Radio Spectrum Policy Group

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

The questionnaire in **Annex 1** has been prepared to facilitate the work of the sub-working group of Radio Spectrum Policy Group (RSPG) preparing the draft opinion on the future spectrum requirements for Wireless Broadband, specifically issues relative to the future of the 700 MHz frequency band (694 -790 MHz). This frequency band is currently used in Europe for terrestrial television and in many countries also for PMSE on secondary basis and represents approximately 30% of the total remaining UHF spectrum used by the television broadcasting. The impact of an exclusive reallocation of this spectrum to wireless broadband will therefore be significantly more important for the broadcasting service than in the case of the 800 MHz band.

The responses to the questionnaire[1] will contribute to the analysis of the RSPG on the future use of the 700 MHz as well as on the evolution of the digital terrestrial platform (DTT) over the next decade (2012 – 2022)

For more information on the background to the various elements of the questionnaire see **Annex 2.**

For an example of how to respond to Question 1 please see **Annex 3**.

Please submit completed questionnaire contained in Annex 1 and return to [zeeshan.nazneen@comreg.ie] by [Friday 28th September 2012].

[1] The RSPG is aware of the ITU-R WP 6A questionnaire which addresses similar issues and we will if possible try to use responses to that questionnaire to complement the information/views in the draft opinion.

Annex 1: Questionnaire

Member State Response details (please complete):

Member State	*Name*	*Organisation*	*Date*
PORTUGAL	Hélder Vasconcelos / Luísa Mendes	ICP-ANACOM	28/09/2012

Question 1 (consider section 1 of Annex 1 to help you with your answer):

(See Annex 2 for example answers for your assistance)

i) Please describe the DTT platform in your country, currently on-air, in following terms (please use the following format for your answers):

Member State	**No. of Multiplexes**	**Reception availability**	**Reception mode**[2]	**Number of TV program services and content format**	**DTT System and modulation**	**Intended coverage reach**[3]	**Coverage obligation (Y/N)**[4]	**Coverage (as a percentage of population)**	**Spectrum band used (UHF IV/V or VHF Band III)**
PT	1	FTA	Fixed (roof-top); Portable indoor in some historic centres	4 national SD + 1regional SD in Azores + 1 regional SD in Madeira	DVB-T , 64-QAM	National	Y	93%; the remaining 7 % is provided via DTH	UHF Band V

[2] E.g., fixed (roof-top), portable indoor, portable outdoor, mobile.
[3] E.g., national, regional, local.
[4] Is there a legislative coverage obligation, e.g., a Public Service Broadcaster.

ii) Are there plans to deploy (a) additional DTT multiplexes and/or (b) foresee the launch of new services **in the short term (1 – 5 years)?**

(a) additional DTT multiplexes (please use the following format for your answers)

Member State	**additional Multiplexes (Y/N)**	**No. of additional Multiplexes**	**Reception availability**	**Reception mode[5]**	**Expected content format (SD and or HD)**	**Expected DTT system and modulation (if known)**	**Intended coverage reach[6]**	**Intended Coverage (as a percentage of population)**	**Spectrum band used (UHF IV/V or VHF Band III)**
PT	Y	1	FTA	Fixed (roof-top); Portable indoor in some historic centres	HD	DVB-T, 64 QAM	National	93%; the remaining 7 % is provided via DTH	UHF Band V

(b) foresee the launch of new services (please use the following format for your answers)

Member State	**Additional Services (Y/N)**	**Expected content format (SD and or HD)**	**Reception availability**	**Expected content format (SD and or HD)**	**Interactive services (Y/N)**	**VoD (Y/N)**	**Ultra High Definition TV (Y/N)**	**Other (Y/N)**	**If answer Yes to Other, please specify**
PT	Y	SD	FTA	SD	N	N	N	N	

[5] E.g., fixed (roof-top), portable indoor, portable outdoor, mobile.
[6] E.g., national, regional, local.

iii) When do the existing DTT licenses in your country expire?

Answer: The right of use for DTT frequencies was granted for a 15-year period of time and expires in 9 December 2023.
This right of use can be renewed in accordance with Article 33 of Law n. 51/2011, of 13 September (see http://www.anacom.pt/render.jsp?contentId=1099877&languageId=1

Question 2

How do you foresee different means of reception (DTT, ADSL, Cable, satellite, etc) complementing each other?

Answer:

In general, ICP-ANACOM considers infrastructure-based competition to be a desirable outcome, and has in many circumstances attempted at promoting it, as well as promoting technology neutrality as a guiding principle. Therefore, as long as it is efficient, ICP-ANACOM believes that different technologies may be actively used by market participants in order to achieve a high level of effective competition.

The use of complementary means of reception instead of using only one, may drop the total costs of reaching the same population level, because it allows the use of the most efficient means of reception in each of the heterogeneous situations that must be contemplated by operators. In the cases where different means of reception cover the same geographic area, there is also the advantage of allowing end users to choose the more convenient means of reception for their specific situation.

Therefore, it can be efficient to use different means of reception in a complementary way; this is true both for Free to Air Television (FTA) and for Pay-TV.

In general, we may speak about "complementariness" from the point of view of the users and the television operators, but in "competition" from the point of view of the platform operators.

More specifically we can add that the satellite platform is in fact a complementary platform for all the others, and both for FTA and Pay-TV.

FTA:

In Portugal the Digital Terrestrial Television (DTT) was implemented using the satellite platform (DTH) to complement the terrestrial platform in the geographic areas where there was no technical viability for DTT implementation, and having in mind the topology of the SFN network. The provision of FTA services through the satellite platform affects a small percentage of the population (less than 10%); however, although not being any more the primary means of

reception, the terrestrial platform is still used by a significant number of households (48.2% of classic family households don't have Pay-TV, and at the same time, from the point of view of "classical families" the percentage is nearly 27% without Pay-TV), in particular in remote and rural areas, either as the unique means of reception or for secondary TV sets in households with other means of reception for the primary TV set. Even though assuming that DTT penetration might decrease a bit further, we still consider it, at least in the short/medium term, the most rational and viable alternative to provide a FTA TV service, available to the whole population.

DTT is in fact the most affordable and simpler option for everyone and everywhere, to access public TV and other popular services. For some users it is also a complement to other means of reception. Investments made so far by DTT network and by consumers in DTT receiving equipment, need to be preserved for sufficiently long time.

Pay-TV:

The satellite (DTH) is also commonly used as a complementary means of reception for Pay-TV, being mostly used in the geographic areas where CABLE, ADSL and FTTH (IPTV) are not available, for technical/economical reasons.

Looking to the existence of different means of reception from the demand side perspective, it is possible that end users consider different means of reception as substitute rather then complementary. In fact we can consider the different platforms (e.g. CABLE, ADSL, FTTH) as competitors.

At this moment we foresee a considerable growth for FTTH in the near future, although the other platforms should remain stable.

Question 3:

i) Do you think that the DTT platform in your country will evolve to being capable of delivering audio-visual services also to mobile terminals?

Answer:

There are different points of view between mobile operators and broadcasters on this subject; the broadcasters are convinced that there will be a DTT evolution towards mobile reception, as presented in several reports and studies by DIGITAG, ACT and EBU, while mobile operators believe that LTE will be the efficient technology to deliver audio visual services to mobile terminals.

The delivery of audio-visual services to mobile terminals is already available, but it is not provided by the DTT platform and it is still very far from being massified. We might anyway assume that it will quite probably occur in the short/medium term (may be 5 – 10 years); it is not clear however, which platform

will be the main one to provide such services. This evolution will be strongly influenced by external factors, in particular the developments in Europe, and will depend on market demand and on availability of a significant number of mobile terminals having DVB tuners.

ii) If yes, what is the required evolution of the DTT network platform architecture? Please give details in relation to: -
   a. the DTT network topology (whether there will be a need to migrate from high- power/ high- tower to low- power/ low- tower type of networks);
   b. to the use of MFN versus SFN networks to achieve the evolution, and
   c. a possible migration to a new DTT system(e.g. to facilitate interactive services) and transmitting technologies (e.g., DVB-T2, DVB-T2 Lite, etc.).

Answer:

a. Considering the Portuguese DTT network topology, a low power/low tower type of networks should not be excluded.

b. Delivery to mobile terminals can be achieved by either MFN or SFN networks, or a mixture of both. SFNs may in some cases increase spectrum efficiency and improve quality of mobile coverage compared to MFN. However, SFNs architecture also bears a number of inherent constraints, in particular those related to self-interference, which require trade-offs to be made between the size of the coverage area, capacity, ruggedness and costs. Therefore, implementing SFN does not automatically lead to better performance for mobile delivery; therefore the use of MFN networks should not be excluded.

c. Concerning a possible complete migration from DVB-T to DVB-T2 or DVB-T2 Lite, we should be aware that the migration to DTT was accomplished only recently, (April 2012), and in order to safeguard users investments it is unlikely to have big changes at technology level in the short/medium term, unless a long simulcast period of both signals would occur; but anyway, we cannot ignore such migration in a medium/longer term, also as a necessary driver for the development of DTT.

iii) Do you believe that a DTT platform evolving towards delivering audio-visual services also to mobile terminals may also be used by mobile operators to cope with:
   a. the data traffic required to deliver linear video content (i.e., with mobile terminals including broadcasting tuners), and
   b. certain non-linear content that could be pushed (and stored)?

Answer: We believe that a DTT platform will deliver audio-visual services to mobile terminals only if it will be used by mobile operators to cope with data traffic required to deliver linear video content. We also believe that for non-linear content, the interactivity of LTE would better suit applications based on video and streaming distribution.

iv) What evolutions do you expect would be required for mobile networks to be capable of delivering linear video content ubiquitously to both fixed and mobile terminals?

Answer: Although we should not exclude, *a priori*, any solution, mobile networks are in principle less tailored to provide linear video services to mass audiences in large areas than broadcast networks, namely to fixed terminals. Anyway, evolved Multimedia Broadcast / Multicast Services (eMBMS), which is already standardized, open the possibility of providing linear video content more efficiently and should be duly considered, at least for mobile terminals with smaller screens (tablets, smartphones, etc).

However, even if mobile technology is already capable of delivering linear video content to mobile terminals, it has a limited capability of delivering linear services to large audiences, in particular because of:

- lack of capacity;
- limited coverage where sufficient QoS can be sustained;
- high costs of delivery;
- nowadays there are no fixed terminal (TV sets) who can be connected to a mobile network.

Mobile networks would need to address the above mentioned issues if they are to become a viable platform for the delivery of linear video content to large audiences.

v) Of a possible convergence between terrestrial mobile and (evolved) DTT platforms,what do you consider will be the consequences of mobile networks being capable of delivering linear video content to mobile terminals?

Answer: This convergence is a possibility to consider in the medium/long term, and it would imply a big change of paradigm, both at the providers (traditional broadcasters, mobile operators, advertisers) and consumers/users levels, as well as at a regulatory level.

The proliferation of delivery options and market fragmentation pose huge challenges to broadcasters and advertisers that will need to intensify and diversify their efforts to reach the same audience. Advertisers will have however the chance of reaching their customers in a more personalized way.
For mobile operators, delivering linear video content may bring additional revenue opportunities and enable competition with the broadcast network operator, depending on the business model.
The provision of linear video will also give mobile operators the chance of exploring together non-linear video services such as catch-up and time shifted. Finally, this also raises opportunities for new comers in the market, providing content aggregation.
Consumers will be able to view TV in a more personalized and ubiquous way, as it might be theoretically available *everytime* and *everywhere*.
Regulators will have to adapt to the growing overlapping of telecommunications and television sectors, with impact on market analysis and subsequent regulatory intervention.

It should also be stated that from the broadcasters point of view, it is very unlikely that this convergence will occur, in particular due to fact that DTT and mobile networks are not only based on different technology, but also in different business models.

Question 4:

i) How many DTT multiplexes do you expect will be needed in your country in the long-term (beyond 2020),

Answer: Having in consideration the present situation, namely from the economic point of view, and not being very easy to anticipate, we foresee that at least five multiplexes will be needed, taking into account opinions of some stakeholders; however this will have to consider the evolving needs of terrestrial broadcasting.

ii) What services do you expect the DTT multiplexes to carry (assuming use of DVB-T2/HEVC)?

Answer: National and Regional FTA TV programmes in HD format (3D, UHD).

iii) What transition and migration paths do you anticipate will be required to achieve this long-term DTT goal for your country?

Answer: It is vital to guarantee that sufficient spectrum must be available to accommodate the evolving needs of terrestrial broadcasting.

The most important area in a migration path is the viewers. People need to be motivated to change the equipment from DVB-T to DVB-T2 (TV sets can be used for more than 10 years); a dual and simultaneous migration, both in the video coding format (HEVC or other) and in the DTT system (T2 Lite or other), would be preferable, to avoid two transitions, and in this way minimizing the social impact, although we can anticipate this transition to be long and slow.
In the long term new multiplexes are expected to be needed for upgrading to HD and UHD TV; such HD or UHD Multiplexes need to be introduced in simulcast with existing ones, to allow consumers to invest in new equipment during transition period.

Another important issue is the cost involved in all the process. As soon as the financial recovery starts, the advertisement market will grow providing a base for the appearance of new channels/new operators.

Annex 2: Background and Context

The terrestrial television digital switchover (DSO), i.e. the transition from analogue to digital broadcasting, is well advanced within the European Union. Most Member States have already completed their migration plan or are expected to have completed it by 2012.

Compared to analogue TV, DTT delivers greater variety and choice for EU households (greater number of services, higher video and audio quality, multichannel sound, better accessibility of TV programmes through higher availability of subtitles and audio-description, linear and interactive services, free-to-air and subscription television, local/regional TV).

The terrestrial broadcast platform is the primary means of delivering broadcast services within the EU and it is observed that DSO has revitalized terrestrial distribution in some European countries, inducing a growing number of viewers at the European scale.

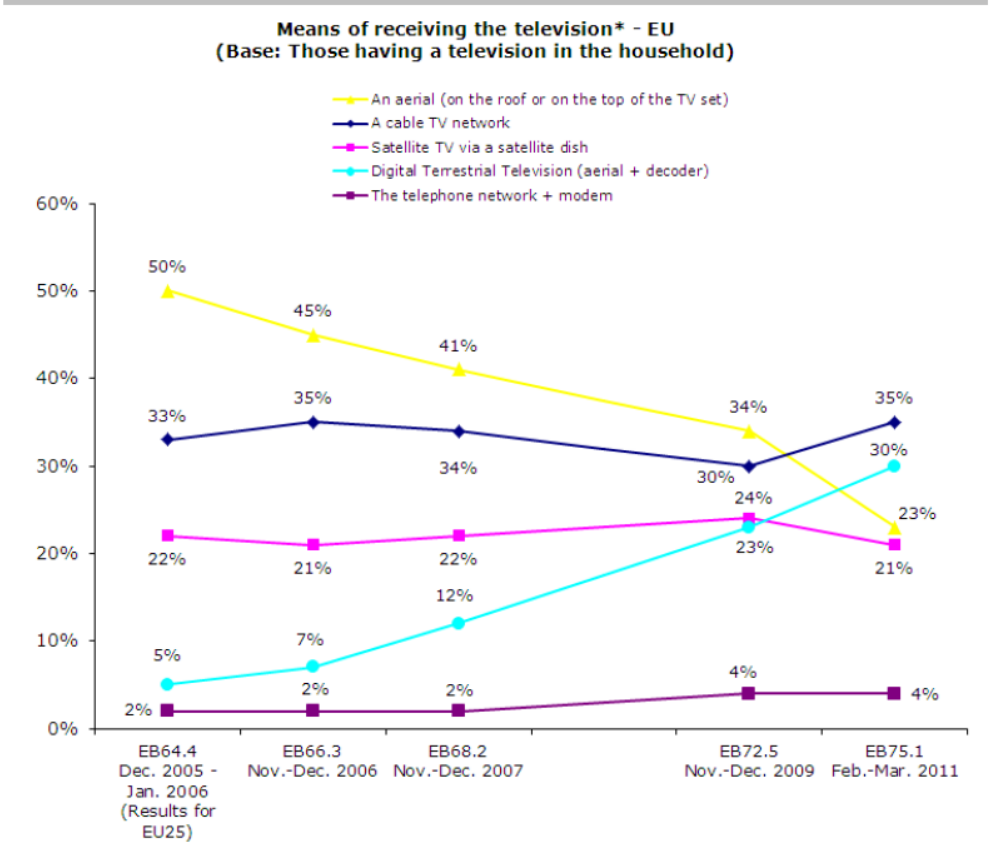
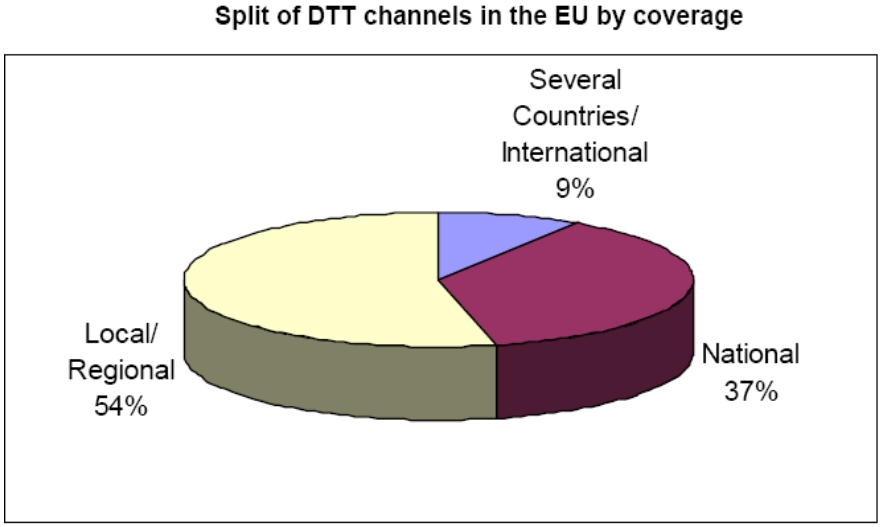


Figure 1: How European households receive TV? (source: Eurobarometer 362[7], E-communications household survey, July 2011)

The objective of this questionnaire is to invite Members States to share their views on the evolution of the digital terrestrial platform (DTT) over the next decade (2012-2022).

1) The DTT platform in 2012 in the EU

According to the "MAVISE TV database", developed by the European Audiovisual Observatory for the European Commission**,** it was expected that 16 EU countries would have completed their switch-off of analogue terrestrial signals by the end of 2011.
The "MAVISE TV database" showed that the total number of TV channels broadcast on European DTT networks was almost 1,800 in June 2011 (compared to almost 1,500 in October 2010). The total includes a very large number of local channels. There are very significant numbers of local channels in Italy, Spain and Denmark.



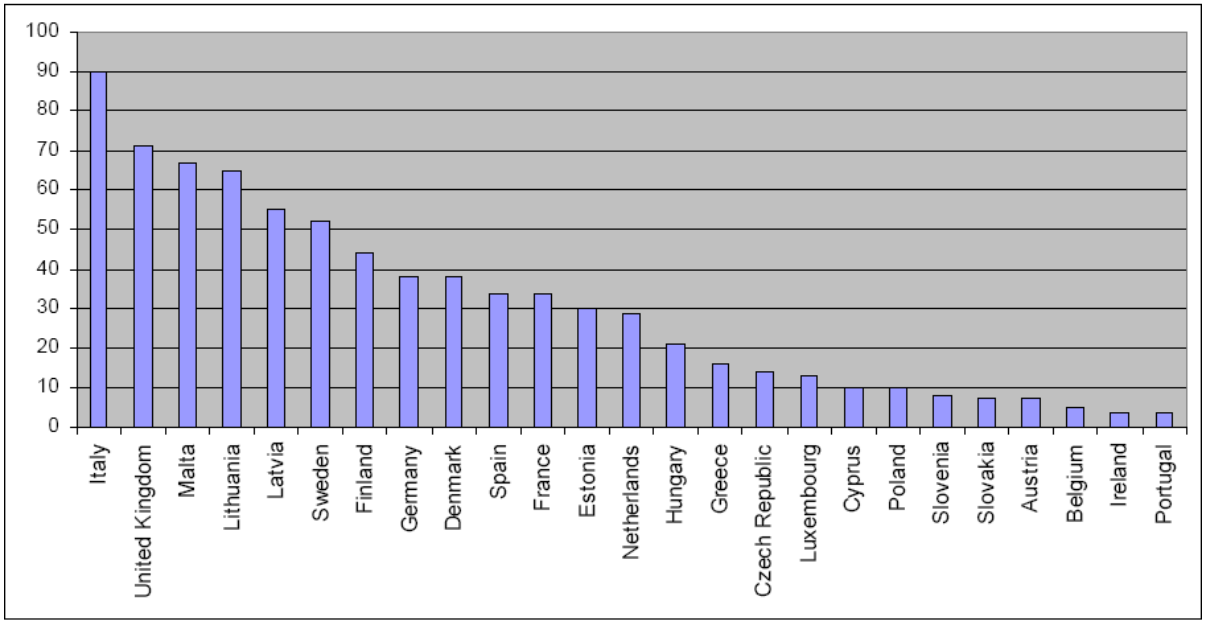
Source: MAVISE June 2011

The number of national and international TV channels available to DTT households has increased to more than 820 in June 2011 (compared to 500 in April 2009).

[7] Conducted by TNS Opinion & Social at the request of Directorate-General Information Society and Media of the European Commission

In the EU, the number of TV channels available nationally varies widely between countries (see figure below). The maturity of the DTT market, the sharing of frequencies between TV channels (full-time TV channels vs. part-time TV channels) and the availability of pay TV packages may influence this. For example, the most recent launches in Ireland and Portugal have the least number of TV channels. At the other end of the scale, Italy has a far higher number of national TV channels than all other EU countries.

National Channels on DTT networks in the EU



Source: MAVISE June 2011

There are various digital TV platforms available in EU countries after DSO
:

- Digital terrestrial TV
- IPTV (“ADSL”) or FttH ;
- Digital satellite;

QC4 Does your household receive the television via...?
(MULTIPLE ANSWERS POSSIBLE)

	Digital Terrestrial Television (aerial + decoder)	An aerial (on the roof or on the top of the TV set)	Satellite TV via a satellite dish + decoder	A cable TV network (analog = directly connected to the TV set)	A cable TV network + decoder (digital TV)	The telephone network + modem and/ or decoder	Don't know
EU27	30%	23%	21%	19%	16%	4%	1%
BE	6%	*0%*	4%	**46%**	34%	14%	0%
BG	19%	19%	7%	**41%**	15%	*0%*	1%
CZ	**34%**	28%	21%	10%	11%	*0%*	0%
DK	7%	13%	13%	25%	**39%**	*6%*	3%
DE	6%	2%	**38%**	30%	28%	*1%*	0%
EE	18%	12%	*10%*	**33%**	23%	*10%*	2%
IE	5%	26%	**43%**	12%	16%	*1%*	3%
EL	11%	**92%**	3%	1%	*0%*	*0%*	0%
ES	**76%**	25%	*2%*	*2%*	6%	2%	1%
FR	**51%**	35%	16%	*4%*	7%	19%	1%
IT	**56%**	41%	17%	6%	9%	*1%*	1%
CY	14%	**82%**	8%	6%	4%	*2%*	0%
LV	29%	7%	15%	**41%**	7%	*2%*	2%
LT	12%	**37%**	6%	**37%**	9%	*2%*	1%
LU	8%	*3%*	21%	32%	**39%**	5%	2%
HU	*1%*	16%	17%	**54%**	12%	*1%*	0%
MT	**37%**	7%	5%	21%	33%	*1%*	1%
NL	22%	*0%*	6%	**42%**	31%	4%	2%
AT	5%	7%	**45%**	37%	10%	*2%*	2%
PL	7%	**32%**	26%	28%	10%	*0%*	1%
PT	8%	**47%**	8%	27%	11%	*2%*	2%
RO	18%	6%	5%	**60%**	10%	*1%*	2%
SI	22%	7%	*4%*	**37%**	23%	10%	1%
SK	13%	26%	**28%**	27%	10%	*1%*	1%
FI	21%	32%	2%	12%	**36%**	*0%*	1%
SE	27%	11%	14%	25%	**28%**	*6%*	4%
UK	35%	27%	**36%**	2%	15%	*1%*	1%

Highest percentage per country *Lowest percentage per country*

Highest percentage per item | Lowest percentage per item

Cable reception, eithe r pay or free.

Figure 2: How European households receive TV? (source: Eurobarometer 362[8], E-communications household survey, July 2011)

The penetration of each digital TV platforms evolves differently in EU countries.

It has also to be noted that many households are equipped with more than one TV set and are using different platforms.

TV platform penetration analysis should also include households which are equipped with at least 2 TV sets as basic pay-TV offers do not include equipment or intellectual property rights to receive TV channels on a secondary TV set[9].

The competitiveness of the DTT platform is related to the number and video-audio quality of services delivered to viewers, which in turn depends on the amount of UHF spectrum available. To deliver benefits to citizens and consumers, the DTT platform should remain sufficiently attractive to viewers so that it can remain commercially sustainable as a platform, and sustain consumer choice in TV content, platforms and equipment.

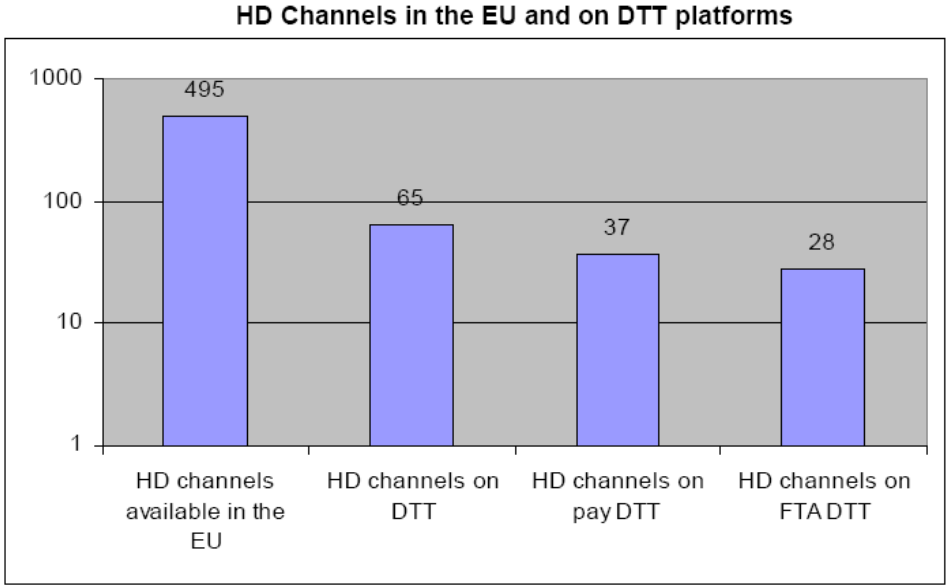
2) Video Format Evolution

There is a strong demand for **HDTV** in the EU, which – among several factors – can be explained by the dramatic adoption of large flat screen television by consumers.

The success of DVD, of Blu-Ray discs, of video-game consoles or home theatre equipments has also reinforced the growing expectation of video and audio quality of EU-households, and is making Standard Definition (SD) content appear comparatively inferior in terms of quality.
HDTV technology, along with large screen displays, has become the norm in homes, where audiences enjoy high-quality programme content.

According to the "MAVISE TV database", developed by the European Audiovisual Observatory for the European Commission**,** HDTV channels were available on DTT platforms in 13 EU countries in June 2011 (as compared to 8 in October 2010): Czech Republic, Denmark, Finland, France, Greece, Hungary, Italy, Latvia, Lithuania, Luxembourg, Spain, Sweden, the United Kingdom and also in Norway.
HDTV channels were available on both Free-to-Air and Pay-TV platforms in most of these countries (except Latvia and Lithuania where HD is on Pay DTT only). On the Free-to-Air platforms, the TV channels were the simulcast or HD versions of the major national public and private generalist TV channels. On the pay-TV platforms, the HDTV channels were niche channels, film channels and pan-European documentary channels.

[8] Conducted by TNS Opinion & Social at the request of Directorate-General Information Society and Media of the European Commission
[9] Secondary TV sets means TV set of rank 2 but also TV sets of rank 3, 4… whenever they exist.



Source: MAVISE June 2011

	SD	HD			UHD	
	576i	720p	1080i	1080p	4Kx2K	8Kx4K
Pixels x Lines	720 x 576 25 frames/s	1280 x 720 50 frames/s	1920 x 1080 25 frames/s	1920 x 1080 50 frames/s	3840 x 2160 50 frames/s	7680 x 4320 50 frames/s
Mpixel/s	10	46	52	104	415	1659

SD = Standard Definition TV format
HD = High Definition TV format (the resolution of HDTV is described in Recommendation ITU-R BT.709 as 1920×1080).
UHD = Ultra High Definition TV format

HDTV offers higher picture quality than SDTV. Instead of providing an image with 576 active lines, HDTV provides an image with a format of either 720 or 1080 active lines on the screen. Motion portrayal can also be better rendered than by traditional SDTV depending on whether the active lines form a progressively scanned picture fifty times a second, rather than a complete interlaced image twenty five times a second. HDTV is also always formatted as 16:9, and for equal picture resolution needs proportionately a greater number of pixels per line than for the conventional 4:3 format.

The 1080i format is often broadcast at a reduced horizontal resolution 1440 pixels x 1080 lines at 25 frames/s, corresponding to 39 Mpixel/s.

Migration towards a full HDTV (1080p) landscape

Production technology is full HD, which means that all programmes in the future will be 1080p HD quality, as for Blu-ray discs. Moreover, consumers are more and more equipped with full HD TV sets.

In order to continue to provide a competitive and attractive DTT platform, it is believed that DTT services should be delivered to consumers in a full HD format (1080p).

3DTV

ITU-R Report BT.2160 «Features of three-dimensional television video systems for broadcasting».

For the next decade (2012-2022), it is assumed that 3D services will be occasionally available on the DTT platform (special sports events or certain movies for example). It is expected that it will remain a relatively minor part of the total programme offering and hence, should not have a significant impact on the overall DTT capacity requirement.

According to the "MAVISE TV database", 3D-DTT tests were being carried out in several EU countries in June 2011 (Italy, the Netherlands, Spain, Sweden, the United Kingdom, etc.). At that time, 3DVoD was already available in Italy.

UHDTV (4Kx2K)

ITU-R Report BT.2246 «The present state of ultra high definition television» was adopted in October 2011: UHDTV[10] is a television application that is intended to provide viewers with an enhanced visual experience primarily by offering a wide field of view that virtually covers all of the human visual field with appropriate sizes of screens relevant to usage at home and in public places.

Compared with current HDTV, UHDTV should bring considerably improved benefits to its viewers. Those benefits may include:

– stronger sensation of reality or presence;
– higher transparency to the real world;
– more information.

It may be presented in:

– living rooms;
– personal spaces in mobile and non-mobile environments;
– collective viewing locations such as theatres.

In ITU-R Report BT.2246, it is concluded that, from the point of view of image presentation, 4Kx2K UHDTV television broadcasting to the home may find acceptance with in-home television audiences, while it may be unlikely that 8Kx4K UHDTV will do so. The 8Kx4K UHDTV image system may instead find applications for television presentations to the public in theatres, in home theatres, auditoria, theme parks, and other public venues.

[10] Ultra High Definition Television

ITU has announced in May 2012 that a new Recommendation that represents a major advance in television broadcasting that will create an entirely new television broadcast environment with the advent of 'Ultra High Definition Television' or UHDTV.

3) The introduction of non-linear services

Non-linear services correspond to on-demand audiovisual services (catch-up TV, VoD…), HbbTV, etc.

4) DTT Reception Mode Evolution: from fixed (rooftop) reception towards mobility

Non-linear content delivery / "Datacasting" [TBD on the basis of ITU-R Report BT.2049 : digital broadcasting to handheld terminals via broadcast spectrum in a mobile environment including in-door, in-vehicle and in-transit reception at speeds matching cellular mobile networks characteristics. Broadcasting of multimedia and data applications to mobile devices will also elaborate the expanded service opportunities offered by the inclusion of interactivity through the application of wireless networks such as those of the IMT family.].

DVB-H, MediaFLO: no commercial success of dedicated mobile TV networks (except T-DMB/S-DMB in Korea).

Some European countries (like Germany or Switzerland) have chosen a mixed fixed/mobile reception scheme for their DVB-T services, which permits to address at least part of the mobile reception, with coverage complemented if needed by other means.

Is there a new opportunity with DVB-T2?

DVB-T2 can provide robust mobile reception at high speeds, at the cost of reduced bitrate. To facilitate the implementation of mobile application, DVB has defined a mobile profile of T2 called *T2-Lite*. This new profile is basically a subset of the already existing T2 specification with a few minor add-ons and a data rate limited to 4 Mbit/s, which allows a reduction of the receiver chip size by 50%. The *T2-Lite* profile allows the mixing of frames with different FFT sizes and guard intervals in a time-division-multiplex – the so-called Future Extension Frames (FEF) thus optimizing OFDM parameters for fixed and mobile reception. The *T2-Lite* profile will soon be completed with additional technologies that are not yet included in the T2 toolbox such as MIMO.

Aside this T2-Lite option, there is also the possibility to have an hybrid network in T2, which delivers HD or SD services both to fixed, portable and mobile receivers, with a coverage complement over other point-to-point networks. It is to be noted that both recent smartphones and tablets embeds high resolution displays that are already very close to full HD resolutions.

Providing services towards mobile terminals is likely to require higher field strength for the coverage. This may have an impact on the platform network architecture.

5) Technical considerations

It appears that DTT landscape will no longer evolve without an evolution of transmission or compression standards.

Improvements in video compression technologies
ITU-T Recommendations H.262 (MPEG-2 Video)

ITU-T Recommendation H.264 (MPEG-4/AVC). MPEG-4/AVC was designed to provide a 50% bit-rate saving compared to MPEG-2. The use of this technology made it possible to launch HDTV services on the DTT platform.

Draft ITU-T Recommendation H.265 (HEVC): a new video compression standard, called HEVC (High Efficiency Video Coding), is currently being developed jointly by ISO/IEC MPEG and ITU-T VCEG. This new technology is designed to achieve up to 50% video compression efficiency gain compared to MPEG-4/AVC, but at a cost of greater computation power[11]. A wide range of video resolutions is expected to be covered, from low resolution to UHD (4Kx2K and 8Kx4K). The HEVC standard may be finalized in January 2013 and it may be possible to envisage the launch of first broadcast services in 2015/2016.
The use of this technology, along with DVB-T2, may allow the transition towards full HDTV services (1080p) and the launch of the first UHDTV (4K) services over the DTT platform within the end of the next decade (2022).

Bit-rate savings (at constant video quality):
There is a gradual evolution of encoders giving greater efficiency within a specification, where existing decoders can continue to be used.
- MPEG-2 encoder performance may still be improved by manufacturers. A further gain of 5 to 10% may be expected within 3 to 5 years;
- MPEG-4/AVC encoder performance will also be improved over time. A further gain estimated between 10% and 20% may be achievable within 3 to 5 years.
- First generations of HEVC encoders may provide, in 2015/2016, a 30% bit-rate saving compared to the best MPEG-4/AVC encoders available today, and a 50% bit-rate saving in 2022.

However, it shall be noted that two specific requirements of broadcast TV services can hinder these bit-rate saving expectations, particularly in the case of the HEVC saving forecast:
- Step-in the live video stream implies higher bit-rates since there is an obligation to regularly broadcast enough information to allow a fast reconstruction of the first image to be displayed after zapping (compared to downloaded media);
- "on the fly" encoding does not allow a great optimization of the bitrates since it has to be performed "real time".

		Today			**Expected 2015/2016**			**Expected 2022**		
Format	Video coding	Video data rate (Mbit/s)	Audio and other associated data	Total (Mbit/s)	Video data rate (Mbit/s)	Audio and other associated data	Total (Mbit/s)	Video data rate (Mbit/s)	Audio and other associated data	Total (Mbit/s)

[11] It is estimated that the computational complexity will be 10 times that of MPEG-4/AVC for encoders and 2 to 3 times for decoders

			(Mbit/s)			(Mbit/s)			(Mbit/s)	
SD	MPEG-2	3	0,5 to 1	3,5 to 4	2,7	0,5 to 1	3,2 to 3,7	2,7	0,5 to 1	3,2 to 3,7
SD	MPEG-4/AVC	2 to 2,5	0,5 to 1	2,5 to 3,5	1,7 to 2,1	0,5 to 1	2,2 to 3,1	1,7?	0,5 to 1	2,2 to 2,7
HD-720p	MPEG-4/AVC	6 to 7	1 to 1,5	7 to 8,5	5,1 to 5,95	1 to 1,5	6,1 to 7,45	5?	1 to 1,5	6 to 6,5?
HD-1080i	MPEG-4/AVC	7 to 8	1 to 1,5	8 to 9,5	5,95 to 6,8	1 to 1,5	6,95 to 8,3	5,8?	1 to 1,5	6,8 to 7,3
HD-1080p	MPEG-4/AVC	12 to 13	1 to 2	13 to 15	10,2 to 11	1 to 2	11,2 to 13	10?	1 to 2	11 to 12?
HD-1080p	HEVC				8,4 to 9,1	1 to 2	9,4 to 11,1	5?	1 to 2	6 to 7?
4k	HEVC				[20 to 30]	1 to 2	[21 to 32]	[11 to 20]?	1 to 2	[12 to 22]?

Rough estimate of average DTT bitrates for different formats&coding technologies over next years[12]

(Highest expected saving figures were retained for calculation)

In addition to the video signal, the audio component and other associated data must be transmitted [TBD]:

- Audio component(s)[13]:: 0,2 to 0,5 Mbit/s;
- Subtitles/audio-description: 0,1 to 0,3 Mbit/s;
- EPG: strongly depending on data depth and details, and on technology used
- Signalling (MPEG PSI, DVB-SI):: [tbd]
- Interactivity (HbbTV,…): typically 0,1 to 1 Mbit/s per channel.

Improvements in DTT transmission technology: DVB-T2

DVB-T2[14] is an improved variant of DVB-T providing higher capacity and/or more robustness. DVB-T2 has already been introduced in some countries, with the main target to provide HDTV using MPEG-4 for fixed rooftop reception.

DVB-T2 also offers additional transmission modes suitable for the provision of portable and mobile reception.

One of the new features DVB-T2 offers is called multiple Physical Layer Pipes (PLPs). Multiple PLPs enable service-specific robustness. For example, a single DVB-T2 multiplex could carry a mixture of HDTV aiming at household television sets fed by rooftop aerials, as well as some low-bit rate, more rugged services aiming at portable receivers.

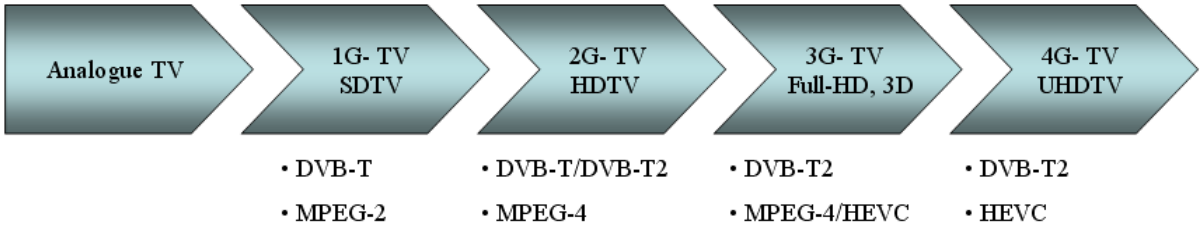
[12] Further studies to better estimate these average bitrates are needed.

[13] There is a trend to add to the national language audio stream two other audio: native original langage, audio description. Moreover multichannel audio (5.1 and over) needs higher bitrates than stereo.

[14] http://www.dvb.org/technology/dvbt2

DVB-T2 can also provide robust mobile reception at high speeds. To facilitate the implementation of mobile application, DVB has also defined a mobile profile of T2 called *T2-Lite* (see above).

Technology transitions



A critical aspect of the implantation of new source coding technologies and transmission technologies is the transition.

Lessons from the DSO:
- For a certain period of time, a simulcast with old and new technologies is required;
- A certain amount of additional spectrum is needed;
- An incentive is required for viewers to accept the transition because they will have to pay for new user equipment. Technology transitions should be associated with new consumer propositions sufficiently attractive to drive the adoption of new technology;
- A Government intervention is required.

The free-to-air DTT platform is a horizontal market where any retailer can market the customer premises equipment (digital TV sets, digital set-top boxes). The DTT platform management and ecosystem are relatively complex. The decision-making process relies on coordination and consensus among many players involved.

Should the technology transition be a market-led process? It seems difficult to envisage a simple infrastructure change with no or little added value for citizens[15]. Many routes are possible in terms of the speed and length of the process, the parties involved, and the degree of government intervention. Furthermore, the transition challenge may vary from MS to MS, depending on the initial situation. In France, HDTV was launched using DVB-T/MEPG-4 in 2008, whereas in the UK, HDTV was launched using DVB-T2/MPEG-4.
MS that have already accomplished the full DSO with MPEG-2/DVB-T will hesitate to quickly adopt MPEG-4 and/or DVB-T2 since viewers would be required to replace their recently acquired receiving equipment. On the other hand, EU countries that made a late start to DTT are in the position to directly begin DTT deployments in MPEG-4/DVB-T2.

[15] See the example of SECAM « bottles » removal in France, that took decades to be completed

Although DVB-T2 may offer many advantages over DVB-T, it is likely that both systems will co-exist across Europe for a relatively long period of time in order to safeguard the users' investments during the analogue switch-off. Nevertheless, a gradual transition to DVB-T2 could be beneficial in the long term.

It is believed that the transition "dividend" shall benefit to maintain an attractive and competitive DTT platform and follow the service offering evolution expected on the other platforms: higher quality, new linear and non-linear services, mobility, etc.

6) Spectrum Requirements

To assess the amount of spectrum required to provide a certain number of services, it is necessary to make assumptions about the required multiplex capacity.

The spectrum needs to support DTT in the EU may be envisaged, based on the identification of 3 different scenarios:

1) EU countries with strong DTT penetration vs. other platforms (France, UK, Italy, Spain, …)
2) EU countries with medium DTT penetration vs. other platforms
3) EU countries with low DTT penetration vs. other platforms (Sweden, Germany, Netherlands, …)

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Annex 3: Suggested format with example Answers to Question 1

Question 1 (i) - Please describe the DTT platform in your country, currently on-air:

Member State	**No. of Multiplexes**	**Reception availability**	**Reception mode**[16]	**Number of TV program services and content format**	**DTT System and modulation**	**Intended coverage reach**[17]	**Coverage obligation (Y/N)**[18]	**Coverage (as a percentage of population)**	**Spectrum band used (UHF IV/V or VHF Band III)**
IX	2	Free-to-air	Fixed	6 SD, 1 HD	DVB-T, 64-QAM	National	Y	98.7%	UHF Band IV/V
IX	2	Pay-TV	Portable indoor	12 SD, 4 HD	DVB-T2, 256-QAM	National	N	90.5%	UHF Band IV/V
AY	2	Free-to-air	Fixed	4 SD, 1 HD	DVB-T, 64-QAM	National	Y	97.5%	VHF Band III
AY	2	Free-to-air	Fixed	6 SD, 4 HD	DVB-T2, 256-QAM	National	N	95.4%	UHF Band IV/V
BZ	4	Free-to-air	Fixed	16 SD, 4 HD	DVB-T, 64-QAM	National	Y	98.2%	UHF Band IV/V
BZ	1	Free-to-air	Fixed	6 SD, 4 HD	DVB-T2, 256-QAM	National	N	96.8%	UHF Band IV/V
BZ	1	Free-to-air	Portable indoor	6 SD	DVB-T, 16-QAM	Regional	N	33.6%	UHF Band IV/V

[16] E.g., fixed (roof-top), portable indoor, portable outdoor, mobile.
[17] E.g., national, regional, local.
[18] Is there a legislative coverage obligation, e.g., a Public Service Broadcaster.

Question 1 (ii) – Are there plans to deploy (a) additional DTT multiplexes and/or (b) foresee the launch of new services in the short term (1 – 5 years)

(a) *additional DTT multiplexes*

Member State	**additional Multiplexes (Y/N)**	**No. of additional Multiplexes**	**Reception availability**	**Reception mode[19]**	**Expected content format (SD and or HD)**	**Expected DTT system and modulation (if known)**	**Intended coverage reach[20]**	**Intended Coverage (as a percentage of population)**	**Spectrum band used (UHF IV/V or VHF Band III)**
IX	Y	2	Free-to-air	Fixed	SD and HD	DVB-T2, 256-QAM	National	99%	UHF Band IV/V
AY	Y	1	Free-to-air	Fixed	HD	DVB-T2, unknown	National	95%	UHF Band IV/V
BZ	Y	4	Free-to-air	Fixed	SD	DVB-T, 16-QAM	Local	25%	UHF Band IV/V
CW	N								

(b) *foresee the launch of new services*

Member State	**Additional Services (Y/N)**	**Expected content format (SD and or HD)**	**Reception availability**	**Expected content format (SD and or HD)**	**Interactive services (Y/N)**	**VoD (Y/N)**	**Ultra High Definition TV (Y/N)**	**Other (Y/N)**	**If answer Yes to Other, please specify**
IX	Y	HD	Free-to-air	SD and HD	Y	N	Y	Y	3D TV
AY	N								
BZ	Y	Free-to-air	Pay-TV	HD	Y	Y	N	N	

[19] E.g., fixed (roof-top), portable indoor, portable outdoor, mobile.
[20] E.g., national, regional, local.