|  |  |
| --- | --- |
|  | **ASIA-PACIFIC TELECOMMUNITY** |
| **The South Asian Telecommunication Regulator’s Council (SATRC)** |  |
|  |  |

**SATRC REPORT ON
HARMONIZED USE OF THE 700MHZ DIGITAL DIVIDEND BAND IN SATRC COUNTRIES**

**Prepared by
SATRC Working Group on Spectrum**

Adopted by
**14th Meeting of the South Asian Telecommunications Regulator’s Council**14– 16 May 2013, Bandos Island, Republic of Maldives

Contents

[1. Introduction 4](#_Toc353974506)

[Acknowledgements 5](#_Toc353974507)

[2. Background and Significance of Digital Dividend 5](#_Toc353974508)

[3. ITU Work Related to IMT 7](#_Toc353974509)

[3.1 IMT Frequency Bands 7](#_Toc353974510)

[4. Global Trends for Harmonized Digital Dividend Band plans 8](#_Toc353974511)

[4.1 Region 1 8](#_Toc353974512)

[4.1.1 CEPT 8](#_Toc353974513)

[4.1.2 Regional Status 8](#_Toc353974514)

[4.2 Region 2 8](#_Toc353974515)

[4.2.1 CITEL 8](#_Toc353974516)

[4.2.2 US Band Plan 9](#_Toc353974517)

[4.3 Region 3 10](#_Toc353974518)

[4.3.1 APT Work on Harmonized Approach for 698-806MHz 10](#_Toc353974519)

[4.3.2 Regulatory Issues and Finalized APT700 band Plan 10](#_Toc353974520)

[4.3.2.1 FDD channel Arrangement 10](#_Toc353974521)

[4.3.2.2 TDD Channel Arrangement 16](#_Toc353974522)

[4.3.3 Implementation Issues 16](#_Toc353974523)

[5. Regional Trend and Adoption of APT 700 Band Plan 16](#_Toc353974524)

[5.1 Adoption by Countries 16](#_Toc353974525)

[5.2 ITU Adoption 17](#_Toc353974526)

[5.3 3GPP Adoption 19](#_Toc353974527)

[6. Questionnaire on Use of 700MHz Band in SATRC Countries 19](#_Toc353974528)

[6.1 Purpose 19](#_Toc353974529)

[6.2 Questions for SATRC Countries 19](#_Toc353974530)

[6.3 Responses to Questionnaire Summarized 20](#_Toc353974531)

[7. Way forward 22](#_Toc353974532)

[Annex-A 22](#_Toc353974533)

[GE06 Agreement 22](#_Toc353974534)

[Annex-B 24](#_Toc353974535)

[Annex-C 28](#_Toc353974536)

[Relevant Agenda Items at WRC-12 28](#_Toc353974537)

[Brief Summary of Results 28](#_Toc353974538)

[Annex-D 30](#_Toc353974539)

[Technical Considerations 31](#_Toc353974540)

# Introduction

The frequency range below 1 GHz is preferred for deployment of cellular mobile systems including IMT due to its favourable propagation characteristics. It is particularly suitable for rural or sparsely populated areas where the cost constraints warrant installation of low cost infrastructure. The significance of this range of frequencies has increased tremendously as a result of the transition from analogue to digital terrestrial television broadcasting. The left over spectrum, as a result of shift to digital broadcasting, is called ‘Digital Dividend’. Some of the countries are planning to make or making available the parts of digital dividend band 470-806/862 MHz to the mobile services.

In order to ensure optimal utilization, it is important to formulate a harmonized frequency arrangement for ‘digital dividend’. One such arrangement is utilization of this spectrum for IMT services; the demand for which is ever increasing.

Keeping in view the above, there is a need for SATRC members to start working on a regional plan for use of above frequency bands. Particularly, the regional plan for 700MHz band is very important for the SATRC region. In order to launch the services in this band, there may be a need of coordination amongst the countries in light of Radio Regulations. With this perspective in mind, it has been decided by the Council to include this study in the list of five assigned work items to be completed under SATRC Action Plan Phase IV for the Spectrum Working Group (WG).The background & scope of this study, as approved by Council, is as follows:

|  |  |
| --- | --- |
| **Work Item** | **S1. Harmonized Use of the 700 MHz Digital Dividend Band in SATRC Countries**  |
| Responsible Working Groups | WG Spectrum |
| Output  | Study Report/Guideline |
| Background and Purpose | Recently 700MHz spectrum band has attracted lot of interest due to the switchover to digital terrestrial television broadcasting. Due to its characteristics, the 700MHz band has become very important band for broadband mobile communications. Globally some parts of the bands will be used for mobile communication as WRC-12 decided to allocate this band to Mobile. From the SATRC countries Bangladesh, India and Pakistan have identified some portions of this band for IMT. It is therefore necessary to devise a harmonized approach for all the SATRC countries for the use of this important frequency band. |
| Scope | * To study current allocation of 700MHz band in SATRC countries
* To study the worldwide utilization of the 700MHz band
* To suggest a harmonized approach for SATRC countries to ensure the maximum benefit.
 |
| Time Frame | * Total study period would be approximately 1 year
 |
| Utilization of Output | * Council can use the output to recommend a harmonized approach on use of 700MHz band in SATRC countries
* Input to APG.
 |

# Background and Significance of Digital Dividend

A tremendous growth has been observed in mobile data traffic as depicted in the following chart. By 2020, mobile devices will be the primary Internet devices for most people in the world[[1]](#footnote-1). A significant growth in smartphone utilization has already been observed around the world. The average smart phone user generates 10 times the amount of traffic generated by the average non-smartphone user[[2]](#footnote-2). These facts are sufficient to prove that demand for spectrum for Mobile broadband will further increase.



Due to its inherent propagation characteristics the UHF spectrum is best suited for extending the mobile broadband to the public. Therefore the digital dividend spectrum is considered as an ideal opportunity to achieve this desired goal. Keeping in view this opportunity, the digital dividend spectrum is being made available in all 3 Regions of ITU for Mobile service. The summary is as follows:

* Region 1 (Europe, Middle East and Africa) identified 790-862 MHz for mobile services. During WRC-12, this region was allocated DD-2 spectrum (694-790 MHz) to Mobile service from 2015 subject to further studies and confirmation by WRC-15. This extension was mainly advocated mainly by Arab & African blocks.
* Region 2 (Americas) identified 698-806 MHz
* Region 3 (Asia) mobile allocation is 470 –960 MHz & 9 Asian Pacific nations identified 698 –806 MHz for IMT (Bangladesh, China, Korea (Rep. of), India, Japan, New Zealand, Papua New Guinea, Philippines and Singapore)

GE06 is an agreement for transition from analogue to digital television. The excess spectrum left due to this transition could be used for Mobile service. The details of GE06 agreement are given in Annex-A.

‘A Boston Consulting Group report has found that allocating 698-806MHz for mobile broadband deployment in Asia would mean a US$1 trillion increase in GDP for Asia Pacific countries by 2020. The report found that a harmonised allocation would create more than 2.7 million newly-created jobs across the region, and a US$215 billion increase in tax revenues. Failure to harmonise could cost up to 30% of these jobs and 18% of the incremental tax revenue in markets that fragment their allocation.’[[3]](#footnote-3)

The full text of the above report[[4]](#footnote-4) describes in detail the benefits of allocating 698-806MHz for mobile broadband in Asia.

# ITU Work Related to IMT

ITU Working Party 5D (WP 5D) is responsible to work on issues relate to IMT. The IMT scope encompasses the well-established IMT‑2000 and the newly developed IMT-Advanced. In 2011, ITU completed the assessment of candidate standards for IMT-Advanced. Finally LTE-Advanced and Wireless MAN-Advanced standards were submitted to the Radiocommunication Assembly 2012; where the ITU Member States have agreed to these two standards. An illustration of capabilities of IMT-2000 and system beyond IMT-2000 is given below.

Figure 1: IMT-2000 and Beyond[[5]](#footnote-5)



## 3.1 IMT Frequency Bands

ITU has identified several frequency bands for IMT. A table of these frequency bands is given in Annex-B. Taking into account the progress made during WRC-12, the summary of 698 – 960MHz (which is the subject of this report) IMT frequency band is as follows:

|  |
| --- |
| Text of Footnotes for f**requency band** **698 – 960MHz** |
| 5.313A: The band or portions of the band 698-790 MHz, in **Bangladesh**, China, Korea (Rep. of), **India**, Japan, New Zealand, **Pakistan,** Papua New Guinea, Philippines and Singapore are identified for use by these administrations wishing to implement International Mobile Telecommunications (IMT). This identification does not preclude the use of these bands by any application of the services to which they are allocated and does not establish priority in the Radio Regulations. In China, the use of IMT in this band will not start until 2015. (WRC‑12)5.317A: Those parts of the band 698-960 MHz in Region 2 and the band 790-960 MHz in Regions 1 and 3 which are allocated to the mobile service on a primary basis are identified for use by administrations wishing to implement International Mobile Telecommunications (IMT) – see Resolutions 224 (Rev.WRC‑12) and 749 (Rev.WRC‑12), as appropriate. This identification does not preclude the use of these bands by any application of the services to which they are allocated and does not establish priority in the Radio Regulations. (WRC‑12). |

The progress on relevant agenda items during the WRC-12 is given in Annex-C.

# Global Trends for Harmonized Digital Dividend Band plans

##

## 4.1 Region 1

##

## 4.1.1 CEPT

In 2009, European countries (CEPT) adopted a harmonized 800 band plan for mobile broadband with a 2 x 30 MHz paired arrangement given below.

Figure 2: CEPT 800 Band plan[[6]](#footnote-6)

#####

## 4.1.2 Regional Status[[7]](#footnote-7)

Germany was the first European country to auction licenses in the 800MHz frequency band. The spectrum was structured in accordance with the CEPT band plan. The 800MHz band was split into 6 lots, each consisting of 2x5MHz of bandwidth for the auction.

##### France

The French government completed its auction of 800MHz licenses in December 2011, comprising four lots: two 2x10MHz and two 2x5MHz.

Sweden's telecommunications regulator, PTS, concluded a radio spectrum auction in March 2011 and announced that Hi3G, Net4Mobility and TeliaSonera had secured blocks of 800MHz spectrum. The bands were auctioned in 2x5MHz lots with a cap of 2x10MHz imposed.

Italy’s busy market for regional broadcasting saw the Italian government overcome significant obstacles ahead of the decision to allocate 790–862MHz to mobile broadband. The government completed an auction for the spectrum in September 2011. Telecom Italia, Vodafone Italy and Wind each acquired 2x10MHz.

As far Spain is concerned, in late December 2010 the Minister of Industry, Tourism and Trade submitted the Draft Royal Decree before Parliament for the auction of several bands including the 800MHz band. The auction was completed in July 2011 with Vodafone, Orange and Telefónica all successful in securing both 800MHz spectrum and 2.6GHz spectrum for LTE deployments.

SADC Region:

In the Communications Regulators Association of Southern Africa (CRASA) workshop in Dar Es Salaam, Tanzania, in January 2011, the SADC group of countries confirmed that its current plan was to follow the 2x30MHz plan at 790–862MHz detailed in the CEPT band plan. However, analogue switch off may not occur in some SADC countries until 2013. South Africa’s recent confirmation that it will be using the DVB-2 digital television standard is expected to accelerate progress in that country.

Many markets in the region are planning to allocate DTT spectrum below the mobile bands (below 698MHz) to provide the opportunity to allocate the Digital Dividend to mobile once the analogue switch-off is complete.

In July 2012, the Kenyan government approved a public-private partnership for 4G, and Digital Dividend spectrum will be allocated to facilitate rural coverage. Orange worked with the government to release 25MHz of 800MHz spectrum so the public-private partnership could maintain a solution that conformed to the CEPT band plan.

698–806MHz in Region 1:

While the CEPT band plan is being rapidly adopted in Europe, some countries elsewhere in Region 1 are considering which arrangement is best suited to their national needs. In Africa and the Middle East, the prevalence of CDMA 800 and military equipment in the 800MHz band has caused some countries to look at the Asia Pacific Telecommunity (APT) arrangement (see Region 3 below) as the best option for enabling rural broadband.

The WRC12 decision to allow mobile to use the 698–806MHz band in Region 1 opens up the possibility of allocations in this spectrum for markets that have existing mobile operations in the 850MHz band or have issues with fixed links and other government use. The 698–806MHz spectrum decision comes into effect in 2015, by which time the band plans and the configuration and alignment of the band with the 790–862MHz spectrum will have been determined.

## 4.2 Region 2

##

## 4.2.1 CITEL

In 2006, the Inter-American Telecommunication Commission of the Organization of American States (CITEL) approved recommendation PCC.II/REC. 18 (VII-06) “Alternative use of the 698 – 806 MHz band in the Americas for Advanced Wireless Systems and Public Protection and Disaster Relief Applications”. Where Advanced Wireless Systems (AWS) include, but are not limited to, broadband wireless access and advanced mobile and mobile broadcasting systems.

The CITEL document recommends:

* the sub-bands 698 to 764 MHz and 776 to 794 MHz for advanced wireless systems
* the sub-bands 764 to 776 MHz and 794 to 806 MHz for PPDR applications;
* measures to ensure RFI compatibility between the advanced wireless systems and systems used for PPDR applications, operating in adjacent bands; and
* adopting the necessary measures in order to protect the broadcasting service[[8]](#footnote-8);

The CITEL document also recommends CITEL administrations utilize applicable ITU-R Recommendations when planning the 698 – 806 MHz range for AWS and PPDR applications

##

## 4.2.2 US Band Plan

United States’ Auction 73 of 700MHz spectrum was conducted in March 2008 according to the following band plan. It was multi-round bidding which continued for two months.

Figure 3: US 700MHz Band Plan[[9]](#footnote-9)



The details of the auction are as follows[[10]](#footnote-10):

Block A: 2X6 MHz (698–704MHz, 728–734MHz), divided into 176 geographic areas

Block B: 2X6 MHz (704–710MHz, 734–740MHz), divided into 734 geographical areas

Block E: 6 MHz unpaired (722–728MHz), divided into 176 geographical areas

Block C: 2X11 MHz (746–757MHz, 776–787MHz), divided into 12 geographical areas

Block D: 2X5 MHz (758–763,788–793MHz), sold as nationwide

Accordingly, Auction 73 raised a total of $19,120,378,000 in winning bids and $18,957,582,150 in net winning bids (reflecting bidders' claimed bidding credit eligibility).

## 4.3 Region 3

##

## 4.3.1 APT Work on Harmonized Approach for 698-806MHz

APT has done considerable work to develop a harmonized 698-806MHz band plan to assist the countries in Region 3 which are planning to use the entire or part of this band for IMT services. This initiative will help in maximizing the benefits to the region through interoperability, economies of scale and seamless roaming by users.

As far as practical, these arrangements should also reflect the important principles of[[11]](#footnote-11):

* Efficient usage of the spectrum;
* Maximum spectrum block size; and
* Appropriate protective measures for services in adjacent bands.

Before we proceed to the details of APT 700MHz band plan, it is important to understand the relevant technical considerations. The details of these considerations is mentioned in Annex-D

##### Germany

## 4.3.2 Regulatory Issues and Finalized APT700 band Plan[[12]](#footnote-12)

###

### 4.3.2.1 FDD channel Arrangement

####

#### *Conventional duplex direction*

The APT700 MHz band plan for a conventional duplex direction is given below:

|  |  |
| --- | --- |
| Spectrum block allocation parameters | Allocation |
| Centre gap | 10MHz |
| Guard band between FDD uplink and system operating below 698MHz | 5MHz |
| Guard band between FDD downlink and system operating above 806MHz | 3MHz |
| FDD size | 45MHz x 2 |

806

698

PPDR

45MHz

3MHz

DTV

694

Mobile uplink

Mobile downlink

5MHz

10MHz

45MHz

Centre

gap

Note: The figure above represents a dual Duplexer configuration and is used to facilitate the technical implementation of the frequency arrangement [See AWF-07/OUT-21 (Rev 1) sec 8.1.4]. The overlap of the dual duplexers also affords flexibility to administrations in national frequency planning.

#### *Reverse duplex direction*

|  |  |
| --- | --- |
| Spectrum block allocation parameters | Allocation |
| Centre gap | 10MHz |
| Guard band between FDD downlink and system operating below 698MHz | 6~7 MHz |
| Guard band between FDD uplink and system operating above 806MHz | 1~2 MHz |
| FDD size | 45MHz x 2 |

45MHz

PPDR

1~2MHz

806

698

DTV

694

6~7MHz

Centre

gap

45MHz

Mobile downlink

Mobile uplink

10MHz

Note: This channel arrangement does not account for the guard band required to avoid 2nd-harmonic interference to GNSS receivers. Providing that GPS is considered, 2~4MHz guard band is needed (Uplink: 1~2MHz (2nd harmonic band of GPS, 787.71MHz), Downlink: 1~2MHz (paired with guard band in uplink) (studies by CG-01)

The figure above represents a dual Duplexer configuration and is used to facilitate the technical implementation of the frequency arrangement [See AWF-07/OUT-21 (Rev 1) sec 8.1.4]. The overlap of the dual duplexers also affords flexibility to administrations in national frequency planning.

### 4.3.2.2 TDD Channel Arrangement

|  |  |
| --- | --- |
| Spectrum block allocation parameters | Allocation |
| Guard band between TDD system and system operating below 698MHz | 4~6 MHz |
| Guard band between TDD system and system operating above 806MHz | 2~4 MHz |
| TDD size | 100MHz |

PPDR

806

Mobile

DTV

2~4MHz

100MHz

4~6MHz

698

694

 This channel arrangement does not account for the guard band required to avoid 2nd-harmonic interference to GNSS receivers (studies by CG-01).

Moreover, the study results of guard band between TDD system and FDD system is given below

|  |  |
| --- | --- |
| Spectrum block allocation parameters | Allocation |
| Guard band for coexistence between TDD system and FDD system | 5~8 MHzNote1) |
| Note1) 5MHz required isolation is result from study by China (CG-05) and Huawei (CG-06). Moreover, Huawei addressed that more than 5MHz may be required if two Base Station are co-sited. ETRI & KT (CG-C2) addressed that more than 8MHz guard band is required when a large number of Mobile terminals are operating in close proximity. |

###

### 4.3.3 Implementation Issues

The issues for implementation of band plans are discussed in Annex-D.

# Regional Trend and Adoption of APT 700 Band Plan

##

## 5.1 Adoption by Countries

The following countries have already adopted the APT700 band plan.

* Australia: Adopted APT700 2x45 MHz band plan. Australia will auction this spectrum in Nov 2012
* Japan: Japan has assigned 3 pairs of 2x10MHz according to APT700 FDD band plan.
* Korea: Allocated 2x20MHz according to APT700 FDD band plan.
* Papau New Guinea: Adopted APT700 FDD 2x45MHz band plan.
* Tonga: Adopted APT700 FDD 2x45 band plan.
* New Zealand: Considering to auction spectrum as per APT700 FDD band plan.
* Taiwan: Auction planned as per APT700 FDD band plan.
* India: Proposed auction according to APT700 band plan.
* Mexican regulator Cofetel has recommended adopting Asia Pacific Model for segmenting 700 MHz band.

## 5.2 ITU Adoption

As per ITU-R recommendation M.1036-4, the APT 700 MHz band plan (A5 in the table below) has been included in the options for IMT frequency arrangements.

Table 1: IMT Frequency Arrangement[[13]](#footnote-13)



Notes to Table 3:

NOTE 1 – Due to the different usage in the bands 698-960 MHz between Regions, there is no commonsolution possible at this time.

NOTE 2 – In A3, IMT systems are operating in FDD mode and use a reversed duplex direction, with mobile terminal transmit within the upper band and base station transmit within the lower band. Such an arrangement provides better conditions for coexistence with the lower adjacent broadcasting service. It is noted that Administrations which do not wish to use this plan or which do not have the full band 790-862 MHz available may consider other frequency arrangements including, e.g. partial implementation of frequency arrangement described in A3, a TDD frequency arrangement (with a guardband of at least 7 MHz above 790 MHz) or a mixed introduction of TDD and FDD frequency arrangements.

NOTE 3 – In A4, administrations can use the band solely for FDD or TDD, or some combination of FDD & TDD. Administrations can use any FDD duplex spacing or FDD duplex direction. However, when administrations choose to deploy mixed FDD/TDD channels with a fixed duplex separation for FDD, the duplex separation and duplex direction as shown in A4 are preferred. Individual band blocks in the mixed channel arrangement may include further subdivisions to accommodate both duplex methods.

NOTE 4 – The frequency arrangements for the band 698-960 MHz have been developed taking into consideration the recognizing above. The frequency arrangements for PPDR systems using IMT technologies in the bands identified in Resolution 646 (WRC-03), according to considering h) and resolves 6 of that Resolution are outside the scope of this Recommendation. There are inherent benefits of deploying IMT technologies for PPDR applications in this band, including advantages of large coverage area and possible interoperability across the 700 and 800 MHz bands, noting the differences in operational requirements and implementations.

NOTE 5 – In A5, 2 × 45 MHz FDD arrangement is implemented by using sub-blocks with dual duplexer solution and conventional duplex arrangement. Internal guardbands of 5 MHz and 3 MHz are provided at the lower and upper edge of the band for better co-existence with adjacent radiocommunication services.

NOTE 6 – In A6, taking into account the external 4 MHz guardband (694-698 MHz), a minimum internal

guardband of 5 MHz at the lower edge (698 MHz) and 3 MHz at the upper edge (806 MHz) needs to be considered.





## 5.3 3GPP Adoption

In addition, the 3GPP standards development organization completed standards specification for the APT 700 FDD 2 x 45 MHz (Band 28) and APT 700 TDD (Band 44) in June 2012.

# **6. Questionnaire on Use of 700MHz Band in SATRC Countries**

##

## **6.1 Purpose**

This questionnaire has been designed to complete the SATRC Spectrum WG Agenda item on “Harmonized approach on use of 700 MHz band in SATRC region”.

## 6.2 Questions for SATRC Countries

**Question 1:**

What is present service wise utilization of 698-806MHz in your country?

**Question 2:**

What are the future short term (3 to 5 years) and long term (5-10 year and above) plans to utilize the above frequency band for various services? Please provide the estimated time schedule for such plans.

1. In case this frequency band is planned for IMT[[14]](#footnote-14) services, what is the channel plan under consideration?
2. What is the approximate 5 year projected demand of IMT services in your country?

**Question 3:**

1. Are there any digital TV broadcast services in your country? If yes, please mention the frequency range.
2. Is your country planning to license the digital TV broadcast services? If yes, what is the exact frequency range planned/allocated?

##

## 6.3 Responses to Questionnaire Summarized[[15]](#footnote-15)

| **Iran** | **Pakistan** | **Bhutan** | **Maldives** | **Bangladesh** | **Nepal** | **India** | **Afghanistan** | **SriLanka** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Q1:** What is present service wise utilization of 698-806MHz in your country? |
| **698-790:** Analog &Digital TV Broadcasting | **698-806:**Fixed/Non-commercial  | 698-806:Fixed & Mobile. (However fully vacant at present) | 698-714MHz for linking nearby islands & will be cleared within 3 years.714-790:Vacant | 698-806 planned for IMT. Presently there is one ISP operator using.704-710/734-740MHz. Rest of the 698-806 MHz band is free. | 698-806(Fully Vacant) | 40MHz to PSUs & captive usages.48MHz - Ministry of I&B. 20 MHz Security agencies. P2P links Defence & BSNL/MTNL in 698-806 MHz.Spots for Public Protection & Disaster Relief (PPDR) in 750 – 806 MHz. | Broadcasting & Mobile(Partially Used)planned freq ( 710-862 )  for Mobile services (IMT2000) | 698 – 806 MHz is fully used for Analog TV |
| Q2: What are the future short term (3 to 5 years) and long term (5-10 year and above) plans to utilize the above frequency band for various services? Please provide the estimated time schedule for such plans. 1. Specify the services with frequency bands.
2. In case this frequency band is planned for IMT[[16]](#footnote-16) services, what is the channel plan under consideration?
 |
| Plan for IMT in 790-882 MHz by having one FDD + TDD in duplexing gap | 698-790 MHz for IMT as per Article 313A (WRC-12). Exact time line not clear at this stage. APT plan likely to be adopted. | No short/long term utilization plan.Most likely to be allocated for IMT.  | 714-803MHz planned for LTE 698-714MHz will be cleared within 3 years. | 698-790 MHz for IMT as per Article 313A(WRC-12)Channel plan is 5MHz each for IMT. This is under discussion. | Planned for future LTE Allocation/deployment in 700 MHz band, but not decided yet.Channel plan likely to be as per international standards | 698-806 MHz for IMT & WBB as per APT Plan. | Broadcasting & Mobile | No change to present allocations for 3 to 5 years.Long term 698-806 for IMT |
| Q3(i) Are there any digital TV broadcast services in your country? If yes, please mention the frequency range. |
| Yes**698-790MHz** | No.  | Yes. Both analog & digital | - | No | No | 585-698MHz allocated for Digital Terrestrial Television Broadcasting (DTTB). Doordarshan will use this band for digitization of terrestrial network. | No | No |
| Q3 (ii) Is your country planning to license the digital TV broadcast services? If yes, what is the exact frequency range planned/allocated? |
| Broadcasting activities in Iran is monopolized in the hand of single governmental organization. So, licensing is not the case of this country. This organization focused on frequency range below 790MHz. | Still not finalized | Most likely 174-230MHz to be used for digital broadcasting. 470-862 to be used most likely for IMT | - | Not yet decided | 542-604.75MHz recommended for digital TV to be started by 2017 | 585-698MHz allocated for Digital Terrestrial Television Broadcasting (DTTB). | - | - |

# Way forward and Recommendation

As discussed above, the APT 700MHz band plan has been finalized after a comprehensive research and it has been adopted by many countries inside and outside APT region. The Council may consider to adopt APT700 band plan for SATRC member countries considering it huge benefit that arises due to harmonization and economy of scale. Possibility of a joint declaration may be worked on in the forth coming SATRC Council meeting.

## Annex-A

##  GE06 Agreement

* According to the GE06 agreement, the transition from analogue to digital television shall end on 17 June 2015 at 0001 hours UTC. This agreement applies in all Region 1 countries except Mongolia and in Iran (Islamic Republic of) in the frequency bands 174-230/470-862MHz. It contains provisions for the terrestrial broadcasting service and other primary terrestrial services, a plan for digital television, and a list of stations of other primary terrestrial services.

Objectives of this plan include:

* Agree on date for Transition to Digital
	+ June 17,2015 decided for transition
	+ After the above date, the analogue broadcasting stations would neither cause harmful interference nor claim protection.
* Establish a digital frequency plan
* Adopt an Agreement that sets out the procedures for making changes to the frequency plan and to bring the frequency assignments into operation.

Some of the relevant activities at ITU; which eventually resulted into GE06, are:

* 2001 –ITU Council decided to plan for digital broadcasting in the European Broadcasting Area (ST61)
* 2002 –decided to include countries in Africa and Middle East
* 2002 –RCC countries included by Plenipotentiary conference(Marrakesh)

The relevant TV frequency bands in GE06 Agreement are:

* VHF Band III: 174-230 MHz
* UHF Bands IV & V: 470-862 MHz

Digital Video Broadcasting (DVB-T) is the technology for digital television with four reception modes of fixed, mobile, portable indoor and outdoor.

It may be noted that coordination between terrestrial services (fixed, mobile and broadcasting) in the frequency band 790-862 MHz between Iran (Islamic Republic of), on the one hand, and the other countries of Region 3, on the other hand, is a matter to be left to the administrations concerned, based on bilateral or multilateral negotiations, if it is mutually agreed by those administrations.

The following figure shows the process of harmonizing a sub-band for digital dividend. Digital TV is spectrally efficient than analogue TV due to the compression techniques and digital modulation. The white spaces represent the leftover spectrum as a result of introduction of spectrally efficient digital TV in spectrum range of 470 to 806 MHz. Since the fragmented spectrum is less useful, therefore reshuffling of frequencies is done to formulate a harmonized plan for digital dividend.



#

Figure 4: UHF Digital Dividend[[17]](#footnote-17)

## Annex-B

**Table 1: IMT Frequency Bands[[18]](#footnote-18) (Modified through addition of Footnotes’ text from ITU RR)**

|  |  |  |
| --- | --- | --- |
| **Band (MHz)** | **Radio Regulations Footnotes Indentifying the Band for IMT** | **Text of ITU RR Foot Notes added in the table under reference** |
| 450 – 470 | 5.286AA | 5.286AA: The band 450-470 MHz is identified for use by administrations wishing to implement International Mobile Telecommunications (IMT). See Resolution 224 (Rev.WRC-07). This identification does not preclude the use of this band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations. (WRC-07). |
| 698 – 960 | 5.313A, 5.317A | 5.313A: The band or portions of the band 698-790 MHz, in Bangladesh, China, Korea (Rep. of), India, Japan, New Zealand, Pakistan, Papua New Guinea, Philippines and Singapore are identified for use by these administrations wishing to implement International Mobile Telecommunications (IMT). This identification does not preclude the use of these bands by any application of the services to which they are allocated and does not establish priority in the Radio Regulations. In China, the use of IMT in this band will not start until 2015. (WRC‑12)5.317A: Those parts of the band 698-960 MHz in Region 2 and the band 790-960 MHz in Regions 1 and 3 which are allocated to the mobile service on a primary basis are identified for use by administrations wishing to implement International Mobile Telecommunications (IMT) – see Resolutions 224 (Rev.WRC‑12) and 749 (Rev.WRC‑12), as appropriate. This identification does not preclude the use of these bands by any application of the services to which they are allocated and does not establish priority in the Radio Regulations. (WRC‑12). |
| 1710 – 2025 | 5.384A, 5.388 | 5.384A: The bands, or portions of the bands, 1 710-1 885 MHz, 2 300-2 400 MHz and 2 500-2 690 MHz, are identified for use by administrations wishing to implement International Mobile Telecommunications (IMT) in accordance with Resolution 223 (Rev.WRC-07). This identification does not preclude the use of these bands by any application of the services to which they are allocated and does not establish priority in the Radio Regulations. (WRC-07).5.388: The bands 1 885-2 025 MHz and 2 110-2 200 MHz are intended for use, on a worldwide basis, by administrations wishing to implement International Mobile Telecommunications-2000 (IMT-2000). Such use does not preclude the use of these bands by other services to which they are allocated. The bands should be made available for IMT-2000 in accordance with Resolution 212 (Rev.WRC-97)\*. (See also Resolution 223 (WRC-2000)\*.) (WRC-2000). |
| 2110 – 2200 | 5.388 | Given above |
| 2300 – 2400 | 5.384A | Given above |
| 2500 – 2690 | 5.384A | Given above |
| 3400 – 3600 | 5.430A, 5.432A, 5.432B, 5.433A | 5.430A: *Different category of service:* In Albania, Algeria, Germany, Andorra, Saudi Arabia, Austria, Azerbaijan, Bahrain, Belgium, Benin, Bosnia and Herzegovina, Botswana, Bulgaria, Burkina Faso, Cameroon, Cyprus, Vatican, Congo (Rep. of the), Côte d'Ivoire, Croatia, Denmark, Egypt, Spain, Estonia, Finland, France and French overseas departments and communities in Region 1, Gabon, Georgia, Greece, Guinea, Hungary, Ireland, Iceland, Israel, Italy, Jordan, Kuwait, Lesotho, Latvia, The Former Yugoslav Republic of Macedonia, Liechtenstein, Lithuania, Malawi, Mali, Malta, Morocco, Mauritania, Moldova, Monaco, Mongolia, Montenegro, Mozambique, Namibia, Niger, Norway, Oman, Netherlands, Poland, Portugal, Qatar, the Syrian Arab Republic, the Dem. Rep. of the Congo, Slovakia, Czech Rep., Romania, United Kingdom, San Marino, Senegal, Serbia, Sierra Leone, Slovenia, South Africa, Sweden, Switzerland, Swaziland, Chad, Togo, Tunisia, Turkey, Ukraine, Zambia and Zimbabwe, the band 3 400-3 600 MHz is allocated to the mobile, except aeronautical mobile, service on a primary basis subject to agreement obtained under No. 9.21 with other administrations and is identified for International Mobile Telecommunications (IMT). This identification does not preclude the use of this band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations. At the stage of coordination the provisions of Nos. 9.17 and 9.18 also apply. Before an administration brings into use a (base or mobile) station of the mobile service in this band, it shall ensure that the power flux-density (pfd) produced at 3 m above ground does not exceed −154.5 dB (W/ (m2 ⋅ 4 kHz)) for more than 20% of time at the border of the territory of any other administration. This limit may be exceeded on the territory of any country whose administration has so agreed. In order to ensure that the pfd limit at the border of the territory of any other administration is met, the calculations and verification shall be made, taking into account all relevant information, with the mutual agreement of both administrations (the administration responsible for the terrestrial station and the administration responsible for the earth station), with the assistance of the Bureau if so requested. In case of disagreement, the calculation and verification of the pfd shall be made by the Bureau, taking into account the information referred to above. Stations of the mobile service in the band 3 400-3 600 MHz shall not claim more protection from space stations than that provided in Table 21‑4 of the Radio Regulations (Edition of 2004). This allocation is effective from 17 November 2010. (WRC‑12).5.432A: In Korea (Rep. of), Japan and Pakistan, the band 3 400-3 500 MHz is identified for International Mobile Telecommunications (IMT). This identification does not preclude the use of this band by any application of The services to which it is allocated and does not establish priority in the Radio Regulations. At the stage of coordination the provisions of Nos. 9.17 and 9.18 also apply. Before an administration brings into use a (base or mobile) station of the mobile service in this band it shall ensure that the power flux-density (pfd) produced at 3 m above ground does not exceed 􀃭154.5 dB(W/(m2 ⋅4 kHz)) for more than 20% of time at the border of the territory of any other administration. This limit may be exceeded on the territory of any country whose administration has so agreed. In order to ensure that the pfd limit at the border of the territory of any other administration is met, the calculations and verification shall be made, taking into account all relevant information, with the mutual agreement of both administrations (the administration responsible for the terrestrial station and the administration responsible for the earth station), with the assistance of the Bureau if so requested. In case of disagreement, the calculation and verification of the pfd shall be made by the Bureau, taking into account the information referred to above. Stations of the mobile service in the band 3 400-3 500 MHz shall not claim more protection from space stations than that provided in Table 21-4 of the Radio Regulations (Edition of 2004). (WRC-07).5.432B: *Different category of service:* In Bangladesh, China, India, Iran (Islamic Republic of), New Zealand, Singapore and French overseas communities in Region 3, the band 3 400-3 500 MHz is allocated to the mobile, except aeronautical mobile, service on a primary basis, subject to agreement obtained under No. 9.21 with other administrations and is identified for International Mobile Telecommunications (IMT). This identification does not preclude the use of this band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations. At the stage of coordination the provisions of Nos. 9.17 and 9.18 also apply. Before an administration brings into use a (base or mobile) station of the mobile service in this band it shall ensure that the power flux-density (pfd) produced at 3 m above ground does not exceed 􀃭154.5 dB(W/(m2 ⋅4 kHz)) for more than 20% of time at the border of the territory of any other administration. This limit may be exceeded on the territory of any country whose administration has so agreed. In order to ensure that the pfd limit at the border of the territory of any other administration is met, the calculations and verification shall be made, taking into account all relevant information, with the mutual agreement of both administrations (the administration responsible for the terrestrial station and the administration responsible for the earth station) with the assistance of the Bureau if so requested. In case of disagreement, the calculation and verification of the pfd shall be made by the Bureau, taking into account the information referred to above. Stations of the mobile service in the band 3 400-3 500 MHz shall not claim more protection from space stations than that provided in Table 21-4 of the Radio Regulations (Edition of 2004). This allocation is effective from 17 November 2010. (WRC-07).5.433A: In Bangladesh, China, Korea (Rep. of), India, Iran (Islamic Republic of), Japan, New Zealand, Pakistan and French overseas communities in Region 3, the band 3 500-3 600 MHz is identified for International Mobile Telecommunications (IMT). This identification does not preclude the use of this band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations. At the stage of coordination the provisions of Nos. 9.17 and 9.18 also apply. Before an administration brings into use a (base or mobile) station of the mobile service in this band it shall ensure that the power flux-density (pfd) produced at 3 m above ground does not exceed 􀃭154.5 dB(W/(m2 ⋅4 kHz)) for more than 20% of time at the border of the territory of any other administration. This limit may be exceeded on the territory of any country whose administration has so agreed. In order to ensure that the pfd limit at the border of the territory of any other administration is met, the calculations and verification shall be made, taking into account all relevant information, with the mutual agreement of both administrations (the administration responsible for the terrestrial station and the administration responsible for the earth station), with the assistance of the Bureau if so requested. In case of disagreement, the calculation and verification of the pfd shall be made by the Bureau, taking into account the information referred to above. Stations of the mobile service in the band 3 500-3 600 MHz shall not claim more protection from space stations than that provided in Table 21-4 of the Radio Regulations (Edition of 2004). (WRC-07). |

## Annex-C

## Relevant Agenda Items at WRC-12

**AI 1.17**.(WG 5C)to consider results of sharing studies between the mobile service and other services in the band 790-862 MHz in Regions 1 and 3, in accordance with Resolution **749 (WRC‑07)**, to ensure the adequate protection of services to which this frequency band is allocated, and take appropriate action

## Brief Summary of Results

* In the Region 1, the allocation to the mobile, except aeronautical mobile, service on a primary basis in the frequency band 790-862 MHz shall come into effect from 17 June 2015. Resolution 749(Rev.WRC‑12) applies to this case. This resolution deals with intra-Region 1 service sharing and its scope applies to Region 1 and Iran only.
	+ Major issue of debate was the effect of aggregate versus single entry[[19]](#footnote-19) interference from the mobile service into the broadcasting service.
	+ Revised Res. 749 acknowledged cumulative effects and noted that studies under Res. 224 need to take into account the cumulative effect of interference.

Table 2: Allocation of spectrum to Mobile services in Region 3

|  |
| --- |
| **Region 3** |
| **Frequency band** | **Service** | **Year/Conference** |
| 790-862 MHz | Mobile | Since 1979 |
| 806-960 MHz | IMT | WRC-2000 |
| 790-806 MHz | IMT | WRC-07 |
| 698-790 MHz | IMT | WRC-12Bangladesh, China, Korea (Rep. of), India, Japan, New Zealand, Pakistan, Papua New Guinea, Philippines and Singapore (Article 5.313A) |
| 790-862MHz | Mobile | All other Asia Pacific |
| From the above allocations, it is vital for Region 3 to formulate a harmonized band plan for 698 – 806MHz.  |

After the above updates, the relevant part of Frequency Allocation Table (FAT) in ITU RRs is as follows:

**Table 3: Overview of relevant part of FAT**

|  |
| --- |
| Allocation to Services |
| Region 1 | Region 2 | Region 3 |
| 470-790BROADCASTING5.149 5.291A 5.294 MOD 5.296 5.300 5.302 5.304 5.306 5.311A5.312 ADD 5.3XX**For 694-790 Resolution COM 5/10 (WRC-12) Applicable**To allocate to the mobile, except aeronautical mobile, service on a co-primary basis with other services to which this band is allocated on a primary basis and to identify it for IMT.Subject to WRC-15 studiesITU-R to study the spectrum requirements for Mobile and Broadcasting services in this band. | 470-512BROADCASTINGFixedMobile5.292 5.293 | 470-585FIXEDMOBILEBROADCASTING5.2915.298 |
| 512-608BROADCASTING5.297 |
| 585-610FIXEDMOBILEBROADCASTINGRADIONAVIGATION5.1495.3055.3065.307 |
| 608-614RADIO ASTRONOMYMobile-satellite exceptaeronautical mobile-satellite(Earth-to-space) |
| 610-890FIXEDMOBILE 5.313A MOD 5.317ABROADCASTING |
| 614-698BROADCASTINGFixedMobile5.2935.3095.311A |
| 698-806MOBILE 5.313B MOD 5.317ABROADCASTINGFixed5.293 5.309 5.311A |
| 790-862FIXEDMOBILE except aeronautical mobile MOD 5.316B MOD 5.317ABROADCASTING5.3125.3145.3155.316 MOD 5.316A 5.319**Resolution 749 (Rev WRC-12) Applicable**The allocation to the mobile, except aeronautical mobile, service on a primary basis in the frequency band 790-862 MHz shall come into effect from 17 June 2015 |
| 806-890FIXEDMOBILE MOD 5.317ABROADCASTING |
| 862-890FIXEDMOBILE except aeronauticalmobile 5.317ABROADCASTING 5.322 |
| 5.319 5.323 | 5.3175.318 | 5.149 5.3055.3065.3075.311A 5.320 |

## Annex-D

# Technical Considerations

According to an APT report on ‘UHF BAND USAGE AND CONSIDERATIONS FOR REALIZING THE UHF DIGITAL DIVIDEND’[[20]](#footnote-20), the relevant technical considerations; which must be considered in devising a plan for UHF digital dividend, are given below and summarized from this report:

#### Duplexer

The duplexer is a filter that provides isolation of the transmitter leakage to its own receiver. Duplexer isolation of > 45 dB is considered feasible by the industry. Duplexer technology affects choice of duplex separation and centre band gap.

**↑/↓ (UL/DL)**

**↓/↑ (DL/UL)**

Duplex spacing

Centre Gap

#### Centre Gap

Centre gap is a key characteristic of FDD-based frequency arrangement. It is common understanding that the duplex spacing and centre gap influence the duplexer performance so that larger separation brings the better isolation performance between downlink and uplink. Technically, this size of spacing affects the duplexer performance in the following two technical aspects:

* Self-desensitization for FDD Mobile Stations (MS) and FDD BSs
* MS to MS interference and BS to BS interference

To prevent self-desensitization, a duplexer must attenuate Tx emissions at the own Rx frequency band below the Rx noise floor.

The centre gap will also determine whether competitive networks can satisfactorily share base station sites with minimum interference and protective site filtering complexity.

#### Duplex Spacing

This is the separation between the up-link channel and its associated down-link channel. A larger separation will result in less likelihood of self interference between a handset transmitter and its own receiver.

The duplex separation requirement is also dependent on the carrier bandwidth in order to protect the receiver from self interference.

A duplex spacing of 30MHz is sufficient to support carrier bandwidths of up to 10MHz. This result is derived using 3GPP specification 3GPP 36.101.

#### Dual Duplexer

The maximum bandwidth of an RF filter or duplexer for a terminal at this frequency range is today around 30-35MHz. Any arrangement that efficiently uses the 108MHz bandwidth in the frequency range 698-806MHz must thus have more than one duplexer. “Dual duplexer” means that the handset has 2 duplexers, one per sub band as illustrated below.

 ****

Figure 5: Illustration of dual duplexer

##

With the use of a dual duplexer arrangement the individual duplex spacing will be increased, providing at the same time more useable spectrum for FDD. With current technology it would not be possible to implement a pass band of 50 MHz with a single duplex solution. The dual duplexer arrangement may lead to a 2x50 MHz FDD band plan.

Dual duplexers are being specified today and would add to the number of band specific duplexers to be accommodated in handsets where physical space is at a premium.

#### Guard Band Broadcasting Boundary

When the broadcasting service and the mobile service are operated in adjacent bands, there could be a co-existence issue. For example, when FDD downlink of the mobile service is operated, there could be interference from broadcast transmitters into FDD mobile terminals and also from FDD base stations into broadcast receivers. CEPT Report 21, “compatibility issues between “cellular / low power transmitter” networks and “larger coverage / high power / tower” type of networks”, provides study results for co-existence issue and some proposals for CEPT case. The suggested value from CEPT Report 23 is around 8MHz. So the necessity for co-existence study in Region 3 own case is presented.

#### FDD/TDD Boundary

In the case of mixing of FDD and TDD throughout the 698- 806 MHz band, guard bands between TDD and FDD will need to be taken into account to avoid interference. The placing of guardbands would require careful spectrum planning.

These considerations and their technical implications were studied by the APT Wireless Forum and the relevant technical reports can be found in document AWF-9/INP-74(Rev.2). The conclusion of the report is as follows. This conclusion is extracted from APT report ‘Summary of technical analysis for FDD and TDD channel arrangement in UHF band for Region 3’[[21]](#footnote-21). There are two relevant reports on this from AWG, these are Report no. APT/AWG/REP-14 & APT/AWG/REP-24.

As per the ITU Recommendation ITU-R M.1036-4, some of the important IMT implementation issues to be considered by administrations are:

#### Important Issues as per ITU Recommendation[[22]](#footnote-22):

#### Traffic asymmetry implications

It is recommended that administrations and operators consider asymmetric traffic requirements when assigning spectrum or implementing systems. Applications supported by IMT may have various degrees of asymmetry. Report ITU-R M.2072 describes not only download dominant applications such as e-newspaper, but also upload dominant applications such as observation (network-camera) and upload file transfer. Also, the degree of asymmetry of other applications such as high-quality video telephony, mobile multicasting, and videoconference depends on their requirements.

As a possible consequence, the amount of resources needed for the downlink may differ from that of the uplink. It is noted that traffic asymmetry can be accommodated by a variety of techniques including

flexible timeslot allocation, different modulation formats, and different coding schemes for the uplink and downlink. With equal FDD pairing for uplink and downlink, or TDD, varying degrees of traffic asymmetry can be accommodated.

#### Duplex Arrangement and Separation

It is recommended that, for bands identified for use by IMT, IMT systems operating in FDD mode should maintain the conventional duplex direction, with mobile terminal transmit within the lower band and base station transmit within the upper band.

This is because the system performance is generally constrained by the uplink link budget due to the limited transmit power of terminals.

In order to facilitate coexistence with adjacent services, in some instances it may be desirable to reverse the duplex direction, with the mobile terminal transmit within the upper band and base station transmit within the lower band.

#### Important Issues as per APT Report[[23]](#footnote-23)

APT report no. APT/AWG/REP-24 on “IMPLEMENTATION ISSUES ASSOCIATED WITH USE OF THE BAND 698-806 MHZ BY MOBILE SERVICES” was adopted by 11th APT Wireless Group meeting in Sep 2011. The summary of technical considerations for channel planning; according to this report is:

The uplink/downlink block size of the 698-806 MHz FDD band plan has already been determined as 45 MHz. The current state-of-the-art allows for a maximum duplexer size of around 3-4% of the center frequency of the band. This results in a duplexer bandwidth in the order of 30MHz. Therefore two overlapping duplexers are currently expected to be required.

The channel bandwidths are not yet defined for this band but it is likely that the widest (20 MHz) LTE channel option will be allowed. Current 3GPP specification 36.101 mandates a 100 kHz channel raster (Channel raster is the steps or frequencies that can be used by a communication device. For the UMTS system, the channel raster is 100 kHz), which would enable a 20 MHz channel to be positioned practically in the middle of the band. This scenario requires a full 20 MHz overlap of duplexers, and leads to a requirement for 2 x 32.5 MHz duplexer pass bands.



Figure 6: 20MHz Channel in the middle[[24]](#footnote-24)

The case of a 20 MHz channel positioned in the centre of the 45 MHz block leaves 12.5 MHz

spectrum on either side, which is not fully consistent with LTE channel bandwidths. For efficient spectrum usage, a 5 MHz raster is very likely to be implemented in practice. Thus, on the basis of a 5 MHz raster, the 20 MHz channel will be positioned 2.5 MHz below the block centre-frequency (case 1 in Figure below) or 2.5 MHz above the block centre-frequency (case 2 in Figure below).

From the figure given below, it can therefore be seen that a 15 MHz overlap is adequate in this case, and a 2 x 30 MHz duplexer arrangement could be implemented.



Figure 7: 20MHz channel with 5MHz raster

Given this overlap arrangement, a number of alternative channel plans can be readily adopted by administrations: In this way 5, 10, 15 and 20 MHz channels can be adopted.

#### Out of Band Emission Limits

As a result of the studies mentioned in the above mentioned APT report, it is considered that the probability of interference to adjacent digital television receivers below 694 MHz from IMT UE would be low when the UE maximum out-of-band emissions were between -30 and -40 dBm/MHz (averaged over the DTV bandwidth). Considering technical and economic factors associated with UE equipment, it was concluded that the average out of band emissions of IMT UE, measured over the bandwidth of the applicable television channel in the country of deployment, must not exceed -34 dBm/MHz below 694 MHz.

The key features of IMT-2000 and IMT-Advanced are contained in Recommendations ITU-R M.1645 and ITU-R M.1822. Frequency aspects and unwanted emission parameters are contained in Recommendations ITU-R M.1580 and ITU-R M.1581.

1. CTIA, Written Ex Parte to FCC, Sept. 29, 2009 [↑](#footnote-ref-1)
2. Pew Internet & American Life Project, Dec. 2008 [↑](#footnote-ref-2)
3. http://www.gsmworld.com/spectrum/wp-content/uploads/DigitalDividend/DDtoolkit/importance-of-harmonisation.html [↑](#footnote-ref-3)
4. http://www.acma.gov.au/webwr/\_assets/main/lib311973/ericsson\_attachment%20a\_ifc34-2010.pdf [↑](#footnote-ref-4)
5. Resolution ITU‑R 56‑1 [↑](#footnote-ref-5)
6. ITU presentation on ‘Digital Dividend and Spectrum considerations’ by Mrs Ilham GHAZI Radiocommunation Engineer- Terrestrial Dept. [↑](#footnote-ref-6)
7. Information taken from http://www.gsma.com/spectrum/wp-content/uploads/DigitalDividend/DDtoolkit/regional-status-map.html [↑](#footnote-ref-7)
8. Broadcasting service as defined in Article 1 in the ITU Radio Regulations [↑](#footnote-ref-8)
9. http://wireless.fcc.gov/auctions/data/bandplans/700MHzBandPlan.pdf [↑](#footnote-ref-9)
10. http://www.gsmworld.com/spectrum/wp-content/uploads/DigitalDividend/DDtoolkit/auctions-summary.html [↑](#footnote-ref-10)
11. HARMONISED FREQUENCY ARRANGEMENTS FOR THE BAND 698-806 MHZ, No. APT/AWF/REP-14 [↑](#footnote-ref-11)
12. Details taken from APT/AWG/REP-14 & APT/AWG/REP-24 [↑](#footnote-ref-12)
13. Table & notes have been extracted from ITU-R M.1036-4 [↑](#footnote-ref-13)
14. Please IMT includes both the IMT-2000 and IMT Advanced as per ITU. [↑](#footnote-ref-14)
15. Sep 2012 Details [↑](#footnote-ref-15)
16. Please IMT includes both the IMT-2000 and IMT Advanced as per ITU [↑](#footnote-ref-16)
17. Qualcomm Presentation, Harmonization of Digital Dividend for AP Region, May 2011 [↑](#footnote-ref-17)
18. IMT-Advanced standards for Mobile Broadband Communications, Chairman ITU–R Working Party 5D (IMT Systems [↑](#footnote-ref-18)
19. Interference protection criteria (IPC) are specified for aggregate interfering signals (i.e., total from all interferers) or single-entry interfering signals (i.e., from one interfering system). Aggregate IPC are generally derived from performance objectives and may be used to define the potential interfering signal environment in system design or performance analyses. Single-entry IPC, in turn, are derived from aggregate IPC and are used as “spectrum sharing criteria” directly or as the basis for other forms of sharing criteria (e.g., transmitter power and antenna pointing limits) [Ref: http://www.ntia.doc.gov/files/ntia/publications/ipc\_phase\_1\_report.pdf] [↑](#footnote-ref-19)
20. AWF-7/OUT-21 (Rev.1) [↑](#footnote-ref-20)
21. http://www.apt.int/sites/default/files/2010/09/AWF-9-INP-74Rev.2\_CG2\_Chairman\_report-rev2.doc [↑](#footnote-ref-21)
22. The details have been extracted from ITU-R M.1036-4 [↑](#footnote-ref-22)
23. The details have been extracted from APT report no. APT/AWG/REP-24 [↑](#footnote-ref-23)
24. APT/AWG/REP-24 [↑](#footnote-ref-24)