UMTS
Forum

UMTS Forum response to the ARCEP consultation on the challenges tied to new frequency bands for electronic communication services access networks

The UMTS Forum represents a significant group of spectrum users, which are directly interested in the development of public mobile communication networks including UMTS/IMT-2000 and, especially, the related spectrum topics. UMTS Forum gathers many different players involved in third generation (3G) mobile communication systems, including equipment manufacturers, operators, administrations, service providers and software developers.

The UMTS Forum welcomes the opportunity to respond to ARCEP public consultation on the challenges tied to new frequency bands for electronic communication services access networks.

Please find below the UMTS Forum comments regarding specific aspects of this public consultation: the importance of low frequency bands for offering mobile broadband services, the role of Digital Dividend and UMTS Forum works for harmonizing a Digital Dividend sub-band.

1. Mobile Broadband Services based on 3G/UMTS are a reality today

Rapid growth in the uptake of IMT-2000 services continues globally, with more than 180 commercial 3G/UMTS networks now operating commercially in around 80 countries. As of September 2007, there were over 160 million subscribers to 3G/UMTS networks.

By mid-2007, more than 120 mobile operators had already deployed HSDPA (High Speed Downlink Packet Access) commercially in over 60 countries, giving their customers access to even higher data rates and exciting new service possibilities. Of this total, a growing number of HSDPA networks support the higher bit rate of 3.6 Mbps. Global HSDPA subscriptions, meanwhile, had already exceeded 7 million by mid-year. HDSPA networks supporting data rates of 7.2 Mbps are also starting to be deployed.

In the same timeframe, at least two operators had commercially introduced HSUPA (High Speed Uplink Packet Access) networks, providing a corresponding boost to uplink data speeds.

There is already an extensive choice of more than 900 UMTS devices. This includes almost 200 HSDPA devices spanning handheld terminals, PC cards, USB modems and notebook PC cards with embedded SIM cards.

3G/UMTS will be continuously evolving to offer increased data rates with 3GPP WCDMA Release 7 and Release 8 and with LTE (Long Term Evolution). This new technology has the potential to transform how users receive, consume and interact with information and content distributed over mobile networks.

LTE, deployed on a mass market scale, the benefits, not just for individual users, but communities and businesses could be considerable. A super fast, efficient and highly reliable mobile network will support the delivery of a wide range of services to multiple devices, improving not just the user experience, but driving efficiency gains for businesses using mobile services, enabling the rollout of new applications, such as M2M (machine to machine) and supporting the exchange of information within community-based projects.

2. The mobile market growth will remain strong in the coming years

The UMTS Forum has developed a number of reports and studies on the mobile market growth and future spectrum needs. Those reports are:

- Report 40 "*Development of spectrum requirement forecasts for IMT-2000 and systems beyond IMT-2000 (IMT-Advanced)"*
- Report 38 "Coverage Extension Bands for UMTS/IMT-2000 in the bands between 470-600 MHz"
- Report 37 "*Magic Mobile Future 2010-2020*"
- Report 33 "*3G Offered Traffic Characteristics"*
- Report 35 "*Mobile Market Evolution and Forecast: Long term sociological, social and economical trends*"
- Report 31 "*UMTS Next Generation Devices*"

For the year 2010, UMTS Forum Report 33 "3G Offered Traffic Characteristics" estimated a total daily traffic of 249 Tbytes (for a representative European country of 52.3 million users), which results in 4.8 Mbytes/users/day. Furthermore, Report 37 "Magic Mobile Future 2010-2020" estimated for the year 2020 the total daily traffic to be 5744 Tbytes, which results in 495 Mbytes/users/day as shown in next Figure.

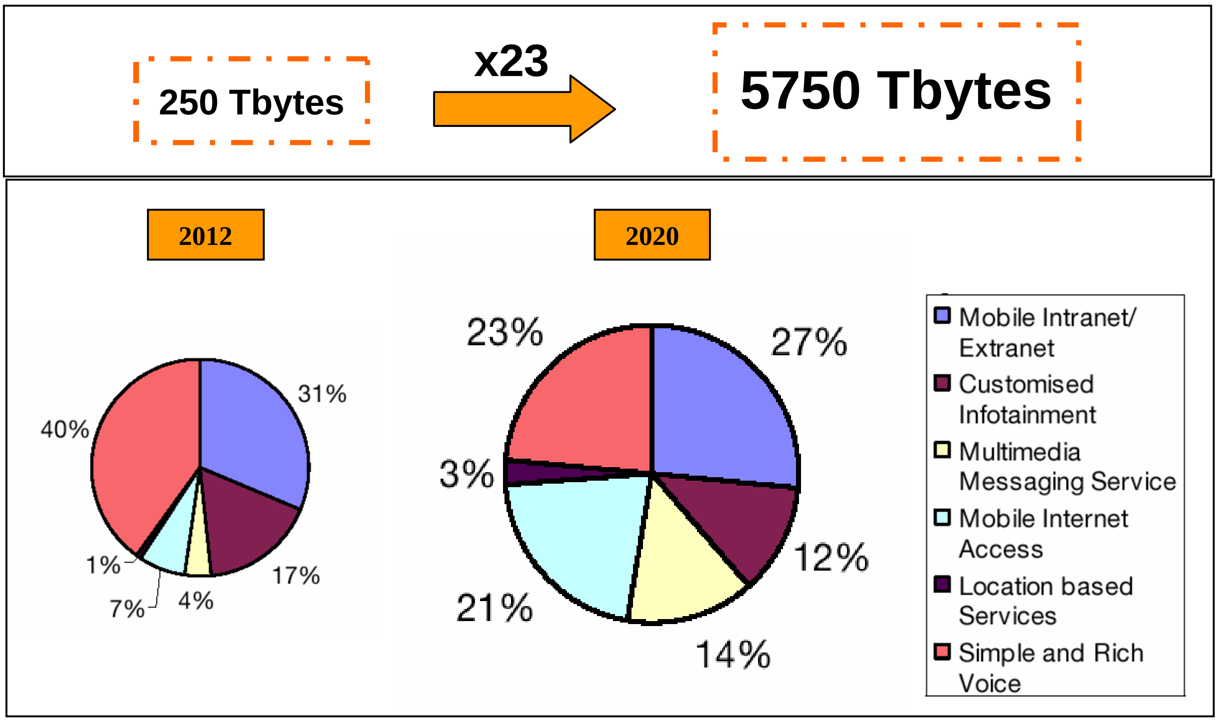

Figure 1: Total estimated daily traffic and its distribution to different service categories for a representative Western European country: year 2012 versus 2020

3. Spectrum for Mobile Broadband Services

It is expected that IMT-Advanced technologies will be about 10-15 times[1] more spectrally efficient than today's mobile technologies. However, these developments cannot alone solve the forecasted spectrum demand. The expected improvement in spectrum efficiency is not high enough to fulfil the traffic needs. Furthermore, the requirement of harmonised spectrum remains important for the next decade and beyond.

With over 160 million IMT-2000/UMTS subscribers, UMTS Forum believes that the band 2500-2690 MHz will be extremely important for the extension of capacity of IMT-2000/UMTS networks to offer evolving services in the next few years to come.

Moreover, the 2.6 GHz band will also offer a unique opportunity for the deployment of IMT-2000/ UMTS, like the LTE (Long Term Evolution) in channels of up to 20 MHz, which allows the provision of very high data rate services. A harmonised channeling arrangement for the 2.6 GHz is equally of extreme importance as it enables economies of scale, facilitates interference free operation and global roaming. The UMTS Forum supports the harmonised band plan adopted by CEPT in ECC DEC(05)05 and which comprises of 2x70 MHz of paired

[1] Based on the figures in ITU-R WP8F Reports M.2078[IMT.ESTIMATE] and M.2074[IMT.RADIO_ASPECTS]

spectrum (for FDD operation) and 50 MHz of unpaired spectrum (for TDD or FDD downlink operation) giving ample spectrum to facilitate both FDD and TDD operations and a flexible support of asymmetric traffic situations. The UMTS Forum is greatly concerned with regards to the plans of some European countries to divert from the harmonised FDD/TDD European band plan. An approach to implement a specific national FDD/TDD band plan, without any coordination at CEPT level, will fragment the European market for mobile broadband services and will create technical and investment uncertainties in the marketplace.

For allowing IMT-Advanced deployment, the 3400-4200 MHz band offers the best potential to fulfil most of the expected capacity demand due to its size. This band could also accommodate IMT-Advanced systems which are envisaged with large carrier bandwidths, up to 100 MHz.

However, these bands need complementary spectrum in lower frequency bands (<1GHz) in order to achieve Mobile Broadband Services everywhere: a harmonized sub-band of the Digital Dividend becomes essential.

4. The Digital Dividend will enable Mobile Broadband Services everywhere

GSM subscriber numbers, traffic and coverage are increasing strongly. However, in 2007 many growth markets still have mobile coverage limited to main cities. These markets should be particularly addressed in the short-term with optimised and enhanced GSM and IMT-2000/UMTS solutions for affordable provisions of voice, text messaging and internet connections. In the medium and longer term, there is a need for very cost effective IMT-2000/UMTS coverage solutions, business models and affordable devices.

Due to lack of lower frequency bands (<1GHz), large geographical areas with low population density are dispossessed of access to mobile multimedia services. Consumers want to benefit from the new services on an equal geographical basis. It is a real challenge for network operators to answer these expectations in large areas of low population density since it would require high investment costs.

In addition, the current 900 MHz band is overloaded. This band is nowadays fully used by GSM, and the introduction of IMT-2000/UMTS point clearly out the limited amount of spectrum not only for the coexistence of more than one technology but also for allowing mobile broadband services. After analyzing the capacity of 900 MHz band, it has been demonstrated by mobile operators that it would be impossible to offer an unlimited mobile broadband access service with the sufficient bit rate, even in the most scarcely populated areas.

For this reason, additional spectrum in lower bands is required in order to offer mobile broadband services everywhere, and to bridge the digital divide between urban and rural areas. Hence, Analog TV switch off spectrum in the UHF band and resulting Digital Dividend represents the only chance for releasing the appropriate additional spectrum below 1GHz for mobile use: a sub-band of around 100MHz.

Moreover, the UMTS Forum strongly believes that the harmonisation of the Digital Dividend is a prerequisite to facilitate interoperability and global roaming allowing UMTS/IMT-2000 usage; worldwide spectrum harmonisation will allow economies of scale and consequently low cost mass-market equipment.

5. The UMTS Forum and the Digital Dividend

During the last years the UMTS Forum performed studies regarding the identification of a new Coverage Extension Band within 470-862 MHz band for IMT-2000/UMTS, to cover part of WRC-07 Agenda Item 1.4 and its related Resolution 228.

The UMTS Forum studied advantages and disadvantages of the 470-862 MHz and contributed the results to CEPT and ITU, in particular its Report 38 “Coverage Extension Bands for UMTS/IMT-2000 in the Bands between 470-600MHz”, and also started a research project about UMTS500. This report showed that lower frequency bands with better radio wave propagation characteristics provide better geographical coverage in a more cost effective way through larger radio network cells. Low frequency bands due to the coverage provision will help to bridge the digital divide between urban and rural areas.

However, the current worldwide framework has shown that a global harmonization in the UHF band could only be possible in the upper part of this band. Moreover, the upper part of UHF band would provide better benefits for mobile operators who are able to reuse 850/900 MHz sites. Hence, in light of the RRC-06 results and taking into account positions expressed by a number of Administrations concerning the Digital Dividend, the UMTS Forum took the decision to focus its studies on the scenario for a harmonised sub-band in the higher part of UHF TV band. In addition, a sub-band in the upper part of the UHF TV band is expected to have less impact (higher part of UHF band is less used) on the GE-06 Plan.

6. A 112 MHz harmonized sub-band in the 470-862 MHz

UMTS Forum has been supporting the CEPT studies related to the feasibility of harmonizing a sub-band on the frequency band 470-862 MHz for UMTS/IMT use. For the UMTS Forum, this frequency band would be essential in the provision of future high bit rate mobile services in a cost effective manner.

In the framework of the CEPT working group on the Digital Dividend (ECC TG4), UMTS Forum has decided to carry out a study about the technical feasibility of releasing a 112 MHz sub-band in the upper part of the UHF band for deploying mobile services.

In June, the UMTS Forum carried out a technical study in order to assess the feasibility to create 112 MHz sub-band while maintaining the national broadcasting services requirements in the remaining 470-750 MHz band, using the country of Belgium as an example. Belgium had been chosen as it is one of the most complex case studies due to several reasons including: a large number of neighbouring countries compared to Belgian size, multilingual characteristics, flat terrain model and a high number of allotments concentrated in the same place (up to 14 allotments over Brussels).

This first study of one country concluded that it is possible to achieve national broadcasting requirements granted during the RRC-06 with negligible interferences on both Belgian and neighbouring countries' allotments (situated up to 50 km away from the Belgian border) with frequency reassignment of all Belgian GE-06 allotments between the channels 21 and 55 (470 – 750 MHz). More details about this study, the assumptions and methodology can be found in document TG4(07)081.

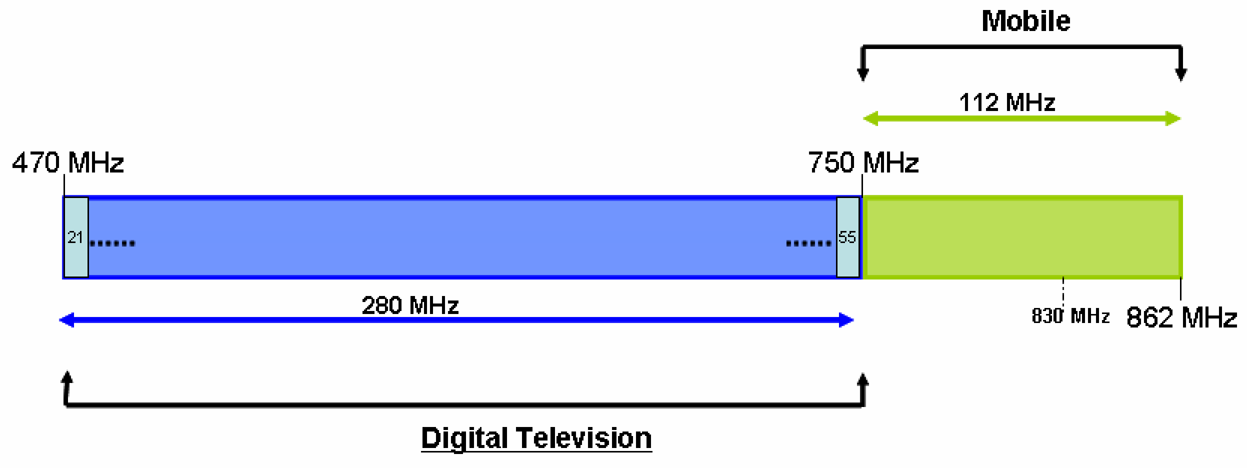

Figure 2: The UHF band with a 112MHz sub-band for mobile use

The aim of this first study was to investigate the feasibility in the case of one Administration for creating a sub-band in the upper part of the UHF band. The study was limited to only one country due to the very tight time schedule of ECC TG4 Report B. However, it was noted that studying only the case in one country did not take into account the difficulties of creating a harmonized sub-band in several countries at the same time.

Hence UMTS Forum decided to go further with its first technical study and to take into account improvements proposed at ECC TG4. This new study would also analyse the possibility of converging through a harmonized sub-band across Europe. In July, UMTS Forum started the evolution of its first study, and results will be presented during next ECC TG4 meeting (2nd-5th October).

This second part of the study is estimating the technical feasibility of creating a sub-band in more than two neighbouring European Administrations. The countries that are studied in this new part are Belgium, France, Holland and Luxembourg. UMTS Forum intention is to show that several Administrations may have a possibility to reassign channels of allotments at the same time, while retaining broadcasting resources obtained in GE-06 and also ensuring protection of broadcasting services in neighbouring countries. For this reason, more than two countries have been studied and re-planned at the same time, and taking into account their respective border countries. The new frequency assignments of these countries, that would allow the harmonization of a sub-band for mobile services, would also protect their neighbouring countries' GE-06 Plan up to 130 km from their border.

The UMTS Forum has carried out these studies to show an alternative frequency plan of the UHF band in Europe, in which the current number of digital TV layers, as in the GE-06 Plan, could be provided and, at the same time, a harmonised digital dividend of around 100 MHz could be found.

7. WRC-07 is the right time to identify the new spectrum for IMT

The global spectrum harmonisation and the regulatory clarity achieved for IMT-2000 at WARC-92 and WRC-2000 have resulted in many successful UMTS/IMT-2000 deployments to the benefit of consumers globally who enjoy affordable services and terminal devices.

However, for WRC decisions, it has typically taken around a decade between the time when the spectrum is identified and when it is made available/licensed. A WRC-07 decision would enable IMT-Advanced deployment in the timeframe of 2015-2020. This is the right timing, based on the ITU studies and on UMTS Forum's own market studies.

Concerning the specific usage of the UHF for mobile services, a WRC-07 decision is crucial to enable the deployment and extend the coverage of IMT-2000 and IMT-Advanced in harmonised spectrum after analogue switch off in 2011-2012 timeframe. Also, licensing of digital TV is on-going in many countries and soon the opportunity for the mobile use is gone. The UMTS Forum believes that delay for a WRC-11 will be a missing opportunity for Europe to take advantage of the Digital Dividend. Hence, UMTS Forum states that the candidate band 470 – 862 MHz should be allocated to the Mobile Service and about 100 MHz harmonized sub-band should be identified for IMT in WRC-07.

8. Status of UMTS standardisation in the UHF band outside Europe

3GPP is currently developing WCDMA specifications for the Digital Dividend spectrum identified in the USA in the 700 MHz range. 3GPP is expected to finalize the UMTS 700 MHz specification by December 2007. The auction of the 700 MHz spectrum in the US is due to take place in January 2008.

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Source: UMTS Forum, Vodafone, Bouygues Telecom, Ericsson, France Telecom-Orange, Nokia Siemens Networks, Nokia Corporation, Qualcomm, SFR

Subject: Creating a 112 MHz sub-band within UHF band for Mobile Services

Summary:

This document considers the feasibility of realising a 112 MHz sub-band in the upper part of the UHF band for Mobile Services, while ensuring that national digital terrestrial television broadcasting resources are still fulfilled: 7 national layers per country.

This UMTS Forum study has been performed in collaboration with the radio planning company ATDI, in order to benefit from their expertise in broadcasting planning methodology and tools, with active participation of UMTS Forum experts and also from Vodafone, Bouygues Telecom, Ericsson, France Telecom-Orange, Nokia Siemens Networks, Nokia Corporation, Qualcomm and SFR.

This study demonstrates that it is feasible to create a sub-band of 112 MHz for Mobile services in two countries (France and Belgium as an example) at the same time while keeping 7 national layers for Digital Broadcasting, and taking into account up to 130km of neighbouring countries GE-06 Plan.

This study analyses also the possibility of realising 112MHz for Mobile Services in the UHF band while keeping 7 national layers in four neighbouring countries at the same time: France, Belgium, Holland and Luxembourg. However, after a first analysis, it has been observed that interference coming from other countries might be too high, and the new frequency plan over these four countries gather substantial interferences in some layers of two countries close to the German border.

Hence, a new case has been studied for analysing the possibility of creating a sub-band of 112MHz in four countries at the same time while taking into account all neighbouring GE-06 Plan excluding German assignments. For this case, a new frequency plan has been obtained for these four countries (France, Belgium, Holland and Luxembourg), taking also into account up to 130km of neighbouring countries GE-06 Plan (without German assignments). Indeed, with this new frequency plan, these four countries could release 112MHz for Mobile Services

while still offering 7 national layers for digital broadcasting.

It should be noted that this study proposes examples of frequency reassignments, first on France-Belgium, secondly on France-Belgium-Holland-Luxembourg. In any case, the results presented should not be considered as the only solution to release a sub-band in the UHF band.

Proposal:

To consider the conclusions of this report about the feasibility of harmonising 112MHz sub-band in several countries at the same time for new usages while maintaining 7 national layers.

The information contained in this contribution is proposed to be added in the CEPT supplementary report (to report B).

Background:

UMTS Forum decided to study the feasibilities to create a 112MHz sub-band for other uses than broadcasting while maintaining national layers required for broadcasting services. UMTS Forum contributed in previous ECC TG4 meeting an alternative broadcast frequency arrangement in Belgium. After receiving some feedback about this study from ECC TG4 group, UMTS Forum decided to improve the analysis of the technical feasibility for releasing 112MHz in the UHF band, and to take into account proposals of ECC TG4. Finally, UMTS Forum, with the collaboration of Vodafone, Bouygues Telecom, Ericsson, France Telecom-Orange, Nokia Siemens Networks, Nokia Corporation, Qualcomm and SFR, decided to launch a second study in order to analyse the technical feasibility of creating a sub-band in more than two neighbouring European Administrations, and take into account up to 130 Km from their neighbouring countries GE-06 Plan.

1. INTRODUCTION

On June 2007, the UMTS Forum carried out a technical study in order to assess the feasibility to create a 112 MHz sub-band while maintaining the national broadcasting services requirements in the remaining 470-750 MHz band, using the country of Belgium as an example. Belgium had been chosen as it is one of the most complex case studies due to a large number of neighbouring countries compared to Belgian size, multilingual characteristics, flat terrain model and a high number of allotments concentrated in the same place (7 multiplexes overlapping over Brussels which represent up to 14 allotments over Brussels).

This first study assessed on one country concluded that it is possible to achieve national broadcasting requirements granted during the RRC-06 with negligible interferences on both Belgian and neighbouring countries allotments (situated up to 50 km away from the Belgian border) with frequency reassignment of all Belgian GE-06 allotments between the channels 21 and 55 (470 – 750 MHz). More details about this study, the assumptions and methodology could be found in document TG4(07)081.

However, the Forum got feedback from ECC TG4 participants that some assumptions of this study were not the most appropriate ones; therefore these preliminary results were not included in Report B (more details about this could be found in 4th ECC TG4 Minutes).

Hence UMTS Forum decided to go further with its first technical study and to take into account improvements proposed at ECC TG4. This new study would also analyse the possibility of converging through a harmonized sub-band across Europe.

This second part of the study estimates the technical feasibility of creating a sub-band in more than two neighbouring European Administrations. The countries that are targeted in this new part are Belgium, France, Holland and Luxembourg as a whole. UMTS Forum intention is to show that several Administrations may have a possibility to reassign channels of allotments at the same time, while keeping broadcasting resources equivalent to those obtained in GE-06 and also ensuring protection of broadcasting services in neighbouring countries. For this reason, these four adjacent countries have been studied and re-planned at the same time, and taking into account their respective border countries. The new frequency plan proposed for these countries, that would allow the harmonization of sub-band for mobile services, would also protect their neighbouring countries GE-06 Plan up to 130 km from their border.

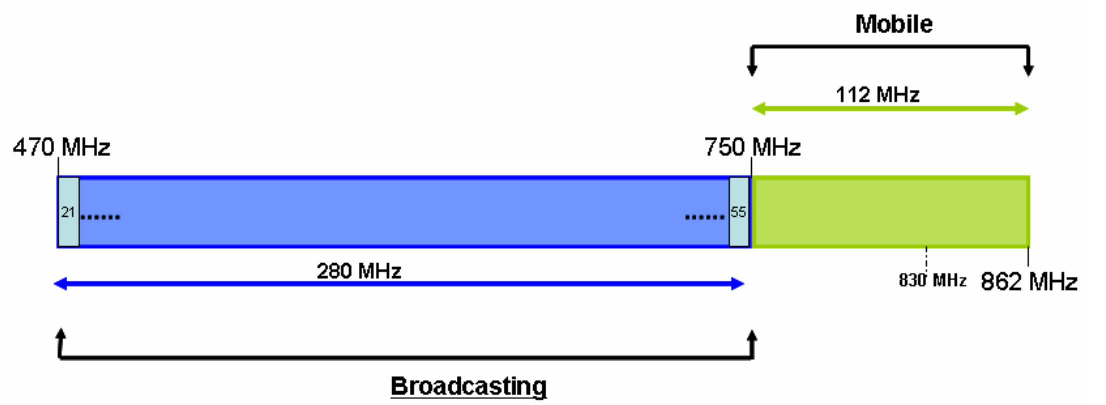


Figure 1 – Potential sub-band for Mobile

As it is shown in Figure 1, the purpose of this Study is to analyze the technical feasibility of realising the 112MHz in the upper part of the UHF band (750 – 862 MHz) over Belgium and France, and also over Belgium, France, Holland and Luxembourg. The release of this sub-band has been done keeping current broadcasting resources in the remaining spectrum (7 layers per country) for broadcasting, and ensuring that their respective neighbouring countries that will keep outputs of GE-06 agreement will not be interfered.

2. METHODOLOGY

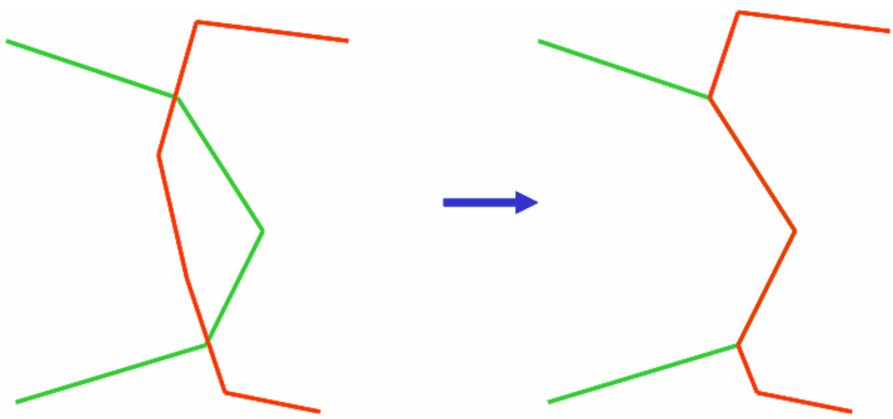
A brief description of the methodology is given below:

- First step, it is assumed a Digital Broadcasting network (including a Mobile Broadcasting network) that reuses all existing broadcasting sites (TV Analogue / TVA and TV Digital / TVD) declared in the BR IFIC;
- Second step, it is modelled a Digital Broadcasting network in each country optimizing the number of sites and antenna patterns in order to assure a DVB-T service everywhere in all allotments, without using sites that are no longer needed to cover all locations of the allotment;
- Thirdly, frequency reassignment of all allotments in each country (France, Belgium, Holland, Luxembourg), according the interference protection ratio for each service, in obtaining a new channel between 470 – 750 MHz (channels 21 to 55, except channel 38 in order to protect radioastronomy services).

2.1. General Methodology

GE-06 allotments of each country

All allotments obtained at GE-06 are imported for modelling each country's coverages. Most of allotments are overlapped; therefore it is needed to redefine allotments shape in order to have adjacent allotments for each layer.



The following figure is showing the whole set of allotments considered in this study: Belgium, France, Holland and Luxembourg.

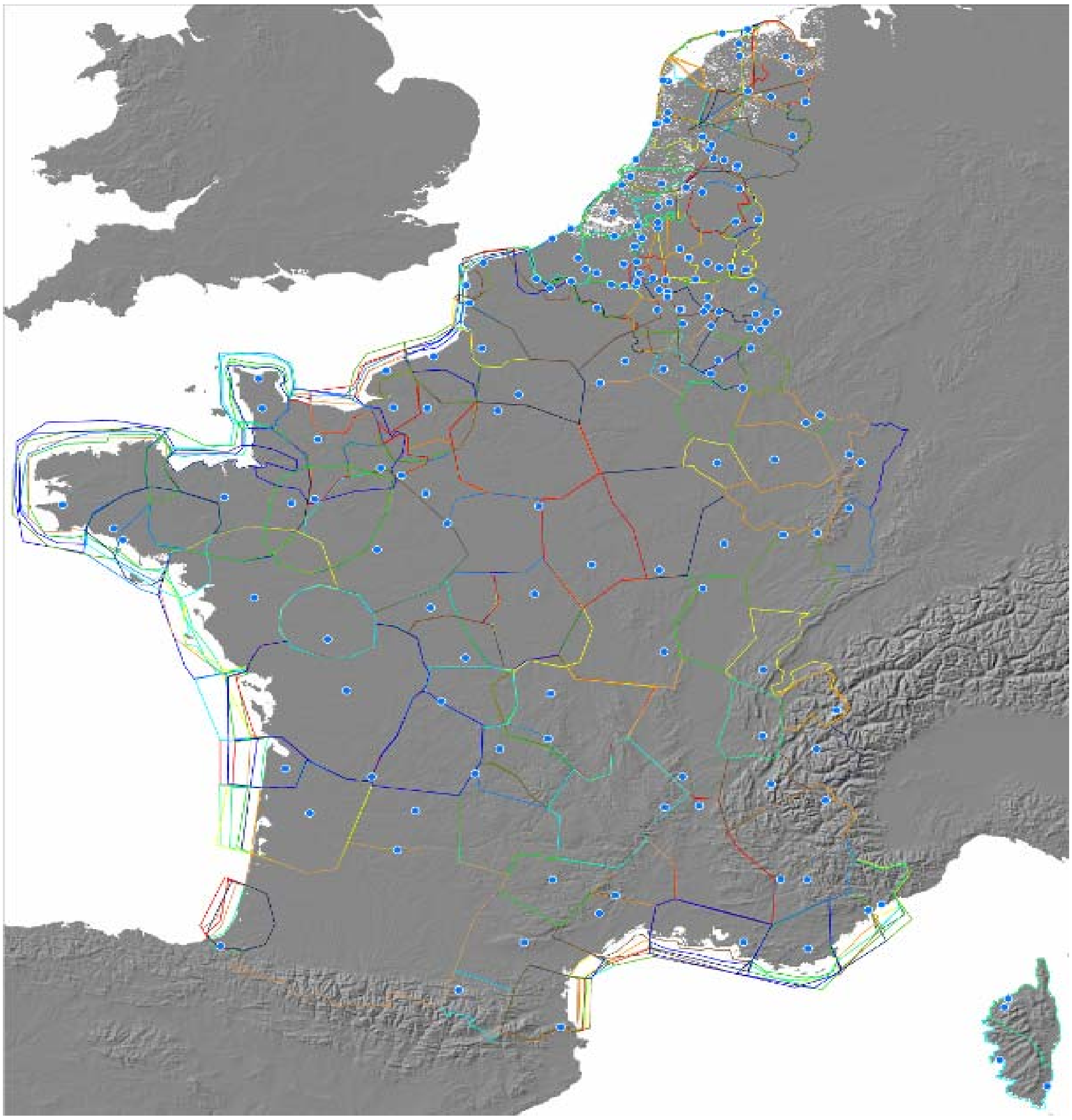


Figure 2 – All allotments over the four studied countries

Modelling a Digital Broadcasting network in each country

Depending on results of GE-06 for each country, a Digital Broadcasting network deployment has been modelled in France, Belgium, Holland and Luxembourg. More details about this modelling are available in section 2.2.

Digital Broadcasting network will be deployed based on these existing sites in order to ensure the corresponding minimum necessary field level in every allotment. Digital sites of these networks are based on existing/declared analogue and digital sites: with the same coordinates, antenna height and radiated power. Power radiation of an analogue site has been adapted for a digital transmission and it has been reduced by 7 dB.

- All existing analogue sites declared on the BRIFIC database are imported. For the case of Belgium, sites introduced in BR IFIC database differ substantially of the Belgian real sites. A list with the real existing broadcasting sites has been provided by the Belgian Administration, with coordinates and antenna height, and have been taken into account for the study
- Concerning analogue sites, if the exact location of the site is not available, this has been relocated on the highest point 2km around;
- Antenna patterns have been defined in order to limit the power received at the border of the allotment to the threshold level (specified in section 3). The main aim of this point is to calculate hypothetical coverage in each allotment that will offer the digital broadcasting service, without doing the real and detailed planning allotment by allotment. This study does not intend to plan on detail each network, this is why adapted antenna pattern (not always realistic) have been considered for simulating the hypothetical coverage. However, in order to demonstrate the feasibility in practice of such coverage in an allotment by using real antenna patterns, here below we can find an example over one allotment showing the equivalent deployment of an allotment with adapted antenna pattern close to other with omnidirective and directive antenna patterns.

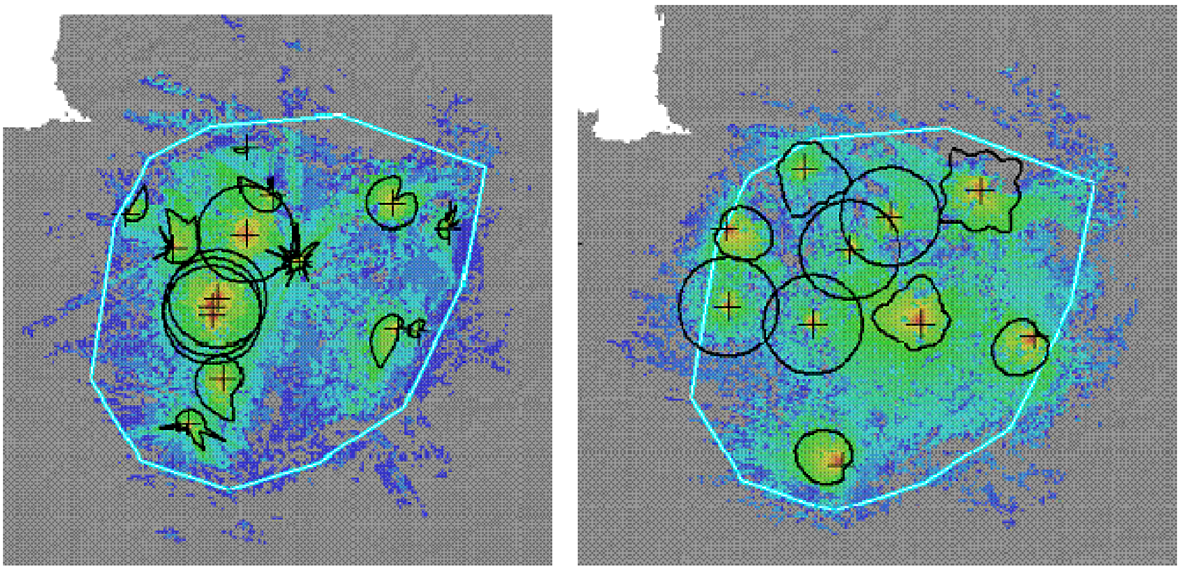


Figure 3 – A real allotment covered using sites with adapted antenna patters (left) and another using real antenna patterns (fight)

Coverage optimization

All allotments of each country have been modelled with a hypothetical network that should cover with the corresponding field level a minimum % of territory in order to achieve at least 95% of population covered for DVB-T services. For Mobile Broadcasting no minimum coverage has been established: around 70% of population is achieved in the study[1]. Taking into account existing sites (see point below):

- If the objective of % population is achieved, any redundant or not relevant site has been removed

[1] A targeted coverage of 60 % of population with DVB-H when the service is mature, is currently discussed at the French level.

- If the objective of % population is not achieved, new sites have been added for improving the existing coverage. Specific parameters of these sites are different depending on the type of service and are indicated in section 3.

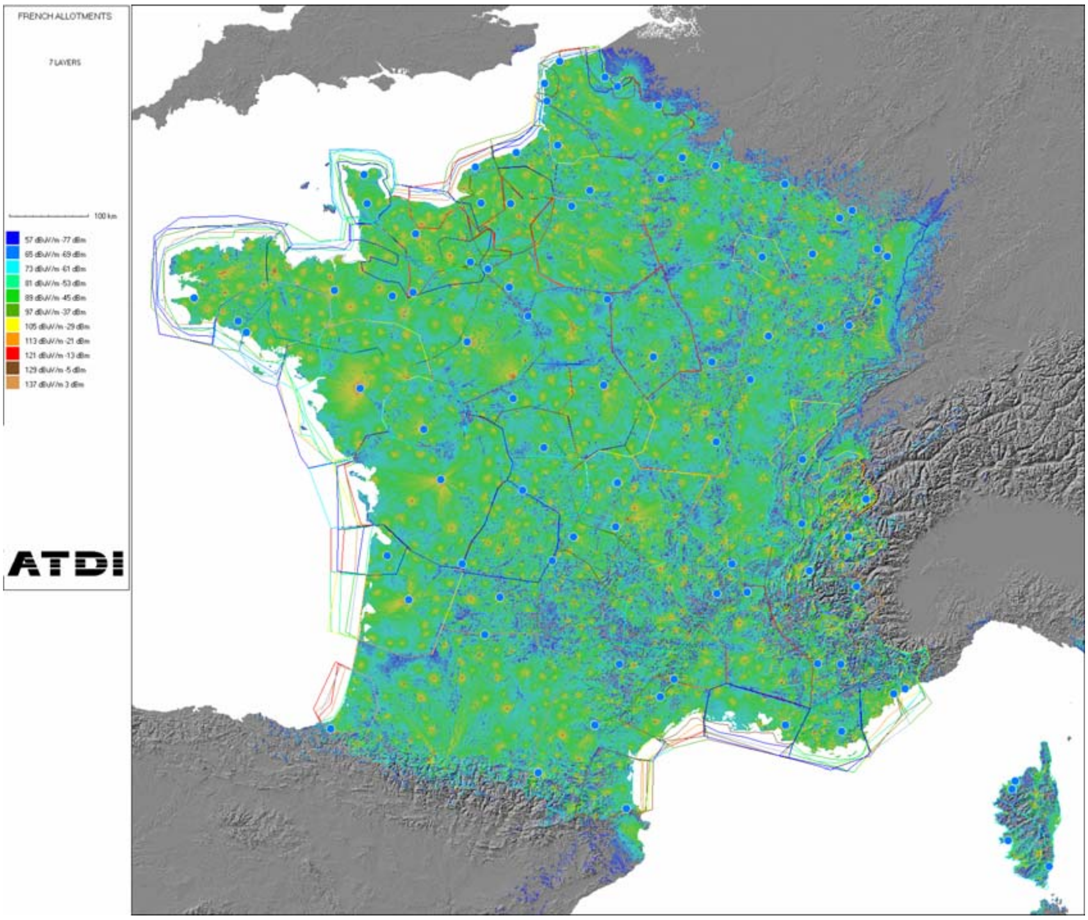


Figure 4 – Example of French allotments modelled for offering DVB-T and Mobile broadcasting services

Modelling Neighbouring countries

The neighbouring countries modelled in this study are Germany, United Kingdom, Switzerland, Spain, Italy, Monaco and Andorra. It has been supposed that neighbouring countries were keeping GE-06 Plan as it is. Therefore, allotments and assignments declared in the Plan are taken into account until 130 Km from the border. The objective is to take into account the emissions of neighbouring countries onto the countries which are reassigned in order to simulate the cross border coordination constraints.

For the neighbouring countries using RPC2 allotments, it has been supposed that the service deployed would be DVB-T for portable reception. For the neighbouring countries using RPC1 allotments, it has been supposed that the service deployed would be DVB-T for fixed reception. In any case, it has also been supposed that one of the layers would offer mobile broadcasting in order to protect also this kind of service. Hence, allotments in each neighbouring country have been modelled as explained before and assignments have been considered as declared in GE-06 Plan.

Frequency Reassignment of allotments taking into account neighbouring countries

This reassignment has been done minimizing interferences not only inside the countries re-planned, but also indirectly in their neighbouring countries. Frequency re-assignment has been done for generating minimum interferences (co-channel and in first adjacent channel) among DVB-T networks as well as with mobile broadcasting over the countries re-planned. The new frequency channels over these countries have been calculated considering their neighbouring countries GE-06 Plan until 130 km from the border; these new frequency channels take into account harmful effects generated by all allotments contained in this territory as well as assignments.

2.2. Digital Broadcasting in each country

Each of the country studied has obtained different resources at GE-06 agreement and they have their own national intentions to put in practice GE-06 Plan. For this reason, it is described here below the assumptions for deploying a Digital Broadcasting network that have been taken into account on a case by case basis.

It is important to note that 7 national layers have been considered in each one of the countries studied for realising a 112MHz sub-band in order to maintain the principle of equitable access[2] among these countries. Hence, all these countries would have 7 national layers for Digital Broadcasting services between 470 – 750 MHz and a common 112MHz sub-band for Mobile Services.

Belgium

This country has obtained around 7 national layers for RPC2, but divided on 3 regions. Belgium has not anymore fixed antenna receptors on the roof because most of population has moved to TV by cable or other transmission ways. Hence, Belgium expects to use most of their layers for DVB-T with portable reception.

For the case of Belgium, it has been considered that 6 RPC2 will be used for DVB-T with portable reception and 1 RPC2 for Mobile Broadcasting.

France

France has obtained in GE-06 agreement 6 national layers and 2 regional layers (thus approximately 6 RPC1 and 1 RPC2). For the study, it has been considered the deployment of 6 layers for DVB-T for fixed reception and one layer for mobile broadcasting.

Holland

This country has obtained also 7 national RPC2 layers like Belgium; for this reason, it has been considered that 6 RPC2 will be used for DVB-T with portable reception and 1 RPC2 for Mobile Broadcasting.

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[2] In accordance with No. 196 of Article 44 of the ITU Constitution

Luxembourg

Luxembourg has 4 RPC2 layers (of only one allotment per layer) and 3 RPC1. For this case, it has been considered a deployment of 3 RPC1 layers for DVB-T for fixed reception, 3 layers RPC2 for DVB-T for portable reception and 1 RPC2 layer for mobile broadcasting.

3. ASSUMPTIONS

3.1. Map resolution

The study is based on a 200 m digital map of Belgium, France, Holland and Luxembourg. This resolution is sufficient to have good results over such large area, covering Belgium, France, Holland, Luxembourg and 130km of neighbouring countries (Germany, United Kingdom, Switzerland, Spain, Italy, Monaco and Andorra).

3.2. Propagation Model

In the study, a deterministic propagation model was used with a receiver height of 10m and 1.5m, as well as customer/population distribution assumptions over the areas of interest.
The propagation model is composed of the following terms:

- Free space loss as described in the Recommendation ITU-R P.525
- Diffraction term as recommended in Deygout 94 method
- Sub-path attenuation factor.

The propagation components are detailed in Annex 4 below for further information.

3.3. Digital Broadcasting parameters

As described in section 2.2 above, each country has been modelled with its corresponding Digital Broadcasting services. For each kind of service offered, different parameters have been supposed and calculated, according to RRC-06 Final Acts as well as other referenced documents such as EBU, ETSI standards and ITU Recommendations. All these parameters are specified in Annex 1 below.

Field Threshold

The coverage of each allotment is defined depending on the type of service ensured in each layer.

The threshold values depend on the four following criteria:

- Type of service and type of reception
- Frequency band
- C/N ratio
- Propagation model

The necessary field strength level estimated for this contribution are based on the specifications [1][2] and the Final Acts of RCC-06[3].

As described before, three types of reception are differentiated in the contribution in order to cover the broadcasting services:

- Digital Broadcasting Fixed reception,
- Digital Broadcasting Portable reception,
- Mobile Broadcasting indoor reception.

The field strength levels to be ensured are also depending on the C/N ratio (Signal to Noise ratio) which is defined by the modulation chosen. The following modulations are assumed to establish the necessary C/N ratios:

- QPSK 2/3 for mobile broadcasting (see DVB-H reception),
- 16-QAM 2/3 for DVB-T portable reception
- 64-QAM 2/3 for DVB-T fixed reception.

When mapping the C/N ratios as defined in the Rec. ITU-R BT. 1368-6 and the RRC-06 Final Acts, and the ETSI specifications, we can evaluate the required field level.

It should be noted that the ETSI specifications are defining margins that need to be taken into account when using a statistical propagation model such as Rec. ITU-R P.1546. However, as the propagation model used in order to asses the coverage is deterministic, the threshold are evaluated without any margin.

The minimum field strength levels for each type of service are recalled in Annex 1 below for information.

Protection ratio

In order to evaluate the interferences between the different allotments as defined in the GE-06 Plan, it is necessary to define the protection ratios between the channels of different services.

The protection ratios that have been used during the study are those defined in the ITU-R BT. 1368-6 Recommendation (the same than those indicated in RRC-06 Final acts), for DVB-T signals, and those defined in EBU Tech 3317 document for Mobile Broadcasting signals.

For **fixed DVB-T** signals, 64 QAM 2/3 modulation, the protection ratios will be: **20 dB for co channel and -30 dB for adjacent channel**.

For **portable DVB-T** signals, 16 QAM 2/3 modulation, the protection ratios will be: **16 dB for co-channel and -30 dB for adjacent channel**.

For the **Mobile Broadcasting** signals, DVB-H with QPSK 2/3 modulation, the protection ratios will be: **13 dB for co-channel and -30 dB for adjacent channel**.

4. RESULTS

Following the methodology as described in section 2.1, and also the assumptions described in the previous section, different cases have been studied:

- Reassignment of allotments over France and Belgium as a whole after releasing 112 MHz
- Reassignment of allotments over France, Belgium, Holland and Luxembourg as a whole after releasing 112 MHz

- Analysis of the impact generated by the German Assignments
- Analysis of GE-06 Plan, without releasing 112 MHz

These cases demonstrate that the frequency rearrangements could be achieved to ensure the protection of neighbouring countries and to release 112 MHz. Those allotments of neighbouring countries are taken into account when analysing the Belgian-French, and Belgian-French-Holland-Luxembourg frequency reassignment.

4.1. France and Belgium

Firstly, it has been studied the feasibility of releasing 112MHz in only two contiguous countries: France and Belgium. For these two countries, a new channel has been obtained between channels 21 and 55 (470 – 750 MHz) for all allotments in their 7 layers; these new channels have been calculated taking into account the neighbouring countries (allotments and assignments) up to 130Km from the border. The simulation for obtaining new frequency reassignments has been done at the same time in both countries. After only five reassignments, a potential solution for re-planning these two countries with a very low level of interferences has been found.

In the table below, it is shown the result of Belgium frequency reassignment; for France, an Excel file is provided with the new frequency channel per allotment and per layer.

Belgium

Name of the layers		Frequency Allotment (MHz)							
French Speaking Region	Layer 1F	586	658						
	Layer 2F	714	482						
	Layer 3F	730	586						
	Layer 4F	666	482	650	666	538			
	Layer 5F	578	618	746					
	Layer 6F	642	682	730					
	Layer 7F	706	626	474	522	506	618	562	714
Dutch Speaking Region	Layer 1VG	618	642						
	Layer 2VG	554	682						
	Layer 3VG	690	634						
	Layer 4VG	514	746						
	Layer 5VG	562	554						
	Layer 6VG	490	650	506	658	530			
	Layer 7VG	594	634	602	570	498	490	490	
German Speaking Region	Layer 1DG	562							
	Layer 2DG	642							
	Layer 3DG	586							
	Layer 5DG	746							
	Layer 6DG	698							
	Layer 7DG	658							

France

France_FreqPlan_2c

According to the new channels indicated before, we can find in next tables the average of the interferences that appear per layer, and the average of population covered per layer. We can observe that in both countries we achieve to offer a DVB-T service for around 97% of population, and the mobile broadcasting layer is almost not interfered.

Belgium	Population Interfered		Population Covered	
	DVB-T	DVB-H	DVB-T	DVB-H
	1,89%	0,17%	96%	68%

France	Population Interfered		Population Covered	
	DVB-T	DVB-H	DVB-T	DVB-H
	1,57%	0,55%	98%	75%

4.2. France, Belgium, Holland and Luxembourg

Secondly, it has been studied the feasibility of releasing 112MHz in four contiguous countries: France, Belgium, Holland and Luxembourg. These countries obtain a new channel between channels 21 and 55 for all allotments in their 7 layers; these new channels have been calculated taking into account up to 130km of neighbouring countries from the border. It is important to note that the simulation for obtaining new frequency reassignments in the four countries is based on the first solution presented in section 4.1 (Belgium and France). Only five reassignments have been launched for obtaining a new frequency plan coordinated over these four countries.

In the tables below, it is shown the results of Belgium, Holland and Luxembourg frequency reassignment; for France, an Excel file is included with the new frequency channel per allotment and per layer.

Belgium

Name of the layers		Frequency Allotment (MHz)							
French Speaking Region	Layer 1F	578	498						
	Layer 2F	746	690						
	Layer 3F	514	682						
	Layer 4F	570	482	554	738	482			
	Layer 5F	490	506	634					
	Layer 6F	730	698	650					
	Layer 7F	722	586	618	562	666	666	642	474
Dutch Speaking Region	Layer 1VG	618	650						
	Layer 2VG	546	658						
	Layer 3VG	530	578						
	Layer 4VG	642	570						
	Layer 5VG	634	490						
	Layer 6VG	594	666	714	682	618			
	Layer 7VG	650	626	554	554	642	498	538	
German Speaking Region	Layer 1DG	618							
	Layer 2DG	642							
	Layer 3DG	650							
	Layer 5DG	738							
	Layer 6DG	522							
	Layer 7DG	498							

France

France_FreqPlan_4c

Holland

	Frequency Allotment (MHz)												
Layer 1	482	498	482	626	490	626	746						
Layer 2	618	546	506	530	634	746	722						
Layer 3	562	658	506	570	738	730	706	530					
Layer 4	738	554	602	682	746	642	714	642	746				
Layer 5	698	666	634	594	658	698	738	626	626				
Layer 6	514	626	578	474	682	722	714	562	746	490	514	578	522
Layer 7	562	602	474	554	570	538	730	602	674				

Luxembourg

	Frequency Allotment (MHz)
Layer 1	482
Layer 2	618
Layer 3	562
Layer 4	738
Layer 5	698
Layer 6	514
Layer 7	562

According to the new channels indicated before, we can find in next tables the average of the interferences that appear per layer, and the average of population covered per layer. We can observe that that first two countries (Belgium and France) achieved already as presented in section before, continue to offer a DVB-T service for around 97% of population in their 6 layers, and their mobile broadcasting layer is almost not interfered and achieved around 70% of population coverage. However, we can observe that most of interferences are concentrated in the two countries reassigned in a second step: Holland and Luxembourg. These last countries obtain a new frequency plan but some of their layers are quite interfered, so the population served with a DVB-T service is not high enough (88% for Holland and 73% for Luxembourg). Some examples of layers interfered in these countries are presented in Annex 3 below.

Belgium	Population Interfered		Population Covered	
	DVB-T	DVB-H	DVB-T	DVB-H
	1,56%	0,17%	97%	68%

France	Population Interfered		Population Covered	
	DVB-T	DVB-H	DVB-T	DVB-H
	1,50%	1,16%	97%	75%

Holland	Population Interfered		Population Covered	
	DVB-T	DVB-H	DVB-T	DVB-H
	10,12%	0,48%	88%	70%

Luxembourg	Population Interfered		Population Covered	
	DVB-T	DVB-H	DVB-T	DVB-H
	24,39%	62,92%	73%	4%

4.3. France, Belgium, Holland and Luxembourg without German assignments but while keeping the German allotments

After the results obtained in section 4.2 for the case of four countries, we have tried to identify the cause of the problems appearing in some layers in Holland and Luxembourg. We have observed that most of these interferences where concentrated in the German border of these countries. For this reason, we have decided to analyse the possibility of realising 112MHz without taking into account German assignments as declared in GE-06 (more information in Annex 2 below) situated in the border, and only taking into account German allotments (based on DVB-T portable and Mobile Broadcasting) and other neighbours' allotments in order to assess the impact of German assignments onto Belgium, France, Holland and Luxembourg. After launching the frequency reassignments for minimise interferences, we have obtained the following frequency plan coordinated in the fours countries.

Belgium

Name of the layers		Frequency Allotment (MHz)							
French Speaking Region	Layer 1F	562	674						
	Layer 2F	626	570						
	Layer 3F	714	738						
	Layer 4F	578	618	602	530	474			
	Layer 5F	594	722	666					
	Layer 6F	546	706	554					
	Layer 7F	706	746	618	482	490	586	482	618
Dutch Speaking Region	Layer 1VG	554	474						
	Layer 2VG	570	498						
	Layer 3VG	690	514						
	Layer 4VG	682	642						
	Layer 5VG	530	730						
	Layer 6VG	490	482	658	578	554			
	Layer 7VG	514	474	490	602	522	482	506	
German Speaking Region	Layer 1DG	482							
	Layer 2DG	490							
	Layer 3DG	506							
	Layer 5DG	522							
	Layer 6DG	538							
	Layer 7DG	546							

France

France_FreqPlan_4c_wGe

Holland

	Frequency Allotment (MHz)												
Layer 1	586	482	474	490	498	538	618						
Layer 2	522	538	514	546	562	626	634						
Layer 3	618	570	506	554	506	530	586	698					
Layer 4	594	602	490	562	570	618	634	658	650				
Layer 5	626	650	626	586	602	658	682	746	634				
Layer 6	706	506	666	498	690	706	578	642	714	674	674	482	738
Layer 7	554	722	530	690	594	722	490	514	698				

Luxembourg

	Frequency Allotment (MHz)
Layer 1	562
Layer 2	706
Layer 3	746
Layer 4	578
Layer 5	634
Layer 6	714
Layer 7	626

According to the new channels indicated before, we can find in next tables the average of the interferences that appear per layer, and the average of population covered per layer. We can observe that without German assignments, we achieve a new frequency plan in the four countries (coordinated at the same time) after realising 112MHz that can offer a DVB-T service for around 98% of population over Holland and Luxembourg as well; also their mobile broadcasting layer is almost not interfered.

Belgium	Population Interfered		Population Covered	
	DVB-T	DVB-H	DVB-T	DVB-H
	0,22%	0,05%	97%	68%

France	Population Interfered		Population Covered	
	DVB-T	DVB-H	DVB-T	DVB-H
	0,74%	1,09%	98%	74%

Holland	Population Interfered		Population Covered	
	DVB-T	DVB-H	DVB-T	DVB-H
	0,01%	0,00%	99%	71%

Luxembourg	Population Interfered		Population Covered	
	DVB-T	DVB-H	DVB-T	DVB-H
	0,42%	0,00%	97%	67%

4.4. GE-06 Plan analysis

This section intends to analyse the results of GE-06 Plan when using hypothesis, methodology and assumptions established in this study. This has been done in order to have a benchmark for our results.

Firstly, we have done the same assumptions for modelling Digital Broadcasting services as explained in sections before in the four countries studied: France, Belgium, Holland and Luxembourg. After that, we have introduced to each allotment of these countries their frequency declared in BR IFIC. Thus, we take into account: 6 French national layers, 7 Belgian national layers, 7 Dutch national layers and 4 national layers from Luxembourg. Finally, we calculate interferences generated over these four countries, taking into account neighbouring countries GE-06 Plan up to 130km form the border. We can find in tables below the average of the interferences encountered per layer, and the average of population covered per layer. It is important to note that in this case we take into account less layers per country than in cases presented before (only 6 national layer in France and 4 in Luxembourg). We can observe that still some population is interfered in some layers.

Belgium	Population Interfered		Population Covered	
	DVB-T	DVB-H	DVB-T	DVB-H
	0,46%	0,81%	97%	67%

France	Population Interfered		Population Covered	
	DVB-T	DVB-H	DVB-T	DVB-H
	1,85%	no layer	96%	no layer

Holland	Population Interfered		Population Covered	
	DVB-T	DVB-H	DVB-T	DVB-H
	0,72%	7,03%	98%	67%
Luxembourg	Population Interfered		Population Covered	
	DVB-T	DVB-H	DVB-T	DVB-H
	0,62%	0,00%	97%	67%

5. CONCLUSIONS

Firstly, it is important to note that this study aims to propose a possibility of creating a common 112MHz sub-band, in several countries at the same time, while using broadcasting needs as expressed in GE-06 Plan. For this reason, it has been assumed a hypothetical deployment of Digital Broadcasting services in all the allotments of each country studied and a hypothetical Digital Broadcasting network based on existing analogue and digital broadcasting sites. After using real terrain models of the countries studied, and real population distribution, a frequency reassignment has been done for releasing 112MHz while keeping most of population covered with Digital Broadcasting services and while reducing interferences also in neighbouring countries.

It should be noted that this study is proposing examples of frequency reassignments, first on France-Belgium, secondly on France-Belgium-Holland-Luxembourg. In any case, the results presented above should not be considered as the only solution to release a sub-band in the

UHF spectrum. Different reassignment combinations could be obtained by changing slightly input hypothesis about services offered.

The first part of this study demonstrates that it is feasible to create a sub-band of 112MHz for Mobile services in two countries at the same time while keeping 7 national layers for Digital Broadcasting, using France and Belgium as an example. Furthermore, the outcome of the GE-06 of all adjacent countries up to 130km from the border with France and Belgium has been taken into account. In this first case, it is demonstrated that with a new frequency plan over these two countries it is possible to release 112MHz in the upper part of the UHF band, and still offering Digital Broadcasting services according to requirements expressed at GE-06.

In a second case, this study analyses the feasibility of releasing also 112MHz in four contiguous countries at the same time. The countries studied are, France, Belgium, Holland and Luxembourg.

For this case of four contiguous countries obtaining a new coordinated frequency plan for releasing 112MHz, the border effects could play an important role in the possibility of offering Digital Broadcasting services for most of population in all national layers available. More studies could be performed in order to try to resolve the specific problem of having too much interference in the border of some layers.

However, after a third case studied, it has been observed that without taking German assignments (only allotments) declared in GE-06 Plan up to 130km from the border of the four countries studied, almost all interferences obtained in the second case disappear. Indeed, a new frequency plan has been obtained for these four countries (France, Belgium, Holland and Luxembourg) with negligible interference levels, while taking into account up to 130km of neighbouring countries GE-06 Plan (without German assignments, but keeping German allotments); thus, all these four countries could have 6 national layers for offering Digital Broadcasting services for around 98% of population and 1 layer for Mobile Broadcasting, and also create a common 112MHz sub-band for Mobile Services.

6. REFERENCES

[1] ETSI TR 101 190, « Implementation guidelines for DVB terrestrial services

[2] ETSI TR 102 377, « DVB-H Implementation Guidelines »

[3] RRC-06 Final Acts « of the Regional Radiocommunication Conference for planning of the digital terrestrial broadcasting service in parts of Regions 1 and 3, in the frequency bands 174-230 MHz and 470-862 MHz (RRC-06) »

7. ANNEXES

7.1. Annex 1 – Digital Broadcasting Parameters

DVB-T for portable reception

- Modulation: 16-QAM 2/3
- A field threshold of 58dBµV/m (at 1.5m) in 95% of locations
- The receiver antenna height will be 1.5m AGL
- Bandwidth: 8 MHz
- Co-channel protection ratio: 16dB
- If new sites are added for improving coverage, the common parameters will be:
  - Transmitter antenna height: 50m AGL
  - Effective Radiated Power (ERP): 4kW

DVB-T for fixed reception

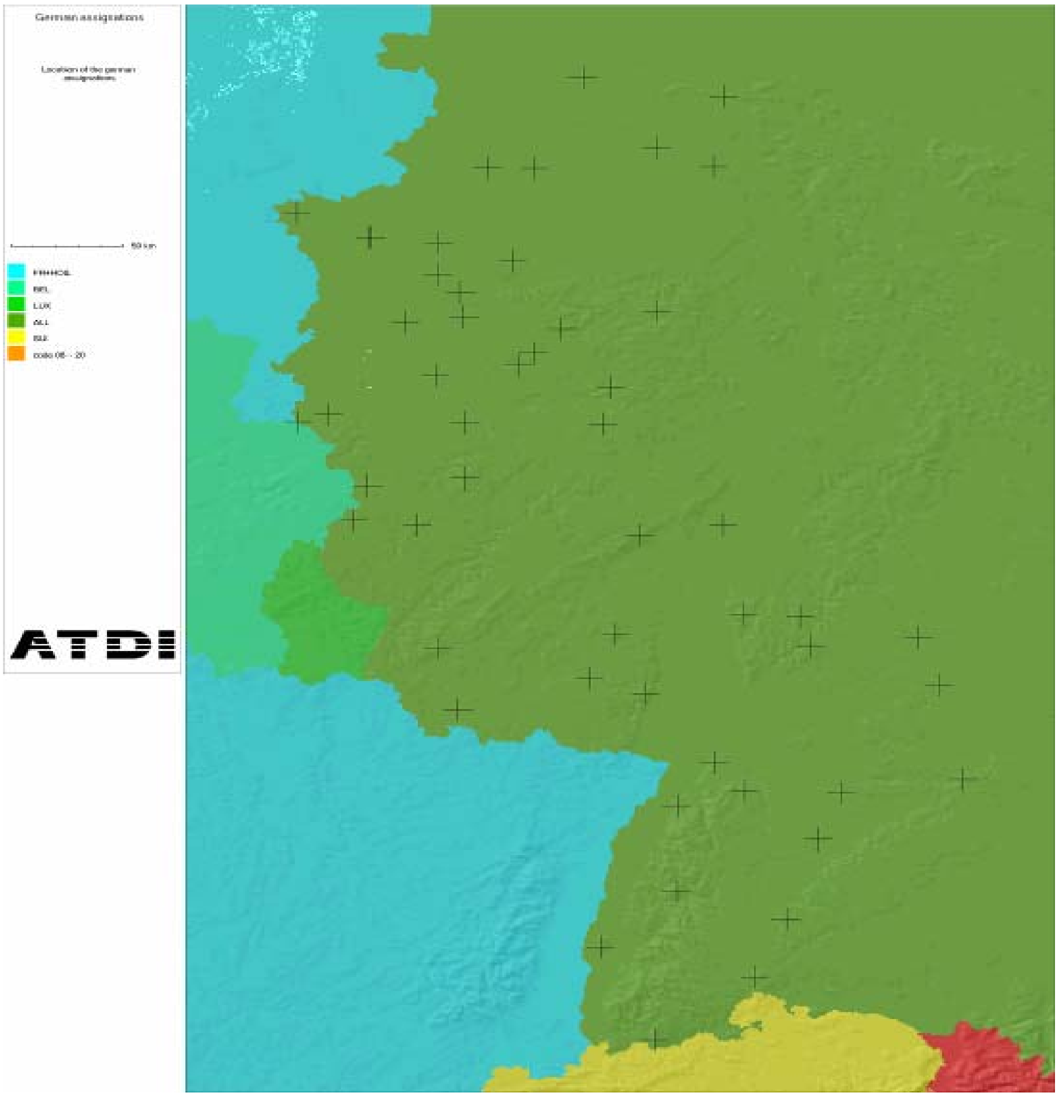
- Modulation: 64-QAM 2/3
- A field threshold of 57dBµV/m (at 10m) in 95% of locations
- The receiver antenna height will be 10m AGL
- Bandwidth: 8 MHz
- Co-channel protection ratio: 20dB
- If new sites are added for improving coverage, the common parameters will be:
  - Transmitter antenna height: 100m AGL
  - Effective Radiated Power (ERP): 5kW

Mobile broadcasting, using DVB-H technology

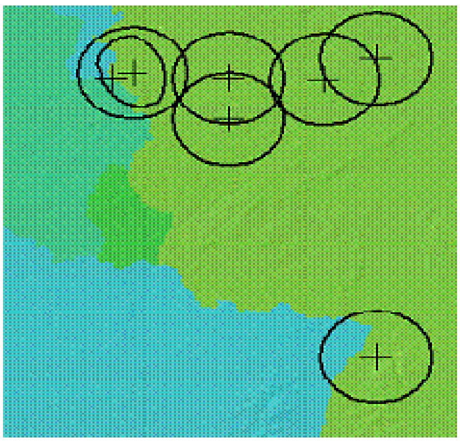
- Modulation: QPSK 2/3
- A field threshold of 69dBµV/m (at 1.5m) for ensuring a good indoor reception in an urban environment. The coverage of this network is targeted at 70% of population.
- The receiver antenna height will be 1.5m AGL
- Bandwidth: 8 MHz
- Co-channel protection ratio: 13 dB
- If new sites are added for improving coverage, the common parameters will be:
  - Transmitter antenna height: 30m AGL
  - Effective Radiated Power: 500W

7.2. Annex 2 – German Assignments

After observing the German assignments declared in the Plan that are closely situated in the border, we have decided to assess the impact of these assignments onto the four countries re-planned and to analyse the possibility of realising these 112MHz without taking into account these assignments. In the figure here below, we can find a part of the German border with some of the assignments.



A high number of these assignments contain omnidirectionnal antenna patterns, as it is shown here below:



In the Excel file he below we can find all German assignments as declared in GE-06 that are situated up to 130Km from the border of the countries studied.

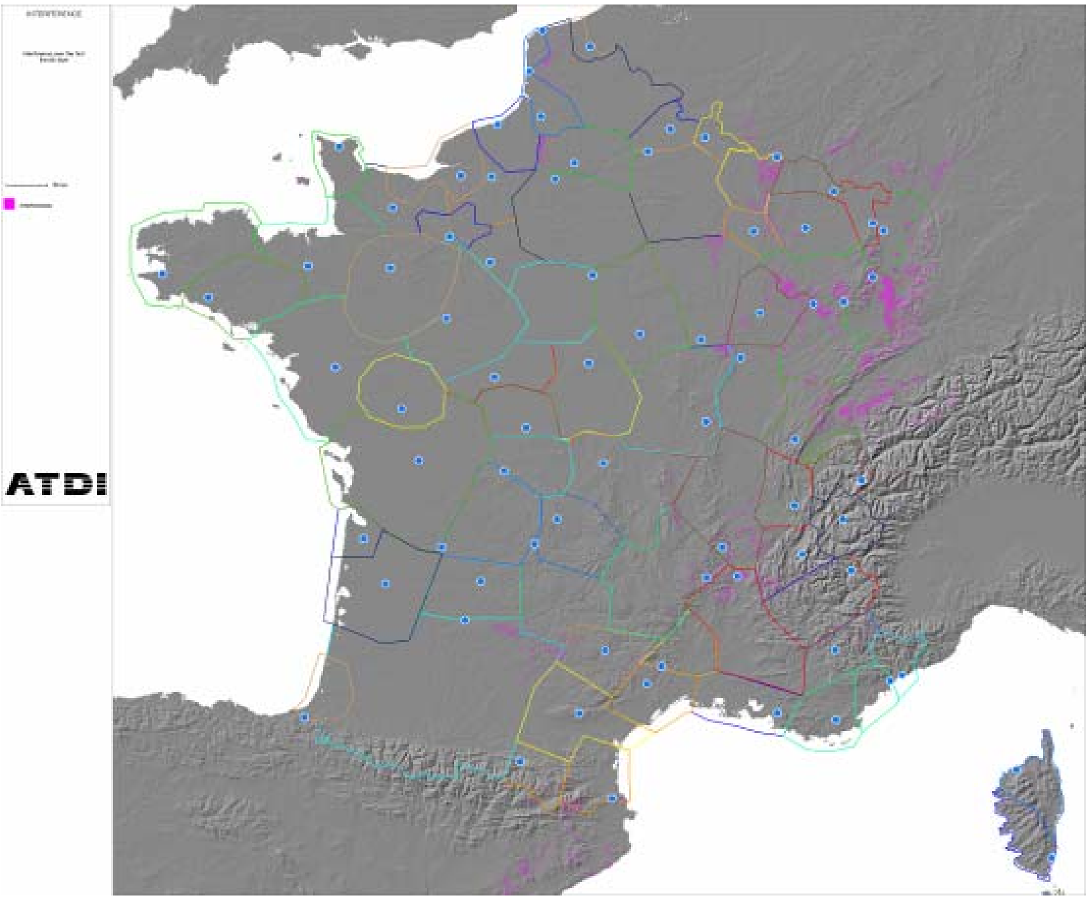
GermanAssignments

7.3. Annex 3 – Results

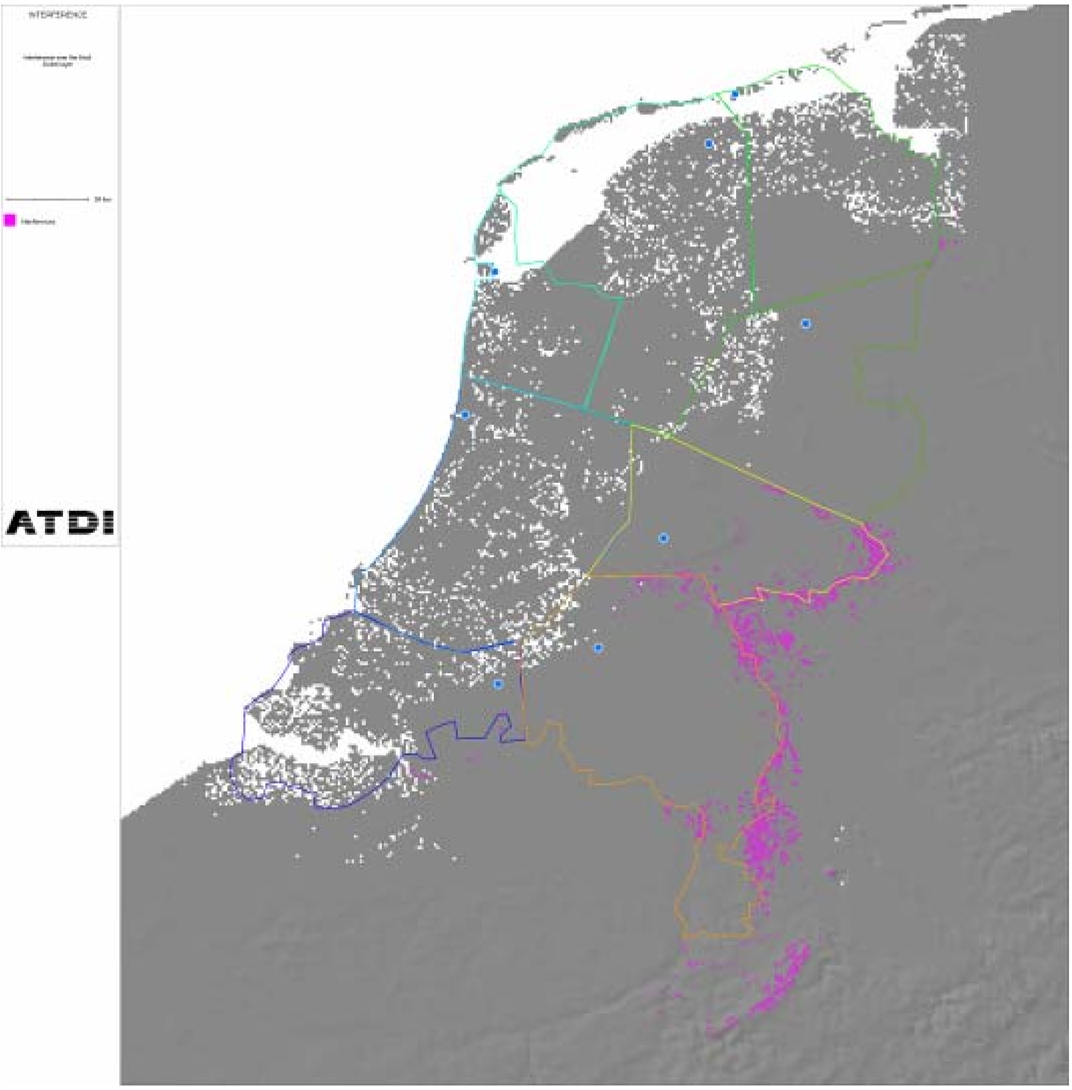
In these Annex it is presented two examples of layers interfered after releasing 112MHz and obtaining a new frequency plan over four countries at the same time: France, Belgium, Holland and Luxembourg. These examples take into account neighbouring countries GE-06 Plan up to 130Km from the border (including also German assignments).

We can find in purple the interferences generated over the territory of the country re-planned as well as over its neighbouring countries.

Example of 1st French layer



Example of 3rd Dutch Layer



7.4. Annex 4 - Propagation model

The chosen propagation model is divided in three components:

- The free space loss term;
- The diffraction loss term;
- The subpath loss term.

Here is a description of each of these three components:

ITU-R 525: free space loss

This denomination actually stands for standard free space attenuation described in the ITU-R P.525- recommendation.

The transmission loss that would occur if the antennas were replaced by isotropic antennas located in a perfectly dielectric, homogeneous, isotropic and unlimited environment, and the distance between the antennas being retained.

$$A_0 = 20 \log \left(\frac{4\pi d}{\lambda} \right) \text{ dB}$$

Where:

λ : wavelength (m)

d : radio path length (m)

This model can be used for field-strength calculations on the margins of VHF bands while showing good performance in UHF and SHF bands. From experience and comparison with measurement, the following are recommended options:

- Diffraction geometry: Deygout 1994;
- Subpath attenuation: Coarse integration.

Deygout 1994: diffraction loss

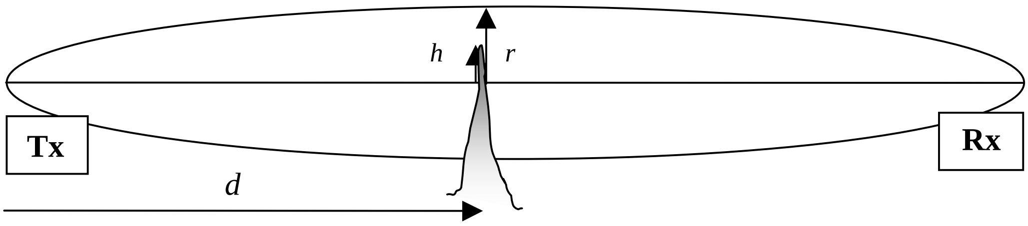
Diffraction loss means attenuation yielded when the direct transmitter/receiver ray encounters one or several obstacles.

In Fresnel theory, the attenuation brought by one single knife-edge located in free space can be derived using Fresnel Integrals. Since those integrals have no explicit solution, a good approximation to this knife-edge diffraction loss is used:

$$\mathbf{L_d=6.9+20log[(\nu-0.1)+sqrt(1+(\nu-0.1)^2)],}$$

Where ν=sqrt(2)h/r.

The fraction h/r, called the clearance ratio, is the ratio of the algebraic height (positive upward) of the edge above the line of sight over the radius of Fresnel ellipsoid at distance d from the Tx.



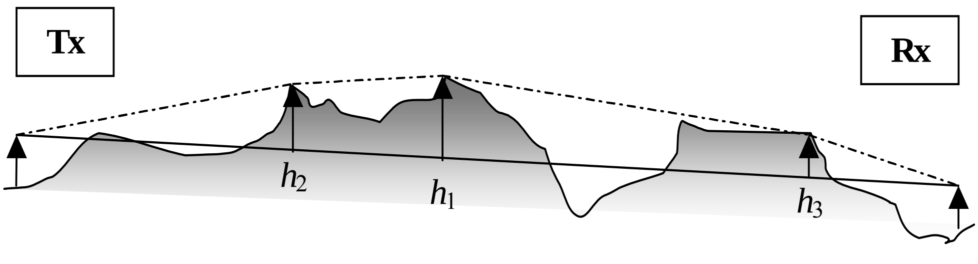
The different diffraction methods actually offer specific ways to identify one ν (single obstacle diffraction) or several ν (multiple obstacle diffraction) according to a path profile.

Deygout Method 1994 for multiple knife-edge diffraction:

In 1966, Deygout proposed a diffraction method that takes 2 obstacles into account: a primary obstacle (obtained from the maximum clearance ratio ν1 w.r.t. the line of sight between Tx and Rx) and, if this primary obstacle exists (ν1>0), a secondary obstacle (obtained from the maximum clearance ratio ν2 w.r.t. the line of sight between Tx and the primary obstacle and between the primary obstacle and Rx). The global diffraction loss is then given by Ld'=Ld(ν1)+Ld(ν2) (cf. Jacques Deygout, Multiple knife-edge diffraction of microwaves, IEEE Transaction on Antennas and Propagation, July 1966). This method provided better estimations than Bullington's, but still slightly optimistic.

In 1994, Deygout presented a generalized improvement of this method using a potentially infinite number of edges (Jacques Deygout, Données fondamentales de la propagation radioélectrique, juillet 1994, Editions Eyrolles). The search for the edges is sequential: if the primary obstacle exists, one searches for two secondary obstacles (one between Tx and the obstacle and the other between the obstacle and Rx). Then, this search is performed again on each side of the secondary obstacles possibly looking for ternary obstacles. This process is reiterated recursively (n+1ary obstacles depend particularly on nary obstacles) until no new obstacle is found.

Then, the global diffraction loss is Ld'=Σi Ld(νi).



Coarse Integration: subpath loss

ATDI's experience in using practically geometrical models with classical diffraction corrections, comparisons with measurements and customer remarks and queries have brought to the following statement: these models provide too optimistic field strength values. Obviously, the other available corrections (clutter, gaseous, rain,…) were not sufficient to provide relevant correction terms. This means that an additional geometrical correction was desirable. In his book [Deygout94], J. Deygout proposed an additional correction term:

$$\mathbf{L_{gr}=20log(75000d)-20log(\pi h_1 h_2 f)}$$

Where d is the distance to Tx (in km), h1 and h2 are respectively the Tx and Rx antenna height (in m) and f the frequency (in MHz).

This correction term is directly derived from surface reflection modeling (for low incident angles). This correction (called Lgr for ground reflection attenuation) works, but only in specific conditions (limited bandwidth, antenna heights).

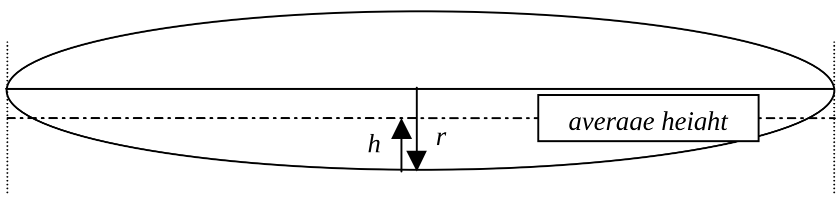
Actually, ICS Telecom's author had the idea that a major part of the missing attenuation could be obtained by some "measurement" of the proportion of the profile that is located within Fresnel ellipsoid below the line of sight (which justifies the denomination of subpath loss).

Coarse integration subpath attenuation:

In this method, the idea is to consider diffraction type subpath attenuation term using a value of h above the virtual Fresnel Ellipsoid lower limit instead of the line of sight. The value of h is defined as the average value of the profile elevation above the lower elevation of the central section of this ellipsoid. If r is the value of the largest radius of the ellipsoid, the subpath attenuation is given by:

$$\mathbf{L_{sp}=6.4+20log[\nu+sqrt(1+\nu^2)],}$$

Where ν=sqrt(2)h/r.



This method is particularly recommended for accelerated calculation times. It has a natural tendency to predict pessimistic results, or in the case of widely changing trajectories, to predict optimistic results.