



Telecom Regulatory Authority of India



Consultation Paper

On

Issues related to Digital Terrestrial Broadcasting in India

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Written comments on the consultation paper are invited from the stakeholders by 22nd July 2016.

Counter comments, if any, may be submitted by 5th August 2016.

Comments and counter comments will be posted on TRAI's website www.trai.gov.in.

The comments and counter comments may be sent, preferably in electronic form to, Prof. M. Kasim, Advisor (B&CS)-III, Telecom Regulatory Authority of India, on the e-mail: mkasim@traigov.in or ks.rejimon@nic.in.

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Chapter 1

Introduction

- 1.1 Television has become a powerful medium for the delivery of information and entertainment. The TV service distribution sector in India mainly comprises of Direct to Home (DTH) services, cable TV services delivered through Multi-System Operators (MSOs) & Local Cable Operators (LCOs), Internet Protocol Television (IPTV) services and Headend-in-the-Sky (HITS) services, and terrestrial TV services. OTT TV services have also begun to penetrate the markets.
- 1.2 TV broadcasting in the country commenced in 1959 with the airing of free-to-air terrestrial TV channels by Doordarshan (DD). The introduction of Cable and satellite TV services led to a revolution in the television sector. Direct broadcast satellite services popularly known as DTH commenced in 2003. Internet Protocol Television (IPTV) services began in 2008. The Government in 2009 laid down a regulatory framework for Headend-in-the-sky (HITS) services which enabled the use of satellites for distribution of digital cable TV signal to last mile operators in far flung areas. Digitization of Cable TV services as mandated by the Government commenced in 2012 and is progressing in a phased manner. Three out of the four planned phases of Cable TV digitization have already been completed. The entire country will thus be under the umbrella of digitized cable TV services on completion of the fourth and final phase of digitization slated to be completed by December 2016.
- 1.3 The broadcasting sector contributes to nearly 46% of the total size of Media and Entertainment industry. At this juncture, there are 869 private satellite TV channels permitted by the MIB in addition to 26 TV channels being broadcast by DD. At present, there are about 100 million cable TV subscribers, 58.5 million pay DTH subscribers, and about 18 million consumers using by free-to-air (FTA) DTH. There are 247 million households in India as per the 2011 census. A large number of these

households particularly in rural and remote areas depend completely on the FTA terrestrial broadcasting TV services being provided by the public broadcaster.

1.4 Terrestrial broadcasting is at present an exclusive domain of DD which ranks amongst the world's largest terrestrial television networks. DD has a network of 1412 analog transmitters that provide TV services through two national channels namely, DD National and DD News. In addition to this, the network also broadcast several regional TV channels over the terrestrial network in a time sharing mode to meet the local and regional needs of people in different parts of the country. All TV channels provided by DD are free-to-air.

1.5 In the existing analog terrestrial broadcasting sector, a transmitting station, along with its towers and antennae, broadcast television programme services in its surrounding areas. As the normal terrestrial transmission range is generally limited by Line Of Sight (LOS) characteristics of the deployed frequency, a typical transmitter with a tower height of 150m covers an area with a 70 – 80 Km radius while being located in a geographically flat terrain. Repeater transmitters are required to provide extended geographical coverage. DD has adopted PAL B/G systems for analog terrestrial TV transmission in VHF/UHF bands. A single TV programme service in PAL B/G standard occupies 7 MHz bandwidth in the VHF band or 8 MHz bandwidth in the UHF band. In analog domain one frequency band of 7 or 8 MHz is referred as one "Frequency Channel" which sometimes is also used to refer to one TV programme service as "TV Channel". If additional TV channels are required to be provided in a given geographical area, additional transmitters and more frequency bands are necessitated. Analog terrestrial broadcasting has several limitations and the major ones are as enumerated below:

- Transmission is susceptible to Radio Frequency (RF) interference resulting in poorer reception quality.

- Spectrally inefficient as more spectrum per TV channel is required and frequency reuse is limited.
- Difficulty in reception of signal in portable environment such as moving vehicles and on handheld devices.

1.6 Digital terrestrial transmission system (DTT) for broadcasting TV programme services was first introduced in the UK in 1998 by deploying the first generation DVB-T standard developed by the European Digital Video Broadcasting (DVB) group. Since then, many new standards have evolved and at this juncture implementation of the second generation standards are underway. The DTT broadcasting spectrum has been harmonized with earlier analog spectrum allocation and therefore DTT makes use of similar analog channel allocations. Latest DTT technologies provide a number of advantages over analog terrestrial broadcasting technology and a few are as enumerated below:

- Better quality TV reception - with enhanced picture and sound performance.
- Efficient use of frequency – one DTT transmitter can broadcast multiple TV channels.
- Frequency reuse possible – a single frequency network (SFN) can be implemented to cover a large geographical area.
- Efficient reception of TV channels in portable environment such as on moving vehicles.
- TV channels can also be received on mobile phones and handheld devices.
- The 7 or 8 MHz TV frequency band can accommodate 10-12 Standard Definition (SD) TV channels or it can be employed as a data pipe to deliver different type of services including radio services.
- DTT platform is flexible and content format agnostic - newer formats of TV channels such as HD TV, 3D TV, UHD TV, data and radio services etc. can thus be delivered.
- Reduced transmission power requirements.

- Digitization also allows for government bodies to reclaim spectrum and repurpose it.
- 1.7 With the advent of digital media and alternate digital distribution platforms, customers today expect a better viewing experience and increase number of TV channels even on the terrestrial transmission network. These days most content production takes place in a digital environment and it is consumed on various devices in diverse environment. In order to meet consumer expectations and ensure optimum utilization of resources, digital terrestrial transmission of TV signals is the need of the hour.
 - 1.8 With standardized DTT transmission and clear advantages in terms of effective frequency utilization as well as enhanced TV quality, many countries the world over have laid down clear roadmaps to switch-off analog terrestrial TV transmission with a transition to DTT. In India, though work for changeover from Analog terrestrial transmission to digital terrestrial transmission by DD has already commenced, a clear roadmap is however unavailable.
 - 1.9 At this juncture, due consideration must also be given to the ever increasing demand and rising popularity of mobile TV channels. It is important to note that multimedia traffic contributes to almost 70 to 80% of the total traffic on the internet which shows that there is a demand for consumption of video content on mobile and handheld devices.
 - 1.10 Effective utilization of the spectrum in the VHF and UHF bands is important especially in view of growth of Internet and developments in OTT services which require additional spectrum resources to be made available to International Mobile Telephony (IMT) services.
 - 1.11 In order to clearly spell out a futuristic roadmap for phasing out the existing analog terrestrial transmission and also for the introduction of DTT and mobile TV, there is a need to engage various stakeholders in a

consultation. This consultation paper focuses on the development of an appropriate model for the switchover from analog terrestrial transmission to DTT/ Mobile terrestrial transmission in a time bound manner while formulating a clear road map, spectrum requirements, timeframe for switchover, and implementation methodology.

Objectives of the consultation paper

1.12 In a competitive multi-channel, multi-platform environment, DTT may provide new opportunities to provide TV channels along with a host of other value-added-services. This paper discusses the existing terrestrial TV broadcasting scenario with an objective to critically examine the ongoing digitization efforts in the light of international practices adopted for such digital migration. Following are the broad objectives of the consultation:-

- i). To examine the viability of DTT platform and services in the context of already existing multiple digital TV distribution platforms.
- ii). To develop and suggest a road map for the transition to Digital terrestrial TV transmission/ Mobile TV transmission and also suggest the timelines for switching off the existing analog transmission.
- iii). To formulate a methodology for digitization terrestrial TV networks
- iv). To assess the spectrum utilization for existing and future digital terrestrial broadcasting services.
- v). To examine the feasibility of participation of the private sector in the growth of terrestrial broadcasting ecosystem.
- vi). To put in place a regulatory framework that encourages migration to DTT/ Mobile TV channels while ensuring transparency and a level playing field that facilitates growth in the sector.

1.13 The consultation paper has been divided into four chapters. Chapter 2 examines the existing scenario and also highlights various international developments. Chapter 3 discusses various issues relating to the subject. Chapter 4 summarizes all the issues for consultation.

Chapter 2

Overview of Digital Terrestrial TV Broadcasting

Status of Terrestrial TV Broadcasting Services in India

- 2.1 TV broadcasting in the country commenced in 1959 with airing of free-to-air terrestrial TV channel by DD. The network underwent a major expansion during the Delhi Asian Games held in 1982 when color TV transmission was in the country. At this juncture, Doordarshan, Public Service Broadcaster, is the sole terrestrial broadcaster in India. In many countries across the world, terrestrial broadcasting was opened up to participation by private entities a long time ago and countries like UK, USA, and Japan amongst others had multiple terrestrial broadcasters in the analog era.
- 2.2 In keeping with the emerging developments at that time, TRAI in 2005 had examined whether terrestrial television broadcasting should be opened to participation by private entities. In its recommendations on “Issues relating to Private Television Broadcasting Service” dated 29th August 2005, TRAI had, *inter - alia*, recommended that :

“After considering all these factors as well as the fact that private television channels are already extensively available through cable and satellite, it is considered that there should not be any bar on throwing open terrestrial broadcasting to the private sector. The question as to whether this would make business sense in a market with high cable and satellite penetration is of course a relevant issue. However, it is considered that this option should be really left to the market to decide. In addition there are the possibilities thrown open by convergence as well as community TV. As a policy there does not appear to be any reason to bar the entry of the private sector for terrestrial television broadcasting any more.”

Accordingly it is recommended that:

- i) Terrestrial television broadcasting should be allowed in the private sector also.*
- ii) This should be allowed also for community television.”*

2.3 Meanwhile in a scenario that was moving rapidly towards digitization and convergence, several countries in the world initiated efforts towards digitization of terrestrial TV broadcasting. The first generation DTT standards introduced towards late nineties provided numerous advantages such as good quality reception, delivery of multiple TV channels from single DTT transmitter, portable reception, reception on hand held devices etc. Subsequently, dedicated terrestrial mobile TV standards such as DVB-H, MediaFlo etc. were also developed for the terrestrial broadcasting platform to deliver TV channels to mobile devices. In view of these developments TRAI, in its recommendations on “Issues relating to Mobile Television Services” dated 23rd January, 2008 recommended to the Government that, apart from DD, private players may also be allowed to provide Mobile TV channels in terrestrial mode and that they may also be assigned at least one frequency slot of 8 MHz bandwidth each in UHF band for mobile TV operation in terrestrial mode.

2.4 Further, TRAI recommended that the choice of an appropriate technology be left to the service provider with an overriding condition that the technology deployed be based on standards issued by International Telecommunication Union (ITU), Telecom Engineering Centre of India (TEC) or any other International Standards Organization such that the chosen technology is a proven one and also that the licensee should ensure interoperability of handsets provided. It also recommended that sharing of terrestrial transmission infrastructure of DD as well as those created by the private service providers be permitted on a mutual agreement basis in a non-discriminatory manner. These recommendations are available on TRAI’s website¹.

¹ http://www.traai.gov.in/Content/ReDis/246_13.aspx

- 2.5 The recommendations were considered by the Ministry of Information and Broadcasting which subsequently sought TRAI's views on certain aspects which, *inter alia*, included issues such as spectrum allocation, license area, ownership, one time entry fee, roll out obligations etc. The Ministry had also sought TRAI's views on other related issues such as maintaining a level playing field between mobile TV operators intending to provide mobile TV services through terrestrial mode and telecom service providers. TRAI submitted its views vide a letter dated 14th April, 2010. A final decision in the matter is still awaited.
- 2.6 DD took an early lead on the introduction of DTT services as far back as 2000. Field trials for introduction of DTT services were initiated. First generation DTT transmitters using DVB-T technology were installed in the four metro cities. However, the enabling eco-system for proliferation of DTT services could not be developed in the country and hence the early opportunity for digital migration could not be capitalized upon. DD has now initiated digitization of its terrestrial network by deploying second generation DTT technologies (DVB-T2) with an estimated timeline for its completion by 2017. The plan envisages setting up 630 digital transmitters out of which 23 have already been installed and another 44 are under implementation. The DTT transmitters, installed already, are presently broadcasting experimental TV channels targeting static TV receivers, mobile TV receivers and also providing radio services.
- 2.7 TV broadcast distribution platforms in the country such as DTH, HITS and IPTV are already digital and ongoing digitization of Cable TV service distribution sector is expected to be completed by the end of 2016. However, as on date, a very large portion of the existing terrestrial transmission network in the country continues to remain analog.

International status of DTT broadcasting services

- 2.8 In order to reap the benefits of digitization, countries the world over have undertaken initiatives to accelerate digital terrestrial migration by

formulating national plans towards setting up of DTT infrastructure and switching off analog terrestrial services. Many European countries including the UK, Germany, Netherland, Spain, and France have already completed the transition. Digital switch over has also been completed in US, Canada, Japan and Australia while countries such as Russia, China, Hong Kong, Malaysia, and Singapore, the switchover are witnessing steady progress.

2.9 The digital migration path for each country varies depending upon the national priorities and plans. In some countries it was a stage wise implementation while in a few others a particular date for Analog Switch off (ASO) has been mandated for the complete transition to DTT. In countries like China, a different switch-off date has been specified for each terrestrial TV channel. In many other countries, simulcast services have been planned wherein a broadcast is simultaneously available to viewers in both analog and digital transmission formats over a certain period. As DTT transmission gains popularity, existing analog services are to be gradually shut down. The plans for migration to DTT that have been drawn up keeping in mind associated issues such as infrastructure, spectrum, services and consumer acceptance.

2.10 DTT broadcasting has emerged as one of the popular digital television platforms in countries such as UK, USA, Japan, Germany, France, Australia as it turns out to be one of the most economical broadcast transmission systems. It allows broadcasters to easily provide content to an unlimited number of viewers in a given area. The unique features of the DTT platform also allow viewers to benefit from regional and local content as well as portable and mobile reception. The same platform additionally caters for provision of a number of radio services to the consumers.

2.11 As per a recent research report² studying 138 countries including India, the global digital TV penetration at the end of 2015 stands at 74.6

²“Digital TV World Databook”, Digital TV Research Ltd, Press Release, 12 May 2016

percent with 1170 million digital TV households in the world. There are 261.9 million analog terrestrial TV and 252 million DTT TV households. DTT households comprise of 239.4 million FTA DTT and 12.6 million Pay DTT Households. Between 2010 and 2015, about 584 million digital TV homes were added, out of which 156 million came primarily from DTT. Trends for DTT and analog Terrestrial TV are depicted in Fig. 1. Trends indicate that FTA DTT households have almost tripled since 2010 and Pay DTT also continues to register a positive growth.

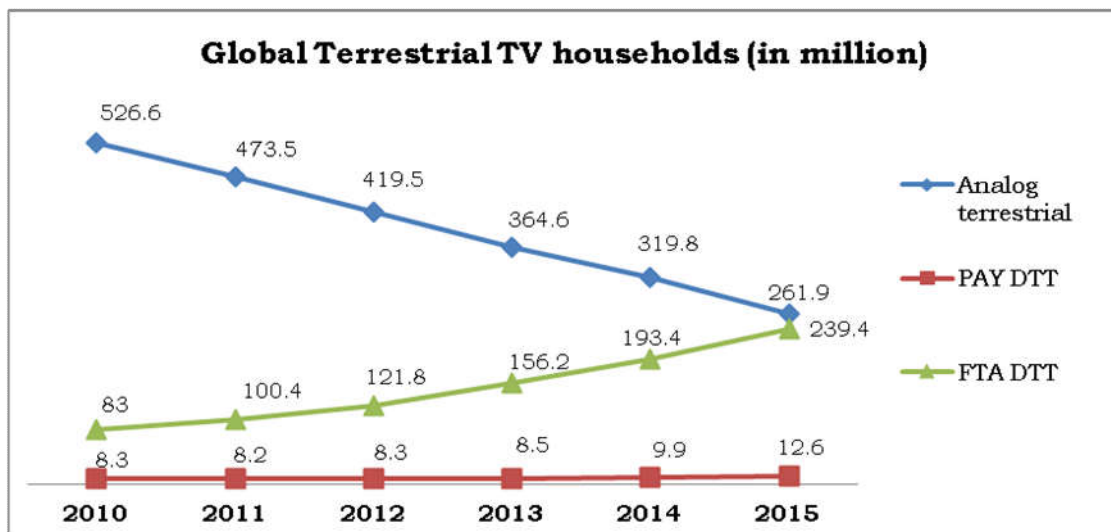


Fig. 1. : Terrestrial TV (Analog and DTT) Global Trends

2.12 The global uptake of DTT services despite the presence of other digital platforms also indicates positive growth trend as shown in Figure 2. At the end of 2015, DTT constituted the second highest user base worldwide among digital TV broadcast platforms next only to that of digital cable TV services.

2.13 In countries where terrestrial broadcasting was opened up to private participation, the process of digitization has also been driven by the presence of multiple terrestrial broadcasters. On date, most developed countries have open terrestrial TV broadcasting policies allowing participation of private sector. DTT services by private and public broadcasters provide an alternate choice to consumers with multiple TV

channels including FTA and pay, in addition to other value added services, in presence of DTH, Cable TV and other platforms.

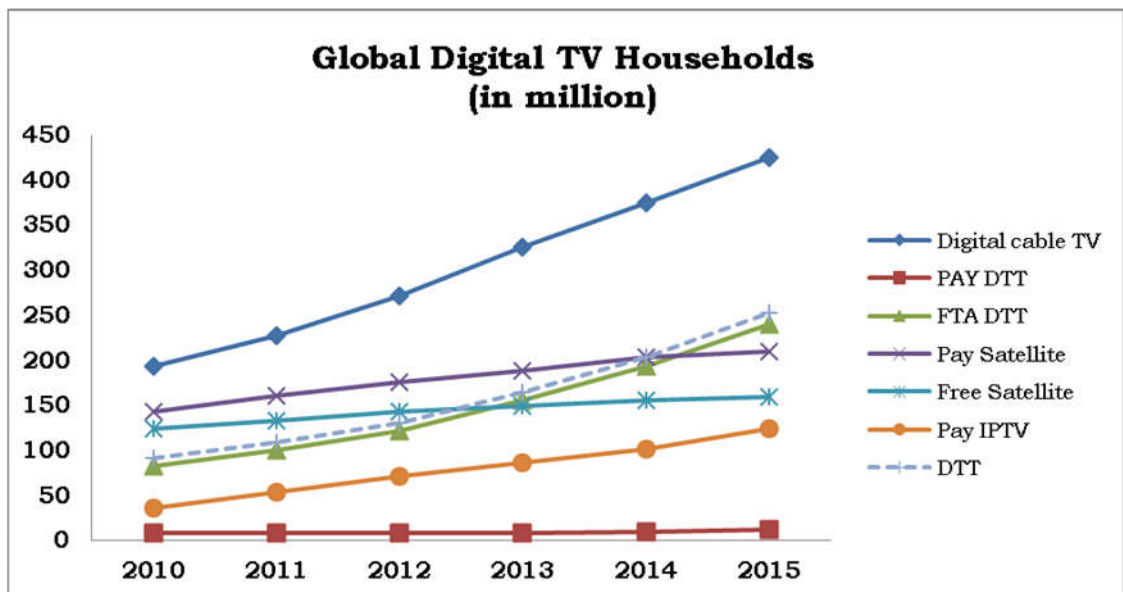


Fig. 2: Global trends for DTT and other digital platforms

Digital Terrestrial Television Broadcasting Standards

2.14 Three TV standards namely PAL, NTSC and SECAM were in predominant usage in the world for analog terrestrial TV broadcasting services. The evolution and adoption of digital terrestrial broadcasting standards have been influenced by the legacy analog TV standards and infrastructure. Most countries have accordingly chosen DTT standards compatible to the existing analog TV standard while a few have gone in for altogether new choices driven by other technological and political considerations. Digital TV standards differ in terms of video & audio formats in addition to the modulation and transmission techniques used for converting the digital TV signal stream into a terrestrial TV broadcast signal. There are four main digital terrestrial broadcasting standards – viz. European standard (DVB-T), Japanese standard (ISDB-T), U.S. standard (ATSC) and the Chinese standard (DTMB). These DTT standards are briefly discussed in the **Annexure – I**.

2.15 Mobile TV and video content can be delivered through a variety of different technologies. There are two main ways of delivering mobile TV and Video content:

- **Mobile Broadcast TV:** delivering one-to-many linear content using broadcast rather than cellular spectrum.
- **Mobile Unicast/ Multicast TV:** delivering one-to-one or one-to-many, linear content over mobile (3G and 4G) data networks.

2.16 Mobile video consumption is growing rapidly due to video content delivered over mobile or Wi-Fi networks via smartphone and tablet applications. Over The Top (OTT) services are also contributing to this growth. Traditional unicast mobile networks require greater capacity in order to handle increasing number of users accessing the same video stream or data download. The LTE Broadcast, also known as multicast or eMBMS (evolved Multimedia Broadcast Multicast Service) utilizes its dedicated spectrum to deliver the same information to multiple users without an additional burden to the network in order to support higher quality video delivery or more simultaneous video streams.

2.17 The latest generation of DTT standards on one hand aim to deliver higher definition TV channels such as HD, 4K, 8K etc. to TV receivers while they also have enabling provisions to customize delivery of TV channels to a variety of handheld devices and reception environment. The focus of latest DTT standards is also shifting towards enabling convergence of broadcast and telecom standards so as to develop hybrid mobile TV DTT platforms which also allows overlaying of LTE broadcast streams over DTT service. In this approach a DTT platform can simultaneously broadcast services to both traditional TV receivers having DTT tuner and LTE enabled mobile phones.

- (a). The DTT technology adoption has been driven by several factors such as existing legacy analog standards, geo-political and economic

considerations etc. In many countries the first generation DTT standards were implemented and now they are migrating to second generation standards whereas in case of India it is almost green field for migration from analog terrestrial to the latest generation of DTT standards. TRAI in its earlier recommendations related to terrestrial broadcasting sector had followed a technology neutral approach while leaving the choice of Technology to the stakeholders to select any mature and well established standard.

Chapter 3

Issues Related to Digitization of Terrestrial Broadcasting

Background

- 3.1 Analog terrestrial TV broadcasting is being phased out world over. Many countries in the world have switched off analog terrestrial transmission and many more are in the process to implement their digitization plans. In digital domain, TV broadcasting is moving in two distinct areas. Firstly, where the resolution of broadcast signal is increasing from HD to 4K and 8K to provide new viewing experience to the viewers using large TV / projection screens with multiple channels of surround sound. This kind of signals have high data rates and require high transmission bandwidth which can only be met by traditional broadcast channels such as satellite, terrestrial and cable. The other area is the increasing universe of handheld devices such as mobile phones, where required resolution is often much lower. Here TV channels can be provided either through broadcast channels or through telecom networks. Terrestrial broadcast method can provide multiple TV Channel to unlimited users in the coverage area without impacting the quality. In case of mobile TV channels through telecom networks, network congestion is an issue and quality of service may get affected if several users are using the service simultaneously. Unlike the broadcast method, the telecom network cannot provide mobile TV channels to unlimited number of users in a given coverage area. Therefore terrestrial broadcasting is relevant not only for traditional broadcast delivery but also for mobile and handheld devices.
- 3.2 The DTT standards has been designed in a manner to maximize utilization of existing infrastructure, however digitization of terrestrial broadcasting is cost intensive and requires creation of new infrastructure. Digitization of terrestrial broadcasting has become a

necessity to meet demand for good quality multiple services and to avoid continuance of the obsolete analog infrastructure as it will soon become unviable to sustain analog broadcasting operations.

- 3.3 India having a huge terrestrial network the process of digital migration becomes more complex as it may require huge resources and time to completely digitize the network. In the following sections some of the critical issues related to migration of analog to digital terrestrial broadcasting are discussed to seek the comments of stakeholders.

DTT services in presence of multiple delivery platforms

- 3.4 Today multiple delivery platforms such as DTH, Cable, IPTV, HITS etc. are available for distribution of broadcasting services. Consumers have choice for access to TV channels from different platforms. Prasar Bharati also operates free to air DTH platform which at present broadcast 59 TV channels and 24 radio services. It is planned to be upgraded to carry more number of services in near future. Thus, a large number of TV channels are available to the people through various delivery platforms providing them a greater choice of subscription.
- 3.5 The terrestrial services are free to air so that the consumers do not pay any recurring subscription. It is therefore assumed that DTT services may also follow the same approach. However, pay DTT services are also likely to be introduced depending up on its commercial viability. For receiving DTT services, the consumer will have to either buy set top box (STB) or a TV receiver with inbuilt set top box and an antenna, which is going to be an important factor in acceptability and penetration of DTT services. It may be argued that there has to be a strong value proposition to the consumer for availing DTT services in the presence of multiple delivery platforms which provide large number and variety of TV channels. In this scenario, it may be a challenge to make the DTT services popular and acceptable to the viewers.

- 3.6 DD has a network of 1412 analog TV transmitters across the country. These are planned to be replaced by 630 DTT transmitters in order to provide similar coverage. Out of these, 400 are Low Power Transmitters (LPTs) and 230 are High Power Transmitters (HPTs). It has been estimated by Prasar Bharati that in order to install 300-400 DTT transmitters in densely populated areas, the requirement of funds would approximately rupees 3000 crores³. The cost of complete digitization of the network using one transmitter in 630 locations each would be much higher. The expenditure if funded by the Government, may have to be justified keeping in view the social and other benefits likely to accrue from digitization.
- 3.7 It is observed from international experience that DTT services are becoming popular even in presence of other platforms and no country in the world has discontinued with terrestrial TV broadcasting. This indicates the importance of terrestrial TV channels in presence of other platforms. DTT offers some unique advantages over cable and satellite broadcast services. Cable TV services cannot be provided in portable environment whereas in satellite, the services get severely affected during heavy rains and inclement weather conditions.
- 3.8 One of the factors favoring DTT service is that it can provide localized coverage directing broadcasts to a specific area and population. The content of DTT services can be easily customized to the needs and preferences of local population. India being a multi linguistic and culturally diverse country, DTT may provide variety of localized content to the consumers of their choice. This can bring new business opportunists as well as may create scope for socially relevant TV channels such as education, health, etc.
- 3.9 One DTT transmitter can provide 10-12 TV channels in Standard Definition (SD) format which may not offer significant value proposition to the consumers. This transmitter can also provide services such as

³ “ Prasar Bharti at Cross Roads” , Yojana, July 2013

mobile TV, radio channels, etc. However, in that case the number of TV channels provided will get reduced according to the capacity consumed by other services. The consumers are used to receiving multiple TV channels. In such situation, optimum bouquet of DTT services may be required for which more number of transmitters and other associated infrastructure would be required to be installed as a multiplex at a particular location. Such a multiplex may comprise of more than one transmitter installed in a particular location each operating at different frequencies. A multiplex is created to increase the number of channels and to provide an optimal composition of different types of services such as TV channels, Mobile TV, Radio channels, etc. If a multiplex of, say 4 DTT transmitters, at each location is to be considered, the estimated funds requirement will be to the tune of several thousand crores. It may be argued that in presence of multiple platforms, this kind of investment may be attracted only when there are enough business opportunities.

- 3.10 The other major advantage in favour of DTT services is that it can also be provided on mobile phones or portable hand held devices. There are devices with inbuilt DTT receivers and other devices can also receive DTT through USB dongle. Keeping in view the mobile penetration in the country, the DTT services may offer a market to the content providers that can be a source of additional revenue stream. One DTT transmitter can provide 10-12 mobile TV channels which may be significant attraction to consumers as good quality services irrespective of any number of users can be made available to them.
- 3.11 It is however a concern that though DTT has provisions to provide mobile TV services, these will be limited to linear scheduled delivery. Consumers would also need mobile phones with DTT tuner chip set or external plug in dongles to receive mobile TV through DTT. The former requires development of new kind of handsets ecosystem which is primarily driven by requirements of telecom industry. The presence of multiple DTT technologies may fragment the device ecosystem creating challenges for integration of these technologies into wide range of devices.

- 3.12 DTT platform can benefit from the fact that it can be used to broadcast large number of radio services which may be very useful as FM spectrum can provide a limited number of radio channels in a city. For example, as of now, in Delhi, there are about 12 FM channels and spectrum is not available to introduce more radio channels. Through one DTT transmitter about 40 to 50 radio channels can be made available to the consumers. It may therefore be possible to provide variety of FM services including regional services in a city through DTT platform, thus offering value proposition to the consumers.
- 3.13 Another strength of DTT platform may be that it creates a transmission network which is flexible, modular and future ready with regard to the evolving television content formats and services such as SD, HD, 4K etc. The DTT platform can easily accommodate TV services in new formats without requiring any major changes in the existing infrastructure.
- 3.2.1 Though Mobile TV services can be provided through telecom networks, however as the Mobile handsets are coming with higher resolution display capabilities and full HD is becoming a normal feature on smart phones, the capacity of such networks is limited to simultaneously cater to a larger number of users with good quality of services. It may therefore be difficult to provide live broadcast content attracting larger viewership through telecom networks unless telecom infrastructure becomes so robust to support bandwidth hungry applications. DTT platforms offer a better alternative to such mobile broadcast services with efficient utilization of spectrum resources.
- 3.14 The viewing habits of consumers are changing in the evolving converged environment. They want to watch TV anytime, anywhere and on different devices. At the same time, they also want to pull content as per their preferences so that they can watch it whenever they like. The consumer demand trends for on-demand, mobile and Higher Definition TV content

impose challenges for TV distribution networks of the future⁴. Provision for feedback and user control of scheduling of programmes, appear to be desirable features especially in mobile and portable situations. Traditional DTT infrastructure is designed for one-to-many architecture with limited interactivity; however Hybrid approaches are being developed to make DTT as complementary delivery platform to telecom network. In mobile situations, telecoms can use DTT broadcast distribution instead of cellular delivery as it can offer larger coverage, higher Quality of Service (QoS) while catering to a large number of users consuming same content in real time. Such converged broadcast and broadband platforms may be an impetus for DTT for providing better user experience and efficient utilization of resources.

3.15 The latest DTT standard (DVB-T2) has extension provision that can be used for developing hybrid mobile broadcast platform where both traditional TV receivers and mobile phones can be targeted to receive broadcast services from a common DTT transmission facility. For example, Long Term Evolution(LTE)-A+ video signal stream can be embedded within a standard DVB-T2 broadcast signal thereby combining standard cellular network with a DTT network. The advantage of this approach is that both the streams can be delivered independently to DVB-T2 receivers or LTE-A+ receiver simultaneously and that the LTE-A+ enabled receiver do not require DVB-T2 tuner to receive the services broadcast over DTT. Thus LTE enabled mobile phones can also receive the hybrid DTT services⁵. The next generation American standard for DTT i.e. ATSC 3.0 which is to be finalized soon is also expected to consider these features. Since video usage over telecom networks is increasing, hybrid mobile broadcast approach, particularly in case of live events which attract larger viewership, may be useful for delivery of video services without constraining the telecom resources.

⁴ Towards a unified 5G Broadcast- Broadband Architecture, Paulo Marques, et.al., "Fundamentals of 5G Mobile Networks", John Wiley & Sons Ltd, 2015

⁵ D. Rother, S. Ilse and F. Juretzek, "A Software Defined Radio based implementation of the "Tower Overlay over LTE-A+" system," 2014 IEEE International Symposium on Broadband Multimedia Systems and Broadcasting, Beijing, 2014, pp. 1-6.

- 3.16 Digitization of terrestrial TV network may have to be considered keeping in view various factors as discussed above. One may argue that terrestrial TV transmission for delivering traditional TV channels may not be relevant today as other existing multiple platforms are adequate to serve the broadcasting needs of the people. Since analog terrestrial TV broadcasts primarily cater to the needs of people in rural, far flung and remote areas, it may also be argued that DTT implementation may be restricted to such areas where a mix of TV and radio services through a single small power DTT transmitter may be made available to the people. This may however require that DTT STBs are made available to them at affordable costs. The introduction of such service in presence of DD FTA DTH may also be challenge.
- 3.17 The other approach may be to consider implementing DTT for commercial objectives such as for providing Mobile TV and other value added service to handheld devices such as mobile phones, laptops, Tablets etc., which other broadcast platforms are unable to address. In this case the ingenuity of fully exploiting the strengths of DTT platform may get restrained. The sector may also require to be opened to private participation for bringing in variety of content, services and improved operational efficiencies.
- 3.18 As discussed above DTT offers several potential benefits for introducing new services and efficient utilization of scarce spectrum resource not only by accommodating more data rates within the same 7/8 MHz channel bandwidth, but also by offering opportunities for developing hybrid mobile platforms. In such scenario DTT may offer new business opportunities and therefore implementation of DTT in major cities and urban areas may be viable option. Comments of the stakeholders are therefore sought on the following issue.

Issue for consultation:

Q.1 Do you perceive the need for introduction of Digital terrestrial transmission in presence of multiple broadcasting distribution platforms? Please provide your comments with justification.

Q.2 If yes, what should be the appropriate strategy for DTT implementation across the country? Please provide your comments with justification.

Private Participation in Terrestrial TV Broadcastings

3.19 Indian broadcasting sector has seen phenomenal growth ever since private sector was allowed to participate in DTH and FM services. The cable sector in the country has been excessively driven by private operators. Entry of private operators in the FM sector has rejuvenated the scene of radio listening in the country, taking FM services in far flung areas. This success story has therefore been primarily dependent on the private players who offer wider choices to the consumers in a competitive environment. DTT migration world over has also been influenced by private sector as there were private terrestrial TV broadcasters already operating in the analog domain .

3.20 As discussed earlier, the issue relating to private participation in the terrestrial television broadcasting was also examined by the Authority in 2005 vide its recommendation on “Issues Relating to Private Terrestrial TV Broadcast Service” dated 29th August 2005. After considering the issue in detail, the Authority was of the view that there should not be any bar on throwing open terrestrial broadcasting to the private sector. Accordingly, it was, *inter-alia*, recommended that terrestrial television broadcasting in India should be allowed in the private sector also. The Authority also laid down broad contours in respect of conditions for commercial terrestrial TV service⁶.

⁶ <http://www.trai.gov.in/WriteReadData/Recommendation/Documents/recom29aug05.pdf>.

3.21 Efforts to digitize terrestrial networks were initiated in India in the year 2000. DTT transmitters using DVB-T technology were installed in each of the four metro cities. This expansion could not continue as enabling ecosystem could not be developed. Introduction of DTT services requires concerted effort on the part of various stakeholders to make available DTT STBs, TV receivers, infrastructure and appealing services to drive migration process. It is expected that the entry of private players in DTT sector may help developing necessary ecosystem

3.22 There are various advantages/reasons in favour of allowing private sector participation in terrestrial TV broadcasting. These are briefly discussed below: -

- (i)* Since large investment is required for migration to digital, sole dependence on government funded approach may not be feasible. Allowing the private sector in terrestrial TV broadcasting would result in inflow of private capital in the sector and growth of terrestrial services. Private sector may develop DTT as competitive and viable optional alternative platform to consumers.
- (ii)* Presently, terrestrial broadcasting is under the exclusive domain of DD and there is no competitive platform in terrestrial TV services. By allowing the private sector in terrestrial TV broadcasting innovation in services will get encouraged. As of now there is little content differentiation between platforms. Private sector may develop new business models for commercial utilization of DTT services. Content differentiation between terrestrial and other platform may improve as private sector may bring in new services.
- (iii)* Even today a large number of free to air Satellite Channels are available to the viewers. However, to avail these channels a person has to pay monthly subscription fee to DPOs. Therefore, even though a broadcaster may be offering a channel as free to air, the viewer can get it only after payment of certain recurring fee. In case

of terrestrial broadcasting, the viewers may get such Free to Air channels without having to pay any subscription fee in case of FTA DTT services.

- (iv) Currently, the Satellite TV Channels have programmes directed at the national/regional audience. It is expected that private terrestrial television broadcasting will lead to enhanced coverage of local issues, events, music and culture.
- (v) The public service broadcasting may get strengthened as private service operators will provides new socially relevant programming such as education, health, etc. Private terrestrial television broadcasters may complement the services of DD by generating more content.

Issue for consultation:

Q.3 Should digital terrestrial television broadcasting be opened for participation by the private players? Please provide your comments with justification.

Models for DTT implementation

3.23 In Indian context, based on the legacy terrestrial network and the evolving scenario, there can be different models for implementing DTT services. In most of the countries, terrestrial television services are FTA which are being provided both by public service broadcaster and private operators. Pay DTT services are also available in some countries. In India, terrestrial television channels provided by DD are free-to-air. In case of DTT, new business models may also evolve depending up on its commercial viability. Some of the possible models for implementing DTT infrastructure are discussed below:-

(i) Integrated DTT Broadcasting Model:

In this model, it is envisaged that both infrastructure and services are provided by an entity that will plan, set up and operate the DTT network and services in an area. Theoretically, the entity can either be a new private body (consortium) or PB itself. However, it may not be feasible for a new entity to set up parallel terrestrial networks as it involves creation of infrastructure like buildings and towers for setting up new DTT transmitters which is capital intensive and time consuming process. PB has already huge infrastructure such as land, building, networks, etc, for its terrestrial transmission. It has also initiated setting up of DTT transmitters. It is therefore a better placed entity for setting up Integrated DTT Broadcasting network. This scenario thus assumes that PB continues be the sole terrestrial broadcaster and it will be responsible for setting up and operating DTT platform in the country. This model will have following pros and cons:

Pros

- Public service broadcasting can be strengthened in the country.
- Dissemination of social, educational programmes to masses through various services such as mobile TV can be increased.
- Reach of services from public broadcaster will enhance immensely.
- No new regulatory framework required for implementation of DTT

Cons

- Arranging of huge funds for digitization process.
- No clear cut road map is available for DTT services
- Manpower for operation and maintenance of the digital infrastructure.
- In absence of commercial motive, the DTT platform may not become popular and viable
- Acceptance of DTT services by the consumers may be a challenge
- Early analog switch off may be difficult to achieve
- For new content creation huge resources may be required

- Monopoly of PB in terrestrial TV broadcasting will continue.
- Due to lack of competition, no scope for bringing in efficiency and innovation in terrestrial TV broadcasting
- Development of conducive eco system for DTT may be a challenge.

In the approach, PB may also become a content aggregator for sharing transmitter capacity with private service providers to give variety of contents while platform remains with PB. This approach is however likely to have following challenges:-

- Mismatch between infrastructure needs of service providers and platform capabilities
- Management of services in case of pay services
- Ensuring quality of service as per the requirement of service providers
- Innovation in DTT platform and services may get affected.

(ii) Transmission Network Model :

There will be huge requirement of digital terrestrial transmission network considering the vast size of the country. One way to address this issue may be to separate the terrestrial network infrastructure and services being provided. This means that in terrestrial domain, there may be DTT network operator(s) and DTT service providers. DTT network may be set up and operated by a separate transmission entity authorized to do digital terrestrial transmission. The entity may be a government body or consortium formed by several stakeholders. Keeping view the huge size of the country, there could be single or multiple entities for DTT transmission network on regional /state basis. In this case all DTT infrastructures will be planned and implemented by the entity and the service providers may seek required capacity on the network for providing their services. This model will have following pros and cons:-

Pros

- Less dependence on government funding in case of PPP model.
- Existing infrastructure will be optimally utilized
- Investment into the sector may get encouraged.
- Private participation will bring technological excellence and operational efficiency.
- Introduction of wide variety of services making DDT more competitive.
- Development of new business model such as subscription based services, value added services, etc.
- Speeding up of digitization process
- Competition in terrestrial TV broadcasting sector
- Opportunity for integration of telecom and terrestrial networks, hybrid services

Cons

- Technology choice may need to be harmonized for inter operability of services.
- Quality of service provided will depend on network infrastructure though its maintenance is expected from service providers.
- Greater level of coordination is required for planning services and infrastructure
- It needs to be ensured that Public service broadcasting channels are carried on the DTT networks

(iii) Common Transmission Infrastructure (CTI) Model

This model is similar to the model followed for introduction of private FM services. The existing infrastructure like tower, building etc. will be shared with the private operators. The private operator interested in launching DTT services may have to seek license to start terrestrial broadcasting services (TV channel/mobile TV/Radio, etc) and install their infrastructure (Transmitter and other associated accessories) at the existing facilities of PB. This model will have following pros and cons:-

Pros

- Easy to implement since basic framework is already available for FM services
- This will reduce the cost of setting up of infrastructure for private operators by avoiding investment in common infrastructure like tower, building, etc.

Cons

- The existing infrastructure is already overloaded due to sharing with private FM and in house expansion of DD. There may not be enough capacity available for accommodating the needs of private operators.
- Demand for infrastructure sharing may be huge in major cities, which may require creation of new CTI infrastructure affecting the digitization process
- Coordination issues for sharing of infrastructure.
- Introduction of DTT in rural areas may be a challenge.

Issue for consultation:

Q.4 Which model or a combination thereof for Digital terrestrial transmission will be most suitable in Indian context? Please furnish your comments with justification.

Spectrum for DTT services

3.24 As per the National Frequency Allocation Plan (NFAP)-2011, VHF Band I (47-68 MHz), VHF Band III (174-230 MHz), UHF Band IV (470-585 MHz)⁷ and UHF Band V (585-698)⁸ spectrum is available for TV “Fixed, Mobile and Broadcasting” in India. As per foot note IND 36, “Requirements of fixed and mobile services will also be considered in the frequency band 470-520 MHz and 520-585 MHz on case-by-case basis”. Further, as per foot note IND 37, “The requirement of Digital Broadcasting

⁷ Additional alloc.: in India, the band 549.75-550.25 MHz is also allocated to the space operation service (space-to-Earth) on a secondary basis.

⁸ Additional allocation: in India, the band 608-614 MHz is also allocated to the radio astronomy service on a primary basis.

Services including Mobile TV may be considered in the frequency band 582-698 MHz subject to coordination on case to case basis”.

3.25 As mentioned earlier, since terrestrial TV broadcasting space in the country was completely under the domain of PB. There has not been any examination of optimal utilization of spectrum for existing terrestrial TV services and future expansion. In other countries presence of private players exists along with the public service broadcasters. These private operators, along with public broadcaster, have developed terrestrial TV platform as alternate delivery platform in presence of Cable and satellite (DTH). Thus, broadcast spectrum has been utilized effectively and there is a demand for additional spectrum for various other terrestrial services such as mobile TV, HD TV, 4K, etc.

3.26 In case of India, the sole terrestrial broadcaster provides two national TV channels over terrestrial networks. The broadcast spectrum is therefore remains partly utilized⁹. It may be argued that since all broadcast channels (spectrum bands) are not utilized, more terrestrial spectrum may not be required for broadcasting services. The spectrum is a scarce resource and therefore it may be better to utilize it for other services. On the other hand, it may be argued that due to lack of timely policy intervention, restricting terrestrials broadcasting to public broadcaster only, lack of content, services and business models the terrestrial sector could not grow like in other countries. Hence, any opinion on under utilization of spectrum allocated for broadcasting sector may not be justified. Therefore the actual demand of terrestrial service and actual spectrum requirement cannot be readily ascertained. A detailed examination of issues such as need of expansion of DTT, entry of multiple operators, DTT implementation architecture, DTT models and services, roadmap for digitization etc. may be conducted before reaching to any conclusion.

⁹ G. Naik, S. Singhal, A. Kumar and A. Karandikar, "Quantitative assessment of TV white space in India," *Communications (NCC), 2014 Twentieth National Conference on*, Kanpur, 2014, pp. 1-6.

3.27 In DTT network, both Multi Frequency Network (MFN) and Single Frequency Network (SFN) architecture can be implemented. MFN is the simplest method of setting up of DTT transmitters in a similar way as was done in case of analog terrestrial network. In case of MFN, a single frequency channel is used at one location which cannot be repeated for operation of any other transmitter in adjacent neighboring areas. This means that more frequency channels are required to cover a larger area. In case of SFN, a single frequency band of 7 or 8 MHz can be used to set up a large network, say on regional basis. Implementation of SFN is however complicated and requires synchronizing all the transmitters working in the SFN.

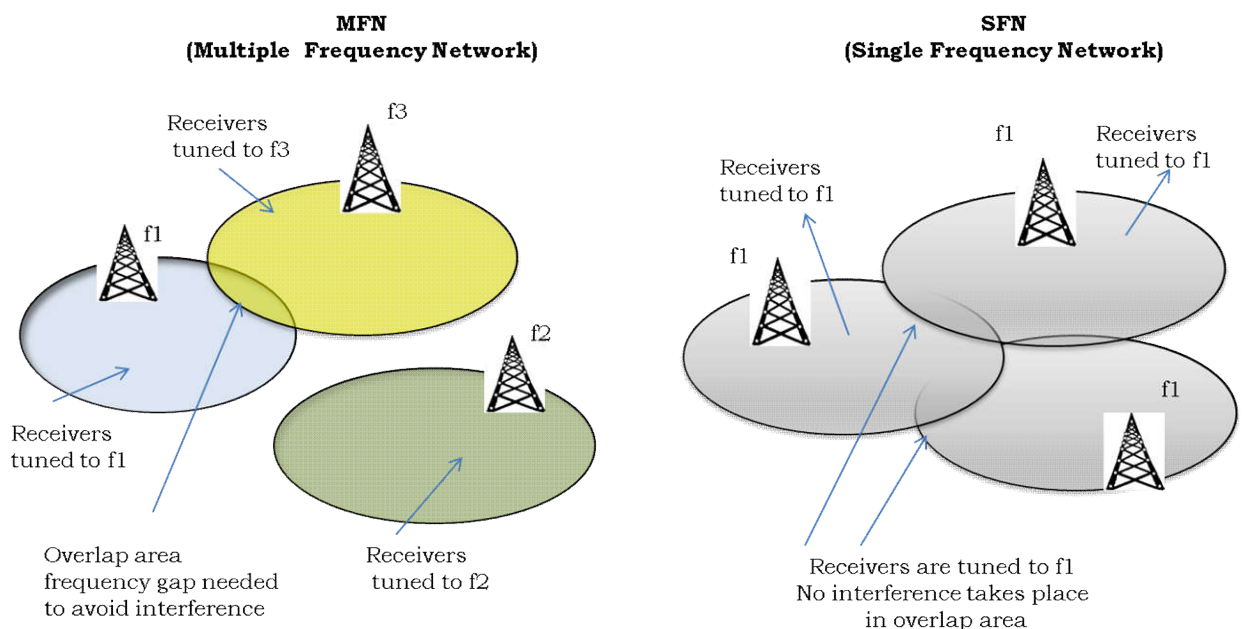


Fig. 3: MFN and SFN Architecture

It also puts restriction of broadcasting the same content from all transmitters working in the SFN. Thus, localized broadcasting may be difficult to implement in this case. The spectrum requirement for expansion of DTT network may be lesser if SFN approach is followed. It is therefore important to examine the use of MFN and SFN for digitization. Further, number of transmitters is required to be installed at one location in a multiplex to provide bouquets of multiple TV channels and other services. It is therefore equally important to

identify optimum size of a multiplex at any location and number of such multiplexes per DTT operator at any location to have broader assessment of spectrum requirement. DD is learnt to have planned for setting up DTT transmitters in MFN mode.

3.28 The requirement of terrestrial broadcasting spectrum may also be increased during the transitional phase of migration from analog to digital. During initial period both analog and DTT services may have to be provided in simulcast as all analog viewers in an area cannot switch to digital immediately. This means that use of broadcasting spectrum for existing analog services and new DTT services may be required simultaneously for some time, thus increasing the overall requirement of spectrum during transition phase.

3.29 Some service providers, particularly telecom operators, are of the view that large chunk of the spectrum in UHF Band IV and UHF Band V remains unutilized though they are useful for IMT applications. They are of the view that spectrum being a scarce resource should be used in an efficient manner and earmarking of spectrum for expansion of terrestrial broadcasting in future tantamount to indirect loss. It is important to observe that in countries where terrestrial TV broadcast spectrum was heavily utilized in analog domain, introduction of DTT has rendered some of the existing terrestrial spectrum surplus for other services. It is observed that requirement for spectrum for wireless broadband services in sub 700 MHz band is increasing due to better signal propagation characteristics. In USA, the broadcast spectrum in sub 600 MHz band is being reorganized nationally to free up more spectrum for new wireless services through broadcast incentive auction¹⁰.

3.30 DD had initiated trials for introduction of DTT services in 2000, and implementation of DTT transmitters using first generation DVB-T technology were installed in four metro cities. However necessary enabling eco-system could not be developed in the country for

¹⁰ <https://www.fcc.gov/about-fcc/fcc-initiatives/incentive-auctions>

proliferation of DTT services and the opportunity to lead digital migration could not be realized. In view of the recent developments around the world, DD has once again embarked on digitization of its terrestrial network by deploying second generation of DTT technologies (DVB-T2) with an initial timeline for completion of the process by 2017. The plan is to set up 630 digital transmitters out of which 23 have already been installed and another 44 are under implementation. DD is also plans to provide mobile TV channels and more choice of services to consumers by setting up DTT multiplexes consisting of 5 transmitters. This will require additional spectrum in Band V (582-698 MHz). In case terrestrial sector is open to private players, there may be further requirement of spectrum.

- 3.31 A DTT transmitter can be configured to provide different kind of services such as TV, Radio service, Mobile TV, data etc. either independently or combined. One DTT transmitter operating on 8MHz can provide 10-12 TV channels in Standard Definition (SD) format or 3-4 HD channels or 8-12 mobile TV channels or many radio channels. Therefore multiplex of more transmitters providing different services may be useful to be attractive service package to the consumers. An optimum bouquet of services may therefore be required to be provided to the consumers at any location.

Issue for consultation:

- Q.5 What should be the approach for implementing DTT network (MFN/SFN/Hybrid)? Please furnish your comments with justification.**
- Q.6 What should be the criteria for arriving at optimum size of DTT multiplex at any location? Please furnish your comments with justification.**
- Q.7 How many digital multiplex per DTT operator should be planned for metro, major cities, urban and rural areas and why? Please furnish your comments with justification.**
- Q.8 What should be most appropriate frequency band as per National Frequency Allocation Plan 2011 for implementation of Digital**

terrestrial transmission including mobile TV? Give your comments with justification.

Q.9 Should spectrum be exclusively earmarked for roll out of DTT services? If so, what should be the quantum considering the broadcasting sector requirement in totality?

Roadmap for Digitization of Terrestrial TV Broadcasting

3.32 It is important to have a well laid down roadmap and timeframe for complete digitization of the existing terrestrial network. A firm analog switch off date may also be required to be mandated to ensure that the stakeholders are able to plan and create necessary eco system for introduction of DTT services. The ITU GE-06 agreement sets the date of 17 June 2015 as the end of analog TV transition period in UHF band in Europe, Middle East, Africa and Iran. Most countries in Asia Pacific and Latin America have plans to complete the transition by 2020. In India, PB has also planned to complete the digitization process by 2017 and implement switch off by 2020.

3.33 Erstwhile Planning Commission's Sub Group on "Going Digital" in its report issued in 2006 *inter-alia*, laid down the migration path for migration from analog transmission to digital domain for terrestrial networks. The committee had suggested that a phased approach may be adopted for going digital. It had recommended following roadmap for commencement of digital terrestrial broadcast in selected cities.

i. Step I	-	Delhi	-	2010
ii. Step II	-	All mega cities	-	2011
iii. Step III	-	All Tier II & Tier III cities	-	2012
iv. Step IV	-	All other areas	-	2013

3.34 However, as on date, the status of digitization of terrestrial TV broadcasting in the country is that around only 40 DTT transmitters

have been installed so far. Analog transmission in these places is still continuing as services to be broadcast over DTT platform are yet to be finalized. Also, the availability of DTT STBs is an issue. In absence of appropriate services and STBs, these DTT transmitters have not contributed towards the digitization process. Further, going by the progress made so far, it is likely to take several years to merely to replace existing analog transmitters. In view of this, the country is not likely to achieve analog switch off target of 2020. There is therefore an immediate need to review the current digitization efforts and to lay down a roadmap for digitalization of terrestrial TV networks and to decide sunset date for analog terrestrial TV services.

- 3.35 Different approaches have been adopted world over for digitization of analog terrestrial TV broadcasting depending upon the size and coverage provided by the analog terrestrial network. While the simulcast approach has been preferred by most countries, it may also be possible to switch off analog services immediately with the launch of DTT. This may however require necessary eco system for DTT such as TV receiver, STBs and services etc to be put in place by the stakeholders well in advance so that consumers are not put to any inconvenience. The cost of simulcast approach is higher as it involves operating both analog and digital services requiring more spectrum usage.
- 3.36 In Indian context digitization may also be implemented in a phased manner on the basis of several criteria such as regions, major cities covering large population, existing terrestrial channels etc. It has to be planned in detail with well laid down road map for switching off analog transmitters throughout the country. The switch off dates may be mandated for each phase. A phased approach may provide some benefits such as learning and evolving strategies from the experience, spreading required costs and resources thus making huge digitization more manageable. It allows observing how the DTT market develops before finally deciding how and when to end analog services. Some countries have begun the process in large urban areas with high population

densities with few transmitters while others especially those with high reliance on the terrestrial television platform have opted to begin the process in areas with low population densities. By doing so, the process can be trialed several times and experience built up can be then successfully replicated on cities with large population. In a phased approach to analog switch-off, technology choices made at the time of the first phase will determine the technology status for the entire switchover process.

3.37 In case digitization happens and analog switch off does not take place, the spectrum will not become available even after digitization. The earlier proposed roadmap by the Go digital Sub Group did not specify the analog switch off date(s) for the areas where DTT transmission was planned and introduced. Though DTT implementation has been initiated in the country, but detailed analog switch off plans for the areas where DTT services have been introduced or planned are yet to be formulated. This is resulting in to two major issues which are adversely affecting the process of digitization. Firstly, both analog and DTT services are continuing in one location occupying spectrum for both analog and DTT transmission with no well defined sunset date. This may result in wastage of scarce spectrum resource. Secondly, as the analog services are still continuing, the consumers do not have any compulsion to switch to DTT services.

3.38 It is pertinent to mention that Cable TV digitization in the country was similarly a huge exercise as the analog cable TV networks spread all across the country. This exercise was planned in phases and for each phase analog switch off date was mandated. This clear roadmap has helped the stakeholders to plan and create required eco system for smooth digitization of cable TV sector. The process of cable TV digitization was started in 2012 and is scheduled to be completed by December 2016, which is the mandated sun set date for the analog switch off. This huge exercise is therefore expected to complete within a period of four years. A similar approach may be required to ensure that

digitization of terrestrial TV sector takes place in a time bound manner. It is therefore essential that a roadmap for DTT implementation formulated on any criteria may also mandate analog switch off date (s).

Issue for consultation:

Q.10 What should be the roadmap for digitization of terrestrial TV network in the country? Please provide your comments with justification.

Q.11 What should be the analog switch off date(s) for the terrestrial TV channels in context with the suggested roadmap for DTT implementation? Please provide your comments with justification.

Any other issue:

Q.12 Stakeholders may also provide their comments on any other issue relevant to the present consultation paper?

Chapter 4

Summary of issues for consultation

- Q.1 Do you perceive the need for introduction of Digital terrestrial transmission in multiple broadcasting distribution platforms? Please provide your comments with justification.**
- Q.2 If yes, what should be the appropriate strategy for DTT implementation across the country? Please provide your comments with justification.**
- Q.3 Should digital terrestrial television broadcasting be opened for participation by the private players? Please provide your comments with justification.**
- Q.4 Which model or a combination thereof for Digital terrestrial transmission will be most suitable in Indian context? Please furnish your comments with justification.**
- Q.5 What should be the approach for implementing DTT network (MFN/SFN/Hybrid)? Please furnish your comments with justification**
- Q.6 What should be the criteria for arriving at optimum size of DTT multiplex at any location? Please furnish your comments with justification.**
- Q.7 How many digital multiplex per DTT operator should be planned for metro, major cities, urban and rural areas and why? Please furnish your comments with justification.**
- Q.8 What should be most appropriate frequency band as per National Frequency Allocation Plan 2011 for implementation of Digital terrestrial transmission including mobile TV? Give your comments with justification.**

- Q.9 Should spectrum be exclusively earmarked for roll out of DTT services? If so, what should be the quantum considering the broadcasting sector requirement in totality?**
- Q.10 What should be the roadmap for digitization of terrestrial TV network in the country? Please provide your comments with justification.**
- Q.11 What should be the Analog Switch off date(s) for the terrestrial TV channels in context with the suggested roadmap for DTT implementation? Please provide your comments with justification.**
- Q.12 Stakeholders may also provide their comments on any other issue relevant to the present consultation paper?**

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List of Acronyms

Abbreviation	Description
ADBT-T	Advanced Digital Television Broadcasting - Terrestrial
ASO	Analog Switch Off
ATSC	Advanced Television System Committee
DD	Doordarshan
DMB-T	Digital Multimedia/TV Broadcasting- Terrestrial
DPOs	Distribution Platform Operators
DTH	Direct to Home
DTMB	Digital Terrestrial Multimedia Broadcasting
DTT	Digital Terrestrial Transmission
DVB	Digital Video Broadcasting
eMBMS	Evolved Multimedia Broadcast Multicast Service
ETSI	<i>European Telecommunications Standards Institute</i>
FTA	Free-to-air
HD	High Definition
HITS	Headend-in -the-Sky
HPTs	High Power Transmitters
IMT	International Mobile Telephony
IPTV	Internet Protocol Television
ISDB-T	Integrated Service Digital Broadcasting Terrestrial
ITU	International Telecommunication Union
LCOS	Local Cable Operators
LOS	Line of Sight
LPTs	Low Power Transmitters
LTE	Long Term Evolution
MFN	Multi Frequency Network
MIB	Ministry of Information and Broadcasting
MSOs	Multi-System Operators
NFAP	National Frequency Allocation Plan
NTSC	National Television System Committee

OTT	Over the top
PAL	Phase Alternating Line
PB	Prasar Bharati
PLPs	Physical Layer Pipes
PPP model	Public Private Partnership Model
SD	Standard Definition
SECAM	Sequential Couleur Avec Memoire (Sequential Color Memory)
SFN	Single Frequency Network
STB	Set top box
TEC	Telecom Engineering Centre
TRAI	Telecom Regulatory Authority of India
UHD	Ultra High Definition
UHF	Ultra high frequency
VHF	Very high frequency

Digital Terrestrial Television Broadcasting Standards

1. **Digital Video Broadcasting (DVB-T) standards:** These standards were developed by the Digital Video Broadcasting (DVB) Group formed by the European broadcast industry. It replaced the PAL and SECAM analog standards which were earlier used in Europe and some other countries. The first generation digital video broadcasting standard for terrestrial transmission (DVB-T) was developed in the 1990s. DVB-T was an open standard wherein several television channels are bundled to form a programme multiplex which is then fed to a DVB-T transmitter working on a unique frequency band as used in analog broadcasting including 7 and 8 MHz bandwidth. The total data capacity of DVB-T allows broadcasting of a multiplexed signal that may contain 4 to 6 standard definition TV television channels. The capacity can also be utilized to broadcast 1 or 2 multiplexed TV channels in HDTV quality. Introduction of HDTV services over DTT proved to be a major attraction for making DVB-T services popular which then resulted in increased demand for such services.

2. Though DVB-T was not specifically designed to cater for mobile and handheld reception, a DVB-T transmission can be configured to make it robust, thereby making it an apt choice for mobile TV. The DVB group in 2004 also developed a specific transmission standard for mobile TV known as DVB-H, Digital Video Broadcasting for Handheld devices. It was specifically oriented towards taking into account the challenges such as difficult receiving conditions, limited power availability, smaller resolution etc. to provide mobile TV services on smaller hand held devices. The standard was designed in such a manner that it was compatible with DVB-T and a DVB-T transmitter could broadcast both static and mobile TV channels if need be. DVB, in 2011 also came up with the DVB-SH standard for Digital Video Broadcasting Satellite

services to handheld devices (SH) below 3 GHz. The DVB-H and DVB-SH systems did not gain much popularity as they necessitated the setting up of new infrastructure, integration of DVB-H chipset in mobile receivers and required new business models to make it commercially viable.

- 3. *Second Generation DVB-T2 Standard:*** An ever increasing demand for capacity to provide more HD quality services triggered the development of the next generation of a digital terrestrial system standard called second generation DVB-T2. The DVB-T2 specification was published by ETSI in September 2009. This standard uses the latest compression technologies in order to achieve higher data rates, thereby providing even greater capacity. It is the world's most widely adopted and deployed digital terrestrial television (DTT) system standard that offers even greater robustness and flexibility with 50% higher efficiency than any other DTT system. It also supports SD, HD, UHD, mobile TV, radio, or a combination of any of these thereof. One excellent feature of DVB-T2 is that it allows for a separate adjustment of the robustness of each delivered service within a common frequency channel of 7/8 MHz in order to meet the required reception conditions (for example in-door or roof-top antenna) by dividing it into Physical Layer Pipes (PLPs). It also allows receivers to save power by decoding only a single service rather than the entire multiplex of services thereby making it suitable for reception on smaller handheld devices. In 2011, DVB added another extension known as T2-Lite to the DVB-T2 profile in order to support mobile and portable TV and further reduce the cost of implementation¹¹. Elements relevant to mobile and portable reception have been included in the T2-Lite subset and the data rate is restricted to 4 Mbps per PLP while the implementation (chipset) complexity has been reduced by half. So far, over 70 countries have already deployed DVB-T services and 69 countries have adopted or deployed DVB-T2. DD has adopted this standard for its DTT implementation.

¹¹ <http://www.dvb.org>

4. ***Integrated Service Digital Broadcasting Terrestrial (ISDB-T):*** The ISDB-T system was developed in Japan to provide flexibility, expandability, and commonality for multimedia broadcasting services using terrestrial networks. ISDB-T system adopted band segmented transmission wherein the standard Channel bandwidth is divided into 14 segments. The segments can then be combined and configured to offer different kind of services targeting different devices while catering for differing receiving conditions. The Japanese digital terrestrial broadcasting system was standardized in 2001. ISDB-T services are already operational in Japan since 2003. In 2007, an enhancement to ISDB-T was developed and standardized, called ISDB-T international which uses the latest compression standards and has also been adopted by ITU. The standard has now been adopted by 18 countries and services already deployed in nine countries¹².

5. ***Advanced Television System Committee (ATSC):*** American ATSC is a digital extension of the analog NTSC standard. This broadcasting system for digital television transmission was developed in the early 1990s aiming at transmission of HDTV and SDTV formats. It is significantly different from DVB-T and ISDB-T standards which have some similar features. International adopters of the ATSC standard include Canada, Dominican Republic, El Salvador, Guatemala, Honduras, Mexico, and South Korea. Currently ATSC 1.0 digital TV standard is implemented and the next generation standard referred as ATSC 3.0 is close to being finalized¹³.

6. ***Digital Terrestrial Multimedia Broadcasting (DTMB):*** It is a Chinese standard for terrestrial digital television broadcasting. Ratified in 2006 it became the mandatory Chinese national standard in 2007. DTMB is a combination of a single carrier system known as the Advanced Digital Television Broadcasting-Terrestrial (ADBT-T) and the multicarrier modulation system known as the Digital Multimedia/TV Broadcasting-

¹² <http://www.dibeg.org>

¹³ <http://www.atsc.org>

Terrestrial (DMB-T). The DTMB standard simultaneously provides terrestrial TV channels and portable services including multimedia services and displays similarities with both DVB-T and ATSC. The next generation of DTTB system with higher data rates and better performance to support both existing services and UHDTV is on the horizon.

Adoption of the various DTT standards worldwide is depicted in Figure 4 below.

- 7. *Mobile Terrestrial TV Broadcasting Standards:*** Mobile TV is the transmission of TV programmes or video for the devices such as cellular phones, PDAs, and wireless multimedia devices. Several standards were developed for reception of broadcasting services on mobile devices. These included DVB-H, DMB, MediaFLO, ISDB-OneSeg, and ATSC-M/H. Among them, commercial service of Terrestrial DMB (T-DMB) was launched in Korea for the first time to provide mobile multimedia services in 2005. These technologies were broadly of two types one based on the legacy DTT technology such as ISDB-OneSeg and ATSC-M/H, and the other such as DVB-H and MediaFlo were new dedicated broadcast technologies specifically developed for receiving broadcast TV on mobile phones and hand held devices. DVB-H and MediaFLO were launched commercially in several countries. But the challenges mobile broadcast TV faced have exceeded the benefits. There was no global standard for mobile broadcast TV; instead regions adopted different broadcast technologies, which in turn required different mobile handset specifications which made mobile device makers less inclined to develop compatible handsets. This is also limited the addressable audience for each technology, making it harder to offer products at scale. T-DMB and OneSeg broadcast mobile services however remain popular in South Korea and Japan.

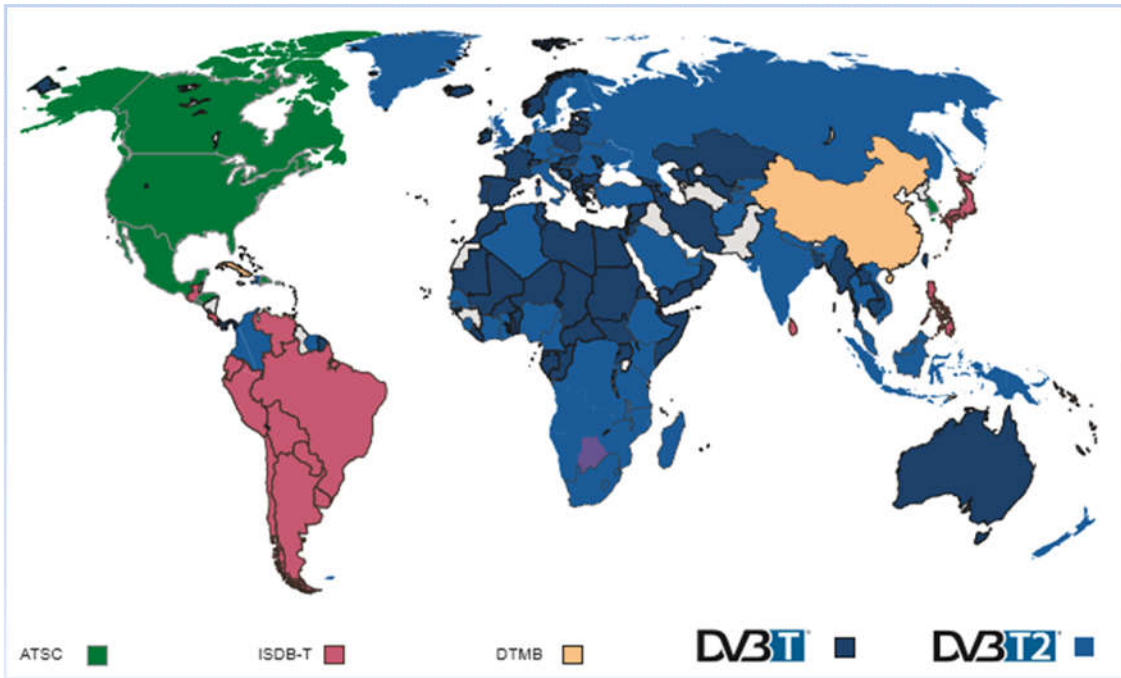


Fig. 4: Adoption of DTT Standards