EU4Digital

EU4Digital: supporting digital economy and society in the Eastern Partnership

EU best practice report on releasing and reassignment of the 700 MHz band

Best practices related to approach on the DDT and PMSE reassignment, cross-border coordination and spectrum authorisation

20 November 2019
Version 1.0

Table of contents

List of acronyms and abbreviations

Table 1. Used abbreviations and acronyms

Abbreviation / Acronym	Definition
A-TV	Analog Television
ARNS	Aeronautical Radionavigation System
BEREC	Body of European Regulators for Electronic Communications
DL	Downlink
DTT	Digital Terrestrial Television
DVB-T	Digital Video Broadcasting – Terrestrial
DVB-T2	Digital Video Broadcasting — Second Generation Terrestrial
EaP	Eastern Partnership
EC	European Commission
eMBB	Enhanced Mobile Broadband
EU	European Union
FDD	Frequency Division Duplex
ICT	Information and Communications Technology
IMT	International Mobile Telecommunications
ITU	International Telecommunication Union
kW	Kilowatt
M2M	Machin to Machine
MFCN	Mobile/Fixed Communication Networks
mMTC	massive Machine Type Communications
MUX	Multiplex
NRA	National Regulatory Authority
PMSE	Programme Making Special Events
PPDR	Public Protection and Disaster Relief
PPP	Public Private Partnership
RSPG	Radio Spectrum Policy Group
RSPP	Radio Spectrum Policy Programme
SDL	Supplemental Downlink
TV	Television
UL	Uplink
URLLC	Ultra-Reliable Low Latency Communications

1 Executive summary

The report on the EU best practice regarding the release and reassignment of the 700 MHz band (hereinafter – Report) was prepared by the EU4Digital: supporting digital economy and society in the Eastern Partnership (hereinafter: EU4Dgital facility). The facility aims to eliminate existing obstacles and barriers for pan-European online services for citizens, public administrations and businesses, including through the harmonisation of the digital environments among the EaP partner countries and with the European Union. One of the subprojects is related to the 700 MHz release and its objective is to develop and implement a coordinated approach for reassignment of the 700 MHz band in the six EaP partner countries, in line with the intra-EU efforts and plans.

The Report is aiming at sharing the best practice experience among the EaP partner countries. In the Report there are defined the best practices regarding two key areas:

- EU approaches towards release of the 700 MHz band;
- EU approaches towards reassignment of the 700 MHz band.

The 700 MHz band is used within the EU mostly by the DTT and PMSE technologies. Regarding freeing up the spectrum there have been defined seven elements that should be taken into consideration during the conduct of the clearance process:

- law/regulations amendments;
- stakeholders identification;
- technology upgrade;
- compensations for the DTT service providers;
- compensations for end users;
- compensations for the PMSE equipment owners;
- cross-border coordination agreements.

The first two elements should be analysed internally on the national level. Regarding the technology upgrade (from DVB-T to DVB-T2) it depends on the national situation – if the upgrade is not required to release the band the EU NRAs decide to not oblige the DTT to upgrade the technology. Considering the compensation mechanisms most EU countries have conducted studies to define whether the market players and the end users are capable of covering the costs of the change of the frequency use – country-specific approaches towards compensations are presented in the Report. As regards cross-border coordination, an approach of each country is also described. Based on that three scenarios among the EU countries have been defined:

- the 700 MHz band is not used in a neighbouring country – the coordination of the sub 700 MHz is only necessary;
- there is a transition period because a neighbouring country release the 700 MHz later:
  - there might occur some interferences and limitations of the IMT usage during the transition period which the country accepts;
  - countries develop plan for the transition period;
- a neighbouring country do not plan to release the 700 MHz band – negotiations are necessary.

It has also been highlighted that in case problems arise, the EU countries practice is to ask for the EC or another third parties assistance.

Considering the future use of the 700 MHz band, the EC Decision 2016/687 has established the harmonization of the 700 MHz band for mobile services. The most common scenario among the EU countries is the following channel arrangement:

- MFCN UL: 703-733 MHz;
- MFCN DL: 758-788 MHz;
- MFCN SDL: 738-753 MHz;
- PPDR UL: 698-703 MHz and 733-736 MHz;
- PPDR DL: 753-758 MHz and 788-791 MHz.

As the 700 MHz band is being released, it is crucial to grant frequency licences – the country-specific approach towards the spectrum authorisation is also described in the Report. Based on the conducted analyses, five significant elements regarding the process have been defined:

- duration of the licences;

- spectrum blocks;
- reserve prices;
- spectrum caps;
- coverage obligations.

Regarding the spectrum authorisation there is not one common approach, however the country-specific analyses have enabled to define which aspects should be taken into consideration before establishing the spectrum authorisation conditions.

2 Introduction

2.1 Background and context of the Report

In order to start using the 700 MHz band for the IMT services within Europe, international regulations needed to be changed. An allocation of mobile services in the 700 MHz band was confirmed internationally during the World Radiocommunication Conference (WRC) in 2012. During the event, ITU adopted a decision that the 700 MHz band was to be allocated to broadcasting as well the IMT services in Region 1 (Europe, Africa, Middle East) as of 2015. A decision on how to use the band was to be dependent on each country internal policy. During the next WRC conference in 2015 a lot of discussions were conducted regarding the usage of the band and possible reallocation of the DTT services. It has been established that frequencies between 470-690 MHz (sub 700 MHz) are to be allocated to broadcasting in Region 1 until 2023 as well as the conditions for the mobile services in 694-790 MHz were specified. The upcoming WRC conference is taking place from 28th October to 22nd November 2019 in Sharm el-Sheikh, in Egypt, where the sustainable development of 5G technology will be discussed.

The 700 MHz band represents an opportunity for a globally harmonized spectrum for mobile services – in other regions the 700 MHz band is increasingly used by the IMT technology. Changing the use of the band brings many benefits related to 5G implementation including:

- cost savings from deploying fewer base stations;
- improvement of coverage in rural areas;
- decrease in consumer prices (due to the cost savings connected with a network deployment).

Using the 700 MHz band for mobile data allows mobile operators to meet a given level of data traffic with fewer base stations. Otherwise, they would have needed more stations due to the need for better network performance at the edge of existing coverage, especially in the rural areas and deep indoors.

Taking into account the advantages of setting the allocation of the 700 MHz band to the IMT services and its allocation existing before 2012 in Europe, the High Level Group on the future use of the UHF band (470-790 MHz) was convened by the European Commission in 2013. The aim of the group was to give recommendations regarding the utilisation of the UHF band in near future within the EU. The so-called “Lamy’s Report”[1] (Pascal Lamy was a chairman of the Group) has defined the 2020-2030-2025 formula which states that:

- the DTT technology should stop using the 700 MHz band by 2020 (plus/minus two years) to enable allocation the 700 MHz band to the mobile telecommunications services;
- the operation of the DTT within the sub 700 MHz band should be guaranteed until the end of 2030;
- the review of the spectrum allocation should be done by 2025 to assess technology and market developments – it will give the opportunity to re-assess the situation and avoid any freeze of regulations compared to the rapid advance in technology and consumers behaviour.

After publishing the report, the EC implemented the Decision 2016/687 on the harmonization of the 694-790 MHz frequency band for terrestrial systems capable of providing wireless broadband electronic communications services and for flexible national use in the Union. Then, in 2017 the EC adopted the Decision 2017/899 on the use of the 470-790 MHz frequency band in the EU. Regarding the decision all EU member states have been obliged to:

- conclude all frequency cross-border coordination agreements with other EU member states by 31st December 2017;
- adopt and publish a national roadmap on the 700 MHz band release by 30th June 2018;
- allow the use of the 700 MHz band for the mobile systems by 30th June 2020 (a later release until 2022 may be permitted in justified national cases).

Moreover, the EU established an initiative called 5G Action Plan in 2016[2]. The strategic initiative aimed to boost 5G roll-out in the EU. It consists of eight actions:

Action 1 was related with a development of a common timetable for the launch of early 5G networks by the end of 2018 and fully commercial 5G services by the end of 2020. The EC, Member States representatives and industry stakeholders were engaged in the process. Their involvement guaranteed a broader assessment

[1] ”Results of the Work of the High Level Group on the Future Use of the UHF Band (470-790 MHz)”, Report to the European Commission by Pascal Remy

[2] ”5G for Europe: An Action Plan”, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Brussels, 14.09.2016

on the current state – not only from a regulatory point of view but also from a perspective of market players. The timetable preparation was driven by the following objectives:

- 5G trials promotion;
- EU member states encouragement to develop national 5G deployment roadmaps by the end of 2017,
- ensuring that in every EU country at least one major city will be 5G-enabled by the end of 2018 and all urban areas and major terrestrial roads will have 5G coverage by 2025.

In order to facilitate the process of 5G deployment, the 5G Infrastructure Public Private Partnership (5G PPP) was established as a join initiative between the EC and key stakeholders (ICT manufacturers, telecommunications operators, service providers, researcher institutions). The objective of the arrangement is to deliver solutions, architectures, technologies and standards for 5G network. The main challenge for the 5G PPP is to secure leadership in the particular areas where Europe is strong or where there is a potential for creating new markets such as smart cities, e-health, intelligent transport, education or entertainment & media.

Action 2 objective was related to identification of a provisional list of pioneer spectrum bands for the initial launch of 5G services including three frequency ranges: below 1 GHz, between 1 GHz and 6 GHz and above 6 GHz. In 2016 the RSPG published a report where the following frequency bands were considered[3]:

- below 1 GHZ: 700 MHz band;
- between 1 GHz and 6 GHz: the RSPG found the 3400-3800 MHz band to be the primary band suitable for the 5G implementation in Europe even before 2020;
- above 6 GHz: in particular the bands: 24.5-27.5 GHz, 31.8-33.4 GHz and 40.5-43.5 GHz were considering.

Action 3 aimed at the full set of 5G spectrum bands establishment. The process ended in 2016. After public consultation and thorough analysis of BEREC and RSPG opinions, 5G bands in the EU have been established. They are the 700 MHz, the 3.6 GHz (3.4-3.8 GHz) and the 26 GHz (24.25-27.5 GHz) frequencies. However, it is worth mentioning that 5G implementation is not mandatory in those bands – spectrum in Europe is assigned based on the technology neutral principle, so operators can choose which technology they want to use.

Action 4 was connected with a close cooperation between the EC, Members States representatives and other stakeholders. Meeting the target of at least all urban areas and all major terrestrial transport paths having 5G coverage by 2025 was improved by setting a roll-out and quality objectives for the monitoring of the progress of 5G implementation. In order to monitor the current state of the 5G implementation across the EU countries the European 5G Observatory was created. The Observatory prepares quarterly reports on the situation of 5G deployment (including trials and spectrum auctions) in each EU member state. It focuses not only on 5G development in Europe but also on major international developments (USA, Japan, China, South Korea) which might have impact on the European market. With the support of the European 5G Observatory and information provided on the website (www.5gobservatory.eu) it is easier to assess the progress of 5G implementation within the EU member states and take necessary actions, if needed, to accelerate the 5G development process.

Action 5 was related to elaboration and promotion of a comprehensive and inclusive approach to 5G standardisation. The standardisation within the EU should be underpinned by initial global standards and backed by industrial user experiments. Additionally, those standards shall promote innovations and create opportunities for start-ups.

Action 6 was connected with the market players activities. The EC called upon the industry to start conducting key technological experiments as early as in 2017 to show benefits of 5G network for important industrial sectors (e.g. automotive, healthcare, electricity market) as well as to present detailed roadmaps on the pre-commercial trials implementation by the end of March 2017.

Action 7 was aimed at 5G promotion by the public sector. The EC encouraged the EU member states to use the 5G infrastructure to improve the performance of communications services used for the public (e.g. PPDR). It is believed public services can be an adopter of 5G connectivity-based solutions and can promote new technology. For example, by migrating public safety and security services to 5G platforms, the public sectors show the possibilities of 5G practical usage. According to network technology suppliers, the new platforms could be a virtual slice on a shared 5G public network or a separate network using standardised 5G technology and appropriate parameters, or a combination of both and it could replace such technologies as TETRA or GSM-R.

[3] Strategic Roadmap towards 5G for Europe – Draft RSPG Opinion on spectrum related aspects for next-generation wireless systems (5G)"; RSPG, RSPG16-031 Final, 08.06.2016

Action 8 was connected with the emergence of new innovation models and new ecosystems – 5G network gives access to real or virtual network resources without the need to own a whole network infrastructure. It enables network slicing which allows to provide various levels of service quality and reliability over the same physical network. In order to trigger the new 5G innovation ecosystems, it was suggested by the industry to set up a specific 5G venture financing facility to support innovative European start-ups aiming to develop 5G technologies and related new application across industrial sectors.

As described above, it is plain to see that the EU has developed a common approach towards 5G implementation. It defines:

- technical aspects of 5G usage (frequency bands that can be used by 5G, standardisation approach),
- ways of promoting 5G deployment (by involving the public sector);
- ways of monitoring 5G development (obligation to prepare the roadmaps, establishment of the European 5G Observatory);
- possibilities for subsiding investment in emerging technologies.

2.2 Purpose and use of the Report

In order to facilitate the development of a coordinated approach, the Report was prepared. The main objective of the Report is to share experience gathered by the EU countries during the process of the 700 MHz band reassignment and formulate best practices related to the process especially in:

- approach on the DTT reassignment;
- approach on the PMSE reassignment;
- cross-border coordination;
- spectrum authorisation.

In order to prepare the Report numerous data sources were analysed including, without limitation:

- responses to a questionnaire prepared by the facility team members distributed among the EU countries via RSPG Platform;
- national roadmaps on releasing the 700 MHz band published by the EU member states;
- information published on the European 5G Observatory website;
- analyses published by Analysys Mason.

3 Analysis of EU countries approaches towards release of the 700 MHz

3.1 Use of the 700 MHz band in the European Union

In order to deploy 5G nationwide and build cost-efficient 5G coverage it is crucial to allocate the technology to a frequency below 1 GHz. The EC decided to select 700 MHz to be the pioneer spectrum for 5G. However, the 700 MHz band is used by the DTT and PMSE technologies in most EU countries. Therefore, there is a need to free up the spectrum to make space for the IMT services (the coexistence of the DTT and IMT cannot be achieved in practice).

The Digital Terrestrial Television plays an important role in the EU as a low-cost access to independent and diverse media. The technology is considered to be accessible, anonymous and easy to get because it does not require any contract or additional costs apart from the receiving set – in case, only free-to-air channels are used. Regarding the Eurobarometer data, there are about 250 million viewers and 2000 national or regional TV channels in the EU member states. Moreover, the DTT penetration equals 42% of TV households (homes that have television)[4].

The Programme-Making and Special Events devices (mostly wireless microphones) are widely used during performances and shows which form creative economy and cultural life of the EU countries. As a consequence, during the release of the 700 MHz band the PMSE devices owners interest has to be taken into consideration.

As demonstrated both the DTT services and the PMSE technology are relevant for the EU. Therefore, there is a need to reassign it and reduce the negative impact the reassignment process may have on the end users and the market competitiveness.

3.2 Release of the 700 MHz band

To free up the 700 MHz band it is necessary to undertake particular in-country and out-of-country steps. The in-country actions might be distinguished between obligatory (a must have) and sometimes required (depending on the situation in each country). The obligatory steps are as following:

- legislation and regulation amendments;
- licences termination or waiting for the licences expiration date.

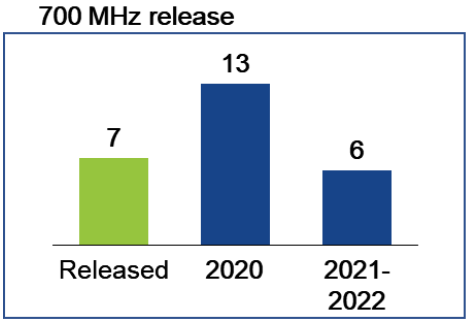
In every EU country government authorities and regulators analyse what legislation and regulation changes are required to release and reassign the 700 MHz band (e.g. update of frequency allocation table, change of the spectrum management rules, change of the regulations to enable the licences withdrawal). Apart from the regulations and policies amendments, the government authorities decide which approach towards the DTT service providers will be used. The choice is between licences termination and not prolonging the licences. The second approach is possible unless the licences expiration date is after 2022 and the national authorities are obliged to prolong the licences. It is due to the fact that the release date has to align with the final deadline set by the EC, which is 30th June 2022.

In some countries it is also required to:

- upgrade of the DTT network – the network modifications are usually required (e.g. network re-planning and transmitters replacement);
- upgrade of the DVB-T technology – it might be impossible to accommodate all DTT channels in the sub 700 MHz band because there is not enough free spectrum, hence the technology upgrade is required to provide greater DTT channels capacity;
- develop compensation mechanisms – in case of licences termination, infrastructure modifications or necessity to replace end users devices, the implementation of the compensation mechanism is sometimes needed (it has to be considered for all service providers using the 700 MHz band as well as end users);
- conduct an information campaign – the campaigns usually target end users to inform them about the necessity to retune or replace their TV receiving sets.

The 700 MHz band is ready to be used by the IMT services in seven EU countries: Finland, France, Germany, Luxembourg, Romania, Slovenia and Sweden. Thirteen EU member states are planning to release the band by 2020, however the rest of the countries will likely postpone the deadline up to the end of June 2022 – mostly due to cross-border coordination problems and issues regarding the licenses withdrawal (see Figure 1).

[4] Eurobarometer, ITU Workshop on the Future of Television for Europe, 7th June 2019



Country	700 MHz release
Austria	Q1 2020
Belgium	Q1 2020
Bulgaria	Q2 2020
Croatia	Q4 2021
Cyprus	TBD
Czech Republic	Q2 2020
Denmark	Q2 2020
Estonia	TBD
Finland	Q1 2017
France	Q2 2019
Germany	Q2 2019
Greece	Q4 2020
Hungary	Q4 2020
Ireland	Q2 2020

Country	700 MHz release
Italy	Q3 2022
Latvia	Q1 2022
Lithuania	Q1 2022 latest
Luxembourg	Released
Malta	Q2 2021
Netherlands	Q1 2020
Poland	Q4 2022
Portugal	Q2 2020
Romania	Q2 2017
Slovakia	Q2 2020
Slovenia	Released
Spain	Q2 2020
Sweden	Q4 2017
United Kingdom	Q2 2020

Figure 1. Progress of the 700 MHz band clearance process

Out-of-the-country actions consist of a cross-border coordination process which all countries have to carry on. All countries have a right to use the spectrum on the whole area of their country. However, possible harmful interference from the stations of different services of one country into the territory and stations of neighbouring (affected) countries enforce a need to pursue negotiations. Although the spectrum decisions are national, a coordination with neighbouring countries is almost always required. The coordination effort can be simplified by a regional harmonisation of spectrum use. In the EU, on 14th March 2012, the European Parliament and Council approved the first Radio Spectrum Policy Programme (RSPP). The aim of the programme is to set out policy orientations to ensure that every EU country manages and uses harmonised spectrum efficiently and in line with the EU priority fields such as e-communication, the Internet of Things, intelligent transport, satellite communications and earth monitoring as well as other spectrum relevant for the European market. It supports the efficiency and flexibility enhancement of the spectrum use as well as helps to sign cross-country coordination agreements – where there is one policy within the region, the coordination process is easier to carry on.

Some of the countries also prepare plans for the transition period until all neighbouring countries switch off the DTT in the 700 MHz. Even in the EU, there is not one common date of the 700 MHz band release, some countries have already released it, others have been working on that matter. Hence, there might occur some interferences during an intermediate period – when the band is used by two different technologies (most likely the DTT and the IMT) in two neighbouring countries. To reduce the interferences, some countries may wish to sign an agreement on the band use during the transition period. The worst case scenario is when a neighbouring country does not plan to stop using the DTT in the 700 MHz band – the analysis of possible interferences is usually performed in that case to define what limitations for the IMT usage in the 700 MHz band may occur. However, the abovementioned situation will not occur between the EU countries, but it might occur on the EU borders.

3.2.1 Approach on the DTT reassignment

3.2.1.1 Service providers

Within the EU there are two approaches towards the DTT service providers:

- licence termination;
- waiting until licences expiration date and not prolonging them.

In fourteen EU countries, it has been necessary to terminate DTT licences to release the 700 MHz band by 2020 or 2022. In nine EU countries, it has been possible to wait until the licences expiration date and not

prolong the licences without missing the deadline set by the EC. The approach to wait until licences expiration date is a favoured one because in that way there are no concerns regarding filing a lawsuit by the TV broadcasting companies or a need to provide a compensation mechanism for them – the broadcasters may seek compensation for loss caused by the withdrawal of the licences. Beyond legal obligations to pay compensations, Ireland has been considering the reimbursement for the DTT providers although, in that country, the local authorities will wait until licences expiration date. It should be highlighted that a non-renewal of the licences for the DTT does not mean that the operators will not incur the cost of migration below 700 MHz. For example, the Irish initial estimation shows that the migration below 700 MHz could amount to EUR 8.6 million (cost of network modifications etc.).

The need of technology upgrade from the DVB-T to DVBT-2 is analysed internally by each country. It is analysed whether it is possible to accommodate channels in the sub 700 MHz band. In case there are not enough free spectrum, the authorities examine if the technology upgrade tackles the technical barrier – the technology upgrade enables to provide greater channel capacity within the same size of the spectrum. If so, imposing the technology upgrade obligation is considered. However, the NRAs practice is to avoid imposing the upgrade obligation if it is not needed to reassign the DTT to the sub 700 MHz band – this approach has been selected only in three EU countries. The approach where the market decides whether to change from the DVB-T to the DVB-T2 seems to be the most favourite one. There are two main reasons of that approach. Firstly, the technology upgrade combined with migration to sub 700 MHz band usually costs more than the migration without the upgrade. Thus, it is not desired to force the market to overinvest, especially because the broadcasters need to fund the network infrastructure replacement costs. Secondly, there is no need to provide extra reimbursement to the DTT service providers for the upgrade from the DVB-T to DVBT-2 technology – in case there is a compensation mechanism, the unnecessary upgrade obligation may cause the EC to reject the state aid request. It should be noted that every financial assistance that an EU government wants to provide needs an approval from the EC. The EC examines whether the aid can be qualified as state aid within the meaning of the Article 107(1) the Treaty on the Functioning of the European Union which provides that “any aid granted by a Member State or through State resources in any form whatsoever which distorts or threatens to distort competition by favouring certain undertakings or the production of certain goods, shall, in so far as it affects trade between Member States, be incompatible with the internal market”. If not, the compensation mechanism can be provided. The intent of the regulations is to avoid favouring a certain company or commercial group that does normal business by an EU member state.

As for the compensation mechanism, the country authorities usually assess whether it is needed or not. The following factors are taken into consideration during the analyses:

- current legislation – whether it is possible to terminate licences/not to renew the licences without any reimbursement;
- situation on the market – whether the operators are capable of funding the cost of the migration (regardless the approach: licence termination or waiting until licences expiration date).

If the legal aspects do not allow the national authorities to avoid the reimbursement or the market analysis shows that it is difficult for the broadcasters to incur the costs of the migration, the compensation mechanism will be applied.

The summary of the various approaches towards the DTT reassignment among the EU countries is presented in the Figure 2. The detailed information on each country is provided in the Annex 1.

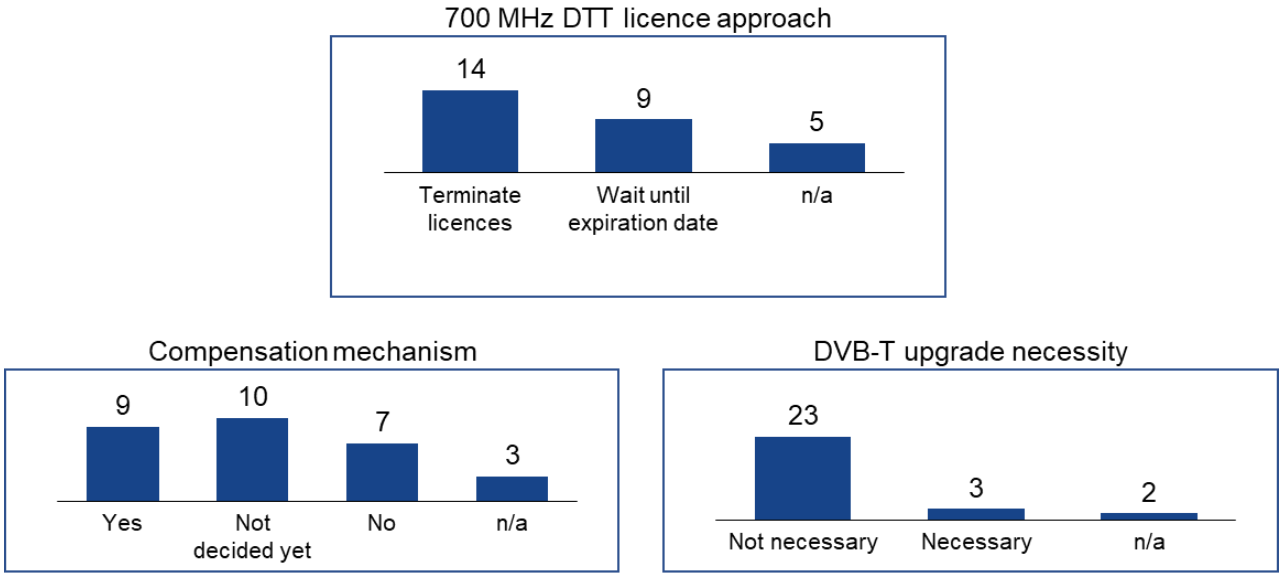


Figure 2. Various approaches towards the DTT reassignment in the EU

Nine EU countries: Austria, France, Germany, Greece, Italy, Lithuania, the Netherlands, Slovakia and Spain have decided to implement the compensation mechanisms for the DTT service providers so far and ten have been considering that.

Selected approaches on that matter are presented below.

France

In 2015 the CSA (fr. *Conseil supérieur de l'audiovisuel*), an independent regulator responsible for broadcasting, requested financial support from the ANFR (fr. *Agence nationale des fréquences*) which is responsible for spectrum management and frequency planning in France. The request was related to the planned release of the 700 MHz – in order to conduct the clearance process, the CSA was asking for a reimbursement.

In France the Spectrum Refarming Fund has been established and it is managed by the ANFR. The aim of the fund is to accelerate the spectrum reallocation. In fact, when a frequency band needs to change its use, the ANFR can pre-finance via the fund the work necessary for the migration of equipment previously using the band. Advanced refarming costs are subsequently reimbursed by the new occupants of the frequency band - in case freeing up the 700 MHz by the mobile operators. The fund has helped to finance several dozens of French radio networks transfer schemes since 1997 amounting more the EUR 300 million.

Because of the existence of the Spectrum Refarming Fund, it was possible to provide financial support to the broadcasting companies. The amount of support was based on the costs of reallocation including, without limitation[5]:

- costs related to frequency changes for multiplexes in operation (including local multiplexes hosting local channels) requiring operators to modify broadcasting equipment on the sites which includes operations like:
  - setting or replacement of a transmitter;
  - setting or replacement of a multiplexer;
- the management costs of the operations incurred by the broadcasters and the costs incurred by the teams sent to the field to adjust transmitters after frequency changes and coordinate these operations.

The total calculated amount of the reimbursement equalled EUR 67 million. The financing scheme was as follows:

- the ANFR financed the migration and paid the reimbursement to the TV broadcasting companies;
- mobile operators paid back the ANFRS at the beginning of every six months;
- during the migration process, the ANFRS was monitoring the expenses and the release of the frequencies on the ground.

[5] "Réaménagements audiovisuels pour la bande 700 MHz Evaluation de l'agence nationale des fréquences", ANFR, 28.09.2015

Germany

In Germany, the DTT licences were valid until 2025 but in 2016 the national authorities and TV broadcasters reached an agreement. The DTT service providers agreed to waive their licences in the 700 MHz band earlier, in case they receive compensation for the costs incurred in connection with the 700 MHz band clearance.

It has been decided that the reimbursement will be granted to the DTT operators that hold licences in the 470-790 MHz frequency band. The compensation mechanism includes only direct technical conversion costs resulting from the release of the 700 MHz band. This covers both costs resulting from the switching from the 700 MHz band to the sub 700 MHz band as well as costs resulting from switching frequency within the sub 700 MHz band, in particular:

- costs for acquisition of technical components required for the conversion (including transmitters, antennas, switches and mask filters);
- costs of work for changing transmitters, antennas, switches and mask filters;
- costs of changing the modulation allocation.

The German authorities have provided thorough analyses and estimated the costs of the 700 MHz band release – for each category of transmitters (low-power transmitters with a power of up to and including 10 kW and medium/high-power transmitters with power higher than 10 kW). They have considered estimates for filter and combiner as well as for antennas – it was calculated on the basis of the cost estimations provided by the market and the NRA. The calculation based on both sources were comparable which allowed the German bodies to determine the typical costs for the conversion of each of the 65 low-power transmitters and the 221 medium/high-power transmitters at around EUR 41 200 and EUR 145 900 respectively. Based on that figures it was possible to form and calculate the compensation amount.

Compensation has been granted in the form of a lump sum, based on the transmission power, and corrected by a proportionate amount of depreciation in view of the fact that the items which need to be replaced have already been in use. This leads to the following average figures per plant:

- EUR 20 000 for 65 low-power transmitters;
- EUR 125 000 for the 221 medium/high-power transmitters.

As a result, the compensation payments range from 48% to 86% of actual purchase value. Thus, the operators must cover the rest in order to adjust transmitters to new frequencies[6]. When not only one change of frequency is required for a particular radio transmitter, the amount of compensation for the second frequency change is EUR 5 000 for a low-power transmitter and EUR 30 000 for a medium/high-power transmitter.

In particular cases, where the actual costs exceed twice the standard compensation amount, it is possible to apply for extra reimbursement based on actual spending. However, if the compensation amount exceeds EUR 500 000 it is necessary to obtain the authorities approval that those expenses are truly necessary – in order to avoid overcompensation.

The German authorities have provided EUR 50 million for the reimbursement. Moreover, the licences usage rights for the frequencies in 700 MHz were shifted to sub 700 MHz band with no payment from the DTT service providers.

Italy

The 2018 budget law foresaw a compensation mechanism for the withdraw of the right of uses for the local operators and compensation regarding the change of technologies from DVB-T1 to DVB-T2 for national TV broadcasting company. The scheme of funding is presented in Tab. 2.

Table 2. Foreseen funding scheme in Italy

Entities	2020	2021	2022
National broadcasters	EUR 24.1 million	EUR 24.1 million	EUR 228.1 million
Local broadcasters	EUR 230.3 million	EUR 73.9 million	-

The amount of the compensation for the local and national broadcasters equals EUR 304.2 million and EUR 276.3 million respectively. The amount, especially in comparison with France or Germany, is very high. One reason is that the DTT licences expires between 2032 and 2034 so the residual value is still high. The second reason is that for the national broadcasters the upgrade of the technology from the DVB-T to DVB-T2 is required.

[6] "State Aid SA.47258 /(2017/N) – Germany, Spectrum migration 700 MHz, 12.12.2018

Netherlands

The Dutch authorities presented different approach towards the compensation mechanism. In 2016 there were launched auctions for 470MHz-790MHz band where one of two bidders dropped out of the DTT auction. That unusual situation led to implementation of a rare compensation mechanism. Instead of applying a financial support, the bidder who stayed was granted the spectrum without charge and was obliged to clear the 700MHz band from DTT usage by 1st January 2020 and fund any costs associated with channel relocation and technological upgrading that is needed to enable the release.

Spain

In Spain, DTT services have the highest penetration rate among TV users equals 76.6%[7]. To release the 700 MHz Spain have to terminate the licences that are currently valid until at least 2025. According to the information provided by Spanish authorities around 25% of the frequencies currently used by the DTT service providers are impacted by the obligation to migrate to the sub 700 MHz band. Moreover, the process implies to reorganisation of the assignment of frequencies below the 700 MHz band. In total, 162 changes of frequencies will occur which results in 68 out of 75 geographical areas affected by the release of the 700 MHz band and a necessity to change emission frequency of 1 143 transmitters[8]. Therefore, the Spanish authorities have also decided to establish a compensation mechanism.

The subsidy will be provided to private broadcasting service providers holding a licence (public broadcasters have been excluded from the subsidy). The reimbursement will support the following costs:

- costs for acquisition of technical components required for the conversion (including signal reception systems, transmitters, the antennas);
- costs of work for changing transmitters, radiant systems and other items of the transmission station;
- costs of changing the modulator.

The compensation does not cover the technology upgrade. The amount of reimbursement depends on the number of frequency channels transmitted by the same transmission site that have to be changed and the power of transmitter.

The maximum amount of subsidy per transmission side for the first or only frequency channel change is presented in Tab. 3. The maximum amount of the subsidy per transmission side for every additional channel change is presented in Tab. 4

Table 3. The maximum amount of subsidy per transmission side for the first or only frequency channel change

Power of the transmission Site	Maximum aid (EUR)
> 10 kW	125 000
1 KW < Transmitter ≤ 10 kW	50 000
100 W < Transmitter ≤ 1 kW	20 000
Transmitter ≤ 100 W	3 000

Table 4. The maximum amount of subsidy per transmission side for additional frequency channel change

Power of the transmission Site	Maximum aid (EUR)
> 10 kW	30 000
1 KW < Transmitter ≤ 10 kW	12 500
100 W < Transmitter ≤ 1 kW	5 000
Transmitter ≤ 100 W	500

The maximum subsidy amounts are calculated based on the costs incurred for each transmission site. The costs of the transmitting equipment used for the calculation of the compensation amount were based on the figures from the technical projects regarding installation of radio stations that are submitted for approval to the Spanish authorities.

[7] https://www.cnmc.es/sites/default/files/editor_contenidos/Notas%20de%20prensa/2018/20181107_NP_Trimestral_Audiov_1T_def.pdf
[8] State Aid SA.51080 – Spain – Audio-visual broadcasting transmission aid for audio-visual service providers

The DTT service providers can only apply for a maximum aid amount which is proportionate to the occupation they have in the multiplex that gets its broadcasting frequency changed. Reimbursement can only be provided once to each beneficiary, for the related frequency channels in each of the geographical areas.

The Spanish authorities estimate that 23 high-power transmitters (>10kW) and 1 120 low-power transmitters (<10kW) need to change equipment which results in about EUR 10 million of the reimbursement in total.

UK

The UK Government as part of its funding for the 700 MHz clearance programme has been considering funding a grant scheme to made funding available to support DTT licensees who need to vacate the 700 MHz band earlier than expected. DTT services providers might be able to seek funding for their necessary costs of moving to alternative spectrum.

Ofcom, the British NRA, worked with DTT licensees and their transmission company to estimate costs. The recent estimation shows that the cost amount ranges from GBP 420 million to GBP 470 million. The value has been estimated as follows[9]:

- a professional third party engaged by the NRA provided a range of estimates of the full costs of infrastructure related to national DTT in 2014 (estimation: GBP 310-470 million);
- the NRA considered that these were overly cautious estimates, and that a narrower range is realistic (estimation: GBP 310-360 million);
- the amount of GBP 50 million was added to cover the cost of local TV re-planning and programme management costs (estimation: GBP 360-410 million);
- to reach a present value estimate of costs was discounted (estimation: GBP 430-490 million);
- the NRA decided the correct estimation of economic costs should include only the cost of bringing equipment replacement forward, rather than full costs which reduces the final cost (estimation: GBP 420-470 million).

It is worth mentioning that the majority of the costs related to the replacement of equipment that were assumed would otherwise have been replaced at the end of its useful life (e.g. DTT transmission infrastructure). The cost of bringing equipment replacement forward, rather than the full cost of the equipment is therefore the economic cost that was adopted for this cost calculation. The calculation was made based on assumptions that assets on average have a life of 43 years and were installed in 2010.

3.2.1.2 End users

For end users there are usually information campaigns and sometimes also subsidies are implemented. Information campaigns are needed to inform the audience about the necessity to retune/replace the receiving sets. Campaigns are usually placed in the internet and TV. Sometimes there are implemented additional measures like call centre for further information and guidance the audience. For instance, Cyprus is planning to activate a relevant call centre for further information and guidance audience during the transition process.

Regarding potential subsidies for end users, in most member states the mechanism is not applied because the reassignment of the DTT requires only retuning of the end users receiving sets and conducing information campaigns is sufficient. However, in two EU countries: Italy and Spain the financial aid is provided and in the UK it has been considered.

Italy

In Italy, in order to release the 700 MHz band, it is necessary to upgrade the technology from the DVB-T to DVB-T2. The technology conversion requires replacement of television sets that are not compatible with the DVB-T2 technology. According to the Italian authorities, almost all households possess a television set that is not compatible with the new DVB-T2 technology[10]. Therefore, Italian authorities have decided to support disadvantaged families to replace the necessary devices. The subsidies will target households that are residents of the Italian territory and that have a total annual income of up to EUR 20 000 based on the ISEE (it. *indicatore di situazione economica equivalente*) indicator – Equivalent Financial Situation Indicator. The ISEE indicator is used to assess and compare the economic situation (income and wealth) of households wishing to receive social benefits. The indicator takes into account the income, the assets and properties of the members of the household, with respect to the number of family members.

Every household can apply for the subsidy only once. The reimbursement will take a form of a reduction in the decoder purchase price up to EUR 50. If the purchase price is lower, the amount of aid is decreased. The Italian authorities have provided EUR 151 million for the reimbursement for the period from 2019 to 2022. The

[9] "Decision to make the 700 MHz band available for mobile data – statement", Ofcom, 19.11.2014
[10] State Aid SA.53376 (2019/N) – Italy Liberation of the 700 MHz band - Reception aid to low-income households, 10.09.2019

amount is allocated on an annual basis as follows: EUR 25 million, EUR 76 million, EUR 25 million and EUR 25 million in 2019, 2020, 2021 and 2022 respectively.

Spain

Spanish authorities estimate that up to 800 000 multi-households buildings out of 1 400 000 will be affected by the release of the 700 MHz and reallocation of the DTT services to the sub 700 MHz band[11]. Hence, a state aid has been established.

The subsidy may be granted for communities of multi-households buildings owners which are located in one of the 68 geographical areas affected by the 700 MHz band clearance process. A community of owners may apply for financial support in order to cover following expenses:

- adaptation of the existing infrastructure for the access to or for the reception of television channels in the new frequency band;
- installation of equipment of any technology that allows for the access to or for the reception of television channels.

The maximum subsidy amount is calculated on the basis of a market price of the most economic technological solution, the type of reception infrastructure to be adopted and the number of multiplexes that have to change frequency. Spanish authorities estimate that the amount of the subsidy will range from EUR 100 to EUR 650 per one multi-households building depending on the necessity to buy additional equipment and the number of multiplexes that have to change frequency.

It is worth to mention that the aid will not exceed 100 % of the community expenses. Moreover, if a more expensive solution is chosen by the community (cheapest technical solution), the subsidy will not be raised.

The total budget of the state aid equals EUR 150 million.

UK

The British NRA has been considering establishment of a subsidy for end users. Vast majority of the DTT end users will only need to retune their TV sets. However, some of the viewers will face the necessity to replace their aerial system – in total between 105 000 and 110 000 household are expected to replace their aerial because of the 700 MHz band clearance process. The estimation prepared by the Ofcom includes the cost of aerial replacement which range from GBP 3 million to GBP 6 million in total. The cost of each aerial replacement was estimated at GBP 150 on average. The cost is not the actual cost of the replacement but a value of bringing equipment replacement forward – there is an assumption that an average asset life is 25 years[12].

The abovementioned costs are the same regardless of whether they are met by consumers or through a grant scheme. The adoption of the subsidy depends on the decision taken by the British government – it is still under consideration. However, the calculation of the potential expenses is still valid.

3.2.2 Approach on the PMSE reassignment

Using the spectrum by the PMSE is usually licence-exempt. Nevertheless, before allocating the 700 MHz band to mobile services it is necessary to define what spectrum can be used by the PMSE devices owners. In principle, the technology can use guard bands and duplex gap in the 700 MHz band as well as it can be fully shifted below the 700 MHz band – the decision on the PMSE use depends on the national authorities policy.

The compensation mechanism for the PMSE equipment owners has been provided only in three EU countries: Germany, France and the UK. Brief information regarding the mechanisms is presented below.

Germany

In 2015 the German Federal Government and the federal states had decided to pay compensations to the PMSE equipment users who needed to switch to the sub 700 MHz band. Due to the 700 MHz band allocation to the IMT services, the PMSE devices owners had to bear the reassignment costs, which was compensated by the German authorities. The reimbursement envisaged two types of compensations.

Compensations for the PMSE devices that were bought between 1st January 2012 and 31st March 2015 were designed as follows:

- the granting authority compared the costs in the amount of the notional residual value with the alternative modernisation costs as part of an economic analysis;
- the amount of the compensation payment was determined by the lower value;

[11] State Aid SA.51079 (2018/N) – Spain Audiovisual broadcasting reception aid for multi-households buildings
[12] "Decision to make the 700 MHz band available for mobile data – statement", Ofcom, 19.11.2014

- if a modernisation was not possible, the amount of the compensation payment depended on the fictitious residual value.

The residual value was calculated based on an acquisition value and linear depreciation of 1/5 per year for the PMSE device (there was an assumption that the asset life equals 5 years). The acquisition value was calculated as the purchase price paid at the time of acquisition increased by an incidental acquisition cost premium of 10 percent of the purchase price.

There were also special provisions applied to applicants who owned the PMSE devices that were bought between 1st January 1997 and 31st March 2015 and:

- pursue charitable, benevolent or ecclesiastical purposes;
- are organized as a public corporation (including countries, municipalities, associations of municipalities and churches);
- are in full or predominant public ownership or financed entirely or predominantly from public funds.

The abovementioned organizations may have applied for the reimbursement which would cover:

- the modification costs up to the amount of the purchase price of comparable new equipment if the modification of the devices was possible;
- the notional residual value of the eligible devices, if the modification was not possible.

The calculation of the residual value in that case was based on an acquisition value of the device and linear depreciation. It was assumed that a useful life equals 20 years and begins in the acquisition year. The depreciation of devices that were bought before 2000 was calculated as they would have been bought in 2000.

Due to the unlimited use of the 694 to 790 MHz frequency band until 31 December 2016, the notional residual value for applications submitted before 1st January 2017 was calculated on the basis of the devices age on 31st December 2016[13].

France

The PMSE audio equipment in France was prohibited to use the 700 MHz band after 1st July 2019. In order to vacate the band, the PMSE devices that were operating in the band should have been replaced or reconfigured, if possible. French authorities estimated that about 25% of the PMSE equipment were operating in the 700 MHz.

Therefore, French authorities considered a reimbursement for the PMSE devices owners. The compensation mechanism was foreseen for any obsolete equipment acquired between 1st December 2011 and 20th June 2015. The French authorities explained that the communication on the reallocation schedule for the 700 MHz band began in December 2014 and that the information was relayed at the beginning of 2015 to professionals using PMSE audio equipment. For this reason, equipment acquired after 2014 was no longer taken into account. The aid was envisaged for the professionals, whose annual turnover excluding tax for the last financial year did not exceed EUR 40 million – the authorities had decided to support only the smallest market player. As a result, most of the television groups were excluded from the support.

Qualified entities had a right to claim for compensations. The reimbursement covered:

- a depreciated value, at the date of the application, of the equipment that has become obsolete;
- the cost of its reconfiguration capped by the depreciated value.

The amount of the aid provided for the equipment replacement was calculated according to the date of acquisition of the equipment and ranged between 36% and 60% of the price paid upon purchase – details are provided in Tab. 5.

Table 5. The amount of subsidy depending of the date of the PMSE devices acquisition

Time between the acquisition and the request for compensation	Refund rate applied
7-12 months	60%
13-18 moths	57%
19-24 months	54%
25-30 months	51%

[13] Bekanntmachung – Richtlinie über die Gewährung von Billigkeitsleistungen für Ausgleichszahlungen an Nutzer drahtloser Produktionsmittel („PMSE“) für aus der Umwidmung der Frequenzen im Frequenzbereich 694 bis 790 MHz resultierende Umstellungskosten (RL-UmstKoPMSE700) vom: 18.09.2015, BAnz AT 07.10.2015 B3

Time between the acquisition and the request for compensation	Refund rate applied
31-36 months	48%
37-42 months	45%
43-48 months	42%
49-52 months	39%
55-60 moths	36%

The amount of the aid provided for the equipment reconfiguration covered the cost incurred by the PMSE devices owners within the limit of the amount that would have been granted under the replacement.

The maximum amount of the aid for one beneficiary equalled EUR 50 000 – details are provided in Tab. 6.

Table 6. The amount of subsidy depending of the date of the PMSE devices acquisition

Time amount of costs resulting from replacement or reconfiguration	Maximum amount of funding
Total amount of costs ≤ EUR 50 000	EUR 5 000
50 000 EUR < Total amount of costs ≤ EUR 100 000	EUR 10 000
100 000 EUR < Total amount of costs ≤ EUR 200 000	EUR 20 000
200 000 EUR < Total amount of costs ≤ EUR 300 000	EUR 30 000
300 000 EUR < Total amount of costs	EUR 50 000

The overall funding was estimated at a maximum amount of EUR 10 million[14].

UK

The 700 MHz clearance timeline means that PMSE users will have to vacate the band by May 2022, 16 months before the end of the period of security of the band usage that was offered to the PMSE equipment owners. In lights of this the UK Government, as part of its funding for the 700 MHz clearance programme, has agreed to fund a grant scheme to support PMSE equipment owners whose 700 MHz equipment cannot be used after the clearance[15].

In order to estimate the value of cost of the PMSE equipment replacement, a survey was conducted which asked a selection of large hiring companies, theatres and other owners of the PMSE devices to provide information on: the tuning range of their equipment, the approximate value of their equipment, when they purchased it and when they intended to replace it. Moreover, third party professionals were hired to provide the same estimation. It was estimated that if the change happens in 2020, the cost will range between GBP 15-26 million or GBP 11-23 million depends on the source of data – the lower amount was calculated by the third-party. As a result of public consultations, it was estimated that the cost will be between GBP 13-21 million – it is a cost of bringing costs of replacement forward based on asset life provided by the users or in case the asset life is unknown, it is assumed that an average asset life is between 10 and 15 years[16].

In 2018 another public consultation regarding the topic were conducted[17]. Finally, the NRA has estimated that in order to compensate the residual value of the equipment that needed to be changed, the PMSE users have to receive at least 60% of the value of the estimated replacement cost of their equipment. Alongside the statement a rate card listing eligible PMSE equipment was published. The rate card consists of the list of devices that are to be replaced, the estimated value of the replacement as well as available reimbursement for each device. The list was prepared based on stakeholders inputs gathered during the public consultations[18].

3.2.3 Cross-border coordination

Cross-border coordination process is usually necessary for the 700 MHz band and the sub 700 MHz band. The agreements how the spectrum can be used in the border area are crucial matters to avoid potential

[14] SA.45084 (2016/N) – France Aide aux propriétaires d'équipements auxiliaires sonores de conception de programmes et de radiodiffusion à usage professionnel, 07.11.2016
[15] PMSE clearing the 700 MHz band – support for PMSE equipment owners, Ofcom, 13.12.2018
[16] "Decision to make the 700 MHz band available for mobile data – statement", Ofcom, 19.11.2014
[17] PMSE clearing the 700 MHz band – support for PMSE equipment owners, Ofcom, 23.08.2018
[18] PMSE clearing the 700 MHz band, PMSE equipment funding rate card, Ofcom, 13.12.2018

interferences. In the 700 MHz band the agreement has to be concluded regarding the use of the IMT services and co-existing technologies – e.g. in Russia the ARNS system uses 700 MHz band, so the use of the mobile services in the border area with Russia should be limited in order to avoid the problems with the navigation system used by Russia. For the sub 700 MHz band the agreements are related mostly to the coordination of the TV channels (DTT-DTT agreements).

According to the EC Decision 2016/687 all member states were obliged to conclude frequency cross-border coordination agreements with EU neighbouring countries by the end of 2017. During negotiations there have been observed minor issues regarding the spectrum allocation in the 700 MHz band and the sub 700 MHz – mostly related to technical aspects which were solved during the negotiations. Moreover, in order to accelerate the negotiations, the EU countries may have used the RSPG "Good Offices", where the RSPG is engaged to assist the countries in bilateral agreements.

It is worth to mention that some countries have also developed intermediate plans. Time discrepancies in the 700 MHz release process between EU countries exist which might lead to interferences in the border area during the transition period. Hence, there might occur some limitations in using the band by the IMT services during that period. In order to reduce or avoid them some countries has developed the plans for that period.

Conducting agreements with non-EU countries more likely requires complex negotiations. Main factor influencing the negotiations is the fact that in many non-EU countries (e.g. Russia, Turkey) the date of switching off the 700 MHz release has not been set yet and there is no decision regarding the use of mobile services in the band. Another factor might be that some countries like Cyprus and Turkey do not maintain political or partnership relations. Nevertheless, in most cases the cross-coordination process with non-EU has been finished. In case of problems, an assistance of the EC and meetings of the telecommunication groups like the Western European Digital Dividend Implementation Platform (WEDDIP) or the South European Digital Dividend Implementation Forum (SEDDIF) are leveraged in order to conduct mediations.

The summary of issues which might occur, and possible solutions are listed in Tab. 7. The detailed information on each country is provided in the Annex 2.

Table 7. Various issues that occurred during conducting negotiations on the cross-border coordination agreements

Issue	Description	Solutions
Occurrence of a transition period	Later switch off the DTT in neighbouring countries may cause interferences during the intermediate period	• Development of the plan for the transition period (e.g. Estonia and Latvia cooperate to clear Latvian TV channels 50-53 from border areas sooner to reduce the interference). • Implementation of limitations in using the band during the intermediate period.
Interference caused by the IMT services to the ARNS system	The ARNS system uses 700 MHz band in e.g. Russia.	• Conducting negotiations regarding development of cross-border coordination plans – all EU countries where there is the use of the ARNS in the border area, have signed the agreement considering ARNS-MFCN.
Interference caused by the DTT and ATV	In some non-EU countries, the deadline for switching off the ATT/DTT or releasing the 700 MHz has not been established yet.	• Conducting negotiations regarding development of cross-border coordination plans. • Finland have agreed to have some interference in the border area with Russia – limitations in using this band for MFCN in those areas, however the negotiations are still in process.
Difficult political situation	Some countries do not maintain political contact with their neighbouring countries. E.g. Cyprus faces interference problems due to illegal TV transmissions originating from the occupied areas of Cyprus, the territory which is not under the control of the Republic of Cyprus. What is more Turkey	• Request for assistance in negotiations to the EC and the ITU representatives.

Issue	Description	Solutions
	refuses any technical coordination discussions and coordination agreements with the Republic of Cyprus	
Minor problems	Initially there occurred some problems related to technical aspects of coordination plans (e.g. UK-Belgium).	• Request for assistance in negotiations to the EC or RSPG. • Leverage meetings of telecommunication working groups/platforms to accelerate negotiations

3.2.4 Conclusions

As can be seen, based on the conducted analysis of the EU countries approaches towards 700 MHz release, seven elements should be taken into account during shaping that process.

1 Law/regulations amendments

It is necessary to conduct analyses of the legislation in order to apply necessary modifications. Each country needs to investigate what law or regulations amendments are necessary in order to free up the band. In order to allocate the 700 MHz band to the IMT services, the modification of the national frequency table is almost always required – regarding the international regulations, the DTT has a right to the 700 MHz however the coexistence of the IMT and DTT technologies is virtually impossible. That is due to the interferences that two technologies cause to each other. Therefore, every country needs to change the national frequency allocation table in order to prohibit the usage of the band by the DTT. In some countries other law modifications are necessary in order to free up the band – for instance, the withdrawal of the licences might not be possible until the law amendments are applied.

The abovementioned analysis shall be provided on the national level.

2 Stakeholders identification

The analysis of what stakeholders should be engaged in the process is also needed. Key stakeholders that usually shall be involved in the release process are as follows:

- national governmental authorities (in order to change the law and current regulations),
- the NRA bodies (in order to monitor the process of the band release, grant licences etc.),
- key market players (in order to gather the information of the costs of refarming and assess, whether a compensation mechanism is needed).

Each EU country has carried on internal actions to identify the stakeholders.

3 Technology upgrade

EU countries have performed analyses whether the upgrade to the DVB-T2 technology is needed.

The release of the 700 MHz band from terrestrial television service providers reduces the spectrum available for television services. In that case, the upgrade of technology is sometimes required to increase the number of programs per MUX. If the upgrade is not necessary countries usually do not impose the obligation on the DTT operators. The EU countries approach is to permit the market to decide, whether to upgrade the technology. The development based on free market conditions is a preferred option within the European Union.

4 Compensations for the DTT service providers

Every EU country has made a decision on their compensation mechanism – whether it is needed or not. Most of the countries where the DTT licences termination is necessary have considered implementing the reimbursement. On the other hand, when the withdrawal of the licences is not required, there is usually no reimbursement.

Two main approaches on the calculation of compensation amounts for the DTT operators have been defined among the EU countries:

- calculation of the residual value of the equipment that is necessary to be replaced;
- calculation of the cost of the infrastructure replacement.

Calculation of the residual value was chosen by Germany. The rationale behind that approach is the fact that the majority of the equipment would otherwise have been replaced at the end of its useful life. Hence, the authorities of those countries have decided to choose that type of reimbursement.

Calculation of the cost of the replacement was chosen by France, Italy and Spain. This approach seems to be easier to implement because it is based on the costs incurred by the operators. In that approach there is no need to estimate average assets life or gain the information about their purchase value. That type of compensation might be also welcomed by the operators which are not obliged to incur the cost of bringing infrastructure replacement forward. However, it can be assumed that this kind of reimbursement may amount more than the amount of compensation calculated based on the residual value of the devices.

The decision what kind of compensation mechanism should be applied depends on the internal market situation analysis. Before applying the reimbursement, it should be examined whether the market players are capable of covering the costs related to the band clearance and what is the legal environment regarding licences withdrawal (whether the compensation is guaranteed by law). Taking into account those two factors it should be determined whether the compensation is necessary and what kind of approach should be chosen.

5 Compensations for end users

Among the EU countries there are usually information campaigns applied. The campaigns are intended to assure that the DTT end users would retune their receiving sets when it is needed.

Regarding the DTT end users it seems that information campaigns are sufficient to release the band without harm to their interests. However, under particular circumstances the implementation of the compensation mechanism should be analysed. Those are:

- technical migration from DVB-T to DVB-T2;
- a large number of households is affected by the spectrum release which results in the necessity of the infrastructure replacement.

If the technology upgrade is required, the national authorities should perform an analysis, whether disadvantaged families are capable of bearing the cost of new set-top boxes. A good practice is to support those families to prevent the DTT access termination which might be the main source of access to independent and diverse media for them.

Whether a large number of households needs an equipment replacement because of the band reassignment, it should be internally analysed if the compensation should be implemented. If so, based on Spanish case, it is a good approach to support the cheapest technical solution instead of funding the actual cost of replacement. This approach guarantees that there will no abuse of the financial support – the aid objective is to provide the access to the DTT not to fund the infrastructure modernisation.

6 Compensations for the PMSE equipment owners

Compensations for the PMSE equipment owners have been applied in Germany, France and the UK.

Based on those cases, a main approach on the calculation of compensation amounts for the PMSE service providers can be defined. It is a calculation of the residual value of the equipment that is necessary to be replaced. In that approach it is assumed that the equipment would otherwise have been replaced at the end of its useful life. When choosing that approach, it is essential to obtain information about devices life and purchase prices. Before applying the compensation mechanism for the PMSE equipment owners it should be determined which market players need the support – e.g. France limited the number of entities that may have applied for the support (only entities with annual turnover excluding tax not exceeding EUR 40 million).

The less common approach toward compensation amount calculation based on the cost of the infrastructure modernisation was partially implemented in Germany. However, it was dedicated mostly to entities supporting a public benefit or it was chosen in case the residual value was higher than the modernisation costs.

All in all, similar to the DTT compensation mechanism, before implementation of the subsidies it should be analysed if the PMSE devices owners are capable of funding the equipment replacement or modernisation and whether the compensation payment is not demanded by law. The performed analysis should define whether the reimbursement is needed and what kind of approach should be chosen.

7 Cross-border coordination agreements

Various approaches towards cross-border coordination process depending on the utilisation of 700 MHz in a neighbouring country among the EU countries have been distinguished:

- if the 700 MHz band is not used in a neighbouring country – there is no need for a transition period, the coordination of the sub 700 MHz is only necessary;
- there is a transition period because a neighbouring country release the 700 MHz later:
  - there might occur some interferences and limitations of the IMT usage during the transition period which the country accepts;

  - countries develop plan for the transition period (e.g. reassignment of the TV channels in the border area);
- a neighbouring country do not plan to release the 700 MHz band – negotiations are necessary.

In most cases the cross-border coordination process is based on partnership and willingness to negotiate.

It is worth to mention that for most EU countries the cross-border coordination is simplified because the deadline for the 700 MHz band release was set by the EC and every EU country is obliged to free up the band. However, in case problems occur, countries ask for the EC or another third parties assistance. Telecommunication working groups as well as ITU representatives are also leveraged to conduct agreements.

4 Analysis of EU countries approaches towards reassignment of 700 MHz

4.1 Spectrum harmonization

The EC Decision 2016/687 has established the harmonization of the 700 MHz band for mobile services (Figure 3.).

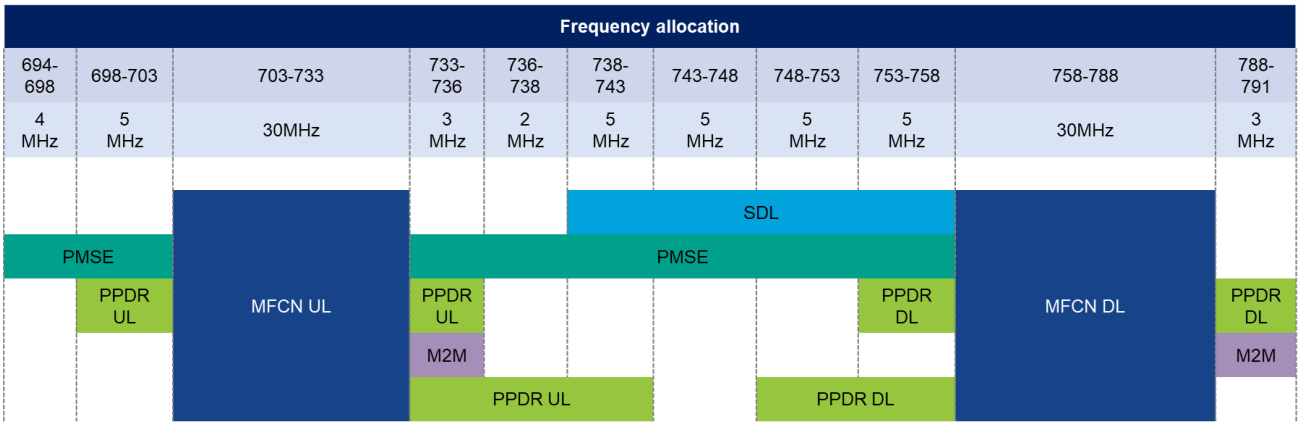


Figure 3. Harmonization of the 700 MHz band according to the EC Decision 2016/687

As described, there are several scenarios, how the EU countries may use the spectrum. There is one channelling arrangement for the MFCN: 703 MHz to 733 MHz UL and from 758 MHz and 788 MHz DL (FDD 2x30 MHz). Moreover, it is possible to implement a supplemental downlink using zero up to four of the following frequency blocks: 738-743 MHz, 743-748 MHz, 748-753 MHz and 753-758 MHz. This decision on the number of contiguous blocks would be taken at national level. This national approach ensures flexibility for combination with other alternative options described hereafter.

There has been also envisaged a possibility of coexistence of more than one technology in the 700 MHz band – apart from the mobile services:

- PMSE could use the guard band 694-703 MHz and the unused part of the duplex gap (733-758 MHz);
- PPDR can use both guard bands (694-703 MHz and 788-791 MHz) and the unused part of the duplex gap (733-758 MHz);
- M2M communications are being considered in the 733-736 MHz and 788-791 MHz spectrum blocks.

The implementation of above mentioned technologies is a national decision.

The decision regarding the spectrum harmonisation results in several scenarios of spectrum utilisation that EU countries have adopted or have been considering that are listed below:

- SDL:
  - Option 1 – SDL implemented in 700 MHz band: Bulgaria (15 MHz), France (15 MHz), Germany (15 MHz), Italy (15 MHz), Lithuania (15MHz), Romania (15 MHz), Slovenia (15 MHz), Sweden (20 MHz), Denmark (20 MHz), United Kingdom, Latvia;
  - Option 2 – no SDL: Austria, Belgium, Cyprus, Czech Republic, Finland, Hungary, Netherlands;
- PPDR:
  - Option 1 – PPDR (2x3 MHz and 2x5 MHz): Austria, Belgium, France, Hungary, Lithuania, Netherlands, Romania, Sweden;
  - Option 2 – PPDR (2x5 MHz): Bulgaria, Cyprus, France;
  - Option 3 – PPDR (2x3 MHz): Bulgaria, Cyprus, France;
  - Option 4 – no PPDR in the 700 MHz band: Italy, the UK.
- PMSE:
  - Option 1 – PMSE implemented in the 700 MHz: Italy (694-698 MHz and 736-738 MHz) and United Kingdom –(694-703MHz);
  - Option 2 – no PMSE in the 700 MHz band: Finland, Germany, Hungary, Ireland, Latvia, Lithuania, Luxembourg, Malta, Romania, Slovakia, Sweden.

As it has been pointed out, it is a national decision what technologies apart from the MFCN can be used in the 700 MHz band. However, as it might be seen, the most common scenario is implementation of the SDL in the duplex gap and the PPDR services in both guard bands as well as in the unused part of the duplex gap (see Figure 4).

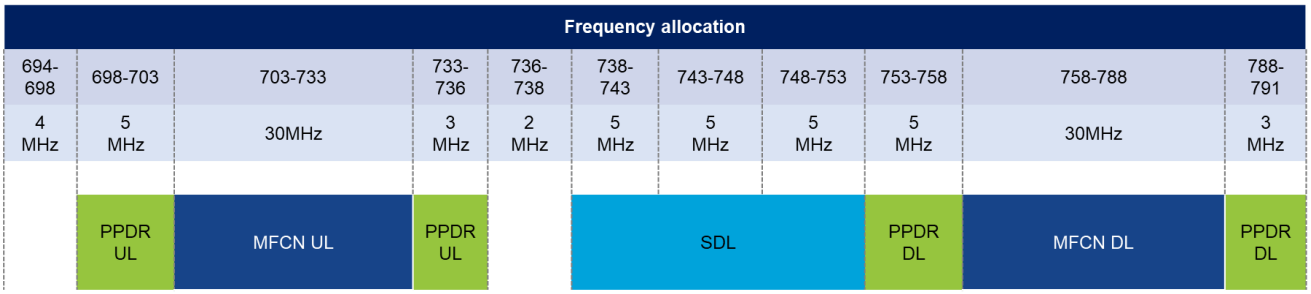


Figure 4. Harmonization of the 700 MHz in EU – the most common scenario

4.2 Spectrum authorization

As the 700 MHz band is being released, European countries are considering the granting of frequency licences. The design of the selection procedures for spectrum licences and the conditions attached to these licenses may have consequences on the structure of national mobile markets (either by enhancing competition or by limiting it). Therefore, it is essential to analyse thoroughly the award procedure, coverage obligations, spectrum caps etc.

All the award procedures in the EU are technology neutral which is consistent with the EU policy not to impose the obligation of 5G use – the governmental authorities have to create such conditions that operators will be eager to implement a new technology. What is more, the technology neutrality offers incentives for new entrants to enter the market – the entities are not obliged to deploy 5G, but they can use 4G technology instead and increase their share in the national mobile services market before 5G technology becomes widely available.

It is worth to highlight that in every EU country the 5G trials are possible – mostly in the 3.4-3.6 GHz band. The trials give the operators a possibility to test new technologies before obtaining a spectrum and making a decision of participation in the spectrum award mechanism.

The 700 MHz frequency band have been assigned to the mobile services in six EU countries so far: Denmark, Finland, France, Germany, Italy and Sweden. In each country the spectrum was awarded through the auction, however the competition measures, licence scope and characteristics as well as coverage obligations varied – see Tab. 8. The highest revenue of about EUR 2.8 billion has been achieved in France (Figure 5).

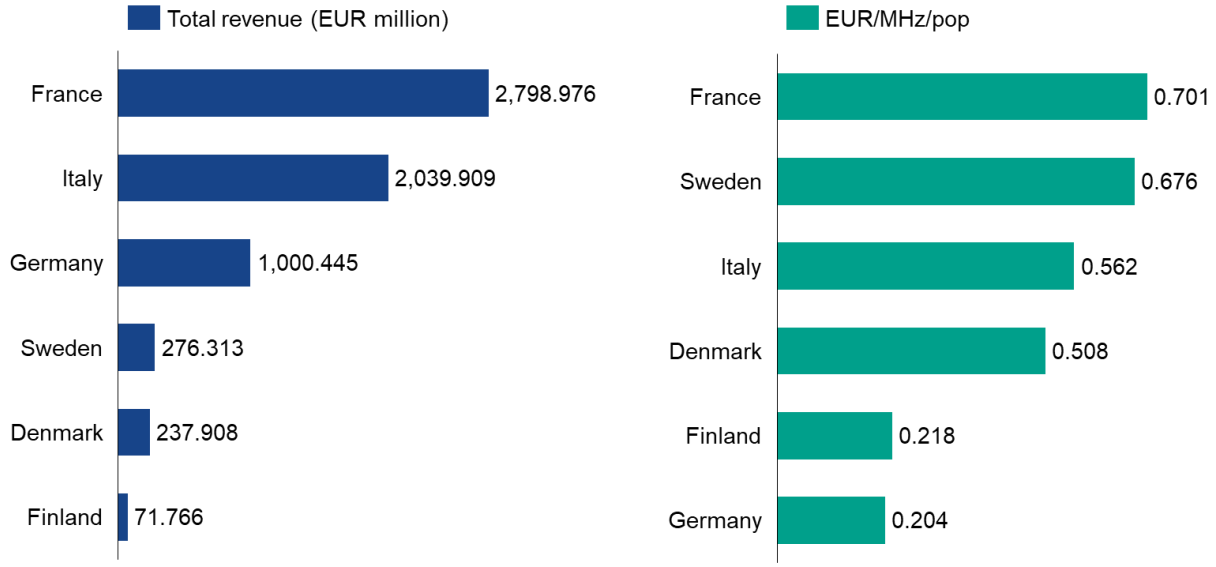


Figure 5. 700 MHz auctions revenues[19]

Selected approaches towards the spectrum authorization are presented below.

[19] Self-study based on the Analysys Mason spectrum auction tracker July 2019

4.2.1 Denmark

In Denmark there were conducted multiband auctions in 2019 (700, 900 and 2300 MHz). With the aim of improving mobile coverage in Denmark, the licences below 1 GHz were allocated with regional coverage obligations attached, where each operator is required to serve a different set of specific addresses with minimum speeds of 30 Mbit/s download and 3 Mbit/s upload as well as voice coverage by the end of April 2022. Those lots were available before the rest of the spectrum in an initial stage of the auctions under conditions of limited competition (each bidder was able to acquire at most one of these lots) and there was no minimum price for those lots. That was because of a broad political agreement regarding the use of coverage obligations in spectrum auctions – the national authorities have focused on mobile coverage improvement as much as possible relative to the value of the spectrum. Coverage obligations has to be applied to at least 98 % of the addresses specified in the licence. What is more the operators have a possibility to choose whether they prefer to fulfil the coverage obligation within the 700 MHz band or the 900 MHz band. Additionally, there were extra coverage requirements – the operators could make bids for a commitment to meet extra coverage obligations in exchange for a reduction in the licence price equals to the bid amount – accepted bids for additional coverage obligations would reduce the licence price for assigned spectrum. All in all, the Danish authorities focused on providing coverage in specified areas where the lack of the mobile coverage was defined[20].

Moreover, the Danish NRA added a mapping of mobile broadband coverage in all country to the website tjekditnet.dk where consumers and businesses can see their coverage locally and search for suppliers at the individual consumer or business address. The mapping of the mobile coverage ensures even more transparency for consumers and businesses. Among other relevant data, the mobile broadband mapping is a part of the underlying basis of the coverage analyses conducted and to be conducted.

4.2.2 Finland

The Finnish NRA conducted auctions of the 700 MHz band in 2016. The frequency was auctioned off as 2x5 MHz lots. The Finnish authorities decided to conduct auctions applying the Simultaneous Multiple Round Auctions model, which was used twice during previous spectrum auctions in 2009 and 2013. Moreover, the spectrum cap was set to 10 MHz FDD which guaranteed that the spectrum would be acquired by at least three entities. The objectives of the restriction were to prevent limitations on competition and concentrated control of the spectrum as well as to secure the future needs of the national mobile operators networks especially in rural areas (2x10 MHz may be effectively used to increase both capacity and speed of the existing network).

The reserve price was established in accordance with hammer prices in European auctions of similar frequencies (700 MHz and 800 MHz). The 700 MHz band and the 800 MHz band have similar technical properties – the 700 MHz has better penetration of building materials and broader base station coverage, however the differences are negligible. The facts that the 700 MHz band would be mainly used to add capacity to existing network was also taken into account when establishing the price as well as restrictions of the spectrum usage in the border area with Russia – 700 MHz is used by the ARNS technology in Russia, which has to be protected against the interference caused by the MFCN services. During the Finnish analysis it was defined that the average hammer price of 700 MHz and 800 MHz band auctions had been EUR 0.51 per MHz per person in the country's population within Europe which gave a starting price of EUR 28 million in Finland. However, in view of the abovementioned restrictions the reserve price was set at EUR 15 million for one frequency pair.

The licences period was set at 17 years (until the end of 2033). According to the Finnish regulations, licences may be issued up to twenty years. However, it was desirable that licences for the 700 MHz band would be valid until the same date as licences for the 800 MHz band – the 800 MHz licences have been granted for a period ending on 31st December 2033. That decision has enabled licences for several frequencies to be granted concurrently in the future.

The coverage obligation was set at 99% of population in mainland Finland by the end of 2019. It may seem high applied in as sparsely populated country as Finland. However, the coverage of the other frequency bands: 800 MHz, 1800 MHz and 2.6 GHz can be included in reaching the target. Since the 800 MHz networks have to cover a minimum of 97% of the population, the coverage requirement for the 700 MHz band is rather moderate to the existing operators[21].

4.2.3 France

[20] Auctions materials: https://ens.dk/en/our-responsibilities/spectrum/auctions.
[21] Ministry of Transport and Communications, Auction of the 700 MHz spectrum

The 700 MHz auctions in France were conducted in 2015. There were four mobile networks operators which were interested in obtaining the spectrum. One of them (Free Mobile) was not granted with the 800 MHz spectrum. Thus, the French NRA was considering how to mitigate the risk of a squeeze-out strategy that may have been applied by other operators that had licences within the 800 MHz band. Hence, two spectrum caps were established:

- maximum 2×15 MHz (3 blocks) per candidate in the 700 MHz band;
- maximum 2×15 MHz (3 blocks) per candidate in the 700 MHz, 800 MHz and 900 MHz band (below 1 GHz).

Taking into account the spectrum caps Free mobile was able to acquire 3 blocks and the other operators maximum 2 blocks each. In the end, Orange and Free mobile obtained 2x10 MHz and the other two operators 2x5 MHz[22].

Coverage obligations were as high as those in the 800 MHz band. The national authorities have put emphasis on coverage in the rural areas to improve the quality of the services in those areas where frequencies above 1 GHz are less suitable. Improving mobile data access on the national railway network has been also highlighted as a priority. The coverage obligations are presented in Tab. 8[23].

Table 8. Summary of coverage obligations in France

Obligation	Licence delivery date + 5 years (late 2020)	17th January 2022	17th January 2027	Licence delivery date + 15 years
Metropolitan population	-	-	98%	99,6%
Main roads	-	-	-	100%
Population in each metropolitan department	-	-	90%	95%
Population in the “priority deployment zone” (18% of population, 63% of territory)	-	-	92%	97,7%
Municipalities in the white zones program (1% of population, 3300 municipalities)	-	-	100%	-
Regional rail roads: nationwide coverage	-	60%	80%	90%
Regional rail roads: coverage in each region	-	-	60%	80%

4.2.4 Germany

In Germany multiband auctions of 700 MHz, 900 MHz, 1800 MHz and additional spectrum in the 1452 to 1492 MHz took place in 2017. A spectrum cap was set within the 900 MHz band, however it was not applied in the 700 MHz band.

A reserve price equalled EUR 75 million (~0.093 EUR/MHz/pop). The amount had been established based on the Frequency Fees Ordinance (FGebV – Frequenzgebührenverordnung) which is an official national document where the exact charges for the spectrum are listed.

The coverage obligation was assigned to the whole spectrum. Each licence holder has to ensure nationwide broadband coverage of the population with a minimum transmission rate of 50 Mbit/s per antenna sector. Within three years of the award of spectrum, each licence holder must provide coverage of a minimum of 97% of households in each federal state and a minimum of 98% nationwide. Full coverage must be ensured for the

[22] Décision n° 2015-1454 de l’Autorité de régulation des communications électroniques et des postes en date du 24 novembre 2015 relative au compte rendu et au résultat de la procédure d’attribution d’autorisations d’utilisation de fréquences dans la bande 700 MHz en France métropolitaine pour établir et exploiter un réseau radioélectrique mobile ouvert au public

[23] Projet de décision de l'ARCEP proposant au minister chargé des communications électroniques les modalités et les conditions d'attribution d'autorisations d'utilisation de fréquences dans la bande 700 MHz en France métropolitaine pour établir et exploiter un réseau radioélectrique mobile ouvert au public

main transport routes (national highways and high speed railway lines). The telecommunication operators may collaborate and lease frequencies in order to fulfil the requirements.

The coverage obligations are not so high for new market entrants. They are obliged to cover at least 25% of the population from 1st January 2021 and at least 50% of the population from 1st January 2023.

Each licence holder has to provide evidence to the NRA that the coverage obligation is met through appropriate simulations and the NRA might check the provided information using appropriate measurement methods[24].

4.2.5 Italy

Multiband auctions of 700 MHz, 3.6-3.8 GHz and 26 GHz finished in 2018. The lots of 5 MHz (paired) were auctioned within the 700 MHz band. Licences for the 700 MHz are valid 15.5 years, starting in mid-2022. The proposed duration of the licences has been considered to be an appropriate time for the development of the new 5G technologies as well as to ensure a good Return of Investment (ROI) index to the mobile operators.

A reserve price for the 700 MHz band was established starting from the reserve price of the 800 MHz spectrum awarded in 2011, proportionally adjusted by considering the amount of spectrum and the licence period, and incremented by a factor up to 5% - it equals about EUR 338 million per block. The minimum price of the lot reserved to new entrants was determined by the sum of the reserve prices of the component blocks

After analyses and public consultations, the domestic authority has decided to impose intra-band cap equals 2x15 MHz within the 700 MHz band and inter-band cap equals 2x30 MHz for all frequencies below 1 GHz that the mobile network operator has acquired. It was defined that those spectrum caps are sufficient to guarantee balanced market competition. To give a possibility for a potential new market entrant to join the market two lots of 5 MHz were pre-auctioned to new entrants or “remedy taker”– it was taken by Iliad Italia. The interests of the new entrant have been safeguarded by a right to a national roaming – existing mobile operators that won spectrum in the 700 MHz (FDD) band have been obliged to offer national roaming on their 700 MHz, 800 MHz and 900 MHZ networks to the new market player for:

- 2.5 years in the entire national territory;
- 5 years in the areas not covered by the new operator.

The new entrant has the right to national roaming only if it has launched commercial service and covered at least 10% of the population with its own frequencies.

There were also coverage obligations imposed. The existing operators have been obliged to use the awarded spectrum in all national provinces within 3 years starting from the availability of the frequency. Other individual coverage obligations are listed below:

- 80% of the population must be provided with 5G services (eMBB, URLLC, mMTC), within 3 years from the availability of the spectrum (4 years for the new operator) – coverage must include communes with more than 30 000 people and the main town in every province, in case of the eMBB services the minimum download speed of 30 Mbit/s must be ensured;
- certain number of touristic locations must be provided with the 5G services within 4 years from the availability of the spectrum. The ministry will define the touristic areas to be covered within 2 years from the assignment. (max 2400 areas for all operators).

The collective coverage obligations within the 700 MHz band have been also established. According to those obligations 99.4% of the population must be provided with the 5G services within 4.5 years from the availability of the band – coverage must include at least 90% of the population of each of 120 communes identified as “deep digital divide” area. It is worth to mention that roaming and spectrum pooling is permitted. The principal national roads and railways through reciprocal agreements must be covered with the 5G services within 3.5 years from the availability of spectrum (e.g. motorways, high speed railways, ports and airports). The coverage

[24] Mobile Broadband – Project 2016 <https://www.bundesnetzagentur.de/EN/Areas/Telecommunications/Companies/FrequencyManagement/ElectronicCommunicationsServices/MobileBroadbandProject2016/project2016_node.html>

must include transport corridors specified at the EU level. If abovementioned obligations are not respected, the right of the spectrum use may be revoked[25,26,27,28].

4.2.6 Sweden

In Sweden, single band auctions of 700 MHz (FDD and SDL) took place in December 2018. The spectrum was obtained by two market players: Telia and Net4Mobility (a joint venture of two operators: Tele2 and Telenor). Telia took two lots of 10 MHz with coverage obligations. Net4Mobility obtained two licences of 5 MHz with no coverage obligations.

Before setting the auction rules the Swedish regulator had analysed the situation regarding mobile services within the country. According the PTS Swedish Spectrum Strategy document[29] a strong emphasis during assigning the spectrum shall be placed on a societal cost-benefit analysis. Moreover, the authorisation procedure prioritises preserving or improving competition and coverage. The assignment is also about ensuring that the common spectrum resource yields the corresponding value for the general public. Based on the internal analysis and the Spectrum Strategy the regulator has decided to improve coverage that would enable the use of different applications in areas where people normally stay or travel through, but where there is no coverage at all (today and probably also at the time of assignment) or where coverage and capacity do not correspond to user demand regarding basic mobile communication with a data rate of at least 10 Mbit/s. In order to achieve the purpose, the Swedish regulator had prepared the coverage mapping of 10 Mbit/s within the country, defined the areas with the lack of coverage and set a coverage obligation associated with two lots of 10 MHz within the 700 MHz.

The coverage requirement was specified in the following way: the bidder who obtained a licence associated with a coverage requirement was obliged to cover a selection of the prioritised areas chosen independently by the licence holder, until the coverage requirement amount had been exhausted. The amount was set to EUR 30 million. It has to be used to deploy new mast sites. The coverage obligation has to be completely fulfilled no later than 2024. A gradual deployment will take place:

- 31st December 2021: 25 % of the amount for prioritised areas;
- 31st December 2022: 50 % of the amount for prioritised areas;
- 31st December 2023: 75 % of the amount for prioritised areas;
- 31st December 2024: 100 % of the amount for prioritised areas.

To ensure that the schedule is followed, the NRA intends to request reports from the operator at regular intervals with regard to the deployment plans on which the coverage requirement deployment will be based.

Based on an overall assessment of demand, commercial life span, technological development and investment period, the NRA assessed that 20-25 years could be considered as a well-balanced term of licence for the 700 MHz band. It was assumed that it is a sufficiently long period to create a real demand, and for an undertaking to get a return on operators investments. At the same time, a term of licence of 20-25 years was believed to be a sufficiently short period for a possibly limited commercial life span and an expected accelerating technological development. The period of validity was also calculated to spread out the licence expiry dates for mobile broadband operating in different frequency bands. Finally, it has been established that the licences will be valid until the end of 2040[30].

The NRA had also considered the measures related to competition such as a spectrum cap. It was established that there was no imbalance between main operators in spectrum holdings, however a cap of 40MHz per operator had been set to ensure that at least two players have access to frequencies.

[25] The Italian approach to the licensing of spectrum in 5G pioneer bands, 27.08.2019
[26] Regulation and award of 5G pioneer bands in Italy, ITU Forum TU Forum “Towards 5G Enabled Gigabit Society”, 11.10.2018
[27] “The Agcom’s regulation for the award and the use of the 700 MHz, 3.6-3.8 GHz and 26.5-27.5 GHz bands to foster the transition to 5G technology”, Joint EMERG-BEREC workshop on the “5G regulation”, 16.01.2019
[28] DELIBERA N. 231/18/CONS PROCEDURE PER L’ASSEGNAZIONE E REGOLE PER L’UTILIZZO DELLE FREQUENZE DISPONIBILI NELLE BANDE 694-790 MHz, 3600-3800 MHz e 26.5-27.5 GHz PER SISTEMI TERRESTRI DI COMUNICAZIONI ELETTRONICHE AL FINE DI FAVORIRE LA TRANSIZIONE VERSO LA TECNOLOGIA 5G, AI SENSI DELLA LEGGE 27 DICEMBRE 2017, N. 205
[29] PTS Swedish Spectrum Strategy, 15.04.2014
[30] Consultation regarding assignment of licences in the 700 MHz band, consultation from 31st January 2018 to 23rd February 2018

Table 9. Summary of conducted 700 MHz auctions in the EU

Country	Date	Spectrum bands	Duration of the licences	Block size	Competition measures	Coverage obligations
Denmark	Mar 2019	**Multiband auctions:** 700/900/ 2300 MHz	20 years (until 2040)	2x5 MHz	**Spectrum cap**: n/a **Reserve price:** EUR 12.7 million per block (2x5 MH)	**Geographical coverage obligations:** • 98% of areas specified in the licence shall be covered with a bit rate of 30 Mbit/s and an upload bit rate of 3 Mbit/s. **Additional information:** There are coverage obligations applied to lots available in the initial phase of auctions related to the 700 MHz or 900 MHz bands where operators are required to provide an outdoor mobile voice service. The coverage obligation applies in the coverage areas specified in the licence, and in each individual coverage area at least 98% of the area shall be covered.
Finland	Nov 2016	**Single band auctions**: 700 MHz	15 years (until 2033)	2x5 MHz	**Spectrum cap**: 2x10 MHz **Reserve price**: EUR 15 million per block (2x5 MHz)	**Population coverage obligations:** • 99% of the population of mainland Finland within 3 years of the start of the license period. **Additional information:** Licensees have to cover 99% of the population of mainland Finland within three years of the start of the license period (all the main roads, secondary roads, regional roads and slip roads in mainland Finland and Finland's entire rail network must be covered). The coverage of the other frequency bands: 800 MHz, 1800 MHz and 2.6 GHz can be included in reaching the target
France	Dec 2015	**Single band auctions**: 700 MHz	20 years	2x5 MHz	**Spectrum cap:** • 2x10 for MNOs with 800MHz licences • 2x15 for other operators **Reserve price:** EUR 416 million per block (2x5 MHz)	**Geographical coverage obligations:** • 100% of France's primary road network by 2030. • 90% of France's railway network by 2030. • 80% of French regional rail roads in each region by 2030. **Population coverage obligations:** • 99.6% of the metropolitan population, excluding overseas territories by 2030. • 95% of the population in each local administrative area by 2030. • 97.7% of population in the "priority deployment zone" (18% of population, 63% of territory) specified in the licences by 2030.

Country	Date	Spectrum bands	Duration of the licences	Block size	Competition measures	Coverage obligations
Germany	Jun 2017	**Multiband auctions:** 700/900/ 1400SDL/1800 MHz	15 years (until 2033)	2x5 MHz	**Spectrum cap:** no spectrum cap for 700 MHz **Reserve price:** EUR 75 million per block (2x5 MHz)	**Geographical coverage obligations:** • 100% coverage for the main transport routes (national highways and high speed railway lines) – not applicable for new market entrants within 3 years from the award of the spectrum. **Population coverage obligations:** • minimum of 97% of households in each federal state and a minimum of 98% nationwide within 3 years from the award of the spectrum. • 25% of the population from 1st January 2021 and at least 50% of the population from 1st January 2023 – only applicable for new market entrants. **Additional information:** • Coverage obligations were imposed but not onto a specific band. • The telecommunication operators may collaborate and lease frequencies in order to fulfil the requirements.
Italy	Oct 2018	**Multiband auctions:** 700 MHz/ 3.5 GHz/ 26 GHz	15.5 years (until 2037)	2x5 MHz	**Spectrum cap:** • intra-band cap: 2x15 MHz • Inter-band cap: 2x30 MHz (including 800 MHz and 900 MHz) **Reserve price:** EUR 338 million per block (2x5 MHz)	**Geographical coverage obligations:** • 100% of touristic locations must be provided with the 5G services within 4 years from the availability of the spectrum the ministry will define the touristic areas to be covered within 2 years from the assignment. (max 2400 areas for all operators). • 100% of main national roads and rail transport routes as well as main sea and airports specified by the NRA within 3.5 years – a collective obligation **Population coverage obligations:** • 80% of population (must include all municipalities with population >30k) with a DL speed of at least 30Mbit/s within 3 years (new entrants have extra 12 months). • 99.4% of population 4.5 years – a collective obligation.
Sweden	Dec 2018	**Single band auctions**: 700 MHz (FDD and SDL)	22 years	2x5 MHz 5 MHz SDL	**Spectrum cap:** 40 MHz both SDL and FDD) **Reserve price:**	**Geographical coverage obligations:** • Deployment of new masts sites in a selection of the prioritised areas chosen independently by the licence holder.

Country	Date	Spectrum bands	Duration of the licences	Block size	Competition measures	Coverage obligations
					• FDD: EUR 9.24 million per lock (2x5 MHz), • SDL: EUR 4.62 million per block (5 MHz)	**Additional information:** • Coverage obligation was applied to one lot. • The bidder who obtained a licence associated with a coverage requirement was obliged to cover a selection of the prioritised areas chosen independently by the licence holder, until the coverage requirement amount had been exhausted. The amount was set to EUR 30 million. It has to be used to deploy new mast sites. The coverage obligation has to be completely fulfilled no later than 2024.

Other EU countries have been considering conducting auctions – the summary of their plans is described in Tab. 10.

Table 10. Summary the plans regarding 700 MHz auctions in the EU

Country	Date	Spectrum bands	Duration of the licences	Block size	Competition measures	Coverage obligations and additional information
Belgium	Not before 2020	**Single band auctions**: 700 MHz	20 years	2x5 MHz	**Spectrum cap:** n/a **Reserve price:** EUR 20 million per one lot	To be defined
Czech Republic	Jun 2020	**Multiband auctions:** 700/3400 MHz	15 years	2x5 MHz	**Spectrum cap**: 2x10 MHz (one block will be reserved for a new market entrant) **Reserve price:** n/a	**Geographical coverage obligations:** • 95% of the areas specified by the NRA within 7 years from spectrum assignment. • 95% of main roads and railway corridors within 7 years from spectrum assignment. **Population coverage obligations:** • 95% of inhabitants within 7 years from spectrum assignment. • 99% of inhabitants for defined areas within 7 years from spectrum assignment. **Additional information**: Existing MNO will be obliged to offer national roaming to the new entrant under regulated conditions. All 700 MHz licensees will have to offer wholesale access to MVNOs under regulated conditions.
Hungary	Q4 2019	**Multiband auctions**	15 years	2x5 MHz	**Spectrum cap:** n/a	**Geographical obligations**: Coverage obligations(collectively):

Country	Date	Spectrum bands	Duration of the licences	Block size	Competition measures	Coverage obligations and additional information
					Reserve price: EUR 15 million per block	• 90% of main: rail routes, road traffic roads, inland waterways, bike paths by the end of October 2025 – a collective obligation. **Population obligations:** • 80% of households within particular cities by the end of 2023.
Lithuania	Mid-2022	**Single band auctions**: 700 MHz	15 years	2x5 MHz	**Spectrum cap:** 2x10 MHz **Reserve price:** n/a	**Additional information:** There is a coverage and speed obligation associated with every band, which specifies mandatory levels of coverage at 3 and 5 years after the licenses start, at which time license owners must offer a commercial service to the covered areas (some areas may be excluded in case no cross-coordination agreement with Russia is signed).
Ireland	TBD	**Multiband auctions**	15 years	2x5 MHz	**Spectrum cap**: 2x35 MHz (taking into consideration existing holdings in the 800 MHz and 900 MHz bands) **Reserve price:** EUR 17 million	**Geographical coverage obligations:** • Outdoor coverage services equal 30 Mbit/s for 75%, 85% and 90% of motorways in 3, 5 and 7 years respectively. • Outdoor coverage services equal 30 Mbit/s for 60%, 75% and 80% of primary roads in 3, 5 and 7 years respectively. • Outdoor coverage services equal 3 Mbit/s for 90%, 91% and 92% of the geographic area in 3, 5 and 7 years respectively. • Outdoor coverage services equal 30 Mbit/s for 70%, 90% and 100% of the special locations like schools, airports, hospitals etc. in 3, 5 and 7 years respectively. **Population coverage obligations:** • Outdoor coverage services equal 30 Mbit/s for 85%, 92% and 95% of the population in 3, 5 and 7 years respectively. • Outdoor coverage services equal 3 Mbit/s for 99%, 99% and 99% of the population in 3, 5 and 7 years respectively. • For new entrants: outdoor coverage services equal 30 Mbit/s for 75%, 85% and 90% of the population in 3, 5 and 7 years respectively.
Luxembourg	Jun 2020	**Single band auctions:** 700 MHz	15 years (with a possibility to extent for at least	2x5 MHz	**Spectrum cap:** n/a **Reserve price:** n/a	**Geographical coverage obligations:** • 50% of the national territory no later than 31st December 2022; • 90% of the national territory no later than 31st December 2024.

Country	Date	Spectrum bands	Duration of the licences	Block size	Competition measures	Coverage obligations and additional information
			once for the next 5 years)			**Additional information:** The operators will be obliged to provide a report regarding the fulfilment of the abovementioned obligations at least once every six months (the first report should be delivered before 1st January 2021).
Netherlands	Q1 2020	**Multiband auctions:** 700/1400/2100 MHz	TBD	D	**Spectrum cap:** • 40% cap on total spectrum possession • 40% cap on possession of frequencies lower than 1 GHz **Reserve price**: n/a	**Geographical coverage obligations:** • 98% of the surface area of each Dutch municipality must have coverage with a minimum speed of 8 Mbit/s and 10 Mbit/s within 2 years and 8 years after granting the licence respectively.
UK	Q4 2019	**Multiband auctions:** 700 MHz and 3.4-3.6 GHz	TBD	D	**Spectrum cap:** n/a **Reserve price:** n/a	**Geographical coverage obligations:** • 90% of the UK landmass including at least 90% of England, 90% of Northern Ireland, 74% of Scotland and 83% of Wales shall be provided with a good quality mobile service outdoors. • 140,000 premises to which it currently does not provide good coverage shall be provided with a good quality mobile service outdoors. • 500 new wide-area mobile sites shall be deployed.

4.3 Conclusions

It is plain to see, based on the conducted analysis of the EU countries approaches towards 700 MHz authorisation, that 700 MHz auctions scheme in the EU-28 consists of five main elements.

1 Duration of licenses

The licences duration is from 15 up to 22 years. Eight out of fourteen countries which have made decisions regarding the licences duration have chosen that licences should be valid for 15 years.

When establishing the licence duration, the authorities are mainly focused on providing security and predictability of the investment for current operators and new market entrants as well as reflecting technology life cycle and enabling the emergence of new innovation models and new ecosystems. Moreover, they take into consideration the current licences expiration date. The authorities also asses the demand for the spectrum as well as national market environment.

All in all, most of the EU countries have decided to set the duration of the licence of 15 years.

2 Spectrum blocks

There lots of size equals 2x5 MHz. Twelve out of fourteen EU countries which have made decisions regarding the size of a block have established that spectrum block should be the size of 2x5 MHz. The size is the minimum size which has been defined in the EC Decision 2016/687: "[…]the assigned block sizes shall be in multiples of 5 MHz".

3 Reserve prices

Seven countries have established a reserve price. Prices varies from EUR 9.2 million in Sweden up to EUR 75 million in Germany per a block of spectrum (2x5 MHz). The reserve prices among the EU countries varies and have been set based on the internal analyses conducted by the national authorities.

It is worth to mention that the final price paid by the operators is sometimes several times higher than the reserve price however it is not a common scenario (see Tab. 11).

Table 11. Percentage of reserve price paid by countries

Country	Percentage of reserve price paid
Finland	100%
France	112%
Germany	218-229%
Italy	101%
Sweden	691-721%

4 Spectrum caps

Eleven countries have established spectrum caps. Some countries decided to establish the cap only within the 700 MHz band (e.g. 2x10 MHz or 2x15 MHz). France have decided to establish two caps: for new entrants on the market (2x15 MHz) and for those operators which hold spectrum in other bands. Sweden, Italy and the Netherlands defined the spectrum caps for whole spectrum below 1 GHz.

The main reason for not establishing the cap is when demand for the spectrum is low and there are not many telecommunication operators in the country. However, when the competition on the market is high, the EU authorities usually decide to set the spectrum cap.

5 Coverage obligations

Coverage obligations specify mandatory levels of coverage that operators must ensure in particular time limits after obtaining a licence. Specific download and upload bit rates are sometimes imposed. The main objective within the EU is to cover all urban areas and major terrestrial transport paths as well as air and seaports – in order to guarantee the deployment of 5G corridors across Europe which are necessary to develop for instance an autonomous cars technology or smart cities.

Additionally, each EU country establish its own coverage obligations that align with the EU policy and impose some country-specific obligations.

It depends on the country internal situation, whether the authorities impose a general coverage obligation or areas obligations. The authorities who have chosen to impose obligations to provide the mobile coverage to remote areas usually determine the locations where the service has to be to be provided. That kind of obligations

are usually established in countries where there is a low density of population (e.g. Sweden) or where there are remote areas with lack of coverage (e.g. Denmark).

Annex 1

Table 12. Various approaches towards the DTT reassignment in the EU

Country	Approach	Compensations	DVB-T2 upgrade
Austria	Terminate licences	**Yes** The maximum amount dedicated for financing the 700 MHz licenses termination is EUR 3.55 million (costs of transmission infrastructure modifications according to necessary changes of frequencies and the cost of information campaigns to inform the audience).	**Migration is not necessary to release 700 MHz** 5 nationwide terrestrial TV MUXs and the most important regional MUXs have finished the migration to DVB-T2.
Belgium	Terminate licences	**Not decided yet** A royal decree related to the 700 MHz clearance process provides compensations for broadcasters, however the final decision regarding the compensation has not been made yet.	**Migration is not necessary to release 700 MHz** Both DVB-T and DVB-T2 standards are used.
Bulgaria	Terminate licences	**Not decided yet**	**Migration is not necessary to release 700 MHz** The upgrade might be chosen by the operators.
Croatia	Wait until expiration date	**No** Possible compensation mechanism was considered within the scope of the working group for the national Strategy of broadcasting transition to DVB-T2 system and assignment of the 700 MHz band, however it was not implemented.	**Migration is not necessary to release 700 MHz**
Cyprus	Terminate licences	**Not decided yet** The plan is to modify the current license granting new frequencies below the 700 MHz and compensate the providers accordingly. The amount of the compensation has not yet been determined, however it should be based on the cost of the infrastructure modification and the cost of the awareness campaign.	**Migration is not necessary to release 700 MHz**
Czech Republic	Terminate licences	**Not decided yet**	**Migration is necessary to release 700MHz.** The transition means to stop DVB-T transmission from particular transmitters, retune them, start DVB-T2 transmission on final frequency channel and stop simulcast transmission from the same location. The process has to be fully synchronized to allow exchange frequencies between networks.

Country	Approach	Compensations	DVB-T2 upgrade
Denmark	Wait until expiration date	**No** No compensation mechanisms will be used in the 700MHz band transition process.	**Migration is not necessary to release 700 MHz** Both DVB-T and DVB-T2 standards are used.
Estonia	n/a	**n/a**	**Migration is not necessary to release 700 MHz** Both DVB-T and DVB-T2 standards are used.
Finland	Wait until expiration date	**No**	**Migration was not necessary to release 700 MHz** Transition to DVB-T2/MPEG-4 will happen on 1st April 2020 (not related to the 700 MHz reassignment).
France	Terminate licences	**Yes** Compensation mechanism using the Spectrum Refarming Fund was implemented. The total calculated amount of the reimbursement equalled EUR 67 million (see section "Approach on the DTT reassignment" for details).	**Migration was not necessary to release 700 MHz**
Germany	Terminate licences	**Yes** Compensation for DTT network upgrade has been used. The German authorities have provided EUR 50 million for the reimbursement. Additionally, the licences were shifted below the 700 MHz band (see section "Approach on the DTT reassignment" for details).	**Migration was not necessary to release 700 MHz** However, it was connected with the change from DVB-T to DVB-T2.
Greece	Terminate licences	**Yes** The individual licenses of the private network providers include compensation in case of the reduction of the awarded spectrum.	**Migration is necessary to release 700 MHz** An evolution of the DTT platform is required in order to release the 700MHz band. This evolution depends mainly on the final number of TV programs and national security issues, which is still to be decided.
Hungary	Wait until expiration date	**No**	**Migration is not necessary to release 700 MHz** However, the evolution of the DTT platform is expected.
Ireland	Wait until expiration date	**Not decided yet** Based on analysis conducted by the independent consultant engaged by the NRA, it was calculated that the migration below 700 MHz could amount to EUR 8.6 million (it is the compensation amount).	**Migration is not necessary to release 700 MHz** Ireland will continue to use DVB-T and MPEG-4.
Italy	Terminate licences	**Yes** The amount of the compensation for the local broadcasters and national broadcasters equals EUR 304.2 million and EUR 276.3 million	**Migration is necessary to release 700 MHz**

Country	Approach	Compensations	DVB-T2 upgrade
		respectively. The 2018 budget law foresaw a compensation mechanism for the withdraw of the right of uses for the local operators and compensation regarding the change of technologies from DVB-T1 to DVB-T2 for national TV broadcasting company (see section “Approach on the DTT reassignment” for details).	
Latvia	Wait until expiration date	**No**	**Migration is not necessary to release 700 MHz**
Lithuania	Wait until expiration date	**Yes** Lithuania plans to replace licenses of channels of 700 MHz band to channels below 694 MHz. Owners of the licenses will retain channels below 700 MHz. No compensation mechanisms are envisaged, however public awareness campaign on clearance of 700 MHz band from TV broadcasting will be organized at the expense of the state budget.	**Migration is not necessary to release 700 MHz**
Luxembourg	n/a There was no DTT	**n/a**	**n/a**
Malta	n/a	**Not decided yet**	**Migration is not necessary to release 700 MHz** In accordance with the national roadmap the DTT platforms will be evolving towards newer generations of broadcasting and encoding standards such as DVB-T2 and MPEG-4. This evolution is not affecting the release of the 700 MHz band.
Netherlands	Wait until expiration date	**Yes** One DTT operator got spectrum without any charges in order to migrate the DTT technology to the sub-700 MHz band (see section “Approach on the DTT reassignment” for details).	**Migration is not necessary to release 700 MHz**
Poland	Terminate licences	**Not decided yet** Plan is under development	**Migration is not necessary to release 700 MHz** However, the technology upgrade is planned.
Portugal	Terminate licences	**Not decided yet** There is an idea to use an amount from the auction revenues to cover all the network costs associated with the DTT migration as well as	**Migration is not necessary to release 700 MHz** However, the technology upgrade is being considered and it may use compensations (additional cost of about EUR 60 million).

Country	Approach	Compensations	DVB-T2 upgrade
		costs associated with user support and provision of public information on the changes.	
Romania	n/a No DTT in 700 MHz	**n/a**	**n/a**
Slovakia	Terminate licences	**Yes** Based on Slovakian law, there are mentioned rules to apply request for "Appropriate compensation of costs resulting from a change to an individual authorization". However, there have not been received any requests from operators so far.	**Migration is not necessary to release 700 MHz**
Slovenia	n/a Migration completed	**No**	**Migration was not necessary to release 700 MHz**
Spain	Terminate licences	**Yes** The Spanish authorities estimates that 23 high-power transmitters (>10kW) and 1 120 low-power transmitters (<10kW) need to change equipment which results in about EUR 10 million of the reimbursement in total. The subsidy will be provided to private broadcasting service providers holding a licence (public broadcasters are excluded from the subsidy) – see section “Approach on the DTT reassignment” for details.	**Migration is not necessary to release 700 MHz** However, the evolution of the DTT platform is expected.
Sweden	Wait until expiration date	**No**	**Migration was not necessary to release 700 MHz** Both DVB-T and DVB-T2 standards are used.
UK	Terminate licences	**Not decided yet** DTT services providers are able to seek funding for their necessary costs of moving to alternative spectrum. The recent estimation shows that the cost amount ranges from GBP 420 million to GBP 470 million. The cost of bringing equipment replacement forward, rather than the full cost of the equipment replacement was adopted for this cost calculation (see section “Approach on the DTT reassignment” for details).	**Migration is not necessary to release 700 MHz**

Sources: EY questionnaire, roadmaps of the EU countries, Answers to the RSPG questionnaire

Annex 2

Table 13. 700 MHz band release process (external)

Country	Coordination plans with neighbouring countries for the clearance of the 700 MHz band	Problems related to cross-country negotiations
Austria	The current coordination status includes signed agreements with 10 out of 10 neighbouring countries (2017/2018).	In general, no issues have been identified, however with Czech Republic and Hungary Austria recognized timing discrepancy on the reshuffling of some TV-channels, which could delay the switch off of some transmitters for half a year. Once the definitive national roadmaps are known, the issue will be further discussed.
Belgium	The current coordination status includes signed bilateral agreements with all neighbouring countries. Negotiations have been covered within the WEDDIP regional cluster.	In general, no problems have been identified.
Bulgaria	Bulgaria has coordinated new DTT plans with Turkey and Ukraine for the frequencies under 694 MHz and signed bilateral agreements, as well as SEDDIF multilateral agreement. In the agreement with Turkey the following important provisions have been specified: - The implementation of the agreed frequency plan will be done step by step in the transition period which commence when the Agreement is signed. Both Administrations will contribute in the timely framework, as specified in the European Parliament and Council decision on the UHF band, with their best effort to implement the new agreed frequency plan in a way that a smooth transition from the existing GE 06 Plan to the new agreed GE06 Plan, with the least possible adverse effects for the audience, can be carried out. - All the DTT assignments of signing Administrations above 694 MHz within the coordination area of SEDDIF will not be used for broadcasting after 30.06.2020 and will be deleted from the Plan GE06 unless in accordance with art. 1 of Decision (EU) 2017/899 EU member administration signatories have to delay allowing the use of the 700 MHz frequency band for wireless broadband on the basis of one or more of the duly justified reasons set out in the Annex to the Decision or a non-EU member signatory decides to delay in accordance with its national needs. Both Administrations agree that they will inform each other about the delaying.	In general, no issues have been identified.

Country	Coordination plans with neighbouring countries for the clearance of the 700 MHz band	Problems related to cross-country negotiations
	In the agreement with Ukraine the following important provisions have been specified: - Implementation of the frequency assignments will be done step by step taking into account the provisions for the transition period. - Transition period is the period following the signing of this document during which the frequency assignments in the Plan Ge06 and/or MIFR shall be protected from the implementation of the new allotments and frequency assignments of Bulgaria and Ukraine, referred to Annex 1 and Annex 2 of this document. - The transition period starts on the date when this document comes into force. - As Ukraine has not yet decided about the refarming of the 694-790 MHz and 790-862 MHz frequency bands for terrestrial systems capable of providing wireless broadband electronic communications services, and noting the request of Bulgaria in the light of the Decision of the European Parliament and the Council (Decision (EU) 2017/899) regarding the use of the 470-790 MHz frequency band in the EU, both Parties, before June 30th, 2020, should additionally agree on a final date of the transition period. - All the DTT frequency assignments of the Parties above 694 MHz within the entire territory of Bulgaria and within the coordination zone of Ukraine, described in Annex 3, shall not be used after the end of the transition period and, consequently, shall be deleted from the Plan GE06. In July 2018, Bulgaria, Greece and Serbia signed an agreement to develop an experimental 5G cross-border corridor (Thessaloniki – Sofia – Belgrade) that will test autonomous vehicles.	
Croatia	1. The current coordination status includes signed agreements with 9 out of 11 neighbouring countries. 2. Albania and San Marino - discussion on general principles in progress.	1. Representatives of the Republic of Albania participated in the work of Adriatic – Ionian and partly in SEDDIF working groups but have not be able to conclude and sign multilateral agreement on coordination due to the national circumstances. Representatives of the Republic of San Marino participated in the work of Adriatic – Ionian working group but have not be able to sign multilateral agreement on coordination due to the national circumstances and open discussions with Italy on frequency usage. However, mediations are in progress and there are not expected major problems during transition or future DTT operation. 2. A delay is expected in the full availability of the 700 MHz frequency band for terrestrial systems capable of providing wireless broadband electronic

Country	Coordination plans with neighbouring countries for the clearance of the 700 MHz band	Problems related to cross-country negotiations
		communications services beyond June 2020. Croatia neighbours (several non-EU countries) plans to continue the usage of 700 MHz for TV broadcasting. Utilization of high power high tower transmitters after June 2020 might result in limited possibility of providing wireless broadband electronic communication services in the 700 MHz in Croatia. Some of those countries have not finished process of ASO (analogue switch-off). Additionally, in Adriatic region occurs the problem of harmful interference from Italian transmitters which operates on coordinated Croatian frequencies planned for DTV refarming. Due to above fact Croatia cannot authorise and refarme the TV broadcasting on channels below 694 MHz because those channels are already in operation in Italy by the uncoordinated stations. Until these channels are not free of interference, HR will have difficulty in making available 700 MHz band in Adriatic region.
Cyprus	Cyprus has participated, as a neighbouring country, in the coordination activities organised by the Arab Spectrum Management Group (ASMG) that aim to assist in coordinating the necessary modifications to the GE06 Digital Plan to ensure the availability of spectrum resources required to support the DTT multiplexes with national coverage. The current coordination status includes signed agreements with 6 out of 7 neighbouring countries – except Turkey.	For political reasons Turkey refuses any technical coordination discussions and coordination agreements with the Republic of Cyprus. There is also a risk of timing discrepancy for allowing the use of the 700 MHz band for mobile with neighbouring countries, since some of the neighbouring countries continue to use the 700 MHz band for TV transmissions and Cyprus is not aware of their migration plans for mobile broadband applications. There are still TV transmissions from Arab neighbouring countries but not heavily used. Cyprus also faces interference problems due to illegal TV transmissions originating from the occupied areas of Cyprus, the territory under which the Republic of Cyprus does not exercise effective control. Cyprus has sent a request for assistance in negotiations with Turkey to the EC and the ITU representatives. None of these actions were helpful. If situation continues, this area will be not licensed due to lack of interest from market, since it will be technically impossible to operate at the same time for both: illegal analogue TV broadcasts and broadband wireless networks.
Czech Republic	The current coordination status includes signed agreements with 5 out of 5 neighbouring countries (including Hungary, which is not a direct neighbour of the Czech Republic).	In general, no problems have been identified.
Denmark	All the necessary cross-border frequency-coordination agreements have been concluded.	The channel plan for 470-694 MHz between Poland and Denmark is agreed, but the specific timing for the release of two specific channels from Poland to Denmark (in order to fully release 700 MHz in Denmark) is not specified.

Country	Coordination plans with neighbouring countries for the clearance of the 700 MHz band	Problems related to cross-country negotiations
		Denmark is in dialogue with Polish NRA, issues will be discussed during mediations.
Estonia	The current coordination status includes signed agreements with 3 out of 4 neighbouring countries – except from Russia where there is an agreement regarding the ARNS but there has been no agreement regarding the MFCN-DTT.	Different usage in the neighbouring countries can have a significant impact on the frequency spectrum usage in Estonia. Latvia will probably use DTT until end of 2021, but both countries cooperate to clear Latvian TV channels 50-53 from border areas sooner to reduce the interference. Problems related to cross-country negotiations include the situation with Russia. Russia uses analogue TV, DTT and ARNS and there is no information on target dates to any changes. There are still ongoing discussions which TV channels are acceptable for coordination (possible changes of DTT channels 50-53 in border areas are discussed) and which not in 700 MHz band, taking into account also equal access to spectrum in border areas. Possible EU-level assistance on this matter is under consideration.
Finland	Finland has Mobile - ARNS coordination agreement with the Russian Federation and sub-700 DTT-DTT agreements with all neighbouring countries.	No problems in releasing the band; some limitations in using the band due to non-EU country 700 MHz use – near border with Russia.
France	The current coordination status includes signed agreements with 12 out of 14 neighbouring countries. With Algeria and Tunisia - coordination was completed – parties decided to register directly the technically agreed assignments in the GE06 Plan without having a signed additional agreement.	There is no issue. All the coordination's of the frequency plan 700 MHz and the associated technical conditions have been coordinated with all the neighbouring countries by the end of 2017. This result is in line with the obligations of the Council and EP Decision on UHF band.
Germany	The current coordination status includes signed agreements with 11 out of 11 neighbouring countries. As a result of a later clearing of the 700 MHz range in neighbouring countries, the protection of foreign DTT uses must be observed by mobile network operators.	Problems have been solved, initially there were some issues. 1. "The proportion of terrestrial TV broadcasting in the neighbouring countries varies widely, from about 2 - 5% in Belgium and the Netherlands to approx. 65% in France. In light of this it will be necessary to find solutions for the various cross-border coordination agreements." 2. "Various respondents addressed the importance of foreign coordination for introducing 549DVB-T2 and using the 700MHz band for mobile services. Agreement on frequency coordination was said to be a mandatory requirement for greater specificity in technical plans and subsequent migration, although so far, no specific results had been achieved. Attention was drawn to the fact that the memoranda of understanding and letters of intent concluded to date with Germany's neighbouring countries (except for Belgium and Austria) did not contain any binding agreements on frequency coordination and thus were not binding in nature. Moreover, these memoranda or letters of intent have so far not been published by the

Country	Coordination plans with neighbouring countries for the clearance of the 700 MHz band	Problems related to cross-country negotiations
		Bundesnetzagentur. One respondent expressly supported the finalization of these agreements with neighbouring countries.”
Greece	Greece has to proceed the coordination with the neighbouring countries. The coordination agreements are signed with the EU-countries, however there are some issues to be solved regarding the coordination plan with non-EU countries. In July 2018, Bulgaria, Greece and Serbia signed an agreement to develop an experimental 5G cross-border corridor (Thessaloniki – Sofia – Belgrade) that will test autonomous vehicles.	In general, no problems have been identified. Coordination with Albania is under progress, with minor dissent. EU-level assistance may be needed in the near future.
Hungary	The current coordination status includes signed agreements with 10 out of 10 neighbouring countries.	In general, no issues have been identified. To handle agreements Hungary found three different ways: - there is no usage in 700 MHz band in the other country – no need for a transition period; - there is the end date of the transition period; - there will be another agreement on the dates of the transition period until a fixed date or after the date of the official decision on 700 MHz.
Ireland	The current coordination status includes signed agreements with 3 out of 3 countries.	In general, no problems have been identified.
Italy	The current coordination status: Signed agreement with all EU countries and with Monaco, Vatican City.	Initial problems with Algeria, Tunisia, Albania and Libya have occurred where the EC assistance has been necessary.
Latvia	The current coordination status includes signed agreements or completed coordination with 7 (EU members) out of 9 neighbouring countries – except from Russia and Belarus. With Russia and Belarus, the discussions are still ongoing.	There are no decisions to change the use of the 700 MHz band from DTT to MFCN in Russia and Belarus. A coordination solution was found with these countries by bilateral negotiations (with regards to the coordination criteria IMT vs ARNS), however, the negotiations to limit the interference possibilities considering IMT vs. DTT are still ongoing. In case of undesirable developments in these countries the use of certain areas along Eastern boarder for MFCN could be excluded with the objective to assure compatibility between MFCN and DTT networks.
Lithuania	The current coordination status includes signed agreements or completed coordination with 5 (EU countries and Belarus) out of 6 neighbouring countries – except from Russia. Coordination agreements on mobile with ARNS were signed with Russia and Belarus in 2015.	In general, no issues have been identified, however no final agreement with Russia has been reached yet regarding the DTT-MFCN interference.

Country	Coordination plans with neighbouring countries for the clearance of the 700 MHz band	Problems related to cross-country negotiations
Luxembourg	The current coordination status includes signed agreements with 6 out of 6 neighbouring countries.	In general, no issues have been identified.
Malta	The current coordination status includes signed agreements with all EU neighbouring countries. There have been some problems with Tunisia and Libya.	Malta has already requested EU-level assistance in accordance due to cross-border difficulties with Tunisia and Libya.
Netherlands	The current coordination status includes signed agreements with all neighbouring countries.	In general, no issues have been identified.
Poland	The current coordination status includes signed agreements with all EU neighbouring countries and two non-EU countries (Ukraine and Belarus).	The deadline for releasing the 700 MHz band in Belarus, Ukraine and Russian Federation has not been determined yet. Following may cause interference during the transition period. Moreover, there are some uncertainty coordinating the switchover with Russia.
Portugal	The current coordination status includes signed agreement with Spain.	In general, no problems have been identified.
Romania	The current coordination status includes signed agreements with 6 out of 7 neighbouring countries.	No cross-border difficulty. Ukraine: Coordination completed in SEDDIF and BSDDIF, but the bilateral agreement not concluded yet due to the reluctance of Ukraine to provide a date for the switch-off of DTT.
Slovakia	The current coordination status includes signed agreements with all neighbouring countries	In general, no issues have been identified.
Slovenia	The current coordination status includes signed agreements with all neighbouring countries	In general, no issues have been identified.
Spain	The current coordination status includes signed agreements with all neighbouring countries	In general, no issues have been identified.
Sweden	The current coordination status includes signed agreements with 9 out of 9 neighbouring countries.	No cross-border difficulty. Denmark and Norway may continue with DTT in the 700 MHz band up to 2020 and 2021 respectively which could affect the mobile networks within certain areas in Sweden during an intermediate period of time. Currently, any discussions about transition plans to alleviate this interference have taken place.
United Kingdom	The current coordination status includes signed agreements with 7 out 7 neighbouring countries.	UK had difficulty in engaging with Belgium to discuss their plans in detail. The WEDDIP meetings were leveraged to accelerate negotiations.

Sources: EY questionnaire, roadmaps of the EU countries, Answers to the RSPG questionnaire