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An analysis of the current and future use of the 600 MHz band, including the Czech Republic's position on the use of the band for DVB-T or IMT

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List of abbreviations and explanatory notes

3GPP	The 3rd Generation Partnership Project, a cooperation agreement in the field of mobile communications. The aim of 3GPP was to develop a third-generation mobile telephone network within the scope of the ITU's IMT-2000 project.
4K	4K refers to a professional film standard using a resolution of 4,096 × 2,160 pixels. A 4K image has twice the aspect ratio of Full HD
5G NR	5G NR (5th Generation New Radio) is a new radio access technology developed by the 3GPP consortium as a global standard for the new radio interface for fifth-generation (5G) mobile networks
8K	An image resolution of 7,680 × 4,320 pixels. The name of this resolution – 8K, meaning eight thousand – derives from the fact that there are almost 8,000 pixels across the screen.
APMS	Association of Mobile Network Operators
ATSC 3.0	Advanced Television Systems Committee, a standard for television broadcasting developed by the Advanced Television Systems Committee (ATSC)
BR	Bureau of Radiocommunication, ITU-R Radiocommunication Bureau
BTS	Base Transceiver Station, a base station controlling the transmission and reception of radio signals, typically in mobile networks
CDN	Content Delivery Network, a network for delivering content; a technology enabling high-quality transmission of audiovisual content via IPTV
CEPT	European Conference of Postal and Telecommunications Administrations
ČMI	Czech Meteorological Institute
ČTÚ	Czech Telecommunications Office
DECT	Digital Enhanced Cordless Telecommunications
DG CNECT	Directorate-General for Communications, Networks, Content and Technology (European Commission)
DTT	Digital Terrestrial Television
DVB-T	Digital Video Broadcasting-Terrestrial, a digital terrestrial television broadcasting system
DVB-S	Digital Video Broadcasting – Satellite, a standard for digital broadcasting transmitted via satellite.
EBU	European Broadcasting Union
EC	European Commission
EIRP, e.i.r.p	Equivalent Isotropically Radiated Power, equivalent isotropically radiated power or effective radiated power
ENG/OB	Electronic News Gathering/Outside Broadcasting, electronic news gathering / radio and television broadcasting from locations outside radio and television studios
ERC	European Research Council, a public body responsible for funding scientific and technical research carried out in the European Union.
ERP, e.r.p.	Effective Radiated Power
EU	European Union
FDD	Frequency Division Duplex, frequency-division duplex operation
FTA	Free-To-Air, free-to-air (unencrypted) broadcasting
FWA	Fixed Wireless Access, a wireless network providing point-to-multipoint broadband connectivity
GSMA	Global System for Mobile Communications Association, an association representing the interests of mobile network operators
HbbTV	Hybrid Broadcast Broadband TV, high-speed internet services displayed on a television screen
HDR	High Dynamic Range (HDR) refers to a wider dynamic range than the so-called Standard Dynamic Range (SDR) in image processing. The term is used primarily in the fields of displays, photography, 3D rendering, sound recording and reproduction, digital imaging and digital audio.

HD(TV)	High Definition TV, see also UHD (Ultra High Definition)
HEVC	High Efficiency Video Coding, or 'high-efficiency video coding', also known as the H.265 standard. This standard was approved in 2013 as ITU-T H.265 (ISO/IEC 23008-2). Compared with the previous H.264 standard used on Blu-ray discs and in HD television broadcasting, it offers similar quality whilst often requiring significantly lower data rates, and thus resulting in significant savings data transmission costs. The savings amount to 30–40 per cent on average.
HPHT	High Power High Tower, an infrastructure based primarily on elevated transmission sites with an effective radiated power in the tens of kW
IEM	In-Ear Monitor System, a wireless monitoring system
IMT	International Mobile Telecommunications: In accordance with ITU-R Resolution 56-2, the abbreviation IMT refers to mobile communications systems and encompasses the IMT-2000, IMT-Advanced and IMT-2020 systems.
IoT	Internet of Things, an ecosystem of computers, smart devices and machines capable of communicating or collaborating with one another without human intervention
IPTV	Internet Protocol Television, internet television enabling the reception of television broadcasts via the Internet Protocol
ITU	International Telecommunication Union
ITU-R	The ITU Radiocommunication Sector
LPLT	Low Power Low Tower, infrastructure based on a network of transmission sites at lower heights, with shorter distances between transmitters and lower transmitter power
LTE	Long Term Evolution of the 3GPP radio technology, the technology preceding the fourth generation of mobile communications,
MPO	Ministry of Industry and Trade
MPMT	Medium Power Medium Tower, infrastructure based on transmission sites at medium heights and with medium power
UN	United Nations
OTT	Over-the-top, a media service offered directly to viewers via the internet, where video is watched directly in a web browser. The internet service provider is unaware of what the user is watching and therefore treats this page like any other. Consequently, during periods of high network traffic, there is a risk of reduced video quality.
PMR	Professional Mobile Radio/Private Mobile Radio, private or corporate mobile radio networks and links
PMSE	Programme Making and Special Events, services related to programmes and special events (music performances, public gatherings)
PPDR	Public Protection and Disaster Relief, public protection and emergency communications
PVRS	Radio Spectrum Utilisation Plan
ROM	Receive Only Mode, mode without the need for a return channel
RSPG	Radio Spectrum Policy Group, an advisory body to the European Commission
SAB/SAP	Service Ancillary for Broadcasting/Service Ancillary for Programme, ancillary applications for the production of radio and television broadcasting or programme production. Note: SAB – only TV programme preparation and TV broadcasting, including ENG/OB. SAP – theatre, pop music concerts, sport, and others
SDL	Supplemental Downlink (i.e. transmission from base stations to terminals)
SD(TV)	Standard-definition television (SDTV) is a television system that includes the PAL (720x576) and NTSC (640x480) standards. SD(TV) is expected to be gradually replaced by HD(TV).
SDO	Standalone Downlink Only (one-way transmission from the content provider to the end user without the need to connect the end device to a mobile network)
SFN	Single Frequency Network, a network of synchronised transmitters broadcasting an identical signal on the same frequency
SG	Study Group, ITU-R study groups
SINR	Signal-to-Interference-and-Noise Ratio
SRD	Short-Range Device
SVoD	Subscription Video on Demand, a system in which service content is made available to users as part of a subscription
TPP	Government Regulation No. 199/2018 Coll. on the Technical Plan for the transition of terrestrial digital television broadcasting from the DVB-T standard to the DVB-T2 standard
TVoD	Transactional Video on Demand, a system in which users pay for each piece of content separately
TVWS	TV White Spaces, white spaces in the television spectrum. A white space is defined as a section of the spectrum that can be utilised at a specific time and in a specific geographical area in a non-interfering and unprotected mode in relation to services with higher priority. An example is the use of a section of a television channel that is not being used for broadcasting at that location at that time TV.
UHD (TV)	Ultra High Definition TV
UHF	Ultra High Frequency; Note: The Czech abbreviation 'UKV' is also used to denote the same frequencies.
VHF	Very High Frequency, very high frequencies. Note: The Czech abbreviation VKV is also used to denote the same frequencies.
VoD	Video on Demand, a system that allows customers to watch content of their own choosing
VR	Virtual Reality

WMAS	Wireless Multichannel Audio Systems. WMAS technology is suitable ale multi-channel wireless systems that require a large number of available frequencies.
WRC-23	World Radiocommunication Conference 2023

Executive Summary

Current situation in the UHF band

Currently, as a result of historical developments (the digital dividend), the UHF band – and specifically the 600 MHz band – is allocated primarily to terrestrial television broadcasting and secondarily to the terrestrial mobile service (PMSE), as is the case in EU countries and ITU Region 1. Other conditions for the use of the band may vary. In Germany, Austria, Denmark, Estonia, Liechtenstein, Serbia and Switzerland, the 470–494 MHz band is also allocated on a secondary basis to the radiolocation service. Member States also allocate parts of the radio spectrum to radio astronomy and radionavigation services.

A key factor in the allocation of radio spectrum was the completion of the transition of terrestrial television broadcasting from the DVB-T standard to the more efficient DVB-T2 standard; this transition was finalised in October 2020, and at the same time the relevant frequencies in the 700 MHz band were released for IMT. Approximately 60 per cent of all domestic multiplexes in EU countries already use the most advanced transmission standard (DVB-T2), and approximately 40 per cent of these use the most advanced coding standard (HEVC). Thanks to the advanced transmission format and the HEVC coding standard (along with other technological solutions such as SFN networks), it has been possible, even within the 'spectrum reduction' for DTT, to maintain a diverse range of programmes and, specifically in the Czech context, to operate four nationwide and several regional networks. At the same time, the spectrum release has had a positive impact on the development of 5G services (the identified key 700 MHz band).

Television broadcasting in the UHF band in the Czech Republic

The operators of the four digital multiplexes in the Czech Republic have been allocated frequencies in the UHF band until the end of 2030. In addition, 16 regional DVB-T/DVB-T2 multiplexes are in operation. Alongside the use of UHF frequencies for DTT services, it is important to mention the need to ensure the functioning of the public service broadcaster (PSB) – Czech Television. In accordance with the law and its code of conduct, it should, amongst other things, provide a pluralistic and diverse range of programmes and impartial and independent news coverage. This service must be universally accessible in accordance with the legislation governing the operation of radio and television broadcasting and the coverage provided by terrestrial television signals.

Technological developments

At the same time, the band below 700 MHz may in fact represent an additional overlapping layer of frequencies, which will increase nationwide capacity in the UHF band, provided that additional investment is made in network roll-out and the acquisition of spectrum usage rights.

One of the standards that could potentially complement DTT in the 600 MHz band is 5G Broadcast. However, existing broadcasting networks are insufficient to provide the level of coverage required for good 5G Broadcast mobile reception. This would require broadcasters to either further develop their own networks at their own expense or reach agreements with existing mobile network operators. Testing of the 5G Broadcast standard is already underway across the EU, including in the Czech Republic, where České Radiokomunikace has been testing this standard. At present, however, it is still difficult to assess the potential benefits of 5G compared with DVB-T2, as 5G Broadcast technology is still only at the testing stage.

Regulatory framework

The basic global framework for access to UHF spectrum management was established at the **WRC-23** meeting in Dubai, United Arab Emirates. The newly approved conditions ensure long-term international protection of the entire 470–694 MHz band, which remains primarily allocated in Europe for TV broadcasting (DTT).

Beyond the scope of this agreement, **the RSPG** recommends that, in the event of a decline in broadcasting requirements at national level, the spectrum should also be made available at national level for emergency communications and national defence, whilst taking cross-border coordination into account. At the same time, this organisation recommends that Member States introducing uses other than broadcasting should retain sufficient spectrum for PMSE needs. **Similarly,** rather than focusing on DTT versus IMT, **the ECC** emphasises the importance of PMSE and the need to support the distribution of audiovisual media in the future. The GSMA, **the association of mobile** network **operators,** highlights the benefits of implementing 5G in the 600 MHz band, citing a 30 to 50 per cent improvement on the current situation in rural areas and indoor locations, whilst also noting lower deployment costs in sparsely populated areas.

Developments in television broadcasting in the EU and the Czech Republic

The use of DTT services by EU citizens is not uniform; the estimated proportion of households relying on DTT for free-to-air (FTA) services ranges from a few per cent (Austria, Denmark, Germany, Estonia, Finland and others) to 30–90 per cent, according to an EC study (estimates for Italy and the Czech Republic; data for Lithuania, Poland, Croatia and Cyprus).

In addition to DTT (and the DVB-T2 standard, which is the most widespread in Europe), other television broadcasting platforms are also used in the Czech Republic, with their market shares varying significantly across individual EU countries. In the Czech Republic, penetration in the fourth quarter of 2022 was as follows, according to data from Nielsen Admosphere: terrestrial broadcasting (DVB-T) accounted for 54.5 per cent, cable networks (CATV) together with IPTV for 40.7 per cent, and satellite transmission (DVB-S) for 17.0 per cent. Globally, a significant proportion of households is expected to continue using DTT over the next five years. IPTV is projected to see the highest growth (by approximately 10 per cent) by 2029. According to the relevant survey, this platform is expected to achieve a higher market share than cable television as early as 2024.

Developments in mobile communications in the Czech Republic

As regards mobile communications services, the total volume of data transmitted in the Czech Republic is growing steadily; for example, between 2021 and 2022, there was an increase of approximately 63 per cent. The share of FWA data transmission in total mobile data transmission is expected to rise from 19 per cent at the end of 2023 to 30 per cent by 2029. The use of high-capacity bands above 1 GHz (for 5G, for example, the identified 3400–3600 MHz and 26 GHz bands) will have a significant impact here.

Currently, spectrum allocation below 1 GHz in the Czech Republic stands at 94.8 MHz of frequencies in the 700, 800 and 900 MHz bands for the three established operators. The potential release of part of the UHF band (600 MHz) would mean an increase in spectrum allocation of a further 2 × 35 MHz.

Interference and compatibility

To identify potential causes of signal interference between DVB-T and IMT, several factors must be considered, ranging from overlapping frequency bands and a lack of protection against interference to the characteristics of the antennas. ITU study groups examined the possibility of compatibility, and their findings, based on simulations, were as follows: if one country intends to use a frequency band for DTT broadcasting and a neighbouring country plans to deploy IMT networks, sharing the spectrum will be very difficult. To reduce interference in shared channels to the level permitted by the GE06 plan, the minimum safe distance along a ground path between an IMT network and a DTT receiver is approximately 243 km. Over water, the minimum separation distance is more than 1,000 km.

For the purposes of this study, the possibilities for operating IMT/5G in Germany in the 600 MHz band whilst DTT coexists in the Czech Republic were analysed with the assistance of the Czech Meteorological Institute (ČMI). The analysis unequivocally demonstrated the incompatibility of the two systems. The separation distance is estimated at between 200 and 300 km. Operation would result in significant interference with DTT in the Czech Republic from almost all IMT operations in Germany. Conversely, interference with DTT in the Czech Republic caused by the operation of IMT/5G base stations in Germany would not be significant and would, in practice, be limited only to base stations with direct radio line-of-sight to the Czech Republic.

Economic impacts of the change in the allocation of the UHF band for DTT

According to an EBU study, the cost of operating 5G networks is €15.05 per capita (€7.32 in the case of concurrent operation of IMT and DTT networks), compared with a cost of €0.28 per capita for DTT operation. According to another study analysed, the allocation of 80 MHz of UHF spectrum to mobile services is expected to generate revenues six times higher than the costs of operating existing DTT programmes. At present, even taking into account the uncertainty surrounding future DTT viewing figures, capacity requirements and innovations within IMT services, there is no relevant study that would assess the overall societal impact of such a change on all stakeholders (citizens, DTT network operators and television broadcasters, IMT service providers and others).

Assessment of specific scenarios for the Czech Republic

To ensure the study's practical relevance, beyond a mere analysis of resources, possible development scenarios were assessed, specifically scenario (1) 'Maintaining the current allocation of the UHF band for DTT' and scenario (2) 'Allocating part of the UHF band (the 600 MHz band) to IMT'. Among other things, the impacts on network operators' financial performance, socio-economic impacts and impacts on the competitive environment were assessed. The key findings are presented below.

1) **Scenario 1 – Maintaining the current allocation of the UHF band for DTT**
   a. DTT: Maintaining the current number of multiplexes could have a positive impact on network operators' business cases due to a slower decline in viewership, the possibility of regionalising broadcasts and ensuring competition on the platform. The possibility of free-to-air programmes continuing to exist even with a continuing decline in viewership. Maintaining the full range will enable the platform to continue to compete, both in terms of broadcasting operations and advertising space, thereby allowing the FTA principle to be upheld.
   b. IMT: Any additional IMT capacity that may be required (particularly in rural areas) will depend on network densification or the use of a different frequency band. Given the high signal coverage, the use of a different frequency band may entail higher costs (compared with the 600 MHz band). A negative impact would, of course, be a potential decline in service quality or a slowdown in the innovation cycle for mobile service users.
   c. PMSE: Maintaining the service in its current full scope.
   d. General: In the event of an earlier launch of the IMT service abroad (a simulation for Germany was created for the purposes of this study), there may be a significant impact on the quality of both services given the separation distances (200–300 km). It is therefore necessary to recognise the need for a unified decision and, where necessary, coordination of operations.
2) **Scenario 2 – Allocation of part of the UHF band (600 MHz band) for IMT**
   a. IMT: The construction and operation of an IMT network in the 600 MHz band may result in lower costs compared with network densification or the use of a higher frequency band (depending, of course, on the final auction price of the spectrum). Consequently, there is an increase in spectrum allocation of 2×35 MHz, thereby improving capacity below 1 GHz. Additional spectrum can be utilised for innovative user services, thereby supporting the development of innovative functionalities (network slicing). An increase in spectrum allocation also has the potential to boost competition (creating scope for innovative solutions).
   b. DTT: A reduction in the range of programmes broadcast may affect the popularity of the platform itself, accelerate the decline in DTT viewing figures, and increase pressure to restrict free-to-air (FTA) broadcasting by commercial stations. There is a reduction in regional content and the potential closure of one national network. Potentially, increasing the spectrum allocated to IMT could lead to the development of 5G broadcasting on the 600 MHz band as a form of innovation in IMT services.
   c. *General DTT: Should a decision to implement this scenario be taken earlier (before 2030), additional costs may arise, particularly due to the need to optimise the network and to replace and write off transmitters and, where applicable, antennas. At the same time, consideration may need to be given to the potential need for compensation for lost revenue from regional broadcasting.*

Management summary

Current situation in the UHF band

At present, as a result of historical developments (the digital dividend), the UHF band – and specifically the 600 MHz band – is allocated primarily to terrestrial television broadcasting and secondarily to terrestrial mobile PMSE services, as is the case in EU countries and ITU Region 1. Other conditions for bandwidth usage may vary. In Germany, Austria, Denmark, Estonia, Liechtenstein, Serbia and Switzerland, the 470–494 MHz band is additionally allocated to the radar service. Furthermore, Member States shall allocate parts of the radio spectrum for radio astronomy and navigation services.

The completion of the transition of terrestrial television broadcasting from the DVB-T standard to the more efficient DVB-T2 standard, which was finalised in October 2020, and the simultaneous release of the corresponding frequencies in the 700 MHz band for IMT, was crucial for the allocation of radio spectrum. Around 60 per cent of all national multiplexes in EU countries already use the most advanced transmission standard (DVB-T2), and around 40 per cent of them use the most advanced encoding standard (HEVC). Thanks to the advanced transmission technology and the HEVC encoding standard (along with other technological solutions such as SFN networks), it was possible to maintain a diverse range of programmes for DTT even amidst the 'spectrum loss' and, specifically in the Czech context, to continue operating four nationwide and several regional networks. At the same time, the release had a positive impact on the development of 5G services (the 700 MHz key band having been identified).

Television broadcasting in the UHF band in the Czech Republic

The operators of four digital multiplexes in the Czech Republic have been allocated frequencies in the UHF band until the end of 2030. In addition, 16 regional DVB-T/DVB-T2 multiplexes are in operation. Alongside the use of UHF frequencies for DTT services, it is important to highlight the need to ensure the functioning of the public service broadcaster (PSB) – Czech Television. According to the law and its implementing regulations, it should provide, amongst other things, a pluralistic and diverse range of programmes and impartial and independent reporting. This service must be universally available in accordance with the legal regulations relating to the operation of radio and television broadcasting and the coverage of terrestrial television broadcasting.

Technological development

The band below 700 MHz could effectively provide an additional layer of frequencies that would increase capacity in the UHF band nationwide (as envisaged for IMT), provided that further investment is made in network construction and the acquisition of spectrum usage rights.

One of the standards that could potentially complement DTT in the 600 MHz band is 5G Broadcast. However, according to studies presented, the existing broadcast networks are insufficient to provide the level of coverage required for good 5G Broadcast mobile reception. This would require broadcasters to either further develop their own networks at their own expense or to reach an agreement with existing mobile network operators. Testing of the 5G Broadcast standard is already underway across the EU, including in the Czech Republic, where the standard was tested by České Radiokomunikace. However, it is currently difficult to estimate the potential advantages of 5G compared to DVB-T2, as 5G Broadcast is still only in the testing phase.

Regulatory assumptions

The basic global framework **for the approach to UHF spectrum management was established at the WRC-23 meeting in Dubai**, United Arab Emirates. The newly approved conditions ensure long-term international protection of the entire 470–694 MHz band, which remains primarily allocated to TV broadcasting (DTT) in Europe.

In addition to this agreement, the **RSPG recommends** that, in the event of a reduction in the need for broadcasting at national level, spectrum should also be made available at national level for crisis communication and national defence purposes, taking into account cross-border coordination. At the same time, the organisation recommends that Member States introducing uses other than broadcasting retain sufficient spectrum to meet the needs of PMSE. Similarly, rather than focusing on DTT versus IMT, the **ECC emphasises** the importance of PMSE and the need to support audiovisual media distribution in the future. **The Association of Mobile Network Operators (GSMA)** highlights the benefits of deploying 5G in the 600 MHz band, citing a 30 to 50 per cent improvement in coverage in rural areas and indoor spaces, whilst also reducing the costs of deployment in sparsely populated areas.

Development of television broadcasting in the EU and the Czech Republic

The use of DTT services by EU citizens is not uniform, whilst the estimated proportion of households relying on DTT for free-to-air (FTA) television ranges from low single-digit percentages (Austria, Denmark, Germany, Estonia, Finland and others) up to 30–90 per cent, according to the EC study (estimate for Italy and the Czech Republic; data for Lithuania, Poland, Croatia and Cyprus).

In addition to DTT (and DVB-T2, the most widely used standard in Europe), other TV broadcasting platforms are also used in the Czech Republic, the market shares of which vary significantly from one EU country to another. In the Czech Republic, penetration in Q4 2022 was as follows, according to data from Nielsen Admosphere: terrestrial broadcasting (DVB-T) reached a share of 54.5 per cent, cable networks (CATV) together with IPTV 40.7 per cent, and satellite transmission (DVB-S) 17.0 per cent. Globally, a substantial proportion of households are still expected to use DTT over the next five years. IPTV is expected to see the highest growth (by around 10 per cent) by 2029. According to the survey, as early as 2024, this platform should have a larger share than cable TV.

Development of mobile communications in the Czech Republic

As regards mobile communications services, the total volume of data transmitted in the Czech Republic is growing steadily, with an increase of approximately 63 per cent between 2021 and 2022, for example. The share of FWA data traffic in total mobile data traffic is expected to rise from 19 per cent at the end of 2023 to 30 per cent in 2029. Here, the use of frequency bands above 1 GHz (for example, the identified 3400–3600 MHz and 26 GHz bands for 5G) will have a major impact.

At present, the spectrum allocation below 1 GHz in the Czech Republic stands at 2 × 94.8 MHz of spectrum in the 700, 800 and 900 MHz bands for three established operators. The eventual release of part of the UHF band (600 MHz) would mean an increase in spectrum allocation by a further 2 × 35 MHz.

Interference and Compatibility

To identify potential causes of signal interference between DVB-T and IMT, it is necessary to consider several factors, ranging from overlapping frequency bands to a lack of interference protection and antenna characteristics. The ITU study groups examined the possibility of compatibility, and their findings, based on simulations, were as follows: if one country intends to use the frequency band for DTT broadcasting and a neighbouring country intends to deploy IMT networks, sharing will be very difficult. To reduce interference in co-used channels to the level permitted by the GE06 plan, the minimum safe distance along the ground route between the IMT network and the DTT receiver is approximately 243 km. Above the water surface, the minimum separation distance is more than 1,000 km.

For the purposes of this study, the possibilities for IMT/5G operation in Germany in the 600 MHz band were analysed using CMI, whilst DTT coexists in the Czech Republic. The analysis unequivocally demonstrated the incompatibility of the two systems. The separation distance is 200 to 300 km. Such operation would result in significant interference to DTT in the Czech Republic from almost all IMT operations in Germany. Conversely, the interference to DTT in the Czech Republic caused by the operation of IMT/5G base stations in Germany would not be substantial and would, in practice, be limited only to base stations with direct line-of-sight to the Czech Republic.

Economic Impacts of Changing UHF Band Allocation for DTT

According to the EBU study, the operational cost of 5G traffic is €15.05 per capita (€7.32 for IMT and DTT co-operation), compared with €0.28 per capita for DTT traffic. According to another study analysed, the allocation of 80 MHz of UHF spectrum to mobile services can be expected to generate revenues six times higher than the costs of running existing DTT programmes. At present, given the uncertainty surrounding the future state of

DTT viewership and capacity requirements, as well as innovations within IMT services, there is no relevant study that would assess the societal impact of such a change on all stakeholders (citizens, operators of DTT networks and television programmes, operators of IMT services and others)

Evaluation of specific scenarios for the Czech Republic

For the purposes of the study, going beyond a mere analysis of resources, possible development scenarios were evaluated, including scenario (1) – maintaining the current allocation of the UHF band for DTT – and scenario
(2) Allocation of part of the UHF band (600 MHz band) for IMT were assessed. Among other things, the impacts on the economic performance of network operators, socio-economic impacts and impacts on the competitive environment were assessed. Key findings are presented below.

1) Scenario 1 – Maintaining the current allocation of the UHF band for DTT

a. DTT: Maintaining the current number of multiplexes can have a positive impact on the business case for network operators due to a slower decline in audience numbers, the possibility of regionalised broadcasting and the maintenance of competition on the platform. This also ensures the continued existence of free-to-air programmes even as viewer numbers continue to fall. Maintaining the full number of multiplexes will enable the platform to remain competitive, both in terms of broadcasting operations and advertising space, thereby upholding the free-to-air principle.
b. IMT: Any additional IMT capacity required (particularly in rural areas) will depend on network densification or the use of a different frequency band. Owing to the high rate of signal propagation, the use of a different frequency band may result in higher costs (compared to the 600 MHz band). The negative impact is, of course, a potential decline in service quality or a slowdown in the innovation cycle for mobile service users.
c. PMSE: Maintaining the service in its entirety.
d. In general: In the event of an earlier launch of the IMT service abroad (a simulation for Germany was carried out for the purposes of the study), there may be a significant impact on the quality of both services with regard to separation distances (200–300 km). It is therefore necessary to recognise the need for a unified decision and possible coordination of operations.

2) Scenario 2 – Allocation of a portion of the UHF band (600 MHz band) for IMT

a. IMT: The actual construction and operation of an IMT network in the 600 MHz band may result in lower costs compared to network densification or the use of a higher frequency band (depending, of course, on the final auction price of the spectrum). Consequently, the spectrum is increased by 2 × 35 MHz, thereby improving capacity below 1 GHz. Additional spectrum can be used for innovative services for users, thereby supporting the development of innovative functionalities (network slicing). By increasing the available spectrum, there is the potential for increased competition (room for innovative solutions).
b. DTT: A reduction in the range of programmes available may affect the popularity of the platform as a whole, accelerating the decline in DTT viewership and increasing pressure to limit free-to-air (FTA) broadcasts by commercial broadcasters. There is a reduction in regional content and the potential dismantling of a single nationwide network. Potentially, the increase in spectrum for IMT could lead to the development of 5G broadcasting at 600 MHz frequencies as an innovation for IMT services.
c. In general, regarding DTT: If this scenario is implemented earlier (before 2030), additional costs may arise, mainly due to the need to optimise the network, replace and depreciate transmitters and, possibly, antennas. At the same time, the need for potential compensation for lost profits from regional broadcasting may need to be considered.

Introduction

General introduction to the issue

The 470–862 MHz frequency band, known as the ultra-high frequency (UHF) band, is characterised by favourable conditions for the propagation of radio waves. The advantages of this band over higher frequencies lie in its low level of interference, good signal propagation, long range and satisfactory signal penetration through walls (wood, steel, concrete). It was originally used for television broadcasting. International commitments regarding the use of the band were set out in the Geneva Agreement of 2006. With the gradual introduction of other distribution platforms (cable television, satellite broadcasting and IPTV) and the transition from analogue to digital broadcasting as a result of overall changes in the consumption of television content, the portion of the spectrum allocated to terrestrial digital broadcasting has been reduced. The choice of how to utilise the UHF band is determined by the benefits to society as a whole (both economic and social). For these reasons, the 790–862 MHz band (hereinafter referred to as the 800 MHz band) and, later, the 694–790 MHz band (hereinafter referred to as the 700 MHz band) were gradually allocated for mobile network services, thereby completing harmonisation with other ITU-R[1] regions.

The World Radiocommunication Conference (WRC-23), held from 20 November to 15 December 2023 in the United Arab Emirates, discussed the revision of radio spectrum usage in the 470–694 MHz[2] (including 600 MHz[3]) beyond 2030, taking into account the needs of existing services. The newly approved conditions, based on the European proposal, ensure the long-term international protection of digital terrestrial television (DTT). The entire UHF band remains allocated in Europe to the priority radio service, including DTT broadcasting. A review of potential amendments to the conditions for the mobile service, including its possible elevation to a priority service, will be discussed at the WRC in 2031. The conditions continue to guarantee Member States the possibility of utilising the full range of frequencies for DTT in the long term.

From the Czech Republic’s perspective, proposals for possible solutions at European Union and CEPT level are particularly significant (and binding) for the further development of UHF band usage.

The Ministry of Industry and Trade (MPO) has previously declared its interest in maintaining DTT in the Czech Republic as the sole free-to-air reception method, which is used by more than half (54.5%[4]) of Czech households. Mobile operators have expressed an interest in the 600 MHz frequency band, as they would like to use it for the roll-out of next-generation 5G and 6G networks. Opposition comes from terrestrial television broadcast network operators and television station operators. The current frequency allocations for terrestrial television broadcast networks are valid until 2030, and at the same time, the operators of these networks are also concluding contracts with their clients up to that date. If terrestrial television broadcasting were to cease, viewers would have to pay for access to television broadcasts via cable, satellite or IP television (in the form of direct household expenditure), unless another suitable method of free reception were proposed. In addition to the licence fee for Czech Television, they would therefore have to pay monthly charges to the provider of the paid service. ČT programmes can currently be received without any additional monthly charges, for example, using a special ČT card for satellite broadcasting; however, other commercial television programmes are encrypted on satellites and there is a charge for receiving them.

Purpose of the document

This document analyses the current and projected use of the 600 MHz band, including the Czech Republic’s position on the allocation of frequencies in this band for digital terrestrial television broadcasting (DVB-T2) services and related services

[1] The Czech Republic belongs to ITU Region 1, which comprises Europe, Africa, the Middle East (excluding Iran), Armenia, Azerbaijan, Russia, Georgia, Kazakhstan, Mongolia, Uzbekistan, Kyrgyzstan, Tajikistan, Turkmenistan and Turkey.

[2] For the purposes of this study, the term ‘UHF’ or ‘the band up to 700 MHz’ is used to refer to this band.

[3] For the purposes of this study, the term ‘600 MHz’ refers to the 617–694 MHz band, which could potentially be allocated for IMT.

[4] As at the fourth quarter of 2022, from *the Report on the Development of the Electronic Communications Market with a Focus on 2022*, ČTÚ (2023)

with the PMSE[5] programme and special events, or for the IMT mobile communications services system. Technological developments in 5G for the transmission of linear and non-linear content using technologies such as 5G Broadcast enable the band to be utilised, amongst other things, for IMT services.

The study contains a description of the existing starting points and a synthesis of existing findings from relevant international sources (ITU-WRC, RSPG, CEPT and others), a description of possible uses, a definition of possible scenarios and an assessment of their impact. The following chapters analyse specific topics and provide answers to key questions:

- Chapter 1: What are the current and future regulatory frameworks for the use of the 600 MHz frequency band for DVB-T and IMT in the Czech Republic, European countries and other countries in ITU Region 1?
- Chapter 2: How can the limited 600 MHz frequency band be used effectively to achieve the best possible coverage for digital television broadcasting (DVB-T) and mobile telecommunications networks (IMT)?
- Chapter 3: What is the approach of the relevant international organisations to the introduction of new technologies in the 600 MHz band?
- Chapter 4: What are the main technological trends, such as 5G Broadcast or other options for compressing television signals?
- Chapter 5: What are the findings to date regarding the potential for minimising interference issues between DVB-T and IMT within a shared frequency band? What investment will be required to upgrade or modernise existing DVB-T infrastructure, and at the same time to roll out IMT in the 600 MHz frequency band? What are the potential economic benefits and sustainability of using the 600 MHz band for DVB-T or IMT?
- Chapter 6: What are the scenarios for the use of the 600 MHz frequency band after 2030? What are the advantages and disadvantages of implementing each scenario?

An integral part of the document are the conclusions and recommendations for any necessary measures that the relevant authorities and stakeholders should take to maximise the benefits of the allocation of the 600 MHz frequency band, taking into account economic and social aspects as well as the need to ensure the availability of digital terrestrial television broadcasting.

[5] PMSE services are operated in sections of the frequency band also referred to as ‘white spaces’, ‘white spots’ or ‘interleaved spectrum’.

1 Regulatory approaches to the UHF frequency band

1.1 Allocation of the UHF frequency band in the Czech Republic

In the Czech Republic, the use of the radio spectrum is regulated by the Czech Telecommunications Office (ČTÚ) (as the central administrative authority responsible for the exercise of state administration, including regulation in the field of electronic communications and postal services) through the Radio Spectrum Utilisation Plan (PVRS), in which it sets out the technical parameters and conditions of use. The PVRS consists of a general section of the Radio Spectrum Utilisation Plan and sections of the Radio Spectrum Utilisation Plan for frequency bands defined by lower and upper frequency limits. The PVRS builds on the frequency band allocation plan (the national frequency table).

The sections of the PVRS are issued by the CTU as the competent state administrative authority pursuant to Section 108(1)(b) of Act No. 127/2005 Coll., on Electronic Communications and on Amendments to Certain Related Acts (the Electronic Communications Act), as amended, on the basis of the results of a public consultation conducted in accordance with Section 130 of the Act, a decision of the ČTÚ Council pursuant to Section 107(8)(b)(2) and for the implementation of Section 16(2) of the Act by means of measures of a general nature.

On 3 May 2022, the Czech Telecommunications Office (ČTÚ) issued, by means of a measure of general application, part of the PVRS No. PV-P/10/05.2022-4 for the 470–960 MHz frequency band. The table below shows the allocation of the UHF band among individual services and applications.

Table 1: Allocation of the UHF band in the Czech Republic

Service	Application	Band section (MHz)
Radio (priority)	DVB-T2 – TV Band IV, channels 21–34	470–582
	DVB-T2 – TV Band V, channels 35–48	582–694
Radio astronomy (secondary)		608–614
Terrestrial mobile (secondary)	SAP/SAB (PMSE)	470–694
-	Wireless audio transmission (SRD)	470–694
-	GPR/WPR radars (SRD)	230–1,000

Source: ČTÚ, adapted by GTA

Within the UHF frequency band, priority allocation for television broadcasting is implemented via Band IV and V bands, using channels 21 to 48 (see 2.1 for further details).

In many countries of ITU Region 1, including the Czech Republic, the 470–694 MHz band is additionally allocated to *the land mobile service* on a secondary basis and is intended for auxiliary radio applications and the provision of PSME news programmes. Stations of the land mobile service in the countries mentioned in this note must not cause harmful interference to existing or planned stations operating in accordance with the frequency band allocation table in other countries.

The **608–614 MHz** band is additionally allocated on a secondary basis *to the radio-astronomy service*. The radio-astronomy service is a passive radiocommunication service based on the reception of radio waves of cosmic origin. The radio-astronomy service is not currently in use in the Czech Republic within the 608–614 MHz band.

The UHF band also provides for an allocation for wireless audio transmission applications (wireless microphones). Such devices, with a maximum effective radiated power (e.r.p.) of 50 mW, must not cause interference nor claim protection.

Throughout this section of the band, as well as in adjacent bands, an allocation is also set aside for ultra-wideband radars for imaging the structure of walls and the earth's surface (GPR/WPR) with the following technical parameters: maximum spectral density e.i.r.p.
-60 dBm/MHz and a maximum peak radiated power of -37.5 dBm/120 kHz (e.r.p.).

1.1.1 Completion of the transition of terrestrial television broadcasting from the DVB-T standard to the more efficient DVB-T2

In 2015, at the World Radiocommunication Conference of the International Telecommunication Union (ITU) – (WRC-2015) – it was decided to release the 694–790 MHz band, which had typically been used for terrestrial television broadcasting, for mobile data service systems. Within the EU, Decision (EU) 2017/899 of the European Parliament and of the Council on the use of the 470–790 MHz frequency band in the Union (hereinafter the 'European Decision') was adopted in 2017 on the basis of the so-called Lamy Report[6]. Article 4 is key for DTT; it stipulates that Member States must ensure, at least until 2030, the availability of the band up to 700 MHz for the terrestrial provision of radio and television broadcasting services, including free-to-air television broadcasting, and for wireless audio PMSE. Any other use of the band up to 700 MHz within their territory must be consistent with national broadcasting needs and must not cause harmful interference to broadcasting in a neighbouring Member State.

The Strategy for the Development of Terrestrial Digital Television Broadcasting (hereinafter referred to as the 'Strategy'), approved by the Government by Resolution No 648 of 20 July 2016, set out the basic conditions for the release of the 700 MHz band through the transition to the DVB-T2 standard. The DVB-T2 standard, with the HEVC compression standard, represents an efficient use of the available radio spectrum, as it utilises fewer frequencies than the DVB-T standard through extensive single-frequency networks (SFNs). Following the approval of the Strategy, the Czech Telecommunications Office (ČTÚ), together with the Czech Meteorological Institute (ČMI), carried out the relevant international coordination of radio frequencies.

From a legislative perspective, the key development was the adoption of Act No. 252/2017 Coll., amending Act No. 127/2005 Coll., on Electronic Communications and on Amendments to Certain Related Acts (the Electronic Communications Act), as amended, and Act No. 483/1991 Coll., on Czech Television, as amended. This so-called 'digital amendment' came into force on 2 September 2017. In August 2018, the Czech Government approved Government Regulation No. 199/2018 Coll. on the Technical Plan for the Transition of Terrestrial Digital Television Broadcasting from the DVB-T standard to the DVB-T2 standard (Technical Transition Plan/TPP). Among other things, the TPP set out specific timeframes for the operation of transitional DVB-T2 networks, the switch-on of the final DVB-T2 networks and the switch-off of the existing nationwide DVB-T networks. In 2020, two amendments to the TPP were adopted in light of the declared state of emergency and government measures relating to the COVID-19 pandemic. The deadline for completing the switchover was postponed by four months to 31 October 2020.

Broadcasting via the DVB-T2 transition networks took place in parallel with the certification process for DVB-T2/HEVC television receivers. Since 2017, both the consumer electronics market and a significant proportion of viewers have adopted the new television broadcasting standard relatively quickly and without any problems. The operation of the transitional networks made it possible to switch off the original DVB-T networks and switch on the new DVB-T2 networks without any negative impact on the availability of terrestrial television broadcasting in the Czech Republic.

The result of this process is the release of the entire 700 MHz band for 5G mobile data connections, whilst also preserving the existing four nationwide terrestrial television broadcasting networks until at least 2030 and, through them, ensuring the continued free reception of television broadcasts. This has ensured the continued availability of a wide choice of freely accessible (i.e. free-to-air) television programmes for all sections of the population across all regions of the Czech Republic via digital terrestrial television broadcasting, as well as opportunities for its qualitative development. The completion of the transition to DVB-T2 broadcasting not only enabled the timely release of radio frequencies in the 700 MHz band, but also the reorganisation of radio frequency usage, which created the conditions for the continued full-scale operation of free-to-air DVB-T reception until at least 2030. The switchover affected at least 2.5–3 million Czech households that rely on free-to-air terrestrial television reception. The transition to the DVB-T2 standard has ensured that viewers can continue to receive all the most-watched television programmes free of charge via DTT, with many of them available in HD quality.

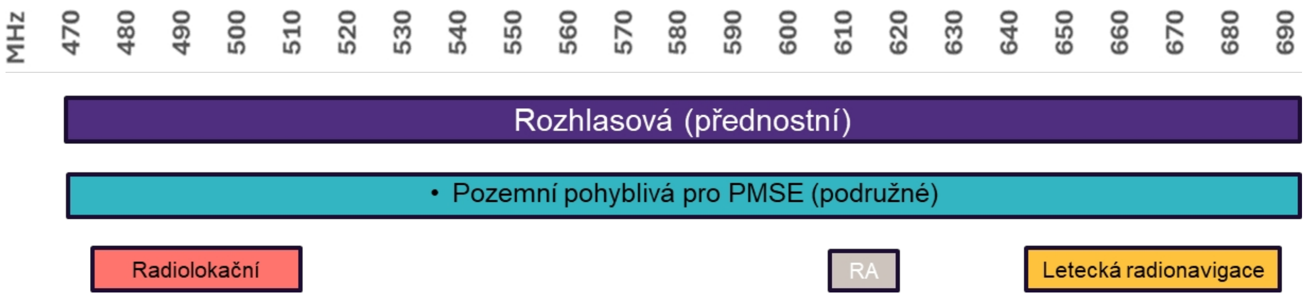
The switch-off of the existing DVB-T networks began in November 2019, when two of Czech Television's main transmitters in Prague and Central Bohemia were switched off, and continued in 2020 with the gradual switchover of the DVB-T2 transition networks to their final frequencies and the simultaneous switch-off of the DVB-T transmitters. The transition was completed in October 2020, and the 700 MHz radio frequencies were released in November 2020 in accordance with the amended Government Regulation No. 199/2018 Coll., on the transition to the DVB-T2 standard. The Czech Telecommunications Office (ČTÚ) granted the operators' requests and, where possible, extended individual authorisations for the use of frequencies beyond 31 October 2020. The relevant individual authorisations for

6 The so-called Lamy Report (2014), *Results of the work of the High Level Group on the future use of the UHF band (470–790 MHz)*: https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=6721

regional broadcasting via regional transmitters (regional networks) allows for broadcasting in both the DVB-T and DVB-T2 standards, depending on the network operator's commercial decision. Reception of regional network broadcasts in the DVB-T standard is possible due to the backward compatibility of the DVB-T2 codec.

1.2 Allocation of the UHF frequency band in EU countries

Figure 1: Allocation of the UHF band in Europe

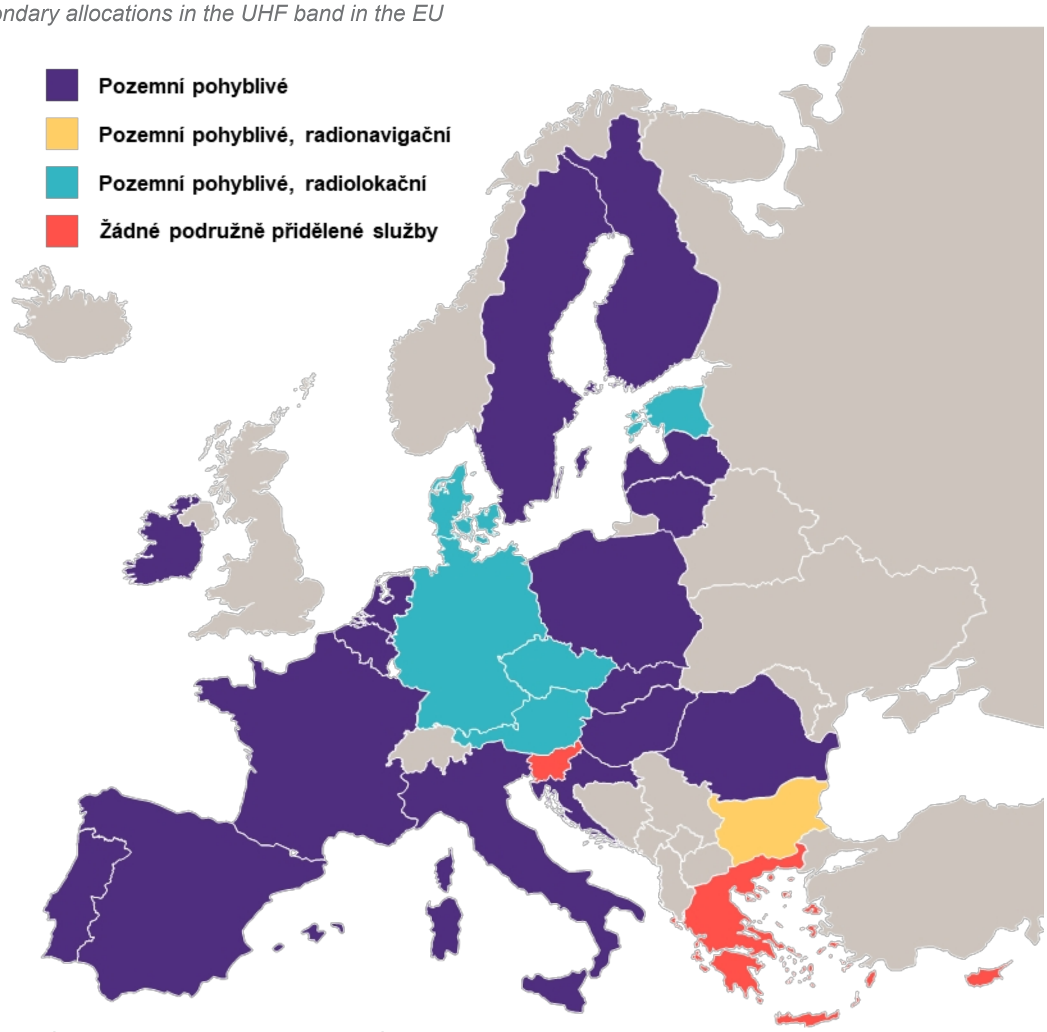


Source: European Commission (2022), adapted by GTA

The 470–694 MHz frequency band is allocated on a priority basis to terrestrial television broadcasting. In most EU Member States (except Cyprus, Greece and Slovenia), the band is also allocated on a secondary basis to terrestrial mobile services. However, these services must not cause interference to, nor require protection from, terrestrial television broadcasting. Furthermore, Member States allocate parts of the radio spectrum to radio astronomy, radiolocation (in Denmark, Estonia, Germany and Austria) and radionavigation services (Bulgaria). Eleven Member States (including the Czech Republic) use DVB-T2 only, eleven Member States use DVB-T, and five use a combination of both services at national level. Approximately 60% of all national multiplexes already use the most advanced transmission standard (DVB-T2) and approximately 40% of these use the most advanced coding standard (HEVC). At least 12 Member States already utilise [SFN] to some extent in their DTT networks7

[7] European Commission (2022), *Final report: Study on the use of the sub-700 MHz UHF band (470–694 MHz)*

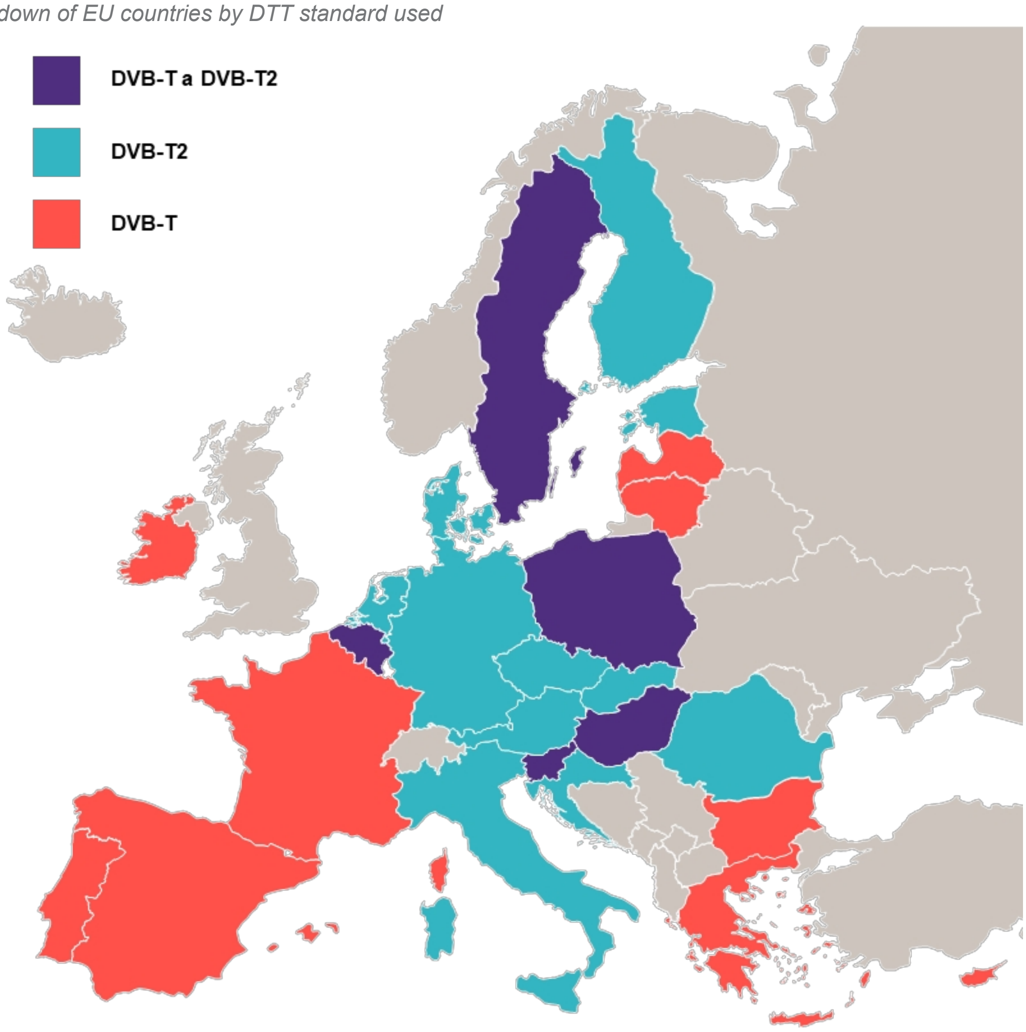
Figure 2: Secondary allocations in the UHF band in the EU



Source: European Commission (2022), adapted by GTA

As regards the Czech Republic's neighbouring countries, Poland and Slovakia have the radio band primarily allocated for terrestrial television broadcasting, with a secondary allocation for land mobile services. Poland also utilises the 694–790 MHz band for terrestrial broadcasting. Austria and Germany also have a secondary allocation for radar services in the 470–494 MHz band in addition to these services. Germany also utilises the 470–608 and 614–694 MHz bands for radio microphones (PMSE), the 608–614 MHz band for radio astronomy services, and the entire band for military radio applications and commercial radio.

Figure 3: Breakdown of EU countries by DTT standard used



Source: European Commission (2022), adapted by GTA

1.3 Frequency band allocation in other countries of ITU Region 1

The situation is similar in other countries of ITU Region 1. The UHF band is primarily allocated to terrestrial television broadcasting. Furthermore, in 86 of the 121 countries in Region 1, this band is secondarily allocated to terrestrial mobile services. In Region 1, two countries – namely Saudi Arabia and the United Arab Emirates – are considering allocating the UHF band to mobile services.

Conclusion to Chapter 1:

- In the Czech Republic, the Czech Telecommunications Office (ČTÚ) has, on the basis of the PVRS, allocated the UHF band primarily to terrestrial television broadcasting, as is the case in EU countries and ITU Region 1. In most EU Member States (with the exception of Cyprus, Greece and Slovenia) and ITU Region 1, this band is also allocated on a secondary basis to terrestrial mobile services (PMSE).
- Other conditions for the use of the band do vary. In Germany, Austria, Denmark, Estonia, Liechtenstein, Serbia and Switzerland, the 470–494 MHz band is additionally allocated on a secondary basis to the radiolocation service. Member States also allocate parts of the radio spectrum to radio astronomy and radionavigation services.
- A key factor in the allocation of radio spectrum was the completion of the transition of terrestrial television broadcasting from the DVB-T standard to the more efficient DVB-T2 standard; this transition was finalised in October 2020, and the relevant frequencies in the 700 MHz band were released at the same time. Approximately 60 % of all national multiplexes in EU countries already use the most advanced transmission technology (DVB-T2), and approximately 40 % of these use the most advanced coding standard (HEVC).

2 Efficient use of of the UHF frequency spectrum

2.1 Television broadcasting services

Within the UHF frequency band, the allocation for terrestrial digital television broadcasting is as follows:

- 470–582 MHz – TV Band IV (channels 21–34);
- 582 MHz–694 MHz – TV Band V (channels 35–48).

In October 2020, the last DVB-T transmitter in the nationwide networks was switched off and the reallocation of transmission channels for the four nationwide multiplexes in the DVB-T2 standard was completed.[8]

Between 2018 and 2019, a decision was issued to change the allocation of radio frequencies from the 470–790 MHz band to the 470–694 MHz band to provide a public electronic communications network using the DVB-T2 standard to the organisations Česká televize, České Radiokomunikace a.s., Czech Digital Group, a.s. and Digital Broadcasting s.r.o. until 31 December 2030. Licences in five other EU Member States (the Netherlands, Croatia, France, Denmark and Luxembourg) are also valid until the same date. In six Member States (Estonia, Austria, Hungary, Poland, Lithuania and Ireland), licences have been granted for a later date, namely until 2035.

Table 2: Allocation of national multiplexes in the Czech Republic

Multiplex	Owner/operator	Channel (transmitters, coverage)	Programmes/TV channels
Multiplex 21	Czech Television / České Radiokomunikace a.s.	Channels 26, plus 33 (Northern Bohemia) and 39 (Western and Southern Bohemia).	Czech Television currently offers the following programmes on its DVB-T2 multiplex: ČT1, ČT2, ČT24, ČT sport, ČT :D/art, and the regional variants ČT1 JM, ČT1 SM, ČT1 JZC and ČT1 SVC in high definition (HD).
Multiplex 22	České Radiokomunikace a.s.	Channels 40 and 28, 22 (Zlín region), 27 (South Bohemia), 34 (West Bohemia) and 38 (North Bohemia).	The multiplex carries 10 Prima TV programmes, two Óčko TV programmes, the Retro Music TV programme and the Českých Radiokomunikace a.s.
Multiplex 23	České Radiokomunikace a.s.[9]	Channels 31 and 33, 23 (South Bohemia), 22 (Prague), 34 (Pardubice) and 35 (Vysočina).	The multiplex includes Nova and Nova Cinema, Seznam.cz TV, three TV Barrandov channels, TV Noe, Spektrum Home and A 11.
Multiplex 24[10]	Digital Broadcasting s.r.o.	Channels 21 (Northern Bohemia and the Pardubice region), 30 (České Budějovice, Beroun), 42 (Prague,	The multiplex carries five Nova TV channels, eight channels from smaller broadcasters, including a Ukrainian children's channel, and one promotional channel operated by the broadcaster.

[8] A multiplex refers to a package of television and radio programmes and supplementary services broadcast on a single channel as part of digital broadcasting (see DVB-T and DVB-T2).

[9] Through its subsidiary Czech Digital Group, a.s.

[10] It is the only nationwide multiplex to have its channels divided by region, and thus includes slots for regional broadcasting.

		Vysočina, Zlín region), 43 (Pilsen, Domažlice, Liberec region), 44 (Central Bohemia and Olomouc), 45 (Jáchymov, Hradec Králové region, Ostrava region) and 46 (South Moravian Region).	In addition, the multiplex includes 13 regional stations.

Source: ČTÚ, adapted by GTA

In addition, 15 regional DVB-T / DVB-T2 terrestrial multiplexes are in operation

Table 3: Allocations for regional networks in the Czech Republic

Regional network	Owner/operator	Channel (transmitters)	Programmes/TV channels
Regional Network 1	Meridi	Channels 21, 30, 46 and 47 (4 transmitters in South Bohemia plus Strašice and Kamýk nad Vltavou).	JČ1 TV, Kurýr TV, A11, Náš region TV
Regional Network 4	České Radiokomunikace a.s.	Channel 46 (Prague).	Prague TV
Regional Network 5	CMS TV	Channel 35 (Litomyšl, Svitavy).	CMS TV
Regional Network 6	AV Park	Channel 21 (Prague).	TV13 SD and TV13 HD
Regional Network 7	Digital Broadcasting s.r.o.	Channels 36 and 37 (Prague, Brno).	Operator's promotional channel
Regional Network 8	České Radiokomunikace a.s.	Channels 23, 28, 30, 32, 33, 35, 38, 41, 46 and 47 (18 transmitters across the Czech Republic).	
Regional Network 9	TV PRODUKCE DAKR s.r.o.	Channels 37 and 47 (Ústí nad Labem Region)	
Regional Network 11	Fiera Touch	Channels 25, 27, 29, 33, 34, 36–38, 41 and 47 (21 transmitters across the whole of the Czech Republic).	i-Vysočina.cz and iVodárenství TV
Regional Network 12	Czech Digital Group, a.s.	Channel 47 (Prague).	Noe TV, Óčko Black and Óčko Expres
Regional Network 14	Jindřichův Hradec Telecommunications	Channel No. 47 (Jindřichův Hradec region, 3 transmitters).	Datel HD, JHTV HD, JČ1 TV and Kurýr TV
Regional Network 15	Vladimír Bílý	Channel 32 (Adamov).	TV Adamov
Regional Network 16	Nataša Pštrossová	Channel No. 46 (Kamýk nad Vltavou, Příbram).	TV Fonka
Regional Network 17	RTI cz	Channel 27 (Pilsen).	Pilsen TV HD
Regional Network 18	JC Media	Channel 47 (Český Krumlov).	JČ1 TV and Kurýr TV
Regional Network 21	TvSat	Channel 27 (Mariánské Lázně).	TVML HD
Regional Network 22	Pavel Kalista	Channel 41 (Klatovy).	

Source: ČTÚ, edited by GTA

Regional networks 2, 3, 10, 13, 19 and 20 are not currently in operation.

2.1.1 Public service media

In the context of DTT, it is also worth mentioning the role of public service media (in particular Czech Television, and to some extent Czech Radio). According to media expert Karel Hvížďala, a public service media organisation is "a term denoting a media organisation that receives funding from public money and has a legally defined scope and set of obligations. The differences between public service media and private media lie primarily in the following aspects"[11]:

[11] Adapted from the teaching material 'One World in Schools' (JSNS, jsns.cz)

- **Legal requirements** – Public service media are required by law to fulfil more obligations than private media. They must, for example, contribute to raising legal awareness among the population of the Czech Republic and foster their cultural identity.
- **Funding** – Czech Television and Czech Radio derive most of their revenue from so-called licence fees, which, by law, are paid by all households with a television or radio receiver.[12] Traditional private media, by contrast, derive most of their revenue from advertising. Licence fees should also ensure that public service media have sufficient funding to produce media content that would be unprofitable for private media (e.g. documentaries, programmes for minority groups, etc.).
- **Target audience** – Public service media are obliged to provide a balanced range of programmes for all sections of the population (representatives of minorities, different religious denominations, etc.). Private media often have a narrower target audience to which they tailor their content.
- **Independence** – After 2000, most major private media outlets came under the control of prominent Czech businesspeople. They might attempt to use the media they have acquired to consolidate their power. This should not be a risk for public service media, as they do not have a traditional owner. The directors-general are elected by the councils that oversee the individual public service media organisations (i.e. the Czech Television Council, the Czech Radio Council and the Czech Press Agency Council).

In the Czech Television Code[13], Czech Television further commits to implementing the Council of Europe's programme for public service broadcasting, inter alia, by:

- Providing a forum for public debate in which the widest possible range of views and perspectives can be expressed;
- Providing impartial and independent news, information and commentary;
- It creates a pluralistic, inventive and diverse range of programmes that meets high ethical and quality standards, and does not subordinate the pursuit of quality output to market pressures;
- It actively contributes to a better knowledge, understanding and dissemination of national and European cultural events and heritage;
- Ensures that its programming schedules include a significant proportion of original productions, particularly feature-length films, drama and other creative works, and takes into account the need for cooperation with independent producers and the film sector.

In 2014, the European Broadcasting Union (EBU) set out the fundamental principles and technical requirements for the operation of public service media and the distribution of linear broadcasting, including:

- The option of free-to-air broadcasting or an equivalent, with no additional costs for viewers and listeners;
- The provision of public service broadcasters' services without blocking or filtering the range of services on offer, i.e. no gatekeeping;
- Integrity of content and services – no modification of content or services by third parties; for example, television content must be displayed on screen without alterations and without unauthorised overlays;
- Service quality requirements are defined by the broadcaster, e.g. in terms of network operation, robustness and reliability;
- The quality of service for each user must be independent of audience size;
- The operator defines the geographical scope of services (e.g. national, regional, local);
- The ability to ensure coverage in exceptional and emergency situations, such as natural disasters.

To ensure a high-quality user experience, the EBU specifies average data rates per programme:

- For live television content, the following data rates are assumed for HDTV signals encoded using MPEG-4 / H.264: an average of 8 Mbit/s, with a minimum of 5 Mbit/s;
- For fixed and portable televisions: an average of 5 Mbit/s;
- For in-vehicle televisions, desktop and laptop computers, smartphones and tablets: a minimum of 2.5 Mbit/s.

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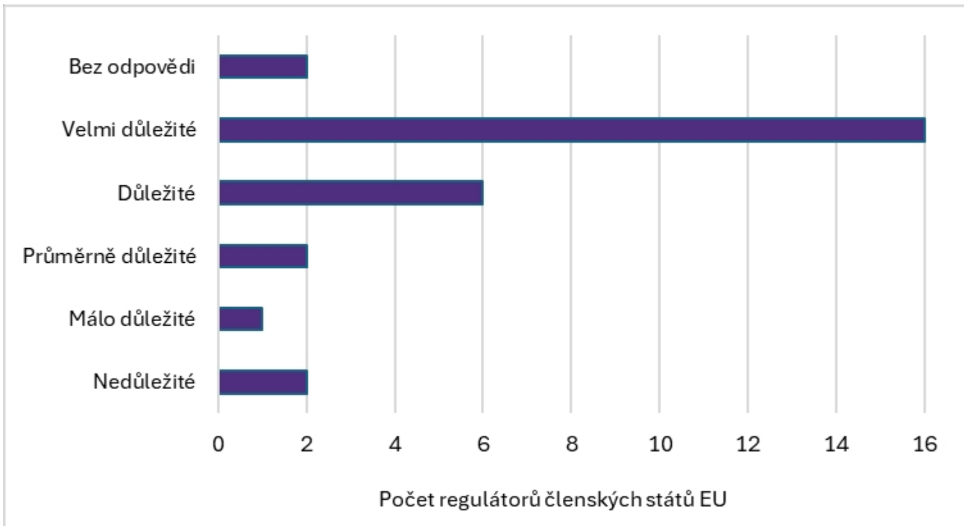
[12] The legislative process is currently underway regarding an amendment to the Act on Czech Television. The definition of the equipment on which the licence fee is levied is to be changed. It will now cover any device capable of receiving and reproducing radio or television broadcasts, such as a smartphone, tablet or computer.

[13] Approved by the Chamber of Deputies of the Parliament of the Czech Republic on 2 July 2003

It is very important for public service media to ensure the free-to-air distribution of their content. In a survey of telecommunications regulators in EU countries, the vast majority (20, including countries with a limited share of terrestrial TV broadcasting) stated that this free-to-air (FTA) distribution remains (very) important.[14]

Figure 1: The importance of free-to-air (FTA) broadcasting of public service media content from the perspective of regulators in EU countries



Source: European Commission (2022), adapted by GTA

The DTT platform is primarily designed to provide linear television services, but various options (i.e. cable television, satellite television and IPTV) are available to users in all countries. The Czech Republic advocates the public interest in the long-term operation of the platform, particularly for the distribution of public service linear broadcasting content, whilst maintaining the conditions for private broadcasting in line with the principle of duality in television broadcasting.

[14] European Commission (2022), Final report: Study on the use of the sub-700 MHz UHF band (470–694 MHz) – https://op.europa.eu/en/publication-detail/-/publication/d77a592e-4f54-11ed-92ed-01aa75ed71a1/language-en

2.2 Mobile communications services

Mobile communications services are gradually 'encroaching' on frequency allocations previously designated for television broadcasting. An overview of frequency allocations (in MHz blocks) to mobile operators in the Czech Republic is provided below.

Figure 4: Frequency allocations for mobile network operators in the Czech Republic

Source: ČTÚ, adapted by GTA

In this context, it is worth noting the position of the Association of Mobile Network Operators (APMS) dated 23 February 2023 regarding the use of the 600 MHz band.[15]

The APMS recommends that the 600 MHz band be allocated in future on a so-called co-primary basis. According to the APMS, this should enable national regulatory authorities to decide flexibly on its future use, particularly in light of trends in television content consumption. At the same time, the APMS is of the view that, from 2030 onwards, it will be socially inefficient to use the full width of this band solely for television broadcasting. This is particularly true if future trends away from linear television viewing (via a roof-mounted aerial) towards on-demand or time-shifted viewing – where a high-quality internet connection is, conversely, a key prerequisite – are confirmed or even intensify.

5G technologies utilise a combination of three types of spectrum: low-band, mid-band and high-band. The low-band comprises frequencies below 1 GHz. The low UHF band is characterised by comprehensive coverage, which allows the signal to penetrate walls or windows more easily. The high-band (frequencies of 24–40 GHz, also known as millimetre waves) has limited applicability, as the signal has poorer propagation characteristics than signals in the low-band. Sometimes the signal only travels a distance of less than one kilometre and is more susceptible to interference from objects such as trees, buildings and even glass. Signals from high-band frequencies also penetrate interiors and buildings relatively poorly. However, the advantage of the millimetre-wave spectrum is that, provided the signal is uncongested, users can achieve connection speeds of between 1 Gb/s and 3 Gb/s, or even higher. The mid-band spectrum (1–6 GHz) represents a compromise between the two mentioned above. For 5G purposes, the RSPG has identified the 700 MHz, 3400–3800 MHz and 24.25–27.5 GHz bands as typical spectrum allocations.

The GSMA, the umbrella organisation for mobile network operators, justifies the need for further spectrum allocation for 5G in its report:

[15] https://apms.cz/pozice-apms-k-vyuziti-pasma-600-mhz/

"5G requires a significant amount of new harmonised mobile spectrum. Regulatory authorities should aim to make available 80–100 MHz of contiguous spectrum per operator in the main 5G mid-bands (e.g. 3.5 GHz) and approximately 1 GHz per operator in the millimetre-wave bands (i.e. above 24 GHz)."[16]

The most recent tender for mobile network frequencies was announced in the Czech Republic on 7 August 2020. Specifically, this involved the granting of rights to use frequencies to provide electronic communications networks in the 700 MHz and 3400–3600 MHz frequency bands (also known as *the 5G Auction*). In the case of the 700 MHz band, three radio frequency allocations of 2×10 MHz were granted, subject to a commitment to gradually roll out 5G networks across the Czech Republic, including major transport corridors. A similar commitment applies to the 3400–3600 MHz band, for which five companies were granted rights of use.[17] For the 3400–3480 MHz and 3640–3700 MHz bands, there is a further obligation to make available up to the full range of their spectrum for local industrial use within a closed industrial site (5G projects in the field of Industry 4.0). Despite initial declarations regarding the need for additional capacity and the reservation of spectrum for IMT, operators in the Czech Republic and elsewhere in Europe did not show much interest in the possibility of allocating frequencies for SDL (see section 2.3.1 below) in the 700 MHz and 1 400 MHz bands.

2.3 Key technological trends

2.3.1 5G Broadcast

One of the standards that could complement or even replace DTT in the sub-700 MHz band is 5G Broadcast. DTT broadcasting has traditionally focused on fixed reception, which is designed to enable the efficient one-way delivery of content to television screens. However, consumers' content consumption is increasingly shifting away from the exclusive use of television screens towards a combination of devices – such as television screens, smartphones, tablets and laptops – and across various locations both within and outside the home. The requirement for fixed reception therefore potentially limits broadcasters' ability to deliver content to certain end-users in the locations and formats that suit them.

A focus on other methods of broadcast reception is possible, but requires an ecosystem of devices capable of incorporating the necessary antennas and decoders. Precisely because of their current low penetration, many broadcasters have begun to utilise broadband connections, which allow for more flexible delivery of content to end users via an internet connection.

Delivering content via broadcast networks represents a spectrum-efficient method of content distribution, as the content is transmitted on a single channel within a geographical area. This contrasts, however, with mobile broadband, where the unicast system requires the content to be delivered to each user to be transmitted separately, regardless of whether two users are requesting the same content. In networks with low traffic loads, this may not be a problem, but in networks with increasing levels of data consumption, the high data demands associated with video consumption can cause issues.

A potential solution, which offers a higher level of spectral efficiency than the unicast system, is therefore the ability for broadcast content to reach new reception methods and devices using 5G Broadcast technology. This technology offers the possibility of delivering broadcast content via 5G (using either broadcasting or the IMT network), as defined within the relevant 3GPP standards.

DTT typically focuses on fixed rooftop reception, and propagation is largely direct with relatively little interference in the vicinity of the receiving antenna (usually 10 m above ground level). By contrast, 5G Broadcast, which is designed for handheld portable reception (usually 1.5 m above ground level), is exposed to much greater interference in the vicinity of the receiver. Consequently, high levels of signal loss are likely with 5G Broadcast. As a result, higher incoming signal levels are expected to be required for receiving 5G Broadcast on mobile devices than for DVB-T/T2 on fixed rooftop antennas.

5G Broadcast can operate in bands with a bandwidth of 1, 3, 4, 5, 10, 15 and 20 MHz, whilst work is underway within 3GPP to standardise the use of 6, 7 and 8 MHz bandwidths as part of 3GPP Rel-17. No information is provided on the anticipated operational frequency bands; however, many assume that 5G Broadcast will be deployed in the current UHF band to facilitate the reuse of existing household transmission and reception equipment. However, given the lack of standardised frequencies currently included in the standard, the technology could also be deployed in other frequency bands. After all, 5G itself

[16] https://www.gsma.com/latinamerica/wp-content/uploads/2019/03/5G-Spectrum-Positions.pdf

[17] CentroNet a.s. (later incrate s.r.o.) sold its allocation to T-Mobile Czech Republic a.s. in July 2023.

technology will be able to be used in the 700 MHz or 26 GHz bands. It may also be used in bands currently designated for 2G, 3G and 4G technologies, such as the 3.4–3.8 GHz band. Frequencies in the 700 MHz and 3.4–3.8 GHz bands for the roll-out of 5G networks in the Czech Republic were the subject of previous spectrum auctions. Large-scale network roll-out is already underway in both bands.

Testing of the 5G Broadcast standard is already underway across the EU with the following remit:

- In the Czech Republic, this standard was tested in two phases by České Radiokomunikace, most recently in May 2023 from two Prague transmitters, Žižkov and Strahov.
- The 5G Broadcast standard has also been tested in many EU countries. One example is France, where testing took place during the 2023 French Open in collaboration with TDF and France Télévisions. Sports broadcasts were transmitted from the Eiffel Tower in UHD resolution to Paris, Toulouse and Nantes. The aim was to test reception on mobile devices.[18]
- In Austria, the broadcaster ORF has been conducting trials in several phases since 2020, which are due to conclude in 2024. In addition to the application and further development of 5G Broadcast, other potential technical functions such as emergency alerts and navigation are also being investigated.
- Tests of 5G Broadcast technology were launched in Finland by the broadcasting network operator Digita in September 2020 and continued until 2022. The tests took place in the Helsinki metropolitan area using an SFN with three transmitters. Following a technical feasibility study, the next phase is currently being planned.[19]
- France, Italy, Germany, the Netherlands, Ireland and Austria are preparing to showcase a jointly developed application and the commercial use of 5G broadcasting to coincide with the 2024 Olympic Games in Paris and the European Football Championship in the same year. This work will enable broadcasters to accurately assess the feasibility of adopting and implementing the new transmission standard over the next few years.[20]

The EBU's overview of mobile broadband bands suitable for broadcasting[21] notes:

'The mobile network configuration options of greatest relevance to linear broadcast distribution are "supplementary downlink" (SDL) and "stand-alone downlink only" (SDO). Both can deliver broadcast content via a downlink, but whilst SDL must be coupled with an uplink in a different spectrum band – which is necessary to establish a connection with the mobile network – SDO is a one-way transmission from the content provider to the user without the need for a connection to the mobile network. SDO is the configuration applicable to LTE-based 5G terrestrial broadcasting. To date, no frequency bands have been standardised exclusively for such use. However, some bands have been specified for SDL (or may be in the future) and could potentially be used simultaneously for LTE-based 5G terrestrial broadcasting/SDO. For example, the SDL allocation in the L band (1452–1496 MHz) provides high bandwidth for the distribution of audiovisual content and could be ideal for use within LTE/SDO-based 5G terrestrial broadcasting. However, this would require reallocation to broadcasters, which seems unlikely given broadcasters' reluctance to utilise it in the past. The identification of SDL in the duplex gap of the 700 MHz band has good technical potential for SDL, but is not suitable for SDO use due to the risk of interference with mobile network services and interference from other parts of the 700 MHz band."

In its Tech Report 063[22], the EBU states the following:

"Hybrid networks comprising three layers – HPHT, MPMT and LPLT – offer the best compromise between good coverage for mobile devices and reasonable site density. These are true three-layer networks, where HPHT sites serve as the overarching layer, supplemented in some rural and suburban areas by MPMT sites, which in turn are supplemented by LPLT sites in urban areas. Such hybrid topologies can ensure sufficiently high SINR values (up to 15 dB), enabling the use of efficient 5G broadcast modulation and coding schemes achieving data rates of up to 7 Mbit/s in a 5 MHz band under reception conditions for mobile and handheld devices."

The EBU's analysis also states that existing broadcasting networks may be insufficient to provide the level of coverage required for good 5G Broadcast mobile reception. This would require broadcasters either to further develop their own networks at their own expense or to reach agreements with existing mobile network operators. This raises the following questions

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[18] https://www.broadbandtvnews.com/2023/06/09/tdf-and-france-televisions-trialling-uhd-on-dtt-and-5g-broadcast/

[19] https://broadcast-networks.eu/wp-content/uploads/5G-broadcast-trial-leaflet.pdf

[20] https://www.tvtechnology.com/news/european-broadcasters-set-roadmap-for-5g-broadcast

[21] https://tech.ebu.ch/publications/bpn116

[22] EBU (2021), *TR 063 5G Broadcast network planning and evaluation*, https://tech.ebu.ch/docs/techreports/tr063.pdf

relating to business models that will help support 5G Broadcast. The traditional broadcasting model involved broadcasters who either operated their own transmission networks or, as is the case in many Member States, paid specialist network operators to run the network on their behalf. If broadcasters are required to densify their existing networks, the question is to what extent this may be economically viable. Given that linear viewing figures are declining, it could be unsustainable for broadcasters to finance further network roll-out. Similarly, the additional costs of funding mobile broadcasting may also be unsustainable.

A key challenge in the roll-out of 5G broadcasting was the availability of receiving equipment, specifically the requirement that it should not require network authentication, be capable of receiving DTT signals with high field strength in the adjacent spectrum, and that such equipment should become widely available within a reasonable timeframe. Some devices compatible with these requirements already exist; however, these are mostly test devices that are still some way from commercial use. This is due to the 3GPP Rel-17 specification, which focused, amongst other things, on services providing free-to-air (FTA) content or devices operating in receive-only mode (ROM).[23] According to studies, the costs of developing a 5G Broadcast network are considerable[24], and although some potential business models are beginning to emerge, it is not currently clear to what extent they would be feasible for broadcasters in all Member States.

2.3.2 Video compression options

Whilst the upgrade from DVB-T to DVB-T2 is capable of increasing the capacity available on the DTT platform within a Member State, improvements in video compression technologies serve to reduce the capacity required for a service, meaning that a greater number of services can be carried within a given capacity. Early digital television networks typically used MPEG-2, a standardised video compression technology dating from 1995. The transition to the more efficient MPEG-4 (also known as H.264) can reduce the bit rate by up to 50 per cent. H.265 HEVC offers similar improvements over H.264 MPEG-4, with reported reductions in the required capacity of 42–50 per cent.[25] H.266 VVC is expected to deliver similar improvements over HEVC, i.e. a further 50 per cent reduction in the required capacity.[26]

Estimates carried out for a European Commission study showed that the transition to DVB-T2 HEVC (from DVB-T MPEG-2/4) would cost a total of between 456 million and 659 million euros for all 28 EU Member States by 2016 (LS telcom, VVA, 2015)[27]. Excluding figures for the United Kingdom, the study showed that such a transition would cost between 439 million and 635 million euros for the current 27 EU Member States, with encoder costs accounting for only approximately 8 million euros of the total costs.

Another option for video compression is the ATSC 3.0 standard, also known as NextGen Broadcasting. NextGen Broadcasting is a digital terrestrial broadcasting standard designed for over-the-air reception; unlike DVB systems, it does not use the HEVC or MPEG codecs, but is entirely based on the IP protocol. It supports high dynamic range (HDR) content with ultra-high resolution and also enables the use of the radio spectrum for a range of new data services. From the outset, it was designed to offer multiple wireless-based services simultaneously, in addition to television broadcasting. At the same time, it caters for fixed, portable and mobile use cases, enabling flexible use of the spectrum tailored to various new platforms. Furthermore, the ATSC 3.0 standard is adaptable to different use cases in different countries. This standard is designed to be decodable for every unique signal, including those yet to be defined. Supporters of this standard also highlight its greater flexibility with regard to the future development of smart devices, which is not possible with 5G Broadcast.[28] Some studies, which used simulations to compare ATSC 3.0 and 5G Broadcast, point to the potential for higher performance in mobile environments and the cost-effectiveness of the former.[29]

Given that ATSC 3.0 is primarily designed for fixed rooftop reception with large-screen televisions based on HPHT infrastructure, it faces a shortage of commercial mobile receivers. On the other hand, 5G broadcasting

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[23] https://www.etsi.org/deliver/etsi_tr/136900_136999/136976/17.00.00_60/tr_136976v170000p.pdf

[24] According to an EBU study, a dense mobile network with higher spectral efficiency than DVB-T2 would cost approximately 25–30 times more per household than the current cost of DTT operation in Germany per household (the study quantified the costs per viewing household).This cost could potentially be reduced to seven to eight times the current cost (IMT versus DTT) if spectral efficiency similar to that of DVB-T2 were achieved.

[25] EBU (2016), *TR 036 TV programme accommodation in a DVB-T2 multiplex for (U)HDTV with HEVC video coding,* https://tech.ebu.ch/docs/techreports/tr036.pdf [Accessed 17 January 2022].

[26] Fraunhofer HHI (2022). *H.266/VVC,* https://www.hhi.fraunhofer.de/en/departments/vca/technologies-and-solutions/h266-vvc.html

[27] European Commission (2015), Economic and Social Impact of Repurposing the 700 MHz band for Wireless Broadband Services in the European Union - https://op.europa.eu/en/publication-detail/-/publication/32345cb6-df78-11e5-8fea-01aa75ed71a1

[28] https://www.tvtechnology.com/opinion/sinclair-dont-fall-for-the-hype-on-5g-broadcast

[29] https://mys.mapyourshow.com/mys_shared/nab23/handouts/Evaluation_of_ATSC_3.0_and_3GPP_Rel-17_5G_Broadcasting_Systems_for_Mobile_Handheld_Applications.pdf

is struggling with a lack of HPHT-based transmission infrastructure for mobile services, even though it can easily provide mobile receivers for road broadcasting services. Despite the obvious similarity between the two standards, their use in the Czech Republic is highly unlikely.

Conclusion to Chapter 2:

- The operators of the four digital multiplexes have been allocated frequencies in the UHF band until the end of 2030. In addition, 16 regional DVB-T/DVB-T2 multiplexes are in operation.
- In connection with the allocation of UHF frequencies to DTT services, it is important to mention the need to ensure the functioning of the public service broadcaster – Czech Television. According to the law and its code of conduct, it should, amongst other things, provide a pluralistic and diverse range of programmes and impartial and independent news coverage. This service must be universally accessible in accordance with the legislation governing the operation of radio and television broadcasting and the coverage provided by terrestrial television signals.
- At the same time, the band below 700 MHz could effectively provide an additional overlapping layer of frequencies, which would increase capacity across the board in the UHF band.
- One of the standards that could complement DTT in the 600 MHz band is 5G Broadcast. However, existing broadcast networks are insufficient to provide the level of coverage that would be necessary for good 5G Broadcast mobile reception. This would require broadcasters to either continue developing their own networks at their own expense or to reach agreements with existing mobile network operators. Testing of the 5G Broadcast standard is already underway across the EU, including in the Czech Republic, where České Radiokomunikace has been testing this standard.

3 International framework for cooperation

3.1 ITU-R and WRC-23

The International Telecommunication Union (ITU) is a specialised agency of the United Nations responsible for coordinating international standards in the field of telecommunications and information technology. The ITU's main objectives include promoting the development and dissemination of telecommunications technologies worldwide, setting standards for the interoperability and compatibility of telecommunications equipment and networks, and coordinating the allocation of frequencies and orbital positions for telecommunications satellites.

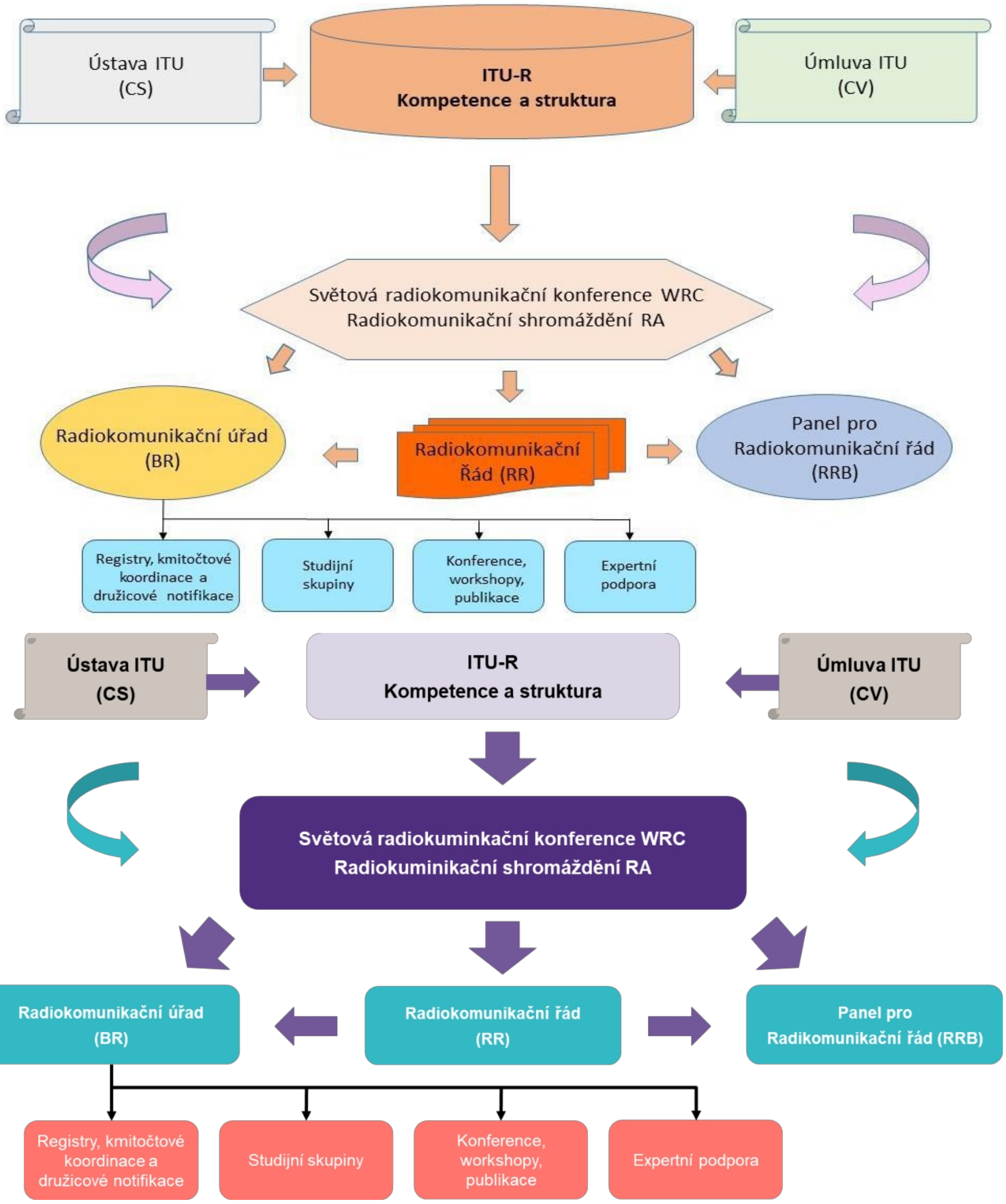
The ITU comprises three sectors: (1) the Radiocommunication Sector (ITU-R), (2) the Standardisation Sector (ITU-T) and (3) the Information and Communication Technologies Development Sector (ITU-D). These sectors work together to achieve the ITU's objectives across various areas of telecommunications and information technology.

The ITU Radiocommunication Sector (ITU-R) plays a key role in the management of the radio spectrum and the development of radiocommunications at a global level. Its activities are based on the objectives of the ITU Strategic Plan, which is approved every four years by the Plenipotentiary Conference.

The ITU-R Sector provides technical and organisational preparation for the World Radiocommunication Conferences (WRCs) and radiocommunication assemblies. Through the Radiocommunication Bureau (BR), it implements and provides support for the practical application of the provisions of the Radio Regulations, as well as technical and organisational support for the activities of the Sector's individual study groups30.

[30] The following study groups are currently active within the ITU-R: SG 1 Radio Spectrum Management, SG 3 Radio Propagation, SG 4 Satellite Services, SG 5 Terrestrial Services, SG 6 Broadcasting Service, SG 7 Scientific Services. The Terminology Co-ordination Committee also functions as a study group.

Figure 5: ITU-R activities, remit and organisational structure[31]



Source: Fundamentals of Radio Spectrum Management, adapted by GTA

The ITU Radio Regulations are a fundamental ITU-R document for the global management of the radio spectrum. They allocate frequency bands to individual radiocommunication services or radio stations in the range from 8.3 kHz to 3,000 GHz. At the same time, it sets out the technical and administrative conditions for the operation of terrestrial and space services and radiocommunication stations, and for protection against unwanted interference. For space services, it specifies the positions of satellites in Earth orbits and methods of protection against unwanted harmful interference.

The Radio Regulations are regularly updated every three or four years at World Radiocommunication Conferences. The outcome of the WRC is a document entitled *'Final Acts'*, which contains the adopted

[31] Taken from P. Ondráček (2023), *Fundamentals of Radio Spectrum Management*, Faculty of Electrical Engineering, Czech Technical University in Prague, Department of Telecommunications Engineering

amendments to the Radio Regulations, ITU-R Resolutions, new ITU-R Resolutions, study questions and the agenda for the next conference, and member states' reservations regarding individual WRC outcomes.

The Final Acts of WRC-23, held on 15 December 2023 in Dubai (United Arab Emirates), were signed by representatives of 151 Member States. The Final Acts constitute a record of the decisions adopted at the conference, including new and revised provisions of the Radio Regulations, all amendments, and new and revised ITU-R resolutions and recommendations incorporated into the Radio Regulations by means of cross-references.

One of the key topics was agenda item **1.5, which concerned the future of the sub-700 MHz band** used in Europe and, more generally, in Region 1 for DTT. The newly approved conditions ensure long-term international protection of the entire 470–694 MHz band, which remains prioritised for TV broadcasting in Europe. The conditions guarantee that countries will be able to utilise the full range of frequencies for DTT in the long term. At the same time, WRC-23 took into account the requests of several countries outside Europe to be able to use the 614–694 MHz band for public IMT mobile networks within their territories. The next review of the 614–694 MHz band will be carried out at the WRC-27 and WRC-31 conferences. From the perspective of the prerequisites and long-term conditions for the use of the band in the Czech Republic, the update to the Radio Spectrum Management Strategy, which is being prepared by the Czech Telecommunications Office (ČTÚ), will be crucial. This is because the ITU largely leaves it to individual member states to decide how to manage the frequencies used for DTT, whilst ensuring interference-free operation.

In addition to the band below 700 MHz, a key item on the WRC-23 agenda was the discussion on conditions for IMT (5G and 6G networks) in the 6 GHz band. A large part of the agenda was also devoted to the development of communication capabilities for critical applications in aviation and transport. The conference also discussed a wide range of issues relating to space communications and scientific applications, which will set the direction for the use of radio frequencies in the future. One of these issues will be the examination of the conditions for direct connectivity from satellite networks.

3.2 RSPG

As a general rule, where the ITU Radio Regulations are amended in a way that affects EU law, the EU's positions on such amendments should be established by a decision of the Council of the EU, taking into account the opinion of the RSPG – the Radio Spectrum Policy Group. The RSPG serves as an advisory body to the European Commission on strategic issues relating to the use of the radio spectrum. It provides input on key issues, such as the setting of strategic objectives to meet the needs not only of electronic communications but also of other sectors, including the means of achieving them. The RSPG may now be called upon by the European Commission, the European Parliament or the Council of the EU to provide an opinion or issue a report on specific radio spectrum policy issues.

The RSPG published its Opinion on the strategy for the future use of the UHF frequency band in October 2023[32]. In it, the RSPG recommends the following approach to the use of the UHF band for the period after 2030:

- **A single scenario may not be applicable to all Member States.** The RSPG therefore recommends that any future EU regulation should facilitate the implementation of different scenarios for individual Member States, whilst emphasising the pursuit of compatible use and focusing on the means to achieve it. These regulatory measures should also take into account possible uses already permitted by the implementation of Article 4 of the European Decision.
- The RSPG also recognises the need to utilise the UHF band in individual Member States for mobile services other than wireless broadband electronic communications services and PMSE, specifically in the areas of PPDR emergency communications and national defence. **The RSPG therefore recommends that, in the event of a decline in broadcasting requirements at national level, spectrum should also be made available at national level for these purposes, taking into account possible cross-border coordination needs.**
- Any long-term developments in the national use of the UHF band may affect the availability of radio spectrum for audio PMSE. **The RSPG recommends that Member States introducing uses other than broadcasting should retain sufficient spectrum for PMSE needs and also take into account technological developments in PMSE.**
- The operation **of radio astronomy services in the UHF band must be safeguarded in the long term, as must the operation of radiolocation services** (wind profiler radars) in certain countries. The RSPG therefore recommends that the European Commission take these services into account in any long-term strategy for the UHF bands in the EU.
- **Developments in UHF broadcasting reception** over the current decade, including factors such as **the number of channels, content format** (HD/UHD) and **technological progress** (e.g. DVB-T2/HEVC, 5G Broadcast), **play a role in shaping any roadmap beyond 2030.** Furthermore, any decision on these factors is a national matter determined by market demand, user equipment, sustainability and the audiovisual sector

[32] RSPG (2023), *Opinion: Strategy on the future use of the 470–694 MHz frequency band beyond 2030 in the EU*

policy. The RSPG recommends that Member States intending to continue using the UHF band primarily for broadcasting should strive to implement the most efficient technologies (e.g. T2/HEVC).

- The RSPG will contribute its recommendations to the process of reviewing the European Decision and, if necessary, updating it before 2030, taking into account the Lamy Report.

3.3 CEPT/ECC

The European Conference of Postal and Telecommunications Administrations (CEPT) brings together regulatory authorities from the postal and telecommunications sectors. CEPT comprises three committees: the International Telecommunication Union Policy Committee (Com-ITU), the Electronic Communications Committee (ECC) and the European Committee for Postal Regulation (CERP).

The ‘ECC Strategic Plan for 2020–2025’ identifies the review of the ITU’s use of the UHF band, in accordance with agenda item 1.5 of WRC-23, as its top priority. **However, rather than focusing on DTT versus IMT, the ECC Plan emphasises the importance of PMSE and the need to support the distribution of audiovisual media in the future**. In conducting this review, the ECC should consider future spectrum requirements to support the distribution of audiovisual media in the long term, taking into account expected developments in broadcast distribution technologies.

In the context of European countries’ preparations for WRC-23, the ECC/CEPT Conference Preparatory Group (CPG) was of particular importance. Within the CPG, Project Team D (PTD) was responsible for drawing up joint European proposals on agenda item 1.5.

CEPT agreed on a common approach to both WRC-23 and future WRCs.

“CEPT proposes, for WRC-23, a secondary allocation for mobile services, with the exception of the aeronautical mobile service, in the 470–694 MHz frequency band (in ITU Region 1) and, as a future agenda item for WRC-31, consideration of a possible upgrade to a primary allocation.”

Furthermore, CEPT fully supported the priority allocation for television broadcasting and the secondary allocation for PMSE applications.

3.4 BEREC

The Body of European Regulators for Electronic Communications (BEREC) is an association of European regulators which has also taken over the activities of the former European Regulators Group (ERG). BEREC’s primary objective is to support the achievement of the regulatory framework’s objectives, in particular through mutual cooperation between national regulatory authorities. BEREC is governed by the Board of Regulators, comprising 28 representatives of national regulatory authorities. The European Commission, the member states of the European Free Trade Association (EFTA) and candidate countries are non-voting members. The Czech Republic is represented by the Chair of the ČTÚ Council.

3.5 DG CNECT Radio Spectrum Policy Unit B.4

The Directorate-General for Communications Networks, Content and Technology, or DG CNECT, is a directorate-general of the European Commission. DG CNECT plays a supporting role in European radio spectrum policy. It generally operates behind the scenes, overseeing public consultations on spectrum policy issues, planning and organising seminars and meetings of the RSPG and the EU Radio Spectrum Committee for stakeholders, and funding studies that provide factual evidence for EU regulations and decisions. Unit B.4 Radio Spectrum Policy (Radio Spectrum Policy Unit B.4) has concluded a contract with LS Telecom to carry out a study examining the current state and future trends in the use of the UHF band in the EU, as well as changes in viewing habits, the role of DTT in the distribution of public service media, and international developments regarding the use of this band. This document cites the study in question on a number of occasions.

3.6 World Broadcasting Union

The members of the World Broadcasting Union (WBU) are (1) the Asia-Pacific Broadcasting Union (ABU), (2) the Arab States Broadcasting Union (ASBU), (3) the African Broadcasting Union (AUB), (4) the Caribbean Broadcasting Union (CBU), (5) the European Broadcasting Union (EBU), (6) the International Association of Broadcasters (IAB/AIR) and (7) the North American Broadcasters Association (NABA). It was founded in 1992 as a coordinating body at the international broadcasting level. Since then, the WBU has provided its member unions with global solutions to key issues. The North American Broadcasters Association acts as the WBU's secretariat. The WBU Technical Committee supported the position that the Radio Regulations should remain unchanged under agenda item 1.5 of the WRC-23 programme for Region 1.

3.7 GSMA

The GSMA is a global organisation representing the interests of mobile network operators through industry programmes, working groups and initiatives to support the sector. As of 2024, the organisation comprised more than 1,000 mobile operators.

In its document focusing on 5G in lower frequency bands after 2030[33], **highlights the benefits of implementing 5G in the 600 MHz band, citing a 30 to 50 per cent improvement on current coverage in rural areas and indoor spaces, whilst also reducing the costs of roll-out in sparsely populated areas.** In its report, it addresses the importance of ensuring internet access for all residents and the resulting positive impact on national economies. Current proposals in the 600 MHz band would allow the use of a frequency band of 2x35 to 2x40 MHz. Among other benefits, the GSMA cites, for example, reduced costs for providing coverage on remote roads for 5G vehicles or the use of IoT in agriculture.

Conclusion on Chapter 3:

- The basic global framework for access to UHF spectrum management was established at the **WRC-23** meeting in Dubai, United Arab Emirates. The newly approved conditions ensure long-term international protection of the entire 470–694 MHz band, which remains primarily allocated for TV broadcasting in Europe.
- The update **to the Radio Spectrum Management Strategy**, which is being prepared by the Czech Telecommunications Office (ČTÚ), will be carried out in line with the approach taken by countries in the European Union. It will take into account the opinions of EU advisory bodies and other international organisations, subject to the proviso that a single scenario may not be applicable to all Member States.
- **The RSPG** recommends that, in the event of a decline in broadcasting requirements at national level, spectrum should also be made available at national level for crisis communication and national defence purposes, whilst taking cross-border coordination into account. At the same time, this organisation recommends that Member States introducing uses other than broadcasting should retain sufficient spectrum for PMSE needs.
- **Similarly, the ECC,** rather than focusing on DTT versus IMT, emphasises the importance of PMSE and the need to support the distribution of audiovisual media in the future.
- **The GSMA, the association of mobile network operators,** highlights the benefits of implementing 5G in the 600 MHz band, citing a 30 to 50 per cent improvement on the current situation in rural areas and indoor locations, whilst also noting lower deployment costs in sparsely populated areas.

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[33] GSMA (2022), *Vision 2030: Low-Band Spectrum for 5G*, https://www.gsma.com/spectrum/wp-content/uploads/2022/07/5G-Low-Band-Spectrum-1.pdf

4 Market situation and trends

4.1 Television broadcasting services

4.1.1 Television broadcasting platforms

In recent years, DTT has generally undergone technological changes that have had an impact in the following three areas:

- **Capacity improvements**: changes that increase the available capacity on the DTT platform or reduce the capacity required by services on the platform; A previous European Commission study estimated the cost of upgrading receivers that had not been replaced during the standard television replacement cycle across the 28 EU Member States.[34] For the purposes of this previous study, it was assumed that consumers replace their televisions on average once every 7 years, and that any publicised information about the switchover may accelerate this cycle (by an estimated 20 per cent), whilst any publicised government support programme may slow it down (by an estimated 20 %). Costs were found to decline over time due to a combination of reductions in set costs (an estimated 5 per cent per year) and the proportion of sets not converted following the normal replacement cycle.

- **Modifications to the network topology**: changes that enable greater spectral efficiency to be achieved; an SFN can increase the spectral efficiency of DTT, as coverage is spread over a larger area (i.e. broadcasting from a greater number of sites) whilst utilising fewer frequencies than in a multi-frequency network (MFN). The EBU, for example, has found that for DVB-T2, a national SFN can in some cases be 25 per cent more spectrally efficient than an MFN and 15 per cent more efficient than a regional SFN, whilst taking into account constraints relating to regional requirements and international coordination.[35] However, operating an SFN is significantly more complex than operating an MFN, both in terms of infrastructure deployment and network planning. Furthermore, operating an SFN across large areas requires large guard intervals, thereby reducing the available multiplex capacity (the robustness settings themselves are at the discretion of operators and may vary).

- **Service improvements**: changes that are noticeable from the end-user's perspective and thus enhance the quality of their user experience. These include, for example, image resolution and the progression from SD standards through HD to 4K and 8K. The following table provides an overview of the capacity requirements for various resolution standards.

Table 4: Capacity requirements for various encoding and video standards

Resolution	Encoding standard		
	MPEG-2	MPEG-4	HEVC
SD	3 Mbps	1.5 Mbps	
HD	> 15 Mbps	8 Mbps	5 Mbps

[34] European Commission (2015), Economic and Social Impact of Repurposing the 700 MHz band for Wireless Broadband Services in the European Union – https://op.europa.eu/en/publication-detail/-/publication/32345cb6-df78-11e5-8fea-01aa75ed71a1

[35] EBU (2014), TR 029 DVB-T2 single frequency networks and spectrum efficiency - https://tech.ebu.ch/docs/techreports/tr029.pdf [Accessed 17 January 2022].

4K			15 Mbps
8K			33 Mbps

Source: Public sources, adapted by GTA

In addition to DTT (and DVB-T(2), the most widespread standard in Europe), other television broadcasting platforms are in use, with their market shares varying significantly across individual EU countries (see 4.1.2).

Many of **the cable systems** in use today are hybrid fibre-coaxial networks, which provide broadband internet to households via cable. The signal is initially transmitted in the form of radio waves from a communications satellite to a headend. At the headend, the radio signal is modulated for distribution via an optical cable, which then transmits the signal at high speed across the physical network. The optical fibre carries the signal, along with television channels and internet data, to a communications node, where the signal is converted from optical fibre to coaxial cable. The signal is then demodulated at the local node so that it can be transmitted via coaxial cables. The final destination of this signal is an IPTV system, a set-top box or a television set equipped with the necessary hardware and software to decode the incoming data into picture and sound. A specific frequency is allocated to each channel, and these frequencies are adjusted when switching between channels. Cable television offers a wider range of television programmes and broadband data services, as well as higher picture quality thanks to shielded cabling that is resistant to external interference. On the other hand, the cost is usually higher than for other technologies, and availability is generally lower in sparsely populated areas.

Satellite television providers transmit a wireless signal from a satellite to the end customer's satellite dish. The digital DVB-S standard allows for a smaller parabolic dish. The television satellite shares the satellite broadcasting bandwidth with mobile radio signals and radar systems in the 3–30 GHz band. From the satellite dish, the signal is transmitted either to a dedicated IPTV headend or directly to the end-user's set-top box, which decodes and displays the content. As with cable television, channels are encrypted to prevent unauthorised access. Due to the use of high-frequency radio waves, the signal is more susceptible to interference. Despite this, satellite television is more widely available than cable, as the possibility of a physical connection is considerably limited in some areas.

IPTV enables the reception of television broadcasts via the Internet Protocol using a high-speed internet connection. The difference between IPTV and 'standard' online video streaming lies in the use of a content delivery network (CDN), which improves the availability of data to end users. Each channel's signal is transmitted via the operator's closed network. Unlike standard DVB-T broadcasting, where all available channels are distributed simultaneously, only one specific programme is broadcast to the viewer at any one time. IPTV offers features such as catch-up TV, an electronic programme guide and pay-per-view programmes. A major advantage of IPTV is that it requires less bandwidth. According to a study by Carnstone[36], IPTV is associated with lower energy efficiency and higher carbon emissions compared to DTT.

Most major providers of paid radio and television broadcasting, regardless of platform, also offer an OTT **(Over-the-top)** version as part of their service. This delivers content to users directly via the internet; data flows between the service provider and the user over a public network to a device with a standard internet connection using the HTTPS protocol. Each transmission is unique and is therefore referred to as unicast. Unlike IPTV, users of this service do not need to be connected to the same provider's infrastructure. To use OTT services, users do not need specialised equipment (e.g. a set-top box), and the cost to the user is generally lower than with other technologies. In the case of slow connections and viewing during peak times, 'throttling' and longer waiting times are common.

In relation to the various television broadcasting platforms, it is also important to mention the distinction **between linear and non-linear content**. Linear content is characterised by the fact that programmes provided by the broadcaster are watched by users at a set time. In this model, users cannot rewind programmes or choose to watch them at a later time. Conversely, non-linear broadcasting can be defined as any method or technology that allows users to choose which programmes to watch and when to watch them at their own discretion; this system is known as video on demand (VoD). The ability to watch a programme at any time is referred to as time-shifted viewing; this can be achieved either by the user recording programmes using a device for later viewing, or by the broadcaster providing content that the user can select at their discretion. Linear content is provided by DTV, cable, satellite television and IPTV. Conversely, a typical provider of non-linear content is OTT. Recently, television channels have also been offering non-linear content via their VoD services, known as 'catch-up TV'. In most cases,

[36] Quantitative study of GHG emissions from the delivery of TV content, https://thelocatproject.org/wp-content/uploads/2021/11/LoCaT-Final_Report-v1.2-Annex-B.pdf

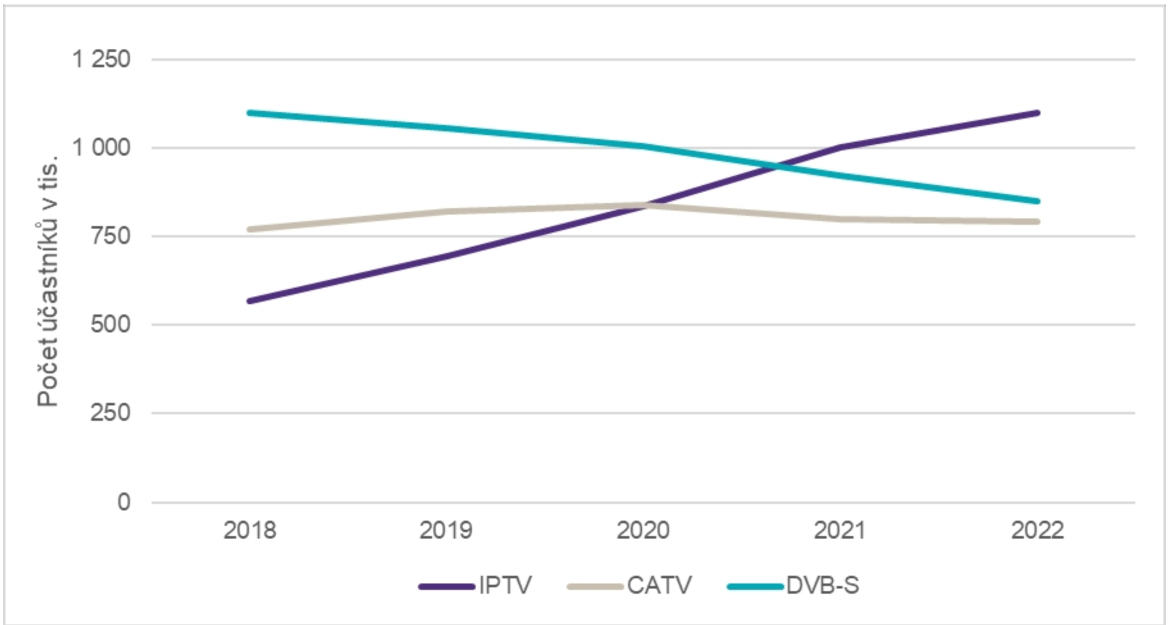
this content is available either via a subscription (SVoD) or by paying for each item of content separately (TVoD).

4.1.2 Use of television broadcasting platforms in the Czech Republic and abroad

According to data from Nielsen Admosphere, market penetration in the fourth quarter of 2022 was as follows: terrestrial (DVB-T) accounted for 54.5 per cent, cable networks (CATV) together with IPTV for 40.7 per cent, and satellite transmission (DVB-S) for 17.0 per cent.

The Czech Telecommunications Office (ČTÚ) monitors data on paid radio and television broadcasting services. According to this data[37], for example, the number of IPTV users is growing steadily; during the period under review (2018–2022), it almost doubled to 1.098 million users. By contrast, the number of satellite (DVB-S) users has been steadily declining; over the five-year period, the number of subscribers to this platform fell by more than a fifth to 849,000 by the end of 2022. The number of cable television users fluctuated around the 800,000 mark during the period under review. Pay-TV recorded a 12.5% increase between 2018 and 2022, representing more than 300,000 new subscribers. DVB-T2 coverage for nationwide networks was approaching 100% at the start of 2024.[38] OTT services are not monitored; however, according to the Nielsen Admosphere[39] survey, in 2022 approximately 20% of households subscribed to Netflix, followed by HBO Max (7%), Voyo (5 per cent) and Disney+ (5 per cent). The total number of households using at least one SVoD service is estimated at 25 per cent, according to the survey.

Chart 2: Trend in the number of subscribers by pay-TV platform in the Czech Republic, 2018–2022



Source: ČTÚ, adapted by GTA

As regards the share of individual services across Member States[40], the highest share of DTT is observed in Greece (71 per cent), Spain (64 per cent) and Cyprus (59 per cent). Cable television is most prevalent in Finland (66 per cent), Romania (56 per cent) and Belgium (52 per cent). Conversely, households in Slovakia (57 per cent), Poland (51 per cent) and Austria (50 per cent) are most likely to have satellite reception, whilst the share of IPTV is significant in France (62 per cent), Portugal (48 per cent) and Slovenia (42 per cent). It is, however, important to note that the source itself acknowledges the difficulty of measuring these shares, which may be distorted, particularly in the case of DTT.

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[37] https://ctu.gov.cz/sites/default/files/obsah/stranky/472017/soubory/zovt_2022.pdf

[38] Updated data from the Czech Telecommunications Office (ČTÚ) by individual broadcasting networks: https://digi.ctu.cz/dtv/

[39] https://www.mediaguru.cz/clanky/2023/02/videa-na-vyzadani-si-plati-ctvrtina-domacnosti-nejvice-netflix/

[40] European Audiovisual Observatory, 2021: https://rm.coe.int/trends-in-the-vod-market-in-eu28-final-version/1680a1511a

The table below shows the proportion of households relying on DTT for free-to-air (FTA) services, as well as the number of national, regional and local multiplexes, and the total number of TV channels – national, regional and local – broken down by HD and SD channels.

Table 5: Overview of DTT and the number of TV channels in EU Member States (2022)

Country (date of granting licences to broadcasters)*	Numbe r of nationa l multipl exes exes	DVB -T	DVB -T2	Number of regional multiple xes x	DVB -T	DVB -T2	Number of local multiplexes	DVB -T	DVB -T2	Národ ní SD	Nation al HD	Nation al FTA	Regio nal SD	Regio nal HD	Regio nal FTA	Local SD	Local HD	Local FTA
AT – Austria (2033)	4		4				3	1	2	34	18	11	0	0	0	25	12	37
BE – Belgium	3	1	2				1	1		20	0	4	0	0	0	1	0	1
BG – Bulgaria	1	1					1	1		6	0	6	0	0	0	5	0	5
CY – Cyprus (2025)	3	3								13	1	14	0	0	0	0	0	0
CZ - Czech Republic (2030)	4		4	3	1.5	1.5	12	6	6	0	30	30	2	2	4	5	5	10
DK – Denmark (2030)	5		5							8	44	20	0	0	0	0	0	0
DE - Germany	6		6				1		1	2	34	15	3	16	19	0	0	0
EE – Estonia	6		6							47	4	8	0	0	0	0	0	0
EL – Greece (2029)	5	5					24	24		12	10	22	0	0	0	106	0	106
ES – Spain	7	7		18	18		282	282		14	12	26	27	26	53	350	347	697
FI – Finland (2027)	6		6	3		3				30	29	21	0	0	0	5	4	9
FR – France (2030)	6	6					1	1		2	28	30	0	0	0	2	40	42

HR – Croatia (2030)	4		4				1		1	30	41	11	0	16	16	0	3	3
HU – Hungary (2032)	5	2	3				32	32		63	6	12	0	0	0	32	0	32
IE – Ireland (2031)	2	2								10	2	12	0	0	0	0	0	0
IT – Italy (2029)	12		12	26		26	47		47	263	39	284	15	0	15	15	0	15
LV – Latvia	5	5		1	1		1	1		46	7	7	4	0	0	1	0	1
LT – Lithuania (2031)	2	2					11	11		13	2	15	0	0	0	18	2	20
LU – Luxembourg (2030)	3	3								9	2	11	0	0	0	0	0	0
MT – Malta	5	5								42	0	8	0	0	0	0	0	0
NL – Netherlands (2030)	5		5				5		5	0	30	3	0	12	12	0	0	0
PL – Poland (2031)	5	1	4				5	4	1	0	55	28	0	0	0	0	8	8
PT – Portugal (2030)	1	1		2	2					7	0	7	2	0	2	0	0	0
RO – Romania (2026)	1		1	1		1				0	9	9	1	0	1	0	0	0
SE – Sweden (2025)	6	3	3							38	11	6	0	0	0	0	0	0
SI – Slovenia (2025)	2	1	1	1	1		2	2		10	9	9	1	0	1	2	0	2
SK – Slovakia (2029)	4		4				64	64		16	15	10	0	0	0	37	36	55
Total	114	41%	59%	55	43%	57%	461	86%	14%									

Source: European Commission (2022), adapted by GTA, The year in which licences expire is given for those countries where this information was available.*

Table 6: Estimated proportion of households reliant on DTT for FTA by country

Country	Proportion of households reliant on DTT for FTA by country
AT – Austria	6% of households
BE – Belgium	Data for the French- and German-speaking communities is not available. Free-to-air (FTA) is not available in the Flemish Community. (<5% rely on pay-TV DTT)
BG - Bulgaria	Data not available.
CY - Cyprus	67% of households rely solely on DTT.
CZ - Czech Republic	Exact figures are not available: the number of households relying on DTT is lower than the DTT reception rate (53%).
DK - Denmark	<1%
DE – Germany	Less than 10%
EE – Estonia	4.2% of households have access only to FTA DTT. 14% of households rely on pay-TV DTT: 9.6% pay-TV + FTA + 5.4% FTA only
EL - Greece	According to the National Commission for Telecommunications and Post (2021), there were 1,110,281 pay-TV subscribers (satellite or IPTV) in 2021. This figure does not include mobile TV subscriptions.
ES – Spain	Free-to-air DTT is the only way of watching television for approximately 64 per cent of Spanish households.
FI – Finland	8% (FTA, 20% DTT)
FR – France	21.2% of households
HR - Croatia	~41% of households
HU – Hungary	10% – households without access to satellite, cable or IPTV
IE – Ireland	12–13% – The Broadcasting Authority also reports that 18% of households have access to other satellite services (other than Sky).
IT – Italy	No information available – 91.3% of Italian households have access to television via FTA (Free-to-Air) DTT.
LV – Latvia	No information available – 14% of pay-TV DTT subscribers (92,681) reported by SPRK in 2020.
LT – Lithuania	In Lithuania, approximately 35–37% of households use DTT. Data on the proportion of these households that have access to other means of reception is not available. Only FTA DTT is available in Lithuania.
LU – Luxembourg	In Luxembourg, there is no reliance on free-to-air (FTA) TV.
MT – Malta	No information is available, but the expected figure is very low. The Broadcasting Authority has conducted an audience survey which states that 0.8 per cent of viewers use free-to-air TV as one of their options for watching television.
NL – Netherlands	1–2 per cent estimated
PL – Poland	35.3% of households
PT – Portugal	5%
RO – Romania	0%
SE – Sweden	8% of households (FTA, 20% DTT)
SI – Slovenia	3% of households (FTA, 0.9% DTT)
SK - Slovakia	No information is available, but the estimated percentage would be relatively low.

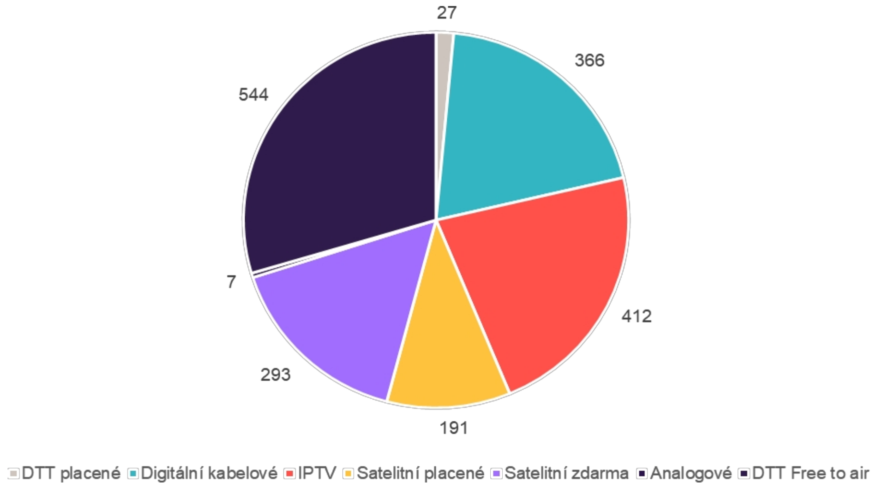
Source: European Commission (2022), adapted by GTA

In Germany, around 6.7% of households use terrestrial digital television broadcasting, and no future developments are planned in the area of DTT. At the end of 2021, the German political parties SPD, Alliance ’90/The Greens and FDP agreed in their coalition agreement to ensure the continued use of the television band for DTT and PMSE on a permanent basis. Germany is also home to the Alliance for Broadcasting and Cultural Frequencies, which seeks to preserve the 470–694 MHz frequency band primarily for DTT and PMSE. Among other things, this initiative publishes articles explaining why it is important to keep the 470–694 MHz band allocated to digital terrestrial television and PMSE (see Chapter 5.3). One of the reasons given for securing this band for DTT is the ability to inform the public in the event of disasters, which is made possible by emergency power supplies at secure transmitter sites.

Figure [41] below shows an estimate of the global market shares of individual broadcasting platforms in 2029. Despite significant regional differences, a substantial proportion of households (more than 31 per cent) will still be using digital terrestrial television in 2029. According to the report by Digital TV Research, IPTV will see the highest growth (10 per cent) between 2023 and 2029. As early as 2024, this platform is expected to achieve a larger share than cable television.

41 A study by Digital TV Research, https://tbivision.com/2023/10/09/global-pay-tv-market-forecast-to-remain-steady/

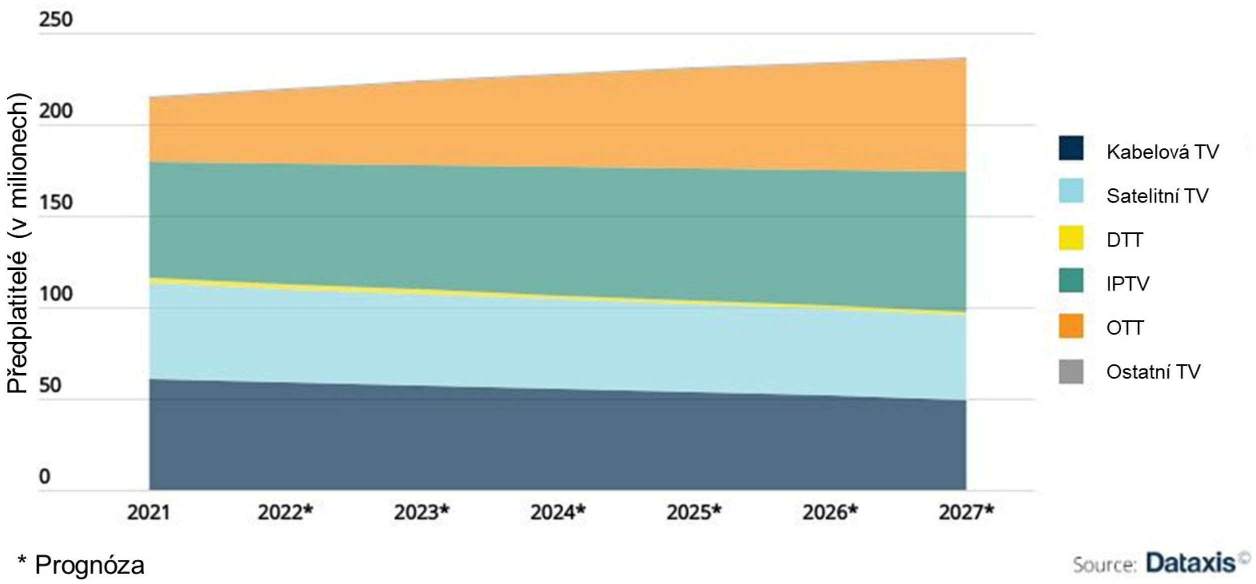
Figure 3: Global breakdown of households by television platform in 2029 (in millions)



Source: Digital TV Research

Dataxis[42] has produced a forecast of the development in the number of broadcasting platforms up to 2027. It anticipates a more pronounced decline for cable and satellite television. Dataxis anticipates that cable television has reached its peak, partly due to the situation across Europe. The long-standing market leader, Liberty Global, is selling its cable assets throughout the region, whilst in 2022, Illiad acquired the Polish service UPC Polska. Apart from a few cases in German-speaking markets, where cable networks have historically dominated both broadband connectivity and access to pay-TV, the vast majority of European cable operators are likely to continue building fibre-optic networks, converting their coaxial infrastructure to fibre-to-the-home (FTTH) connections and migrating their legacy TV offerings to IPTV. On the other hand, however, growth is expected in IPTV and, in particular, OTT services. By 2027, OTT is therefore expected to account for almost 19 per cent of pay-TV services in Europe.

Chart 4: Breakdown of pay-TV by platform, forecast for Europe



Source: Dataxis

[42]https://dataxis.com/researches-highlights/779216/25-of-european-pay-tv-on-ott-by-2027-will-the-industry-maintain-its-value/

4.1.3 Further analyses of platform usage and forecasts of future usage A

study from the UK

Silver Voices conducted a survey in 2023 across the UK and published a study entitled *The Future of Broadcast TV and Radio*, which summarises the results of a questionnaire survey (conducted online and by telephone) involving 4,012 respondents. The five key findings include:

- On average, people believe that television and radio broadcasting should be safeguarded until the 2040s, with a timeframe ranging from 2051 to 2079.
- Three-quarters (74 per cent) stated that the partial or complete phasing out of broadcasting services in the future poses a risk that a significant proportion of the population will be left out.
- The cost of online subscriptions (53 per cent of respondents) and difficulties in affording an internet connection (46 per cent of respondents) over the next 15 years were cited as the main barriers to a transition to online-only television and radio services.
- Two in three respondents (67 per cent) fear that a large proportion of the population would be left out if television and radio broadcasting were not protected, citing the older generation, people with disabilities and those living in rural areas as the groups most vulnerable to future changes.
- 81 per cent state that universal access to public service content should be protected by law.

Another study of 3,006 respondents focusing on the UK in 2022, conducted by Ipsos and Arqiva ('The Future of Broadcast TV & Radio: A crucial service that must be safeguarded: Digital Terrestrial Television and broadcast radio continue to play a critical role in British society. Public attitudes towards aerial-based TV & radio services'), presents the following key findings for future development:

- **Despite the proliferation of other services, broadcasting remains one of the most popular ways for people to access television and radio content.** More than half (56 per cent) of British adults aged 18 and over watched television via DTT in the last year.
- **People living in rural areas tend to watch and listen to broadcast services more frequently than those living closer to urban centres.** More than half (55 per cent) of those living in rural areas watch free-to-air television daily. Around three-quarters (73 per cent) said that free-to-air television via DTT is important, if not essential.
- **90 per cent of people believe that broadcasting services should continue to be supported**, with 85 per cent stating that the government and local councillors should continue to actively support broadcasting services, and 83 per cent stating that the BBC should continue to actively provide these services.
- **Whilst all demographic groups watch free-to-air television via DTT, it is particularly important for vulnerable groups, including older viewers,** people living alone and those from the lowest socio-economic groups. Weekly viewing figures peak among two-thirds (68%) of all people aged 75 and over, a group that is less likely to use streaming services. Almost one in five (18 per cent) people aged 65 and over watched only free-to-air DTT in the last year.
- **The loss of broadcasting services would have a significant impact on well-being**. A quarter of people (25 per cent) said they would feel very lonely if free-to-air services via DTT were lost. Vulnerable audiences would be affected to a greater extent – 44 per cent of people aged 65 and over who live alone.
- **Broadcasting services (DTT) are also recognised as important sources of news and entertainment across all demographic groups**. Nearly four in ten agreed that without these services, they would find it difficult to keep up with the news and important information.
- **Many people would reduce – or stop – watching television channels if services were not available via DTT**. 56 per cent of weekly viewers of free-to-air DTT would reduce or stop watching television channels if free-to-air were not available.
- **Availability and willingness to pay are the main barriers to the roll-out of alternatives to free-to-air** and radio broadcasting. 13 per cent of adults say they cannot afford pay-TV services. Despite improvements in connectivity, 7 per cent of adults stated that their internet connection is not good enough to watch TV programmes or listen to the radio online.

EY produced a study entitled 'TV distribution after 2034: Why it cannot be assumed that broadband will offer a universal solution for all of the UK' in 2024, in which it assessed the differences between DTT and IPTV platforms and evaluated the best-case scenario for the future functioning of television content distribution after 2034. Key findings include:

- It is estimated that by 2040, more than 5.5 million households in the United Kingdom (18 per cent) will be without a high-speed broadband subscription, despite the government's commitment to 99 per cent network coverage by 2030.
- Those projected to be without high-speed broadband are disproportionately drawn from vulnerable groups in society, such as older people, people with disabilities and low-income households.
- It is essential that government policy on TV distribution continues to reflect the needs of everyone in society, not just those with access to the fastest broadband networks.
- For television distribution after 2034, a hybrid solution incorporating the existing DTT network is likely to remain the best outcome for all stakeholders, given the implications for social equity, complexity, costs, reliability and energy aspects of a complete migration to IP distribution.
- Political certainty regarding the future of DTT will help to encourage the investment needed to ensure the continued provision of a universal service offering consumers a genuine choice.

APMS study for the Czech context

APMS supplemented its position on the use of the 600 MHz band (see section 2.2) with the results of a study it commissioned from NMS Market Research, which examined the ways in which users watch television programmes. According to this study, only 3 per cent of Czech households rely on terrestrial broadcasting (DVB-T2), whilst 38 per cent can watch television programmes via IPTV, cable or satellite television, and a further 53 per cent use a combination of DVB-T2 and the aforementioned alternatives. Another key finding of the study was that 60 per cent of households use the internet to watch television, and 40 per cent of all time spent watching television is accounted for by various forms of internet connection. By contrast, 32 per cent of time spent watching television is accounted for by terrestrial broadcasting, and the remaining 28 per cent by cable or satellite broadcasting.

It is therefore clear that an increasing number of households are consuming video content via the internet. According to the APMS survey, this trend is set to accelerate further in the near future. Streaming services are expected to see the greatest growth, with a fifth of current viewers intending to watch them more than they do today; households will also see an increase in viewing figures for HbbTV (14 per cent), online programmes such as those on YouTube (13 per cent) and IPTV (12 per cent). Furthermore, one in ten Czech households is considering purchasing a television with a wider range of programmes in the near future.

The survey was carried out in April and May 2023 on a representative sample of 1,520 respondents aged 15–75, who were interviewed online via the Czech National Panel. In its follow-up survey, APMS plans to include the over-75 age group – which is currently the most reliant on reception via an aerial – and to use a method other than online surveying, so that the results reflect the entire population of the Czech Republic across all categories of technical literacy. This will make it possible to verify whether the Czech Republic is in line with the critical findings regarding the very high significance for vulnerable sections of the population (older citizens, etc.) as reported in the English study, or not.

4.2 Mobile communications services

In addition to mobile connections, an increasing proportion of fixed-line connections is now provided via FWA networks. In sparsely populated regions, where the costs of rolling out high-speed broadband via fixed-line infrastructure are not economically viable, the significantly lower capital expenditure associated with FWA represents a viable way of reaching many households. Instead of laying fibre-optic cables throughout a town, a single base station can provide high-speed connectivity to several hundred households, using relatively inexpensive equipment installed at the consumer's premises.

Thanks to 5G NR technologies, the same networks can be used for both mobile and FWA services, which further reduces costs and enhances certain features, such as significantly lower latency. This makes FWA increasingly attractive for rolling out high-speed connectivity to the most remote locations. Ericsson estimates[43] that by 2029 there will be 330 million FWA connections worldwide (130 million FWA connections were estimated at the end of 2023), which would represent almost 20 per cent of all fixed connections. The share of FWA data traffic in total mobile data traffic is expected to rise from 19 per cent at the end of 2023 to 30 per cent by 2029.

Similarly, the total volume of data transmitted in the Czech Republic is growing steadily; between 2021 and 2022, it increased by just under 63 per cent to 943,000 terabytes. We can also observe rising data consumption per user; for example, according to

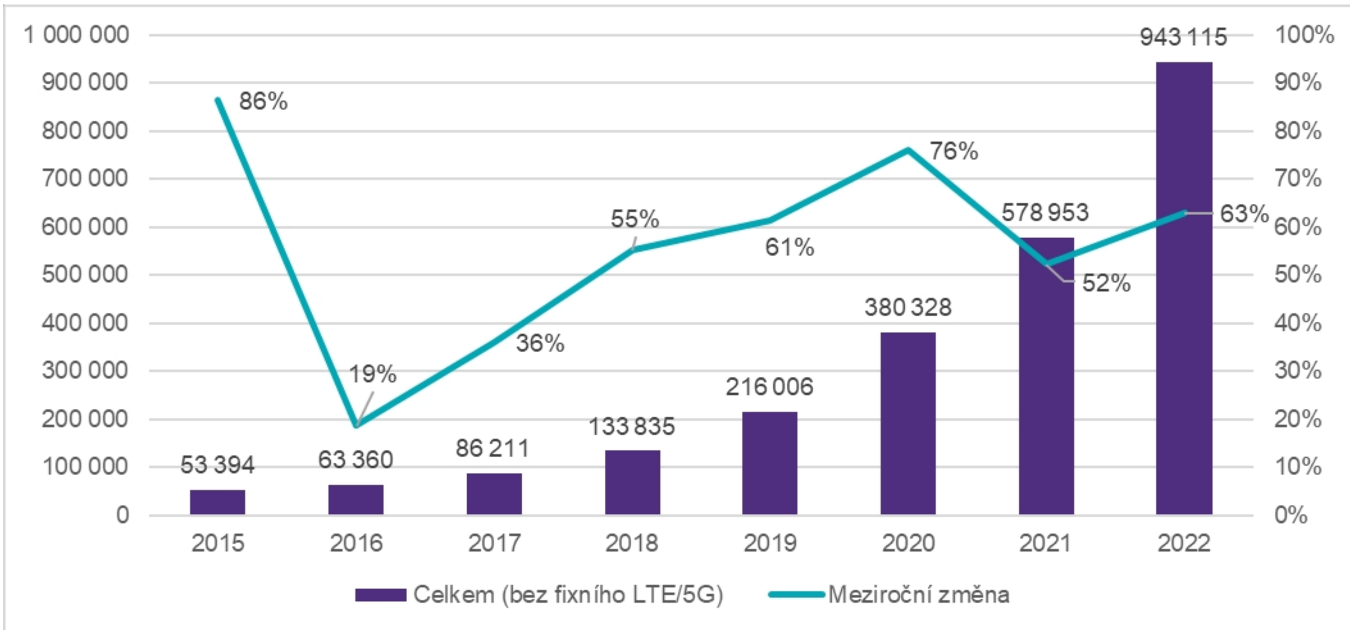
[43] https://www.ericsson.com/en/reports-and-papers/mobility-report/dataforecasts/fwa-outlook

data from the Czech Telecommunications Office (ČTÚ)[44], the average data consumption per mobile data SIM card rose to 7 GB in 2022, representing a year-on-year increase of 51 per cent.

Investment in certain sparsely populated areas is unprofitable for mobile network operators for two main reasons: low demand and low willingness or ability to pay, and higher network roll-out costs45. Costs can be reduced by utilising spectrum in lower bands, increasing the distance between base stations – as there will be no need to commission additional base stations to increase the capacity required for high performance – and reducing the amount of equipment required.

However, Nokia states46 that the ideal frequency band for 5G FWA networks is 2 GHz–6 GHz. Although it covers the same area as 4G, it has a channel bandwidth of up to 100 MHz and better spectral efficiency. This means more data and higher connection speeds. The mid-band spectrum is therefore ideal for FWA and offers 10 times the capacity of 4G.

Figure 5: Data traffic on mobile networks in the Czech Republic (TB)



Source: ČTÚ, adapted by GTA

4.3 PMSE

PMSE in the UHF band primarily comprises radio microphones and in-ear monitors, with this band constituting the main part of the radio spectrum used for these technologies. PMSE equipment requires high audio quality and low latency when used for live performances. Any interruption or delay can cause significant complications. Some PMSE applications are time- and location-specific (for example, at occasional outdoor events such as concerts or sports broadcasts), whilst others are of a more continuous nature (for example, in television studios).

PMSE audio equipment, which was historically operated in an analogue environment, made inefficient use of the radio spectrum. As a result of technological advances, such equipment is now capable of delivering approximately three times the number of audio channels within a given amount of radio spectrum, whilst maintaining an acceptable level of quality.[47] Sections

[44]https://ctu.gov.cz/sites/default/files/obsah/stranky/460071/soubory/vyrocni_zprava_ceskeho_telekomunikacniho_uradu_za_rok_2022.pdf

[45]https://www.gsma.com/spectrum/wp-content/uploads/2020/11/Rural-Mobile-Coverage-Positions.pdf

[46]https://www.nokia.com/about-us/newsroom/articles/fixed-wireless-access-explained/

[47] The alternative DECT technology allows access to additional spectrum outside the UHF band, but may not be suitable for applications with high demands on latency and quality. Techniques such as Cognitive-PMSE and more advanced approaches to spectrum management could help maintain audio quality in congested spectrum and open up possibilities for the use of alternative bands.

These bands are allocated as complementary to the radio service, as they utilise so-called 'white spaces' in the television band (TVWS).

Instead of static channel assignments, PMSE users are increasingly being offered 'tuning ranges', which give them a degree of freedom in selecting temporary operating channels. However, the migration of television broadcasting from the 700 and 800 MHz bands has significantly reduced the bandwidth available to PMSE, as both applications share the spectrum. Since 2012, audio PMSE has lost almost half of its available spectrum. This raises concerns that PMSE may no longer be able to meet client expectations without access to new frequency bands.

The needs of PMSE users are growing[48], both in terms of the number of PMSE devices required at a typical venue or event, and in terms of the number of events/venues where PMSE is required. Whilst the need for spectrum for PMSE is temporary or limited to specific locations, the increase in the number of PMSE devices used at a given location or event results in higher peak demand. This, together with the reduction in available spectrum in the ultra-high frequency (UHF) band resulting from the clearance of broadcasting services from the 700 MHz band, has affected PMSE users. Although other bands are available for PMSE (e.g. the 174–216 MHz and 1785–1805 MHz bands, and certain bands outside the aviation safety services), the UHF band is harmonised at European level, which contributes to the development of standardisation for PMSE equipment.

The table below provides an overview of the frequency bands currently recommended by CEPT for use by audio PMSE applications. The information in the following table is taken from the updated ERC Recommendation 25-10, Annex 2.[49]

[48] See, for example, CEPT (2021), ECC Report 323 'Spectrum use and future spectrum requirements for PMSE' – https://docdb.cept.org/download/3470

[49] CEPT ERC/REC (last updated 2023) *Recommendation on Frequency Ranges for the Use of Terrestrial Audio and Video Programme Making and Special Events (PMSE) Applications* – https://efis.cept.org/report/report2510AnnexRecommendation.do?annexId=1

Table 6: Overview of frequency bands according to ERC recommendations

Use	Frequency band (MHz)	Relevant technical standards	Additional information
Radio microphones and wireless (re)listening systems	174–216	EN 300 422	Shared use
	470–694	EN 300 422	This is currently the main band for professional PMSE use. Shared use.
	733–757.5	EN 300 422	Availability depends on national decisions. Shared use.
	821.5–832	EN 300 422	The risk of unwanted out-of-band emissions from adjacent mobile services means limited suitability for high-quality audio broadcasting. Harmonised across EU Member States.
	863–865[50]	EN 300 422 EN 301 357	The risk of unwanted out-of-band emissions from adjacent mobile services and other short-range devices means very limited use for broadcasting. Shared use.
	1350–1400	EN 300 422	Shared use
	1518–1525	EN 300 422	Shared use
	1785–1805	EN 300 422	Harmonised amongst Member States
Portable audio links, mobile audio links and temporary point-to-point audio links[51], talkback and production communications[52]	174–216	EN 300 454	Shared use
	470–694	EN 300 422 EN 300 454	Shared use

Source: ERC, adapted by GTA

All EU Member States have allocated the UHF band for PMSE use. However, access to other bands for PMSE varies significantly between Member States. The use of the 823–832 MHz and 1785–1805 MHz bands is common (in 20 and 21 Member States respectively), as is the use of the 174–216 MHz band (in 19 Member States). By contrast, bands above 1800 MHz are used less frequently.

According to a European Commission study[53], approximately 50% of EU Member States have recorded an increase in demand for PMSE spectrum, amounting, for example, to 10% per year in the Netherlands and 20% per year in Spain. A study by the Swiss radio and television broadcaster SRF[54] states that, based on currently used technologies, daily spectrum requirements for PMSE range from 42 MHz for smaller local events to 115 MHz for major events. The requirement for major events reached as high as 174 MHz. Demand for spectrum for PMSE is growing and may potentially require up to 224 MHz for major events in the future (i.e. the entire UHF band).

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50 The 863–865 MHz band is available for radio microphones; however, it should be noted that it is also used for non-professional and consumer radio applications (wireless audio, etc.).

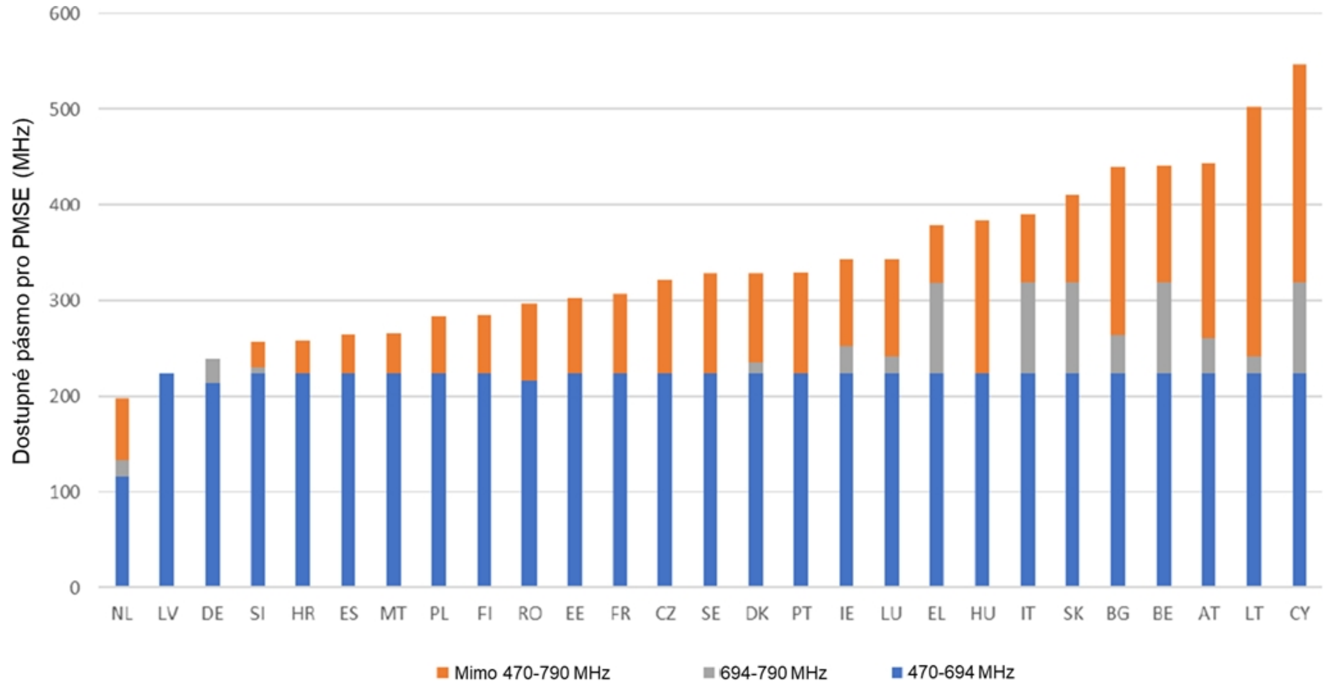
51 Depending on the specific use case, channel width and required transmit power, portable, mobile and temporary point-to-point audio links may be located either in the 174–216 MHz and 470–694 MHz bands, which are reserved for professional radio microphones (typically for low-power, wideband applications), or in other VHF/UHF bands, including the PMR band (typically for high-power, narrowband applications).

52 'Talkback' is a term used in audio production and communication, particularly in the television and radio industries. It refers to a system of two-way communication between various members of the production team, such as directors, camera operators, technicians or presenters. A talkback system enables rapid and effective communication during live broadcasts or recordings. Talkback systems are a key element in production environments where rapid and reliable communication is essential for coordinating various tasks during a broadcast or recording.

53 European Commission (2022), *Final report: Study on the use of the sub-700 MHz UHF band (470–694 MHz)* – https://op.europa.eu/en/publication-detail/-/publication/d77a592e-4f54-11ed-92ed-01aa75ed71a1/language-en

54 SRF (2022), *Report on spectrum requirements for Audio PMSE* – https://apwpt.org/wp-content/uploads/2022/03/Report-PMSE-Audio-spectrum-requirement.pdf

Figure 6: Available spectrum for PMSE in EU Member States



Source: European Commission (2022)

The coexistence of DTT and PMSE in the ultra-high frequencies has resulted in a mutually beneficial relationship. A specific and recent example is the Spectrum Management Plan for the Paris 2024 Olympic Games.[55] To illustrate this, the table below provides an overview of frequencies from part of the UHF band allocated to various sports venues in the cities where the Olympic competitions will take place. The overview relates to wireless microphones and in-ear monitors.

Table 7: Overview of frequencies for wireless microphones and in-ear monitors in the UHF band for the 2024 Olympic Games

BAND	RANGE (MHz)		SPECTRUM WIDTH (MHz)	TECHNICAL SPECIFICATIONS	GEOGRAPHICAL COVERAGE AREAS								
	From	To			PARIS IDF	LILLE	LYON	MARSEILLE	NANTES	BORDEAUX	NICE	SAINT-ETIENNE	TEAHUPO'O
UHF	470	478	8	Max. transmission power: 50 mW Channel bandwidth ≤ 200 kHz	x		x	x	x	x	x	x	
	478	486	8			x	x	x	x	x		x	
	486	494	8		x								
	494	502	8		x		x	x	x	x	x	x	x
	502	510	8			x		x	x	x		x	x
	510	518	8		x		x		x			x	x
	518	526	8		x			x	x	x		x	x
	526	534	8				x	x	x	x		x	x
	534	542	8		x		x			x	x	x	x
	542	550	8			x	x					x	x
	550	558	8		x		x	x	x	x	x	x	x
	558	566	8			x	x	x		x		x	x
	566	574	8		x	x	x	x	x	x		x	x
	574	582	8		x	x	x	x	x	x	x	x	x
	582	590	8			x	x		x	x		x	x
	590	598	8		x		x	x	x	x		x	x
	598	606	8		x	x	x	x	x		x	x	x

Source: International Olympic Committee, adapted by GTA

[55] https://library.olympics.com/Default/doc/SYRACUSE/2875163/spectrum-management-plan-paris-2024-organising-committee-for-the-paris-2024-olympic-and-paralympic-g?_lg=en-GB

The frequencies listed and those up to 694 MHz with the specified parameters (maximum transmission power 50 mW, capacitive bandwidth 200 kHz) may only be required if a cable-based solution cannot be used, which is, however, practically impossible.

In some areas, it would currently be difficult to secure access to such a spectrum width, given that the UHF band is shared with digital terrestrial television (DTT). Securing such access to a sufficient amount of spectrum would be even more difficult in the event of a further reduction in the available spectrum in the 600 MHz band. The efficiency of spectrum utilisation by PMSE could be improved through WMAS technology. This involves wireless microphones (and IEMs) that use the entire available UHF band for signal transmission, unlike current systems, which operate on a single selected frequency. WMAS technology is therefore suitable for large-scale, multi-channel wireless systems that require a large number of free frequencies. The innovation offered by WMAS, utilising broadband systems and digital coding schemes, certainly has potential; however, it is unlikely to be universally applicable in the foreseeable future, and the equipment is not yet fully available. Similarly, the use of alternative frequency bands requires the development and procurement of new equipment, which will necessitate the necessary investment.

Conclusion to Chapter 4:

- In addition to DTT (and DVB-T2, the most widespread standard in Europe), other television broadcasting platforms are in use, with their market shares varying significantly across individual EU countries.
- In the Czech Republic, according to data from Nielsen Admosphere, penetration in the fourth quarter of 2022 was as follows: terrestrial broadcasting (DVB-T) accounted for 54.5 per cent, cable networks (CATV) together with IPTV for 40.7 per cent, and satellite transmission (DVB-S) for 17.0 per cent.
- Globally, a significant proportion of households is expected to continue using DTT over the next five years, according to the findings mentioned above. IPTV is projected to record the highest growth (by approximately 10 per cent) by 2029. As early as 2024, this platform is expected to achieve a larger share than cable television.
- As regards mobile communications services, the total volume of data transmitted in the Czech Republic is growing steadily; for example, between 2021 and 2022, there was an increase of approximately 63 per cent. The share of FWA data traffic in total mobile data traffic is expected to rise from 19 per cent at the end of 2023 to 30 per cent by 2029.
- The reallocation of television broadcasting from the 700 and 800 MHz bands has significantly reduced the bandwidth available for PMSE, as both applications share the spectrum. All EU Member States have set aside the UHF band for PMSE use. However, access to other bands for PMSE varies significantly across Member States. The use of the 823–832 MHz and 1785–1805 MHz bands is common (in 20 and 21 Member States respectively), as is the use of the 174–216 MHz band (in 19 Member States). By contrast, bands above 1800 MHz are used less frequently.

5 Issues relating to the transition to new technologies

5.1 Interference and other issues arising from spectrum sharing between DVB-T and IMT

Interference issues between DVB-T and IMT arise because they share the same frequency band. Potential problems may include the following:

- **Overlapping frequency bands:** IMT and DVB-T systems have specific frequency bands allocated to their operators. If these bands are too close together or overlap, signal interference may occur. Frequency coordination and management are key to minimising this problem.
- **Interference in adjacent channels:** If IMT and DVB-T channels are positioned next to one another, interference may occur in adjacent channels. Strong signals from one system may affect signal quality in the adjacent channels of the other system.
- **High IMT transmit power:** IMT systems often operate at high transmit power, which can increase the likelihood of DVB-T signal interference if they are too close.
- **Lack of interference protection:** Inadequate interference protection on DVB-T receivers may make them more susceptible to interference from nearby IMT transmitters.
- **Impact on coverage and signal quality:** Interference can affect the coverage and signal quality of both systems, which may lead to user dissatisfaction.
- **Antenna characteristics:** The characteristics of the antennas used in IMT and DTT systems may contribute to interference. The directivity and radiation patterns of antennas affect how signals propagate and may impact neighbouring systems.

When the mobile telecommunications and digital terrestrial broadcasting systems (IMT and DTTB) were allocated joint priority rights to use the 700 and 800 MHz frequency bands, it was understood that individual countries could decide for themselves which service to authorise. This was because it was considered unlikely that these two technologies could coexist without causing mutual interference. However, the actual extent of their incompatibility had not yet been determined at that time.

ITU Study Group 5 (responsible for IMT-related issues) and ITU Study Group 6 (responsible for broadcasting-related issues) began to examine the possibility of compatibility in greater detail. In 2017, they jointly published a report on such compatibility."[56] The most important findings were as follows:

- If one country intends to use a frequency band for broadcasting and a neighbouring country intends to deploy IMT networks, sharing will be very difficult.
- To reduce interference in shared channels to the level permitted by the GE06 plan, the minimum safe distance along a terrestrial path between an IMT network and a digital terrestrial television receiver is approximately 243 km. Over water, the minimum separation distance is more than 1,000 km.

[56] ITU-R (2017) Report BT.2337-1: *Sharing and compatibility studies between digital terrestrial television broadcasting and terrestrial mobile broadband applications, including IMT, in the 470–694/698 MHz frequency band* – https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-BT.2337-1-2018-PDF-E.pdf

These findings were largely based on simulations[57] and a number of field tests. However, a migration from digital broadcasting to IMT subsequently took place in a number of countries. This enabled the ITU to publish a follow-up report based on a greater amount of real-world experience.[58] The findings were essentially the same, but also included specific measures to counter interference.

Nevertheless, television broadcasters continued to maintain that it was physically impossible for digital broadcasting to share spectrum with IMT. For this reason, it came as something of a surprise when the EBU announced in 2021 that "compatibility between 5G Broadcast and DTT… is manageable with the help of mitigation and resolution measures currently in use in DTT networks."[59] The main rationale given was that 5G Broadcast differs quite significantly from 5G in non-broadcast mode, and that coexistence with DTT is considerably easier.

For the purposes of this study, ČMI analysed the possibilities for IMT/5G operation in Germany in the 600 MHz band whilst DTT coexists in the Czech Republic. The analysis carried out of the theoretical interference caused by operational and internationally coordinated DTV transmitters in the Czech Republic on IMT/5G base station receivers (uplink) in the 600 MHz frequency band unequivocally demonstrated the incompatibility of the two systems. The separation distance is estimated at approximately 200 to 300 km. Operation would result in significant interference caused by DTT transmitters in the Czech Republic to almost all IMT operations in Germany. By contrast, DTT interference within the Czech Republic caused by the operation of IMT/5G base stations in Germany would not be significant and would, in practice, be limited only to base stations with direct radio line-of-sight to the Czech Republic. For further details, see the annexes to this study.

5.1.1 Experience with mutual interference between DVB-T and mobile networks

In the Czech Republic, the Czech Telecommunications Office (ČTÚ) is responsible for resolving issues related to television signal interference. As part of its remit, it handles complaints regarding poor-quality television signal reception via antenna. According to the complainants, the cause is 4G and 5G mobile networks. Under certain conditions (see above), mobile network signals can cause interference with television signal reception. However, this problem was anticipated when the 700 MHz band was released for IMT services.

For this reason, protective measures designed to completely eliminate this undesirable phenomenon were established from the outset as part of the conditions for mobile network frequency allocation holders. Eliminating this phenomenon is not complicated, but it cannot be prevented before it occurs due to the difficulty of predicting where it will occur. Eliminating the interference requires technical intervention on viewers' television receiving aerials, whether these are individual aerials or communal television aerials. The technical modifications at viewers' premises are arranged and paid for by the mobile network operator whose signal caused the interference. Information on the issue of the impact of mobile networks and recommended procedures is published on the ČTÚ website and is also sent to the local authorities of the specific town or village in whose area a mobile network in the 700 MHz band is being commissioned.

A form[60] is available on the ČTÚ website, which citizens can use to quickly provide the necessary information to resolve any issues arising from television signal interference. The ČTÚ assesses developments regarding resolved complaints in regular monthly monitoring reports. In 2023, the ČTÚ assessed 1,315 complaints, of which only 269 identified a 4G or 5G signal as the source of interference. This therefore represents just under a fifth of the complaints. In all cases, the interference was rectified (within a few days of the problem being reported to the ČTÚ), thereby resolving the reception issues. It can therefore be concluded that the operation of mobile radio networks does not cause a permanent deterioration in the quality of television signal reception. Poor reception is most frequently (in around 50 per cent of cases) caused by the condition of the receiving antenna system. In particular, this relates to unsuitable antennas, damaged antenna leads or cables, and the positioning and orientation of antennas. Another cause of poor television reception is, for example, an insufficient or otherwise degraded television signal, which depends on the television signal coverage provided by television network operators in the area in question.

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[57] Among more recent studies based on software simulations, one example worth mentioning is the 2023 paper *'Co-Channel Compatibility Analysis of IMT Networks and Digital Terrestrial Television Broadcasting in the Frequency Range 470–694 MHz Based on Monte Carlo Simulation*'. The simulation results confirm that sharing the same frequency band between IMT and DTTB networks would lead to significant mutual interference.

[58] ITU-R (2021), *Report BT.2301-3: National field reports on the introduction of IMT in the bands with co-primary allocation to broadcasting and mobile services* – https://www.itu.int/pub/publications.aspx?lang=en&parent=R-REP-BT.2301-3-2021

[59] EBU (2021), *Technical Report TR-064 – Compatibility between 5G Broadcast and Other DTT Systems in the Sub-700 MHz Band*, https://tech.ebu.ch/publications/tr064

[60] https://dvbtform.ctu.cz/formular/udaje-o-podavateli

5.2 Investments relating to infrastructure modernisation

Building on the Lamy Report, Decision 899/2017, through Article 4, created a predictable environment for longer-term investment in digital terrestrial broadcasting by allocating the UHF band to DTT and PMSE services until at least 2030 in all Member States, whilst taking into account the principle of technological neutrality.

5.3 Economic benefits and use of the UHF band

According to a 2019 EBU study[61], the annual cost of a 5G network per capita is many times higher than that of DTT broadcasting. It is important to emphasise that costs differ depending on whether the 5G network is operated alongside DTT (€7.32 per capita) or not (€15.05 per capita). Even so, these costs exceed those of DTT, which costs just €0.28 per capita. Furthermore, the study shows that providing coverage for 20 per cent of the population living in rural areas accounts for approximately half of the total network operating costs for the whole country. This huge disparity could raise doubts about the feasibility of achieving sufficient network densification for these areas in the future.

Another cost-benefit analysis[62] of possible future scenarios for the allocation of the 470–694 MHz band found that allocating a further 80 MHz of UHF spectrum to mobile services would yield benefits six times greater than the costs incurred by the broadcasting sector whilst maintaining the current number of digital terrestrial television channels. Furthermore, if the entire 470–694 MHz band were allocated to mobile services, the benefits for a typical European country would be four times higher than under the current situation. The cost savings resulting from the allocation of additional UHF spectrum to mobile services therefore significantly outweigh the costs that would be incurred to ensure that consumers continue to have access to the broadcasting services they require. The authors themselves, however, acknowledge the limitations of this analysis and the need to take into account differences between individual countries. At the same time, this analysis relates solely to the perspective of mobile operators, and its main limitation is, in particular, the complete failure to take into account the social impacts and costs to citizens arising from the need to switch from the FTA DTT platform to another.

Conclusion on Chapter 5:

- Potential causes of signal interference between DVB-T and IMT can take many forms, ranging from overlapping frequency bands and a lack of protection against interference to the characteristics of the antennas.
- ITU study groups examined the possibility of compatibility, and their findings, based on simulations, were as follows: if one country intends to use a frequency band for broadcasting and a neighbouring country plans to deploy IMT networks, sharing will be very difficult. To reduce interference in shared channels to the level permitted by the GE06 plan, the minimum safe distance along a ground path between an IMT network and a DTT receiver is approximately 243 km. Over water, the minimum separation distance is more than 1,000 km.
- For the purposes of this study, ČMI analysed the possibilities for IMT/5G operation in Germany in the 600 MHz band whilst DTT coexists in the Czech Republic. The analysis unequivocally demonstrated the incompatibility of the two systems. The separation distance is estimated at approximately 200 to 300 km. Operation would result in significant interference with DTT from the Czech Republic affecting almost all IMT operations in Germany. Conversely, interference with DTT in the Czech Republic caused by IMT/5G base stations operating in Germany would not be significant and would, in practice, be limited only to base stations with direct radio line-of-sight to the Czech Republic.
- In the Czech Republic, the Czech Telecommunications Office (ČTÚ) is responsible for resolving issues related to interference with television signals. Last year, the ČTÚ assessed 1,315 such complaints, of which only 269 identified a 4G or 5G signal as the source of interference. This therefore represents just under a fifth of the complaints.
- A cost-benefit analysis of possible future scenarios for the allocation of the 470–694 MHz band found that allocating a further 80 MHz of UHF spectrum to mobile services would yield benefits six times greater than the costs incurred by the broadcasting sector, whilst maintaining the current number of digital terrestrial television channels.

[61] https://tech.ebu.ch/docs/techreview/EBU_Tech_Review_2019_Lombardo_Cost_analysis_of_orchestrated_5G_networks_for_broadcasting.pdf

[62] https://www.econstor.eu/bitstream/10419/277945/1/Bahia-et-al.pdf

6 Scenarios for the development of 600 MHz band usage after 2030

6.1 Summary of key findings and recommendations for future decision-making

Going beyond a review of secondary and primary sources, the study assessed the specific impacts of the findings within defined scenarios in the Czech Republic. The defined scenarios include (1) **maintaining the current allocation for DTT** and (2) **allocating part of the UHF band (specifically the 600 MHz band) to IMT.** For each scenario, the impacts on network operators' economic costs, socio-economic impacts, impacts on the competitive environment and other impacts identified as relevant were assessed. A summary table for each scenario is presented below, highlighting the main positive and negative impacts and drawing attention to potential risks. *The positive and negative impacts are assessed primarily in terms of the differences between the two scenarios.*

Table 7 – Scenario 1: Maintaining the current allocation for DTT

Impact categories	Positive impacts	Negative impacts and risks
Impact on network operators' costs	• DTT: The downward trend in viewing figures does not have a significant impact on broadcasters' financial performance. • DTT: Maintaining the scope of multiplexes may have a positive impact on network operators' business cases due to a slower decline in viewership, the possibility of regionalising broadcasts and ensuring competition on the platform.	• IMT: Any additional IMT capacity that may be required (particularly in rural areas) will depend on network densification or the use of a different frequency band. Given the high signal propagation, the use of a different frequency band may entail higher costs (compared with the 600 MHz band). • DTT: The licence term must (even in the case of IMT) be sufficiently long to ensure that network operators can maintain a viable business case.
Socio-economic impacts	• DTT: Operating an FTA platform and broadcasting PMS-type programmes represents a significant socio-economic benefit, as it avoids the additional costs that might arise under schemes such as IPTV or satellite television (particularly the highly negative social impact in the current period of rising prices and economic crisis).	• IMT: A potential spectrum shortage and the resulting capacity constraints could be reflected in end-user prices or a reduction in service quality. • IMT: The aforementioned spectrum shortage may potentially have a negative impact on innovations that could utilise additional spectrum (IoT and other potential innovations).
Impacts on the competitive environment	• DTT: Maintaining the full range will enable the platform to continue to compete, both in terms of broadcasting operations and advertising space, thereby allowing the FTA principle to be upheld.	• IMT: More spectrum may lead to the development of innovative solutions in mobile networks and thus potentially give rise to additional competition. At present, it is not possible to assess this impact directly.

Other impacts	• *PMSE: The service will be maintained in its current full scope.*	• General: In the event of an earlier launch of the IMT service abroad (a simulation for Germany was created for the purposes of the study), there may be a significant impact on the quality of both services, given the separation distances (200–300 km). It is therefore necessary to recognise the need for a unified decision and, where necessary, coordination of operations.

Source: GTA's own analysis

Table 8 – Scenario 2 – Allocation of parts of the UHF band (600 MHz) for IMT

Impact categories	Positive impacts	Negative impacts and risks
Impact on network operators' costs	• IMT: The construction and operation of an IMT network in the 600 MHz band may result in lower costs compared with network densification or the use of a higher frequency band (depending, of course, on the final auction price of the spectrum).	• DTT: A reduction in the range of programmes broadcast may affect the popularity of the platform as such, accelerate the decline in DTT viewing figures, and increase pressure to restrict the broadcasting of free-to-air commercial channels.
Socio-economic impacts	• IMT: Allocating spectrum to IMT could, assuming a shortage of capacity, improve the quality of services for users in rural areas. • IMT: Additional spectrum could be used for innovative services for users and to support the development of innovative functionalities (network slicing).	• DTT: There is a reduction in regional content and the potential closure of one nationwide network.
Impacts on the competitive environment	• IMT: Additional spectrum may promote competition in terms of service quality (capacity). At the same time, this may lead to potential competition amongst mobile operators in terms of innovative services. • DTT: Potentially, an increase in spectrum for IMT could lead to the development of 5G broadcasting on the 600 MHz band as a form of IMT service innovation.	• DTT: A reduction in the content broadcast may pose a risk of a further decline in the platform's popularity and have a direct competitive impact both at the content level (programme broadcasting) and at the platform level.
Other impacts	• *Not defined.*	• *DTT: Should a decision to implement this scenario be taken earlier (before 2030), additional costs may arise, particularly due to the need to optimise the network and to replace and write off transmitters and, where applicable, antennas. At the same time, consideration may need to be given to the potential need for compensation for lost revenue from regional broadcasting.*

Source: GTA's own analysis

<u>Recommendations for future decisions</u>

In order to make an informed decision in the future (well in advance of the expiry of the licences), it is necessary to assess key factors. The key factors identified include, in particular, the following, beyond the scope of regional coordination:

- Assess viewing preferences across individual television platforms, as well as trends and changes in the patterns of audiovisual content consumption and its popularity;
- From a DTT perspective, it is necessary to monitor viewing figures and the sustainability of the service as such, as well as the potential impact of a decline in viewing figures on the possible need to cease FTA broadcasting and to mitigate the impact on the public;
- From an IMT perspective, it is necessary to monitor spectrum usage and identify potential capacity requirements or issues with regard to current and potential IMT services;
- Use of the service as one of the crisis management and coordination media in the event of a crisis (alongside radio and other platforms);
- Develop a strategy for future development, taking into account the long-term nature of the decisions, and analyse the specific impact on the investments of all stakeholders.

6.2 Definition of scenarios

For the purposes of the analysis in this study, two relevant scenarios for the future development of the regulatory approach to the use of the UHF band have been identified:

(1) Maintaining the current allocation for DTT
(2) Allocation of part of the UHF band (specifically the 600 MHz band) to IMT

6.2.1 Scenario 1: Maintaining the current allocation for DTT

This scenario involves the continued use of the UHF band for digital terrestrial television (DTT) and PMSE, with the possibility of using services other than DTT in this band, provided they are compatible with it. A necessary step will be the renewal or extension of licences. As is standard practice, television broadcasters are guaranteed access to the spectrum for the entire duration of their licences. This enables broadcasters to invest with the ability to calculate the return on their capital, and also to negotiate long-term contracts. At the same time, the free-to-air television market can continue to operate on a stable user base even after 2030.

This scenario, which assumes no changes from the current situation, implies that the spectrum currently allocated to DTT will not be available to IMT providers in the foreseeable future. Any potential shortage of IMT network capacity caused by future developments will need to be addressed either through technological innovation, network densification and/or more efficient use of other frequency bands (reallocation, spectrum sharing, etc.). Under this scenario, PMSE may continue to use the UHF spectrum.

6.2.2 Scenario 2: Allocation of part of the band to IMT

This scenario involves retaining the majority of the UHF band for TV broadcasting (470–614 MHz, channels 21–38) and introducing a dedicated band for IMT 5G in line with developments in ITU Region 2. The allocation for IMT would be in accordance with the 3GPP specification: downlink 617–652 MHz and uplink 663–698 MHz. Other services, such as PMSE, may coexist in the 652–663 MHz duplex band.

IMT would therefore have the option of utilising a 2 × 35 MHz block in FDD mode for the operation of 5G mobile services. This will create an incremental layer for a potential increase in capacity within the sub-1 GHz bands currently available to operators.

6.3 Establishment of evaluation criteria

The following criteria have been established for the evaluation of individual scenarios; where relevant, these will be applied to assess both scenarios from the perspective of digital terrestrial television (DTT) broadcasters and mobile telecommunications networks (IMT), as well as the societal impact on individual user groups.

- **Impact on network operators' costs**: The direct and indirect impacts on costs or revenues arising from a given scenario are assessed.
- **Socio-economic impacts**: One of the key benefits of free-to-air DTT is its socio-economic impact on users and the market. In particular, it is a public service medium (free-to-air PMS) which, in addition to its obligation to provide up-to-date and balanced news coverage, also plays a significant role in the areas of cultural heritage and the production of documentaries, films, series and other content. At the same time, the impact on improving the quality of IMT services for mobile service users will also be assessed.
- **Impacts on the competitive environment**: Should any decision be taken regarding the future of DTT in the 600 MHz band, the risk of distortion of competition should also be assessed. The level of competition can be defined both at the level of television channels and for the platform itself.
- **Other potential impacts and comments**

Given the importance and complexity of the audiovisual broadcasting market and mobile network operations, the environmental impact is not assessed in this comparison. A mix of technologies, platforms and services will always be in operation, with customers using several services simultaneously. A separate assessment of technologies such as 5G Broadcast, IPTV versus DTT could therefore lead to a distortion, particularly given the significant technological developments (for example, 5G Broadcast, which is currently mainly in the testing phase) expected by 2030.

6.4 Assessment of Scenario 1: **Maintaining the current allocation for DTT**

Description

This scenario represents the least change for DTT, as it maintains access to the radio spectrum for DTT, with the possibility of use by other services only in cases where spectrum management does not pose problems for coexistence, or where the radio spectrum is not required for DTT.

Of course, where DTT usage is widespread, this may preclude use by other services in many areas due to the often-required large separation distances for coexistence between DTT and IMT (200–300 km). This scenario allows for the continued use of the spectrum by PMSE services. At the same time, this scenario preserves the scope of public service broadcasting (PMS) and commercial services via FTA (this fact is closely linked to the use of platforms, in particular the use of DTT, which must be monitored in accordance with the binding decision).

6.4.1 Key changes to spectrum allocation

In this case, there is no fundamental change; the band remains allocated to DTT as the priority service. PMSE continues to have the current spectrum range at its disposal and may continue to operate under the same regime. No spectrum is allocated to IMT in the UHF band; it has only the existing radio spectrum allocation below 1 GHz at its disposal.

6.4.2 Impact on individual groups of spectrum users

DTT: No change; the current radio spectrum range for DTT broadcasting is retained. **IMT:** No

change; the current radio spectrum range for IMT below 1 GHz is retained. **PMSE:** No change; the

current radio spectrum range for PMSE is retained.

6.4.3 Assessment according to the specified criteria

6.4.3.1 Impact on network operators' costs

From a DTT perspective:

With regard to the scenario of extending (or reallocating) spectrum allocations, it is necessary to consider the licence duration, which has a direct impact on the distribution of costs over time and the calculation of the profitability of the solution in question. This is a strategic decision which, even within the context of IMT, must be coordinated across the region and take into account the projected needs of both DTT and IMT.

The current licences held by DTT operators were granted to run until 2030, and the construction and renewal plans of companies operating television stations and content have been adapted accordingly. The lifespan factor is therefore crucial, as it can be expected that investments in broadcasting infrastructure have been made in such a way that their lifespan aligns with that of the licences, i.e. until 2030. It can therefore be expected that DTT operators will aim to factor all planned costs into their broadcasting costs.

In light of the above, further investment will be required, which will be significantly influenced by the timing of the start of discussions on the extension or reallocation of spectrum for DTT services. Theoretically, it would be possible to consider the need for investment on a similar scale to that required for the construction of the original infrastructure (antennas and the like). *Of course, relevant savings can be anticipated due to increased efficiency of equipment (technology) and a fall in their prices. On the other hand, an increase in costs can be expected due to rising energy and labour costs, as well as increased demand in view of regional coordination across several EU Member States.*

Within the EU, DTT is currently showing a downward trend, whilst new technological solutions, new platforms and ways of consuming content (entirely new technologies such as VR and the like) are emerging, which may cause a fundamental shift in revenue per user whilst a decline is expected in the user base (for television programmes) that uses DTT as its primary platform.

From an IMT perspective:

Should additional capacity be required, costs associated with network densification may arise; however, it is essential to bear in mind the specific characteristics of the UHF spectrum (specifically the 600 MHz band), which is not a key 5G spectrum identified for addressing capacity issues. It is therefore not possible, looking beyond 2030, to predict the need for additional frequencies or to quantify the additional costs of any network densification.

At the same time, the use of the 600 MHz band for IMT does not represent a fundamental change in coverage provision, but is relevant as a capacity layer for further use, particularly for 5G mobile services (fixed 5G services with lower speeds may also be considered).

From a PMSE perspective:

No significant additional costs are incurred.

6.4.3.2 Socio-economic impacts

From the DTT perspective:

There is no restriction on the spectrum allocated to DTT in the UHF band (or, more specifically, in the 600 MHz band), thus enabling the uninterrupted continuation of DTT operations within the current scope. There remains scope for ensuring the functioning of free-to-air public service broadcasting via DTT.

At the same time, without any restriction on the UHF spectrum for DTT services, regional broadcasting can continue to operate; this is currently an effective means of disseminating relevant information and, at the same time, offers broadcasters a higher degree of monetisation of advertising space due to more precise audience targeting.

At the same time, the possibility of using this platform as a means of communication in emergencies (in addition to radio) is ensured.

From an IMT perspective:

There is a potential scenario of spectrum scarcity below 1 GHz, in which the UHF band – or, more specifically, the 600 MHz band – could serve as an additional spectrum layer to ensure increased capacity at long-range frequencies (or the ability to penetrate buildings within built-up areas). This would limit any deterioration in service quality or increase in costs resulting from network densification (all of which is, of course, closely linked to the form of allocation and the resulting auction price).

However, it is important to recognise that the UHF spectrum (600 MHz) alone is not a solution for providing a signal in areas where there is currently none. Operators have a wide range of spectrum resources in the band below 1 GHz that can meet these needs, including the 900 MHz frequency bands (within the Czech Republic) currently under consultation, or the 700 MHz band, which some countries are still considering allocating for SDL.

At the same time, the UHF band is not a suitable solution for providing additional capacity; higher frequency bands are more appropriate for this purpose (e.g. 3400–3800 MHz, as identified as key 5G bands).

6.4.3.3 Impacts on the competitive environment

This scenario has a neutral impact on the competitive environment, as competition between television stations and individual broadcasting platforms will continue to be maintained without any external intervention that could accelerate the loss of viewers.

By retaining all DTT multiplexes and regional broadcasting, the platform’s overall appeal is enhanced, thereby ensuring greater competitiveness compared with Scenario 2 below.

6.4.3.4 Other possible impacts

For the scenario under consideration, a simulation was carried out of the launch of the IMT network in the 600 MHz band in Germany to determine the impact of its operation on DTT propagation in the Czech Republic.

The analysis carried out of the theoretical interference caused by DTT transmitters operated in the Czech Republic and internationally coordinated transmitters on IMT/5G base station receivers (uplink) of IMT/5G in the 600 MHz frequency band clearly demonstrated the incompatibility of the two systems, with the repeat distance amounting to approximately 200 to 300 km. This result is consistent with studies carried out abroad and with the ITU document ‘Co-channel sharing and compatibility studies between digital terrestrial television broadcasting and international mobile telecommunications in the 694–790 MHz frequency band in the GE06 planning area’.

When considering only the impact of transmitters currently in operation in the Czech Republic – and not all internationally coordinated transmitters in the country – it can be concluded that the restrictions on the deployment of IMT/5G networks in neighbouring countries do not apply to the entire band. It concerns only the part of the band within the frequency range of television channels 45 and 46. Channel 48 remains unused in this case, and the restrictions caused by low-power transmitters on channel 47 do not appear to be significant. Such a solution represents a considerable concession for the Czech Republic in the form of a loss of coordinated frequencies. Concurrent operation would affect most of Germany and would result in significant interference with 5G services in Germany.

By contrast, interference with digital television broadcasting in the Czech Republic caused by IMT/5G base stations in Germany would not be significant. In practice, the restriction would apply only to base stations with direct radio line-of-sight to the Czech Republic. Given the geographical conditions and the mountainous border areas, there are likely to be only a small number of such cases. Provided the principles of international frequency coordination set out in the conclusions of the RRC-06 conference are observed, there should be no interference with television broadcasting in the Czech Republic.

6.4.4 Scenario 1 in European Union countries

The European Commission's study also examined the Member States' positions on the individual scenarios.[63] Four EU Member States emphasise that they are unclear as to which services could share the radio spectrum with DTT, given its current usage, whilst three point out that this may limit the future development of IMT. However, the incomplete set of responses from national regulators limits the broader applicability of these conclusions. Similarly, several Member States noted that they had not yet considered the implications of these scenarios, as DTT licences in many cases will not expire for several years. Further details on the positions of individual Member States that commented on the proposed scenarios are set out in Table 9.

Table 9: Positions of EU Member States on the proposed Scenario 1 according to the 2022 EC study

Country	Estimated positions/impacts and conclusions of Scenario 1
Austria	No significant impact on DTT, but potentially limited benefits for IMT
Croatia	Low impact on DTT.
Czech Republic	A pan-European approach is required.
Estonia	If the spectrum requirements for DTT are reduced, spectrum utilisation will be inefficient.
Finland	DTT cannot share spectrum with IMT, so parts of the band would need to be cleared if necessary, and the spectrum would then be available for mobile networks.
France	It is unclear which services other than DTT could share the spectrum.
Greece	Allows DTT services to be retained as required.
Hungary	It is unclear which services other than DTT could share the spectrum, and there is potentially limited benefit for IMT.
Italy	Rights have been granted to DTT operators for 10 years (starting in 2019). The state has not compensated national operators for the reduction in multiplexes (a conventional conversion factor of 0.5 from DVB-T to DVB-T2 was applied).
Latvia	A flexible approach allowing for the retention of DTT services where necessary. Favourable in terms of coordination and the application of the Radio Regulations vis-à-vis non-European countries.
Lithuania	DTT and SDL could potentially share the spectrum.
Luxembourg	It is unclear which services other than DTT might share the spectrum.
Malta	No impact
Netherlands	Potential inefficient use of the band.
Romania	Low impact on DTT
Slovenia	No socio-economic benefits; restricts the development of IMT.
Spain	This scenario is unlikely given the high demand for DTT in Spain

Source: European Commission, adapted by GTA

[63] European Commission (2022), Final report: Study on the use of the sub-700 MHz UHF band (470–694 MHz) – https://op.europa.eu/en/publication-detail/-/publication/d77a592e-4f54-11ed-92ed-01aa75ed71a1/language-en In addition to the two scenarios outlined here, the EC considered two further scenarios in its study: i) the introduction of an optional portion of the band for shared use with equal broadcasting rights, subject to coordination and compatibility, or for unified business models; ii) the conversion of the entire 600 MHz band for joint IMT/DTT use with equal rights.

6.5 Assessment of Scenario 2: **Allocation of part of the band for IMT**

Description

This scenario envisages a partial reallocation of the band (617–698 MHz) to mobile telecommunications network operators (IMT services). This is an alternative scenario which partially restricts the spectrum available for DTT, with a direct impact on capacity (and potentially on quality, depending on future settings which cannot be estimated and are therefore not analysed further). It will have a negative economic impact on content creators, as the distribution of content via other platforms will potentially entail higher costs.

A possible advantage of this scenario is that mobile operators and technology developers will be incentivised to develop 5G Broadcasting technologies. However, it is currently difficult to estimate the potential benefits of 5G compared with DVB-T2, as 5G Broadcasting technology is as yet virtually non-existent and is only at the testing stage.

6.5.1 Key changes to spectrum allocation

The main change for DTT will be a reduction in the allocated UHF band, which will affect the number of networks – and therefore television stations, particularly regional ones – whilst the operation of public service broadcasters will not be affected by the change. The use of PMSE services will also be restricted. In contrast, mobile operators will be allocated duplex spectrum in the range of approximately 2×35 MHz FDD (617–698 MHz).

6.5.2 Impact on individual groups of spectrum users

DTT: When analysing the impacts on DTT services, it is necessary to distinguish between national (commercial and public service) and regional broadcasting. This scenario remains unchanged for public service broadcasting and commercial broadcasting at national level. However, the key issue is the reduction (loss) of multiplex 24, which carries regional broadcasting. Public service broadcasting (PMS) is therefore maintained, but the distribution of regional content is restricted.

IMT: Allocation of a band of approximately 2×35 MHz for IMT services in the 600 MHz band, or other potential services provided by mobile network operators.

PMSE: A reduction in the frequency range for PMSE, but the service is maintained in this UHF band, excluding the 600 MHz band.

6.5.3 Evaluation according to the specified criteria

6.5.3.1 Economic costs

From the DTT perspective:

This scenario should not entail any additional costs for DTT after 2030, nor any costs that, by their nature, constitute sunk costs or lost revenue requiring compensation. The current licences held by DTT operators are valid until 2030 and will therefore not be released earlier. It can be assumed that an appropriate amount was paid for the spectrum during the allocation process (auction), taking into account the duration of the licences, so as to ensure a commercial return for DTT broadcasters.

At the same time, the reduction in the number of broadcast channels in the future could lead to a decline in the platform's appeal, and thus put pressure on DTT broadcasters regarding broadcasting prices. Given the accelerating rate of viewer loss, the reduced appeal of the platform may lead to significant pressure on the television programmes themselves, and thus potentially necessitate a move away from free-to-air (FTA) broadcasting and the introduction of reception charges. (This impact is, of course, also a risk in the first scenario, though the probability is lower).

Alternative scenario:

For the purposes of the study, an alternative impact scenario was considered in the event of an earlier implementation of the scenario involving the withdrawal of DTT from the 600 MHz band (in the sense of an earlier revocation of DTT operators' licences by the Czech Telecommunications Office), in which case it is necessary to consider the costs incurred and lost revenue, which, by their very nature, will need to be compensated.

The costs can be categorised into several groups:

(1) The cost of retuning and optimising current broadcasting;
(2) Potential costs arising from the purchase of new antennas;

(3) Potential costs arising from the purchase of new transmitters;
(4) Write-off of existing non-compliant hardware;
(5) Lost revenue associated with the reduction in regional networks;
(6) To a minimal extent, the cost of constructing new masts.

In the event of a forced clearance of the frequency band at an earlier date, it is likely that the state will be required to compensate for the costs incurred, including any potential loss of profit, as was the case with the transition from DVB-T to DVB-T2. In the case of the transition from DVB-T to DVB-T2 and the parallel operation of the networks, the costs in the Czech Republic amounted to EUR 18 million (CZK 473,391,429), according to the EC notification. These costs included both the costs of network conversion and the costs of parallel network operation. The notified aid represented 47 per cent of the costs, whilst the government estimated the total costs at EUR 39 million (CZK 1,007,476,444).[64]

From an IMT perspective:

The main costs arise from the allocation of spectrum, network roll-out and network operation. However, it is difficult to estimate the extent of such costs, which will depend heavily on the state of the network and the development of IMT in 2030. At the same time, it is not possible to predict with certainty the potential for monetising such investments, given the distant timeframe beyond 2030.

It can, however, be stated that the total of these costs will be lower than simply densifying the network and utilising other frequency bands; for example, if the auction price were to exceed these costs, operators would, as a matter of rationality, opt to densify the network rather than continue bidding for the frequencies.

6.5.3.2 Socio-economic impacts

From the DTT perspective:

A reduction in regional content, whilst public service broadcasting is maintained. A potential reduction in the platform's appeal and content diversity, and thus the need to discontinue commercial broadcasting on a free-to-air (FTA) basis if an adequate audience size is not achieved to incentivise television programmes to pay DTT network operators for content transmission.

From the IMT perspective:

This represents a relatively small increase in capacity. At present, mobile operators have 94.8 MHz of radio spectrum below 1 GHz at their disposal. The increase therefore represents a 37 per cent rise. At present, the specific use of individual frequencies is not fully known, and consequently the need for further layers to ensure capacity is unclear.

Potentially, the 600 MHz band could be used as a carrier layer for NSA (non-standalone) IMT 5G solutions. In rural areas, no significant capacity shortage is currently to be expected (if any shortage exists, it relates to the signal itself). At the same time, there are other potential frequencies, such as those in the 900 MHz band, which offer similar spectral characteristics below 1 GHz and can be utilised in a similar manner.

The 600 MHz band may offer benefits for urban development (given its ability to penetrate buildings). However, it is to be expected that capacity issues will be addressed primarily by frequencies above 1 GHz, for example through the spectrum identified for 5G, namely 3400–3800 MHz.

The spectrum can, of course, be used for other technologies or services, such as the IoT, innovative solutions within network slicing, and the like.

From a PMSE perspective:

Restriction of the frequency range for PMSE, but retention of the service as such.

6.5.3.3 Impacts on the competitive environment

From a DTT perspective:

[64] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52022AS64153#ntr33-C_2022282EN.01001101-E0030

Regional television stations will be lost, and a further decline in the platform's audience figures and a reduction in content diversity can be expected. At the same time, the platform's popularity is waning.

From the IMT perspective:

Under this scenario, mobile operators would receive a spectrum allocation in the 600 MHz band, which would further strengthen their market position, provided that only existing operators apply for the relevant licences. Revenues for IMT are likely to be incremental, and an increase in capacity and service quality for the public can be expected. At the same time, this scenario implies a decline in regional content and may therefore lead to competition at the platform level (IPTV, cable television), which could mean additional revenue for operators who also run these platforms as part of their service portfolio.

There is a potential incentive for mobile operators to develop further platforms such as 5G Broadcast, which, thanks to additional spectrum, may find the capacity required for its operation.

6.5.4 Scenario 2 in European Union countries

The scenario involving the allocation of a mobile band within the 617–694 MHz band is the one in which the greatest economic impact on DTT can be expected, as it would be necessary to free up DTT in the 600 MHz band in favour of the new mobile band.

Under this scenario, it would be necessary to implement a co-primary allocation for ITU Region 1 at the next WRC, as well as a new European decision that would require the creation of a dedicated 600 MHz band, similar to what occurred with the 700 MHz band. It is likely that this option would also require significant re-planning of the remaining broadcasting services in order to achieve sufficient capacity to support the television platform as required. Consequently, extensive international coordination and amendments to the Geneva Agreement GE06 would probably be necessary.

The aforementioned European Commission study, in its assessment of the impacts of Scenario 2, drew the following conclusions. One Member State highlights the socio-economic benefits that additional IMT spectrum would bring, with a harmonised approach across Europe ensuring economies of scale for mobile network operators. However, this would be offset by a reduced ability of DTT to meet the requirements for free-to-air broadcasting and broadcasting pluralism (6 Member States) and by the administrative burden involved in amending the Geneva Agreement GE06 (3 Member States). Further details on the positions of individual Member States that commented on the proposed scenarios are set out in Table 10.

Table 10: Positions of EU Member States on the proposed scenario 2

Country	Estimated positions/impacts and conclusions of Scenario 2
Austria	A significant reduction in the number of channels, with a considerable economic impact on DTT
Croatia	High impact, threat of DTT being squeezed out
Czech Republic	A pan-European approach is required
Estonia	Needs should be balanced with IMT; negligible contribution to mobile network capacity
Finland	According to the regulator, IMT will require additional spectrum, but the use of the 600 MHz band would depend on its use in other countries.
France	Significant restructuring of DTT multiplexes and a major impact on the ability to maintain a pluralistic range of television programmes. A very challenging scenario from the perspective of democracy and pluralism.
Greece	Requires a transition to DVB-T2, but could potentially reduce the range of programmes on offer and require considerable effort to reach coordination agreements with neighbouring countries.
Hungary	Problems with frequency coordination, the need for financial compensation and investment issues, loss of viewers, and difficulties in ensuring fair access to the spectrum amongst neighbouring countries.
Latvia	No spectrum is available for pay-DTT services; significant restrictions on the spectrum available for PMSE, which cannot be replaced elsewhere.
Lithuania	There is a risk that broadcasters' spectrum requirements cannot be met, which may limit opportunities for the development of DTT. Difficulties may also arise in ensuring harmonisation and spectrum sharing within the EU.
Luxembourg	The administrative burden involved in amending the Geneva Agreement GE06; the third digital dividend may not be a suitable solution.
Malta	This creates problems with cross-border coordination between Member States and non-EU countries. The transition to sub-600 MHz could be difficult for some Member States, particularly those whose neighbours make intensive use of DTT or are outside the EU.
Netherlands	Potential difficulties in meeting FTA obligations; possible shortage of spectrum for PMSE.

Romania	DTT could be re-planned with minimal impact, but PMSE usage would have to change significantly.
Slovenia	Medium-term socio-economic benefits; helps operators capitalise on economies of scale, but requires considerable effort to amend the Geneva Agreement GE06.
Spain	This scenario is unlikely, given the high demand for DTT in Spain. Any changes would require significant re-planning and network development.

Source: European Commission (2022), GTA amendment

Annex 1: Introduction to the issue the request to release the 600 MHz frequency band for mobile services

At the request of the Czech Telecommunications Office (ČTÚ), the Czech Radio Communications Institute (ČMI) prepared a study in November 2018, the terms of reference for which included:

- A summary of the current situation regarding the use of the relevant radio frequencies in the Czech Republic and Europe (particularly in neighbouring countries), which could lead to a call within the EU for the release of the 600 MHz band;
- A review of frequency options in the Czech Republic following the release of the 600 MHz band in line with the new frequency plan;
- An analysis of frequency options in neighbouring countries with regard to equal access to the frequency spectrum (particularly in border regions) following the release of the 600 MHz band;
- Proposal for the further use of the remaining frequencies in the Czech Republic for the possible implementation of nationwide and regional broadcasting networks;
- Formulation of measures and positions that the Czech Telecommunications Office (ČTÚ) and the Ministry of Industry and Trade (MPO) should adopt in negotiations within the EU, ITU and CEPT bodies.

This analysis concluded that, under Czech conditions, the potential release of the 600 MHz band (for IMT) would result in the loss of 10 television channels (numbers 39 to 48), whilst 18 channels (numbers 21 to 38) would remain available for further use in digital TV broadcasting.

The potential release of the 600 MHz band would result in the loss of two of the six layers of the plan in force at the time. From the perspective of the broadcasting networks, the situation in the Czech Republic would not be particularly critical, as the public service multiplex 21 and commercial network 23 would not be affected in any way by the release of the 600 MHz band. The lost channels in multiplex 22 could be replaced by extending the use of existing channels into neighbouring allotments and moving channel 25 from layer 5 to the South Bohemian Region. However, a problem for multiplex 22 would be finding a solution for the South Moravian Region, which could only be resolved in coordination with the relevant Austrian or Hungarian authorities.

Conversely, the release of the 600 MHz band would have a devastating impact on multiplex 24, which would effectively cease to exist and would have to be replaced by allotments from the planned Layer 6, whilst only channel 21 from the original network could be utilised; the channel in the South Moravian Region would be replaced by channel 29 from Layer 5. This solution would result in the end of regional broadcasting in the Czech Republic.

Appendix 2: Study on the impact of the implementation of IMT services in Germany in the UHF band (ČMI study)

At the request (terms of reference) of the Czech Telecommunications Office (ČTÚ), ČMI carried out an analysis in March 2024 of the impact of the roll-out of IMT services in Germany on television broadcasting in the Czech Republic in the 600 MHz band and vice versa, including verification of minimum separation distances.

This analysis was intended to answer the question: *What are the potential separation distances*? The terms of reference for ČMI specified the use of specific locations in the Czech Republic and examples of IMT installations in Germany, utilising IMT technical parameters in accordance with ITU-R WP5D. Interference was analysed separately for the uplink band (663–698 MHz) and the downlink band (617–652 MHz).

The analysis of the theoretical interference caused by DTT transmitters operated in the Czech Republic and internationally coordinated transmitters on IMT/5G base station receivers (uplink) in the 600 MHz frequency band unequivocally demonstrated the incompatibility of the two systems, with the repeater distance ranging from 200 to 300 km. This result is consistent with studies carried out abroad and with the ITU document *‘Co-channel sharing and compatibility studies between digital terrestrial television broadcasting and international mobile telecommunications in the 694–790 MHz frequency band in the GE06 planning area’.*

When considering only the impact of transmitters currently in operation in the Czech Republic – and not all internationally coordinated transmitters in the country – it can be concluded that the restrictions on the deployment of IMT/5G networks in neighbouring countries do not apply to the entire band. It concerns only the part of the band within the frequency range of television channels 45 and 46. Channel 48 remains unused in this case, and the restrictions caused by low-power transmitters on channel 47 do not appear to be significant. Such a solution represents a considerable concession for the Czech Republic in the form of a loss of coordinated frequencies. Concurrent operation would affect most of Germany and would result in significant interference with 5G services in Germany.

By contrast, interference with digital television broadcasting in the Czech Republic caused by IMT/5G base stations in Germany would not be significant. In practice, the restriction would apply only to base stations with direct radio line-of-sight to the Czech Republic. Given the geographical conditions and the mountainous border areas, there are likely to be only a small number of such cases. Provided that the principles of international frequency coordination, as set out in the conclusions of the RRC-06 conference, are adhered to, there should be no interference with television broadcasting in the Czech Republic.

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