be similar as in the scenarios described above.

### Description

**Services**

* Linear and non-linear TV services, as they evolve over time;
* 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 with catch-up and on-demand services;
* The interleaved spectrum (white spaces) would continue to be used for secondary services such as PMSE and, potentially, white space devices, possibly under LSA regime.

**Terminal / user devices**

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

**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 eMBMS 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 consumers 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 eMBMS (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.

### Assessment

[Ed. note: The text in § 5.6.2 was not considered by the meeting]

[Comment from Doc. 23, BNE*: For this scenario to deliver an equivalent service to that provided in the reference scenario ‘scenario 1’ this scenario would require modification of the 3GPPP specifications of LTE eMBMS in order to allow for SFNs with larger inter-site distances (larger guard interval, increase of the number of OFDM carriers). It is unclear if these modifications will be accepted by the 3GPPP and how CEPT administrations can achieve such a change.*

*Moreover, even if such modifications were to be achieved experience would suggest that manufacturers will not include such receivers in smartphones or tablets. DTT/DVB-H receivers have not been included in devices to date as there has not been a demand from the Mobile Operators for such functionality, even though portable / nomadic reception is possible in countries such as Germany.*]

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
* Significant investments would be required to roll-out eMBMS 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 eMBMS, e.g. migration from DVB-T to DVB-T2 and beyond.
* It is unclear whether eMBMS 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.

There would be a risk of service interruption and erosion of audience on terrestrial platforms.

#### 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

If LTE eMBMS is to be deployed within the current DTT channelling arrangement then an 8 MHz variant would be required.

#### Cross-border 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 is 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.

#### 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 eMBMS platform as is currently the case for DTT. If so, audiovisual media policy objectives would continue to be fulfilled (see also section 3.3 above).

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

[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.][Ed. note: The impact of this scenario on the spectrum available for other users (PMSE and other white space users) will need to be further assessed]

*Economic – Costs & Benefits*

Investments would be required to implement HPHT LTE 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 eMBMS 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 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.

#### 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 this scenario could be based on either:

1. amending the GE06 rules to enable adjacent channel aggregation (i.e. similar to the provisions in the Ma02revCo07); or
2. bi- and multilateral coordination outside the scope of the GE06 Agreement, based on the principle of equitable access to the spectrum. In that case the Agreement itself may need to be abrogated.

Regulatory conditions for a free-to-air provision of audiovisual services over LTE eMBMS networks must be established, including the appropriate coverage and quality obligations. In particular:

* 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 fully free of charge

The current Must Carry rules in favour of citizens would need to be extended to cover also the LTE networks used for the delivery of public service media.

#### Migration issues

Migration issues are caused by the substitution of DVB technology with LTE. The impact would be significant across the whole DTT 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 DTT and LTE eMBMS 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.

[Ed. note: The above text was not considered by the meeting]

## SCENARIO 6 [from Docs. 25 (EBU), 38 (Qualcomm)]

In this scenario linear and non-linear broadcast services are delivered using the LTE eMBMS specification with a cellular low-power network topology.

This scenario assumes that the broadcast services in the UHF band would in the future be delivered via LTE eMBMS LPLT networks. [Service requirements, the types of user devices and usage environments are assumed to be similar as in the scenarios described above.]

[Ed. note: more explanation is required on this scenario]

### Description

**Services**

[Ed. note. To check whether these bullets should be also copied into Scenario 5]

* Linear and non-linear TV services, including free-to-air, as they evolve over time (SDTV, HDTV and, eventually, UHDTV);
* [For terminals with unicast connection (e.g. an LTE connection):] [Ed. note: further considerations are required regarding the place for this bullet]
  + 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.
* The interleaved spectrum (white spaces) would no longer be available. Therefore, neither the current secondary services such as PMSE would be able to operate in the 470-694 MHz band nor it would be possible to introduce white space devices.

**Terminal / user devices**

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

**Usage environment**

* Home environment including in urban, sub-urban and rural areas through fixed rooftop reception;
* [Mobile environment (indoor, outdoor, public places and vehicles), in areas where the networks provide the required coverage.][Ed. note: the text needs to be made clear]

**Delivery**

In this scenario, the LTE eMBMS networks is deployed in a low-power-low-tower (LPLT) configuration. The existing cellular network architecture could be used.

The LTE-Broadcast platform delivers its services over a large Downlink (DL) standalone channel. The network delivers content to all users.



Figure 10: Adaptive LTE-Broadcast platform (excluding UL) scenario.

[The uplink, if required, will be in a separate band.

If necessary the uplink will be implemented in another LTE frequency band.]

The LTE-Broadcast platform delivers most services over a large Supplemental Downlink (SDL) channel operated as a Secondary Component Carrier (SCC). A single network delivers content to all users.

### Assessment

[Ed. note: The text in § 5.7.2 was not considered by the meeting]

[Comment from Doc. 23, BNE: *The relationship between the inter site distance and the spectrum efficiency has to be clearly described as it will determine the overall network layout and e.g. the number of sites. An inter site distance of 10km as given in the scenario description cannot achieve the spectrum efficiency required to support this scenario.*

*The evolution of the current LTE eMBMS technology to allow larger SFNs with a similar bitrate is the introduction of additional carriers to compensate the loss due to the larger guard interval. Such modification may imply a degradation of the ability to work in vehicles due to the Doppler Effect and/or result in higher power consumption for the user devices. Furthermore, additional spectrum resources will be needed at country borders and in the case of regions.]*

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 (e.g. smartphones and tablets) 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:

* Significant investments would be required to roll-out LPLT eMBMS networks with a coverage equivalent to the current DTT networks
* It is unclear whether eMBMS 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.
* There would be a risk of service interruption and erosion of audience on the terrestrial platform.
* Fixed reception consumers would need to re-align their roof top aerial towards the nearest transmitter to ensure a robust and stable signal.
* The potential of this scenario in the UHF band may be limited in some countries due to the non-ionising radiation limits.

In addition, this scenario implies that PMSE and white space devices would no longer have access to the UHF band.

#### Technical/feasibility studies

*Longer Cyclic Prefix for nationwide SFN*

The current LTE carrier design uses large intercarrier frequency separation to support high speed mobility in high frequency bands (e.g. 2.5 GHz). On the other hand, the cyclic prefix is currently limited to 33.3 μs as in a traditional LTE network the different version of the wanted signal correspond to multipath coming from a single base station.

In order to support nationwide SFN with large cell range, it is necessary to extend the cyclic prefix. In order 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 should remain similar to existing LTE Broadcast 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 exceed 16k.

The two additional reception modes defined in Table 2 fulfil the criteria detailed above.

Table 5: Definition of 2 new LTE-B modes for fixed rooftop reception

| **#** | **Number of Symbols /Subframe** | **Duration (msec)** | **Fraction CP (%)** | **CP (μs)** | **Per RB** | **Carrier Spacing (Hz)** | **FFT for 20 MHz1** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 12 | 0.08 | 20 | 16.7 | 12 | 15000 | 2048 |
| 2 | 6 | 0.17 | 20 | 33.3 | 24 | 7500 | 4096 |
| 3 (New) | 3 | 0.33 | 20 | 66.7 | 48 | 3750 | 8192 |
| 4 (New) | 2 | 0.5 | 20 | 100 | 72 | 2500 | 16384 |

1Includes margin for antialiasing and 97% occupancy

*Dedicated carrier*

As LTE Broadcast/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 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.

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 some countries, regulatory requirements for free-to-air service is likely to require that the service should 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).

*Summary of standard modifications*

Table 6: Summary of LTE standard modification to enable Scenario X (“Adaptive LTE-Broadcast platform, including UL”).

| **Name** | **Modification** | **Justification** |
| --- | --- | --- |
| Longer Cyclic Prefix for Mobile SFN | CP = 100 μs | Required to enable country wide SFN with fixed rooftop reception |
| Dedicated carrier | 100% eMBMS frame | Required for the delivery of linear terrestrial TV |
| Service without user registration | Extend LMS to eMBMS | Required to support Free-to-air |

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; It is estimated that a minimum of 20 linear TV channels would have to be broadcast simultaneously which would require substantially large dedicated bandwidth to be provided by LTE eMBMS.
* free-to-air delivery of linear and nonlinear audiovisual services
* seamless access to broadcast programmes across different networks
* meeting the coverage and capacity requirements within the regulatory limits for non-ionising radiation

how regional TV services and coverage across national borders can be implemented and the implications on spectrum requirements

#### Cross-border coordination and coexistence

Compared to high power high tower networks which operate mostly in a noise limited environment, LTE-B networks are designed to operate in an interference limited environment. The received signal strength is higher due to the much denser network structure.

*LTE-B network vs LTE-B network*

An LTE-B network operates typically at an SINR of 15 dB. In a cross border situation, careful network design can ensure that at the border itself, the signals from each side of the border are of similar amplitude, corresponding to a theoretical SINR around 0 dB. The adoption of a directional antenna would push the cross border interference below the national signal by the back to front ratio of the directional antenna. Currently directional UHF antennas are available with minimum back to front ratio ranging from 20 to 30dB in the UHF band. The installation of appropriate fixed antennas would be sufficient to ensure reception.

As soon as the receiver location is within the network, i.e. not within the ‘first ring’ of border cells, the cross border interference would become negligible compared to the interference from the national network, should typical directional antenna be adopted.

*LTE-B network impacting high power high tower network*

[Initial studies are available in TG6(13)012]

*High power high tower network impacting LTE-B network*

High power high tower networks operate with lower received signal strength as LTE-B networks. As such, the limiting case should remain the interference from LTE-B to high power high tower network.

Cross-border coordination of LPLT LTE eMBMS would be similar to other cellular networks.

Under the assumption that LTE networks would be deployed with the reuse factor 1 (i.e. the same frequency used across the whole coverage area) 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.

Some spectrum savings compared to a HPHT deployment may be possible, but this is highly dependent on regulatory, technical and coverage requirements.

This scenario could be combined with DTT-based scenarios that assume evolution of DTT networks towards LPLT configuration (e.g. Scenario 2 above). This would ease the cross-border coordination issues if different countries adopt different approaches or time frames.

#### 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 to the LPLT eMBMS platform as is currently the case for DTT. If so, audiovisual media policy objectives would continue to be fulfilled (see also section 3.3 above).

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

*Economic – Costs & Benefits*

[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.][Ed. note: The impact of this scenario on the spectrum available for other users (PMSE and other white space users) will need to be further assessed]

Investments would be required to implement LPLT LTE networks with a coverage and capacity equivalent to the current DTT networks. The HPHT eMBMS 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 in order to ensure the low delivery costs over a long term. Possible tools are at least a real competition between network operators or efficient price regulation, or a mix of both.

Users would need to invest in new TV receivers that are LTE 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.

#### Regulatory impact

The GE06 Agreement would not provide a suitable regulatory framework for the introduction of LPLT eMBMS platform for the delivery of audiovisual services in the UHF band. Instead, bi- and multilateral coordination would need to be carried out for the border areas. The GE06 Agreement may need to be abrogated.

Regulatory conditions for a free-to-air provision of audiovisual services over LTE eMBMS networks must be established, including the appropriate coverage and quality obligations. In particular:

* 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 fully free of charge

The current *Must Carry* rules in favour of citizens would need to be extended to cover also the LTE networks used for the delivery of public service media.

#### Migration issues

Migration issues are caused by effectively replacing the current DTT platform with LTE. The impact would be significant across the whole DTT 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 DTT and LTE eMBMS platforms, in order to minimise the adverse impact on the viewers and interruptions of services. During this period additional spectrum would be required.

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.

Solutions for PMSE users would need to be found outside of the UHF spectrum.

[Ed. note: The above text was not considered by the meeting]

## SCENARIO 7 [from Doc. 38, Qualcomm]

In this scenario LTE Broadcast is a service to deliver broadcast and multicast content over LTE cellular networks. The service is delivered over a technology standardised by 3GPP as eMBMS.

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);
* The platform ensures fixed rooftop reception nationally and mobile reception in high density areas 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 national linear broadcast content, the network operates as nationwide SFN delivering a minimum 2 bps/Hz. 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.

### Description

#### DL delivery platform supporting interactivity

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 11: 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. radio astronomy, PMSE). An example band plan, assuming that the entire 470-694 MHz band is dedicated to broadcast, is illustrated in the Figure 3 below. This band plan is not proposed as a recommended band plan as, amongst other questions, does not take into account the spectrum requirement of other services, assumes that the band 694-703 MHz is available. Further studies are required to determine an appropriate band plan, should this option be selected. The band plan is only provided to illustrate that the FDD sub-band is significantly smaller than the SDL sub-band, i.e. the platform remains a DL dominated platform.

#### Dynamic broadcast/unicast

The LTE-Broadcast platform is, as illustrated in Figure 10 is a large mobile downlink pipe that can deliver broadcast or unicast content. The platform can 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 can 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.

#### Mixed Service SFN

The network operates as a nationwide SFN (Frequency reuse 1) for linear broadcast content. The network is designed for ‘Mixed Service’, i.e. delivering mobile coverage in areas of interest, while guaranteeing fixed rooftop reception throughout the network, as illustrated in Figure 11. The network requires a transmission site density lower or equal to that of existing cellular network (10 km cell range), in order to ensure that an initial deployment could be achieved by simply reusing existing cellular sites (no network densification). The adoption of a coverage mode (ranging from true mobile to fixed rooftop) for a given area would be the result of discussions at national level, but does not impact the band plan or the harmonisation. 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 network densification.

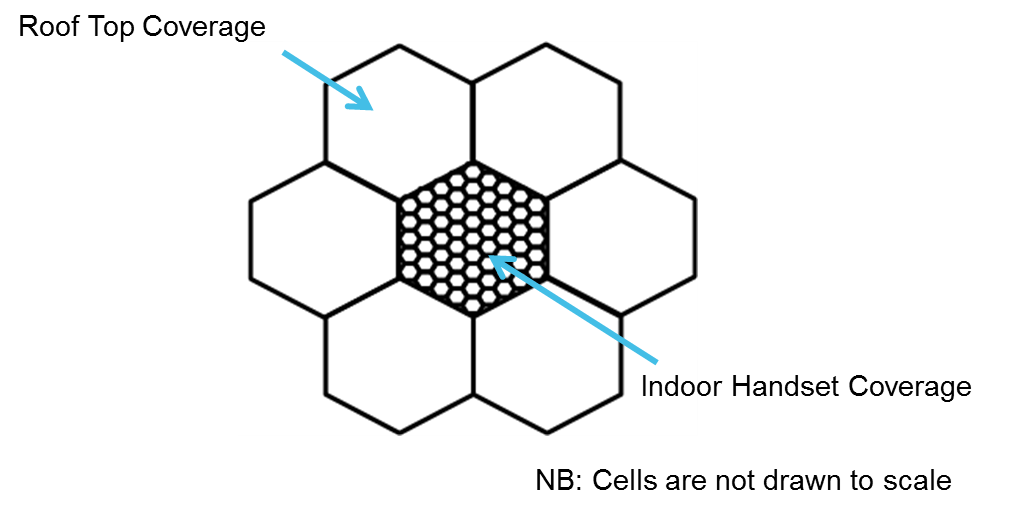


Figure 12: Mixed Service SFN

Such a Mixed Service SFN is interference limited. Directional antennas, even pointed in the wrong direction, would be able to receive the signal. In the long term, the adoption of a ‘low power low tower’ type of network implies that omnidirectional antennas would be sufficient for fixed rooftop reception, reducing significantly the cost of rooftop reception and increasing the flexibility of the platform and it ability to evolve in time.

[Ed note: §§ 5.8.1.4 and 5.8.1.5 will need to be merged with relevant §§ in Chapter 4]

[

#### IP-based platform

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

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

In particular, while the LTE FEC is integrated in LTE Broadcast itself, a number of functionalities, such as outter block coding (i.e. Raptor code), encapsulation (DASH) and source encoding/decoding (e.g. HEVC) are performed at application layer as illustrated in Figure 12. This provides a number of benefits, the most important being the ability of the delivery network to integrate seamlessly the latest standards of video-delivery.

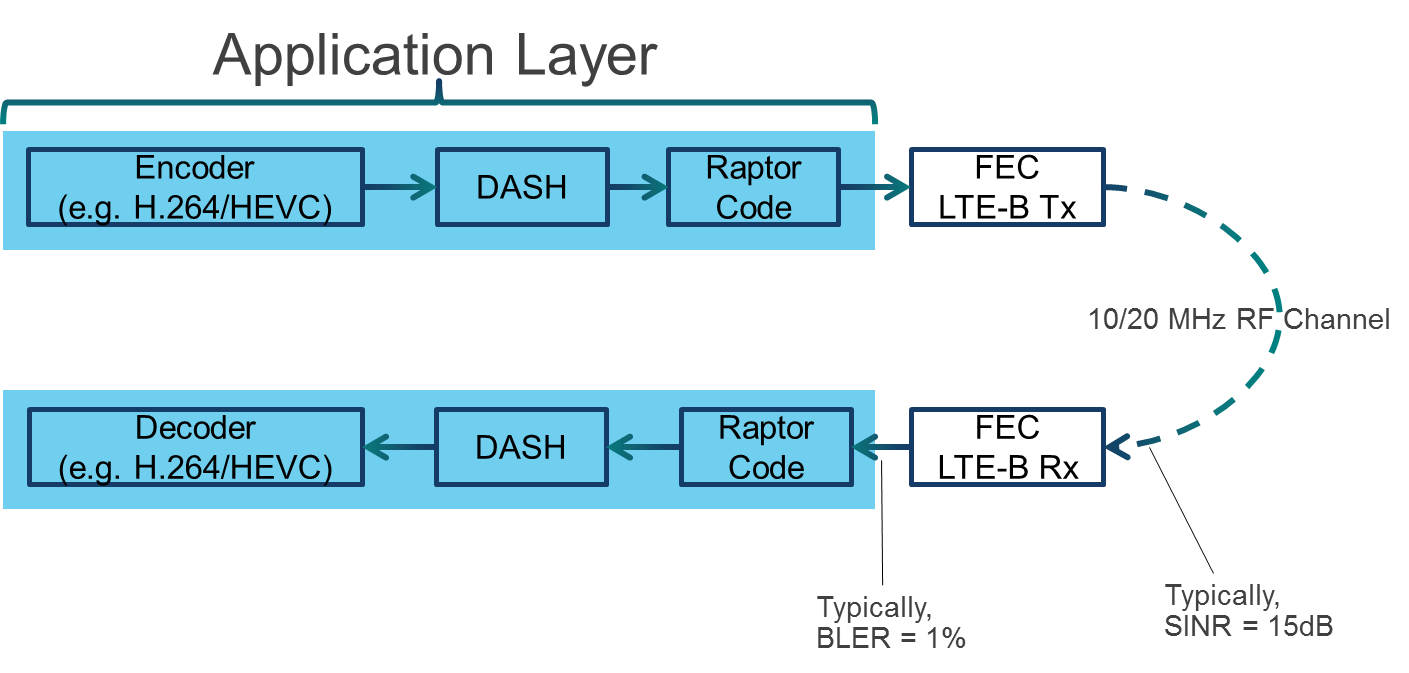


Figure 13: Typical LTE-Broadcast encoding/decoding chain

LTE supports both unicast delivery and multicast/broadcast delivery (through LTE Broadcast). 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, hybrid delivery scenario can be deployed by leveraging the functionality of Dynamic Adaptive Streaming over HTTP (DASH) on top of LTE Broadcast.

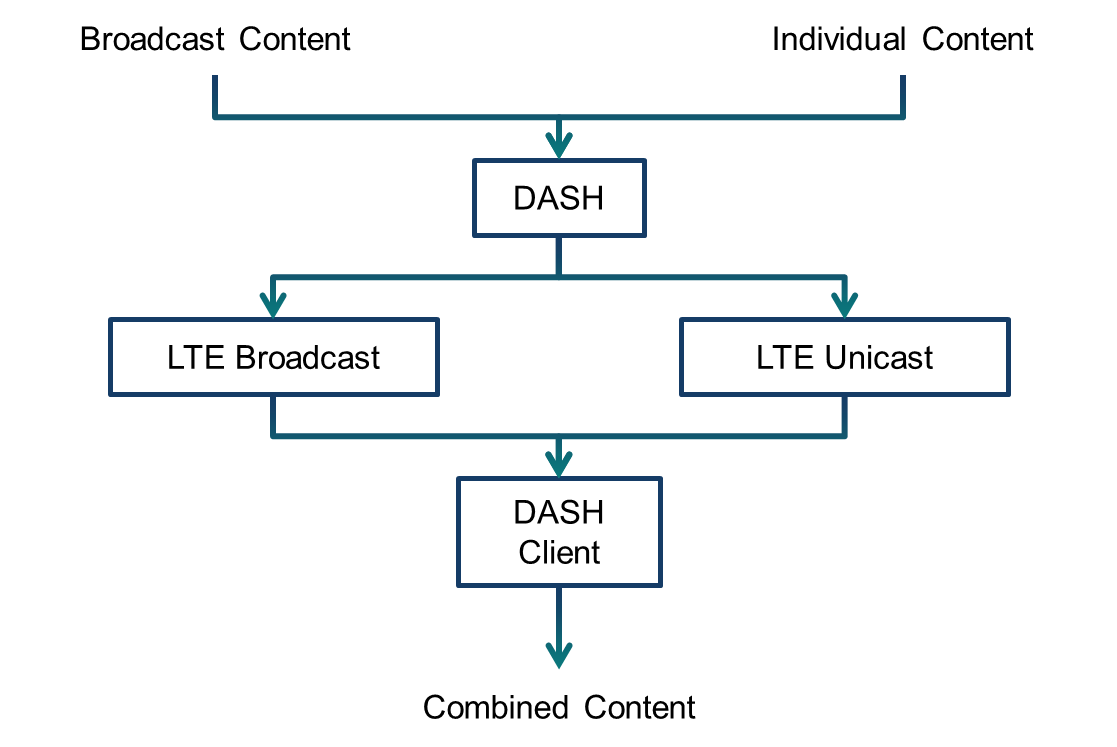


Figure 14: Hybrid delivery scenario

Hybrid delivery scenarios support the following features:

* Delivery of certain components/media streams/representations/segments over broadcast and other components over unicast with synchronization at the client;
* Use of unicast for optimized user experience, for example for reducing channel-change times unicast may be used to enable an immediate switch until sufficient broadcast data is available to seamlessly switch back to the broadcast delivered representation;
* Seamless transition of a broadcast-delivery into a time-shift mode, such that the same content is available for later consumption in the cloud;
* Coverage extensions for broadcast distribution;
* Dynamic unicast/broadcast.

#### LTE Broadcast Service Area/MBSFN

While the network supports nationwide SFN areas (desirable for national linear TV channels), there is often 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 up to 8 MBSFN areas, as illustrated in Figure 14. Interference between neighboring MBSFN areas is tolerable when the areas are separated by a few kilometers in a low tower low power deployment. Directional receiving antennas can be beneficial to discriminate signals at the edge between 2 co-channel MBSFN areas.

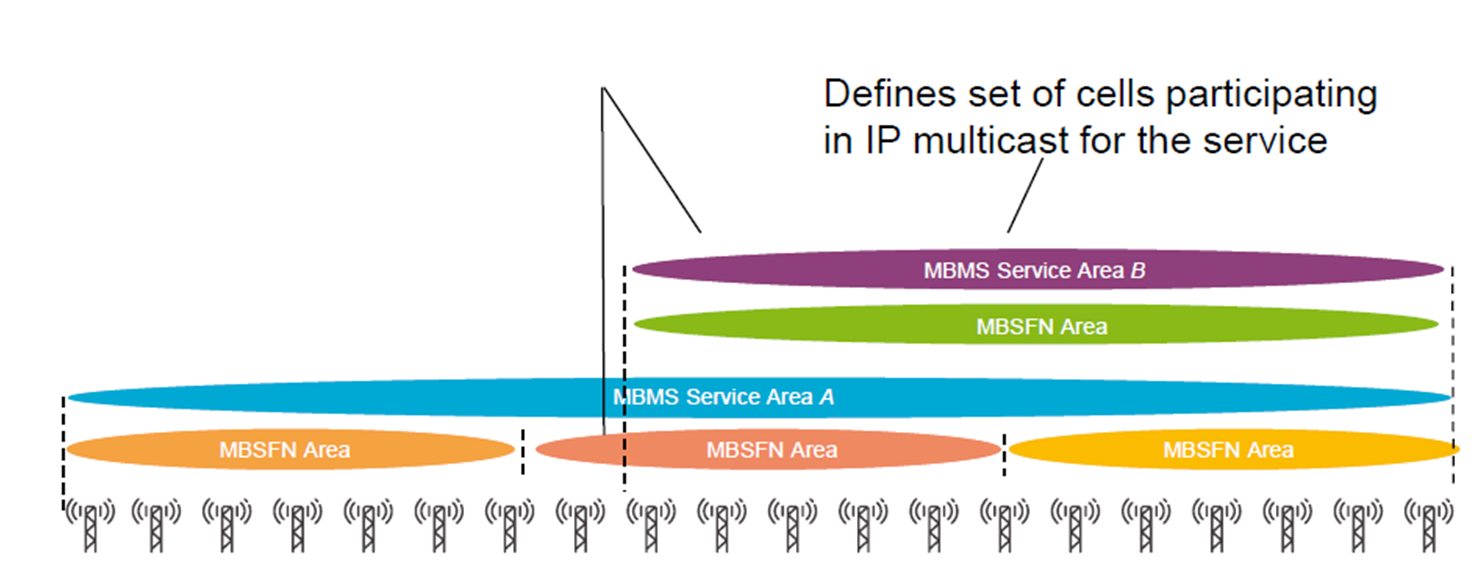


Figure 15: LTE-Broadcast supports multiple MBMS Service area and MBSFN areas

]

### Assessment

[Ed. note: The text in § 5.8.2 was not considered by the meeting]

[Comment from Doc. 23, BNE*: In the section describing dynamic broadcast/unicast the paragraph ending with «As such, the platform can adapt to the national broadcast requirements while maintaining harmonization at CEPT level.» needs greater explanation on the basis for this conslusion as the spectrum efficiency of LTE is directly linked with the inter site distance.*

*Furthermore, we encourage the sponsor to be more precise on what is really possible based on the given assumptions. For example, the proposed cell range of 10 km doesn’t provide an adequate level of spectrum efficiency to provide an alternative to scenario 1. Based on the work of Ericsson[[20]](#footnote-20) for an inter site distance of 10 km, the spectrum efficiency is 0.6bit/s/Hz. Therefore to replicate the current capacity available in a DTT network of circa 200 Mbit/s then 330 MHz of spectrum would be required, which is well in-excess of the 224 MHz of spectrum that would be available if the 700 MHz band were to be cleared. This is also a best case approach and spectral efficiency is likely to be even lower since not all roof top aerials will be pointing directly to the new low tower network. A similar discussion but based on portable DTT reception can be found in document TG6(13)044.*

*One possible solution is to reduce the inter site distance to circa 2km (as proposed by Ericsson, see Scenario 9), but this much denser network will add considerably to the cost of service provision and increase the environmental impact with many more sites disrupting the landscape.*

*The section on LTE Broadcast Service Area MBSFN needs to be expanded upon to explain how this affects the aggregate available bit rate.*

*Finally the impact of regional services on spectrum requirements needs to be considered further, this aspect also applies to geographic borders. ]*

#### Technical/feasibility studies

*Longer Cyclic Prefix for nationwide SFN*

The current LTE carrier design uses large intercarrier frequency separation to support high speed mobility in high frequency bands (e.g. 2.5 GHz). On the other hand, the cyclic prefix is currently limited to 33.3 μs as in a traditional LTE network the different version of the wanted signal correspond to multipath coming from a single base station.

In order to support nationwide SFN with large cell range, it is necessary to extend the cyclic prefix. In order 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 should remain similar to existing LTE Broadcast 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 exceed 16k.

The two additional reception modes defined in Table 2 fulfil the criteria detailed above.

Table 7: Definition of 2 new LTE-B modes for fixed rooftop reception

| **#** | **Number of Symbols /Subframe** | **Duration (msec)** | **Fraction CP (%)** | **CP (μs)** | **Per RB** | **Carrier Spacing (Hz)** | **FFT for 20 MHz1** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 12 | 0.08 | 20 | 16.7 | 12 | 15000 | 2048 |
| 2 | 6 | 0.17 | 20 | 33.3 | 24 | 7500 | 4096 |
| 3 (New) | 3 | 0.33 | 20 | 66.7 | 48 | 3750 | 8192 |
| 4 (New) | 2 | 0.5 | 20 | 100 | 72 | 2500 | 16384 |

1Includes margin for antialiasing and 97% occupancy

*Dedicated carrier*

As LTE Broadcast/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 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.

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 some countries, regulatory requirements for free-to-air service is likely to require that the service should 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).

*Summary of standard modifications*

Table 8: Summary of LTE standard modification to enable Scenario X (“Adaptive LTE-Broadcast platform, including UL”).

| **Name** | **Modification** | **Justification** |
| --- | --- | --- |
| Longer Cyclic Prefix for Mobile SFN | CP = 100 μs | Required to enable country wide SFN with fixed rooftop reception |
| Dedicated carrier | 100% eMBMS frame | Required for the delivery of linear terrestrial TV |
| Service without user registration | Extend LMS to eMBMS | Required to support Free-to-air |

#### Cross-border coordination and coexistence

Compared to high power high tower networks which operate mostly in a noise limited environment, LTE-B networks are designed to operate in an interference limited environment. The received signal strength is higher due to the much denser network structure.

*LTE-B network vs LTE-B network*

An LTE-B network operates typically at an SINR of 15 dB. In a cross border situation, careful network design can ensure that at the border itself, the signals from each side of the border are of similar amplitude, corresponding to a theoretical SINR around 0 dB. The adoption of a directional antenna would push the cross border interference below the national signal by the back to front ratio of the directional antenna. Currently directional UHF antennas are available with minimum back to front ratio ranging from 20 to 30dB in the UHF band. The installation of appropriate fixed antennas would be sufficient to ensure reception.

As soon as the receiver location is within the network, i.e. not within the ‘first ring’ of border cells, the cross border interference would become negligible compared to the interference from the national network, should typical directional antenna be adopted.

*LTE-B network impacting high power high tower network*

[Initial studies are available in TG6(13)012]

*High power high tower network impacting LTE-B network*

High power high tower networks operate with lower received signal strength as LTE-B networks. As such, the limiting case should remain the interference from LTE-B to high power high tower network.

#### Economic, social and cultural issues

#### Regulatory impact

#### Migration issues

[Ed. note: The above text was not considered by the meeting]

## SCENARIO 8 [from Doc. 35, NSN, Nokia]

### Description

This MBB-scenario is based on the assumption that the demand for DTT is decreasing and, at least, part of the band could be used for other services. [ ]

Therefore, regulators may gradually withdraw some DTT [licenses][multiplexes], maybe one by one, and repurpose these frequencies for Mobile Broadband use. On the other hand, the most used DTT [licenses][multiplexes] can continue as long as required. It is assumed that most of DTT will be evolved to DVB-T2 technology, which is more spectrum efficient than DVB-T and also supports single frequency networks (SFNs).[Ed. note: consider moving this paragraph into the assessment part]

Mobile Broadband (MBB) networks can be licensed to those freed channels. The freed channels could be best used by Supplementary Downlink (SDL) (combined with other MBB bands via LTE Advanced carrier aggregation (CA)), as SDL is better 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 towards 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).

[Ed. note. The figure should show the end situation only. The migration part needs to be moved into the assessment]

69x

30 MHz DL

30 MHz UL

790

791

821

832

862

700 MHz WRC-12/15

470

DTT and MBB SDL (MBB & eMBMS)

DTT

800 MHz

700 MHz

Interim term “Flexible DTT- mobile use”

69x

30 MHz DL

30 MHz UL

790

791

821

832

862

700 MHz WRC-12/15

470

DTT

800 MHz

700 MHz

Starting point”

69x

30 MHz DL

30 MHz UL

790

791

821

832

862

700 MHz WRC-12/15

470

Mobile SDL (MBB & eMBMS)

DTT

800 MHz

700 MHz

long term vision “Flexible DTT- mobile use”

**Services**

Linear and non-linear TV services

Downlink data delivery

**Terminal/ user devices**

Large screen, small screen, tablet, smartphones [Ed. note. Further thought on enabling eMBMS]

**Usage environment**

DTT primarily the home environment

MBB everywhere within the network coverage

**Delivery**

DTT networks would remain to be a mix of high-power-high-tower (HTHP) and low-tower-low-power (LTLP) networks and the networks should be migrated from MFN to SFN as much as possible.

MBB LTE SDL networks are LPLT SFN networks and can be implemented in the released DTT channels (based on GE-06 framework). Based on market demand LTE SDL can be used for ‘traditional’ MBB services or for LTE broadcast using eMBMS. Mobile allocation is needed to support flexibility.

### Assessment

[Ed. note: The text in § 5.9.2 was not considered by the meeting]

[Comment from Doc.23, BNE: *BNE has two principal points for clarification;*

* *This Mobile Broadband scenario is based on the assumption by NSN that the importance of linear terrestrial broadcasting transmission services in the UHF band will diminish. We encourage NSN to further elaborate the evidence that underpins this assumption as this position is inconsistent with the evidence provided by BNE and EBU to the TG6 second meeting and also inconsistent with the information provided by Ericsson in their input to scenario 9.*
* *It is indicated in the general description that there’s a trend for linear TV reception to be increasingly done via broadband (fixed and mobile/wireless). Whilst this statement may be factually correct it is off a very low base and forecasts demonstrate that terrestrial service provision will continue to be the largest European service platform for EU systems for the foreseeable future. In addition, hybrid solutions both terrestrial and IP, are being introduced where linear viewing is dominated by the terrestrial element of delivery and the IP aspect delivers the relatively modest on demand service requirements. Therefore we need to be clear about the reception mode when determining future demand, whilst the device may be connected if its primary source of reception is DTT then it should be classified as a terrestrial broadcast connected device.*

*The recent introduction of LTE in the 800MHz band has been supported by several technical studies measurement campaigns, especially on mitigation techniques in order to facilitate compatibility between broadcasting reception below 790 MHz and LTE transmission above 791 MHz. gives some technical feedback. In order to protect DTT reception, it was necessary e.g. to add low pass filters after the receiving antenna and before the domestic amplifier which, in the vicinity of the base station was subject to overloading. However, it seems to be difficult to apply this particular mitigation technique if a channel which is to be used for other purposes (SDL transmission) would be within the spectrum still to be used for DTT and further explanation is needed on how this problem will be managed. Is the intention e.g. to add notch filters for each SDL channel replacing a DTT transmitter? In this case, the impact of the different insertion losses of such filters on DTT coverage needs to be examined.]*

#### Technical/feasibility studies

LTE SDL can be implemented in the released DTT channels utilizing the GE-06 framework. In principle, 5 MHz LTE SDL fits in 8MHz channel without additional interference to remaining DTT network, as the freed 8MHz tolerates HTHP DVB transmitter. Based on the 800MHz studies, 1MHz guard band is sufficient between mobile downlink and DTT. Taking into account the reuse about 7 of MFNs, it is possible that a wider than 5 MHz LTE can be used, if the adjacent channels of the released channel can be used, but this needs more studies. If/when SFN is taken into use in DTT, 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.

LTE technology will also evolve to respond the possible new requirements for the optimum use of this band. E.g carrier aggregation (CA) facilitates that 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.

#### Cross-border coordination and coexistence

Cross-border issues do not change, while LTE SDL is implemented within GE-06 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.

#### 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). DTT may not be the optimum delivery way for TV content of limited audience and the regulators should consider how much DTT capacity is necessary in individual countries. The band 470-694MHz is beneficial for MBB due to good coverage building characteristics. Digital Agenda targets of 30Mbit/s to be available for each EU citizen everywhere by year 2020 and that at least 50% of households have an access to at least 100 Mbit/s will be a challenge to operators. On the other hand, when 30Mbit/s is available, it can be used for IPTV as well.

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

#### Regulatory impact

Mobile allocation is needed to support flexibility. In the beginning, MBB LTE SDL can be implemented within the GE-06 framework and not much is needed from regulatory side. If (and when) the DTT need is decreasing significantly e.g. if SFN is used widely in DTT networks, it may be beneficial to harmonize part of the band for mobile use with a specific band plan and move the remaining DTT towards the lower end of the UHF band.

#### Migration issues

In the longer term, it is expected that DTT will move from MFNs to SFNs as much as possible. SFNs could be moved to the lower end of the band.

LTE already contains many of the capabilities that are needed to 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.

[Ed. note: The above text was not considered by the meeting]

## SCENARIO 9 [from Docs. 7, 40, Ericsson]

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.

### 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 clips services[[21]](#footnote-21). 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.

### Assessment

[Ed. note: The text in § 5.10.2 was not considered by the meeting]

[Comment from Doc.23, BNE: *This scenario gives additional technical details that are relevant to earlier scenario 7; it indicates that “The simulations show that MBMS has a spectral efficiency of 3.1 bit/s/Hz up to a cellular inter site distance (ISD) of 2 km. With this, 84 MHz of spectrum sufficient to provide the desired aggregate service rate.” Beside the fact that this statement is based on one particular study, only, and that other studies show much lower spectrum efficiency, it leads to the following remarks:*

* *The network density will have to be largely increased compared to the mean value of 10 km inter site distance given in scenario 7.*
* *The scenario assumes that one base station every 2 km would be necessary. Therefore, the number of base stations to cover larger areas or even countries will drastically increase. Such estimations should be done to give an evaluation of the cost of the proposal while operators tend to reduce their network costs by sharing their infrastructure. Some information can be found e.g. in document TG6(13)044.*
* *Is there any country ready to launch such a network on a national basis? A higher inter site distance will have a direct impact on the spectrum needs.*

*In addition, the scenario is unclear as finally it doesn’t give a clear figure of what is proposed:*

* *The use of LTE networks is proposed for ENG/OB but the improvement of the consumer experience of such a modification is unclear as well as the potential spectrum efficiency improvement.*

*Broadcast networks and LTE networks are presented as complementary in the beginning and later the presentation of LTE eMBMS is given for television broadcasting which doesn’t give a clear figure of what is proposed.*]

[Ed. note: the paragraphs below are moved from the introduction of this scenario]

The purpose of this scenario is to explore some of developments and results with regards 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 is presenting 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 program 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.

The simulations show that MBMS has a spectral efficiency of 3.1 bit/s/Hz up to a cellular inter site distance (ISD) of 2 km. With this, 84 MHz of spectrum are sufficient to provide the desired aggregate service rate. Comparing this to the 300 MHz used by television services today, the potential savings in spectrum are significant. It is noted that spectrum requirements could be further reduced by replacing MPEG2 with H.264, for which bit-rate efficiency gains of 30 – 50 % have been reported. H.264 has been defined as one codec to be used with MBMS; however, for television services targeting large screens, additional H.264 profiles will have to be mandated for MBMS.

[Ed. note: the paragraphs below are moved from the description part of this scenario]

#### 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 behaviors where media content, in addition to the living room based television set, is also consumed on desktops, laptops, tablets and smartphones {1} {16}. 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 behavior 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 becoming more flat, or even having a somewhat negative trend with regard to linear television viewing {1}, 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 {1} 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 behavior 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 behavior 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 {2} entitled “Navigating Convergence II: Charting Canadian Communications Change and Regulatory Implications“ 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 {3}. 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 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.

In addition to the demands of media consumers, mobile broadband networks also provide interesting opportunities for supporting wireless feeds for news gathering applications for program development in the domain of Electronic News Gathering/Outside Broadcasting services (ENG/OB). This mobile broadband application provides real time feeds for broadcasting; the users could be professionals (e.g., camera people on a motorcycle following an event and transmitting the feed using LTE) or consumers (e.g., people with smartphone terminal devices sending videos to newspapers and broadcasters). Indeed, the more advanced LTE networks enable the transmission of high-definition (HD) video streams from live cameras with the low latency and high quality required for studio feeds. This has been demonstrated in several events, including:

* Swedish Crown Princess' Royal Wedding in 2010, where Swedish television companies broadcasted live from the celebrations in Stockholm, as well as being available live from the official website of the wedding {2};
* Japanese Nippon television reporting from the Nobel press conference in Stockholm 2010 {3};
* YouTube streamed the entire wedding of Prince William and Kate Middleton's event live from [The Royal Channel](http://www.youtube.com/user/TheRoyalChannel), which was built specifically for wedding. BBC provided full streaming of the event at BBC News' [dedicated wedding site](http://www.bbc.co.uk/news/uk-11767495). It was possible to watch the entire event live on a smartphone or other Internet devices such as tablets {4};
* For the Summer Olympics 2012, Bell Mobility and Rogers set up Canada’s Olympic Broadcast Media Consortium (in both English and French) to broadcast live events from London over the Internet, television, and mobile. One week into the Games, 61% of the traffic on the Consortium’s digital platforms was powered by mobile devices, receiving nearly 90 million page views and indicating an enthusiastic shift in consumer behaviour as viewers took the Games with them wherever they went {4}; and
* Viewer statics for BBC on Olympics 2012 are available at <http://www.bbc.co.uk/blogs/bbcinternet/2012/08/digital_olympics_reach_stream_stats.html>.

Compared to using alternative dedicated / transportable links for ENG/OB, LTE networks can be more readily setup with less overhead. The LTE quality of service framework ensures priority for the ENG/OB services above other types of traffic in the LTE network, thereby providing carrier-grade performance. The LTE quality of service framework ensures priority for the ENG/OB services above other types of traffic in the LTE network, thereby providing carrier-grade performance.

For these reasons, it is necessary to address further the opportunity of new advanced IP-based mobile broadband radiocommunication technologies to offer a complement to the current terrestrial broadcasting technologies with the aim of improving the consumer experience.

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.

An overview of the Multimedia Broadcast / Multicast Service (MBMS) that has been introduced in 3GPP specifications in recent years, including for LTE, is presented, as one solution to cope with live television as well as podcasting. One advantage of MBMS is that it enables the use of single frequency networks (SFN) for television broadcasting. LTE evolved MBMS (eMBMS) is based for SFN use and therefore an overview of a study of the spectrum requirements for television broadcasting over LTE is presented.

#### Technical/feasibility studies

#### Cross-border coordination and coexistence

#### Economic, social and cultural issues

#### Regulatory impact

#### Migration issues

[Ed. note: The above text was not considered by the meeting]

## SCENARIO 10 [from Doc. 4, GSMA]

[Ed. note: More elaborated description of the scenario is required]

**Service(s)**

Audio-visual content (linear and/or non-linear), and information/data for other (broadband) data services / applications.

**Terminal / user device(s)**

Various types of devices (with small and large screens), including smartphones, tablets, PCs/laptops, and large flat screens.

**Usage environment(s)**

Stationary, portable, mobile. Outdoor and indoor. At home, work locations and public places. Urban, suburban and rural environments.

**Delivery**

[LTE (e.g. FDD/SDL). In combination with LTE broadcast and/or DTT. LPLT network.]

## SCENARIO 11 [from Doc.34, S]

[Ed. note: Further clarifications on Scenario 11 are required]

### Description

**Service**

In this scenario the content/information/function are *smart data quantities*. These smart data quantities are being stored in a data storage or produced in a data production or generated in a data function generator which are all placed in one *generic smart communication unit*. They can easily be transmitted in the most efficient manner from the source unit to the destination unit. The source and the destination unit have the same functionalities – their role is defined by the user and it changes depeding on the type of communication which is agreed and established.

**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 so that it can easily 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, 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 in simple and efficient manner 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 sensing 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.

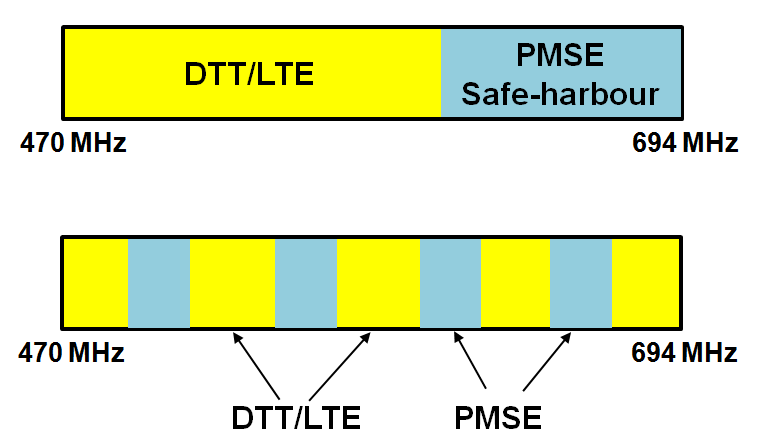
## SCENARIO 12 [from Doc. 47, SUI and Doc. (14)16, APWPT]

In this scenario, event and content production using PMSE systems, in particular, audio PMSE operate in dedicated spectrum. PMSE systems have always been living in a sharing scenario. If spectrum sharing with new technologies is no longer possible dedicated spectrum appears to be the only option.

[Ed. note: To add the assumption of the modification of the use of the spectrum. APWPT will provide the required wording]

### 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 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.



[Ed. note: The position of the safe harbour in the band needs to be discussed]

The amount of dedicated/reserved spectrum needs to be defined on the basis of spectrum requirements for PMSE systems. Studies conducted by APWPT indicate a need of minimum 96 MHz required to safeguard daily audio production activities and around 270 MHz for regular events.

[From Doc. 16, APWPT]

**Services**

* Event and content production based on PMSE production tools.

**Terminal / user devices**

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

**Usage environment**

* [Fixed installations, public places and vehicles are the environment for the daily use of PMSE production tools.] [Ed. note: The description should be specific to the environment and not to the devices]

**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

### Assessment

#### Technical/feasibility studies

#### Cross-border coordination and coexistence

#### Economic, social and cultural issues

#### Regulatory impact

#### Migration issues

## SCENARIO 13 [from Doc. (14)14, VF]

In this scenario, a small part of the UHF spectrum is used for public safety communications (ECC Report 199 has estimated that 2 X 10MHz is needed for broadband public safety communications). This spectrum might be within the 470-694MHz band, overlapping the 694MHz boundary, or above 694MHz but close enough that it should be taken into account for adjacent channel coexistence (for example, an uplink band of 698-703MHz).

**5.13.1 Description**

**Services**

* Voice, including group call.
* Data
* Video (mainly uplink)

**Terminal / user devices**

* Handheld terminals for voice and data
* Vehicle mounted radios
* Wireless video cameras to send images from incidents to the control room.

**Usage environment**

* Primarily public places and public buildings
* Vehicles

[Ed. note: to check whether this description covers all the foreseen situations]

**Delivery**

It is assumed that broadband public safety networks will use LTE technology. The network architecture will probably be similar to a public mobile broadband network, but perhaps with a lower user density and larger cell size.

## ANALYSIS OF THE SCENARIOS AND COMBINATIONS

[Ed. note: The text in § 5.15 was not considered by the meeting]

[Doc. 20, F]

Different scenarios presented in the sections above can be classified into three categories:

**Category 1: Primary services are Broadcast-Multicast only.**

In this category, apart for interleaved usage, the 470-694 MHz band is dedicated to Broadcast Content– Multicast Content (BC - MC). Two examples are listed below:

1. The first example corresponds to the existing situation in most CEPT countries where the BC-MC delivery platform is made of HP HT sites. Some networks also have additional gap fillers and relays. The BC-MC content is mainly audio-visual linear content (television and radio), for large screen television sets, with high video / audio quality expectations (HDTV and in the medium/longer term, ultra-HD TV).

This BC-MC delivery platform may also be used to deliver any other BC-MC content to devices embedding BC-MC tuners.



1. A second case corresponds to an evolution of the previous case. The network is also based on the existing DTT network, but significantly additional LPLT sites are rolled-out in order to improve mobile coverage (and possibly indoor coverage) without decreasing the global capacity of the platform to continue delivering high-picture quality TV (HDTV, UHDTV) to large screen television sets.

To provide additional mobile and/or indoor coverage and continue addressing large screen television sets, this second scenario could tend towards a full LPLT BC-MC platform.



**Category 2: Primary services are broadcast and cellular downlink only.**

In this category two examples of combinations for the band plans and delivery platforms are given below:

1. In the first case, both the BC-MC and cBB DL contents are delivered using LPLT delivery platforms. Contents are either multiplexed together (in a way allowing flexible capacity allocation for both services), in this case the same platform is used, as for eMBMS where temporal multiplexing is used. The two services may also be delivered in two different adjacent sub-bands. In this case a shared platform is possible and likely because duplication of platform would be very inefficient. The network is made of many base stations, as in the case of a cellular network.

Cellular traffic may require an uplink channel, in this category it is considered that the uplink is not in the 470-694MHz band and therefore should be disregarded in the studies.



1. In the second case, the BC-MC and cBB DL are on two separated platforms and therefore the content is sent on two adjacent bands. The BC delivery platform is HPHT.



**Category 3: Primary services broadcast and cellular downlink and uplink.**

Again, two examples are of particular interest. They are similar to the cases of category 2, except that an uplink sub-band is introduced

1. In the first case the BC-MC and cBB DL use LPLT delivery platforms (see category 2.a).



1. In the second case, the BC-MC is sent over an HPHT delivery platform, and the cBB DL and UL platforms are LPLT.



[Ed. note: A discussion is required on stand-alone scenarios and the scenarios that occur in combination with other scenarios]

### Cross-border coordination and coexistence

[Ed. note: The above text was not considered by the meeting]

## SUMMARY OF ANALYSIS

[Ed. note: The text in § 5.16 was not considered by the meeting]

[Doc. 22, Huawei] Several different standards in the same terminal will increase the complexity, the cost and the risk of a poor QoS (difficult compatibility between two different standards).

[Doc. 5, RUS] It should be noted that using the mitigation techniques such as frequency filters is not possible within the operating tuning range of TV receivers, making it difficult or even not possible to resolve compatibility issues when using scenarios that supposes uplink transmissions from user terminals within the frequency band 470-694 MHz. Laboratory and field trials of wireless broadband systems in the frequency band 470-694 MHz indicate the EMC issues occurring between broadcasting and systems using uplink within broadcasting receivers tuning range.

[Doc. 5, RUS] From a technical point of view to improve the compatibility, more appropriate for use in the band 470-694 MHz are scenarios in which this band is only used for broadcasts or data transmission in the direction to the user. In case of need to use the 470-694 MHz band for broadband access or other telecommunication, it is preferable to use this band for downlink only. In addition to that, in some cases it will be necessary to impose restrictions on locations and technical parameters of broadband access systems or mobile systems base stations.

[Ed. note: The above text was not considered by the meeting]

# RECOMMENDATIONS

# Conclusions

Body text (style: ECC Paragraph)

(advice: a conclusion may review the main points of the ECC Report. A conclusion might elaborate on the results of the ECC Report and suggest extensions.)

1. Terms of reference of ecc tg6: "Long term vision for the UHF broadcasting band"

The Task Group shall:

1. Conduct studies as outlined in the Appendix aiming at the development of a long term vision for the UHF broadcasting band (focusing on the band 470-694 MHz) in Europe, specifically addressing 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 EC Mandate);
   * 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;
   * How to provide a certainty that there will be a stable environment for future investment by the services envisaged in the band (including PMSE).
2. Prepare a draft ECC Report on the above studies.
3. Consult, as appropriate, with relevant external organisations.
4. Report to the ECC Plenary.
5. Plan to send the draft ECC Report in Public Consultation by mid-2014.

**Appendix**

In developing a long term vision for the UHF broadcasting band (focusing on the band 470-694 MHz), the studies need to consider the strategic objectives for broadcasting[[22]](#footnote-22) and mobile broadband as well as for the other applications such as PMSE. Furthermore it is of essential importance to take into consideration the interests and needs of the consumers who use these services.

These studies should take into account the demand and supply of services envisaged, based on the technological evolutions of the various platforms (e.g. mobile and digital terrestrial television) and the relevant indicators of the future consumer demand for these services. Therefore a set of indicators should be defined in order to monitor the assumptions made on expected developments.

Additionally, the impact of any potential spectrum redeployment, and the timescales involved, is to be duly considered given the existing international harmonization agreements such as the GE06 and the role of terrestrial broadcast services in achieving free-to-air reception, secondary TV set reception and national and European audiovisual policy objectives and in maintaining inter-platform competition for media services.

The overall objective of the studies is to define an underlying long term technical approach which is harmonised and which recognises differences in the balance of requirements that different countries in Europe may have to the different uses.

The studies should comprise the following:

Technical issues related to:

1. The evolution of broadcasting and mobile networks and services as well as other services and applications.

In this context, broadcasting should encompass foreseen developments in video resolution, coding, modulation/systems, receiving modes and coverage requirements. Mobile services should include categories of data traffic, traffic asymmetry, network topologies, off-loading, technologies such as eMBMS and Tower-Overlay. In addition, the concept of convergence/cooperation of both types of services/networks should be addressed.

1. Identification of cross-border coordination issues between different services (broadcasting, mobile, etc) and different network topologies.
2. Potential co-frequency and adjacent bands coexistence issues, taking into account the need to improve sharing possibilities between various usages.

General description of economic, social and cultural issues related to scenarios for the development of the band (advantages and risks, probability to happen, time scale) and a roadmap for the long term developments in the band as guidance for the CEPT administrations. This description should consider aspects such as:

1. ECC Strategic objectives
2. The delivery of mobile and broadcast services and their impact on programme making and special events (PMSE) applications
3. The appropriate balance between flexibility, including possibility of evolution of services nationally, and harmonisation in the band
4. Accommodating the evolution of broadcast usage and mobile traffic
5. Possible timelines, transition and re-farming issues
6. Costs and benefits

Regulatory aspects related to:

1. Existing regulation (Radio Regulations, GE06, RSPP, EC, Policies and regulation of audiovisual services, National digital agendas on wireless broadband…)
2. On-going discussions for the preparation of WRC-15 (AI 1.1 and 1.2) and the EC mandate on 700 MHz
3. The possible spectrum management framework in order to achieve the appropriate balance between flexibility, including possibility of evolution of services nationally, and harmonisation in the band.
4. 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 , and the regulatory framework for electronic communications networks and services, i.e. the Telecom Package Directives, in particular the Framework Directive and the Universal Service Directive . Furthermore, the Radio Spectrum Policy Programme defines the current spectrum priorities in the EU whilst the Geneva'06 Agreement 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.

* 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).

* 1. 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.

* 1. 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.'

* 1. Radio Spectrum Policy Programme

The Radio Spectrum Policy Programme (RSPP) defines the roadmap for how Europe can translate political priorities into strategic policy objectives for radio spectrum use. The following provisions 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.

* 1. Geneva Agreement 2006

The GE-06 Agreement is an international treaty that governs the use of the UHF band for terrestrial TV and other services in the ITU Region 1. In particular, the GE-06 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 GE-06 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.

* 1. 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.

1. Heading (style: ECC Annex heading1)
   * + 1. Heading 4 (style: ECC Annex heading4)
2. List of reference
3. 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>)
4. 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.
5. EC Mandate on 700 MHz (exact title).

1. 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)****.* [↑](#footnote-ref-1)
2. 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.* [↑](#footnote-ref-2)
3. Special Eurobarometer 396 - e-Communications Household Survey, August 2013   
   (<http://ec.europa.eu/digital-agenda/en/news/special-eurobarometer-396-e-communications-household-survey>) [↑](#footnote-ref-3)
4. See also <http://tech.ebu.ch/docs/r/r131.pdf> [↑](#footnote-ref-4)
5. 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> [↑](#footnote-ref-5)
6. 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>) [↑](#footnote-ref-6)
7. 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>) [↑](#footnote-ref-7)
8. Directive 2002/21/ EC, of 7 March 2022, 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>) [↑](#footnote-ref-8)
9. Directive 2002/22/EC, of 7 March 2022, 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>) [↑](#footnote-ref-9)
10. Further information on DVB-T2 including the latest specification can be found at <http://www.dvb.org/standards/dvb-t2>. [↑](#footnote-ref-10)
11. <http://tech.ebu.ch/docs/techreports/tr015.pdf> [↑](#footnote-ref-11)
12. A relevant sub-set of the DVB-T2 specification has been published as a T2-Lite transmission profile. [↑](#footnote-ref-12)
13. See <http://www.hbbtv.org>. [↑](#footnote-ref-13)
14. <https://extranet.itu.int/rsg-meetings/sg6/wp6a/default.aspx> [↑](#footnote-ref-14)
15. **Médiamétrie - Eurodata TV Worldwide - One Television Year in the World - Edition 2013** - <http://www.mediametrie.com/eurodatatv/communiques/one-tv-year-in-the-world-2012-or-the-multiple-tv-experience.php?id=831> [↑](#footnote-ref-15)
16. Average linear viewing time in Germany, France, Italy, Spain and the UK. [↑](#footnote-ref-16)
17. The MAVISE TV Database (<http://mavise.obs.coe.int/>) is maintained by the European Audiovisual Observatory. [↑](#footnote-ref-17)
18. <https://tech.ebu.ch/docs/techreports/tr013.pdf> [↑](#footnote-ref-18)
19. The Future of Broadcast Television Initiative (FoBTV) <http://www.nercdtv.org/FoBTV2012/en/aboutus.html> [↑](#footnote-ref-19)
20. IEEE International Symposium on Dynamic Spectrum Access Networks "Spectrum requirements for TV broadcast services using cellular transmitters", Ericsson, 2011 [↑](#footnote-ref-20)
21. 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> [↑](#footnote-ref-21)
22. See response 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>) [↑](#footnote-ref-22)