



**Report ITU-R BT.2302-0**  
(04/2014)

**Spectrum requirements for terrestrial  
television broadcasting in the UHF  
frequency band in Region 1 and  
the Islamic Republic of Iran**

**BT Series**  
**Broadcasting service**  
**(television)**



## Foreword

The role of the Radiocommunication Sector is to ensure the rational, equitable, efficient and economical use of the radio-frequency spectrum by all radiocommunication services, including satellite services, and carry out studies without limit of frequency range on the basis of which Recommendations are adopted.

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<b>RA</b>	Radio astronomy
<b>RS</b>	Remote sensing systems
<b>S</b>	Fixed-satellite service
<b>SA</b>	Space applications and meteorology
<b>SF</b>	Frequency sharing and coordination between fixed-satellite and fixed service systems
<b>SM</b>	Spectrum management

*Note: This ITU-R Report was approved in English by the Study Group under the procedure detailed in Resolution ITU-R 1.*

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## REPORT ITU-R BT.2302-0\*

**Spectrum requirements for terrestrial television broadcasting in the UHF frequency band in Region 1 and the Islamic Republic of Iran**

(2014)

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**1 Abstract**

In the framework of the activities in support of the preparations for WRC-15, WP 6A has conducted studies on spectrum requirements for the broadcasting service. The results of these studies are presented in this Report.

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\* Radiocommunication Study Group 6 made editorial amendments to this Report in October 2017 in accordance with Resolution ITU-R 1.

## 2 Introduction

Broadcasting serves an important social function, and consequently many countries have established public service broadcasters as a matter of public policy. The British Broadcasting Corporation (BBC), for example, is established by Royal Charter in the United Kingdom. That Charter states six public purposes:

- sustaining citizenship and civil society;
- promoting education and learning;
- stimulating creativity and cultural excellence;
- representing the UK, its nations, regions and communities;
- bringing the UK to the world and the world to the UK;
- helping to deliver to the public the benefit of emerging communications technologies and services, and taking a leading role in the switchover<sup>1</sup> to digital television.

In other countries, publicly-funded and commercial broadcasters often undertake similar public purposes in exchange for access to spectrum.

Historically, all television delivery was by terrestrial means. The delivery mechanisms in place have evolved in subsequent decades, and have also diverged. In some countries, delivery via cable systems or satellite has come to dominate, while in others terrestrial delivery remains dominant.

In Region 1 and in Iran, the use of the band 470-862 MHz is regulated by the Geneva 2006 Agreement (“GE06”). It recognizes three distinct reception conditions for digital television: fixed, portable outdoor (mobile) and portable indoor. While cable or satellite delivery are suitable for fixed reception, only terrestrial delivery can be used in portable, mobile and fixed reception scenarios. There are also significant differences in different geographical or regional areas because of different penetration of fixed, satellite and terrestrial services.

There is a global difference in availability of telecommunication services in different geographical areas between highly developed countries and developing countries and inside countries between urban and rural populations.

The urban population is usually provided with broadband fixed connections and, additionally, several alternative information service delivery links such as cable broadcasting or broadband mobile communication are also available. On the contrary, rural areas and small towns often have very few additional means to deliver information services.

Operators of broadband communication networks face difficulty when providing adequate levels of modern information services to rural and remote areas. This is caused by insufficient returns to cover their expenses for building and operating such networks due to low population density and therefore a potentially low return on investment.

Rural areas, therefore, have generally lower penetration levels of fixed communications infrastructures than urban areas. Thus, to successfully solve the issue of bridging the digital divide, it is necessary to use an approach which is able to combine wide bandwidth and low cost for building and operation of the networks.

Currently, there are several technologies providing delivery of broadband digital content to remote and rural areas. Each technology is mostly suitable for a specific task.

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<sup>1</sup> The term “digital switchover” is used to indicate the transition of a radiocommunication broadcasting service from analogue to digital technology

TABLE 1  
Specific properties of different radiocommunication technologies

Technology	Advantages	Disadvantages
Wired communication	All types of content and information services, the highest data transmission rate, robustness against interference, bidirectional data transmission	Very high expenses for building and operation of communication links due to specific rural conditions, high requirements to routing nodes and upper level communication channels, impossibility to serve mobile subscribers
Mobile communication	All types of content and information services, possibility to serve mobile subscribers, portable receive equipment, very suitable for on-demand content delivery, bidirectional data transmission	Great demand for radio spectrum, limited radio link bandwidth, degraded communication when user peak load, high expenses for building and operation of infrastructure, high cost of user terminals supporting broadband access
Satellite communication and broadcasting	Low levels of terrestrial infrastructure required (uplink and downlink terminals), very efficient delivery of the same content to the whole country or large region	Small bandwidth per subscriber when delivering individual content, low efficiency of local content transmission, shortage and high cost of satellite channels, expensive and complex installation of subscriber equipment
Terrestrial broadcasting	Low cost of transmission network infrastructure, low cost of receiving devices, very efficient delivery of the same content to medium and small territories	Small bandwidth per subscriber when delivering individual content, limited number of available radio channels, one direction transmission (down link)

In the future, it is anticipated that most households and most users will have alternative ways of communication or content reception using terrestrial mobile communication, fixed-satellite communication, satellite and/or terrestrial broadcasting. Smart user terminals and home multimedia centres will be able to transmit and receive data from different networks, record broadcast data and seamlessly present content from different sources to the user. This will realize the benefits of all the data transmission technologies and environments to obtain the desired information in the most-efficient way.

Broadcasting transmission will ensure very cheap subscriber delivery of common information such as entertainment and news, in high definition format. Deployed properly, this could offload traffic from mobile networks, reducing their task of transmitting large volume of multimedia downlink traffic.

An attempt to transmit multiple copies of the same programs in high definition via mobile networks would lead to inefficient use of resources (bandwidth and transmitter power for a large number of base stations) in the networks primarily designed to transmit different data packets to different subscribers. Use of a broadcast mode in the mobile network would improve the situation but such transmissions may still be much more expensive than transmission through broadcast networks. On the other hand, unicast transmission of individual data packets, with exception of very sparsely populated areas, could be better provided by terrestrial fixed or mobile service.

When considering the future use of the radio spectrum, a lack of spectrum resource for terrestrial broadcasting will lead to an increase of mutual interference between stations, and a more complicated and expensive infrastructure of communication and broadcasting networks will be required to compensate for this increased mutual interference.

A lack of radio spectrum for development of broadcasting service will reduce the opportunities it could offer in future telecommunication markets. The parties mostly affected by such a change would be the end users of telecom services whose choice will ultimately be more limited.

It is important to note that even in countries with high cable or satellite penetration, terrestrial broadcasting continues to operate. In some cases, this is because of government policy, in others it is because it is commercially attractive to do so. In many countries, both reasons apply.

To support a competitive and fast development of data transmission technologies and broadband access in rural areas, as well as to continue to support the cultural value of broadcasting services, it will be necessary to make an appropriate amount of frequency resource available for digital terrestrial data/TV broadcasting service.

### **3 Spectrum requirements questionnaire**

In order to inform the content of this Report, and to make representations to JTG 4-5-6-7 on the requirements for broadcasting in the UHF band, WP 6A sent a questionnaire to all Administrations and Sector Members in Region 1 and Iran. The responses to this questionnaire, along with some analysis of those responses, are presented in Annex 1.

A detailed case study in Annex 2 shows the impact that reducing spectrum availability would have in the Russian Federation and in neighbouring countries. Finally, a statement from the Islamic Republic of Iran in Annex 3 highlights issues which that country faces in ensuring sufficient spectrum is made available for its broadcasting requirements.

### **4 Spectrum allocations for television broadcasting**

The GE06 Agreement applies to almost all of Region 1, plus the Islamic Republic of Iran. It governs the use of the spectrum for delivery of digital sound and television broadcasting in VHF Band III (174-230 MHz), and UHF Bands IV & V (470-862 MHz). Subsequently, part of Band V (790-862 MHz) was allocated to the mobile service at WRC-07. Many countries in Region 1 have now implemented this mobile allocation.

Many countries have television assignments in all three bands, whereas others use Band III for sound broadcasting only, and rely on the UHF bands for television broadcasting.

Under the GE06 Agreement, Plan entries exist as either allotments or assignments. Whereas the details of how these are implemented are different, they each result in a coverage or “layer”. A layer is a set of frequency channels distributed across the planning areas such that each location of the planning area, where reception is intended, is covered with one multiplex<sup>2</sup>.

The number of RF channels required to give one complete layer depends on aspects such as:

- the size and shape of the intended service areas;
- the network structure applied;
- the target coverage (area/population);
- the intended reception conditions.

In general, it was found that 6-8 RF channels were required for a single layer across most of the planning area. In the parts of Bands IV & V (470-790 MHz), therefore, the 40 RF channels, equivalent to 320 MHz of spectrum, can support around 6 layers.

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<sup>2</sup> The multiplex is a digital data stream that combines several programmes streams into a single stream for transmission over an RF channel.



Similarly, in areas where Band III is used for television broadcasting, it is found to be able to support another one layer.

Typically, if first generation DVB-T technology is used, each multiplex can deliver a capacity of around 24 Mbit/s for fixed reception. For portable or mobile reception the signal needs to be more robust (i.e. lower code rate and/or lower modulation scheme) and the capacity decreases accordingly.

The number of television programmes that can be carried in each multiplex depends on the total capacity of the multiplex, the type of source coding used for the television programme and the desired quality in which the programme is to be delivered.

Early implementations of DVB-T specified MPEG-2 coding. The bit-rate required for delivery of a single standard definition (SD) TV programme is around 4 Mb/s using MPEG-2 coding. Therefore, in France, for example, six SD programmes are delivered in 24.1 Mbit/s. Through the use of statistical multiplexing<sup>3</sup>, gains can be made to allow more services to be carried in the available capacity. In the UK, for example, up to 9 SD programmes are carried in the same 24.1 Mbit/s.

The ability to employ statistical multiplexing will depend on how a multiplex is managed and may not be possible for operational reasons.

According to the analysis of the questionnaire responses, if the availability for broadcasting radio spectrum in the 694-790 MHz band is reduced, in particular by more than 40 MHz, it will require massive revision of the frequency plan for the terrestrial broadcasting service ("GE06" Plan), if the same number of multiplexes is to be maintained. This is due to significant loss in the number of multiplexes in some geographical areas. It should be noted that as a consequence of that, if one needs to keep the same number of planned channels in a smaller frequency range, there could be some impairment in the technical performance of the broadcasting service. Some countries may be forced to change to newer transmission modes to attempt to recover some of the lost service capacity, which would then oblige their citizens to buy new television sets.

In some areas, where compatibility conditions are more difficult, allocation of the appropriate number of RF channels for each of the interested Administrations within a reduced frequency range will be a very challenging task, providing no guarantee for success of the re-planning exercise. Such re-planning is more likely to succeed if conducted on a multilateral basis.

## **5 Capacity improvement techniques**

Improved video coding systems are now available that can reduce the bitrate required for delivery of television programmes. H.264/MPEG4 coding can reduce bitrate by 30-60% for an SD service compared to MPEG2, and further improvements are expected in the future. In contrast, MPEG2 coding of video signals offers little if any future reduction. Note however that newer video coding schemes are not necessarily compatible with older decoders, so broadcasters are faced with the choice of taking advantage of the improvements available via adoption of newer coding techniques, or protecting reception by audiences who do not possess newer decoders.

At the time of the GE06 Agreement, digital television broadcasting in the GE06 planning area was foreseen to be delivered by DVB-T. Since 2006, the second-generation system DVB-T2 has been developed. This gives improved channel coding resulting in an increase in capacity of between 50% and 100%. The current implementation of a DVB-T2 multiplex in the UK, for instance, has allowed delivery of an additional 67% total capacity while maintaining the same coverage.

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<sup>3</sup> Statistical multiplexing is the application of dynamic allocation of the available bit rate to the various programmes streams carried in the multiplex, according to the quasi-instantaneous bit-rate need of each stream. This provides a gain in picture quality of each stream.

The capacity gained from these improvements could be used by broadcasters to deliver some or all of the following to their audiences:

- delivery of additional services;
- delivery of enhanced services (for example, HD or 3D programmes);
- greater robustness of the delivery platform to improve reception.

Even newer video coding techniques (e.g. H.265/HEVC) are now on the horizon. Although these offer the potential of even greater efficiencies, they still suffer the problem of lack of compatibility with existing receivers and decoders and would mean a complete change of all the receivers yet again. Typically, unless consumers receive some concrete incentive to upgrade, market forecasts indicate that even after 10 years, there may only be penetration to around 80-90% of households.

## **6 Spectrum efficiency techniques**

In addition to the improved channel coding available in DVB-T2, the system also allows for more extensive use of single-frequency networks (SFNs) by virtue of the increased FFT size and consequentially longer guard interval that can be employed. SFNs can, under certain circumstances, allow a layer to be constructed using fewer RF channels. This is not universally true however, and in some cases can result in the same spectrum efficiency as MFNs.

Further spectrum efficiency gains may be achievable by a change from high-power, high-tower infrastructure to medium-power, medium-tower or low-power, low-tower infrastructure. A change to an infrastructure with higher density of transmission sites would provide a more uniform distribution of field-strength. Also the smaller sites and lesser power would result in a shorter distance at which a frequency can be reused for different content. Over a wide area, therefore, the number of frequencies needed to provide a complete layer is reduced, relative to the high-power, high-tower approach. It should also be noted, however, that a complete change of network infrastructure is likely to incur substantial additional cost of investment for the network operator.

## **7 Limitations on efficiency**

While careful design and deployment of SFNs can result in an overall lower number of RF channels required per layer, there are constraints on their use that limit the efficiencies that can be gained. Firstly, political or commercial requirements for national or regionalized programming may not be accommodated within an SFN. This applies, for instance, across national borders, and across regional borders within a single country where broadcasting is regionalized (for example, in Germany where the Federal states mostly have different broadcasting organizations).

Secondly, depending on the choice of guard interval, there is a practical maximum size over which an SFN can operate without self-interference starting to take effect.

DVB-T2 is designed with a larger range of guard intervals, including some of several hundred microseconds. For the case of a dense DTT transmitter network, this could effectively remove the upper limit on SFN size, as signals from transmitters “too far away” would be sufficiently attenuated by path loss to avoid causing interference.

The guard interval represents lost transmission time in the network. Therefore increasing the guard interval leads to a loss in network capacity.

There are additional limitations of spectrum efficiency that apply to both SFNs and MFNs. For example, the presence of sea paths between target areas can enhance propagation and hence increase the distance within which frequency re-use is not possible. In some parts of the world, extreme propagation effects frequently occur which increases frequency re-use distance.



In many cases, spectrum efficiency can be improved by detailed planning and moving away from relying on high-level planning algorithms. This, however, is a complex task requiring technical expertise and often sophisticated computer planning tools.

## 8 Foreseen evolution of broadcasting services: present and future trends

Various future trends can be identified that could have an impact on future demand for broadcast spectrum. The applicability of these will vary from country to country, but are likely to include:

- **High Definition (HD):** is the rapidly spreading television standard, utilizing the benefits of digital transmission technology by bringing to the end-user the remarkable and significant improvement of picture quality in comparison to the former analogue TV broadcasting systems. It is expected that there will be a demand for many (for a medium-term period), and for all (for a long-term perspective) services, to migrate to HD. It is likely that there will be a transitional period where most HD services require to be also broadcast in a SD version, to ensure they can be received by all viewers. It is important to note improvements in portable display technology that allows the mass market HD displays to be no longer restricted to fixed reception devices.
- **Ultra-High Definition (UHD):** is a new television standard, providing further improvement in image quality which will become available on large and ultra-large screen TV receivers that are expected to appear at the mass market by the end of current decade. It is expected that the foreseen spread of the ultra-large screens and video-walls, providing the presence effect, will be an important factor in future media delivery. In that case, broadcasting is the most efficient way to deliver the high data rate demanding UHDTV content to a large number of users simultaneously.
- **3D television:** allows representation of the third dimension when displaying a television picture, currently mostly using conventional stereo image technology. 3D TV is gaining a substantial audience, especially for “special events” such as major sporting occasions and public events. In future, a full 3D service might be possible. It is expected that the technical characteristics of mass market 3D displays will continue to improve, increasing the demand for 3D television broadcasting.
- **Non-linear television and multimedia content broadcasting:** is the technology providing the features of interactive services. This technology can significantly reduce the loading of conventional telecommunication networks, or provide partial compensation for the users who have no access to adequate broadband services, which is very important for remote or rural areas.
- **time shifted services:** in which channels are rebroadcast, e.g. one hour later than originally broadcast, are proving very popular with consumers, providing over 20% of viewing for some channels in the UK. Whilst increasingly sophisticated DTR technology might make them less important, they have definitely a role to play for the next few years.
- There is an increasing demand for **local, regional and community services**. Such services, in comparison to country-wide broadcast networks, typically cover a more limited area, and are attractive to audiences because they are able to select content which is more focused on their region.

## 9 Conclusions

Viewers still value the services provided by DTTB, which drives the demand for spectrum. The main factors that drive this demand for current services and possible future expansion with new higher quality services have been highlighted in this Report.

## **Annex 1**

### **Analysis of responses to Circular Letter 6/LCCE/78**

In May 2012, ITU-R Working Party 6A sent a questionnaire to all Administrations of Member States of the ITU, Radiocommunication Sector Members, ITU-R Associates participating in the work of Radiocommunication Study Group 6 and ITU-R Academia.

At the time of preparation of this Report, in March 2014, the following points are noted:

- Section 1 of the analysis shows the number of responses received. A total of 100 responses have been received as of 27 March 2014, of which 89 are from Member States.
- In Section 8, the analysis shows the amount of spectrum in the band 470-862 MHz that Administrations consider will be required in the future. At the time of writing, 72 Administrations have expressed a clear view on this question. Of those, 28 expressed a requirement for more than 224 MHz, 40 require exactly 224 MHz and 4 Administrations indicate a requirement for less than 224 MHz.
- In the Attachment to this Annex, there is a detailed table of all responses received. In addition, the full text of all responses can be found on the Working Party 6A web page at <http://www.itu.int/md/R12-SURVEY.WP6A-SP/en>.

The list of Administrations and detailed responses considered in this analysis is provided in Attachment 1 to this Annex.

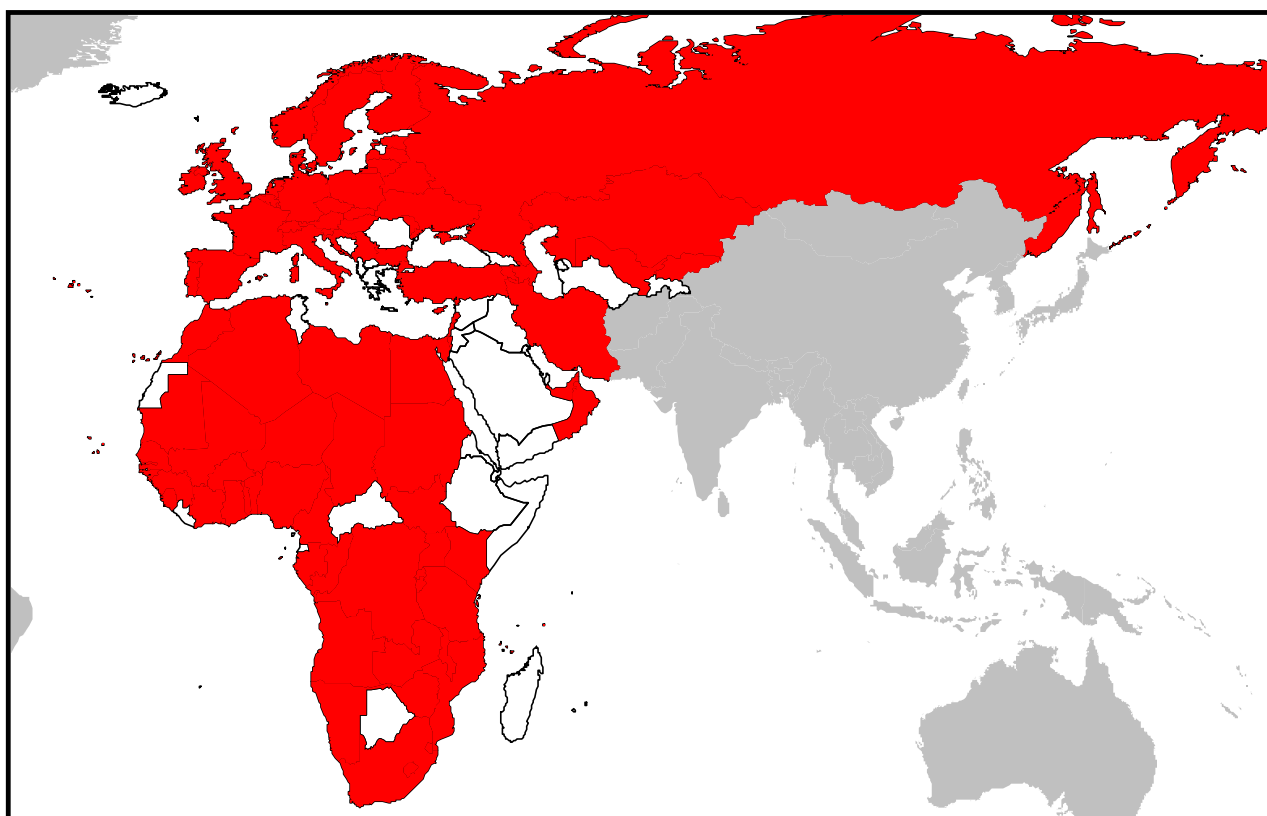
In order to avoid the possibility of double-counting, only responses from Administrations are considered in the analysis.

## 1 Responses

TABLE 1  
Total number of responses

	Responses
Total administration responses received	89
Sector Members	11
Total responses received	100

FIGURE 1  
Responding Administrations<sup>4</sup>



NOTE – Some Administrations sent more than one response. In this analysis, the most recent response only from each has been considered.

<sup>4</sup> The status of the territory of Western Sahara is being ascertained for future versions of this Report.

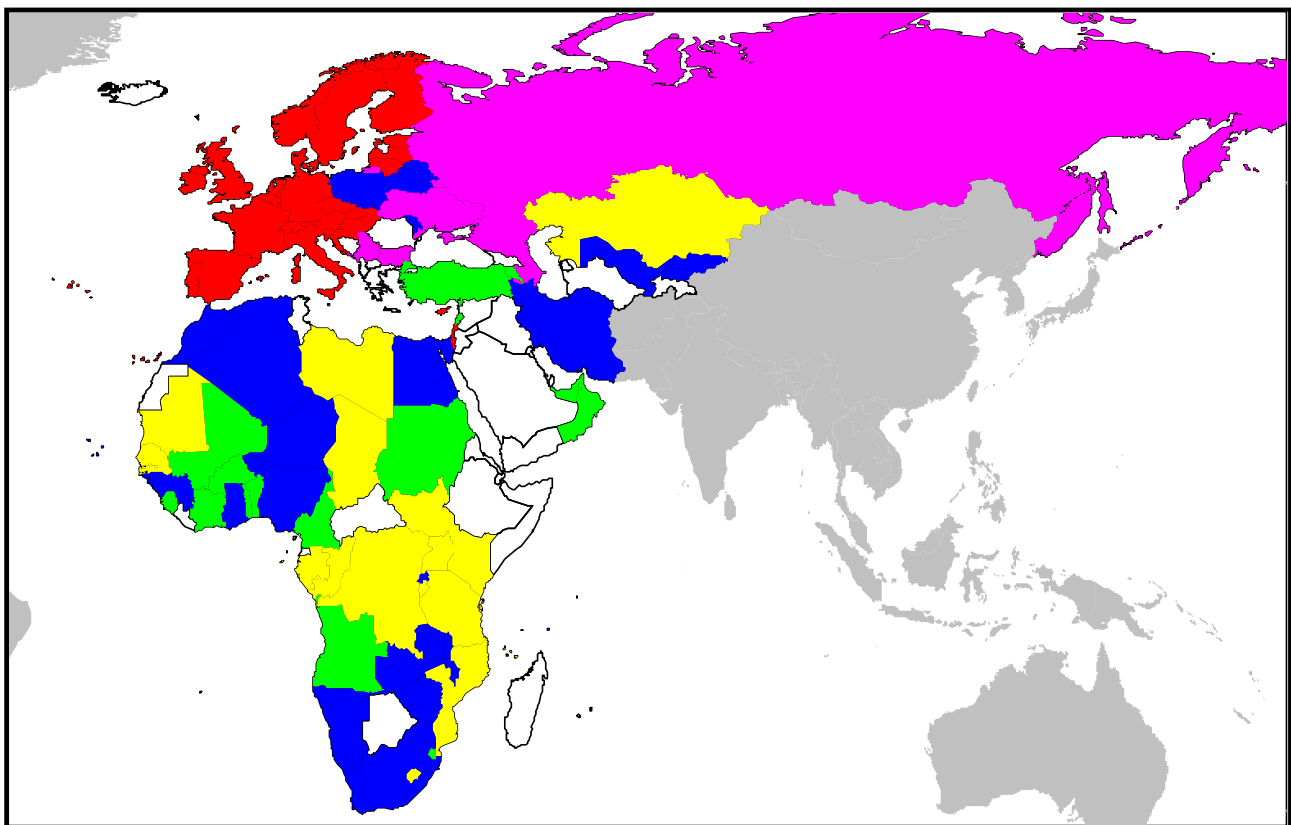
## 2 Introduction of digital terrestrial television

The status of DTT introduction and analogue switch off is shown in Table 2 below.

TABLE 2  
Status of DTT introduction and analogue switch off (ASO)

	DTT not started	DTT started but ASO not started	DTT started and ASO started	DTT started and ASO completed	No reply
Total administrations considered	15	22	6	28	18
Map colour					

FIGURE 2  
Status of introduction of digital television



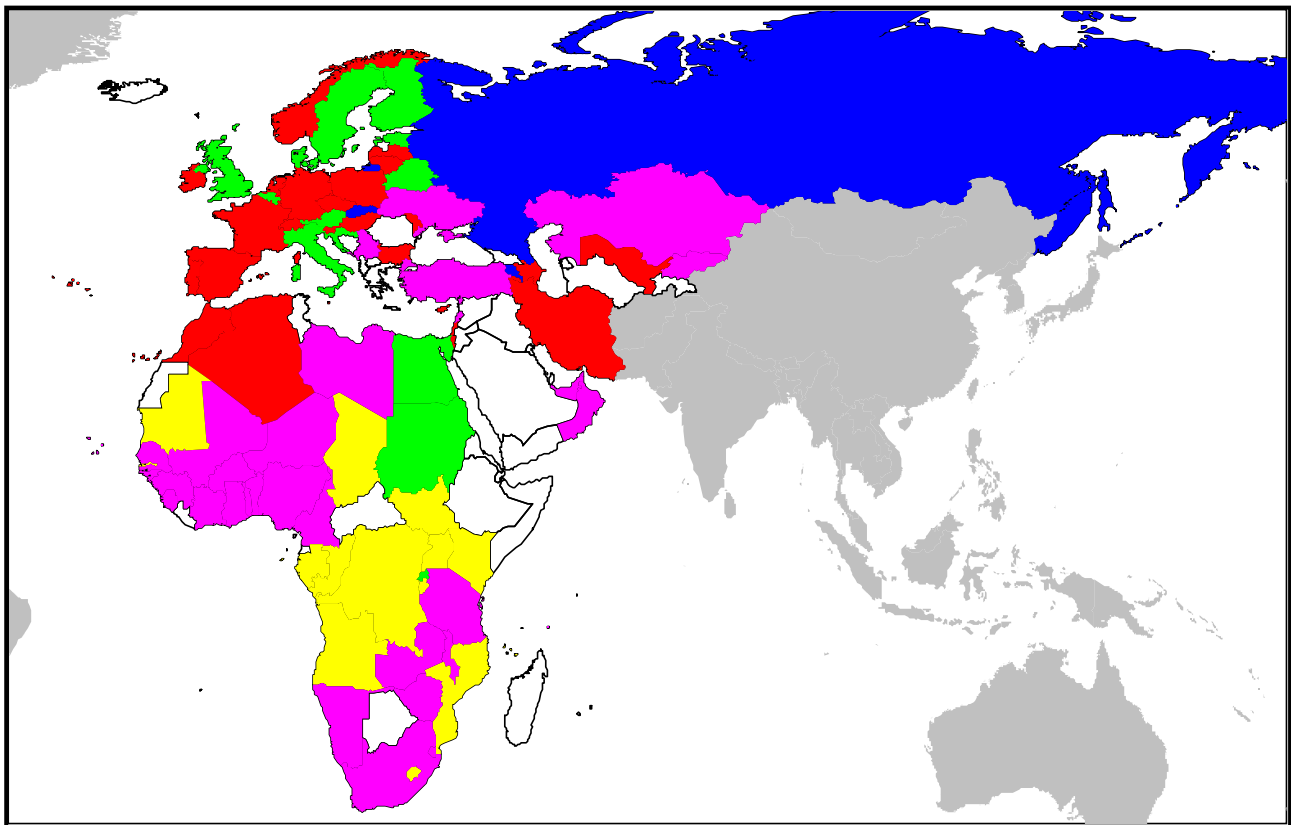
### 3 Choice of technology

The choice of DTT technology is shown in Table 3 below.

TABLE 3  
Choice of the DTT technology

	DVB-T	DVB-T and DVB-T2	DVB-T2	DVB-T, DVB-T2 and DVB-H	No reply
Total administrations considered <sup>5</sup>	26	13	32	3	15
Map colour	Red	Green	Magenta	Blue	Yellow

FIGURE 3  
Choice of the DTT technology



### 4 Proportion of users who receive television by terrestrial broadcasting

The proportion of users who receive television by terrestrial broadcasting (including first and second sets, reception through cable head ends and reception through MATV) is divided into ranges as shown in Table 4. Where this total proportion was not quoted in a response, proportion of PRIMARY DTT users was used for the analysis.

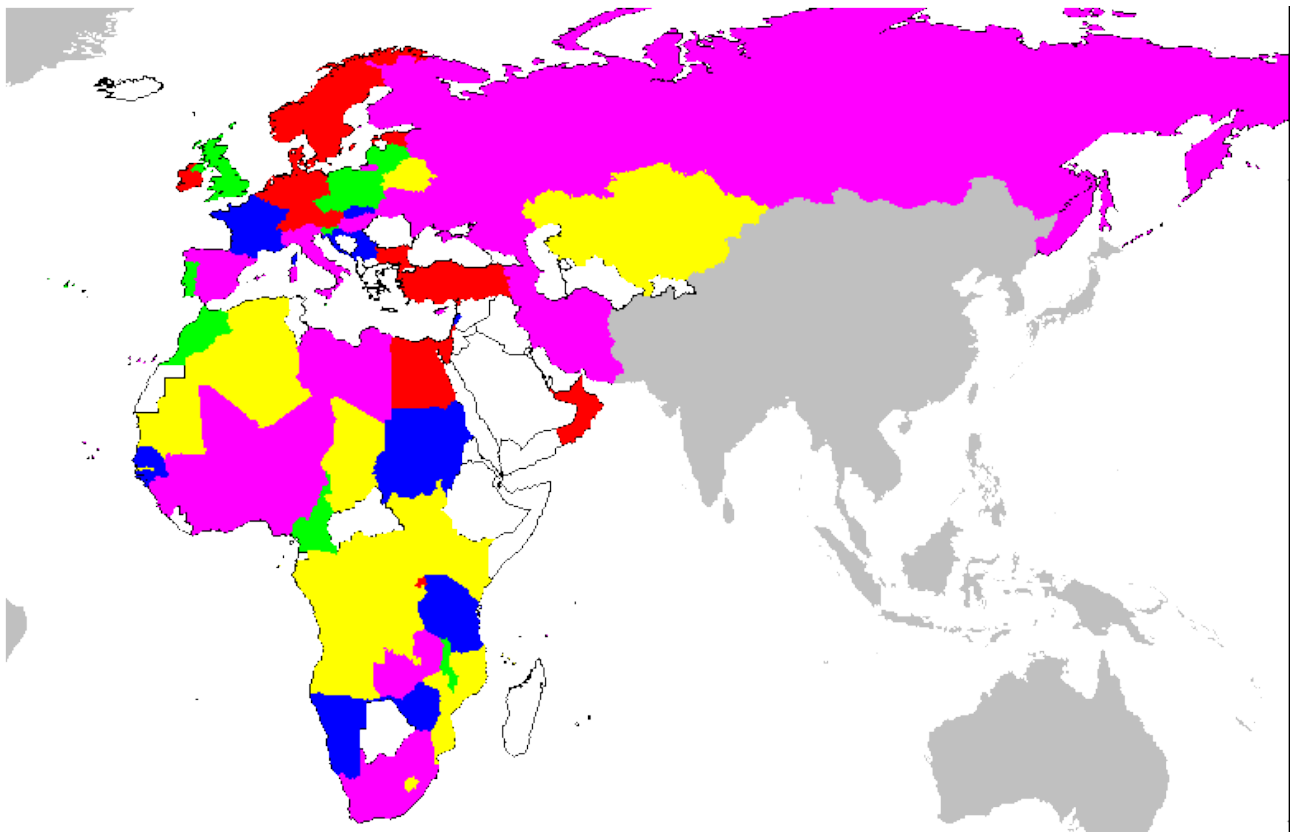
<sup>5</sup> In Armenia (Republic of) the DTT systems used at introduction are DVB-T and DVB-H.

TABLE 4

**Proportion of users who receive television by terrestrial broadcasting**

	<25%	≥25 and <50%	≥50 and <75%	≥75%	No reply
Total administrations considered	18	11	11	28	21
Map colour	Red	Green	Blue	Magenta	Yellow

FIGURE 4

**Proportion of users who receive television by terrestrial broadcasting****5 Number of operational or planned DTT transmitters and/or allotments**

The number of operational or planned DTT transmitters and/or allotments with split by frequency band is shown in Table 5.

TABLE 5

**Number of operational or planned DTT transmitters and/or allotments**

	694-790 MHz	470-694 MHz and 790-862 MHz
Total administrations considered	21 240	59 867

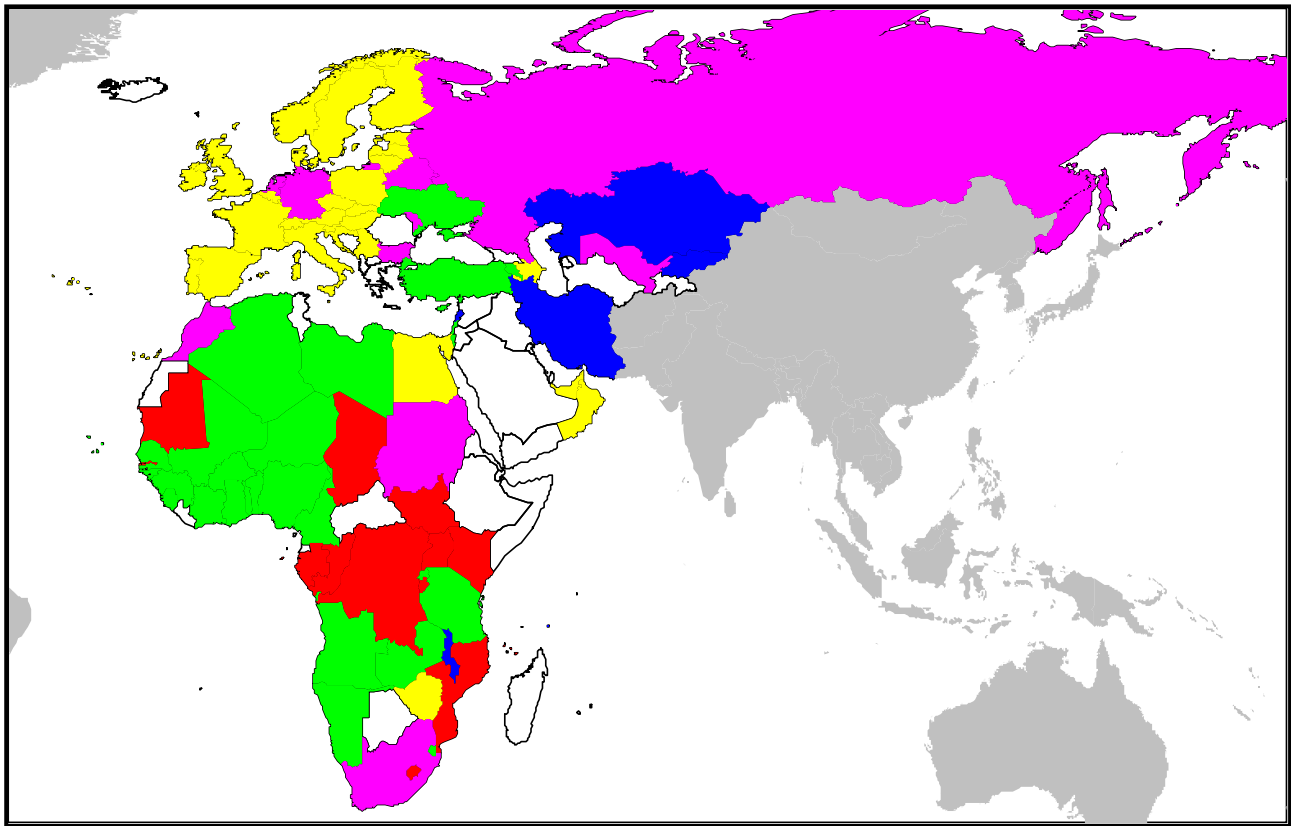
## 6 Other usages of the band 470-862 MHz

The existence of other primary services, secondary services or primary and secondary services is shown in Table 6 below.

TABLE 6  
Other usages of the band 470-862 MHz

	Primary services <sup>6</sup>	Secondary services <sup>7</sup>	Primary and secondary services	No other services	No reply
Total administrations considered	6	31	10	28	14
Map colour	Blue	Yellow	Magenta	Green	Red

FIGURE 5  
Other usages of the band 470-862 MHz



<sup>6</sup> Primary services: aeronautical radionavigation service, military and radiolocation services, fixed and mobile services, PMR (Private Mobile Radio), RAS (Radio astronomy).

<sup>7</sup> Secondary services: PMSE (Programme Making and Special Events), SRD (Short Range Devices), RAS (Radio astronomy), UWB (Ultra Wide Band), PMR (Private Mobile Radio), wind profile radars.



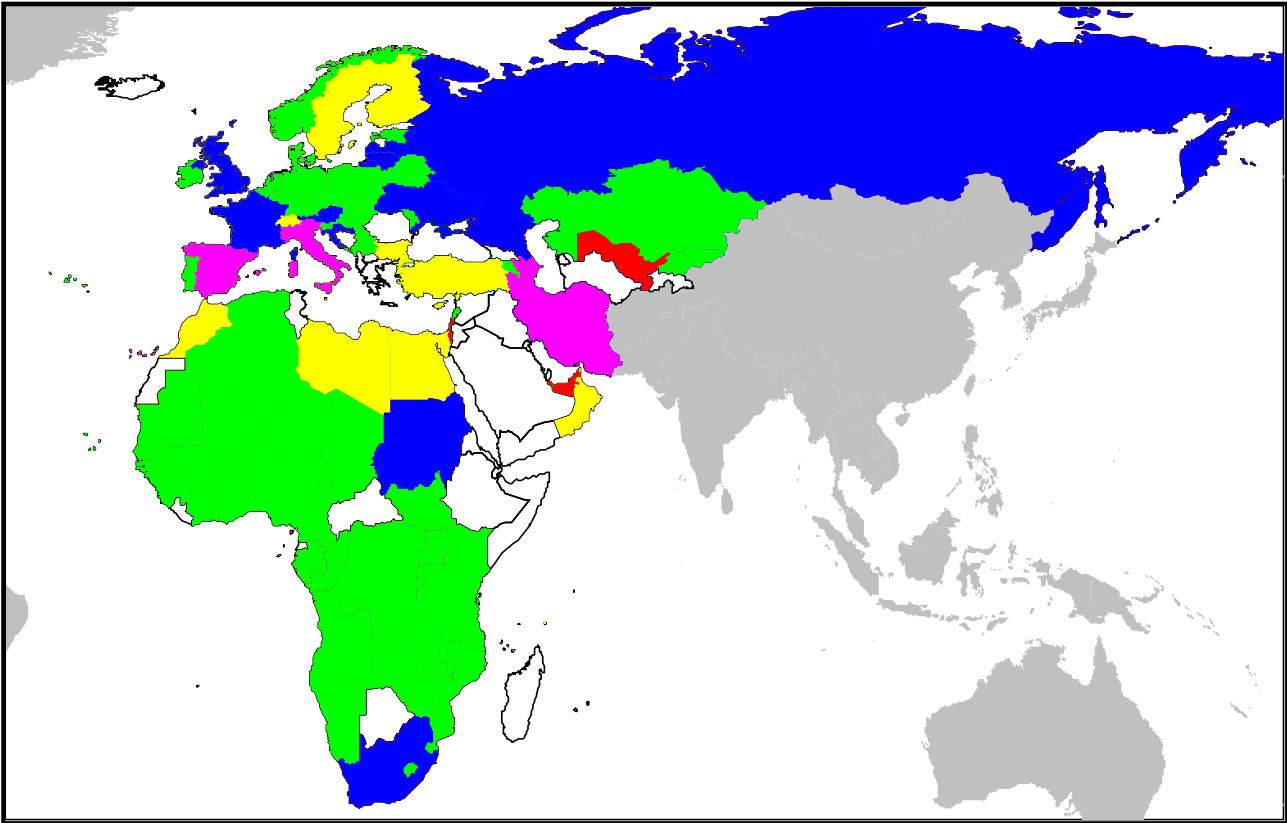
7 Required number of multiplexes in the band 470-862 MHz in the future

The number of multiplexes required in the band 470-862 MHz is divided into ranges, as shown in Table 7.

TABLE 7  
Required number of multiplexes in the band 470-862 MHz in the future

	0-3	4-6	7-8	>8	To be determined
Total administrations considered	4	58	11	4	12
Map colour					

FIGURE 6  
Required number of multiplexes in the band 470-862 MHz in the future



## 8 Required amount of spectrum in the band 470-862 MHz for DTT in the future

The required amount of spectrum in the band 470-862 MHz in the future is divided into ranges, as shown in Table 8. The figure 224 MHz corresponds to the amount of spectrum in the band 470-694 MHz.

TABLE 8

### Required amount of spectrum in the band 470-862 MHz for DTT in the future

	< 224 MHz	= 224 MHz	> 224 MHz and < 320 MHz	= 320 MHz	> 320 MHz	To be determined
Total administrations considered <sup>8</sup>	4	40	8	17	3	17
Map colour						

<sup>8</sup> The Administrations requiring less than 224 MHz are Egypt (Arab Republic of), Sudan (Republic of the), Oman (Sultanate of) and United Arab Emirates.

The Administrations requiring exactly 224 MHz are Angola (Republic of), Benin (Republic of), Burkina Faso, Burundi (Republic of), Cameroon (Republic of), Cape Verde (Republic of), Chad (Republic of), Comoros (Union of the), Congo (Republic of), Côte d'Ivoire (Republic of), Czech Republic, Democratic Republic of the Congo, Estonia, Gabonese Republic, Gambia (Republic of the), Ghana, Guinea (Republic of), Guinea-Bissau (Republic of), Kenya (Republic of), Lesotho (Kingdom of), Libya, Malawi, Mali (Republic of), Mauritania (Islamic Republic of), Mozambique (Republic of), Namibia (Republic of), Niger (Republic of the), Nigeria (Federal Republic of), Rwanda (Republic of), Sao Tome and Principe (Democratic Republic of), Senegal (Republic of), Sierra Leone, South Africa (Republic of), South Sudan (Republic of), Swaziland (Kingdom of), Tanzania (United Republic of), Togolese Republic, Uganda (Republic of), Zambia (Republic of) and Zimbabwe (Republic of).

The Administration requiring more than 224 MHz and less than 320 MHz are Algeria (People's Democratic Republic of), Armenia, Belarus, Ireland, Kazakhstan, Switzerland, Uzbekistan and Vatican City (see Appendix 1 for exact amount of spectrum required in the 694-790 MHz band).

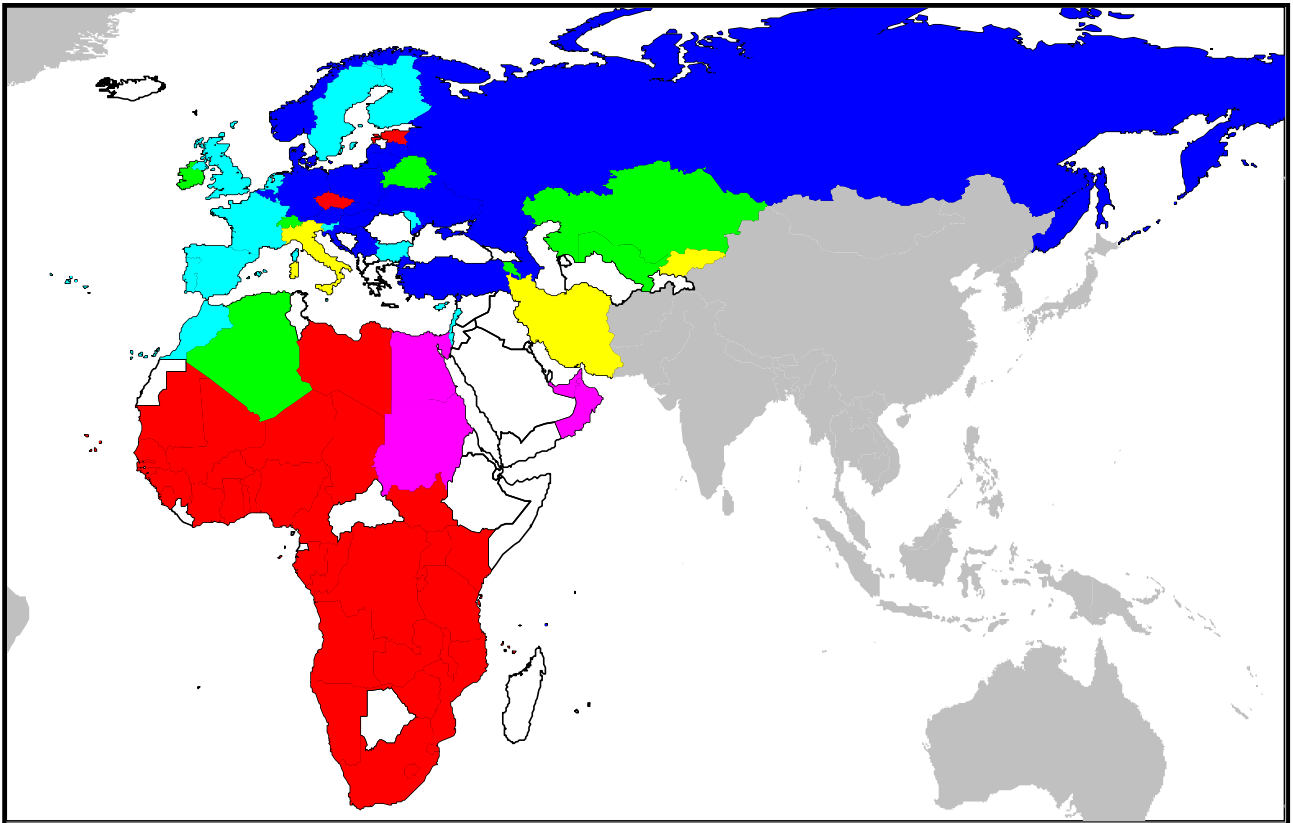
The Administrations which required exactly 320 MHz are Austria, Azerbaijani Republic, Belgium (Flemish and German Communities), Croatia, Denmark, Germany, Hungary, Latvia, Lithuania, Norway, Poland, Russian Federation, Serbia, Seychelles (Republic of), Slovak Republic, Turkey and Ukraine.

The Administrations which required more than 320 MHz are Italy, the Kyrgyz Republic (it requires 384 MHz) and Iran (Islamic Republic of) (it requires 392 MHz).

The Administrations which have not yet determined their response are Bahrain (Kingdom of), Bulgaria (Republic of), Cyprus, Finland, France, Israel (State of), Lebanon, Luxembourg, Malta, Moldova, Morocco (Kingdom of), Netherlands, Portugal, Slovenia, Spain, Sweden, and the United Kingdom.

FIGURE 7

Required amount of spectrum in the band 470-862 MHz for DTT in the future



## Attachment 1 to Annex 1

Detailed answers used for the analysis  
Updated March 2014

ITU Region	Member name	Proportion of users who receive television PRIMARILY by terrestrial broadcasting (including reception through MATV, when indicated)	Total proportion of users who receive television by terrestrial broadcasting (including first and second sets, including reception through cable headends, when indicated)	DTT introduction DTT not started: N DTT started: Y	Technology	ASO (Analogue Switch Over) ASO not started: N ASO started: S ASO Finished: F	Date of ASO completion in the UHF band	Number of currently operational or planned DTT multiplexes in the UHF band (excluding very small coverage local multiplexes when indicated)	Number of operational or planned DTT transmitters and/or allotments in the 694-790 MHz band	Number of operational or planned DTT transmitters/allotments outside the 694-790 MHz band (including 470-694 and 790-862 MHz)	Required number of multiplexes in the UHF band in the future	Required amount of spectrum in the UHF band in the future (MHz)	Other usages of the UHF band	Date of arrival
1	Algeria (People's Democratic Republic of)	No or unclear answer	No or unclear answer	Y	DVB-T	N	2015	2	26	152	5	312	-no service	Summer 2012
1	Angola (Republic of)	No or unclear answer	No or unclear answer	N	No or unclear answer	N	2015		0	Not clear	4-6	224	no service	March 2013 24July13
1	Armenia (Republic of)		99.8%	N	DVB-T and DVB-H	N	2015	0	Not clear	Not clear	4-6	304 (96 in the 694-790MHz)	no service-	Summer 2012 Updated March 2013
1	Austria	5.0%	11.0%	Y	DVB-T and DVB-T2	F	2011	3	70	390	7	320	PMSE	Summer 2012
1	Azerbaijani Republic	99.9%	99.9%	Y	DVB-T	S	2013	6	107	298	>8	320 (96 in the 694-790MHz)	PMSE	Summer 2012 Updated March 2013
1	Bahrain (Kingdom of)	No or unclear answer	Mostly Satellite	Y	DVB-T2	S	2013	1	0	1	7	48 ?	no service-	Summer 2012
1	Belarus (Republic of)	No or unclear answer	No or unclear answer	Y	DVB-T and DVB-T2	N	2015	3	24	36	6	296 (72 in the 694-790MHz)	ARNS-PMSE	March 2013
1	Belgium (Flemish Community)		<5%	Y	DVB-T and DVB-T2	F	2008	6	2	16	6	320	PMSE	Summer 2012
1	Belgium (German Community)	25.0%	65.0%	Y	DVB-T and DVB-T2	F		5	1	4		320	PMSE	Summer 2012
1	Benin (Republic of)	90.0%	90.0%	N	DVB-T2	N	2014	4	0		4	224	no service-	July 2013
1	Bulgaria (Republic of)	21.0%		Y	DVB-T	S	2013	7	38	28	No or unclear answer	To be determined	ARNS-PMSE	Summer 2012 Updated Nov 2013
1	Burkina Faso	70.0%	90.0%	N	DVB-T2	N	2014	4	0		4	224	no service-	July 2013
1	Burundi										4-6	224		24 July 2013
1	Cameroon (Republic of)	34.9%	33.0%	N	DVB-T2	N	2015		0	Not clear	4-6	224	no service-	March 2013
1	Cape Verde (Republic of)	90.0%	90.0%	Y	DVB-T2	N	2014	4	4	4	4	224	no service-	July 2013
1	Chad (Republic of)										4-6	224		24 July 2013
1	Comoros (Union of the)										4-6	224		24 July 2013
1	Congo (Republic of)										4-6	224		24 July 2013
1	Côte d'Ivoire (Republic of)	80.0%	80.0%	N	DVB-T2	N	2014	4	0		4	224	no service-	July 2013

ITU Region	Member name	Proportion of users who receive television PRIMARILY by terrestrial broadcasting (including reception through MATV, when indicated)	Total proportion of users who receive television by terrestrial broadcasting (including first and second sets, including reception through cable headends, when indicated)	DTT introduction DTT not started: N DTT started: Y	Technology	ASO (Analogue Switch Over) ASO not started: N ASO started: S ASO Finished: F	Date of ASO completion in the UHF band	Number of currently operational or planned DTT multiplexes in the UHF band (excluding very small coverage local multiplexes when indicated)	Number of operational or planned DTT transmitters and/or allotments in the 694-790 MHz band	Number of operational or planned DTT transmitters/allotments outside the 694-790 MHz band (including 470-694 and 790-862 MHz)	Required number of multiplexes in the UHF band in the future	Required amount of spectrum in the UHF band in the future (MHz)	Other usages of the UHF band	Date of arrival
1	Croatia	62.2%	72.1%	Y	DVB-T and DVB-T2	F	2010	5	14	42	7	320	PMSE-SRD	Summer 2012
1	Cyprus (Republic of)	90		Y	DVB-T	F	2011	4 + 2 planned	5	7	No or unclear answer	To be determined	no service-	July 2013
1	Czech Republic	47.0%		Y	DVB-T	F		4	40	35	4	224	PMSE	Summer 2012
1	Democratic republic of the Congo										4-6	224		24 July 2013
1	Denmark	18.3%	20.9%	Y	DVB-T and DVB-T2	F	2009	6	27	51	6	320	PMSE	Summer 2012 Updated March 2014
1	Egypt (Arab Republic of)	5.0%		Y (Trial)	DVB-T and DVB-T2	N	2015	3 (Trials)	0	2	No or unclear answer	<150	PMSE (outside 694-790MHz)	March 2013
1	Estonia	20.0%	20.0%	Y	DVB-T and DVB-T2	F	2010	5	10	35	5 + 1 planned + 30 local planned	224	PMSE	March 2014
1	Finland	50.0%	90.0%	Y	DVB-T and DVB-T2	F	2007	6	73	173	No or unclear answer	To be determined	PMSE	Summer 2012
1	France	58.0%	63.0%	Y	DVB-T	F	2011	8	3895	10 262	8	To be determined	PMSE	Summer 2012
1	Gabonese Republic										4-6	224		24 July 2013
1	Gambia (Republic of the)										4-6	224		24 July 2013
1	Germany	5.0%	12.0%	Y	DVB-T	F	2008	9	140	445	6	320	PMSE, Wind Profiler Radar, RAS	Summer 2012
1	Ghana	80.0%	80.0%	Y	DVB-T2	N	2014	10 + 4	0	8	4	224	no service-	July 2013
1	Guinea (Republic of)	85.0%	90.0%	Y	DVB-T2	N	2014	4	0	8	4	224	no service-	July 2013
1	Guinea-Bissau (Republic of)	75.0%	70.0%	Y	DVB-T2	N	2014	4	0	6	4	224	no service-	July 2013
1	Hungary	17.0%	77.0%	Y	DVB-T	F	2013	5	24	73	6	320	PMSE	Summer 2012 Updated February 2014
3	Iran (Islamic Republic of)	99.9%		Y	DVB-T	N	No or unclear answer	3	467	1438	8-10	392	Fixed, Mobile	Summer 2012
1	Ireland	12.2%	18.7%	Y	DVB-T	F	2012	2	51	71	4-6	208-304	PMSE	Summer 2012 Updated Nov 2013
1	Israel (State of)	15.0%		Y	DVB-T	F	2011	1	0	28 + 15 gapfillers	3	48 ?	no service-	March 2013
1	Italy	83.0%		Y	DVB-T and DVB-T2	F	2012	24 nationwide + 18 local	5684	13 448	24 nationwide + 18 local	>320	PMSE	Summer 2012

ITU Region	Member name	Proportion of users who receive television PRIMARILY by terrestrial broadcasting (including reception through MATV, when indicated)	Total proportion of users who receive television by terrestrial broadcasting (including first and second sets, including reception through cable headends, when indicated)	DTT introduction DTT not started: N DTT started: Y	Technology	ASO (Analogue Switch Over) ASO not started: N ASO started: S ASO Finished: F	Date of ASO completion in the UHF band	Number of currently operational or planned DTT multiplexes in the UHF band (excluding very small coverage local multiplexes when indicated)	Number of operational or planned DTT transmitters and/or allotments in the 694-790 MHz band	Number of operational or planned DTT transmitters/allotments outside the 694-790 MHz band (including 470-694 and 790-862 MHz)	Required number of multiplexes in the UHF band in the future	Required amount of spectrum in the UHF band in the future (MHz)	Other usages of the UHF band	Date of arrival
1	Kazakhstan (Republic of)	No or unclear answer	No or unclear answer	Y	DVB-T2	–	2015	2	Not clear	Not clear	4	260 (36 in the 694-790MHz)	ARNS	March 2013
1	Kenya (Republic of)										4-6	224		24 July 2013
1	Kyrgyz Republic	No or unclear answer	No or unclear answer	Y	DVB-T2	N	-	4	62	140	4	384 (80 in the 694-790MHz)	ARNS	March 2013
1	Latvia	25.0%	25.0%	Y	DVB-T	F	2010	7	12	42	7 + 1 local planned	320	PMSE	March 2014
1	Lebanon	50%-55%		N	DVB-T2	N	2015	2	0	0	5	To be determined	PMR	March 2013
1	Lesotho (Kingdom of)										4-6	224		24 July 2013
1	Libya	70.0%	80.0%	No or unclear answer	DVB-T2	N	2015		0	Not clear	No or unclear answer	224	no service-	March 2013
1	Lithuania	40.0%		Y	DVB-T	F	2012	7	33	40	8	320	PMSE	Summer 2012
1	Luxembourg	4.3%		Y	DVB-T	F	2006	7	0	3	6	To be determined	PMSE	Summer 2012
1	Malawi	48.0%	48.0%	Y	DVB-T2	N	2015	5	27	75	5	224	RAS, Fixed and Mobile	July 2013
1	Mali (Republic of)	80.0%	75.0%	N	DVB-T2	N	2015		0	Not clear	4-6	224	no service	March 2013 Updated 24 July 2013
1	Malta	43.9%		Y	DVB-T	F	2011	9	3	6	No or unclear answer	To be determined	PMSE	Summer 2012
1	Mauritania (Islamic Republic of)										4-6	224		24 July 2013
1	Moldova (Republic of)	72.50%	94%	Y(Trial)	DVB-T	N	2015	1	12	44	6	To be determined	FIXED SERVICE (790-862MHz) PMSE	March 2013
1	Morocco (Kingdom of)	30.7%		Y	DVB-T	N	2015	3	31	190	No or unclear answer	To be determined	Fixed and Mobile, PMSE	March 2013
1	Mozambique (Republic of)										4-6	224		24 July 2013
1	Namibia (Republic of)	50.0%	50.0%	Y	DVB-T2	N	2016	4	0	0	4-6	224	no service-	March 2013
1	Netherlands	10.8%		Y	DVB-T	F	2011	5	14	31	5	To be determined	RAS, PMSE	Summer 2012
1	Niger (Republic of the)	85.0%	85.0%	Y	DVB-T2	N	2015	8	0	4	4	224	no service-	July 2013
1	Nigeria (Federal Republic of)	70.0%	80.0%	Y	DVB-T2	N	2014	4	0	4	4	224	no service-	July 2013
1	Norway	20.0%		Y	DVB-T	F	2009	6	784	1 909	6	320	PMSE	Summer 2012
1	Oman (Sultanate of)	< 20%		N	DVB-T2	N	2015		0	Not clear	No or unclear answer	208	PMSE	Summer 2012 Updated March 2013
1	Poland (Republic of)	27.0%	35.0%	Y	DVB-T	N	2013	3	40	127	6	320	PMSE	Summer 2012
1	Portugal	25.0%	25.0%	Y	DVB-T	F	2012	4	Not clear	Not clear	5	To be determined	PMSE	February 2014

ITU Region	Member name	Proportion of users who receive television PRIMARIL Y by terrestrial broadcasting (including reception through MATV, when indicated)	Total proportion of users who receive television by terrestrial broadcasting (including first and second sets, including reception through cable headends, when indicated)	DTT introduction DTT not started: N DTT started: Y	Technology	ASO (Analogue Switch Over) ASO not started: N ASO started: S ASO Finished: F	Date of ASO completion in the UHF band	Number of currently operational or planned DTT multiplexes in the UHF band (excluding very small coverage local multiplexes when indicated)	Number of operational or planned DTT transmitters and/or allotments in the 694-790 MHz band	Number of operational or planned DTT transmitters/allotments outside the 694-790 MHz band (including 470-694 and 790-862 MHz)	Required number of multiplexes in the UHF band in the future	Required amount of spectrum in the UHF band in the future (MHz)	Other usages of the UHF band	Date of arrival
1	Russian Federation	50.3%	82.0%	Y	DVB-T, DVB-T2 and DVB-H	S	2015	2	2 426	7 488	5 federal + 2 regional + 1 local	320 (96 in the 694-790 MHz)	ARNS, BC Satellite, PMSE	Summer 2012 Updated March 2014
1	Rwanda (Republic of)	10.0%	10.0%	N	DVB-T and DVB-T2	N	2013	23	14	35	4-6	224	no service	March 2013 Updated 24 July 2013
1	Sao Tome and principe (Democratic republic of)										4-6	224		24 July 2013
1	Senegal (Republic of)	80.0%	70.0%	No or unclear answer	DVB-T2	N	2015		0	Not clear	4-6	224	no service-	March 2013
1	Serbia (Republic of)	48.0%	62.0%	Y	DVB-T2	S		6	8	5	6	320	PMSE	Summer 2012
1	Seychelles (Republic of)	80.0%		Y (Trial)	DVB-T2	N	2015	1 (Trial)	Not clear	Not clear	No or unclear answer	320	RAS	Summer 2012
1	Sierra Leone	70.0%	85.0%	N	DVB-T2	N	2014	4	0		4	224	no service-	July 2013
1	Slovak Republic	25.6%	55.7%	Y	DVB-T, DVB-T2 and DVB-H	F	2012	5	24	46	5	320	PMSE	Summer 2012
1	Slovenia	30.0%	40.0%	Y	DVB-T	F	2011	5	149	390	5	24	PMSE-RAS	Summer 2012
1	South Africa (Republic of)	85.0%		Y	DVB-T2	N	2015	7 planned	131 (to be migrated < 694 MHz after ASO)	230 (composed of 200 in the 470-694MHz and 30 in the 790-862 MHz)	7	224	RAS, Fixed links, Mobile PMSE, TV Gap fillers, In house distribution	March 2013
1	South Sudan (Republic of)										4-6	224		24 July 2013
1	Spain	87.0%	98.0%	Y	DVB-T	F	2010	11	4 747	17 614	10	To be determined	PMSE	Summer 2012
1	Sudan (Republic of the)	60.0%		N	DVB-T and DVB-T2	N	2015		0	238	7	216	Mobile, PMSE	March 2013
1	Swaziland (Kingdom of)	75.0%		N	DVB-T2	N	No or unclear answer		Not clear	Not clear	4-6	224	no service-	March 2013 Updated 24 July 2013
1	Sweden	20.5%		Y	DVB-T and DVB-T2	F	2007	7	488	1 231	No or unclear answer	To be determined	PMSE	Summer 2012 Updated March 2013
1	Switzerland	5.0%	5.0%	Y	DVB-T	F		7	Not clear	Not clear	No or unclear answer	<320	RAS, PMSE, UWB, PMR, Wind profiler Radars	Summer 2012 Updated Nov. 2013
1	Tanzania (United Republic of)	80.0%	70.0%	No or unclear answer	DVB-T2	N	2013		0	Not clear	4-6	224	no service-	March 2013 Updated 24 July 2013
1	Togolese Republic	70.0%	80.0%	N	DVB-T2	N	2014	4	0		4	224	no service-	July 2013
1	Turkey	17.3%		N	DVB-T2 to be determined	N	2015	0				320	None	November 2013



ITU Region	Member name	Proportion of users who receive television PRIMARILY by terrestrial broadcasting (including reception through MATV, when indicated)	Total proportion of users who receive television by terrestrial broadcasting (including first and second sets, including reception through cable headends, when indicated)	DTT introduction DTT not started: N DTT started: Y	Technology	ASO (Analogue Switch Over) ASO not started: N ASO started: S ASO Finished: F	Date of ASO completion in the UHF band	Number of currently operational or planned DTT multiplexes in the UHF band (excluding very small coverage local multiplexes when indicated)	Number of operational or planned DTT transmitters and/or allotments in the 694-790 MHz band	Number of operational or planned DTT transmitters/allotments outside the 694-790 MHz band (including 470-694 and 790-862 MHz)	Required number of multiplexes in the UHF band in the future	Required amount of spectrum in the UHF band in the future (MHz)	Other usages of the UHF band	Date of arrival
1	Uganda (Republic of)										4-6	224		24 July 2013
1	Ukraine		90.0%	Y	DVB-T2	S	2015	6	Not clear	Not clear	8	320 (96 in the 694-790MHz)	no service-	Summer 2012
1	United Arab Emirates	3.0%	3.0%	N	DVB-T2	N	2013	3	0	7	3	120	PMSE	July 2013
1	United Kingdom	41.1%		Y	DVB-T and DVB-T2	F	2012	8	1 379	2 383	8	To be determined	PMSE	Summer 2012
1	Uzbekistan (Republic of)	No or unclear answer	No or unclear answer	Y	DVB-T	N	2017	1	0	54	3	288 (no Muxes in the 694-790MHz)	ARNS-PMSE	March 2013
1	Vatican City	99.0%		Y	DVB-T	F		3	1	2	3	Between 224 and 320 MHz	PMSE	Summer 2012 Updated Nov 2013
1	Zambia (Republic of)	80.0%	80.0%	Y	DVB-T2	N	2014	2 (trial)	89	263	4-6	224	no service-	March 2013 Updated 24 July 2013
1	Zimbabwe (Republic of)	70.0%		Y	DVB-T2	N	2015	4	64 (not in use)	190	4 national + 10 metropolitan	224	PMSE	March 2013

## Annex 2

### Case Study 1 – The consequences of the loss of further broadcasting spectrum for RCC countries<sup>9</sup>

This case study examines the digital broadcasting spectrum requirements of RCC countries, and the consequences of the possible elimination of 694-790 MHz band in addition to the already eliminated 790-862 MHz band from the Geneva-06 Plan. It also contains an example methodology for evaluating spectrum requirements for digital terrestrial broadcasting.

#### 1.1 Existing and planned situation(s)

##### 1.1.1 Consequences of possible elimination of 694-790 MHz band in addition to already eliminated 790-862 MHz band from “Geneva-06” Plan for RCC countries

In the case of use of TV broadcasting bands for mobile communications on the basis of the end-to-end channel arrangement, a substantial part of frequency allocations of “Geneva-06” Plan will be lost or cannot be used for TV broadcasting. Tables with total number of in “Geneva-06” Plan in the 470-694, 470-790, 470-862 MHz frequency bands for RCC countries are given below.

TABLE 1.1.1

**Total number of frequency allotments**

<b>RCC members</b>	<b>21-48 TV channels</b>	<b>21-60 TV channels</b>	<b>21-69 TV channels</b>	<b>Total reduction (%)</b>
Azerbaijan	234	317	375	38
Armenia	135	175	204	34
Belarus	133	179	205	35
Georgia	107	140	156	31
Kazakhstan	951	1371	1674	43
Kyrgyzstan	162	234	269	40
Moldova	33	44	56	41
Russia	5 347	7 629	9 226	42
Tajikistan	218	315	377	42
Turkmenistan	153	216	268	43
Uzbekistan	424	602	675	37
Ukraine	354	513	636	44

<sup>9</sup> Regional Commonwealth in the field of communications.

TABLE 1.1.2

**Average number of radio channels in the band**

<b>RCC members</b>	<b>21-48 TV channels</b>	<b>21-60 TV channels</b>	<b>21-69 TV channels</b>	<b>Total reduction (%)</b>
Azerbaijan	7,1	9,6	11,4	38
Armenia	15	19,4	22,7	34
Belarus	5,3	7,1	8,2	35
Georgia	10,7	14	15,6	31
Kazakhstan	5,7	8,3	10,1	44
Kyrgyzstan	16,2	23,4	26,9	40
Moldova	1,8	2,4	3,1	42
Russia	5	6,7	8	38
Tajikistan	19,8	28,6	34,3	42
Turkmenistan	3,6	5,1	6,4	44
Uzbekistan	10,6	15	16,9	37
Ukraine	4,4	6,3	7,8	44

TABLE 1.1.3

**Minimum number of radio channels in the band**

<b>RCC members</b>	<b>21-48 TV channels</b>	<b>21-60 TV channels</b>	<b>21-69 TV channels</b>	<b>Total reduction (%)</b>
Azerbaijan	2	4	5	60
Armenia	4	7	8	50
Belarus	4	6	7	43
Georgia	5	9	11	55
Kazakhstan	2	3	5	60
Kyrgyzstan	8	11	12	33
Moldova	0	0	2	100
Russia	1	2	5	80
Tajikistan	6	10	13	54
Turkmenistan	0	1	4	100
Uzbekistan	4	6	6	33
Ukraine	2	2	3	33

TABLE 1.1.4

**Maximum number of radio channels in the band**

<b>RCC members</b>	<b>21-48 TV channels</b>	<b>21-60 TV channels</b>	<b>21-69 TV channels</b>	<b>Total reduction (%)</b>
Azerbaijan	25	35	40	38
Armenia	25	33	38	34
Belarus	8	9	10	20
Georgia	17	23	25	32
Kazakhstan	12	17	22	45
Kyrgyzstan	26	38	45	42
Moldova	5	5	5	0
Russia	30	40	49	39
Tajikistan	26	38	47	45
Turkmenistan	8	8	9	11
Uzbekistan	26	36	41	37
Ukraine	8	11	12	33

**1.2 Future situation(s), consequences of the new allocation**

Let us consider the consequences of full redistribution of 694-790 MHz frequency band for mobile service (first of possible scenarios of future use). They are divided into short-term and long-term consequences.

**1.2.1 Short-term consequences**

- 1) Necessity to replace operating radio channels and implementing digital broadcasting networks

During the first phase, changes will be required to modify frequency plans for the first and second multiplexes, as well as search for available resource to replace lost frequency channels of the 694-790 MHz band by lower channels.

Additionally, digital stations operated in TV channels 49-60 will be needed to be transferred to other frequency channels. Large frequency shift of radio channel is an expensive and long procedure, requiring the following measures:

- a) selection of new radio channel with lower frequency, taking into account the protection of incumbent TV broadcasting systems and other primary services, ensuring coverage area not worse than that of initial channel and considering a change in electromagnetic environment at new frequency (the lower the frequency, the more complex the electromagnetic environment is as a rule). With this, it is necessary to consider that planned frequencies in lower part of the UHF band rather will not be available due to the high occupancy of lower frequency bands;
- b) for a single frequency network, it is necessary to find the channel which is to be used by all stations of this network;
- c) harmonization of frequency use with radio systems of other primary services and international coordination for non-planned frequencies;

- d) obtaining an authorization for frequency use and other authorizing documents;
- e) manufacturing and assembly of new elements of transmitting path (antenna and feeder, channel filters, transmitter when there is no capability to tune the channel within necessary band). Recall that the price of the channel filter for high-power stations is comparable to the price of the transmitter;
- f) after change of channel frequency for all stations in a single frequency network, it is necessary to synchronize single frequency network to the new channel;
- g) measures to inform population.

If there is no available channel in lower part of the band even for few stations of single frequency network, the change of channel will be possible only after analogue stations are switched-off.

Taking into account the above mentioned, successful replacement of frequency channels by the end of transitory period is not guaranteed.

During the second phase a search for frequency resource for new multiplexes will be required. According to preliminary evaluations, in Russia about 10% of allocation areas may have difficulties with the search for available frequencies for the third multiplex. For the next multiplexes this figure will only be increasing. Therefore, evidently, it will be necessary for frequency re-planning to recover frequency resources available for radio broadcasting service as large as for 5-6 multiplexes, and, as a consequence, international harmonization of these changes with border countries.

## 2) Replacement of radio channels or switching-off of incumbent analogue broadcasting stations

In RCC countries there are a substantial number of analogue broadcasting stations operating in the frequency band above 694 MHz (Russia operates 1 281 analogue broadcasting stations). Due to highly intensive use of the band below 694 MHz (Russia operates here 7 474 analogue TV stations), search for frequencies to replace channel in this part of UHF band could be problematic.

Substantial frequency shift of analogue broadcasting channel will require the same measures as those for channel of a digital station.

Taking into account the above mentioned, successful radio channel replacement of analogue TV station is not guaranteed.

If there is no available channel in the lower part of the band, use of mobile service frequencies will be possible only after analogue station are switched-off. Limiting date for analogue stations switch-off in RCC countries is not defined yet, and "Geneva-06" Agreement does not contain an obligatory requirement to switch off analogue stations in 2015, but only terminates their international protection, if otherwise not agreed to between Administrations. The concept of digital TV implementation, accepted by some of RCC countries, supposes that analogue station switch-off will be possible only after duplicating coverage of the entire service territory by digital broadcasting.

## 3) Ensuring electromagnetic compatibility between terrestrial TV broadcasting and mobile communications

The experience with implementation of mobile communication systems in the frequency band 790-862 MHz in a number of countries showed problems concerning electromagnetic compatibility with TV broadcasting systems operating at frequencies lower than 790 MHz. The main source of the problems is an overload of broadband amplifiers in antenna system, input stages of air and cable TV receivers due to emissions from base stations and mobile user terminals in the tuning bandwidth when their level is considerably exceeding the level of wanted TV broadcasting signal.

Bench tests showed that frequency offset doesn't play a role, but interference will affect all TV channels in the UHF band. In addition, cable networks are also affected by interference due to insufficiently high decoupling between cables and consumer equipment.

Around base stations and mobile user terminals so-called “grey zones” are observed where receiving of air TV programs is impossible in UHF band. During ITU-R JTG 5-6 studies when allocation of frequency band 790-862 MHz for mobile service was considered, these issues were described in the JTG 4-5-6-7 Chairman’s Report only by one phrase: that they might be resolved in the future by the improvement of TV receivers. Definitely, the only reliable solution for the overload problem is to install bandpass filter and change algorithm for setting operating point in broadband amplifiers for air and cable broadcasting, as well as for input stages of TV receivers. Thereby, changing up to 95% of user receivers could be required, as well as active receiving antennas located distantly from the TV centre. Otherwise it will not be possible to guarantee reception of digital signal because portable terminal could begin operation somewhere close at any time.

Alternative solution of this issue is a full withdrawal of uplinks (transmissions of user terminals) from the TV broadcasting frequency band, and location of base stations (downlinks) at a distance from location of terrestrial TV broadcasting receivers.

Also there is a difficulty to ensure electromagnetic compatibility between mobile systems and TV broadcasting in the overlapping frequency bands. In this case, mobile networks will be affected by interference as well. If a neighbouring country does not implement mobile services but continues to use TV broadcasting, then a risk of interference arises in border areas, and coordination of mobile systems with such countries out of “Geneva-06” Plan will be extremely complicated due to conservatism of “Geneva-06” provisions with respect to any modifications of the Plan.

Terms and conditions for mobile communication use of the frequency band 694-790 MHz can be considered only after successful solution of its EMC problem with TV broadcasting, otherwise implementation of digital broadcasting can be at risk in addition to difficulties with the implementation of mobile networks. This may depreciate government efforts to create up-to-date national TV broadcasting network and unified information space.

#### 4) Ensuring electromagnetic compatibility between CATV and mobile communication systems

Cable TV (CATV) networks represent a rapidly growing market segment of broadcasting services. Deficiency in terrestrial TV channels and difficulties in installation of satellite receive equipment within urban areas encourage the rapid development of CATV networks. In spite of growing competition from IPTV, broadcasting networks are many times cheaper in deployment and operation, do not require special user equipment and do not suffer from peaks of user traffic resulting in unavailability of interactive services.

Currently most of the population (up to 75-90%) in large cities and towns receives programmes via CATV networks. Cable broadcasting networks are expected to retain high penetration in large cities and towns and will continue to be actively developing in small towns, especially in areas of tenement house construction. As the regulator does not stimulate CATV operators to transfer services to digital technologies, many of them will continue operating in analogue format beyond 2015, as it will keep their subscriber base at the maximum level. Moreover, a necessity to deliver high-definition programmes will force operators to use digital systems (DVB-C, DVB-T/T2) in parallel to analogue broadcasting.

CATV networks use the same frequencies as terrestrial broadcasting to transmit programmes, but the number of programmes per radio channel is considerably more than in the air broadcasting networks. CATV operators are using not only all air bands, but starting to actively use extended cable TV band (below 470 MHz), despite that it is not supported by old-fashioned TV sets. Thus they practically have no possibilities to transfer some programmes from 694-790 MHz and 790-862 MHz bands to other spectrum parts.

### 1.3 Assessment of spectrum requirements for terrestrial TV broadcasting in the frequency band 694-790 MHz for the RCC countries

Currently the development of terrestrial TV broadcasting is practically blocked due to lack of unoccupied frequencies in economically developed areas which are commercially interesting for broadcasting. Priority was given to allocation of frequency channels for operation during transition period (for duplication of analogue broadcasting), in order to allow radio spectrum release by transferring federal and regional TV stations with analogue channels to the digital broadcasting system which uses radio spectrum more efficiently. Programmes in the federal multiplexes are transmitted with «standard» quality which is not better and even a bit worse than picture resolution in analogue broadcasting systems. This resulted from the lack of frequency resource (among other reasons) available before analogue stations are switched off.

Frequency resource for further development of terrestrial broadcasting will show up after the start of the analogue stations switch-off. Mass implementation of up-to-date and advanced broadcasting technologies will start with high-definition TV, 3D TV, non-linear TV, multimedia broadcasting, ultra-high-definition TV. Picture size and image quality of TV displays are permanently growing – with the development of light-emitting OLED technology very large screens will be used by 2020, which will make the presence effect. They will require programmes with the appropriate resolution.

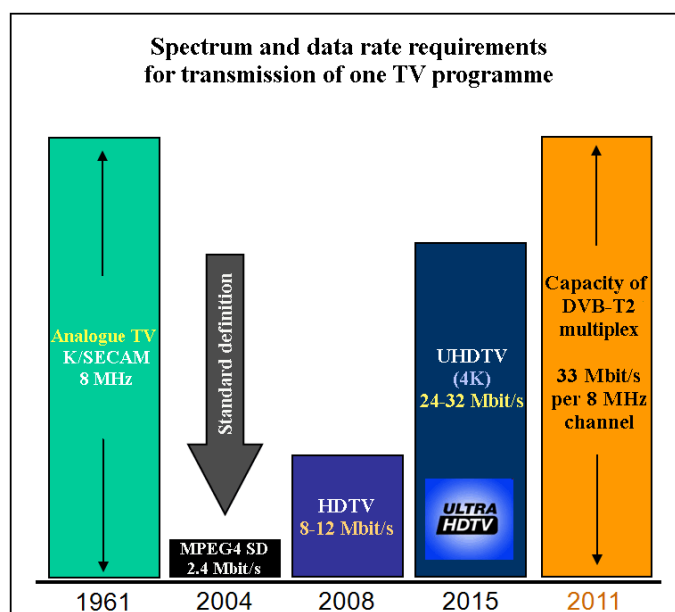
On 24 May 2012, the ITU announced a new Recommendation which is a substantial progress in TV broadcasting, as Ultra-High Definition TV (UHDTV) is the absolutely new environment for broadcasting television.

The UHDTV standard is supposed to be implemented after 2025. It will require implementation of new principles of broadcasting arrangement (switchover from multichannel broadcasting to transmission of individual multimedia programmes) which will allow a limited number of UHDTV programmes without additional allotments of great spectrum resource. One or two more additional multiplexes will be required for real-time nation-wide UHDTV coverage. The rest UHDTV programmes will be transmitted as a part of existing multiplexes.

The increase in spectrum requirements (capacity) for digital broadcasting standards is shown in Fig. 1.3.1.

FIGURE 1.3.1

Radio spectrum requirements for different broadcasting standards





The requirements in frequency bandwidth and bit rate within multiplexed radio channel for existing and future broadcasting technologies are shown in the diagram. The analogue broadcasting systems transmit one programme per radio channel with bandwidth of 8 MHz. Using DVB-T2 system, it is possible to transmit a digital stream at a bit rate of ~33 Mbit/s in the same radio channel. The standard definition programme requires a bit rate of 2.4 Mbit/s, while high definition programme – 8-12 Mbit/s, 3D programme – 10-16 Mbit/s and ultra-high definition programme requires a bit rate 32 Mbit/s or more.

It is evident that a number of radio channels necessary to transmit the same number of programmes will increase during implementation of new technologies, and in the future it will approach the figures of analogue broadcasting with incomparably higher quality of a transmitted image and availability of multimedia services.

Taking into account development of image compression techniques, up to two 4K UHD lower profile programmes (compared to one programme per channel in analogue broadcasting system) will possibly be transmitted as a part of DVB-T2 multiplex stream in the future. Thus considering the requirement to transmit 20 or more programmes, availability of the second digital dividend<sup>10</sup> as a consequence of reduced frequency resource below 790 MHz for TV broadcasting is rather disputable.

### **National plans for use of the band 470-862 MHz**

Preparing a response to the ITU questionnaire concerning future requirements of terrestrial TV broadcasting in the band 694-790 MHz, the RCC Administrations have estimated the minimum number of terrestrial digital broadcasting multiplexes necessary for TV broadcasting development and corresponding frequency resource in this band.

The total frequency resource in the band 694-790 MHz (ignoring constraints from radio systems of other services) is 96 MHz (12 TV channels).

The results of analysis of national frequency plans for use of the band 470-862 MHz obtained on the basis of responses to the ITU questionnaire concerning the radio spectrum requirements for terrestrial broadcasting service are given in Table 1.3.1.

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<sup>10</sup> The term “digital dividend” is used to indicate the improved efficiency in the use of the spectrum, consequential to the digital switchover.

TABLE 1.3.1

**National plans of the RCC Administrations concerning development of terrestrial broadcasting service and radio spectrum requirements to develop terrestrial TV broadcasting in the UHF band and in the band 694-794 MHz**

<b>Administration</b>	<b>Analogue stations in the band 694-790 MHz/ in the other part</b>	<b>Existing multiplexes</b>	<b>Spectrum requirements for existing MUXES in UHF (MHz)</b>	<b>Spectrum requirements for existing MUXES in the band 694-790 MHz (MHz)</b>	<b>Planned MUXES</b>	<b>Spectrum requirements for planned MUXES, (MHz)</b>	<b>Spectrum requirements for planned MUXES in the band 694-790 MHz (MHz)</b>
ARM	54 / 283	no	–	–	4-6	304	96
AZE	57 / 176	86	320	96	8+	320	96
BLR	16 / 123	3	256	32	6	296	72
KAZ	91 / 1 397	2	260	36	4	260	36
KGZ	35 / 102	4	336	72	4	384	80
MDA	40 / 107	1	48	96	6	**	**
RUS	1 281 / 7 474	2	376	96	5-6*	280*	56*
UKR	378 / 1 584	6	336	96	8	320	96
UZB	20 / 387	1	480	MUXES do not operate in this band	3	288	MUXES do not planned in this band

\* Not taking into account full transition to HDTV, under study.

\*\* Under study.

Example of calculated requirements in frequency resource in the UHF band for broadcasting service are given below.

**Example – Assessment of spectrum requirements for the development of terrestrial TV broadcasting during the transition to HDTV**

The realistic scenario assumes that the development of terrestrial broadcasting will not be limited to the social segment (commercial transmitting stations will be in operation), all the programmes will be transferred to advanced broadcasting standards and terrestrial broadcasting will also be used for mass non-TV broadband content delivery over the downlink. At the same time it is assumed that the total number of delivered programmes will be significantly lower than in satellite and cable channels, and that the broadband content delivery in the downlink will gradually replace the delivery of common TV programmes and therefore will not require an additional frequency resource.

Calculations of realistic radio spectrum requirements for the development of broadcasting were performed according to the following assumptions:

- 20 federal and regional TV programmes will be sufficient for terrestrial broadcasting during the unlimited period;
- it is believed that standard definition broadcasting is to be replaced by high definition broadcasting with 3D capability;
- it is believed that a coverage of more than 55% of country population by portable broadcasting reception will not be demanded;
- overall transition of broadcasting to UHDTV is not expected. It is assumed that several UHDTV programmes will be enough to meet the demands of population in high-quality terrestrial TV broadcasting for a long period of time.

The calculated estimation is given for average local conditions regarding complexity of electromagnetic compatibility (EMC). The necessity to preserve radio spectrum in the band 694-790 MHz and a part of the spectrum in the band 790-864 MHz for TV broadcasting may be reduced, only under the condition of a successful completion of total broadcasting service replanning in the UHF band for operation under conditions of higher mutual interference. It should be noted that to release a significant amount of frequency resource using replanning is impossible, the release of spectrum takes place as a result of a minor spectrum economy with a simultaneous increase in the cost of transmitting TV broadcasting networks, which can be assumed to have a quadratic dependence from the amount of spectrum released during replanning.

Beyond 2025 the broadcasting service requirements, including broadcasting multimedia programme and data delivery, will be defined by the role which will be dedicated to the terrestrial broadcasting service delivery in the system approach to overcome the digital divide. It should be underlined that the assessed averaged requirements for broadcasting service takes into consideration only the common multi-programme TV broadcasting needs under the condition that broadcasting multimedia programme and data delivery will gradually replace the conventional multi-programme broadcasting and will not require additional frequency spectrum allotment.

**Number of multiplexes for digital terrestrial TV after analogue broadcasting switch-off (2015-2025)**

	Number of SD multiplexes (2015)	Capacity of a multiplex (Mbit/s)	Bit rate per one SD TV programme (Mbit/s)	Number of SD programmes in a multiplex (2015)	Bit rate per one HD/ 3D programme (Mbit/s)	Number of HD/ 3D programmes in a multiplex (2025)	Number of multiplexes (2025)
Federal multiplexes	2	33.2	2.9	10	8	4	5
Regional/local multiplexes	1	33.2	2.9	10	8	4	2
Broadcasting for portable reception	1	18.8	2.0	9	–	–	1

**Overall radio spectrum requirements for the development of digital terrestrial TV broadcasting in 2015-2025**

Country	Number of multiplexes	System and modulation	Reception type <sup>[1]</sup>	Capacity of a multiplex (Mbit/s)	Assumed percentage of population coverage	Multiplex content	Multiplex generation	Transmitting network type	Average number of radio channels per multiplex	Average required bandwidth (MHz)	Maximum number of radio channels per multiplex	Maximum required bandwidth (MHz)
RUS	5	DVB-T2, 64-QAM	Fixed	33.2	95%	4 HD H.264	Federal	Single frequency	6	240	8.2	328
	2	DVB-T2, 64-QAM	Fixed	33.2	95%	4 HD H.264	Regional/local	Multiple frequency	9	144	12	192
	1	DVB-T2, 16-QAM	Portable	18.8	55%	9 SD H.264	Local	Single frequency	3	24	5	40
<b>Total spectrum requirements (MHz)</b>										<b>408</b>		560

<sup>[1]</sup> For example, fixed, portable outdoor/mobile, portable indoor.

**Radio spectrum requirements for the development of digital terrestrial TV broadcasting in the band 694-862 MHz (49-69 TV channels)**

	Average assessment, radio channels	Average assessment (MHz)	Maximum assessment, radio channels	Maximum assessment (MHz)
Required	51	408	70	560
Used in the VHF band (174-230 MHz)	7	56	7	56
Cannot be used according to the EMC conditions with systems of other primary services (MHz)	4	32	5	40
<b>Required in the UHF band</b>	44	<b>352</b>	63	504
<b>Upper limit in the UHF band (MHz)</b>	48	<b>854</b>	68	1 014
<b>Required in the band above 694 MHz</b>	20	<b>160</b>	40	320

### Annex 3

#### **Case Study 2 – Supporting elements on the response to the questionnaire by the Islamic Republic of Iran**

In its response to the WP 6A questionnaire on spectrum requirements for broadcasting, the Islamic Republic of Iran provided the following supporting elements for its response:

- “1) Due to prevailing circumstances in our country, television broadcasting services are provided generally through the terrestrial infrastructure. In addition, broadcasting service provides variety of functions and applications such as educational, cultural, health, safety, agricultural and disaster relief and preparedness. Television broadcasting is therefore the most vital and crucial service/application in this country.
- 2) Population dispersion, geographical situation, propagation conditions such as mountains, super refractivity and ducting effect, make the planning of television broadcasting more complex. Consequently there are several cases which require more spectrum to fulfil the objectives of broadcasting transmission.  
  
The above situation has resulted the establishment of a mixture of high power, medium power and many low power stations, which also requires additional spectrum.
- 3) Having fairly vast area (1 648 000 km<sup>2</sup>) and several thousands of km of borders with 14 countries, the majority of which are situated in Region 1, extensive and time consuming multilateral and bilateral coordination with these countries are required. In the south due to numerous neighbouring countries, it is necessary to carry out coordination when all of our southern neighbours are attending, which makes the process of coordination much more complex. Propagation conditions in that area have added more complexity, to the extent that, major restriction would be imposed, so that more spectrum is needed to meet the broadcasting requirement.  
  
For the time being, there are 145 operational channels between 694 to 862 MHz in the above mentioned area, while our broadcasting objectives are not yet achieved.
- 4) Until analogue switch-off takes place and the full DTT platform is implemented, no clear information is available to use part of UHF band (790-862 MHz) for mobile services and until the adequate protection of the television broadcasting from the mobile is not ensured no decision can be made in this band. Similar conclusions are also applicable to the 694-790 MHz band.

In view of the above, in replying to the Questionnaire we have stated that at this stage we need the entire frequency band from 470-862 MHz.”

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