Technical Report 013

The Future of Terrestrial Broadcasting

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Contents

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Version 1.1 of this document supersedes BPN 100 (which has been withdrawn). In particular, with respect to version 1.0, all instances of the term *DVB-T2 Mobile* have been replaced with the new term *T2-Lite*. The opportunity was also taken to correct some typos that were discovered in the original version of the document.

Report on the Future of Terrestrial Broadcasting

Keywords: Terrestrial Broadcasting, Satellite, Cable, Internet.

This Technical Report supersedes EBU BPN 100*

Summary

In many countries the terrestrial broadcast platform is the primary means of delivering broadcast services. For EBU members it has an important role in fulfilling their universal service obligations and general interest objectives.

The terrestrial platform combines a number of features such as

- near-universal coverage,
- ability to provide for fixed, portable and mobile reception,
- ability to efficiently provide regional and local content
- large receiver base,
- free-to-air services,
- flexibility,
- technical and cost efficiency,
- support by broadcasters, network operators, regulators and the industry,
- market success and acceptance by the public, and
- the potential for further development.

This powerful combination would be difficult to replicate by any single alternative technology.

New technologies (e.g. IPTV, fixed and wireless broadband) will complement terrestrial broadcasting but are not perceived as viable alternatives for distribution to a mass audience across large areas. In particular, these new technologies may not be available in the sparsely populated areas.

It is therefore expected that the terrestrial broadcast platform will remain very important at least for the next 5 - 10 years and possibly much longer, both for radio and TV services. Nevertheless, the role of the terrestrial platform is changing alongside the evolving needs of the broadcasters and the audiences.

* This report was originally published as EBU BPN 100, available only to EBU Members. The EBU Technical Committee decided in October 2011 that the content of BPN 100 should be made available to the public. This has been done by publishing the present EBU Technical Report. For reasons of editorial practicality, BPN 100 has been withdrawn.

Broadcast services

Traditional linear broadcast services will continue to develop with ever increasing demand for choice and quality. The number of terrestrial TV channels is steadily growing and the same is true for the viewing time. Content is increasingly offered in HD quality and in the future this may include 3DTV and maybe also Ultra-HDTV. Likewise, there is increasing demand for more radio programmes and enhanced radio services.

One of the most important developments in recent years is a significant growth of non-linear media services. Particularly popular are catch-up and time-shifted viewing or listening of the linear programming and true on-demand content. In addition, data services are being provided in support of the primary audiovisual offers. This often includes social media, where new programme formats are being developed that engage the audience and promote the broadcaster's brands. Demand for non-linear services, some of which are considerably different from traditional broadcast services, is expected to continue to grow in the future.

The context in which the users access media services is also changing. In addition to the traditional shared environment, the users are creating a personal environment where media services are accessed via an additional device (e.g. a personal or tablet computer or a mobile phone) which can be used independently from or in conjunction with the main screen. Both could be stationary or portable or entirely mobile.

Distribution options

A fundamental issue that broadcasters face is how to deliver the full range of their services, both linear and non-linear, to the shared environment as well as to the personal environment. Broadcast networks are uncontested in providing linear radio and TV services, given their ability to serve very large audiences with high QoS. This is particularly relevant for the shared user environment but also for the personal environment, provided that user devices are equipped with broadcast receivers.

Access to non-linear services normally requires a return channel and some degree of interactivity. Truly non-linear services have been introduced on broadband networks to be received on PCs, tablet computers and mobile phones. These services are very popular and are one of the main drivers for broadband take-up and the consumer device market. An issue for broadcasters is that these devices usually do not come with a broadcast receiver. At the same time, an increasing number of TV sets and radio receivers are able to connect to the Internet. In any case, distribution of radio and TV services over broadband networks is becoming more and more important.

Broadcast and broadband technologies can be used in a truly complementary way thus combining the advantages of both platforms to enable the full range of services (linear, non-linear, interactive, personalized and on-demand) to a variety of users.

The current hybrid broadcast-broadband (HBB) solutions combine broadcast and broadband delivery in the TV receivers. Unfortunately, the multitude of different existing standards is a potential obstacle for the future developments. Furthermore, as the broadband delivery is generally not under broadcaster's control there is a risk that the quality will not be maintained throughout the delivery chain. Also, the broadcast signal could be altered when displayed on the screen or mixed with the content from other sources.

Hybrid distribution networks may be developed in the future that will combine both broadcast and broadband functionality in the same network(s) and this might provide a solution for broadcasters in the long term. In such a scenario the terrestrial broadcast platform will need to evolve and possibly converge with the mobile broadband technologies. Further research is required in that area and a number of technical, regulatory and commercial issues need to be addressed.

Receivers

Stand-alone broadcast receivers will need to continue to be available in the foreseeable future to ensure universal availability of linear broadcast services. Multi-standard radio receivers would in particular facilitate the transition to digital terrestrial radio.

To access non-linear services, receivers need to be capable of connecting to broadband networks and this is increasingly the case for broadcast receivers, both radio and TV. Devices primarily intended for broadband access would need to be enhanced by including broadcast receiver technology.

In some cases non-linear service offers can also be realized by using receiving devices equipped with suitable storage and software technologies that enable creation of personal media archives. The content can be stored during linear transmissions and used later in a non-linear fashion. Depending on their capabilities such devices may be suitably combined with the linear as well as the true on-demand services.

The future role of the terrestrial broadcast platform

The proliferation of delivery options and the fragmentation of the markets raise a number of important issues for broadcasters who seek to be present on a number of platforms. They need to critically analyse the potential of available distribution options to fulfil their requirements (e.g. coverage, capacity, reception mode, type of service) taking into account any conditions and constraints that may be imposed by regulation, market forces, potential evolution of the usage and available budgets.

In order to remain viable in the long term the terrestrial platform must be digital. Full digital terrestrial radio is probably still some years ahead and DAB/DMB/DAB+ will prevail, ideally complemented by DRM/DRM+. Digital TV distribution is already common in many countries and it is expected that DVB-T will be complemented or gradually replaced by DVB-T2 transmissions.

The recently approved *T2-Lite* profile may enable combining the delivery of fixed and mobile broadcast services over the same network(s). Mobile broadband technologies and networks (e.g. LTE) can be considered as complementary to *T2-Lite*, or as an alternative.

The role of the terrestrial platform is different in different countries. These differences reflect specific market and regulatory situations, administrative and political organization as well as the related legacy issues in each country. National circumstances may change but the diversity between countries is likely to remain for the foreseeable future.

A number of different scenarios could be envisaged for the terrestrial platform in the future. These could be expansion and further development, reduction in scope or phasing out entirely. The latter may be relevant if circumstances occur that make it impossible to maintain the terrestrial platform. The key prerequisites for the terrestrial platform to continue to exist include a favourable regulatory and political climate, sufficient amount of spectrum, market success and support by broadcasters, network operators and equipment manufacturers.

The terrestrial broadcast platform will be relevant in the long term if its usage offers veritable benefits to the broadcasters, the audiences and the society as a whole.

Recommendations

Present analysis indicates that the terrestrial broadcast platform is vital for EBU members. It is thus crucial to ensure that in the long term the terrestrial distribution networks remain capable of:

- delivering the current and future, advanced linear broadcast services,
- fulfilling the ever increasing requirements for quality and choice of services, including non-linear broadcast services, and supporting the public service mission of EBU members.

The following recommendations are therefore addressed to the Members.

1.	Adopt a proactive attitude in promoting the interest of the broadcasting community at national and international (EU, CEPT and ITU) levels and in all relevant domains, e.g. technical, regulatory and commercial.
2.	Initiate discussions with regulators and commercial broadcasters on a national strategy for the transition to digital terrestrial radio.
3.	Engage with manufacturers to develop the multi-standard radio receivers necessary to facilitate the transition to digital broadcasting.
4.	Consider introduction and progressive transition to DVB-T2 in order to cope with the demands for capacity and quality, recognizing that in some countries DVB-T and DVB-T2 may need to co-exist for a longer period of time.
5.	Assess spectrum requirements for the short and long term evolution of broadcast services.
6.	Design digital radio networks for portable and mobile reception and where technically and commercially feasible, indoor reception.
7.	Consider the use of the *T2-Lite* profile as a broadcast technology to deliver TV services to mobile and portable terminals.
8.	Encourage manufactures to integrate broadcast receivers into mobile personal devices.
9.	Investigate alternative solutions where indoor coverage from broadcast networks is found to be inadequate.
10.	Develop a concept of transcoding broadcast signals to IP-based technologies (e.g. WiFi, femtocells).
11.	Work towards harmonization of technical HBB solutions taking into account the interests of the broadcasting community and the viewers and listeners.
12.	Engage in the development of hybrid networks and the corresponding receiver technology.
13.	Study the feasibility of using mobile broadband (e.g. LTE MBMS) for distributing broadcast content. Liaise with mobile industry in this process to achieve an integrated broadcast and broadband service environment.
14.	Formulate clear, concise positions on regulatory issues; in particular the spectrum policy.
15.	Lobby nationally and internationally to promote the broadcasters' vision for the future.
16.	Seek to align positions with commercial broadcasters, broadcast network operators and the industry.
17.	Request a regulatory decision from administrations that the costs of releasing the digital dividend spectrum should not be borne by the broadcasters or the viewers.
18.	Investigate the direct and indirect impact on the terrestrial platform of related aspects such as net neutrality, the rights to distribute the same content across all platforms, must carry rules for linear services, and QoS for non-linear services.

1. Introduction

EBU Members are facing technological developments that affect the way they will deliver their services to the viewers and listeners. The market situation and consumer expectations are changing in many countries. It is crucial therefore to consider what kinds of service broadcasters will be producing in the coming years and how these services are to be delivered most effectively.

This Report was developed in the context of the Strategic Programme, which was set up by the EBU Technical Committee to evaluate the future role of the terrestrial broadcast platform.

A survey was carried out amongst EBU members and, to a limited extent, the associated industry, seeking their views about the key values of the terrestrial broadcast platform and their assessment of its current and future roles. The results of the survey are presented in §2 of this Report.

A number of ongoing trends and developments that may have impact on the terrestrial distribution platform have been identified in §3. Technological changes in media distribution and consumer devices have been analysed as well as the evolution of broadcast services and consumer expectations. As the radio spectrum is an essential resource for terrestrial broadcasting, the relevant regulatory aspects have been discussed as well. Equally important, cost implications for both broadcasters and the users have been analysed.

On the basis of the two main inputs to the study, i.e. the results of the survey and the analysis of the relevant trends and developments, implications for the terrestrial broadcast platform are discussed in §4. Broadcast and broadband technologies have been compared in terms of their suitability to support the current and future broadcast services. The future role of the terrestrial distribution has been analysed and several issues related to receiving devices have been raised. In addition, the role of broadcasters in relation to terrestrial and hybrid distribution has been discussed.

Three possible scenarios for the evolution of terrestrial broadcast platforms are outlined in §5, including conditions that may lead to the choice of a particular scenario and their implications.

A number of recommendations are made in §6. They are intended to ensure the long term viability of the terrestrial broadcast platform for EBU Members.

The list of references and specialist terms are provided in §7 and §8, respectively.

2. The current and anticipated role of the terrestrial broadcast platform

In many countries the terrestrial broadcast platform is the primary means of delivering broadcast services. For EBU members it has an important role in fulfilling mandatory universal service obligations or general interest objectives. An EBU survey[1] revealed that in many countries coverage of more than 98% of the population and free-to-air access to services are mandatory.

Even in countries where cable, satellite or broadband hold a significant market share, terrestrial broadcasting is usually regarded, alongside these other platforms, as an essential, flexible and reliable 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.

[1] The survey was conducted in the autumn of 2010, in the context of the EBU's Strategic Programme on the Future of Terrestrial Broadcasting. 30 EBU members, 1 commercial broadcaster, 2 network operators and 2 manufacturers responded to the survey. Detailed information is at http://workspace.ebu.ch/display/spgbroadcast/The+Survey

The introduction of digital terrestrial broadcast technologies has revitalized terrestrial distribution in some European countries [6]. Indeed, in some areas the market share of digital terrestrial television (DTT) has either been stabilized at a very high level or even increased with digital switch over. It can be expected that this might happen in countries going digital in the future as well. Providing a comparable coverage to analogue television and a higher capacity which enables a more attractive programme offer have been the key elements to facilitate steadily growing number of viewers at a European scale.

The aforementioned survey was conducted by the EBU in 2010 to gain insight into:

- the current and future role of terrestrial broadcasting as assessed by EBU members and other interested organizations (commercial broadcasters, network operators and equipment manufacturers)
- their views on the current and foreseen technological and market developments and the impact they will have on the terrestrial platform
- broadcasters' strategies with regard to the terrestrial distribution platform in the future.

The main results of the survey can be summarised as follows:

1. The main reasons for transmitting terrestrially are:
   - Free-to-air access
   - Delivery to all reception scenarios, especially mobile
   - Near-universal coverage
   - Affordable costs for viewers, listeners and broadcasters
   - Direct access to audiences – no gate keeping
   - Legal obligations fulfilled – terrestrial transmission is usually mandatory
   - Suitable for regional / local coverage
   - Reliability (e.g. in emergency situations)
   - Simplicity of use for the viewers

Note: Most of the reasons cited above are not specific to any particular transmission system or technology. Rather, they reflect the generic potential of the terrestrial platform. It may therefore be expected that these reasons will remain relevant even though the technology changes over time.

2. The terrestrial broadcast platform will remain very important at least for the next 5 - 10 years, and possibly much longer, for both radio and TV services.

3. New technologies (e.g. IPTV, fixed and wireless broadband) will complement terrestrial broadcasting but are not perceived as viable alternatives for distribution across large areas to a mass audience, particularly in the sparsely populated areas where these new technologies may not be available.

4. The role of the terrestrial platform is changing. The main foreseen developments are:
   - Digital switch-over, including for radio
   - Further increase of the content and service offering, both linear and non-linear[2]

[2] This does not necessarily refer to the market share and distribution of linear vs. non-linear audiovisual services. Strong growth of non-linear services is foreseen in all countries. Linear services generally show steady growth in a number of countries, in particular where the digital switch-over has been completed.

- Shift towards HDTV, possibly also 3DTV and Ultra-HDTV at some point in the future
- Growing importance of portable and mobile reception
- Hybrid broadband / broadcast will become commonplace, possibly including wireless broadband
- Growing interest in DVB-T2

5. Prerequisites for further development of the terrestrial broadcast platform

- Compelling new content / services
- Availability of radio spectrum
- Sustainable distribution costs
- Availability of new (affordable) receivers
- New standards, including for HBB
- Regulatory certainty

The results of the survey clearly indicate that the terrestrial broadcast platform will remain very important for the EBU members in the foreseeable future. However, the terrestrial platform needs to evolve in order to cope with the future needs of broadcasters and viewers. In particular, it needs to be able to support growing amount of content (e.g. both linear and non-linear) and operate in synergy with other delivery platforms, in particular broadband.

Continuous efforts are required from the EBU community and associated industry to ensure favourable conditions, in particular technical and regulatory, for future development of terrestrial broadcasting.

3. Relevant trends and developments

Broadcasting is currently undergoing dramatic changes. Traditionally, broadcast content, both radio and television, has been distributed by means of a limited number of dedicated distribution paths. Historically, terrestrial distribution was the first to reach a mass audience with linear programmes. Cable and satellite distribution followed and, more recently, IPTV.

Broadcast technology is constantly evolving. This process is greatly accelerated with the advent of digital technology both on the production and on the distribution side. Transition from analogue to digital transmission brought about an unprecedented increase in capacity available on the terrestrial platform. This in turn enables an extended offer of programmes as well as increased technical quality (e.g. HDTV and possibly 3DTV and Ultra-HDTV in the future). For this reason DTT has been chosen by a large number of viewers as their main means of reception thus facilitating the analogue switch-off.

Furthermore, the Internet is increasingly influencing the way people live and work. This becomes manifest in the broadcasting sector as well. Indeed, any aspect of broadcasting is impacted by the tremendous development of the Internet, which is emerging as a new delivery platform for audiovisual services. Linear radio and TV programmes are streamed over the Internet, but also non-linear services such as on-demand and time-shifted programmes are being offered. In addition broadcasters are offering dedicated Internet sites with thematic content and additional services. All of this influences user's behaviour and expectations. Fast Internet connections already deliver broadcast programmes to home whereas wireless broadband networks are increasingly capable of delivering media content to portable and mobile devices such as mobile phones.

This section provides an overview of those trends and developments that may have an impact on the future position of the terrestrial broadcast platform within the next 10 years or so.

3.1 Technology

3.1.1 Distribution

Digitization opened the door to entirely new opportunities to distribute radio and television content to listeners and viewers. This section sketches relevant distribution technologies touching upon broadcast systems as well as non-broadcast options.

3.1.1.1 Radio broadcast systems

Terrestrial

At present, FM transmission is the most important distribution mechanism for radio services. However, further development of FM radio is hampered by capacity constraints of the available spectrum. In order to accommodate more programmes and new data services digital systems are required. The most obvious candidate digital system is DAB/DAB+/DMB [1], but over the last few years DRM+ [2] has also become a viable system that could replace FM.

DAB/DAB+/DMB is characterized by transmission of a large number of programmes in a multiplex employing a bandwidth of 1.5 MHz. All programmes in the same multiplex have the same coverage area and are provided with the same QoS. If there are not a sufficient number of programmes to fill a multiplex for a certain coverage area, DAB may not be economically attractive. This is particular an issue for local broadcasting. Furthermore, some broadcasters are reluctant to share a multiplex with their direct competitors.

DMB is a variant of the DAB standard, developed for distribution of video, sound and data with a focus on video content. Moreover, DAB+ represents another evolution of DAB, which differs in particular by the fact that a more advanced audio coding scheme is employed (AAC instead of MPEG-1 Layer 2).

DRM+ operates within a bandwidth of 100 kHz, which is compatible with the existing channel raster in Band II (the main frequency band for FM radio). Therefore, DRM+ could be a possible replacement for FM radio. This would allow an offer of 1 - 4 radio programmes within the same spectrum currently occupied by one FM programme. Similar to FM, DRM+ can be deployed on a "one-transmitter - one coverage area - one programme" basis. This may be more attractive than DAB for local or regional programmes. DRM+ may also be more suitable than DAB in cases where different broadcasters would have to share a DAB multiplex but do not have the same coverage obligations (or intentions). A conceivable digital future for terrestrial radio broadcasting could therefore be a combination of DAB+ and DRM+.

AM radio is losing its importance, at least in Europe. Tests with DRM in the LF/MF/HF frequency bands have been carried out in order to study a switch-over from analogue to digital transmission. However, it seems unlikely that there will be a general transition to DRM in Europe. Many broadcasters have already stopped using AM or have reduced their transmissions, mainly due to high cost and very few listeners. Nevertheless, a certain degree of AM transmission is likely to continue in order to provide international or overseas broadcast services.

Cable and satellite

Radio is also distributed over cable networks using both analogue and digital modulation and on satellite as a digital transmission only. However, both cable and satellite platforms target fixed reception and are consequently not used for the large part of radio listening that is done on-the-move. For radio services, cable and satellite distribution therefore have to be seen as complementary to terrestrial distribution.

Internet

Streaming is currently the main means of distributing radio over the Internet and it is becoming more and more important. This provides access to a virtually unlimited number of radio programmes. Internet radio can be received on any digital radio receiver equipped with Internet connectivity as well as on other devices such as personal computers and mobile phones. In order to receive radio over the Internet, the listener must have an adequate Internet connection and an 'unlimited download' type of contract. Portable indoor reception is viable on mobile phones and laptops in case of WLAN access to the Internet.

Conclusions

- Terrestrial networks will remain the dominant distribution mechanism for radio services at least for the next 10 years or so
- To provide new opportunities radio needs to become digital; over time radio will be digital on all platforms
- The future of digital radio is currently anticipated as being DAB/DMB/DAB+, and ideally combined with DRM/DRM+.
- Radio streamed over the Internet to fixed, portable and mobile receivers is important

3.1.1.2 TV broadcast systems

Terrestrial

DVB-T [3] has already replaced analogue television in many European countries. The remaining countries are expected to complete the transition within the coming years. DVB-T offers excellent technical performance and has allowed for a much larger number of new channels and sometimes even HDTV on terrestrial networks than analogue technology. However, an ever increasing demand for capacity, for example to provide higher quality, has triggered the development of a second generation digital terrestrial system called DVB-T2.

DVB-T2 is an improved variant of DVB-T providing higher capacity and/or more robustness. DVB-T2 is being introduced in some countries, with the main target to provide HDTV using MPEG4 encoding for fixed rooftop reception. DVB-T2 can be used in the same way as DVB-T to provide digital audio services to stationary TV equipment. However, DVB-T2 also offers additional transmission modes suitable for the provision of portable and mobile radio and / or TV services.

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 high definition services aiming at household television sets fed by rooftop aerials as well as some low-bit rate, more rugged services aiming at portable television receivers or even radio services.

Although DVB-T2 may offer many advantages over DVB-T, it is likely that both systems will co-exist across Europe for a 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.

DVB-H was developed a few years ago based on DVB-T to suit requirements for TV services to handheld devices. Market success of DVB-H was rather limited.

However DVB-T2 not only supports high data rates for stationary reception, it also provides the relevant technologies for robust mobile reception at high speeds to support use cases like e.g. high speed trains. 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 in addition the data rate is limited to 4 Mbit/s. The

definition of the subset plus the data rate limitation 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. This new profile will provide the most efficient air interface achievable with current technology. Whether this new system will be able to succeed is currently unclear since it will depend on a number of factors beyond technical. (See also the alternatives described in §3.1.1.3 Broadband Systems, below).

Cable and satellite

Cable and satellite television have a significant market share in many countries, in particular for primary TV receivers. The transition from analogue to digital is on its way but a full analogue switch off on satellite and in particular on cable seems to be far in the future. Cable is especially important in densely populated areas and cities while satellite is more important in rural areas. Cable has the advantage of a very large capacity in terms of the number of digital programmes it can accommodate, but the cost of infrastructure may prohibit the roll-out in less populated areas.

Satellite has the advantage of covering almost all households in a given area and its infrastructure cost is significantly lower than that of a nation-wide digital terrestrial network. But due to the large satellite footprints it is not possible to limit the coverage to one single (smaller) country. Where reception has to be restricted to the national territory (e.g. because of content rights that prohibit transmissions abroad) this can be achieved by basic encryption solutions. Only inhabitants of a given country could be offered the means to decrypt the programmes of this country distributed via satellite. For regional or local programmes this basic encryption approach might, however, not be practical. In addition, the use of the satellite to target small regional or local audiences may not be cost efficient.

Conclusions

- DVB-T offers excellent technical performance and has allowed for a large number of new channels on terrestrial networks
- DVB-T and DVB-T2 will co-exist for a prolonged period of time
- The future of mobile TV is currently unclear

3.1.1.3 Broadband systems

Broadband is emerging as a new delivery platform for media services. Fixed broadband in particular over xDSL or optical fibre networks has in many areas reached sufficiently high penetration and performance to be attractive for delivery of linear broadcast services. Both technologies have the advantage of providing two-way services, which enable the delivery of interactive, on-demand and personalized media services. Especially fibre has the potential to deliver a large number of programmes, also in HD quality, together with other Internet services.

Wireless broadband is gaining popularity as it enables mobile access to the Internet. The HSPA - *High Speed Packet Access* is currently being implemented on 3G mobile networks whereas the most promising future technology is called LTE - *Long Term Evolution* [4] (sometimes also referred to as 4G). LTE can deliver high speed Internet access and will therefore be able to deliver IP based audio and video content. LTE will support three different modes of delivery of media content:

- Unicast - delivery to individual users
- Multicast - simultaneous delivery to groups of users
- Broadcast - simultaneous delivery to large audiences

Delivery to multiple users is enabled by MBMS - *Multimedia Broadcast / Multicast Services* where the downlink capacity is shared by means of transmitting the content from a single source to multiple users at the same time. Further enhancements are expected from MBSFN (Mobile Broadcast in SFN), which is currently under development and may be part of the LTE specifications.

Wireless broadband networks have cellular topology and are primarily designed to provide Internet access for portable and mobile devices, such as laptop and tablet computers and mobile phones. Bitrates are generally sufficient for the delivery of radio and mobile TV services to devices with small screens.

Conclusions

- Fixed broadband networks (xDSL and/or optical fibre) may offer sufficiently high speed and capacity to be attractive for delivery of linear broadcast services, including HDTV, for fixed reception.
- Wireless broadband networks (e.g. HSPA and LTE) may be suitable for the delivery of broadcast content to devices with relatively small screens, such as laptop and tablet computers and mobile phones. Non-technical issues (cost, coverage, control) need to be addressed.

3.1.1.4 Hybrid broadcast / broadband television and radio

Hybrid distribution is an approach where media content is delivered over both broadcast and broadband networks (sometimes called HBB - Hybrid Broadcast / Broadband). The incitement for this is that both types of networks can be used in a true complementary way. Broadcast networks are optimized for the delivery of broadcast content (e.g. linear channels) to large audiences whereas broadband networks are best suited for interactive, on demand services and niche media services.

Access to on-demand services requires an appropriate return channel. For fixed reception in the home (e.g. living room) a fixed broadband Internet connection could be used for this. The available bitrates on fixed broadband connections are sometime sufficiently high for large TV screens.

In the case of portable or mobile reception a return channel could be established via wireless broadband connection. The available bitrates on wireless broadband networks could be sufficient for smaller size screens such as on laptops, tablet computers or mobile phones.

In order to satisfy the growing demand for non-linear services, in addition to the traditional linear programming, receivers should incorporate both digital broadcast technology and broadband Internet functionality. Merging the two technologies is considered the best solution from an economic perspective as well as it can be cost efficient for consumers, broadcasters and network operators alike. An additional benefit is that it enables new services over the existing terrestrial platform thus keeping the users in the familiar environment.

A number of HBB solutions have been proposed, or are under development, that enables a linkage between linear and non-linear content (e.g. HbbTV, YouView, MHP, MHEG-5). In addition, some receiver manufacturers are implementing their own proprietary solutions on their devices. As of writing of this report there may be a prospect of a pan-European standard in the market.

In the currently available hybrid solutions the receiver is connected to both broadcast and broadband network simultaneously. Content and services available on both networks are available to the user. Upon user's choice the content or services is brought onto the screen. There is no interaction between delivery networks.

HBB delivery is expected to grow significantly in the future thus it is very important for broadcasters. It is the subject of a multi-disciplinary strategic activity within the EBU. The main

concern is that the various proposed solutions are mutually incompatible, which may lead to fragmented markets and significantly reduce the benefits of HBB. Standardized technology encourages more competition between suppliers, lower costs and more choice for consumers. There may be no complete solution to this, but the more stakeholders use common solutions across the world, the greater the potential for success of HBB. Viewers should be given direct access to the broadcaster's non-linear offer (e.g. multimedia content or applications) when watching one of its linear channels.

Although hybrid systems offer real opportunities, there is a risk that the broadcast signal would be altered when displayed on screen, causing a loss of control for broadcasters and a deterioration of the viewing experience for users. In turn, this could lead to a mixing-up of content from different sources on viewers' screens, with or without the individual viewer's participation. Additionally it could also lead to the commercial exploitation of the broadcasters' programmes and audiences by third parties. Measures to prevent this should be embedded in the design of hybrid systems, as asserted in the EBU *Principles for Internet-Connected and Hybrid Television in Europe* [5].

Even though developments such as HBB are very important for broadcasters they do not offer full control over the different distribution paths. So far, the merging of the two worlds, i.e. broadcast and broadband, is accomplished by integrating different systems side-by-side in a single receiver. What might be needed in the future however is a tight linkage between broadcast and broadband networks. Over time, new kinds of hybrid solutions might appear, based on a single terrestrial network technology that is able to provide both broadcast and broadband services in a flexible and dynamically reconfigurable way. Such possibilities are to some extent already available on IPTV networks. The choice of which delivery mechanism is employed for which content shall be left to the content/service provider and/or the network operator(s) in order to optimize the use of network resources and user experience. DVB-NGH and LTE with enabled MBMS may be the first stages of development on the way to full hybrid distribution networks that might provide a solution for broadcasters in the long-term future. But clearly, further research is needed in this area.

Conclusions

- HBB combines the advantages of both broadcast and broadband technologies to enable the full range of services (linear, non-linear, interactive, personalized and on-demand) to a variety of users.
- A multitude of different standards is considered an obstacle for the future developments.
- The risk that broadcaster's signal is altered when displayed on the screen or mixed-up with the content from other sources should be prevented by the design of hybrid systems.
- Hybrid distribution combining both broadcast and broadband functionality in closely linked broadcast and broadband networks and, eventually, within the same terrestrial networks might provide a solution for broadcasters in the long term.

3.1.2 Consumer devices

Broadcast systems are dedicated and optimized for delivery of linear content to large audiences.

Receiving devices must include a corresponding broadcast tuner. Indeed, majority of the current broadcast receivers are still dedicated to broadcast services and cannot yet connect to non-broadcast networks. In particular, portable and mobile radio receivers are ubiquitous.

Multi-Standard Broadcast Receivers

Digital broadcast technology is evolving. Demands for higher data rates, better content quality and portable/mobile reception are the driving forces. Furthermore, there are complementary technologies targeted at fulfilling the needs of different broadcasters. In order to grant access to the full variety of broadcast content it seems inevitable that a multitude of different broadcast

standards must be integrated in the receivers. DAB/DMB/DAB+ and DRM/DRM+ are examples of these standards for digital radio. Other combinations of broadcast standards might be advantageous in the future as well, including those that combine radio and TV standards. A number of issues may need to be addressed with regard to commercial viability of such devices and their positioning in the market.

Internet connectivity

New generation broadcast receivers often come with Internet connectivity. Internet enabled radio receivers offer the possibility of receiving radio programmes via FM and DAB or of receiving radio streams from dedicated websites. A number of new models of television receivers is available on the market that support one or another variant of HBB (see §3.1.1.4 above). Such an approach allows the watching of linear television programmes and at the same time provides access to Internet resources such as servers from which programmes can be streamed or downloaded. It is expected that all broadcast receivers will be Internet enabled at some point in the future.

Non-broadcast receiving equipment

Another observed development is that access to broadcast content no longer presumes the use of a dedicated broadcast receiver. For instance, computers and mobile phones can be equipped for the reception of terrestrial broadcast services. Sometimes broadcast receivers are integrated in the device (e.g. FM receivers in mobile phones), while in other cases external digital tuners can be connected (DVB-T receivers with a USB or WiFi connection). There have been mobile phones on the market with integrated DVB-T receivers for some time. Other examples include an external DAB receiver, which can be connected to some smartphones to receive radio programmes distributed via DAB networks.

The above examples may indicate a trend in the receiver market. However, this trend is not (yet) widely accepted. One possible reason is that mobile devices are often subsidized by non-broadcast network operators that may not have incentives to enable broadcast reception. At the same time there is a growing base of IP-enabled consumer devices that are capable of supporting media services but do not have broadcast tuner (e.g. laptop and tablet computers, mobile phones).

Personal video recorders

Viewing habits are changing with the use of personal video recorders, in particular at home. Recording and storage facilities enable the content to be stored for later viewing.

As large storage space is becoming more affordable and increasing number of receivers is connected to the Internet, this concept can be taken further. If the content is stored locally during linear delivery, it could be viewed later. This would effectively become a virtual catch-up service.

Moreover, software applications could be developed to build viewing profiles and offer content based on personal preferences. Such services could be entirely controlled by the user or could be offered and controlled by the content/service provider.

The storage facility can also be used for pre-download of content when there is available capacity on the network. The content would be released at a pre-defined point in time, hence becoming a virtual linear channel. This approach could be used to optimize the use of network capacity and to offer content for niche audiences. Further development can be expected in this area.

Conclusions

- Multi-standard broadcast receivers will have a significantly growing market share Future receivers will be multi-purpose, allowing access to different networks.
- Broadcast receivers are increasingly equipped with Internet connectivity
- Non-broadcast receivers sometimes come with the possibility to receive broadcast services via terrestrial broadcast networks (e.g. DVB-T tuners with USB connection, FM receivers in mobile phones)
- Broadcasters need to consider ways to deliver linear and non-linear services to consumer devices that do not come with broadcast tuners (e.g. laptop and tablet computers, mobile phones).
- Personal video recorders could enable personalized catch-up and on-demand services. They could also facilitate optimization of network use and serving niche audiences.

3.2 Services and consumer expectations

The digital revolution has had, and continues to have, a tremendous impact on the way people access and use information. This is also true for broadcast content. For the analysis of services and consumer expectations it is important to distinguish between different types of media services and the context in which these services are used.

In general terms a service is composed of a number of distinct elements, such as:

- *video and audio elements*

This is the core proposition of an EBU-member's service.

- *data elements*

Typically signalled from the core audio/video element of the service, this element could be in the form of data targeting a multimedia platform in the target device, or a stand-alone platform.

- *Electronic Programme Guide (EPG)*

This provides regularly updated scheduling information for current and upcoming programmes, typically for the following 7 to 14 days. It can include functionality that allows the user to discover and select programmes e.g. by time, title, channel, or genre.

- *third party applications*

These could include social media applications such as Facebook or Twitter, which are linked with the main audiovisual service and closely associated with the brand of a broadcaster.

Such a service could be distributed via linear and non-linear means. Linear audiovisual services are traditional radio and TV broadcast channels that are received in real time. Non-linear audiovisual services include time-shifted, catch-up on-demand, and personalized media services. The exact nature of a service could be network dependent, device dependent and user demographic dependent.

3.2.1 Linear broadcast services

Traditionally, radio and television were provided exclusively in terms of linear services, Programme makers create many different radio and television programmes that are distributed in a form of linear channels. The audiovisual content progresses without any navigational control on the side of the viewer or listener (i.e. other than selecting a channel). Initially, linear services were delivered over broadcast networks to fixed receiving antennas. Over time, portable and mobile reception

became possible, in particular for radio services. Most of the broadcast content is still delivered the same way.

Free-to-air services are available on the terrestrial and satellite broadcasting platforms. This is particularly important for public service broadcasting although free-to-air programmes are also provided by a number of commercial broadcasters. Cable operators are often bound by must-carry obligation to offer public service programmes.

In addition to free-to-air, some commercial broadcasters have successfully introduced subscription based TV services (pay-TV) with premium content and high technical quality. Pay-TV services have initially been offered on cable and satellite platforms and recently they are also present on terrestrial and IPTV networks. In some European countries the pay-TV service offer is steadily growing [6].

3.2.2 Non-linear media services

Active participation of the viewer or listener is usually required to access *non-linear* media services (above the simple selection of service as in linear broadcasting). Typically, the user can select individual pieces of audiovisual content and control, as a minimum, the timing and sequence of the delivery. This assumes a two-way communication platform where the forward path (also called downlink) is used for service delivery while the return path (or uplink) enables user's intervention. The most significant example for such a platform is broadband Internet connection.

Particularly popular non-linear services are catch-up and time-shifted viewing or listening of the content that has previously been transmitted in a linear fashion over broadcast networks and true on-demand content that is available online but may not have been previously delivered over broadcast networks. Demand for non-linear services, some of which are considerably different from traditional broadcasting (e.g. games based on specific TV or radio programmes) is expected to continue to grow in the future.

A combination of linear programming distributed via broadcast networks with non-linear media services distributed over broadband networks on the TV screen is sometimes referred to as '*over the top TV*' (OTT). These services are increasingly provided by new entrants in the market who act as content aggregators. User experience varies although in some cases is comparable to that of premium pay-TV.

Combination of broadcast radio and Internet radio is also happening, for example via services such as *RadioDNS* where information is transmitted over terrestrial broadcast networks that enables radio receivers to access additional services that are offered on-line by the same broadcaster.

3.2.3 Data services

Data services include a range of different services such as EPGs or programme associated information like background material, additional pictures or movie clips. These kinds of services could be either provided by the content providers or by independent companies on a subscription basis. Examples could be digital programme journals, file-casting offers or advertisement. In some cases data services may be extended e.g. to include search and recommend tools on the Internet.

3.2.4 Social media

Some broadcasters are present and active on social media platforms such as Facebook, Twitter and others. New programme formats have been developed that use these platforms to enable listeners and viewers to directly and easily interact with the running radio or television programmes. The primary objective is to create programme associated communities and facilitate the link between the audience and the main audiovisual service and to promote the broadcaster's brands and content.

3.2.5 The context of media usage

Users may have different expectations concerning the type of media service and their experience, depending on the context in which the service is used. In this report three typical situations have been identified where media services are used.

- *Shared*
  Social interaction within a group (e.g. family, friends), normally indoors, stationary reception, large screen (e.g. the main TV set in the house), high picture quality, low interactivity.
- *Personal*
  - Stationary and portable
    Mostly individual experience, normally indoors, stationary or portable reception, medium size screen (e.g. PC, tablet computers), medium to high picture quality, high interactivity. The devices used in the personal environment provide an alternative primary screen for some users. More importantly, they serve as secondary devices ('a companion screen') that can be used in conjunction with a 'main' screen, for example, for communications related to main screen content or to access additional, related content.
  - Mobile
    Individual experience, usually (but not exclusively) outdoors, mobile reception. Mobile radio listening (e.g. in cars) has been common for a long time whereas mobile TV viewing is relatively recent and typically features small to medium size screens (e.g. mobile phones, tablet computers), less stringent requirements on picture quality, and medium to high level of interactivity.

3.2.6 Managed services vs. public Internet

With respect to broadband delivery, a distinction needs to be made between *managed services* and the public, open Internet.

The public Internet is an enabling platform for access to a variety of services and applications. The user is free to access any service or application. For broadcasters this provides an opportunity to offer new, innovative services such as catch-up and on demand services, thematic channels for niche audiences, additional content related services etc. Potential constraint is that the open Internet provides only the 'best efforts' quality that in some cases may not be sufficient for high quality media services such as SDTV and HDTV. Furthermore, signal integrity and reception quality are beyond broadcasters' control.

Managed services are offered by Internet service providers (ISP) in addition to the open Internet. They often include premium services with guaranteed technical quality and high quality of user experience. IPTV and video-on-demand (VoD) are examples of managed services. The users or the content providers may usually be required to subscribe to managed services separately, although IPTV and VoD are often included in a bundled offer alongside telephone and Internet access.

Conclusions

- Broadcast service consists of a number of elements: the core audiovisual element, data elements, EPG and, possibly, third party applications such as social media.
- Linear programmes remain very important both for radio and television broadcasters. Viewing and listening times are generally stable and even growing in some countries.
- Free-to-air services are available on terrestrial broadcast networks in all countries in Europe Subscription based TV services (pay-TV) have been successfully introduced in some countries
- Non-linear such as time-shifted, catch-up, true on-demand, interactive and personalized are available for both radio and TV. Demand for non-linear services is expected to continue or to grow in the coming years.

- EPG and supplementary data services are closely associated with the main audiovisual content. In some cases they may be extended e.g. to include search and recommend tools on the Internet.
- Social media platforms can be used to create programme related communities, to facilitate the connection between the audience and the core audiovisual service and to promote the broadcaster's brands and content.
- Broadband delivery comes in two flavours; the public, open Internet and managed services. Both provide opportunities for broadcasters.

3.3 Spectrum

3.3.1 Spectrum regulation

Terrestrial broadcasting relies on radio frequency spectrum. The use of spectrum is regulated on a national as well as international level in order to ensure its efficient use and avoid harmful interference. The most important organizations responsible for spectrum regulation in Europe are:

- The International Telecommunication Union (ITU)[3]
- The European Conference of Postal and Telecommunications Administrations (CEPT)[4]
- National regulatory authorities

International spectrum management seeks to harmonise the use of spectrum bands in different countries. Harmonisation helps to create valuable economies of scale and improves the market for consumers, e.g. through competitive prices.

The amount of available spectrum is limited. Broadcast spectrum is under pressure to be shared with other users and in some cases to be released for other use (e.g. mobile broadband). As spectrum is a scarce public good it must be managed with 'special attention', striking a balance between economic, cultural and social values in the public interest. Spectrum is vital for radio and television broadcasting today and in the future. Public service broadcasters need adequate spectrum to evolve with new technology, drive innovation, and meet audience expectations.

National Administrations adopt a national table of radio spectrum allocations, define a framework for use of the radio spectrum and assign radio spectrum to the different users via licenses or via license-free arrangements.

At European level, the Electronic Communications Committee (ECC) of the CEPT, the European Commission and ETSI cooperate on technical and regulatory issues relevant for radio equipment and spectrum both on the EU and pan-European levels. This work is open to industry and professional associations such as the EBU.

At a worldwide level, the Radiocommunications Bureau of the ITU co-ordinates the development and standardisation of radiocommunication networks and services. Spectrum management issues are driven by international treaties developed within the framework of the ITU.

3.3.2 Envisaged spectrum requirements for broadcasting

Demand for radio and TV programmes is different from one country to another. Consequently, the corresponding spectrum requirements will be different. In the following an average demand for the

[3] The ITU is the leading United Nations agency for information and communication technology issues, and the global focal point for governments and the private sector in developing networks and services (www.itu.int)

[4] The CEPT has 48 member administrations (www.cept.org)

necessary spectrum is suggested for 2015. This date corresponds to the end of the analogue-to-digital broadcast transition period for Region 1 as established in the Geneva 2006 (GE06) Agreement. In preparing the assumptions on spectrum demands for 2015 the latest developments in broadcast technology are taken into account. The figures given include both commercial and public service broadcasting.

HDTV

It is expected that in a near future all TV programmes will be in HD quality. Irrespective of the market share of DTT in a given country around 20 to 25 HDTV programmes could be needed to create an appealing offering[5], in some countries up to 40 programmes are envisaged. A number of 25 programmes is equivalent to 5 - 6 DVB-T2 multiplexes. Additional capacity may be needed for the transition from SDTV to HDTV.

Mobile Radio & Multimedia

Around 50 stereo radio programmes are required which is equivalent to a minimum three DAB+ multiplexes[6]. To provide 20 to 25 mobile TV programmes at least four T-DMB multiplexes will be needed.

Further transition periods would be needed for those countries that will decide to convert entirely to

MPEG-4, DVB-T2 and T-DAB+. Furthermore, in the future broadcasters might wish to offer occasional 3DTV or Ultra-HDTV programmes on the terrestrial platform. This might further increase the spectrum demand in the longer term.

Conclusions

- Spectrum requirements for broadcast services differ from country to country, depending on national circumstances.
- Capacity requirements are expected to increase, which can mean more programmes and/or services requiring higher data rates are offered
- The amount of available spectrum for broadcasting is limited
- If more services or higher quality services need to be offered then broadcasting needs to request more spectrum, reduce coverage, or use the available spectrum more efficiently

3.4 Costs

Costs are one of the main elements to be considered, in particular when a new technology is to be adopted or new services are to be introduced. Financing of public service broadcasting is increasingly under scrutiny and broadcasters often have a rather limited scope to increase their revenues. Investments must be justified by the anticipated reduction of operational costs or by

[5] With the latest digital terrestrial TV system, DVB-T2, it is possible to aggregate four to five HDTV programmes in one multiplex. Therefore, a total of five to six multiplexes are needed. To migrate from SD to HD, the transition may be done without simulcasting all the SD channels in HD. Nevertheless to create an appealing offering engaging toward HD, between 2 and 3 equivalent HD-multiplexes (about 10 HD channels in DVB-T and 15 - 18 HD channels in DVB-T2) would be a minimum to drive the switch-over process. That means between 8 and 10 multiplexes will have to be broadcast simultaneously.

[6] Based on the number of FM radio programmes in densely populated areas where more than 40 programmes are normally available. By using the improved coding provided by DAB+, 18 good quality stereo audio programmes can be accommodated in one multiplex resulting in a minimum number of three multiplexes. A similar number of stereo audio channels can be provided using T-DMB but there is also the alternative possibility for carrying a combination of video channels and audio channels.

expanded service offering, or both. This section is to shed some light on cost implications emerging from conceivable changes of the broadcasting environment.

3.4.1 Distribution costs

Costs of terrestrial distribution in a given coverage area are fixed and independent of the number of simultaneous viewers or listeners. This is also true for other broadcast platforms (e.g. cable, satellite, IPTV). On the contrary, costs for distribution of broadcast content over broadband networks are generally proportional to the number of concurrent users. Multi-cast or broadcast modes on broadband networks could potentially decrease the distribution costs.

Furthermore, distribution costs depend on the quality of service, the number and type of programmes to be distributed, the competition on the market of network providers, regulation of the market and the influence on the network operation by the broadcasters.

In particular the last point is important with regard to the terrestrial platform. Usually, the influence of the broadcaster is larger in this case than for any other platform. This can have an indirect impact on the distribution costs for non-terrestrial platforms because of the competitive pressure from the terrestrial platform.

Technology upgrades on transmission networks require significant investments but often bring a clear cost advantage in the longer term. The well known example is the switch-over from analogue to digital terrestrial networks. Digital technology allows spectrum to be made use of more efficiently. Hence, more content per MHz can be delivered. In addition, digital networks are generally less expensive to operate.

High quality services (e.g. HDTV) require more transmission capacity and therefore may be more expensive to distribute.

It is observed that total costs of distribution tend to increase with the number of different distribution platforms over which the content is distributed. Repurposing of the content for distribution via different platforms has implications on production costs. At the same time distributing the same content on multiple platforms significantly increases distribution costs.

3.4.2 Costs for consumers

The basic cost of broadcasting for consumers is the license fee that is usually regulated by law. The license fee is used to finance public service broadcast services that are available to all viewers and listeners without additional charges, i.e. free-to-air. Some commercial radio and TV services are often also available free-to-air.

In many European countries commercial broadcasters offer additional services (mostly TV) such as premium content and extended choice of programmes. These services are available on broadcast networks, including terrestrial, but the viewers need to subscribe.

Furthermore, a range of *pay-per-view* services are offered on the Internet. In addition to the costs of purchasing the content, consumers need to have an adequate broadband connection, which incurs additional costs.

Bundled offers including telephone, Internet and TV are increasingly being promoted by telecom providers, which may obscure the real costs of broadcast reception.

Another source of costs is the decreasing life span of consumer equipment, which puts additional burden on consumers. To some extent these expenses may be offset by decreasing prices of consumer equipment.

3.4.3 Costs of spectrum re-allocation

The 800 MHz band (790 – 862 MHz, comprising TV channels 61 - 69) has been re-allocated to mobile services in Europe and will no longer be available for broadcasting. Within a few years this band needs to be freed from broadcasting which entails costs both for broadcasters and viewers. Broadcasters and broadcast network operators will need to change the transmission networks whereas the viewers may need to modify their receiving installations.

Furthermore, there is a risk of interference from the new mobile networks to broadcasts services. Moreover, interference levels between broadcast services below 790 MHz may increase as a result of the loss of the 800 MHz band. Resolving these interference incidents will cause additional costs.

Conclusions

- More efficient broadcast technology leads to lower delivery costs per programme.
- Serving multiple distribution platforms leads to higher distribution costs.
- Budgets available to broadcasters to cover distribution costs are limited.
- Decreasing life span of consumer equipment puts additional burden on the consumers that might be offset by the dropping prices of consumer equipment.
- Spectrum re-allocation has cost implications for broadcasters and the viewers.

4. Discussion

A fundamental issue that broadcasters face is how to deliver the full range of their services, both linear and non-linear, to the shared environment as well as to the personal environment. The situation is illustrated in Figure 1 for TV and Figure 2 for radio.

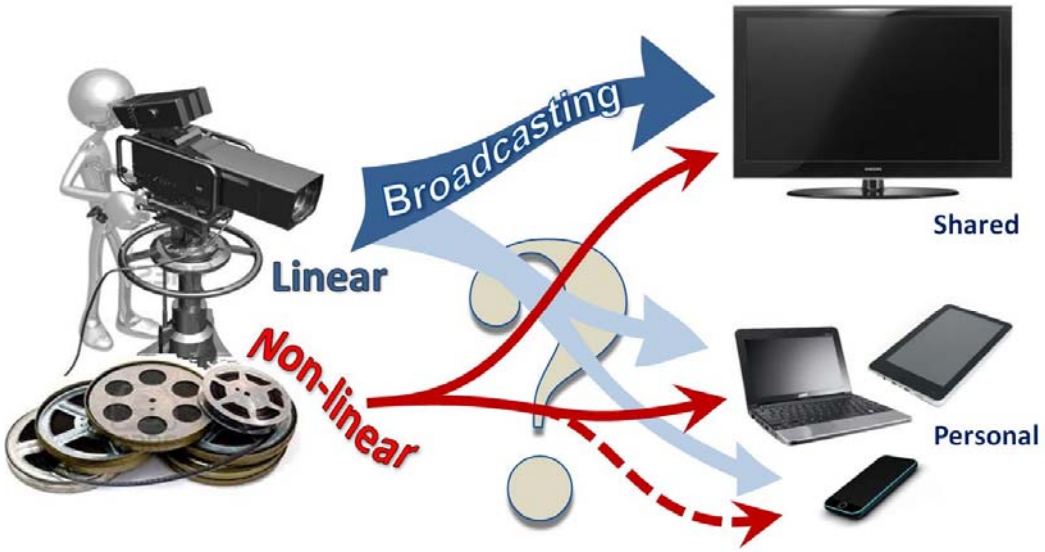

Figure 1: How to deliver linear and non-linear TV content

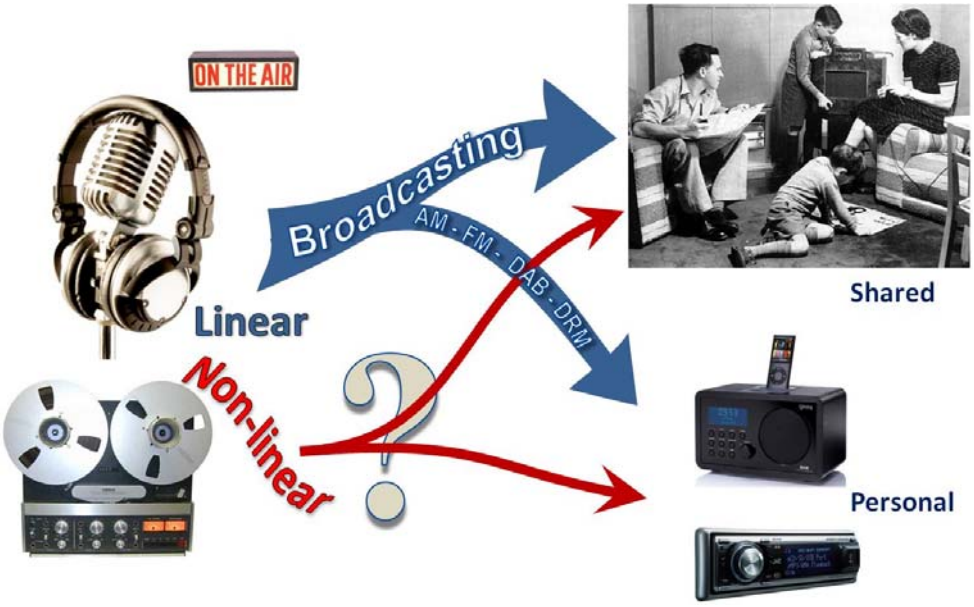

Figure 2: How to deliver linear and non-linear radio content

Broadcast networks are uncontested in providing linear radio and TV services, given their ability to serve very large audiences with high QoS. This is particularly relevant for the shared user environment but also for the personal environment, provided that user devices are equipped with broadcast receivers.

Truly non-linear services have been introduced on broadband networks to be received on PCs, tablet computers and mobile phones. These services are very popular and are one of the main drivers for broadband take-up and the consumer device market. An issue for broadcasters is that these devices usually do not come with a broadcast receiver. At the same time, an increasing number of TV sets and radio receivers are able to connect to the Internet. Consequently, distribution of radio and TV services over broadband networks is becoming more and more important for both the traditional media services provided by broadcasters and for entirely new services embedded around traditional contents (e.g. news, music or sport websites, games).

4.1 Comparison between broadcast and broadband

According to the results of the survey discussed in §2 it is expected that the terrestrial broadcast platform as a means to deliver radio and television services will remain very important or even indispensible for broadcasters in the future. This is reflected by the current developments of broadcast technology resulting in advanced digital terrestrial broadcast systems. They will exploit the available spectrum more efficiently; provide higher achievable data rates and flexibility to accommodate specific demands and constraints. Clearly, the primary objective of digital terrestrial broadcast systems is to distribute linear radio and television services.

Growth of broadband is expected to continue, largely driven by media services. Where available, high speed fixed broadband networks may be able to deliver both linear and non-linear broadcast services for fixed and portable indoor reception. Mobile broadband is becoming increasingly available and capable of providing sufficiently high data rates for the delivery to portable and mobile devices as well. **Table 1** below provides a comparison between the two worlds.

Broadcast and broadband technologies can be used in a truly complementary way to enable the delivery of the full range of linear and non-linear services for both shared and personal usage context and to the plethora of user devices. The current HBB solutions combine broadcast and broadband delivery in the TV receivers. In the future hybrid solutions may emerge that will combine broadcast and broadband elements in the delivery networks.

Table 1: Comparison between broadcast and broadband technologies

	Broadcast	Broadband	
		Open Internet	Managed Services
Capabilities			
Guaranteed quality of service	Yes	No	Yes
Is quality dependent on user numbers?	No	Yes	Generally No
Ability to deliver HD quality	Yes	No	Yes
Fixed, portable and mobile reception	Yes	Yes (where mobile Internet is available)	No (as yet unavailable on mobile networks)
Coverage	Universal	Varies across different countries, but growing	Limited, but growing
Free to air	Yes	No	No
Secondary reception	Yes	Not without separate subscription	Not without separate subscription
Services			
Linear services	Yes (both radio & TV)	Radio: Yes TV: possible on small screens. Some fixed broadband networks can also deliver to large screens	Yes (both radio and TV)
Non-linear services	No (except for PVR)	Yes, where sufficient bit-rates are possible	Generally Yes
Data services	Yes	Yes	Yes
Electronic programme guide	Yes	Yes	Yes
Support for third party applications (e.g. social networks)	No	Yes	Yes
Ability to serve niche audiences (e.g. thematic channels, archive material)	Limited by the network capacity	Yes, where sufficient bit-rates are possible	Generally Yes
Role in public safety & emergencies	Yes	Yes in some countries	Limited
Subscription required	No (except for Pay-TV)	Yes (for broadband Internet access)	Yes
Costs			
For the broadcasters	Fixed	Proportional to the number of users	Subject to agreement with the service provider or broadcaster's own investments
For the viewers and listeners	Free or subscription	Subscription to the Internet access	Subscription based, with or without additional charges
Receivers			
Choice of receiving equipment	Large and free	Any Internet enabled device. Limited choice for mobile Internet	Decided by the service provider
Open standards	Yes	Yes to some extent	No
Penetration	100%, often multiple receivers per household	Proportional to the penetration of broadband networks	Corresponds to the service penetration
Regulation			
Content regulation	Yes	No	Yes (partly)
Dependent on Spectrum	Yes (terrestrial & satellite networks	Yes (mobile networks, market based award)	No
Broadcasters' engagement			
Control over quality of service	Yes	No	No (except where broadcasters have invested in their own infrastructure)
Control over signal integrity and the use of the screen space	Yes	No	No
Control over delivery networks	Yes, to some extent	No	No
Involvement in standardization work	Yes	No	No

Technological evolutions towards some kind of a hybrid distribution scenario are expected and welcomed by broadcasters, as the survey shows (see §2). However, there are several potential pitfalls where broadcasters need to be observant in order to bring their influence to bear. Broadband delivery is not in the hand of broadcasters. Therefore, the questions of gate-keeping and network control have to be addressed in a way that suits the needs of broadcasters. Broadband access requires a subscription, which is an issue for broadcasters providing free to air services. Whether wireless broadband technologies like LTE will be used to offer free to air broadcast services has yet to be clarified.

The growth of broadband traffic is expected to continue and this raises a number of issues that may have significant impact on broadcasters, such as investments in broadband networks, traffic management by the network operators, delivery costs for broadcasters, and quality of services delivered to the users.

4.2 The role of the terrestrial broadcast platform

The proliferation of delivery options and the fragmentation of the market raise several important issues. Broadcasters seek or have to be present on a number of platforms in order not to lose their audience. However, they need to carefully analyze which of the distribution platforms are relevant and justify the associated costs. Budgets of broadcasters are limited and are likely to be reduced in the coming years. Consequently, the number of platforms served may have to be limited. Under some circumstances this might diminish the relevance of the terrestrial broadcast platform for some broadcasters.

Terrestrial broadcasting may in the future be replaced by alternative technologies e.g. by a combination of fixed and wireless broadband or by other broadcast platforms. From a broadcaster's point of view such an alternative distribution solution would need to fulfil the same requirements as terrestrial broadcasting does (e.g. quality of audio and video, associated services such as sub-titling, multiple audio and audio description, extent and quality of the coverage, costs for the broadcaster, availability, free-to-air, flexibility and broadcasters' control over QoS). According to the results of the survey (see §2, above) no such replacement is anticipated.

Terrestrial broadcasting may also be considered as complementary to other broadcast platforms. Examples include provision of broadcast services where no other platform is available (e.g. an extension to IPTV networks in rural areas or coverage in satellite shadows), broadcasting of local content, delivery only to mobile devices.

There is also a growing recognition by the mobile community that cellular mobile systems such as HSPA and LTE will not be able to provide the same coverage and quality of service for the distribution of linear broadcast content as digital terrestrial broadcast systems. This is due to their limitations in supporting the traffic associated with the delivery of TV services to large audiences even though mobile standards such as MBMS could be employed. However, there are currently no indications that linear free-to-air services that are currently available on terrestrial broadcast networks will be offered across mobile networks concurrently to a mass audience. Therefore, HSPA and LTE are currently not seen as a replacement but rather as a complement to broadcast technologies.

Portable and mobile reception is very important for broadcasters even though the network costs are higher than for fixed reception. At the same time, it is expected by broadcasters and others that mobile TV will become more relevant in the future. The question is what kind of services will be requested for mobile TV. Linear free-to-air services could be delivered to a mass audience via dedicated mobile TV networks such as DVB-H or MediaFLO, although neither of these has been successful on the market.

Media services are mostly used indoors, whereas broadcast networks are often designed for fixed roof-top reception. Therefore, innovative ways of portable indoor distribution are required. A

possible approach could include indoor repeaters using broadcast standards or those that receive content via (fixed reception) broadcast networks and retransmit using an IP standard on another technical distribution platform that consumer devices support (e.g. femtocells or WiFi technology).

According to the results of the survey presented in §2, it is expected that the terrestrial distribution platform will remain very important or even indispensible for broadcasters. There is probably no single path all broadcasters can follow. Across Europe the national conditions under which broadcasters operate are very different. Therefore, they need to identify their individual demands and define their own strategy towards the future role of the terrestrial platform, depending on their specific situation, i.e. the envisaged content offer, distribution technology, national regulation and last but not least available budgets.

Furthermore, in many countries terrestrial broadcasting has a role in the public protection and safety; in particular as an information channel from the national authorities to the general public in case of emergency. Such an obligation is often included in the broadcasting license. Contingency plans are supervised by national governments and there are stringent requirements concerning reliability and business continuity of the networks.

4.3 Receiving devices

The future of terrestrial broadcasting is undoubtedly digital. On the radio side DAB/DMB/DAB+ together with DRM/DRM+ will prevail while at least in Europe DVB-T is expected to be gradually replaced by DVB-T2 transmissions. Full digital terrestrial radio is probably still some years ahead while for television digital distribution is already common in many countries. Stand-alone broadcast receivers will need to continue to be available in the foreseeable future to ensure universal availability of linear broadcast services. Multi-standard radio receivers would particularly facilitate the transition to digital terrestrial radio.

To access non-linear services, receivers need to be capable of connecting to broadband networks. This is increasingly the case for high-end broadcast receivers, both radio and TV. It is expected that in the future all receivers will have this feature.

On the other hand, devices primarily targeting broadband access would need to be enhanced by including broadcast receiver technology. In both cases, such hybrid broadcast/broadband devices would enable access to the full range of linear as well as non-linear broadcast services.

Near non-linear service offers could be realized if receiving devices were to be equipped with suitable storage and software technologies that enable creation of personal media archives. The content can then be stored during linear transmissions and used later in a non-linear fashion.

4.4 Broadcasters' engagement in terrestrial and hybrid distribution

The role of broadcasters has changed over the last few decades. Their core activity is to produce radio and television content. In the past broadcasters often built and operated their own terrestrial networks to ensure that their content could reach their viewers and listeners. Over time network operators emerged on the market. At the same time the market opened and it became possible for broadcasters to outsource the technical distribution of programmes. Increasingly, broadcasters do not own or operate their own transmission networks.

Nevertheless, the issue of distribution remains a vital concern. Indeed, it is of strategic importance, in particular for public service broadcasters. Depending on market conditions, the broadcaster can:

- operate its own network, or
- operate a network in partnership with an external company, or

- outsource the terrestrial delivery, or
- abstain from terrestrial delivery

Even if broadcasters no longer operate transmission networks themselves, they need to retain sufficient control over the network operation and be able to influence the development of distribution platforms in order to ensure that their requirements are met. The content has to be delivered at high quality, universal access for free, at least for public services, has to be granted and all that at reasonable costs.

With regard to hybrid distribution (i.e. HBB) broadcasters have a vital interest in ensuring that the content they provide can easily be accessed by viewers and moreover is displayed on screen unaltered, without unauthorised overlays and in high quality. Appropriate measures to ensure this should be embedded in the design of hybrid systems. Furthermore, it is essential to ensure maximum technical commonality between different HBB systems. This is why broadcasters should encourage and seek to influence standardization work and regulation.

5. Scenarios

The terrestrial broadcasting platform will only be viable in the long term if its usage offers veritable benefits compared to other platforms. Broadcasters have to critically analyse the potential of available distribution options to fulfil their requirements (e.g. coverage, capacity, reception mode, type of service) taking into account any conditions and constraints that may be imposed by regulation, market forces, potential evolution of the media usage, and available budgets.

Distribution enables the services produced by broadcasters to be delivered to the users in any situation. Table 2 illustrates the current options for delivery of a particular type of service (linear, non-linear) in a given usage scenario (shared, personal).

Table 2: Current options for delivery of linear and non-linear services to the 'shared' and 'personal' usage scenarios

Media service / User's context		**Linear** (audiovisual content)		**Non-linear** (audiovisual content)	
		Radio	**TV**	**Radio**	**TV**
Shared		broadcasting (small part on broadband)	broadcasting (small part on broadband)	broadband	broadband (small part on broadcasting)
Personal	*Stationary*	broadcasting (small part on broadband)	broadcasting & broadband	broadband	broadband
	Mobile	broadcasting (small part on broadband)	broadcasting & broadband	broadband	broadband

The colour indicates the significance of broadcast delivery at present, as follows:

- Broadcast networks play a major role
- Broadcast networks play a minor role
- Broadcast networks currently play no role

The future development and relevance of the terrestrial broadcast platform as a viable and competitive distribution platform for radio and television services very much depends on the way media content will be produced and consumed in the future. Even though there are some very

general common trends across Europe such as a demand for higher quality content (HD, 3DTV, Ultra-HDTV, surround sound, …) and nonlinear services (time-shifted, catch-up and true on-demand, …), still there are very pronounced differences between European countries with respect to a conceivable role terrestrial broadcasting could play in the future. These differences reflect specific market and regulatory situations, administrative and political organization as well as the related legacy issues in each country. National circumstances may change but the diversity between countries is likely to remain for the foreseeable future. On the contrary, the changes in media usage and user's habits are similar in most countries.

There are a number of aspects that determine the decision about what distributions platforms are most beneficial in a given national context, for example:

- The need to ensure that the full range of services, both linear and non-linear, is provided to the users.
- Available choice of distribution platforms in a given country
- Commercial aspects such as coping with an increasing user demand for traditional and new media services, the need of broadcasters to optimize distribution costs or safeguard the market position of their broadcast brands;
- Operational aspects, which involve issues like the flexibility and efficiency of a distribution platform, the need to guarantee QoS, the fact that there may be no distribution alternatives or that their deficiencies rule out their usage and finally the intention to enable hybrid distribution scenarios;
- Regulatory aspects covering national audiovisual, consumer and competition policies in order to promote pluralism, cultural diversity, universal service and to stimulate competition with other platforms.

In order to focus the analysis on the future perspectives of the terrestrial distribution platform, it is useful to identify a set of scenarios that can be clearly differentiated with respect to the relevance of terrestrial broadcasting in a given context. Three scenarios have been defined in this report that outline different dynamics of the future development of the terrestrial platform. They are called:

- "*Expansion*"
- "*Reduction*"
- "*Phase Out*"

Table 2 reflects the present situation. When it is applied to the terrestrial platform it provides a suitable departure point for each of the three scenarios, bearing in mind that the actual relevance of the terrestrial platform is different in different countries. The scenarios each indicate the way in which the terrestrial broadcast platform could evolve; they elaborate on how such an evolution could be achieved and indicate the implications of such a development. They refer to a development over a certain period rather than a snapshot in time.

Moreover, the change denoted by a designation of a given scenario may refer to any relevant aspect of terrestrial distribution. Primarily important are the changes concerning:

- market share (penetration percentage),
- size and geographical layout of coverage areas,
- coverage targets (fixed, portable, mobile),
- amount of different services (number of channels or programmes)
- quality of service,
- reliability of the service, in particular for the users that rely on the terrestrial reception, and
- competition for the delivery of free-to-air audiovisual content.

No recommendation is offered concerning a choice of a particular scenario in a given country. Instead, a set of conditions has been identified that may warrant a particular scenario to be chosen. As a principle, any of the three scenarios could be applied in any given country, if justified by the specific circumstances.

This applies equally to terrestrial radio and TV. Nevertheless, a choice of a scenario for radio may or may not be the same as that for TV.

The scenarios presented here are to be understood as decisions taken for a whole country on how the broadcasting sector should evolve in the long term. These decisions might be strongly influenced by factors that lie beyond the scope of this report, such as size and shape of a given country, geographic distribution of its population and main traffic routes or economic focus of its domestic industry. Nevertheless, the trends and developments analysed in this report, such as technology developments, number and type of services, user expectations, control over distribution platforms and regulatory obligations will play an equally important role. Broadcasters must take an active part in the decision making process.

5.1 Scenario 1: 'Expansion'

The need to satisfy national requirements may lead to the conclusion that growth of the terrestrial platform is the preferred option. Expansion of the terrestrial platform can manifest itself in many different ways, including:

- offering more content, new content or content of a different type;
- improved coverage (larger coverage areas, better service quality, additional reception modes);
- increased capacity (additional multiplexes, more efficient terrestrial broadcast technologies);
- increased market share of the terrestrial platform;
- development of hybrid distribution solutions built on terrestrial broadcast and broadband platforms in order to provide linear services alongside with non-linear offers;
- the objective to deliver to an extended range of user equipment, including all types of broadcast receivers but also PCs, smartphones and tablet computers

Any of the abovementioned targets, or any combination of them, could be an incentive for growth of the terrestrial broadcast platform.

As shown in Figure 3, terrestrial radio is well established in the delivery of linear content for both the shared and the personal user context. Possible expansion could consist of a shift towards delivery of non-linear services if this is justified by listeners' demands[7].

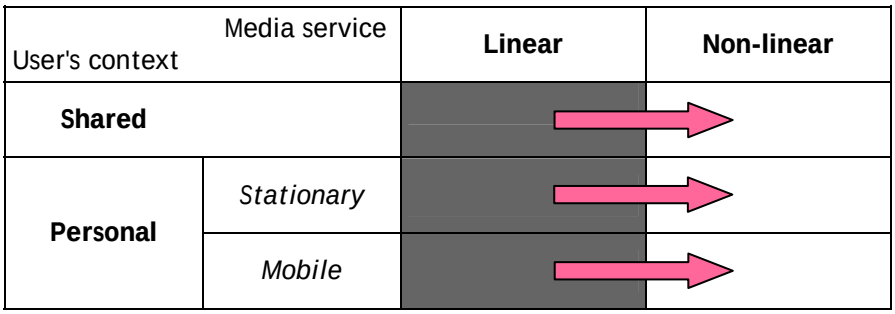

Figure 3: Opportunities for expansion of the terrestrial radio[8]

[7] Technological possibilities for the distribution of radio services are described in §3.1.1.1. Services and consumer expectations are discussed in §3.2. For the role of terrestrial broadcasting platform see §4.2.

One of the main prerequisites of such a development is the transition to digital terrestrial radio broadcasting.

Terrestrial TV is well established in the delivery of linear content to the shared user environment. To some extent it is also used to deliver linear TV services to the personal user environment and non-linear services to the shared environment.

Terrestrial TV could expand towards those areas where it was not used before or it could strengthen its position in the situations where it is currently present but not utilised to its full potential. Figure 4 illustrates these opportunities.

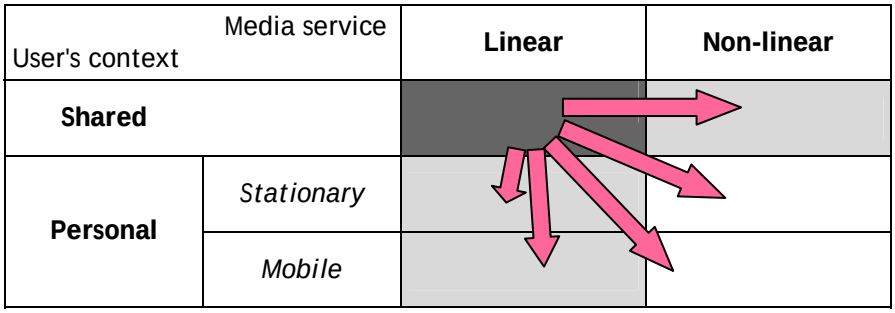

Figure 4: Opportunities for expansion of terrestrial TV

Obviously, the terrestrial broadcast platform will only grow if it provides clear benefits compared to other platforms (e.g. in terms of costs, quality, availability, flexibility) and if these benefits are recognized by the viewers and listeners as well as the broadcasters and other relevant market players.

Important conditions that will facilitate growth of the terrestrial platform include a favourable regulatory and political climate, particularly concerning general interest objectives of broadcasting and free-to-air delivery, sufficient amount of spectrum, market success and support by broadcasters, network operators and equipment manufacturers.

Broadcasters should seek strategic alliances with partners from all relevant sectors, in particular those that share the same public values and have complementary commercial interests such as network operators and manufacturers. Ideally, they would act proactively towards market developments along the whole value chain of broadcast (i.e. production, distribution, development of new technology and services). This means broadcasters should encourage and seek to influence standardization work and national and international regulation. They also have to have control over the rights for the transmitted programmes in order to be independent in the development of new types of services.

Implications of the 'Expansion' scenario

Terrestrial broadcasting provides significant economic, social and cultural benefits to the society. These benefits will be preserved and possibly increased. EBU members would benefit from the expansion of the terrestrial platform in particular where it is instrumental in fulfilling their public service mission.

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[8] Colour key for Figures 3, 4, 5, & 6:-

- Broadcasting networks play a major role
- Broadcasting networks play a minor role
- Broadcasting networks play no role

Furthermore, the terrestrial platform will be able to play an important role in the hybrid delivery of broadcast services (e.g. the broadcast component to complement broadband). This is very important as it is expected that hybrid distribution will grow significantly in the future. Combining terrestrial broadcasting with wireless broadband would enable full range of linear and non-linear services to be delivered to any device that is capable of connecting to either broadcast or broadband network, or both. Innovative solutions will be required for portable indoor distribution where the existing broadcast and broadband networks do not provide sufficient coverage.

In the future, new standards may emerge that will include both broadcast and broadband functionality thus will enable truly hybrid terrestrial distribution networks.

Broadcasters need to cooperate with telecom operators to ensure that the needs of both industries are satisfied, including the efficient use of the spectrum, sharing transmitter locations and, possibly, designing common networks. Such converged networks would enable allocating resources to broadcasting and broadband according to the respective service requirements and size of audiences.

5.2 Scenario 2: 'Reduction'

This scenario could be applicable in various situations, such as

- decrease of users' demand for terrestrial broadcasting (e.g. because of the shift towards other platform(s) or different usage such as more on-demand oriented)
- shift of the broadcaster's focus onto alternative platforms
- reduced spectrum availability
- to fulfil specific competition policy objectives
- shift of the reference point (in terms of quality of service) to other platform(s)
- no scope for maintaining the current level (e.g. because of financial constraints)
- the terrestrial platform being reduced to a complement to other platforms

Similar to the two scenarios outlined above, a number of aspects could be considered as relevant indicators of the change. Reduction of the level and the position of the terrestrial platform could manifest as:

- reduced content offer;
- reduced coverage;
- reduced capacity;
- reduced market share;

In the context of this scenario significance of terrestrial radio in the delivery of linear content could be reduced, as shown in Figure 5. This may happen, for instance, if wireless broadband networks could be used to provide this kind of service in the future.

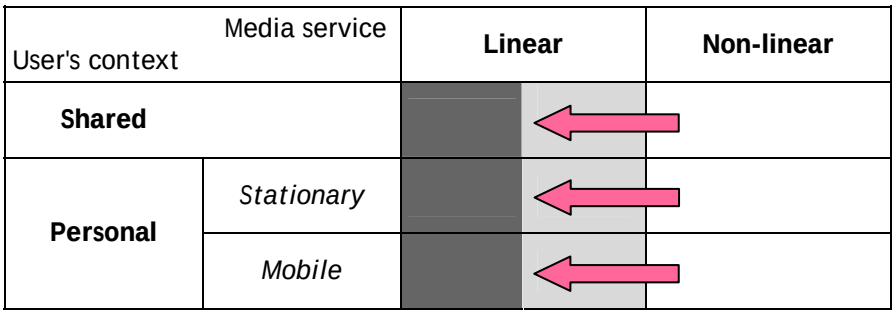

Figure 5: Possible ways of reduction of terrestrial radio

Reduction of the terrestrial radio platform may also occur if the transition to digital technology is delayed, irrespective of the reasons. In that case terrestrial networks may lose audience because they will not be able to deliver enhanced radio services.

Reduction of the scope of terrestrial television could have many facets. It could lose market share to other broadcast platforms or be reduced to their complement (e.g. to provide coverage where other platforms are not available, or to deliver to mobile devices only).

Alternatively, DTT could be used to carry only public service programmes, or only free-to-air services, or only local content, or only SDTV. In all these cases, the currently strong position of terrestrial TV networks in the delivery of linear content to the shared user environment could not be maintained.

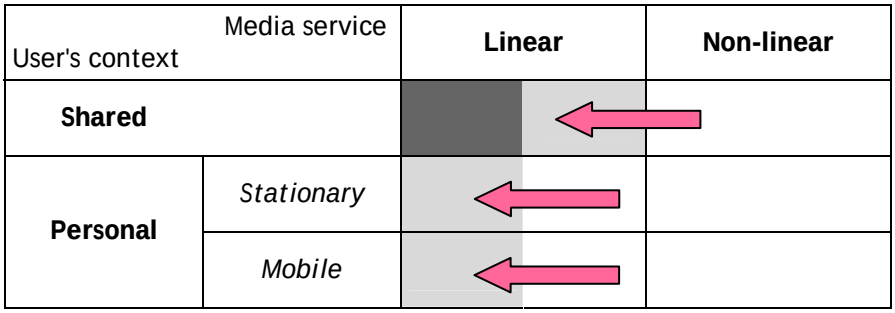

Figure 6: Possible ways of reduction of terrestrial TV

Even in the situation where the scope of the terrestrial broadcast platform is intentionally reduced it is important that regulatory and political support continues. It is equally important that an adequate amount of spectrum is preserved and that broadcasters, network operators and equipment manufacturers continue to support the terrestrial platform. It is absolutely critical that the type and amount of content offered on the terrestrial platform is sufficient to ensure its long term existence either as a competitive alternative or as a complement to other platforms. In any case the terrestrial platform should not be reduced beyond its capability to fulfil its main purpose, in particular the universal service obligation and in the future to be capable of supporting the hybrid delivery of broadcast services.

In a situation where alternative delivery can offer comparative advantage it might be possible for a particular broadcaster to reduce its presence on the terrestrial platform even though the platform itself continues to flourish.

Broadcasters need to cooperate with telecom operators to ensure that the needs of both industries are satisfied, including the efficient use of the spectrum, sharing transmitter locations and, possibly, designing common networks. Such converged networks would enable allocating resources to broadcast and broadband according to the respective service requirements and size of audiences.

Implications of the 'Reduction' scenario

The impact of the reduction would not be the same in all counties. It would largely depend on

- audience that depend on the terrestrial platform either for their primary or secondary reception. The impact would be stronger where this portion of the population is larger. This is particularly relevant for radio because it primarily depends on terrestrial delivery
- broadcasters plans for the development of services and associated delivery strategies. It should be noted that e.g. portable and mobile services can only be delivered terrestrially. Furthermore, even in its reduced form the terrestrial platform should be capable of supporting the hybrid solutions.

- the degree by which the terrestrial platform is reduced and which services will remain on the terrestrial platform
- availability of suitable alternative platforms, if any

Reduction of the market share of the terrestrial platform does not necessarily imply reduction of the required coverage as it may be defined by regulatory conditions such as public service obligations or market forces. Consequently, it does not necessarily lead to a reduction of spectrum requirements.

Broadcasters would need to adjust to the reduced potential of the terrestrial platform, e.g. by:

- migrating the audiences to other platforms without losing them
- focusing on particular type of service / coverage
- increasing cost effectiveness of the terrestrial platform
- pro-active approach towards market developments

Competitiveness of the terrestrial platform may be reduced in this scenario and this would have implications on the costs for viewers and listeners as well as on their choice.

5.3 Scenario 3: 'Phase-out'

This is a radical scenario and it is currently not foreseen in any European country. Nevertheless, it is included in the present document for two reasons. Firstly, the 'phase out' scenario is being contemplated by some national administrations that wish, in the long term, to release the spectrum currently used by TV broadcasting to other users. It is important that broadcasters are aware of these considerations and are involved in the relevant discussions. Secondly, this scenario provides an illustrative context for evaluating the role of the terrestrial broadcast platform at present and in the future.

The terrestrial broadcast platform is valuable and important for EBU members and they should ensure that that it remains viable in a long term. Nevertheless, they must be free to assess all available delivery options, in particular should the circumstances change in the future. Technology, market and regulatory developments may require the EBU members to adapt their delivery strategies, while keeping focus on fulfilling their public service mission and providing high-quality and free to air services.

If the specific circumstances are such that there is no possibility to maintain the terrestrial platform, it would be necessary to adopt a 'phase-out' scenario. This could happen because, for instance:

- the market share of the terrestrial platform falls below critical minimum (e.g. the audiences change to other platform(s))
- a political decision
- lack of spectrum
- broadcasters have shifted their focus entirely on alternative platforms
- shift of the reference point (in terms of quality of service) to other platform(s)
- maintaining the terrestrial platform is not economically viable

Implications of the 'Phase out' scenario

Without the terrestrial platform broadcasters and audiences would have to rely on other broadcast platforms. This would have severe implications in terms of costs for the viewers that would need to change their receiving equipment. For instance, currently all TV sets come with DTT receiver built

in, which is not the case for other platforms. The impact may not be significant for those households that are already equipped with alternative means of reception. Radio broadcasting would be severely affected everywhere as it is currently delivered primarily via terrestrial networks. On the TV side it is likely that the viewing share of PSB services would fall as it is generally higher on terrestrial than on other broadcast platforms.

Indirect cost implications for both the broadcasters and the viewers could occur because of the reduced competition between platforms. Flexibility to provide local services would be reduced.

Broadcasters would need to prepare and implement a contingency plan that should include

- migrating the audiences to other platforms without losing them
- finding alternative ways to fulfil their universal service obligations, including free-to-air services
- optimizing the costs of delivery via alternative platforms
- pro-active approach towards market developments

6. Recommendations

The following recommendations are addressed to EBU Members.

Present analysis indicates that the terrestrial broadcast platform is vital for EBU members. It is therefore crucial to ensure that in the long term the terrestrial distribution networks remain capable of:

- delivering the current and future, advanced *linear broadcast services*,
- fulfilling the ever increasing requirements for quality and choice of services, including *non-linear broadcast services*, and
- supporting the public service mission of the EBU members.

Furthermore, the terrestrial platform provides a reference point for alternative distribution platforms in terms of cost and quality that may be outside broadcasters' control.

Even though broadcasters were traditionally in the position to influence the development of broadcast technology and the regulatory environment this is no longer necessarily the case. In order to ensure that their interests are properly taken into account broadcasters need to stay involved in all relevant current and future developments.

Recommendation 1

Adopt a proactive attitude in promoting the interest of the broadcasting community at national and international (EU, CEPT and ITU) levels and in all relevant domains, e.g. technical, regulatory and commercial.

6.1 Terrestrial broadcast systems

The future of digital radio in Europe is currently foreseen as DAB/DMB/DAB+ ideally combined with DRM/DRM+. Radio streamed over the Internet to fixed, portable and mobile receivers is an integral part of the current and future radio distribution landscape. Terrestrial networks will remain the dominant distribution mechanism for radio services for the foreseeable future. To provide new opportunities terrestrial radio needs to become digital.

Recommendation 2

Initiate discussions with regulators and commercial broadcasters on a national strategy for the transition to digital terrestrial radio.

Recommendation 3

Engage with manufacturers to develop the multi-standard radio receivers necessary to facilitate the transition to digital broadcasting.

Digital television networks are based on the DVB-T and, increasingly, on the DVB-T2 standard. It is essential that DTT networks have sufficient capacity to support a service offer in HD quality, data services and, possibly, also 3DTV and Ultra-HDTV in the future.

Recommendation 4

Consider introduction and progressive transition to DVB-T2 in order to cope with the demands for capacity and quality, recognizing that in some countries DVB-T and DVB-T2 may need to co-exist for a longer period of time.

Recommendation 5

Assess spectrum requirements for the short and long term evolution of broadcast services.

6.2 Portable indoor and mobile reception

Portable and mobile reception is essential for radio and increasingly important for TV. The recently approved *T2-Lite* profile may enable combining the delivery of fixed and mobile broadcast services on a single technology and perhaps single networks.

Recommendation 6

Design digital radio networks for portable and mobile reception; and, where technically and commercially feasible, indoor reception.

Recommendation 7

Consider the use of *T2-Lite* profile as a broadcast technology to deliver TV services to mobile and portable terminals.

In addition, there is a growing population of portable and mobile personal devices (e.g. personal and tablet computers, smartphones) that can support media services with sufficient quality and are widely used to access on-demand media services vie broadband networks. The issue to be addressed is how to deliver linear broadcast services to these devices since, in most cases, they do not come with a broadcast receiver hence are not optimized for linear viewing or listening.

Recommendation 8

Encourage manufactures to integrate broadcast receivers into mobile personal devices.

In many cases terrestrial broadcast networks are planned for fixed roof-top reception hence they do not provide adequate portable indoor coverage. Therefore, innovative solutions need to be investigated to augment their indoor coverage. These could be based on broadcast technologies

(e.g. on-channel repeaters), transcoding[9] of broadcast signals to IP-based signals (e.g. WiFi, femtocells) and exploiting fixed broadband access supplemented by WiFi for portable reception.

Recommendation 9

Investigate alternative solutions where indoor coverage from broadcast networks is found to be inadequate.

Recommendation 10

Develop a concept of transcoding broadcast signals to IP-based technologies (e.g. WiFi, femtocells).

6.3 Hybrid delivery systems

In order to be able to offer the full range of linear and non-linear services, broadcasters need both broadcast as well as broadband delivery networks. HBB delivery is expected to grow significantly in the future thus it is very important for broadcasters. The terrestrial platform is well placed to be the broadcast pillar in HBB solutions. The potential for such co-operation requires further research.

Every effort should be made to increase the commonality of technical HBB solutions across the world. In addition, it is in the interest of both the broadcasters and the viewers that the broadcast signal remains unaltered when displayed on the screen, in accordance with the EBU *Principles for Internet-Connected and Hybrid television in Europe*. Measures to ensure this should be embedded in the design of hybrid systems.

Recommendation 11

Work towards harmonization of technical HBB solutions taking into account the interests of the broadcasting community and the viewers and listeners.

In the longer term, new kinds of transmission standards may develop towards single network technology that will be able to provide both broadcast and broadband services in a flexible, seamless and dynamically reconfigurable way. Although such systems are at an early stage of development and further research is required, broadcasters should be involved in their development and eventual standardisation. This applies both to the network infrastructure technology (truly hybrid networks) as well as the development of enhanced receivers (including sufficiently large storage and intelligent software for recording and profiling).

Recommendation 12

Engage in the development of hybrid networks and the corresponding receiver technology.

6.4 Complementary technologies

No alternative technology will be able to replace terrestrial broadcasting in all aspects in the foreseeable future. However, broadband technologies are increasingly important as a complement to broadcasting, in particular for the delivery of non-linear services. All relevant issues both technical and non-technical such as costs, coverage, access to the networks, QoS, control over the signal integrity, and contact with the audiences need to be addressed.

Liaison with mobile industry will be required on issues such as the use of mobile broadband for the delivery of broadcast content.

[9] In this context, transcoding means to pick up a broadcasting signal and to cast it onto an IP stream.

Recommendation 13

Study the feasibility of using mobile broadband (e.g. LTE MBMS) for distributing broadcast content. Liaise with mobile industry in this process to achieve an integrated broadcast and broadband service environment.

6.5 Regulatory issues

A number of regulatory issues will have an impact on the future position of terrestrial broadcast and hybrid networks and their availability to EBU members, in particular:

- long term spectrum availability,
- conditions for access to broadband networks,
- control over QoS and signal integrity in HBB, and
- regulatory certainty.

In particular, a viable future role of the terrestrial platform presumes access to sufficient and appropriate spectrum.

Recommendation 14

Formulate clear, concise positions on regulatory issues; in particular the spectrum policy.

Focused and co-ordinated lobbying activities are crucial to ensure favourable and stable regulatory conditions. Lobbying activities must target relevant national and international levels.

The lobbying strategies should be based on the broadcasters' vision for the future based on technical solutions that will enable the full range of linear and non-linear broadcast services and continuously increasing quality and choice of the service offering.

Recommendation 15

Lobby nationally and internationally to promote the broadcasters' vision for the future.

In order to strengthen the positions of EBU members it would be beneficial to agree common views on regulatory issues with commercial broadcasters, broadcast network operators and the industry so far as there are common or overlapping interests.

Recommendation 16

Seek to align positions with commercial broadcasters, broadcast network operators and the industry.

The introduction of DTT has enabled the analogue switch-off and the subsequent release of the 800 MHz band for mobile services (the Digital Dividend). The costs of the transition to DTT and the analogue switch-off were largely borne by the broadcasters and the public. Migration out of the 800 MHz band will incur significant additional costs that should neither be borne by broadcasters nor by the viewers.

Recommendation 17

Request a regulatory decision from administrations that the costs of releasing the digital dividend spectrum should not be borne by the broadcasters or the viewers.

A number of important issues have been identified that have an impact on the terrestrial platform but are considered to be outside the scope of the present document, such as net neutrality, rights to distribute the same content via all platforms, must carry rules for linear services, and QoS for non-linear services. These issues require further investigation.

Recommendation 18

Investigate the direct and indirect impact on the terrestrial platform of related aspects such as net neutrality, the rights to distribute the same content across all platforms, must carry rules for linear services, and QoS for non-linear services.

7. Abbreviations & Acronyms

Term	Remark
AAC	Advanced Audio Coding
DSL	Digital Subscribers Line. The acronym xDSL is sometime used to refer to DSL technologies in general, including ADSL, HDSL, SDSL and VDSL.
DTT	Digital Terrestrial Television
DVB-NGH	DVB New Generation Handheld
CEPT	European Conference of Postal and Telecommunications Administrations
EPG	Electronic Programme Guide
EU	European Union
HBB	Hybrid Broadcast / Broadband
HbbTV	Hybrid broadcast broadband Television
HDTV	High Definition Television
HSPA	High Speed Packet Access
IPTV	Internet Protocol Television
ISP	Internet Service Provider
ITU	International Telecommunications Union (www.itu.int)
LF/MF/HF band	LF band: 30 – 300 kHz; MF band: 300 kHz – 3 MHz HF band: 3 – 30 MHz
LTE MBMS	Long Term Evolution - Multimedia Broadcast and Multicast System
MBSFN	Multimedia Broadcast over a Single Frequency Network
MHP	Media Home Platform
MHEG	Multimedia and Hypermedia Experts Group MHEG-5 specification is the same as ISO/IEC 13522-5
MPEG-1 Layer 2	Moving Picture Experts Group MPEG-1 Layer 2 is an audio compression format MPEG-4 is a method of compression of audio and visual (AV) digital data
OTT	Over-the-top - a general term for service deliver over a network but not offered by the network operator
PLP	Physical Layer Pipe
PSB	Public Service Broadcasting
QoS	Quality of Service

T2-Lite	A subset of DVB-T2 specification specifically intended for mobile reception.
Ultra-HDTV	Ultra High Definition Television
USB	Universal Serial Bus
VoD	Video on Demand
WLAN	Wireless Local Area Network
3DTV	3-Dimensional Television

8. References

[1]	Specifications related to DAB/DAB+/DMB: http://www.worlddab.org/introduction_to_digital_broadcasting/standards_specs
[2]	Specifications related to DRM/DRM+: http://www.drm.org/standardisation
[3]	Specifications related to DVB-T and DVB-T2: http://www.dvb.org/technology/standards
[4]	Information on 3GPP specifications: http://www.3gpp.org/specifications
[5]	EBU Principles for Internet-Connected and Hybrid Television in Europe: http://www.ebu.ch/en/union/news/2011/tcm_6-71722.php
[6]	'2010 a milestone year for DTT in Europe', Press release by the European Commission, 11 Oct 2010: http://www.obs.coe.int/about/oea/pr/mavise_oct2010.html
[7]	ITU Terminology database: http://www.itu.int/terminology/index.html