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National field reports on the introduction of IMT in the bands with co-primary allocation to the broadcasting and the mobile services

BT Series

Broadcasting service (television)

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REPORT ITU-R BT.2301-2

National field reports on the introduction of IMT in the bands with co-primary allocation to the broadcasting and the mobile services

(2014-2015-2016)

Introduction

A number of countries have recently introduced new mobile services in the parts of the UHF band in which they have a co-primary allocation to the broadcasting and the mobile services, in particular international mobile telecommunications (IMT) systems utilizing long-term evolution (LTE) technology.

The annexes in this Report provide a compilation of national approaches/best practices and their experiences so far in the protection of DTTB Services in conjunction with the introduction of LTE.

The national field reports (initial or final) in Annexes 1, 2 and 3 hereafter are related to the introduction of LTE in the 800 MHz Band using the reverse duplex arrangement. They are based on data available at the date of their inclusion.

When new data becomes available these reports could be updated, if appropriate.

It is intended to include further national approaches/best practices as they are made available by members.

Annex 1

Field report on the applied methodology used by Germany to protect the broadcast service when implementing the IMT service in the 800 MHz band

1.1 Background

Germany has implemented IMT services in the 800 MHz band. In order to protect the broadcasting service operating in the 700 MHz band adjacent to the frequencies used by the IMT service, the Federal Network Agency has set up a process to set the site-related frequency usage parameters of each individual mobile base station before such base station is put into operation.

The frequencies gained at auction can only be used after assignment subject to "their compatibility with other frequency usages". The applicant must prove for an efficient and interference-free use of the frequencies. In planning their network build and rollout, frequency assignees must therefore apply for the site-related frequency usage parameters to be set before the individual frequencies can actually be used.

Applications for site-related frequency usage parameters to be set can only be granted if they meet the relevant requirements. In particular, applications for the use of frequencies in the 800 MHz band must take account both of the frequency usage conditions and of usage provision 36 of the national frequency band allocation Ordinance, which states that the mobile service in the 790-862 MHz frequency band must not cause any interference into the broadcasting service. These regulations constitute fundamental framework conditions which must be taken into account by applicants.

1.2 Frequency engineering and regulatory framework and key assumptions

One of the tasks and aims of the procedure for setting site-related frequency usage parameters is to guarantee protection for the broadcasting service in all relevant application situations. This is particularly relevant if there is a residential area within a certain radius of a mobile service base station in the broadcast coverage area.

Preventive studies aimed at avoiding interference to terrestrial digital television reception can be restricted to a certain radius around a base station. It can be assumed that the probability of interference to DVB-T reception outside this radius is extremely low. If, nevertheless, interference occurs in a particular case, contrary to expectations, the notice setting the parameters can be revoked by exercising the right provided for in the notice, and further safeguards can be put in place accordingly.

In cases where interference could be caused to DVB-T reception within the radius referred to above, the applicants must show which appropriate measures they will take in order to take account of the protection requirements of the broadcasting service. The applicant must show how the requirement for frequency assignment – and hence for setting the site-related frequency usage parameters – is met. In this connection, the network operators are required to take account of broadcasting interests starting at the planning stage and to take any necessary preventive measures (e.g. radiation characteristics, orientation of sectors, antenna height).

The probability of interference below DVB-T channel 52 in individual cases has not been looked at separately because, as matters stand at present, the current interference studies cover the interference potential at these frequencies.

Taking account of the limit on LTE out of block emissions below 790 MHz (max 0 dBm per 8 MHz given a planned maximum LTE radiated power) and broadcasting coverage with the lowest minimum median wanted field strength of 41 dBμV/m (exactly 41.9 dBμV/m for fixed terrestrial broadcasting

coverage with DVB-T system variant A1 on channel 52 in accordance with the regulations in the Geneva 2006 Agreement), a maximum (protection) radius of approximately 1.1 km is considered sufficient. This (maximum) radius is assumed for all system variants in operation.

The probability of interference then depends on:

1) whether or not there is actually any DVB-T coverage within the (interfering) radius of the base station; and

2) whether or not there are actually any relevant digital terrestrial television broadcasting application situations within the (protection) radius.

If both these factors apply, it is necessary to see in each particular case if the DVB-T field strength available seems high enough in order to make interference to broadcasting reception from the LTE base station improbable. In this case, the applicant must explain how he will protect the broadcasting service (further remedies may be required) or why interference to broadcasting reception is improbable.

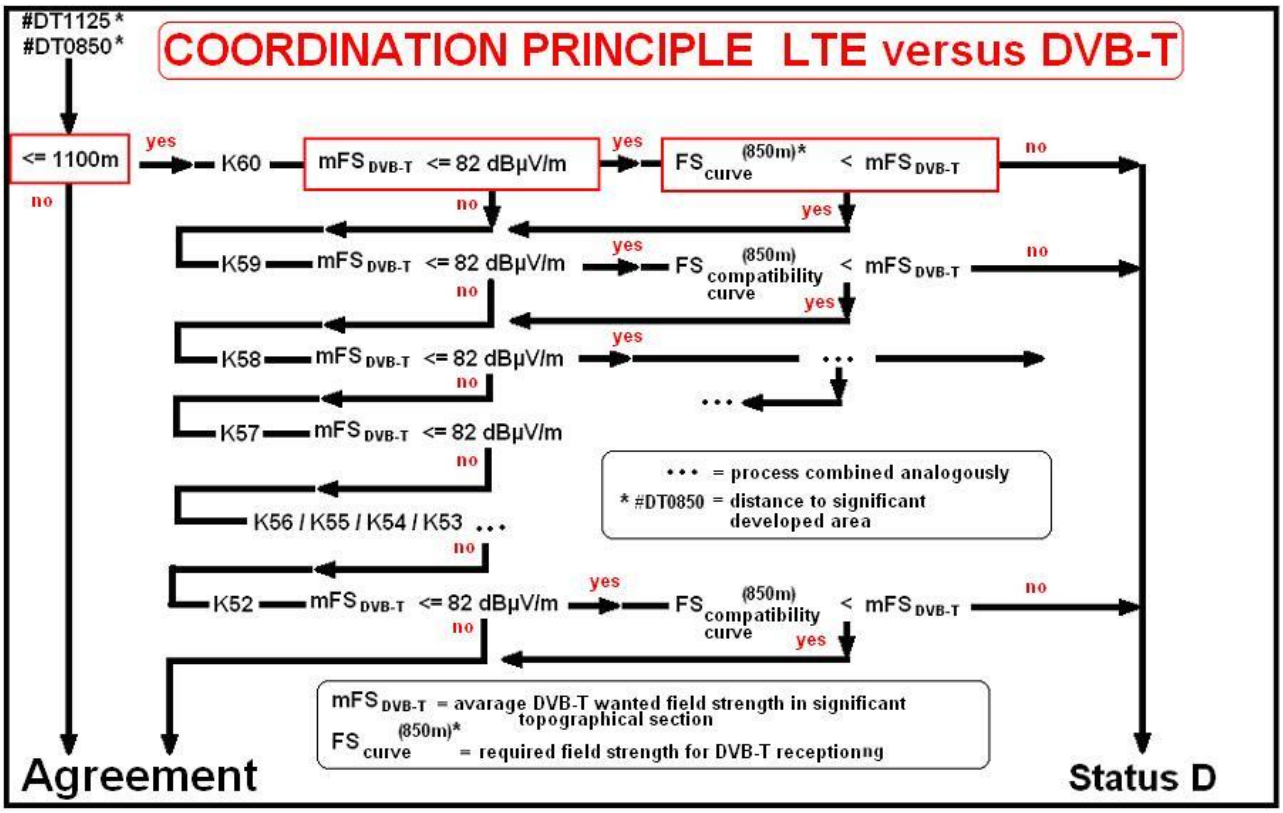
This procedure for setting site-related frequency usage parameters takes account of the fact that such parameters in the 800 MHz band at the interface with broadcasting are being, or have been, set for the first time and may need to be refined, depending on the actual effects the operational mobile networks have.

1.3 Steps for a computer-assisted standard procedure for determining compatibility between LTE and broadcasting in specific cases before setting the site-related usage parameters for an LTE base station

The following flow chart illustrates the individual steps in the procedure to provide protection for DVB-T broadcasting. Other necessary coordination steps (such as international coordination) are not included in the chart but must also be taken before site-related usage parameters can be set.

FIGURE A1.1

Flowchart



NOTE 1 – If the distance between the LTE base station and the residential area is more than 1 100 m, the application for parameters to be set can be granted.

NOTE 2 – If the distance between the LTE base station and the residential area is less than 1 100 m, a DVB-T coverage map calculated for each of the channels from 60 to (currently) 52 is used. The calculations are made using internationally recognized propagation models for DVB-T television broadcasting emissions. The coverage map is used to allocate field strengths for DVB-T coverage on each channel to grid points spaced at intervals of one arc second, following the recognized assumptions for location and time percentages for broadcasting reception.

NOTE 3 – First, the average DVB-T field strength available per channel is calculated as the arithmetic mean of all the grid point field strengths greater than 41 dBµV/m, for a 600 m by 600 m square around the LTE base station.

NOTE 4 – If the average available DVB-T field strength calculated is at least 82 dBµV/m, the application for site-related frequency usage parameters for an LTE base station can be granted, on the assumption that the base station radiated power is 59 dBm.

If the planned base station radiated power is lower than the maximum radiated power of 59 dBm, the average minimum available DVB-T field strength of 82 dBµV/m can be reduced by the difference between a radiated power of 59 dBm and the planned lower radiated power, since the LTE out of block emissions will also be correspondingly lower.

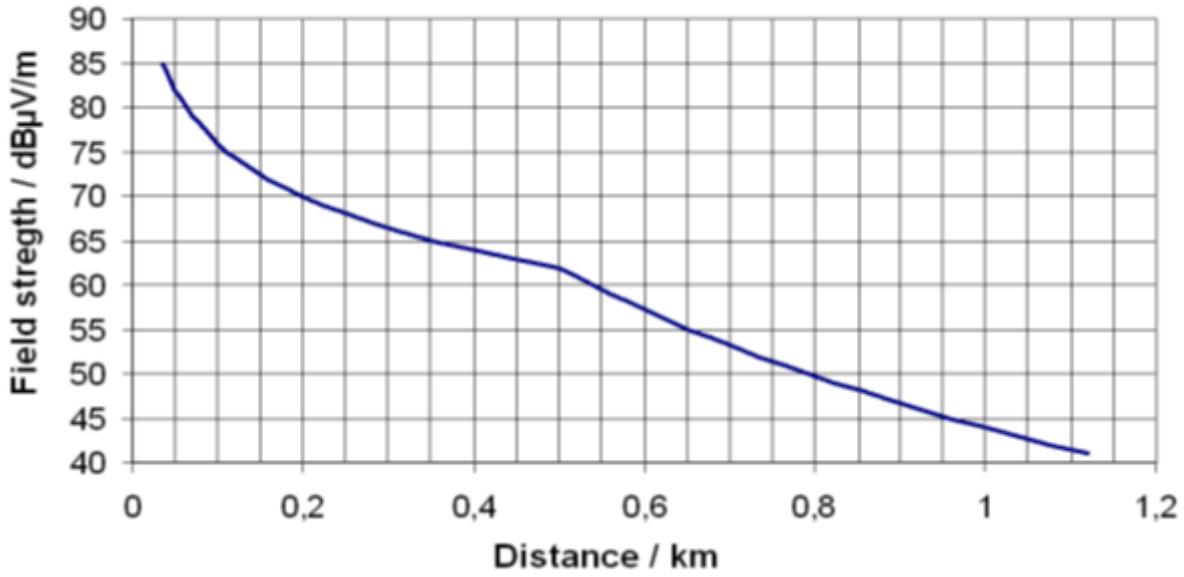
NOTE 5 – All other cases:

The necessary field strength for DVB-T reception, corresponding to the distance between the LTE base station and the nearest residential area (up to 1 100 m), can be read from the graph below (compatibility curve).

If the average available DVB-T field strength calculated in step 3 is higher, the application can be granted.

FIGURE A1.2

Distance as a function of the available DVB-T field strength



NOTE 6 – If the average available DVB-T field strength calculated is less than 41 dBµV/m on each DVB-T channel considered, the application can also be granted, since the field strength is lower than the minimum required for DVB-T coverage, i.e. absence of broadcast coverage.

NOTE 7 – If, having followed steps 1 to 5, an application cannot be granted, further information must be provided by the mobile network operator in order for a decision to be taken on the application.

1.4 Compatibility with broadcast service in neighboring countries

Compatibility with broadcast service still in operation in neighboring countries has been achieved successfully by bilateral agreements which are based on the principles outlined in the Geneva 06 Agreement, i.e. on the use of a maximum interfering field strengths at the border.

Depending on the specific situation, values in the range from 25 up to 44 dBµV/m (8 MHz, 10 m height) were used in such agreements.

1.5 Conclusion

By the end of 2012 about 6 000 mobile base stations have been in operation in the 800 MHz band in Germany.

For 4 000 additional base stations the parameters had been assigned, which is the prerequisite for starting operation. By October 2013 most of them are in operation, too.

Only 10 (ten) of the complaints raised until October 2013 in respect of interference into the broadcasting service were identified as caused by LTE. Most of them were easily solved by simple adjustments of the DVB-T reception antenna system (e.g. antenna directivity, antenna amplifier level, additional low cost filter, etc.).

This illustrates that the implemented methodology provides a very high protection level of the broadcasting service.

Annex 2

Interim national field report on the introduction of IMT downlinks in the 800 MHz band with co-primary allocation to the broadcasting and the mobile services in France

Introduction

LTE 800 MHz roll-out is underway in France since March 2013, while LTE 700 MHz roll-out started on April 2016 in some limited areas. The information presented in the following section on the accounting of interference from LTE 800 to DVB-T reception dated from 31 May 2016. The concerned roll-out has been carried out by the three main French mobile network operators and was urban predominated during the first years of the roll-out. It included 16283 base stations (BS). The total number of BS needed for full national coverage of the 800 MHz band is estimated to be about 30000 for the three network operators.

The aim of this document is to share experience on the deployment of mobile service LTE networks, and the impact of LTE downlinks on fixed roof-top DVB-T reception below 790 MHz in France. Note that the fixed DVB-T reception "chain" means a roof-top antenna, an amplifier system (in some cases), a passive cable and a TV receiver. Portable and mobile DVB-T receptions are not under consideration in this paper.

Based on the work carried out in CEPT and in ITU-R, a mechanism to address the potential interference from IMT base station to fixed DVB-T reception has been put in place:

– Mobile operators have the obligation to implement on all base stations filtering characteristics called "Case A/channel 60" of BS BEM out-of-block EIRP limits over frequencies below 790 MHz (see Annex, part B, table 4 of European Commission decision 2010/267/EU).

– In addition, mobile operators in the 800 MHz have the obligation:

  • to solve interference of TV installation receiving broadcasting stations assigned before the LTE deployment;

  • to provide the French TV viewers a common interface to complain in case of interference, and to help mobile operators to identify quickly where and which operator should intervene, ANFR is managing a call centre for interference to DVB-T reception and also collects the information provided by mobile operators in the 800 MHz band (e.g. BS deployment and BS putting into service information).

Moreover, information is provided (i.e. the phone number of the call centre mentioned above) through different means to local professional aerial installers, apartment block administrators, local authority and TV viewers before base stations are put into service.

Analysis of the cause of interference

The vast majority of reported interference cases that have been observed so far on fixed DVB-T reception were caused by LTE base station provoking DVB-T overloading (active systems like amplifiers or DVB-T television/set-top box). Overloading means that usually all TV channels are interfered.

The interferences are mainly caused by LTE 800 MHz BS. LTE 700 MHz roll-out is at its very early stage in France, thus it is difficult to draw any conclusion on its impact on DVB-T reception yet. Indeed, in case of LTE 700 MHz, there is a greater frequency offset between the mobile downlink and the highest DVB-T channel 48. However, according to the experience gained from LTE 800 MHz roll-out, this would have a limited beneficial impact on DVB-T overloading effects. Actually, the

overloading of active DVB-T reception seems to be independent of the frequency offset between the mobile downlink and DVB-T.

Note that the LTE 800 MHz experience does not provide relevant information about the interference from mobile uplink to DVB-T reception.

Summary of interference situation

During the period from 1st November 2012 to 31st May 2016, 16283 LTE Base Stations have been put into service in the 800 MHz band, in particular in urban areas, and there have been 67857 reported cases of interference to fixed DVB-T receiving installations, domestic or community aerial (some interference may not have resulted in claims from TV viewers), which represents interference to 168778 households.

The number of interference cases per base station is very dependent on the local conditions of DVB-T reception. In areas where the DVB-T signal is weak or the houshols have several TV sets, TV viewers are likely to have installed an amplifier and have a higher risk of being interfered with.

It has been observed that the median interference distance between the IMT base station and the DVB-T fixed reception installation is 572 m and the maximum interference distance reported is about 6.5 km. While, in 99% of cases the interference distance is below 2.1 km.

The following Tables summarize the interference situation from LTE 800MHz networks to DVB-T reception:

TABLE A2.1

Number of interference

Real-life interference from LTE 800 to DVB-T reception in France Information dated from 31 May 2016			
Number of interference			
	Number of active three sectorial base stations (BS)	**Number of households per communal aerial reception (on average)**	**DVB-T penetration rate (%)**
	16 283	13	56.2
DVB-T reception mode	**Number of interference to DVB-T reception**	**Estimated raw number of interference to households**	**Estimated weighted number of interference to households**
Individual aerial Reception(1)	51 853	51 853	51 853
Communal aerial reception(2)	16 004	208 052(3)	116 925.224(4)
Total number of interference	67 857	259 905	168 778.224
Average number of interference per BS	4.2	16.0	10.4

(1) An individual aerial reception is when a single TV aerial feeds a single household.

(2) A common aerial reception is when a single TV aerial feeds several households.

(3) =16 004 × 13

(4) =16 004 × 13 × 0.56

TABLE A2.2

Number of mitigation filters used

Number of mitigation filters[1][2] used Number of active three sectorial base stations = 16 283 Total number of interference = 67 857	
For resolution of interference	70 500[1]
For prevention of interference	8 000
Total number of filters	78 500
[1] Filters are installed at the DVB-T receiving antenna (either head-end filters or user filters). [2] More than one filter may be needed to mitigate the interference for some individual aerial receptions.	

TABLE A2.3

Interference ranges

Real-life interference from LTE 800 MHz to DVB-T reception in France Number of active three sectorial base stations = 16 283 Total number of interference = 67 857	
Estimated interference distance[1]	
Max distance (m)	≈ 6 544[2]
Average distance (m)	≈ 672
Median distance (m)	≈ 572
Standard deviation (m)	≈ 481
[1] Distance between the victim DVB-T receiver and the interfering BS transmitter. [2] In 99% of cases the interference distance is below 2.1 km.	

Mitigation measures taken to resolve interference situations

Every interference case due to the deployment of LTE BS in the 800 MHz band onto the fixed roof-top DVB-T reception has been resolved by the introduction of a LTE 800 filter, either head-end filters (if active systems like amplifiers are present between the roof-top antenna and the television/set-top box) or user filters. In total 78500 filters were used to resolve or prevent the interference from LTE BS to DVB-T reception. The specifications of these filters have been defined by the administration, taking into account studies conducted with the help of stakeholders (broadcasters and the 800 MHz mobile operators). An industrial label could help consumers and professional aerial installers to identify efficient filters.

Conclusions

In view of the information detailed above, the following can be concluded about the interference situation between LTE 800 MHz BS downlinks and fixed roof-top DVB-T reception in adjacent band:

Real-life experience of the roll-out of LTE 800 MHz networks in France shows that LTE base stations, operating in an adjacent band to DVB-T reception, cause harmful interference to the latter, despite a guard band of 1 MHz between DVB-T band edge at 790 MHz and LTE downlink band edge at 791 MHz. This has been observed since the beginning of the roll in France. Indeed, this interference is limited and can be resolved, case by case, by mitigation techniques; mainly by filtering out the interfering LTE signal by an external filter connected to DVB-T receiver antenna output.

Actually, on 31 May 2016, for 16283 active LTE BS, 67857 interferences to DVB-T reception were identified (≈ 4 interferences per BS), which represents interference to 168778 households. All the interference cases were resolved by filtering. However, such operations cost time and money. Note that the total number of BS needed for full national coverage of the 800 MHz band is estimated to be about 30000 for the three network operators.

The median interference distance between the interfering IMT base station and the fixed roof-top DTT reception installation is 572 m and the maximum interference distance reported is about 6.5 km, while, in 99% of cases, the interference distance is below 2.1 km. Consequently, the interference from LTE BS to fixed roof-top DVB-T reception is essentially a national matter and does not require any provision in the RR.

Almost all reported interferences were caused by LTE base stations provoking saturation of DTT receivers (active systems like amplifiers feeding DTT televisions / set-top boxes) and all had been resolved by the introduction of an LTE 800 filter. The filter is installed at the DVB-T receiving antenna of the household (either head-end or user filters). Administration and operators have been able to manage successfully this kind of interference;

It should be underlined here that the interferences to DVB-T reception are mainly caused by LTE 800 MHz BS. LTE 700 MHz roll-out is at its very early stage in France, thus it is difficult to draw any conclusion on its impact on DVB-T reception yet. Indeed, in case of LTE 700 MHz there is a greater frequency offset between the mobile downlink and the highest DVB-T channel 48. However, according to the experience gained from LTE 800 MHz roll-out, it can be noted that the overloading of active DVB-T reception seems to be independent of the frequency offset between the mobile downlink and DVB-T.

Furthermore, the LTE 800 MHz experience does not provide relevant information about the interference from mobile uplink to DTT reception.

Annex 3

Interim national field report on the LTE rollout in the 800 MHz band in the Netherlands[1]

Introduction

On the 31st of October 2012 the multiband auction for LTE started in the Netherlands and came to a conclusion on the 14th of December 2012. As a result licenses to three companies were granted on the 2nd of January 2013 in the 800 MHz band:

- Tele2 mobiel B.V.: 791-801 MHz paired with 832-842 MHz
- Vodafone Libertel B.V.: 801-811 MHz paired with 842-852 MHz
- KPN B.V.: 811-821 MHz paired with 852-862 MHz

Since then about 5 200 LTE antennas came in to service in the 800 MHz band. Vodafone Libertel rolled out about 775 LTE antennas in the cities Amsterdam, The Hague, Utrecht and Maastricht. All other antennas were rolled out by KPN mainly in the Randstad area (roughly the triangle between Amsterdam, Rotterdam and Utrecht).

[1] This interim report reflects the national situation in the Netherlands and will be updated when appropriate.

Precautionary measures

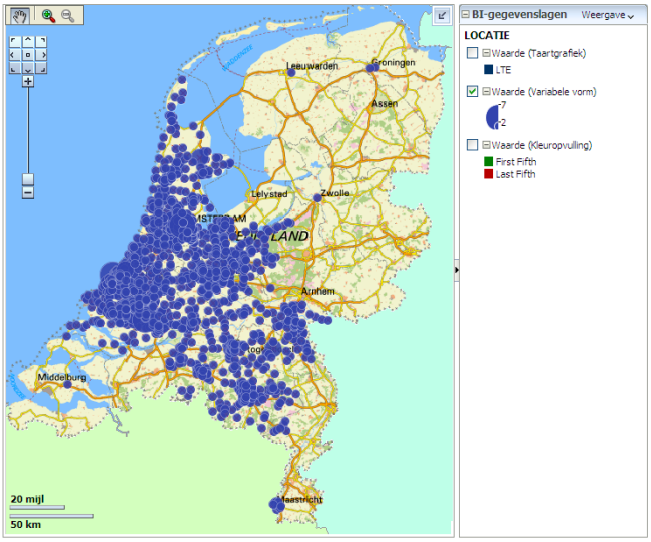
In order to prevent interference with existing users of the radio spectrum, especially the DVB-T usage below 790 MHz, only general precautionary measures were taken. In the granted licenses the follow wording was added (for convenience translated from Dutch):

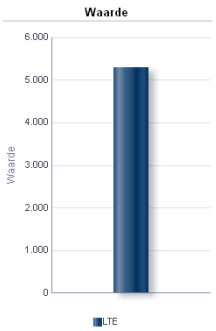
- "The usage of frequencies is such that adequate measures are taken to protect systems in adjacent frequency bands."
- "The licensee causes no unacceptable barriers with the desired signal of radio transmitters into radio transmitters and receivers of electronic or electric facilities"

In the annex of the license additional technical requirements were defined for in band (64 dBm EIRP) and out of band emissions. For emissions in the band below 790 MHz additional requirements were defined: 0 dBm/8 MHz or less and if the base station causes no interference to the primary service below 790 MHz this level may be increased to a maximum of 22 dBm/8 MHz.

Network rollout

The picture below shows the LTE network rollout in the 800 MHz band on the 19th of November 2013. At that time only KPN and Vodafone Libertel had started to use the 800 MHz band. Vodafone Libertel rolled out about 775 LTE antennas in the cities Amsterdam, The Hague, Utrecht and Maastricht. All other antennas were rolled out by KPN mainly in the Randstad area.





Interference cases

In the Netherlands DVB-T is operated by Digitenne which is a subsidiary of KPN. This eases the coordination of the LTE rollout in the 800 MHz band with DVB-T usage for KPN if necessary. However coordination within KPN with respect to the placing of LTE antennas did not take place. Digitenne reported no interference even when specifically asked. Nearly all DVB-T receivers put in to service by KPN are able to receive up to 862 MHz.

As of the 19th of November 2013 no interference cases were reported to the Radiocommunications Agency. Since Tele2 did not rollout any LTE antennas in the 800 MHz the most stringent sharing conditions between LTE and DVB-T still have to come.

Annex 4

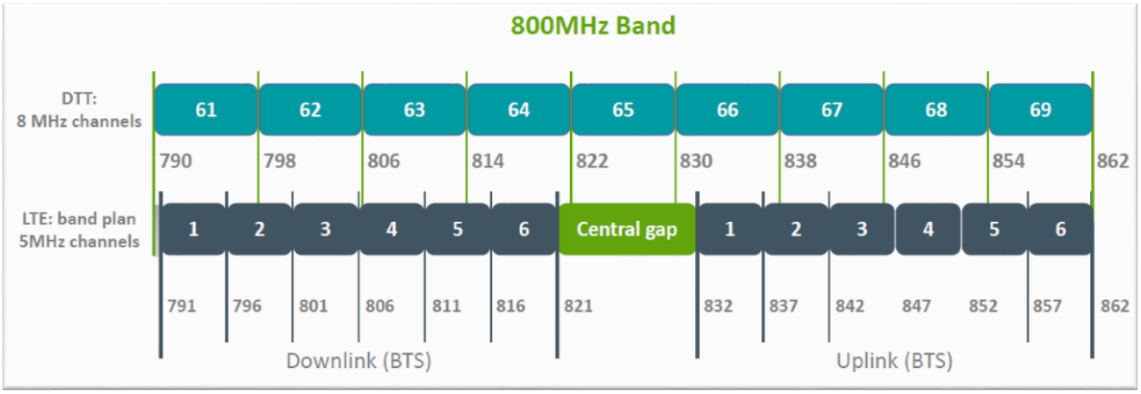
Field report on interference to 800 MHz band IMT base stations in Portugal from DTTB transmissions in Spain

During the process of freeing up the 800 MHz band in Spain there were interferences to several Base Stations operating LTE on the 800 MHz band in Portugal. The interferences were caused by the Spanish DTTB emissions in the same band.

In Spain, among others, 3 nationwide SFN were in operation on channels 67-68-69, on the same frequency range as the 800 MHz LTE uplink, as shown in Fig. A4.1.

FIGURE A4.1

Overlap between DTTB channels 67, 68 & 69 and 800 MHz LTE



Although Spain fully cleared the 800 MHz band on March the 31st 2015, in order to avoid or minimise the interferences on the cross border zones, the Spanish administration has asked the DTTB network operator for an early change of frequencies in several border DTTB sites. Figure A4.2 shows the DTT transmitters in Spain impacting LTE800 in Portugal and which were switched off. Calculations showing the extent of the interference from Spain to Portugal are provided in Report ITU-R BT.2247.

FIGURE A4.2

DTTB transmitters in Spain impacting LTE800 in Portugal