CEPT Report 21

Report A from CEPT to the European Commission
in response to the Mandate on:

"Technical considerations regarding harmonisation options for the Digital Dividend"

"Compatibility issues between "cellular / low power transmitter" networks and "larger coverage / high power / tower" type of networks"

Final Report on 30 March 2007 by the

Electronic Communications Committee

Electronic Communications Committee (ECC)
within the European Conference of Postal and Telecommunications Administrations (CEPT)

Table of contents

0 EXECUTIVE SUMMARY

Introduction

This Executive Summary is an extract of the text of CEPT Report 21 - Report A in response to the 1st Mandate on Digital Dividend and highlights the positions found. Throughout this Report mobile multimedia and multimedia broadcasting services or applications are understood as downlink services e.g. no up link is included in the present considerations.

The detailed contributions will be found in the main body of this report.

Justification

It was noted that the EC has mandated the ECC to explore the **technical feasibility** of relevant potential uses of the future digital dividend, to identify any major **coexistence limitations** of these potential uses due to interference issues, and to assess possible **spectrum management strategies** to address those issues.

Digital dividend

TG4 accepted the definition as given by the Radio Spectrum Policy Group (RSPG) as a bases of the work: "*The digital dividend is understood as the spectrum made available over and above that required to accommodate the existing analogue television services in a digital form, in VHF (band III: 174 - 230 MHz) and UHF bands (bands IV and V: 470 - 862 MHz)".*

This Report covers in particular ECC Mandate on downlinks of multimedia applications relating to harmonization options for the digital dividend:

- the practical coexistence between high and low power density networks (i.e. co-existence of RPC-1 and RPC-2/3 configurations in adjacent channels;
- the possibility of harmonising at EU level a sub-band for multimedia applications, minimising the impact on the GE-06 plan.

Geneve 2006 (GE-06) in relation with the Mandate

The Geneva 2006 (GE06) Agreement establishes a Plan containing frequency allotments and assignments for the transmission of DVB-T and T-DAB services in Band III (174 - 230 MHz) and DVB-T services in Bands IV/V (470 - 862 MHz).

Flexibility is an integral part of GE06. In other words, the Plan does permit assigned frequencies (digital entries) to be used for implementing broadcasting services with different characteristics or other applications, provided the interference and the protection requirements are kept within the envelope of the corresponding entry in the Plan. An administration can modify its entries in the Plan by applying the provisions of Article 4 of the GE06 Agreement.

Multimedia broadcasting and the future

"Hybrids" of traditional broadcast and mobile multimedia applications, are considered as promising candidates for multimedia broadcasting applications. For example, the development of the Digital Video Broadcasting to Handheld (DVB-H) standard makes it possible to deliver live broadcast television to a mobile handheld device. Although these mobile multimedia broadcasting technologies may use the same frequency spectrum as DVB-T, they are likely to require dedicated networks. These networks will be designed taking into account that reception on a handheld device requires higher field strength values compared to fixed DVB-T reception in order to compensate for the low antenna gain, lower receiving height and, when indoor operation is targeted, building penetration loss.

Practical coexistence between high and low power density networks

Following the Mandate the report describes compatibility issues which may appear between DVB-T and multimedia broadcasting type networks due to differences in received field strength when using non-co-sited transmitters in adjacent channels and beyond and proposes solutions to overcome these conflicts.

Explanation of the issue

As part of the GE06 Agreement the "Reference Planning Configurations" (RPCs) incorporate the different system variants and the different reception modes which are possible with digital broadcasting technologies. Three RPCs were assumed for DVB-T planning: RPC 1 for fixed reception, RPC 2 for portable outdoor or mobile reception, RPC 3 for portable indoor reception.

In general, broadcasting and multimedia services for indoor reception, as for example DVB-H, need a higher density of transmitters in order to provide a sufficiently high field strength across an entire planned service area (e.g. RPC 3-type networks). Fixed DVB-T reception using roof top antennas is provided by sparsely located high-power transmitters (e.g. RPC 1-type networks). Consequently, adjacent channel interference may occur between overlapping (or nearby) DVB-T and multimedia broadcasting coverage areas. The problem should be considered on the first adjacent channels (N±1) and beyond (N±M, M>1).

Adjacent channel interference is caused when a receiver tuned to the wanted service is subject to interference in the wanted channel from another service operating in an adjacent channel. If the two services are transmitted from the same location using appropriate power levels and an appropriate spectrum mask it is possible to ensure that there is no harmful interference in the coverage area of both services. However, if the two services are transmitted from different locations and/or at significantly different power levels it is much harder to specify how to protect both wanted services across their entire coverage area.

This situation is especially relevant to the protection of DVB-T services broadcast from a high power/tower transmitter network (which typically employs a relatively small number of sites) from another service operating at medium or even low power using a dense network. In the vicinity of the transmitters of a dense network the relative field strength of the service transmitted using the dense network signals could be significantly higher than that of the high power network near the edge of its coverage area, due to the different propagation distances from the transmitters. This is particularly true when the required field strength of the dense network intended for multimedia broadcasting is high. This can result in adjacent channel interference (referred to as hole punching) to receivers close to the transmitters used in the dense network.

It should be, however, pointed out that the compatibility issue of co-existence of DVB-T and multimedia broadcasting networks planned for different types of reception appears primary at national levels and is to be considered as a domestic problem, in terms of geographic location. European countries have selected different RPCs, depending on their national requirements. In some areas this selection has been based on compromises found in long and intense bi- and multilateral negotiations, in order to have an equitable access to the frequency spectrum.

How incompatibilities should be treated and can be solved or mitigated using different engineering solutions

Mobile multimedia networks could use the GE-06 Plan by applying the provisions of the GE06 Agreement including the envelope concept.

Compatibility issues between DVB-T fixed reception and mobile multimedia broadcasting type of networks may be relevant within any country wishing to deploy multimedia broadcasting networks and having DVB-T fixed reception networks. Any cross-border conflicts are to be solved under the GE06 Agreement.

The Report indicates that the risk of adjacent channel interference exists only in close vicinity of the interfering multimedia broadcasting transmitter, located within the coverage area of the non-co-sited service. Therefore, it should be considered as a domestic problem and be treated on a national basis. In some cases, where the interfering transmitter is located very close to the borders, cross-border interference may occur, requiring treatment involving neighbouring Administrations. In general, the problem should be assessed technically on an area by area basis.

Different methods can be used on an area by area basis in order to minimise the impact of adjacent channel interference. Use of one or another technique or their combination depends largely on planning assumptions made both for DVB-T and multimedia broadcasting services. Some multimedia broadcasting networks target services mostly in urban areas, whereas others foresee operation across large territories.

In general, the best transmitting configuration to cover the same area by several transmitters still is to co-site them and to use the same antenna system noting that coverage area of multimedia transmitters will be smaller than the fixed reception DVB-T coverage. A less good solution could be to use the same site but with different antenna systems or to use very close sites. The most difficult configuration is to use different and widely separated sites. In this case several measures are recommended in the Report in order to ensure the compatibility between the non co-sited DVB-T and multimedia broadcasting transmitters.

Conclusions

Adjacent channel interference should be considered for a large frequency offset between wanted (DVB-T) and interfering (mobile multimedia broadcasting) services, although the first adjacent channel is a more problematic scenario. Currently, DVB-T receiver protection ratios were shown to be slightly better than IEC standards at frequency offsets N±2 and considerably better beyond in cases when the front-end receiver is not overloaded. In order to ensure better performances with regard to high level out-of-channel interference in the future an improvement of the relevant standards should be sought.

The risk of adjacent channel interference exists only in close vicinity of the interfering multimedia broadcasting transmitter, located within the coverage area of the victim service. Therefore, it should be considered as a domestic problem and be treated on a national basis and on a bilateral level when it extends across a local border. In general, the problem should be assessed technically on an area by area basis.

In summary, co-existence of “cellular / low-power transmitter” networks and “larger coverage / high power/tower” type of networks in Band IV/V is possible within the GE06 Agreement by applying the available mitigation techniques together with careful network planning.

Concerning possibility of harmonising a sub-band of bands IV and V for downlinks of multimedia applications

The RSPG was noting that: *“There may be EU-wide benefits to the use of the digital dividend by broadcasting services. The current international regulatory framework, as settled by the Radio Regulations and the GE-06 Agreement, provides an appropriate framework for this development. Within this framework:*
In the absence of significant re-planning activities, it would in general be feasible to make available one or more layers per country suited for high field strength downlink services. Within this harmonised sub-band, the channels used for that purpose may differ from area to area.

A common (but not dedicated) sub-band of the UHF band for high field strength downlink services could permit improved terminal performance/reduced network costs and improved compatibility with fixed reception broadcasting, and facilitate interactive services using the 900 MHz band for the return channel.”

The GE06 Plan does permit assigned frequencies (digital entries) to be used for other services under the spectrum mask concept as long as they are notified under the envelope of broadcasting assignment and do not require more protection or cause more interference than is allowed according to the GE-06. Therefore the conclusion is valid that the GE-06 agreement already allows the introduction of mobile multimedia applications. It is assumed that spectrum harmonised for these application will improve their introduction.

The spectrum that could be harmonised for these services in the UHF band is currently worldwide being identified in the context of the digital dividend. Various countries outside Europe are currently assessing the future use of the digital dividend for new services including mobile multimedia services. This is particularly the case in Japan, Korea and the United States. In Europe, UK has identified its digital dividend to be 112 MHz.
Mobile broadcasting television has already been launched in a few countries. In others, different trials and pilot tests have been carried out.

Technical elements in relation to the potential harmonisation of a sub-band
Terminal design is an important issue to be considered. Antenna performance and implementation within a mobile terminal are highly dependent on the required operating frequency bandwidth. In general, narrowband antenna gain improvements can be expected over a bandwidth around 10% or less of the centre frequency.

The use of filters need to be considered where mobile broadcast UHF receiver in a mobile terminal needs to be well designed since the receiver may need to co-exist and simultaneously operate with multiple other radio sources that are already integrated in the same terminal. Limiting the mobile broadcast receiving spectrum range to a narrower sub-band would allow to either increase the mobile broadcast receiver sensitivity with lower filters insertion loss if the sub-band is below 750 MHz, or to increase the possible operating frequency for mobile broadcast beyond the current limit of 750 MHz at constant filters insertion losses.

Today, almost all products available at present for mobile broadcast have external antennas which are so far accepted by customers, however, considering the market for mobile terminals, it is expected that consumers would prefer in the future integrated antennas. Narrowband operation allows the integration of small fixed antenna in the new generation of thin phones.

Some manufacturers are developing terminals with multiple narrow band internal antennas which are able to cover the whole UHF band, in order to have an integrated device. However, as a consequence, the devices have larger size and are more costly.

Mobile broadcast operation over a narrow band leads to an improvement in terminals design (better antenna gain and lower filters insertion loss) which translates directly into an overall improvement in the link budget of the mobile broadcast network. This improvement in the link budget leads to an increase of coverage or alternatively to an increase in the network capacity through the implementation of better coding schemes.

With regard to technical elements in relation to the potential harmonisation of a sub-band it should be also mentioned that the GE-06 Agreement has been optimised for digital terrestrial broadcasting using common planning criteria and parameters. Provisions contained in the GE-06 Agreement, including the interference envelope concept (Figure 4) already allow the introduction of multimedia applications

Status of the current digitalization of the Bands IV and V

DVB-T has already been introduced in 14 European countries (see Figure 5), and other countries are planning to launch within 2007/2008.

Successful commercial implementation of Mobile TV in the UHF band has already taken place in Italy based on a strong market push, and Finland launched DVB-H in 2006 as well. Others countries like Germany (in 2007) and Czech Republic are planning to start soon. Spain has already developed several trials and has announced that the launch of the commercial service will take place soon. Mobile broadcasting television has already been launched in a few countries. In others, different trials and pilot tests have been carried out.

As a consequence, mobile multimedia networks in the near future are likely to use channels located in a wide range of frequencies and terminals will have to cope with this situation from the start. For the medium term, in the context of the digital dividend and the analogue switch off, narrow band operation may be envisaged for mobile broadcasting and would lead to better terminal performances. However, by that time, existing infrastructure and terminals may not benefit from this narrow band operation, since they will not be optimized for this special sub band.

Other services

Assignments to other services having primary status in the Radio Regulations have been taken into account at RRC-06. These services include radio navigation and fixed or mobile services for military applications. In addition there are services with secondary status in the Radio Regulations in Band IV/V.

There is an additional increase in demand due to the trend towards wireless solutions for the back link to the artist, such as in-ear monitors and talkback links and due to the new demand for high quality wireless microphones for HD TV content. This situation is exacerbated by the fact that the use of SAB/SAP in Band IV/V is becoming more restricted since the band is more densely planned for DVB-T, leaving less room for SAB/SAP.

Spectrum requirement for the operation of multimedia mobile networks and the effect of the harmonisation on existing layers

Theoretically, a 32 MHz sub-band (i.e. 4 channels) would enable the deployment of mobile broadcast networks based on a 4 frequency reuse pattern and large area SFN. Such area could be a country, a region, a linguistic area, depending on the national specificity and on the need to broadcast local programs over such mobile multimedia networks, noting that other networks may also be used for such local programs (e.g., broadcasting like mobile multimedia networks, 3G networks …). The 4 channels are available inside such areas, however, when approaching the boundary, interference between different SFN networks would require frequency reuse pattern. According to the graph theory, the availability of 4 channels would guarantee the possibility to have at least one channel available at each border between countries, regions or linguistic areas.

In frequency planning for high power broadcasting systems this theorem does not apply. At least 6 channels are normally needed to achieve full coverage. However, using cellular networks might make it possible to reach this lower bound or at least come close to it in multi-countries or inter service border areas. Therefore, for conventional high power broadcasting networks, it will be difficult to reach the same level of coverage within the 4 channels approach.

If 2 channels have to be available everywhere, then 2 sub bands of 32 MHz (i.e., 64 MHz) needs to be defined. Some countries may wish to operate more than two multimedia services across their territories. This would involve a large (≥ 96 MHz) band dedicated for implementation of multimedia services and, as a consequence, a loss of the benefits of harmonization in terms of antenna gain.

It should be noted that the above considerations may not apply to networks which would use channels narrower than 8 MHz.

Consequences in terms of cross/border coordination and GE06 Plan
Overall the GE06 Plan has been highly optimised to provide a very intricate balance of allocations to all countries. It is also highly optimised to fit together the national requirements of all neighbours. The high level of interlocking dependencies means that any change to an assignment or an allotment characteristics (power, frequency, …) could result in consequential changes being required across several adjacent countries. The mask concept allowing for versatile reuse of the allocations also provides for the introduction of new applications in the future as a natural evolution without the need for a replan. All CEPT countries are signatories to Declaration 42 which allows for this flexible reuse while retaining the Plan structure as a whole. This provision means that each country already has the necessary mechanisms to allocate future resources internally without causing any additional interference beyond the existing agreements.

In case an assignment or an allotment of the GE-06 plan is to be changed for deploying multimedia applications, Article 4 procedures of the GE06 Agreement should be applied in each single case. This would probably be necessary for a limited number of plan entry if an harmonised sub-band is explicitly reserved for a certain application. Coordination will also be necessary with GE06 Plan entries of other countries not directly involved in this re-planning.
Furthermore, the outcome of such a re-planning process needs to ensure the same level of equitable access as the GE06-plan.

Identifying an harmonised sub-band would create holes in some of the layers obtained at RRC-06 in countries implementing such band and would require them to accept constraints to protect and to accept interference from the GE-06 entry plans of their neighbours. It would not be possible to make up for these losses in the remaining available spectrum without significant cross-border coordination activities. CEPT considers that there should not be a new planning conference such as GE06 nor a European conference at CEPT level, so that the issues should be solved on a national or bilateral basis.

Consequences in terms of costs, affected markets and delay
It was already recognised by the RSPG that "modifying the frequencies of existing or planned broadcasting services, which may make such modifications extremely difficult if not impossible."
Due to the ongoing digitisation throughout Europe, there are existing licences, services and many hundreds of digital stations in operation.

In principle, there would be different categories of costs which would have to be balanced to the eventual benefits of the creation of a sub-band. Cost for re-planning, modification of antenna systems, when informing the public or in penalty clauses etc.

In case of a harmonised allocation of a sub-band, the necessary re-planning process would most likely be complex and time-consuming.

Cost and availability of terminals
Harmonisation of spectrum has an impact on the cost and availability of terminals. The development of multi-band terminals, resulting from a lack of harmonisation, also has an impact on the handset performance, such as more insertion loss and lower sensitivity, and on its complexity.

Therefore, harmonisation of frequency bands used in a mobile terminal leads to economies of scale and reduces their cost.

A wideband terminal that could cover the whole UHF band could achieve more economies of scale than a narrow band terminal, depending on the respective market in which these equipments will be used.

It should be noted that in case of harmonisation of a narrow sub-band, the new narrow band terminals will not be compatible with transmissions spread across the range 470 - 750 MHz.

Scenarios and approaches for the introduction of a sub-band
Two possible scenarios for sub-band harmonisation could be envisaged, a narrow sub-band located above 750 MHz, and a narrow sub-band located below 750 MHz
The second scenario would also ensure the backward compatibility with wide band mobile broadcast terminals that operate over the band 470 - 750 MHz as these terminals will be able to operate within the sub-band.

Two potential approaches for the implementation of mobile multimedia are:
1. implementation based on existing GE-06 plan entries and
2. harmonisation of a narrow sub-band.

Conclusions
Two approaches to implement downlinks of mobile broadcast networks in the UHF-bands IV and V have been discussed in this report

- Approach 1: Implementation without a harmonized sub-band, based on the GE06 Plan entries
- Approach 2: Implementation based on a harmonized sub-band

These two approaches are not mutually exclusive and could be implemented by administrations jointly or in a different timeframes:

Approach 1
GE-06 Agreement has de facto harmonized the entire band IV and V for all forms of broadcasting including multimedia applications. According to the GE06 Agreement on average 7 UHF layers have been allocated to each European Administration. On a national basis the flexibility is given to arrange the frequencies of the GE06 Plan such that several national layers result with assigned frequencies below a certain threshold (e.g. <750MHz) or within certain sub-band(s).

Those layers may be assigned to mobile multimedia broadcasting services. The network structure of such mobile multimedia broadcasting services may be based on conventional (broadcasting like) or cellular like networks or on a combination of both (distributed networks).

In European countries, the implementation of mobile multimedia broadcasting services is possible and has already started in many countries on the basis of the GE06 Plan and its provisions. Up to 7 multimedia-layers may be deployed in border areas and up to 49 SFN networks away from borders, out of range of interference.

Depending on the outcome of bi-lateral negotiations between neighboring administrations, with regard to the transition period, an immediate implementation of mobile multimedia broadcasting services is possible.

Approach 2
The harmonization of a narrow sub-band (up to 10% of the centre frequency) would allow an improvement of the technical characteristics of receivers (better antenna gain). As a consequence the implementation costs for networks will be reduced irrespective of the network topology.

Harmonizing a narrow sub-band of 10% of the centre frequency (e.g. 64 MHz at 650 MHz) would enable the deployment of at least 2 SFN networks in multi-country border areas, providing successful coordination, and up to 8 SFN networks away from borders, out of range of interference.
Receivers designed to operate in a specific sub-band will consequently not be able to receive available services operated in accordance with approach 1 outside the sub-band.

Based on the new GE06 Plan, many licenses for digital broadcasting or mobile multimedia broadcasting services have already been granted in Europe for the next 10 to 15 years. Therefore, the European wide harmonization and implementation of a sub-band for mobile multimedia broadcasting services is not realistic before at least 2020.

Therefore, in the near and medium term, harmonisation of a sub-band for mobile multimedia may only be considered on a non-mandatory basis, with countries adopting harmonised channels for mobile multimedia where feasible and beneficial. The harmonised sub-band would need to be known in a relatively short time frame. It may also need to be reviewed in the future, taking into account the progress of technology and service deployment, with a view to enable other countries to benefit from harmonisation.

Recommendations
For the deployment of mobile multimedia applications, option 1 minimizes the impact on the current status of GE-06 Plan. Since this plan may evolve continuously through the application of its modification procedure, it is possible for it to evolve towards a harmonised sub-band for mobile multimedia applications.

List of Terms (Abbreviations)

Band III	VHF Channels 5 – 12 (174 – 230 MHz)
Band IV	UHF Channels 21 – 34 (470 – 582 MHz)
Band V	UHF Channels 35 – 69 (582 – 862 MHz)
DVB-H	Digital Video Broadcasting to Handheld
DVB-T	Digital Video Broadcasting – Terrestrial
EBU	European Broadcasting Union
ERP	Effective Radiated Power
ETSI	European Telecommunications Standards Institute
FLO	Forward Link Only
GE06	The Geneva 2006 Agreement and Plan
HSDPA	High Speed Downlink Packet Access
ITU	International Telecommunications Union
ITU-R	ITU Radiocommunication sector
MBMS	Multimedia Broadcast and Multicast Service
RPC	Reference Planning Configuration
SAP/SAB	Services Ancillary to Broadcasting and Programme making
SFN	Single Frequency Network
T-DAB	Terrestrial Digital Audio Broadcasting
T-DMB	Terrestrial Digital Multimedia Broadcasting
VHF	Very High Frequency
WCDMA	Wideband Code Division Multiple Access
WiMAX	Worldwide Interoperability for Microwave Access

1 INTRODUCTION

The Geneva 2006 (GE06) Agreement [1] establishes a Plan containing frequency allotments and assignments for the transmission of DVB-T and T-DAB services in Band III (174 - 230 MHz) and DVB-T services in Bands IV/V (470 - 862 MHz) as well as other primary services.

Flexibility is an integral part of GE06. In other words, the Plan does permit assigned frequencies (digital entries) to be used for implementing broadcasting services with different characteristics or other applications, provided the interference and the protection requirement are kept within the envelope of the corresponding entry in the Plan. An administration can modify its entries in the Plan by applying the provisions of Article 4 of the GE06 Agreement.

“Hybrids” of traditional broadcast and mobile multimedia applications, are considered as promising candidates for mobile multimedia broadcasting applications. For example, the development of the Digital Video Broadcasting to Handheld (DVB-H) standard makes it possible to deliver live broadcast television to a mobile handheld device. Although these mobile multimedia broadcasting technologies may use the same frequency spectrum as DVB-T, they are likely to require dedicated networks.

These networks will be designed taking into account that reception on a handheld device requires higher field strength values compared to fixed DVB-T reception in order to compensate for the low antenna gain, lower receiving height and, when indoor operation is targeted, building penetration loss.

This preliminary report describes compatibility issues that may appear between DVB-T and multimedia broadcasting type networks due to differences in received field strength when using non-co-sited transmitters in adjacent channels and beyond, and proposes solutions to overcome these conflicts.

Throughout the Report mobile multimedia broadcasting services or applications are understood as high field-strength downlink services, e.g. no up-link is included in the present considerations.

It is acknowledged that mobile multimedia services can be provided by various systems, such as DVB-T, DVB-H, T-DMB, FLO, WiMAX, WCDMA/HSDPA, MBMS or other cellular services. These services may require high downlink field strengths, potentially causing problems within DVB-T services using adjacent channels. A key issue is the large difference in field strength requirements between a DVB-T service and an interfering mobile multimedia application. The conclusions of the studies on DVB-H networks in this Report are, therefore, also valid for other mobile multimedia services using high field strength downlinks. However, the differences in transmission masks between different systems will need to be taken into account.

The report also broadly distinguishes between two different types of mobile multimedia networks: networks based on existing TV sites, using high tower and high power transmission (i.e., broadcasting like), and large area SFN networks using also low power and dense transmitters (i.e., cellular like).

2 MANDATE TO CEPT

Having considered the RSPG opinion on multimedia services [2], EC mandated CEPT to carry out activities relating to harmonization options for the digital dividend, in particular to study:

- the practical coexistence between high and low power density networks (i.e. co-existence of RPC-1 and RPC-2/3 configurations) in adjacent channels;
- the possibility of harmonising at EU level a sub-band for multimedia applications, minimising the impact on the GE-06 plan.

This Report has been developed by the European Conference of Postal and Telecommunications Administrations (CEPT) in response to these two above elements of the mandate.

3 REPORT

3.1 The co-existence of RPC1 and RCP2/3 networks in bands IV and V

3.1.1 The issue

3.1.1.1 General description

Adjacent channel interference is caused when a receiver tuned to the wanted service is subject to interference in the wanted channel from another service operating in an adjacent channel. If the two services are transmitted from the same location using appropriate power levels and an appropriate spectrum mask it is possible to ensure that there is no harmful interference in the coverage area of both services. However, if the two services are transmitted from different locations and/or at significantly different power levels, it is much harder to specify how to protect the wanted service across its entire coverage area.

This situation is especially relevant to the protection of DVB-T services broadcast from a high power/tower transmitter network (which typically employs a relatively small number of sites) from another service operating at medium power using a dense network. In the vicinity of the transmitters of a dense network, the relative field strength of the service transmitted using the dense network signals could be significantly higher than that of the high power network near the edge of its coverage area, due to the different propagation distances from the transmitters. This is particularly true when the required field strength of the dense network, intended for multimedia broadcasting, is high. This can result in adjacent channel interference (referred to as hole punching) to DVB-T receivers close to the transmitters used in the dense network.

The problem between networks with transmitters not co-sited is schematically demonstrated in Figure 1.

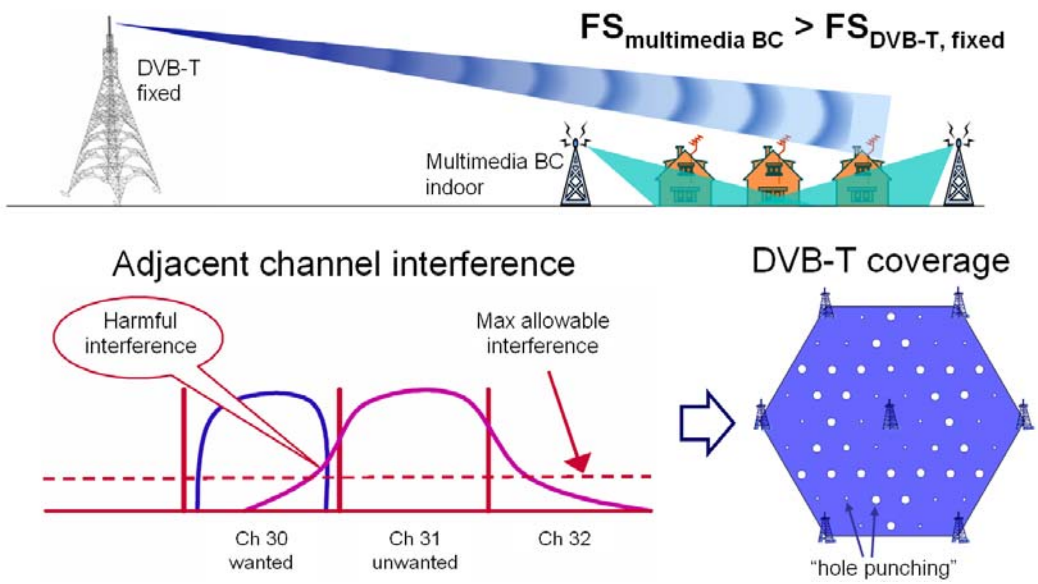

Figure 1
Adjacent channel interference from multimedia broadcasting network into DVB-T service.

Compatibility issues between DVB-T fixed reception and multimedia broadcasting types of networks may be relevant within any country wishing to deploy multimedia broadcasting networks and having DVB-T fixed reception networks. Any cross-border conflicts are to be solved under the GE06 Agreement.

On the other hand, if a country deploys networks for multimedia broadcasting primarily based on the existing broadcasting infrastructure, especially on high-power and high-tower sites (ERP up to 100 kW), then no compatibility issue is expected. This is demonstrated by the fact that during the FIFA WC 2006 in Germany, four DVB-H reference projects ("Showcases") were launched in four larger cities: Berlin, Munich, Hamburg and

Hanover. All networks were based on existing broadcasting infrastructure, i.e. existing high-power sites already in use for DVB-T. The coverage for about 1000 receivers from 5 different vendors (send out to VIP users) was quite stable and almost as predicted; no problems with existing DVB-T coverage / reception were reported.

3.1.1.2 The GE-06 Plan

Part of the GE06 Agreement flexibility is assured by “Reference Planning Configurations” (RPCs). The RPCs incorporate the different system variants and the different reception modes which are possible with digital broadcasting technologies.

Three RPCs were assumed for DVB-T planning: RPC 1 for fixed reception, RPC 2 for portable outdoor or mobile reception, RPC 3 for portable indoor reception. The reference values for minimum median field strengths assumed in the development of the GE06 Plan are given in Table 1. It can be noted that RPC 3 reference field strength is 32 dB above the reference field strength assumed for RPC 1.

RPC	RPC 1	RPC 2	RPC 3
$(E_{med})_{ref}$	56	78	88

Table 1: **Reference values for minimum median field strength $(E_{med})_{ref}$ (GE06 Agreement)**

European countries have selected different planning configurations, depending on their national requirements (Figure 2). In some areas this selection has been based on compromises found in long and intense bi- and multilateral negotiations, in order to have an equitable access to the frequency spectrum.

Multimedia downlink networks could use the GE-06 Plan by applying the provisions of the GE06 Agreement [1] including the envelope concept.

In general, broadcasting and multimedia services for indoor reception, as for example DVB-H, need a higher density of transmitters in order to provide a sufficiently high field strength across an entire planned service area. Fixed DVB-T reception using roof top antennas is provided by sparsely located high-power transmitters. Consequently, adjacent channel interference may occur between overlapping (or nearby) DVB-T and multimedia broadcasting coverage areas. The problem should be considered on the first adjacent channels (N±1) and beyond (N±M, M>1).

It should be, however, pointed out that the compatibility issue of co-existence of DVB-T and multimedia broadcasting networks planned for different types of reception appears primary at national levels and is to be considered as a domestic, in terms of geographic location, problem.

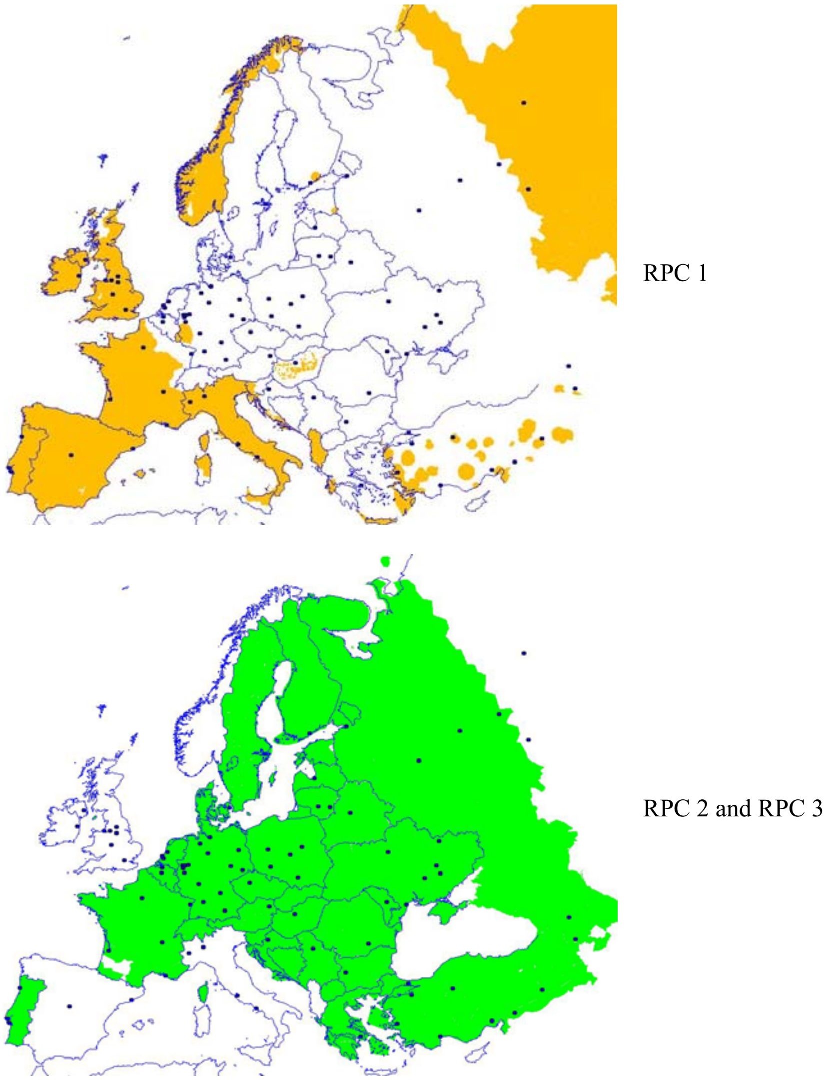

Figure 2: Reference planning configurations selected by European countries.

3.1.1.3 Bases for technical solutions

The GE06 Agreement and Plan are the most up-to-date framework for the studies of the treatment of the compatibility issues under discussion within the frequency band from 470 MHz to 862 MHz. The analysis and evaluation of GE06 provisions and their practical implementation have effects both on the level of rights of the administrations and on the level of practical implementation.

In terms of rights of the administrations the issue is limited to those countries, having RPC 1 type entries in the GE06 Plan and wishing to deploy high field strength multimedia services, in at least two respects. First, these countries have to cope with the practical difficulties within their own territory as described in this Report. Second, these countries may like to extend such a high field strength multimedia service to their borders. This may lead to international coordination which has to be addressed under the provisions of the GE06 Agreement.

Regardless of the entry type in the GE06 Plan, in terms of practical implementation it might be helpful to have some additional technical guidelines and more detailed knowledge on the compatibility issue. Firstly, this could help the domestic roll-out of any high reception field strength networks in areas having DVB-T fixed reception. Secondly, this could also ease the practical bilateral coordination and collaboration according to the GE06 Agreement, if requested by an administration whose Plan entries are RPC 1 type.

3.1.2 Compatibility studies

3.1.2.1 Protection requirements

There are three major reasons for adjacent channel interference into receivers:

- Insufficient out-of-channel filtering of the interfering signal (expressed in terms of interfering transmitter spectrum mask).
- Insufficient receiver selectivity;
- Low receiver front-end overload threshold (expressed in terms of interfering signal level in dBm).

The combined effect of these factors is expressed in terms of protection ratio (C/I) required between the wanted signal on channel N and interfering signal on channel N±M, where M ≥1.

For DVB-T protection ratios, various values are provided in the following documents:

- ETSI TR 101 190 V1.2.1 [3]: Implementation guidelines for DVB-T services:

  "For adjacent and image channel interference a protection ratio of -40 dB is assumed to be an appropriate value due to lack of data".

- ITU-R BT 1368-6 [4]: Planning criteria for digital terrestrial television services in the VHF/UHF bands:

  A ratio of -30 dB for channels N-1 and N+1 is specified with the following comment: "It is known from measurements of existing receivers that they permit lower protection ratios. But for planning purposes it is an advantage to have this value".

- IEC 62216-1 [5]: Digital Terrestrial Television Receivers for the DVB-T System (IEC documents generally provide terminal specifications):

  A ratio of -25 dB for channels N-1 and N+1 and a ratio of -40 for all others channels are specified except images frequencies (-30 dB).

The above-mentioned protection ratio values imply that the DVB-T receiver selectivity does not improve beyond the frequency offset of ± 16 MHz between the useful and interfering signals. However, such a flat protection ratio curve can only be encountered if the receiver front-end is overloaded by a very strong interfering signal.

Measurements have been conducted in France which aimed:

- to define the actual protection ratios of DVB-T receivers under normal operation conditions (no receiver front-end overloading);
- to define the front-end overload thresholds of DVB-T receivers and their selectivity under front-end overload conditions, in the presence of interference from DVB-H.

It should be noted that:

- the interfering signal generated was not in full conformity with the expected DVB-H transmitter spectrum masks. Consequently, it could be expected to obtain slightly better DVB-T protection ratios under normal operation conditions for frequency offsets of ± 8 and ± 16 MHz, when the interfering signal conforming to "Critical DVB-H mask" was generated;
- the protection ratios measured under front-end overload conditions depend not only on the frequency offset but also on the interfering signal levels.

The results obtained are given in Tables 2 and 3. The comparison between the measured DVB-T protection ratios with those defined in EMC standard IEC 62216-1 [5] is plotted in Figure 3.

Interfering signal frequency (MHz)	570	578	602	618	626	634	642	650	658	666	674	682	698	714	722	730
Channel position	N-10	N-9	N-6	N-4	N-3	N-2	N-1	N	N+1	N+2	N+3	N+4	N+6	N+8	N+9	N+10
C/I (dB)	-72	-68	-60	-50	-43	-36	-27		-27	-45	-56	-63	-65	-68	-44	-68

Table 2: DVB-T worst-case protection ratios under normal operation conditions (f_u=650 MHz, no receiver front-end overloading)

Interfering signal frequency (MHz)	570	578	602	618	650	674	682	698	714	722	730
Channel position	N-10	N-9	N-6	N-4	N	N+3	N+4	N+6	N+8	N+9	N+10
I level (dBm)	-6<	-7<	-12<	-19<		-19<	-15<	-13<	-10<	-27<	-10<
C/I (dB)	-40	-40	-40	-40		-40	-40	-40	-40	-30	-40

Table 3: DVB-T worst-case protection ratios under front-end overload conditions (f_u=650 MHz)

The DVB-T protection ratios measured clearly show that the choice of an appropriate frequency offset between the useful DVB-T and interfering DVB-H signals constitutes a very flexible and powerful interference mitigation technique. The higher the absolute frequency offset, the better the DVB-T protection ratio (except image frequencies).

Moreover, if the interfering transmitter power is optimised to avoid the DVB-T receiver front-end overloading, it is possible to prevent any interference into the DVB-T receivers from the multimedia broadcasting transmitter by a proper adjustment of frequency separation.

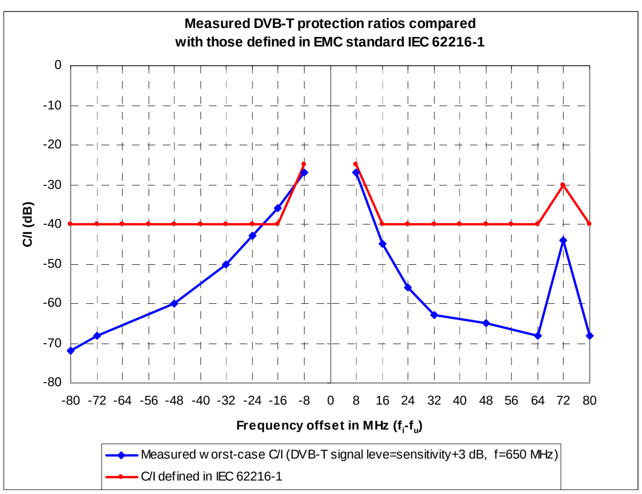

Figure 3: Measured DVB-T protection ratios with a DVB-H interferer compared with those defined in EMC standard IEC 62216-1 [5]

3.1.2.2 Field strength required for planning of multimedia broadcasting services

For a multimedia broadcasting service, the minimum median equivalent field strength required for reception depends on:

- the system variant used, which is defined by the target data-rate;
- the reception mode. Four to five reception modes are usually defined (see ETSI TR 102 377 V1.2.2 DVB-H implementation guidelines, January 2006, and BMCO mobile broadcast services link budgets, November 2006 [6]). These are:
  - Indoor (sometimes divided in two sub-modes: Light-indoor and Deep-indoor);
  - Outdoor pedestrian;
  - Mobile in-car;
  - Mobile roof-top (with car built-in antenna);
- the clutter type in the target coverage area. This includes rural, suburban, urban (and sometimes dense urban) clutter types.
- the target coverage quality, in terms of percentage of locations where the reception is ensured within a small area (of 100m x 100m). A "Good" coverage quality corresponds to 95% locations for indoor and outdoor pedestrian reception modes, and 99% locations for mobile reception modes. An "Acceptable" coverage quality corresponds to 70% locations for indoor and outdoor pedestrian reception modes, and 90% locations for mobile reception modes. "Intermediate" quality level can also sometimes be used, with 85% locations for indoor and outdoor pedestrian reception modes for example (TG4(07)005), and 95% locations for mobile reception modes.

Usually, the minimum median field strength is specified for a receiving antenna located at 1.5 m above ground level. This corresponds to the general reception conditions for portable and mobile in the street or on the ground floor of a building. However, for purposes of interference assessment, it is necessary to calculate all concerned signals (interfering signal from the multimedia transmitter and wanted signal from DVB-T) at the same receiving antenna height, which is usually set at 10 m. A correction is therefore applied to the field strength to derive the minimum median equivalent field strength at 10 m from the value calculated at 1.5 m (EBU Tech.doc. 3317: Planning parameters and implementation aspects of hand-held TV reception, considering the use of DVB-H and T-DMB in bands III, IV/V and L [7]). It should be noted that this correction due to receiving antenna height is still subject to formal verification.

Considering the DVB-H standard as a representative example for a multimedia broadcasting system, Table 2.4 provides examples of possible values of the minimum median equivalent field strength at 10 m required for the multimedia transmitter coverage in Band IV (nominal frequency 500 MHz) for a set of minimum carrier-to-noise (C/N_{min}) values (Detailed explanations and calculations can be found in EBU Tech.doc. 3317 [7]). A given combination of system variant and reception mode requires a given value of C/N_{min} required for the reception. However, for any other C/N_{min} values, the corresponding minimum median equivalent field strength increases or decreases by the same amount as C/N_{min} and, therefore, can be easily derived from Table 4.

C/N_{min}* (dB) →	9.5	11.5	9.5	11.5
Reception type → Coverage quality** ↓	Mobile roof-top (rural) (dBµV/m)	Outdoor pedestrian (urban) (dBµV/m)	Mobile in-car (rural) (dBµV/m)	Indoor (urban) (dBµV/m)
Good	68	86	89	101
Intermediate	65	82	85	96
Acceptable	63	79	83	92

Table 4: Possible values of minimum median equivalent field strength (dBµV/m) at 10 m required for a multimedia transmitter coverage in Band IV (nominal frequency 500 MHz)

* According to (EBU Tech.doc 3317), the C/N_{min} values given in this table correspond to QPSK Code Rate 1/2, Guard Interval 1/4, MPE-FEC 3/4, noting that in other source documents different C/N_{min} values are used for this same system variant (TG4(07)005).

** Coverage quality:

- Good: 95% locations for indoor and outdoor pedestrian reception modes, and 99% locations for mobile reception modes
- Intermediate: 85% locations for indoor and outdoor pedestrian reception modes and 95% locations for mobile reception modes
- Acceptable: 70% locations for indoor and outdoor pedestrian reception modes, and 90% locations for mobile reception modes.

It should be remarked that the calculation of the minimum median equivalent field strength is based on the assumption that the field strength variation is represented by a log-normal distribution with a fixed standard deviation (obtained by measurement using a single transmitter). When a distributed network structure (with several low/medium power transmitters in SFN mode) is used, especially in an urban environment, a gain due to the diversity of the signal sources is obtained, which gives a lower variation of the field strength inside the coverage area. This results in a lower standard deviation of the log-normal distribution and consequently in a lower minimum median equivalent field strength, compared to the values in Table 4, which apply for a single multimedia transmitter. This aspect is not yet fully characterised, and requires further investigations, but it is not expected that any gain obtained is constant throughout the coverage area.

3.1.2.3 Antenna discrimination and cross-polarisation

In the cases where cross-polarisation discrimination is relevant to protect a fixed DVB-T reception an isolation of up to 16 dB in the main lobe can be applied in compliance with Recommendation ITU-R BT.419 given that sometimes higher values may be encountered. Outside the main lobe an overall antenna and cross-polarisation discrimination of 16 dB should be assumed, noting that sometimes higher values may be encountered.

3.1.2.4 Summary of compatibility studies

As described in Section 3.1.1.1 each multimedia broadcasting transmitter, if not co-sited with DVB-T transmitters has the potential to punch a hole in the coverage of a DVB-T service. This compatibility issue could be relevant for any type of reception mode of the DVB-T wanted signal (fixed, portable outdoor/mobile or portable indoor) but the potential interference is highly dependent on the DVB-T wanted signal level, thus it is significant mainly for fixed reception (i.e., RPC-1).

Several studies have been carried out to assess the adjacent channel interference situation, focusing on the case of protection of DVB-T fixed reception. These studies are using two different approaches: the first one calculating the interference distance around the multimedia broadcasting transmitter (exclusion zone); the second one assessing the ratio between the interfered area around the multimedia broadcasting transmitter and the coverage area of the same transmitter:

- **Exclusion zone approach**

In this approach, the assessment of the potential interference is made in terms of the exclusion zone around a multimedia broadcasting transmitter, in which the protection criteria is not met. The size of the exclusion zone is a function of:

- the ERP of the multimedia broadcasting transmission system in any given direction;
- the available DVB-T signal level;
- the DVB-T receiver performance with regard to out-of-channel interference;
- the channel separation;
- the DVB-T receiving antenna directivity and/or polarisation discrimination in the case of fixed antenna reception.

- **Ratio of interfered area to coverage area approach**

In this approach, the assessment of the potential interference is made in terms of the ratio between the interfered area around the mobile multimedia transmitter (which corresponds in principle to the exclusion zone described above) and the coverage area of the same mobile multimedia transmitter. This latter coverage area is function of the ERP of the mobile multimedia transmitter and of the clutter type (urban, suburban or rural). The calculated ratio (as a percentage) is sometimes called the probability of interference. For a given clutter type, the ratio varies with the RF parameters in the same way as the exclusion zone radius described above. However, for different clutter types, the estimated coverage area of the mobile multimedia transmitter changes and produces different ratio figures.

Table 5 gives some results of simulations which have been done under the following assumptions:

- Homogeneous DVB-T wanted signal over the DVB-H coverage area
- Antenna discrimination assuming contra-polar transmission of 15 dB (1 dB less than the value discussed in Section 3.1.2.3)
- QPSK 2/3 modulation and a frequency of 650 MHz
- Antenna height for DVB-H transmitter of 30 m
- Protection ratio of 40 dB

DVB-H Parameters				**DVB-T Parameters**					
Envirmt	Penetration	Min Field strength @ 10m	Coverage distance		min FS	Min Planning FS	min Planning FS + 10 dB	min Planning FS + 20 dB	min Planning FS + 30 dB
	dB	dBµV/m	Km	DVB-T Field strength @ 10 m	44	53	63	73	83
U	20	94,7	0,753	Interference % of surface	*31,6%*	10,0%	2,8%	0,8%	0,2%
SU	14	88,7	1,105	Interference % of surface	*14,7%*	4,6%	1,3%	0,4%	0,1%
R	8	82,7	1,622	Interference % of surface	*6,8%*	2,2%	0,6%	0,2%	0,0%

Table 5

It should be noted that these figures are only applicable in the absence of mitigation techniques as discussed in Section 3.1.2.5.

As a general conclusion from the studies, the compatibility between DVB-T fixed reception and non-co-sited mobile multimedia transmitter is an issue that must be considered. Based on nominal performances of DVB-T receivers (with regard to the rejection of non-co-channel interfering signals) as specified in the current standards and if no action is taken to improve this compatibility, the exclusion zone could be too large or the ration of interfered area to coverage area too high to be acceptable. This applies for any frequency separation between the wanted and the unwanted channels, especially when the multimedia broadcasting transmitter is implemented near the edge of the DVB-T coverage area (i.e. where the wanted DVB-T field strength is close to the minimum required field strength).

Appropriate engineering actions on the planning parameters (listed above) can lead to a reduction in the size of the exclusion zone, thus facilitating the compatible operation of DVB-T and multimedia broadcasting type networks on adjacent channels. Section 3.1.2.5 deals with the practical solutions to reduce the exclusion zone and improve the compatibility.

Actual performances of the DVB-T receivers with regard to out-of-channel interference can be better than the current specifications, when the interfering signal does not overload the digital receiver front-end (see Section 3.1.2.1). This could have made a big difference in those real situations, which have been examined, where the absence of interference may be explained by better performances of existing receivers compared to specifications. However, in order to ensure the benefit from improved protection ratio values they have to be included in the receiver specifications of the manufacturers. It is therefore recommended to modify IEC standard 62216-1 accordingly.

It should be also noted that several trials and service launches of mobile multimedia broadcasting (using DVB-H) have already taken place in different European countries, under the current spectrum framework, using channels in the range 21 (474 MHz centre frequency) to 55 (746 MHz centre frequency). Initial investigation was carried out to identify any real interference case. The information available so far shows that interference cases have been limited and that solutions have been found to solve interference problems on a case by case basis.

3.1.2.5 Possible mitigation techniques

As discussed earlier in this Report the risk of adjacent channel interference exists only in the close vicinity of the interfering multimedia broadcasting transmitter, located within the coverage area of the victim service. Therefore, it should be considered as a domestic problem and be treated on a national basis. In some cases, where the interfering transmitter is located very close to the borders, cross-border interference may occur, requiring treatment involving neighbouring Administrations. In general, the problem should be assessed technically on an area by area basis.

Different methods can be used on an area by area basis in order to minimise the impact of adjacent channel interference. Use of one or other technique or their combination depends largely on planning assumptions made both for DVB-T and multimedia broadcasting services. Some multimedia broadcasting networks target services mostly in urban areas, whereas others foresee operation across large territories.

In general, the best transmitting configuration to cover the same area by several transmitters still is to co-site them and to use the same antenna system noting that coverage area of multimedia broadcasting transmitters will be smaller than the fixed reception DVB-T coverage. A less good solution could be to use the same site but with different antenna systems or to use very close sites. The most difficult configuration is to use different and widely separated sites. In this case several measures are recommended in order to ensure the compatibility between the non co-sited DVB-T and multimedia broadcasting transmitters.

The following are non-exhaustive examples or possible techniques that could be recommended when a multimedia broadcasting network is planned, to minimise interference into DVB-T fixed reception service from non-co-sited multimedia broadcasting transmitters:

- Use of cross polarization between the DVB-T and the multimedia broadcasting transmitter.
- Use of critical spectrum mask (as defined in the GE06 Agreement) for the multimedia broadcasting service transmitter.
- Adjusting the power of the interfering multimedia broadcasting transmitter, taking into account the local conditions, in particular the level of the wanted (DVB-T) field strength received in the area where the multimedia broadcasting transmitter is to be implemented.
- Adjusting the antenna height of the interfering multimedia broadcasting transmitter with regard to the surrounding DVB-T receiving antennas, with correct usage and control of its vertical radiation pattern.
- Applying adequate frequency separation between the wanted and the interfering signals depending on the difference of levels between the two signals.

Summarizing, it can be stated that careful network planning aimed to reduce as much as possible the exclusion zone, is necessary to ensure compatibility between DVB-T and multimedia broadcasting type networks.

For mobile broadcasting network deployments based on re-using existing cellular sites, to a large extent the mitigation techniques may potentially need to be applied for a large number of sites.

The effect of careful network planning has been theoretically demonstrated when studying an implementation scenario that considers a simultaneous deployment of DVB-T and mobile multimedia broadcasting networks in either small or large areas. In particular, it has been demonstrated that a target coverage for both a DVB-T fixed reception network and a mobile multimedia broadcasting network operating on adjacent channels can be achieved by the usage of some engineering measures as listed above. It has been also shown that a detailed optimisation of multimedia broadcasting network topology reduces considerably the number of transmitters required to serve the given area.

After the design phase of the multimedia broadcasting networks, if interference cases were encountered despite the application of the previous mitigation techniques the following measures could be taken:

- Installing rejecting filters on the fixed reception installations located near the multimedia broadcasting transmitter to reduce the interferer signal level. When relevant, this helps to avoid the possible overload of the DVB-T receiver input or any wideband antenna amplifier used in the receiving installation.
- Increasing the power of DVB-T transmitters to increase the wanted field strength within the GE06 constraints. Alternatively, installing additional DVB-T transmitter(s) to cover the area concerned.

3.1.2.6 Conclusion

Adjacent channel interference should be considered for a large frequency offset between wanted (DVB-T) and interfering (multimedia broadcasting) services, although the first adjacent channel is a more problematic scenario. Currently, DVB-T receiver protection ratios have been shown to be slightly better than IEC standards at frequency offsets N±2 and considerably better beyond, in cases when the front-end receiver is not overloaded. In order to ensure better performances with regard to high level out-of-channel interference in the future, an improvement of the relevant standards should be sought.

The risk of adjacent channel interference exists only in close vicinity to the interfering multimedia broadcasting transmitter, located within the coverage area of the victim service. Therefore, it should be considered as a domestic problem and be treated on a national basis, and on a bilateral level when it extends across a local border. In general, the problem should be assessed technically on an area by area basis.

In summary, co-existence of “cellular / low-power transmitter” networks and “larger coverage / high power/tower” type of networks in Band IV/V is possible within the GE06 Agreement [1], by applying the available mitigation techniques together with careful network planning.

3.2 The possibility harmonising a sub-band of bands IV and V for downlinks of multimedia applications

Throughout this part of the Report multimedia broadcasting services or applications are understood as equivalent to the terminology “multimedia services or applications”, as used in the RSPG opinion, i.e., high field-strength downlink services, e.g. no up-link is included in the present considerations.

The report also broadly distinguishes between two different types of mobile multimedia networks: networks based on existing TV sites, using high tower and high power transmission (i.e., broadcasting like), and large area SFN networks using also low power and dense transmitters (i.e., cellular like).

3.2.1 Technical elements in relation to the potential harmonisation of a sub-band for the implementation of downlinks of multimedia applications in the band 470 - 862 MHz

3.2.1.1 Terminal design

3.2.1.1.1 Relation between antenna bandwidth and antenna performance

Antenna performance and implementation within a mobile terminal are highly dependent on the required operating frequency bandwidth. In a cellular phone, space for an antenna is usually limited due to aesthetic considerations.

The measurements of antenna gain were made on a limited number of available products. These measurements showed the following general levels: An internal narrowband antenna (with a size equivalent to current GSM integrated antennas) over 4 UHF channels, 32 MHz (3 dB bandwidth), can achieve a gain advantage of around 2 to 3 dB relative to al small external wideband, 250MHz (3 dB bandwidth), antenna. There is a similar additional advantage of 2 to 3 dB for the external wideband antenna over a wideband antenna integrated into a handset. For a particular internal narrowband antenna over 8 UHF channels (64 MHz) operating at 700 MHz, an advantage of 4 dB could be achieved compared to an internal wideband antenna.

It should be noted that the limited set of measurements were taken under idealised laboratory conditions and do not indicate any production line spreads in values, and should only be taken as a guide to the trade off between the possibilities.

In general, narrowband antenna gain improvements can be expected over a bandwidth around 10% or less of the centre frequency. As an example, at 650 MHz, a bandwidth of around 10% is equivalent to 64 MHz, corresponding to 8 channels of 8 MHz. The performance of such an antenna should preferably be as uniform as possible across the whole bandwidth, in order to avoid good and bad channels

The choice between the options will result in compromises between the units versatility, cosmetic appearance, and performance. There is potential for cost savings in network implementation with a narrow band optimised device, but the volume in which the device could be manufactured, depends on the size of the market corresponding to the countries implementing the harmonised approach.

3.2.1.1.2 Filters

Mobile broadcast UHF receiver in a mobile terminal needs to be well designed since the receiver may need to co-exist and simultaneously operate with multiple other radio sources that are already integrated in the same terminal. The primary source of interference on a mobile broadcast reception into an integrated GSM terminal is mostly driven by GSM 900 MHz jamming and by the noise level generated by GSM 900 transmit Power Amplifier (PA). For wideband operation, the required filter selectivity and insertion loss could be achieved if the frequency separation from GSM operation is large enough which leads to set an upper limit for mobile broadcast operation at 750 MHz. Limiting the mobile broadcast receiving spectrum range to a narrower sub-band would allow to either increase the mobile broadcast receiver sensitivity with lower filters insertion loss if the sub-band is below 750 MHz, or to increase the possible operating frequency for mobile broadcast beyond the current limit of 750 MHz at constant filters insertion losses.

3.2.1.1.3 Integrated vs. external antennas

The current and future generations of cellular phones are packed with multimedia components such as a camera, an audio player, and external memory cards which limit the space available for integrated antennas. Fixed external antennas such as a retractable whip or helical stubby can possibly cover a wide frequency band. Today, almost all products available at present for mobile broadcast have external antennas which are so far accepted by customers, however, considering the market for mobile terminals, it is expected that consumers would prefer in the future integrated antennas. Narrowband operation allows the integration of small fixed antenna in the new generation of thin phones.

Some manufacturers are developing terminals with multiple narrow band internal antennas which are able to cover the whole UHF band, in order to have an integrated device. However, as a consequence, the devices have larger size and are more costly.

3.2.1.1.4 Consequence in terms of network planning

Mobile broadcast operation over a narrow band leads to an improvement in terminals design (better antenna gain and lower filters insertion loss) which translates directly into an overall improvement in the link budget of the mobile broadcast network. This improvement in the link budget leads to an increase of coverage or alternatively to an increase in the network capacity through the implementation of better coding schemes.

As an illustration, an improvement of 5 dB in the antenna gain performance due to a narrow band operation over 32 MHz compared to a wideband operation for a cellular-like deployment could theoretically lead to about roughly doubling the coverage area of a mobile broadcast network (assuming Okumura-Hata model with 30 m antenna height, i.e., 35log d propagation loss). However, these savings have to be seen in relation to the deployment costs. A more cost efficient solution may be obtained with an approach that uses fewer sites.

Obviously, there are some other elements relevant for network deployment, which will depend on whether the mobile multimedia network is based on a broadcasting-like topology, a cellular-like topology or a mixture of the two. They are not addressed here.

3.2.1.2 Interference envelope concept

The GE-06 Agreement has been optimised for digital terrestrial broadcasting using common planning criteria and parameters.

Provisions contained in the GE-06 Agreement, including the interference envelope concept (Figure 4) already allow the introduction of multimedia applications.

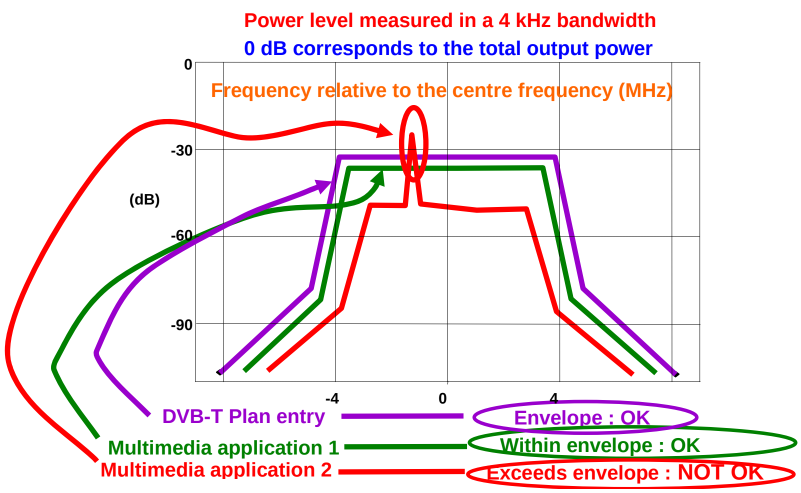

Figure 4: Interference envelope concept (image courtesy of EBU)

3.2.2 Frequency management and market elements in relation to the identification of a sub-band for the implementation of downlinks of mobile multimedia applications in the band 470 - 862 MHz

3.2.2.1 Status of the current digitalization of the band 470 - 862 MHZ

3.2.2.1.1 DVB-T

DVB-T has already been introduced in 14 European countries (see Figure 5), and other countries are planning to launch within 2007/2008.

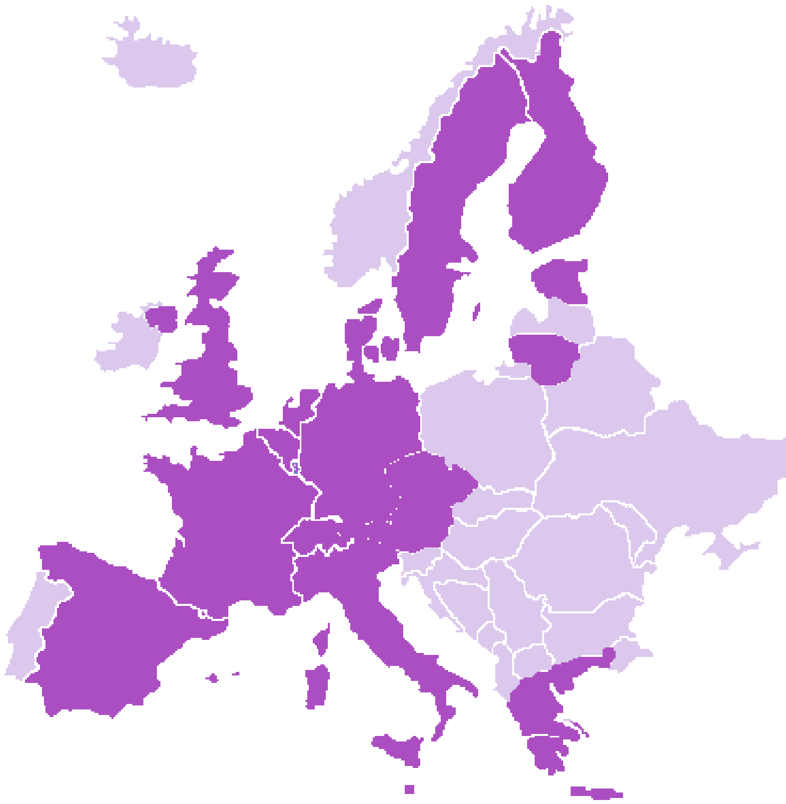

Figure 5: Status of introduction of DVB-T in Europe – in dark all countries which already launched DVB-T regular services (from DigiTAG)

The spectrum that could be harmonised for mobile multimedia services in the UHF band, on a worldwide level, is currently being identified in the context of the digital dividend. Various countries outside Europe are currently assessing the future use of the digital dividend for new services including mobile multimedia services. This is particularly the case in Japan, Korea and the United States where the digital dividend was identified respectively to be 48 MHz (from 722 to 770 MHz additional 12 MHz from 710 to 722 are currently under consideration), 54 MHz (from 752 to 806 MHz) and 108 MHz (from 698 to 806 MHz).

In Europe, UK has identified its digital dividend to be **112 MHz** (64 MHz within the band 550 - 630 MHz and 48 MHz from 806 MHz to 854 MHz).

It should be noted that the countries mentioned above are still in the process of open consultation with potential candidate usages including mobile multimedia.

3.2.2.1.2 Mobile multimedia deployment in Europe and worldwide

Successful commercial implementation of Mobile TV in the UHF band has already taken place in Italy based on a strong market push, and Finland launched DVB-H in 2006 as well. Others countries like Germany (in 2007) and Czech Republic are planning to start soon. Spain has already developed several trials and has announced that the launch of the commercial service will take place soon.

Mobile broadcasting television has already been launched in a few countries. In others, different trials and pilot tests have been carried out.

Worldwide information regarding DVB-H trials and service launches are available from DVB Project Office www.dvb-h.org. In Europe 3 countries have launched DVB-H under the current spectrum framework using channels in the range 21 (474 MHz centre frequency) to 55 (746 MHz centre frequency). In addition 15 countries have performed trials using different channels spread from channel 21 to 55. Furthermore, one country has performed trials in channels above channel 55. Outside Europe, 12 countries have also performed DVB-H tests and 3 have announced the expected launch date; the frequencies used are also spread from 470 MHz to 750 MHz. In most of the countries more than one company have performed trials and have announced expected launch date.

In the USA, MediaFLO technology delivers mobile broadcasting on channel 55 (716 - 722 MHz) and DVB-H is envisaged on channels 54 and 59 (710 - 716 MHz, 740 - 746 MHz), both in SFN configurations.

It should be noted that in different part of the world, different frequency channel raster and channel numbering are used.

It should be mentioned that the choice of frequencies to make trials or to launch regular services in the short term, in the UHF band depends on the actual availability of channels in each country, taking into account the fact that, in most countries, analogue and digital fixed broadcasting TV are simultaneously in operation.

In the medium term, particularly after analogue switchover, there will be more flexibility in the availability of channels.

As a consequence, mobile multimedia networks in the near future are likely to use channels located in a wide range of frequencies and terminals will have to cope with this situation from the start. For the medium term, in the context of the digital dividend and the analogue switch off, narrow band operation may be envisaged for mobile multimedia and would lead to better terminal performances. However, by that time, existing infrastructure and terminals may not benefit from this narrow band operation, since they will not be optimized for this special sub band.

3.2.2.1.3 Other services

Assignments to other services having primary status in the Radio Regulations have been taken into account at RRC-06 when requested by the Administrations concerned. These services include radio navigation and fixed or mobile services for military applications and are shown in the “List” of Annex 5 of GE06 [1]. In any re-planning process, if so required, these services must also to be taken into account. In addition there are services with secondary status in the Radio Regulations in Band IV/V. These services are not taken into account when primary services are planned. However, on a national basis, these services could be of great importance, for instance the Radio Astronomy Service in channel 38 and Services Ancillary to Broadcasting and Programme making (SAB/SAP).

SAB/SAP services are of increasing importance because an increase in the number of broadcast programmes, and such non-broadcast applications as stage shows, sporting events, multimedia programme production, etc., means also an increase in the demand for professional wireless microphone systems. There is an additional increase in demand due to the trend towards wireless solutions for the back link to the artist, such as in-ear monitors and talkback links and due to the new demand for high quality wireless microphones for HD TV content. This situation is exacerbated by the fact that the use of SAB/SAP in Band IV/V is becoming more restricted since the band is more densely planned for DVB-T, leaving less room for SAB/SAP.

3.2.2.2 Spectrum requirement for the operation of downlinks of mobile multimedia networks in a sub-band

As shown in section 3.1.2.1., antenna measurement and simulations have shown that antenna gain for internal antenna type could be improved when considering a narrow band operation.

Taking into account self interference limitations and cross-border coordination between neighbouring countries, Single Frequency Network (SFN) networks for large area coverage would benefit from the deployment of a dense networks with low power base stations (“cellular-like networks”)

There are several considerations that should be taken into account with respect to implementing large scale cellular-type of multimedia broadcasting networks. Degradation by self-interference and multipath reflections from the terrain and buildings is still an open question for the various system variants; the synchronisation of a very large number of transmitters may pose problems on the network operation; from a modelling point of view network engineering is faced with new issues like the complex field statistics of a very large number of signals.

Therefore, coverage planning and network engineering of such networks will be complex and would benefit from further investigation, although there are some practical examples of such networks.

Theoretically, a 32 MHz sub-band (i.e. 4 channels) would enable the deployment of mobile broadcast networks based on a 4 frequency reuse pattern and large area SFN. Such area could be a country, a region, a linguistic area, depending on the national specificity and on the need to broadcast local programs over such mobile multimedia networks, noting that other networks may also be used for such local programs (e.g., broadcasting like mobile multimedia networks, 3G networks …). The 4 channels are available inside such areas, however, when approaching the boundary, interference between different SFN networks would require frequency reuse pattern. According to the graph theory, the availability of 4 channels would guarantee the possibility to have at least one channel available at each border between countries, regions or linguistic areas.

However, if a country A would like to introduce multimedia services on a channel within the harmonised sub-band, but the neighbouring country B is using the same channel for television or other services in accordance with the GE-06 Plan then Country A will not be able to roll-out the service in a certain area close to the border of common interest. The size of this area will be limited if low power transmitters are used and larger for high power transmitters.

In frequency planning for high power broadcasting systems this theorem does not apply. At least 6 channels are normally needed to achieve full coverage. However, using cellular networks might make it possible to reach this lower bound or at least come close to it in multi-countries or inter service border areas. Therefore, for conventional high power broadcasting networks, it will be difficult to reach the same level of coverage within the 4 channels approach.

If 2 channels have to be available everywhere, then 2 sub bands of 32 MHz (ie, 64 MHz) needs to be defined. Some countries may wish to operate more than two multimedia services across their territories. This would involve a large (≥ 96 MHz) band dedicated for implementation of multimedia services and, as a consequence, a loss of the benefits of harmonization in terms of antenna gain.

It should be noted that the above considerations may not apply to networks which would use channels narrower than 8 MHz.

3.2.2.3 Effect of sub-band harmonisation on existing layers and consequence in terms of cross-border coordination and GE-06 plan

The term "layer" is not defined in the GE06 Agreement, nor was it defined at RRC-06, but for most European countries it may be described as a set of channels which can be used to provide coverage for one multiplex in a defined region, and the region could extend right up to nationwide. The number of layers in a certain region depends, among others, on the geographical situation, the level of accepted interference, transmission and reception characteristics and the way an Administration composes its layers from of the Plan entries. RRC-06 was aiming for a balanced number of nationwide layers for participating administrations to provide equitable access to the spectrum.

The RSPG already stated:

"As part of the GE-06 Agreement, each country has been allocated a total of 7 to 8 full-coverage layers in the GE-06 digital Plan. This means the territory of each country has been divided in allotment/assignment areas, with each of them receiving 7 or 8 channels. To prevent interference, the channels used in one area are different from those used in neighbouring areas. RRC-06 has optimized the process of allocating channels to areas in a way which provides each country with the same number of full layers (the equitable access principle). This number was the maximum achievable at RRC-06, i.e. it entails a fair level of optimization, calculations and multi-lateral negotiations."

Overall the GE06 Plan has been highly optimised to provide a very intricate balance of allocations to all countries. It is also highly optimised to fit together the national requirements of all neighbours. The high level of interlocking dependencies means that any change to an assignment or an allotment characteristics (power, frequency, …) could result in consequential changes being required across several adjacent countries. The mask concept allowing for versatile reuse of the allocations also provides for the introduction of new applications in the future as a natural evolution without the need for a replan. All CEPT countries are signatories to Declaration 42 which allows for this flexible reuse while retaining the Plan structure as a whole. This provision means that each country already has the necessary mechanisms to allocate future resources internally without causing any additional interference beyond the existing agreements.

Furthermore, there are two possibilities to define "extra layers" capacities. The first possibility can only be achieved at the expense of accepting higher interference levels which may result in lower quality services, or reduced coverage areas. The second possibility is to deploy more dense networks using low power transmitters, thus limiting cross border issues but not removing it completely. Bi/multilateral co-ordinations are essential in these cases.

In the GE06 Plan the channels are scattered all over the spectrum. It has to be noted that in a given area national or regional plan allotments of different layers do not have always the same shape and thus their coverage areas are not congruent. As a consequence an interchange of channels between layers while relying on the same transmitter sites could make it necessary to implement additional low power repeaters to cover the original coverage area.

In case an assignment or an allotment of the GE-06 plan is to be changed for deploying multimedia applications, Article 4 procedures of the GE06 Agreement should be applied in each single case. This would probably be necessary for a limited number of plan entry if an harmonised sub-band is explicitly reserved for a certain application.. Coordination will also be necessary with GE06 Plan entries of other countries not directly involved in this re-planning.

Furthermore, the outcome of such a re-planning process needs to ensure the same level of equitable access as the GE06-plan. There should not be losers in the re-planning process since this would have significant implications where future licenses have already been promised or issued.

Identifying an harmonised sub-band would create holes in some of the layers obtained at RRC-06 in countries implementing such band and would require them to accept constraints to protect and to accept interference from the GE-06 entry plans of their neighbours. It would not be possible to make up for these losses in the remaining available spectrum without significant cross-border coordination activities. CEPT considers that there should not be a new planning conference such as GE06 nor a European conference at CEPT level, so that the issues should be solved on a national or bilateral basis.

Concerning the issue of coexistence between high field strength multimedia networks and DVB-T, even if a dedicated sub-band is used for implementing multimedia broadcasting services, the same precautions (i.e., regarding out of channel interference into DVB-T) as if the implementation is using the whole band have to be taken and the same mitigation techniques are recommended.

However, implementing a sub-band would reduce the number of cases where multimedia broadcasting networks and fixed reception DVB-T are in first or second adjacent channels. In addition, the reduction of mobile multimedia planning field strength if a dedicated mobile multimedia handset with improved antenna gain is used would enable either:

- to reduce transmitter power (keeping the same number of sites, i.e., not fully benefiting from the reduction in the cost of network in the affected area) and consequently the exclusion zone, or alternatively,
- to decrease the number of transmitters (to benefit from cost reduction in network deployment) but keeping the same power and consequently the exclusion zone will have the same size, but the number of exclusion zones will be lower.

3.2.2.4 Possible consequences in terms of cost, affected markets and delay

The RSPG stated that "modifying the frequencies of existing or planned broadcasting networks could cause significant cost or disruption to the provision of broadcasting services, which may make such modifications extremely difficult if not impossible." In this section, some of the aspects are discussed more in detail.

3.2.2.4.1 Consequences in terms of costs

Due to the ongoing digitisation throughout Europe, there are existing licences, services and many hundreds of digital stations in operation. This section addresses the costs occurring in case re-planning affects digital stations already operating.

In principle, there would be different categories of costs which would have to be balanced to the eventual benefits of the creation of a sub-band :

- Costs due to re-planning and changes in the frequency allowed to be used:
    - Costs for re-planning the UHF-bands, including bi-/multilateral meetings and a new Planning Conference if pan-European harmonization is envisaged, taking into account that GE-06 plan entries of countries outside Europe will have to be protected and interference from such entries accepted.
    - to modify antenna systems (on transmitting and receiving sides) and to change filters and combiners

      Important investments have already been undertaken to change transmit antennas in the process of digitalization of the band and a new change in channel may lead to the implementation of additional transmitters, higher power or additional restrictions on antenna pattern, due to different propagation characteristics and/or a different interference situation. On the receiver side, in cases where rooftop antennas are used and are still limited to band IV reception, a channel change from band IV to band V may lead to the replacement of antennas, the substitution of band limited amplifiers and rejection filters.

    - to inform and assist the public in retuning the receiving equipment

      A further transition from digital to digital may be difficult to explain to the population if the broadcast user is impacted by this transition and if no benefits appear for him. The regular transition is easily explained as digital TV is being introduced and the offer is enlarged and better reception is offered, which is one of the major reason for the success of the switch-over. However, it should be noted that such transition from digital to digital will have to take place in some countries having a long period of analogue-digital simulcast leading to the use of channels other than GE-06 Plan entries in the short term.

- Costs due to delays:
    - Penalty clauses in existing contracts would be imposed.
    - Additional interest costs due to delays before going on air
    - Loss of earnings for a broadcaster not on air

3.2.2.4.2 Consequences in terms of delay

National switch off and Digital transition timings have been announced publicly by many governments and it will be very difficult and highly disruptive to try to amend these dates. Therefore, there would be a potentially serious political issue if the European proposed final switchover date of 2012 is not met.

In case of a harmonised allocation of a sub-band, the necessary re-planning process would most likely be complex and time-consuming. DVB-T has already been introduced in many European countries (see Figure 5), and digitisation is planned in many others countries within the next years. By the time any re-planning process would be completed, many more DVB-T transmitters would be in operation. Therefore, any plans for a harmonisation should avoid delaying and disrupting this European-wide digitisation process and the national transition processes.

A second transition phase would also be necessary to implement the harmonised sub-band. This transition period would be on-top of the ongoing digitisation in Europe mentioned above, i.e. the bilaterally agreed processes steps in order to migrate from analogue TV to digital.

It should be noted that such a transition process would present similarities with those already known for organizing the digital switch-over and such transition from digital to digital will have to take place anyways in some countries having a long period of analogue-digital simulcast leading to the use of channels other than GE-06 Plan entries in the short term.

If a country A would like to introduce multimedia services on a channel within the harmonised sub-band, but the neighbouring country B is using the same channel for television or other services in accordance with the GE-06 Plan then Country A will not be able to roll-out the service in a certain area close to the border of common interest. The size of this area will be limited if low power transmitters are used and larger for high power transmitters.

At this point, it should be noted that there might be other transition process on a national level, e.g. one for the migration from MPEG-2 to MPEG-4 (or another coding standard). However, such transition do not require a re-planning.

3.2.2.4.3 Long term aspects of the harmonization of a sub-band

DVB-H is a subset of DVB-T from the spectral point of view. Therefore, a mixed DVB-T/DVB-H is possible. The mixed operation of DVB-T/DVB-H in one DVB-T multiplex does not appear relevant in a dedicated sub-band. However, services have already been launched in this mode in some countries. The mixed mode gives flexibility to an operator to allocate different capacity for mobile broadcast and traditional broadcast and provides a further opportunity for broadcast operators to provide DVB-H services. The management of capacity is possible on day by day basis without any interruption of services and hardware modification. However, this mixed mode assumes that DVB-T and DVB-H are using the same variant in terms of guard intervals (i.e., that DVB-T has been planned for mobility) and leads to a correlation between the DVB-H and DVB-T coverage. DVB-T2 may even enhance the flexibility in operating this mixed mode in the future.

The limited size of a sub band will consequently also limit the number of mobile multimedia networks which could be implemented in this sub-band.

3.2.2.5 Cost and availability of terminals

Harmonisation of spectrum has an impact on the cost and availability of terminals. The development of multi-band terminals, resulting from a lack of harmonisation, also has an impact on the handset performance, such as more insertion loss and lower sensitivity, and on its complexity.

Therefore, harmonisation of frequency bands used in a mobile terminal leads to economies of scale and reduces their cost. Adequate consideration should therefore be given to the European and worldwide situation with regards to the spectrum used for mobile multimedia in order to ensure that this spectrum is available in the largest possible addressable market which would then drive the cost of RF components down.

A wideband terminal that could cover the whole UHF band could achieve more economies of scale than a narrow band terminal, depending on the respective market in which these equipments will be used.

It should be noted that in case of harmonisation of a narrow sub-band, the new narrow band terminals will not be compatible with transmissions spread across the range 470 - 750 MHz.

3.2.2.6 Scenarios for the introduction of a sub-band

Two possible scenarios for sub-band harmonisation could be envisaged:

- A narrow sub-band located above 750 MHz,
- A narrow sub-band located below 750 MHz

The second scenario would ensure the backward compatibility with wide band mobile broadcast terminals that operate over the band 470 - 750 MHz as these terminals will be able to operate within the sub-band.

3.2.3 Potential approaches for the implementation of mobile multimedia

3.2.3.1 Approach 1: Implementation based on existing GE-06 plan entry

The GE-06 Plan includes entries for fixed rooftop reception, portable outdoor/mobile reception and portable indoor reception for DVB-T services in band 470 - 862 MHz. The technical parameters of each plan entry are the result of a complex international coordination process, which took several years. Some Administrations decided to use the spectrum within their territories more densely than their neighbours by planning more coverage's / allocations for digital broadcasting and other primary services. As a consequence those Administrations had to adapt the technical parameters of their plan entries such that it was possible to reach a compromise between the number of coverage's and the envisaged purpose for these allocations. The GE-06 Plan does not include entries, for example, for digital TV services designed for reception on hand-held receivers (e.g. DVB-H). However, modifications to the Plan can be done by applying Article 4 of the GE-06 Agreement [1] and negotiating cross-border agreement with affected administrations; When the plans to implement multimedia services have been already incorporated into the GE-06 Plan, administrations do not have to apply article 4 of the GE-06 agreement to implement multimedia services avoiding additional delay in the deployment of mobile multimedia services nor in the deployment of DVB-T services.

Under this approach, the whole band IV and V can be used in a flexible way for all broadcasting applications, including mobile multimedia.

3.2.3.2 Approach 2: Harmonisation of a narrow sub-band

Administrations may also wish to deploy mobile multimedia networks using harmonised sub-band, taking into account the benefits of using a harmonised narrow sub-band. Scenarios for such harmonised sub-band(s) are discussed in section 5.2.

It should be noted that the implementation of such approach by an administration should not delay the introduction of mobile multimedia networks. In other words, the implementation of approach 1 and approach 2 are not mutually exclusive and an administration may wish to start implementation of a mobile multimedia network based on approach 1 and, later, implement a new mobile multimedia networks based on approach 2, although in this case terminals designed for the reception in the sub-band only may not be able to access to the services offered over the network operating under approach 1.

It should be noted that due to the RRC-06 planning process, the frequencies allocated to the GE-06 Plan entries in a given area are scattered over the whole band 470 - 862 MHz. Dedicating a sub-band for multimedia services would punch holes in the national layers. Therefore, the harmonisation of such a sub-band would require a certain re-allocation of frequencies at national level and additional international coordination. Therefore, the introduction of multimedia services will need to be preceded by changes into the GE-06 Plan entries by applying Article 4 of the GE-06 Agreement and an associated coordination activity.

Based on the new GE06 Plan, many licenses for digital broadcasting or multimedia broadcasting services have already been granted in Europe for the next 10 to 15 years. Therefore, the European wide harmonization and implementation of a sub-band for multimedia broadcasting services is not realistic before at least 2020 and CEPT is of the opinion that mandatory harmonization should not be sought.

3.2.4 Conclusions and recommendations

Two approaches to implement downlinks of mobile multimedia networks in the UHF-bands IV and V have been discussed in this report

- Approach 1: Implementation without a harmonized sub-band, based on the GE06 Plan entries
- Approach 2: Implementation based on a harmonized sub-band

These two approaches are not mutually exclusive and could be implemented by administrations jointly or in a different timeframes :

Approach 1

GE-06 Agreement has de facto harmonized the entire band IV and V for all forms of broadcasting including multimedia applications. According to the GE06 Agreement on average 7 UHF layers have been allocated to each European Administration. On a national basis the flexibility is given to arrange the frequencies of the GE06 Plan such that several national layers result with assigned frequencies below a certain threshold (e.g. <750MHz) or within certain sub-band(s).

Those layers may be assigned to multimedia broadcasting services. The network structure of such multimedia broadcasting services may be based on conventional (broadcasting like) or cellular like networks or on a combination of both (distributed networks).

In European countries, the implementation of mobile multimedia broadcasting services is possible and has already started in many countries on the basis of the GE06 Plan and its provisions. Up to 7 multimedia-layers may be deployed in border areas and up to 49 SFN networks away from borders, out of range of interference.

Depending on the outcome of bi-lateral negotiations between neighbouring administrations, with regard to the transition period, an immediate implementation of mobile multimedia broadcasting services is possible.

Approach 2

The harmonization of a narrow sub-band (up to 10% of the centre frequency) would allow an improvement of the technical characteristics of receivers (better antenna gain). As a consequence the implementation costs for networks will be reduced irrespective of the network topology.

Harmonising a narrow sub-band of 10% of the centre frequency (e.g. 64 MHz at 650 MHz) would enable the deployment of at least 2 SFN networks in multi-country border areas, providing successful coordination, and up to 8 SFN networks away from borders, out of range of interference.
Receivers designed to operate in a specific sub-band will consequently not be able to receive available services operated in accordance with approach 1 outside the sub-band.

Based on the new GE06 Plan, many licenses for digital broadcasting or multimedia broadcasting services have already been granted in Europe for the next 10 to 15 years. Therefore, the European wide harmonization and implementation of a sub-band for multimedia broadcasting services is not realistic before at least 2020.

Therefore, in the near and medium term, harmonisation of a sub-band for mobile multimedia may only be considered on a non-mandatory basis, with countries adopting harmonised channels for multimedia where feasible and beneficial. The harmonised sub-band would need to be known in a relatively short time frame. It may also need to be reviewed in the future, taking into account the progress of technology and service deployment, with a view to enable other countries to benefit from harmonisation.

For the deployment of multimedia applications, option 1 minimizes the impact on the current status of GE-06 Plan. Since this plan may evolve continuously through the application of its modification procedure, it is possible for it to evolve towards a harmonised sub-band for multimedia applications.

4 REFERENCES

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