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Frequency usage and digital dividend in India

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FREQUENCY USAGE AND DIGITAL DIVIDEND IN INDIA

Introduction

Spectrum is a scarce natural resource which is not only essential for important economic objectives but also for achieving social and cultural goals. The radio spectrum is allocated to different wireless services according to the international and the national allocation plan. The demand for the spectrum is rapidly growing which was seen from the recently concluded auction for the vestige of spectrum in the different part of the world. The government of India earned a total revenue of over Rs.10 6262 crore (US\$19.23 billion) from the auction of the spectrum for 3G, and Broadband wireless services (Mishra, Varshney & Karandikar, 2012), which is approximately, 10% of the expenditure budget of India for the year 2009–2010. The emerging wireless technologies fuel the demand for the spectrum and create the scarcity of the spectrum. The regulatory bodies find very much difficulty in allocating the spectrum for the emerging wireless technologies. The objective of the spectrum regulation is to give access to the spectrum for the largest chunk of interested parties in due time with ensuring high spectrum efficiency and avoiding harmful interference between users. The spectrum scarcity problem can be overcome by spectrum refarming or spectrum sharing using Cognitive Radio Technology. Spectrum refarming in the traditional sense means the recovery of spectrum from its existing users for the purpose of re-assignment, either for new uses, or for the introduction of new spectrally efficient technologies. As such refarming is a spectrum management tool that can be used to satisfy new market demands and increase spectrum efficiency (Electronic Communications Committee, 2002). Cognitive radio (Mitola III, 2000) is an intelligent device which give opportunity to the unlicensed users to share the licensed spectrum with licensed users without harmful interfer-

ence to the licensed users. The concept of spectrum refarming and sharing gained momentum from the shocking results obtained about the low spectrum utilization from the spectrum occupancy measurement campaigns conducted worldwide which are summarized in (Patil, Prasad, & Skouby, 2011).

Worldwide terrestrial TV broadcasting has started to shift from analogue to digital transmission for improved quality and bandwidth saving. The switchover of analogue to digital terrestrial TV (DTTV) broadcasting is going to save much spectrum. This spectrum is called the digital dividend. The digital dividend spectrum is located between 200 MHz and 1 GHz. This spectrum band offers an excellent balance between transmission capacity and distance coverage. There is discussion going over the issue of allocation of the digital dividend spectrum either to digital terrestrial TV Broadcasting or to mobile telecom services. A fair and well-balanced reallocation of the spectrum between the mobile broadband, broadcasting and ICT industries will ensure that society reaps the full social and economic benefits of the digital dividend. There are several factors that must be considered in determining the allocation of spectrum i.e. regulation, socio-cultural, economic, and business aspects.

This article focus on the spectrum occupancy result of 2G Global System for Mobile communication (GSM) cellular band from the measurement campaign conducted at Pune for the band 700-2746.6 MHz. The occupancy in cellular band found to be quite high. The high spectrum utilization in cellular band shows the demand for the mobile telecom services. In this article, we discuss the future spectrum requirement of mobile telecom services, VHF and UHF assignment along with digital dividend spectrum scenario in India and need for aligning with ITU in global harmonization of spectrum for IMT-Advanced services. Also the views of different stakeholders on 700 MHz band plan and the harmonized Frequency Division Duplex (FDD) and Time Division Duplex (TDD) frequency arrangement for the 698-806 MHz band for IMT systems in APT is discussed. Finally, the benefits of allocation of the digital dividend to mobile telecom services are discussed.



Fig. 1. Measurement set up used in Pune campaign

1. Spectrum occupancy measurement campaign

1.1. Measurement set up

The spectrum occupancy measurement is an important step to determine the current usage of spectrum and motivate spectrum regulatory body accordingly to change the policy for the efficient spectrum utilization. We conducted the spectrum occupancy measurement campaign at roof top of the commercial building on Law college road, Pune (Latitude: $18^{\circ} 50' 34.04''$ North, Longitude: $73^{\circ} 49' 51''$ East). The measurement set up employed in the measurement campaign in Pune consists of a laptop, which is remotely control the Rhode and Schwarz portable spectrum analyzer R&S FSH 3 via optical cable (see Fig. 1). The spectrum analyzer R&S FSH 3 is having a frequency range of 100 KHz to 3 GHz. We used the smaller discone antenna AOR DA 5000 having frequency range of 700-3000 MHz. It is vertically polarized and having Omni-directional characteristics in the horizontal plane. The FSH Remote software is used for automatically setting the equipment for measurement and recording the captured data in Laptop. The MATLAB software package is used to analyze the data. The spectrum analyzer configuration parameters setting are listed in Table 1.

Table 1

Spectrum analyzer configuration parameters

Parameter	Value
Frequency Range	700 to 2746.6 MHz
Frequency Span	60 MHz (34 blocks x 60 MHz)
Frequency (measurement) points	301
Resolution bandwidth	100 KHz
Sweep time	Auto
Measurement duration	2 days and 7 days
Video bandwidth	100 KHz
Detection type	RMS detector
Reference level	-20 dBm
Built-in Preamplifier	Activated (10 MHz–2.5 GHz)
Instrument	R&S FSH 3

Source: Patil, Skouby & Prasad (2012).

The spectrum occupancy measurement campaign is conducted across the frequency range 700 to 2746.6 MHz for two week days. The overall frequency range is divided into 34 bands; each is having a frequency span of 60 MHz. Each frequency span of 60 MHz has 301 frequency points. Thus the total number of frequency points collected in the frequency range is $34 \times 301 = 10234$. The separation between two consecutive frequency points is 200 KHz. The detailed measurement setup and further measurement results were reported in (Patil, Skouby & Prasad, 2012).

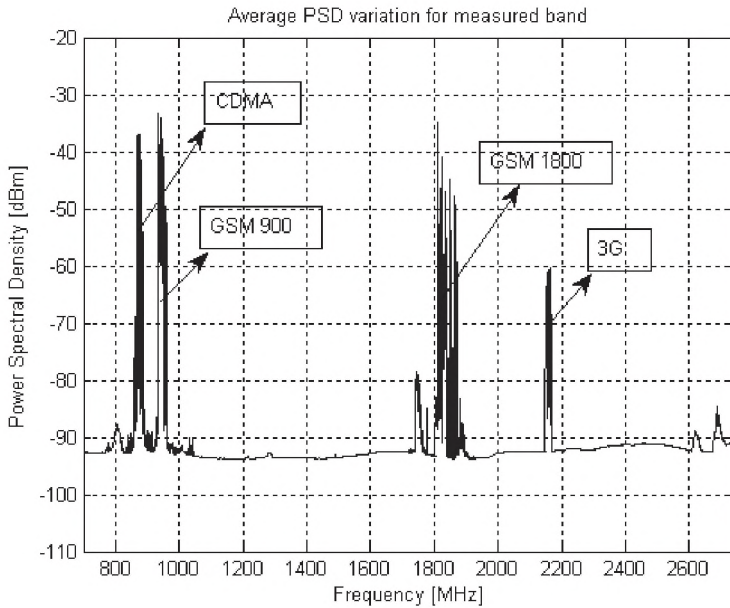


Fig. 2. Average PSD variation over frequency range 700-2746.6 MHz

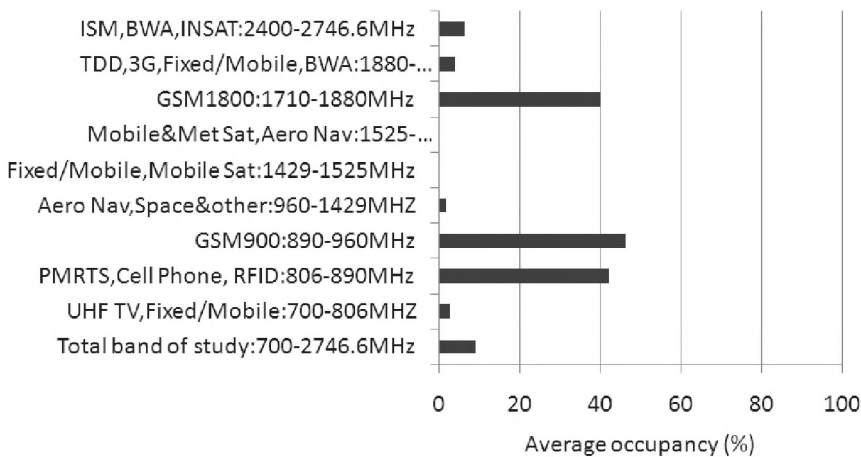


Fig. 3. Band by band occupancy statistics

1.2. Spectrum occupancy results of cellular band

This section particularly focus on the results of the spectrum occupancy of GSM 900 and GSM 1800 band after conclusion of the spectrum occupancy measurement campaign. The average PSD variation for the measured range reveals the higher spectral activity in the cellular communication services (see Fig. 2). The

890-960 MHz band (GSM 900) and 1710-1880 MHz (GSM 1800) has been allocated for the cellular telecom services (NFAP-2011, 2011). These two bands have average occupancy 46.29% and 40.09% respectively which is quite high (see Fig. 3). The occupancy of uplink and downlink sides is not same. The uplink occupancy is found to be 11.16% and 28.36% in GSM 900 and GSM 1800 band respectively. The downlink occupancy is found to be 97.78% and 61.44% in GSM 900 and GSM 1800 band respectively. The spectrum occupancy in cellular band is found to be quite high. The spectrum occupancy is highly depending on the location and the choice of decision threshold. The location is in crowded and commercial area of Pune city. The decision threshold selected in this campaign is 3 dB above the measured thermal noise. Thermal noise is measured by terminating the spectrum analyzer by a 50 ohm resistor. The active primary user signals which are below the decision threshold level may not detect and will not contribute to evaluated spectrum occupancy. Thus the actual spectrum occupancy may be higher than the evaluated one. This shows that the occupancy in the busy part of the Pune is high indicating the demand for the mobile services and the potential need for additional spectrum.

2. Future requirement of the spectrum for mobile services

Past several years, Indian telecom industry has seen exponential growth due to the cellular communication services. According to Telecom Regulatory Authority of India (TRAI) every month more than 18 million mobile subscribers are being added in India (TRAI, 2011). The tremendous growth has put the pressure on the available spectrum which is limited. The current spectrum management policy in India for mobile communication is thoroughly analyzed in (Lewin, Jervis, Davis, & Pearson, 2008). The observations are:

- The spectrum allocated for 2G cellular communication in India is less as compared to other countries. It is in between 2×40 MHz and 2×70 MHz in most cities. Most countries have allocated between 2×90 MHz and 2×110 MHz.
- The total amount of spectrum allocated to 2G cellular services is around 20% less in India than the average of benchmark countries.
- When measured in terms of busy hour traffic per square kilometer per MHz in the dense urban areas, mobile operators in India are generating typically eight times more capacity in their use of spectrum than operators elsewhere in the world.

So there is an urgent need to identify and open up the new frequency bands for the cellular services which can be used for future growth in India. The ITU conducted a highly detailed analysis of spectrum needs as a basis for work on the IMT-

Advanced project. The ITU report, projects a total spectrum requirement of as much as 840 MHz by 2010, 1300 MHz by 2015 and 1720 MHz by the year 2020. Even at a lower market development rate, the projections are 760 MHz by 2010, 1300 MHz by 2015 and 1280 MHz by 2020 (ITU Report, 2006).

Table 2

TV channel allocation in VHF and UHF band

Band	Spectrum	No of TV channels available	TV channel number
VHF band I	47–68 MHz	3	2–4
VHF band III	174–230 MHz	8	5–12
UHF band IV	470–582 MHz	14	21–34
UHF band V	582–806 MHz	28	35–62

Source: (TRAI, 2007)

3. Digital dividend: Solution to the spectrum requirement of mobile services

3.1. VHF and UHF assignment in India for TV

The spectrum available for Terrestrial TV broadcasting along with TV channel distribution in India is given in table 2. Doordarshan, public TV broadcaster of India, has assigned only one channel (channel number 4) out of three channels available in the VHF band for terrestrial TV broadcast. This band is underutilized and completely vacant in future due to switchover from analogue to digital TV transmission which is digital dividend from VHF I band. Doordarshan has assigned all 8 channel of VHF III band for analogue TV transmission. The 470–960 MHz UHF band is allocated for terrestrial broadcasting and mobile services on primary basis in India. Presently, the 470–806 MHz band is available for terrestrial TV broadcasting and 806–960 MHz band is used by fixed and mobile services for transmission of data/voice and video. There are 14 TV channels available in the UHF band-IV (470–582 MHz) with each having channel bandwidth 8 MHz. Doordarshan has assigned and operating about 330 transmitters in this band. Doordarshan's three digital TV transmitters at Kolkata, Chennai and Mumbai are also operating on an experimental basis in this band. Doordarshan has started its mobile TV service in Delhi using DVB-H technology in this band at channel 26 in May 2007. But this pilot mobile TV was stalled by a lack of DVB-H-enabled hand-sets. There are 28 channels available with 8 MHz bandwidth in UHF band-V from 582–806 MHz. Doordarshan has not been assigned any channel in this sub-band for analogue TV transmission. However, frequency 735–755 MHz and 775–795 MHz has been assigned to Doordarshan to operate short distance UHF links. Some of the

Government agencies are operating point to point microwave links in 610-806 MHz.

3.2. DTTV transition plan in India

There is already a move to shift the terrestrial TV transmission from analogue to digital mode across the world. USA switched to digital TV broadcasting from analogue TV transmission for full power stations from June 12, 2009. The United Kingdom has a phased switchover based upon region, with the last analogue signals to be shut down by the end of 2012. The Geneva 2006 agreement sets 17 June 2015 as the date after which countries will no longer be required to protect the analogue services of neighboring countries against interference and be able to freely use frequencies assigned for digital services. This date is generally viewed as an internationally mandated analogue switch-off date; at least along national borders (DigiTAG, 2008). The European Union (EU) has mandated the end of 2012 as the final date for analogue switch off (ASO). There is proposal of phase wise digitization of TV transmission in India by March 31, 2015. In this proposal, the four metros of Delhi, Mumbai, Kolkata and Chennai will be the first to switch from analogue to digital, phase-II that includes 35 cities with population of more than one million will have to make the transition by March 31, 2013. All urban areas are expected to digitize by November 30, 2014 and the remaining areas by March 31, 2015. The key factors which are affecting switchover strategies include the size of the terrestrial platform, the availability of spectrum, digital terrestrial television (DTT) penetration and coverage as well as compliance with international obligations (DigiTAG, 2008). During the transition period, the double transmission i.e. analogue and digital terrestrial transmission will increase the spectrum requirements. In addition to this the double transmission period need to be shortened to release the spectrum. As projected by Doordarshan and TRAI, the additional spectrum requirement to be accommodated in 585–698 MHz band. The complete analogue switch off is expected by March 31, 2015. But the analogue transmission may continue side by side till 2017. The actual cutoff is depending on the auction of the 700 MHz spectrum and its availability.

3.3. Digital dividend

The digital dividend refers to the spectrum which is released in the process of digital TV transition. The EU defines the digital dividend as the spectrum over and above the frequencies required to support existing broadcasting services in a fully digital environment, including current public service obligations (Electronic Communications Commission, 2007). When TV broadcasters switch from analogue platforms to digital only platforms, part of the electromagnetic spectrum that has been used for broadcasting will be freed up because digital TV needs fewer spectrums than analogue TV. The reason is that new digital compression technology can

transmit 6 to 8 digital TV channels by using the same amount of spectrum used to transmit one analogue TV channel. Thus depending on different technological parameters a spectrum efficiency of 6 to 8 times can be achieved when we go from analogue to digital (Henten, A., Tadayoni, R., & Windekilde, I., 2010). The size of the dividend will also depend on the technology being used (EBU, 2008). The size of the dividend will vary from one country to another, owing to national circumstances, such as the geographical position, size and topography, penetration of satellite/cable services, the requirements for regional or minority services, and spectrum usage in adjacent countries. The digital transition radically changes the spectrum situation. Digital dividend has a broader meaning in ICT for development relating to developing economies like India. The effective management of the digital dividend spectrum shall boost the innovation in ICT and can provide cost effective services to the people.

The Europe has digital dividend spectrum in the 800 MHz band and in the VHF band. According European decision the 800 MHz band will be used for mobile broadband on a technology neutral basis. The spectrum will be harmonized at European level and because of its good propagation characteristics will be suited for covering rural areas with mobile broadband. Denmark is also following the European decision regarding the digital dividend spectrum.

In India, the digital dividend will be available in VHF-I band and UHF-band V. The mobile industry is not showing interest in VHF-I band due to technical characteristics of VHF devices, telescopic antenna and characteristic of spectrum. The UHF-band V 582-806 MHz is already shared by Doordarshan for short distance UHF link and military services. So there is no as such digital dividend in UHF band since there is no analogue TV transmission in this band. But the band 698-806 MHz i.e. 700 MHz band will be refarmed by vacating the spectrum by existing user and reallocating for the IMT services. This 700 MHz band is widely termed as digital dividend spectrum in India. This band is identified for the IMT services according to footnote given in the National frequency allocation table of India. (NFAP-11, 2011).

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„The requirement for IMT and Broadband Wireless Access may be considered in the frequency band 698-806 MHz subject to coordination on a case-by-case basis.”

The need of global frequency harmonization of this band in region-3 is discussed in next section.

3.4. The band 698-960 MHz in ITU

Globally harmonization of spectrum produces substantial benefits for businesses, consumers, governments and the mobile industry. Fragmentation of spectrum creates unnecessary costs. Recommendation ITU-R M.1645 concluded that internationally agreed frequency bands will encourage in particular the adoption of

IMT-Advanced systems (ITU, 2003). Common global spectrum should be the preferred objective to ensure global roaming, generic terminal to avail IMT-Advanced services and equipment cost reduction through economies of scale.

Table 3

New Spectrum identified for IMT in WRC 07

Spectrum amount	Frequency band	Region
20 MHz	450–470 MHz	Globally
72 MHz	790–862 MHz	Region 1 (Europe) and Parts of Region 3 (Asia)
108 MHz	698–806 MHz	Region 2 (Americas) and some countries of Region 3 (Asia)
100 MHz	2.3–2.4 GHz	Globally
200 MHz	3.4–3.6 GHz	No global allocations, but identified in 82 countries

Source: (ITU, 2007).

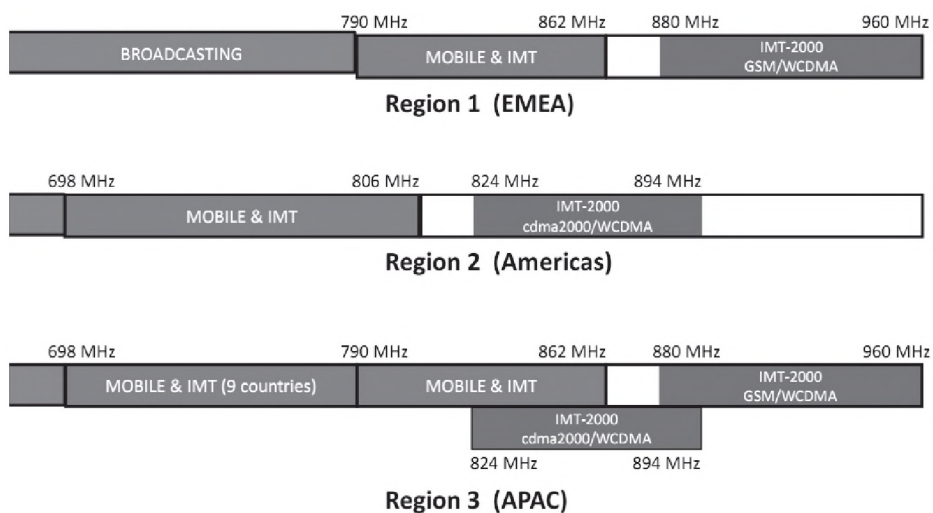


Fig. 4. The band 698–960 in ITU

Source: (Khan, 2009).

World Radiocommunication Conference 2007 (WRC-07) has identified globally harmonized spectrum for the use by IMT-2000 and IMT-Advanced is summarized in table 3. WRC-07 identified parts of the UHF band for IMT attracting significant interest from both the Member States and mobile industry understanding the potential benefit that this frequency band would give to customers and the society as a whole when being used by mobile communications. Presently the 698–806

MHz band has been arranged in the USA, while in the European Conference of Postal and Telecommunications Administrations (CEPT) countries the band 790-862 MHz is being considered for a 2×30 MHz arrangement. Several key region 3 countries – Bangladesh, China, Korea (Republic of), India, Japan, New Zealand, Papua New Guinea, Philippines and Singapore identified the 698-790 MHz band for IMT-Advanced (See Fig. 4).

4. 700 MHz band plan

4.1. 700 MHz band plan for India from the perspective of stakeholders

Wireless planning and coordination (WPC) wing of department of telecom is an authority for coordinating and assigning radio spectrum in India for various wireless users. The proposal has been invited by the WPC wing for 700 MHz band plan from the different stake holders. Most of the stakeholders including GSM Association (GSMA), Telecom Equipment Manufacturers Association (TEMA), Association of Unified Telecom Service Providers of India (AUSPI), Ericsson, Nokia-Siemens network / Nokia and Cellular Operator Association of India (COAI) except WiMAX forum (WF) and Doordarshan proposed 2×50 MHz FDD arrangement for 700 MHz band (GSMA, 2009), (AUSPI, 2009), (TEMA, 2009), (Ericsson, 2009), (Nokia- Siemens, 2009), (Doordarshan, 2009), (COAI, 2009), (WF, 2009) (see Fig 5).

This arrangement has benefits like:

- most spectrum efficient design,
- can implement dual duplexer and reverse duplex arrangement for better co-existence with adjacent radio communication services,
- avoid potential fragmentation of the band for mobile broadband usages, thereby reducing the complexity of the terminals and possible in-band interference issues.

The GSM Association (GSMA) proposes that all countries should consider the use of the UHF band for mobile services, in order to benefit from significant propagation advantages this band provides in providing ubiquitous, affordable, mobile broadband services. Also put forth the regional harmonization in UHF band is required to realize the potential economies of scale, driving down handset and network equipment costs (GSMA, 2009). The proposal from WiMAX Forum (WF) for the 700 MHz band include following (WF, 2009).



Fig. 5. 2×50 MHz FDD arrangement for 700 MHz band plan

- Basic raster should be on a 5 MHz grid to allow 5 MHz and 10 MHz and 20 MHz channels.
- Technology neutrality – The frequency arrangements in the band should not be specific to any one technology.
- Duplex – Both TDD and FDD should be possible
- Service Neutrality – The market should decide what services are provided by operators (data, voice, video etc.).
- Usage neutrality – Fixed, nomadic (Portable) and mobile should be permitted by regulation.
- TV set protection – FDD will probably need reverse duplex i.e. downlink in the lower sub-band. TDD will need a guard band to be determined (could be 5–10 MHz).

Doordarshan proposal suggests the allocation of 698-806 MHz band for many important broadcasting applications (Doordarshan, 2009).

4.2. 700MHz band plan in APT

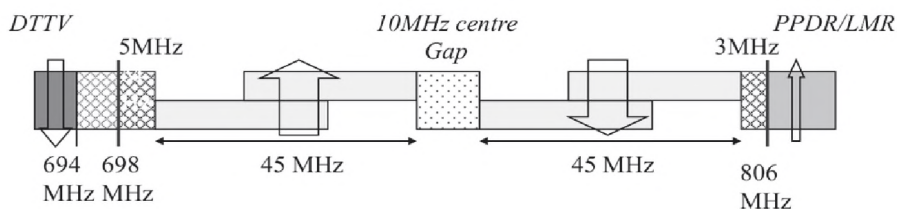


Fig. 6. FDD frequency arrangement for 700 MHz band plan

Source: (APT Report, 2011).

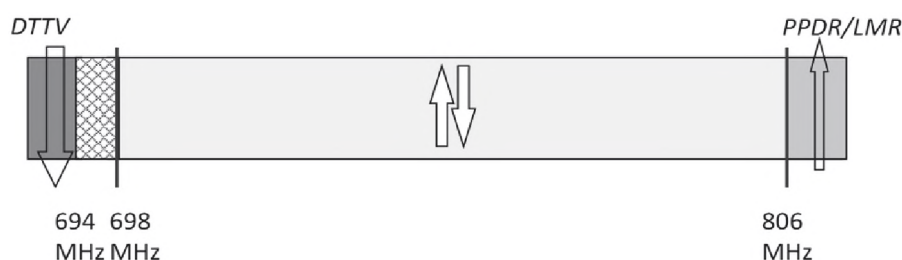


Fig. 7. TDD frequency arrangement for 700 MHz band plan

Source: APT Report, 2011).

The harmonization of 700 MHz band for region 3 is the agenda for the ITU WP 5D meeting. The two harmonized frequency arrangements agreed by APT members for the band 698–806 MHz for IMT services is suggested and it is in the line of the Indian proposal for the 700 MHz plan (see Fig. 6 & 7). One is based on FDD and another on TDD. The 2×45 MHz FDD frequency arrangement with 10 MHz central gap is proposed. This plan has conventional duplex arrangement with uplink frequency band allocated to the lower spectrum block of the FDD pair. The internal guard band of 5 MHz is kept at 698 MHz and 3 MHz at 806 MHz. In additions to this 4 MHz external guard band below 698 MHz is available after deploying 8 MHz TV channel raster in India. Thus the total guard band at 698 MHz frequency border will be 9 MHz which is higher than the minimum requirement of 8 MHz guard band between DTTV broadcast and mobile services as suggested in (CEPT, 2008). The another 700 MHz band plan based on TDD include internal guard band of 5 MHz at 806 MHz. Additional 4 MHz external guard band below 698 MHz is also available because of the 8 MHz TV channel raster in India. The FDD based band plan may be considered more suitable for India's particular domestic situation as mentioned earlier because it maximizes the use of the limited spectrum available in India, delivers large contiguous blocks of spectrum for mobile broadband, avoids the potential fragmentation of the band and possible in band interference issues and it is technically the most efficient design of the band.

4.3. Discussions on 700 MHz Spectrum for Mobile Services

Spectrum utilization found in 2G cellular bands in India from the measurement campaigns is quite high indicating the demand for the mobile services. The high utilization of the 2G spectrum because of first, large number of mobile subscriber and this number is growing in every month by more than 18 million subscribers second; the spectrum available for these services is less as compared to other countries. There is big demand of spectrum for mobile services according to TRAI and ITU in future.

With around 833 million populations living in rural areas of India having only 32% rural teledensity there is a big market for introduction of latest technologies. Introduction of new wireless technologies can bridge the digital divide in developing countries such as India (Rao, S., 2005). Wireless broadband can play a vital role in achieving penetration of broadband in rural region. Thus promoting wireless broadband in rural areas is the key to ensuring the whole population is able to benefit from the wireless broadband services. If just 25%, or around 100 MHz, of the spectrum currently used by analogue TV (470–862 MHz) is re-allocated to mobile communications, the mobile industry could dramatically speed up the rollout of broadband communications and increase coverage. Enormous benefits would ensure around the world, in terms of both social impact and increased productivity (CEPT Report, 2008). Widespread use of mobile broadband technology will not only support a growing industry, but it will increase overall broadband penetration, which shows a strong positive correlation with the country's economic welfare. For example, one study had done across multiple countries shows a correlation in which every 1% increase in broadband penetration corresponds to \$2000 per capita higher Gross Domestic product (GDP) (Tournassoud, 2008). The key problem in developing wireless broadband networks is access to spectrum. In India, the 3G licenses were auctioned in May 2010. However, the auction of the digital dividend and refarming of spectrum in the 900 MHz and 1800 MHz bands has long been delayed, despite the TRAI recommendation. In our view, the Government authority should take its final decisions on spectrum in these bands soon, which will enable wireless broadband to cover rural and remote areas more effectively and thus assisting in reducing the digital divide. Because of excellent signal propagation characteristics of digital dividend spectrum, fewer infrastructures will be required to provide wider mobile coverage, meaning that communications services can be provided in rural areas at lower cost.

Conclusion

Spectrum occupancy measurement campaign provides valuable information about the dynamic spectrum utilization of the wireless services. Thus results of the campaign providing necessary inputs to the regulatory body to take accordingly certain decisions for efficient spectrum utilization such as spectrum refarming and spectrum sharing in certain bands. Our measurement campaign reports that the highest spectrum utilization is found in 2G wireless cellular band. The high utilization of the spectrum in cellular band, growing mobile subscribers and the benefits of the mobile services experienced show the need of additional spectrum for mobile services for the future development. Digital dividend is the excellent opportunity for penetrating the wireless broadband in rural area. Digital dividend is the spec-

trum freed after switchover from the analogue TV transmissions to spectrum efficient digital TV transmission. During switch over, the double transmission i.e. analogue and digital TV transmission period need to be shortened to get immediate benefits of the digital dividend and minimize the period with additional spectrum required during switchover for double transmission. There are different interests in the use of the Digital Dividend; however, most of the stakeholders agree that the digital dividend can be the efficient solution for the spectrum requirement of the IMT-Advanced mobile services. There is a strong need of global frequency harmonization in the IMT-Advanced services via generic terminal layout which will provide substantial socio-economic benefits for society at large. To achieve this in the India, access to the spectrum should be given by auctioning the digital dividend spectrum after refarming as soon as possible. The 700 MHz band plan agreed consensually by APT members includes FDD based frequency arrangement and TDD based frequency arrangement in ITU WP 5D meeting.

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FREQUENCY USAGE AND DIGITAL DIVIDEND IN INDIA

Summary

Spectrum is a precious, non-perishable, natural resource available equally, in all countries. The optimum utilization of the spectrum by appropriate allocation is the foremost task of international and national governing bodies. This paper presents the spectrum utilization results of mobile telecom services particularly, GSM from the spectrum occupancy measurement campaign conducted in Pune, India. We observed the highest occupancy rate in the 2G cellular telecom services band. This shows the demand for mobile telecom services is high in India, and so for the spectrum. The International Telecommunication Union (ITU) has shown a huge demand for the spectrum in its future projection. There is an urgent need of spectrum allocation for the cellular telecom services in India. The results of our measurement campaign endorses the decision of India to identify the 698–806 MHz band (700 MHz band) for the International Mobile Telecommunications (IMT) services which is also in the line of ITU initiative of global harmonization in IMT band. Further, we discuss about the switchover plan from analogue to digital Television (TV) in India, and resulting digital dividend spectrum (700 MHz band) from spectrum refarming, which could be the solution for the spectrum requirement for mobile telecom services in India. The views of the different stakeholders about 700 MHz band plan is presented. Finally, the two harmonized frequency arrangement for IMT systems agreed by the Asia Pacific Telecommunity (APT) for 700 MHz band is discussed.

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