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*

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)**
IE	1	Free to Air	Fixed	7SD, 1HD	DVB-T, 64 QAM	National	Y	98%	UHF Band IV/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)**
IE	Y	1	Free to air	Fixed	SD and HD	DVB-T, 64QAM	National	98%	UHF Band IV/V
IE	Y	4	TBD	TBD	SD and HD	DVB-T or DVB-T2	TBD		UHF Band IV/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**
IE	Y	SD and HD	TBD	SD and HD	N	TBD	TBD	TBD	Unknown

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

Answer: The spectrum licences are up to 2019, there are no broadcasting policy plans to terminate these PSB services and the legislation can be understood to mean that spectrum licences will be issued again for the PSB multiplexes.

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

Question 2

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

Answer:
The DTT service provides free to air PSB TV services to 98% of households, especially those households which do not subscribe to commercial cable systems or satellite platforms. DTT also provides FTA Irish services to secondary TVs in households when these are not connected to commercial cable systems or satellite platforms. The terrestrial DTT network, delivering Irish content throughout the State, provides Irish national TV content distribution independent of commercial cable and satellite systems. There are no coverage obligations on pay TV services (such cable and satellite systems).

There are some households which use combined DTT and Satellite receiver set top boxes to complement the Irish TV services with non-Irish originated services FTA on satellite. Commercial subscription cable and satellite systems offer a wide range of content. In Ireland DSL services currently are typically less than 10Mbps. A Ka band spot beam satellite carries only the core Irish PSB services FTA.

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:
Not Known – but unlikely due to the lack of take up of (or business case for) watching AV content on small screens. In June 2008 ComReg opened a consultation (ComReg doc 08/44) on authorisation of a "mobile TV" service, however it became clear during the consultation that there was not a strong interest. In January 2011, ComReg published an information notice 11/01 giving notice of its intention not to proceed with the competition. Whilst AV delivery for use by or on transport networks using larger display screens or personal passenger display screens is a possibility, it is a relatively niche business and could not be compared to general mobile terminal use

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: Irrespective of aspects of service delivery to mobile terminals, DTT systems will undoubtedly migrate over time to newer technologies. IRL has essentially chosen an MFN DTT network architecture similar to that used for analogue TV. An MFN network architecture is probably the most cost effective to implement at DTT launch and most suited to fixed DTT reception. There are coverage (self interference) and cost trade-offs to be made in implementing an SFN.

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: As indicated above, take up of AV service on small screens is not a proven business case. However collaboration with mobile networks to deliver data to many devices at the same time is a possible future business for DTT transmission networks. With reductions in storage device costs, non linear delivery of content to PVRs in households (push) would be a potential business model for broadcasters. DTT network topologies are inherently not suited to internet service provision.

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: If mobile networks can deliver a service to mobile terminals, they can deliver to fixed terminals. Ireland makes no comment on the current state of the art of mobile networks for the delivery of linear video content, suffice to say it is not a common occurrence. Ireland notes that in evolving from a mobile network to a fixed point to multipoint network user expectations and network design would be different to that of a purely mobile network. Compatibility with other networks both within the band and in adjacent spectrum would need to be reassessed. If mobile networks are required to deliver unique linear video to many users, a large amount of bandwidth will be required, which could only be found above 3GHz.

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: It is yet to be seen if existing mobile networks will evolve to deliver linear video content to mobile terminals. This proposal faces many obstacles including an interest by viewers in watching video content on small screens, ubiquitous signal coverage availability and the consistent reliability of data rate for delivery in order to avoid lost frames, jumpy and erratic motion display.
If DTT network concepts of “broadcast” one to many unidirectional streaming were adopted for delivery to mobile terminals, the major differences compared to DTT for fixed reception could be in encoding, modulation and error correction in order to overcome consistency and signal reliability issues or in network topology in order to achieve adequate signal levels to give adequate error free coverage. The former approach requires more computational power within the receiver or “lite” modulation. The later approach requires significant increases in DTT network build costs.
Notwithstanding the technical equipment constrains, the spectrum required to deliver large numbers of unique linear video streams in a rugged modulation would be quite significant. As indicated above, spectrum above 3GHz might provide an adequate band. User charges would be significantly more than for “broadcast” delivery of the same linear video content to many devices. Business cases would need to be developed.

Question 4:

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

Answer: Current broadcasting legislation (Broadcasting Act 2009, No 18 of 2009) requires that spectrum planning be made for 6 national DTT multiplexes. Legislative change would be required for this figure to change.

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

Answer: Unknown. SD, HD and Ultra HD may be anticipated.

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

Answer: The broadcast policy goal is provided for in the Broadcasting Act 2009, no steps are currently being taken to amend that legislation. Therefore future service transition and migration paths cannot be determined or estimated with certainty.

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.

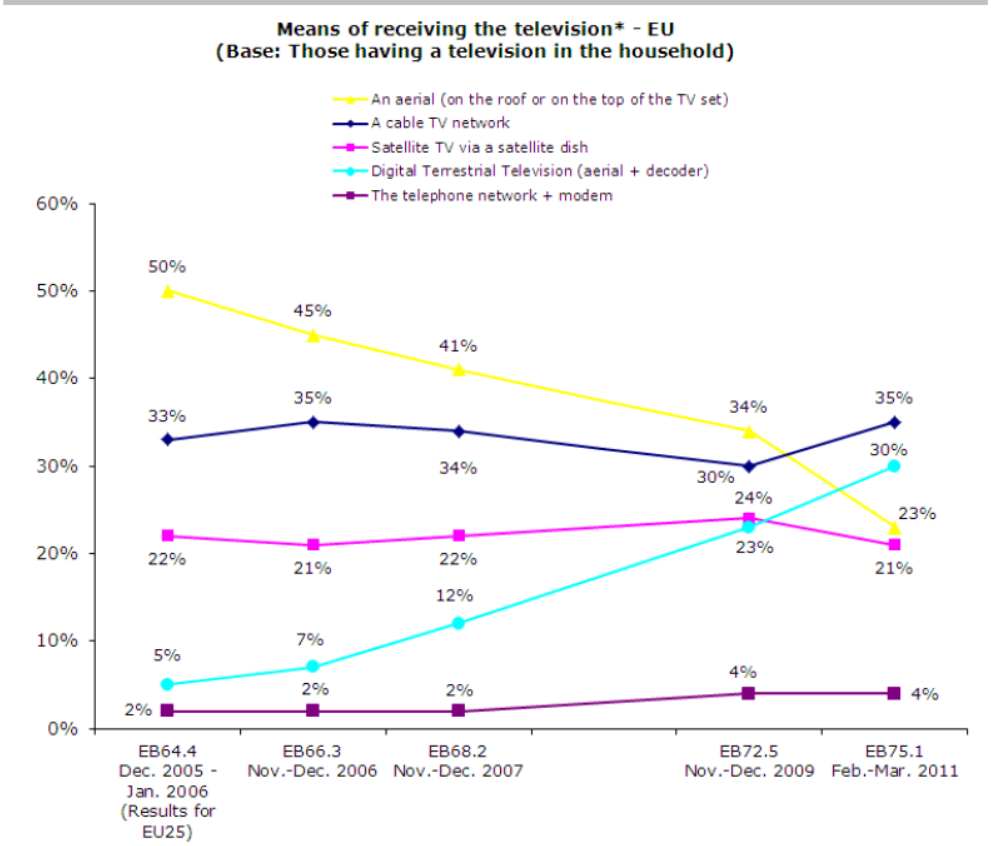
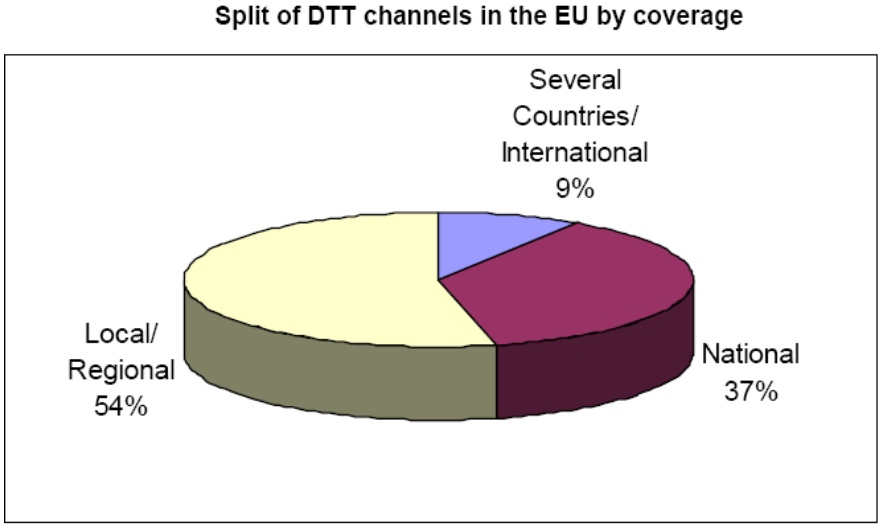


Figure 1: How European households receive TV? (source: Eurobarometer 362[7], E-communications household survey, July 2011)

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.



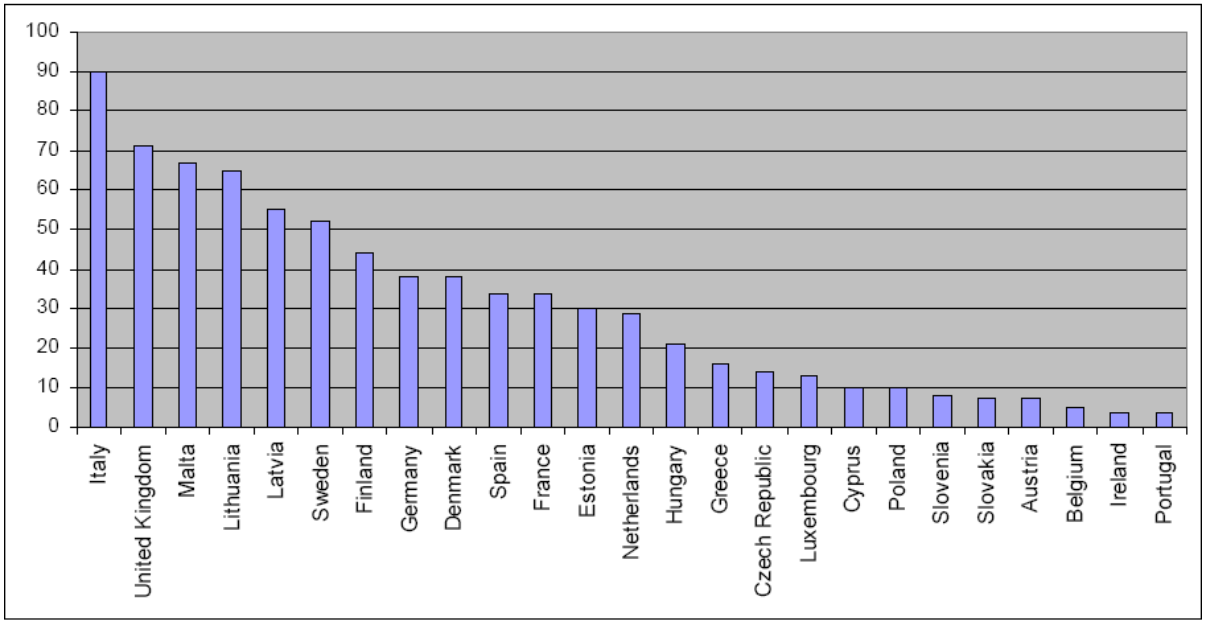
Source: MAVISE June 2011

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.

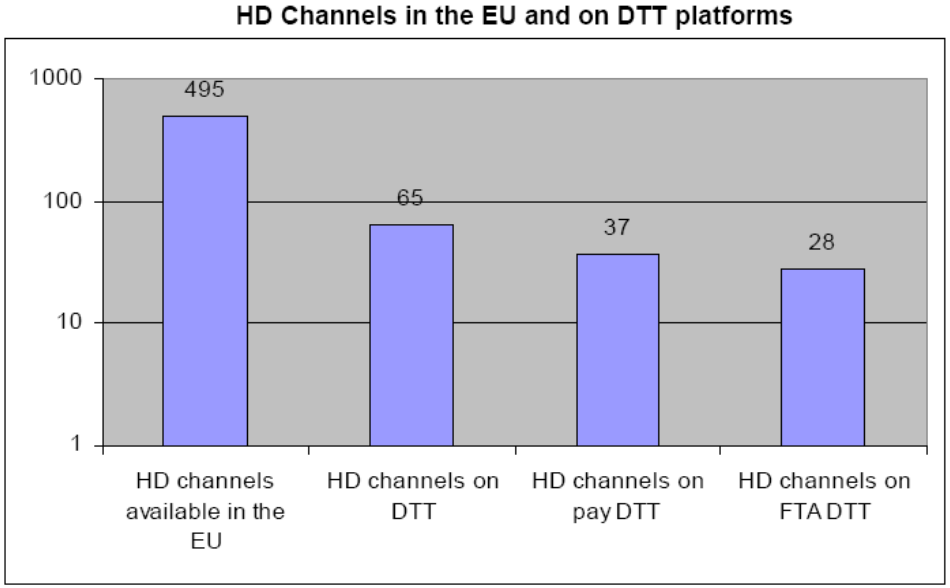
2) Video Format Evolution

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.

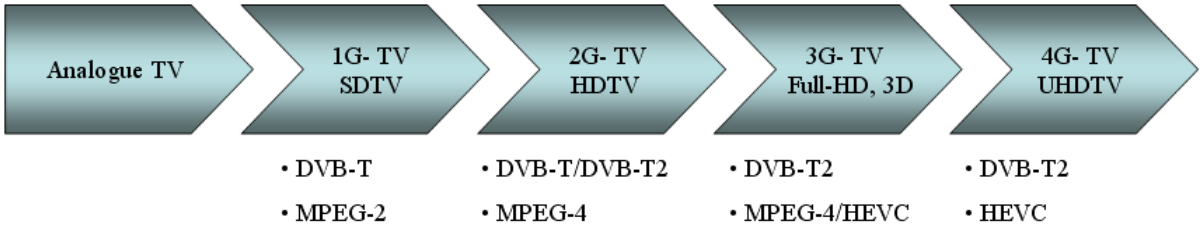
[12] Further studies to better estimate these average bitrates are needed.

[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.