RF SPECTRUM ALLOCATION PROCESS IN INDIA

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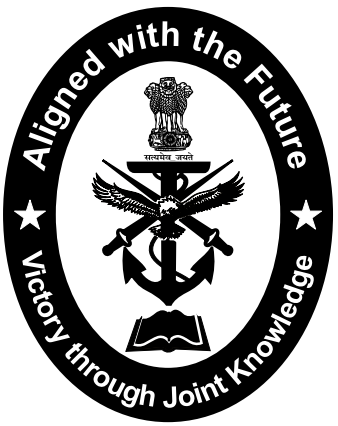
By

Brigadier (Dr) Navjot Singh Bedi



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"India may be one of the world's biggest telecom success stories, but when it comes to quality of service, its mobile-telephony sector portrays a picture which is on the path to maturing. Despite billions of dollars of investments over the past decade, the world's fastest-growing telecom market is still grappling with inadequate infrastructure at certain rural locations . Added to this are the Tariff Wars amongst the Telcos, which have adversely affected their financials.

Introduction

1. Radio frequency spectrum is a limited natural resource. The word 'Spectrum' basically refers to a collection of various types of Electro Magnetic radiations of different wavelengths. In India, allocation of spectrum to various services has been given in NFAP which covers frequency range from 9 KHz to 3000 GHz and are being used for different types of services like fixed communication, mobile communication, broadcasting, radio navigation, radiolocation, fixed and mobile satellite service, aeronautical satellite service, radio navigational satellite service etc. Some of the important and typical characteristics of the radio frequency spectrum are as given below:-

(a) Radio frequency spectrum does not respect international geographical boundaries as it is spread over a large terrestrial area.

(b) Use of radio frequency spectrum is susceptible to overlapping interference and requires the application of complex engineering tools to ensure interference free operation of various wireless networks.

(c) Unlike other natural resources, radio frequency spectrum is not consumed upon its usage. It gets wasted whenever it is not used optimally and efficiently. Radio frequency spectrum usage is therefore to be shared amongst the various radio services and must be used efficiently, optimally and economically in conformity with the provisions of national and international laws.

(d) The limitation of the radio frequency spectrum is mainly due to the following factors:-

(i) Propagation characteristics of different types of radio waves.

(ii) Availability of technology and equipment for different types of radio frequency spectrum applications.

(iii) The suitability of frequency bands for specific applications.

Spectrum Management at International And Regional Level

2. All nations share the electromagnetic spectrum and reserve their right to its unlimited use. However, for international telecommunications cooperation to support trade, transportation, communications, and mutual protection against interference, they have agreed to an International Telecommunications Convention. This serves as the basic instrument of the International Telecommunications Union (ITU) and its supporting bodies. The United Nations recognizes the ITU as the specialized agency in the telecommunications field. The ITU maintains cooperation to improve all telecommunications. The ITU allocates the international radio frequency (RF) spectrum, registers frequency assignments, and coordinates resolving interference. Upon ratification by member nations, **ITU regulations have treaty status**. Each ITU member nation imposes regulatory measures within its administration. These measures must

comply with the current Radio Regulations (RR) unless expressly excluded by either footnotes or by special arrangements.

The ITU Organization

3. The Plenipotentiary Conference is the supreme agency of the ITU. It formulates general policies, establishes budgetary guidelines, elects members, and concludes agreements between the ITU and other international communications organizations. The ITU has three organizations: the World Radio Conference (**WRC**), the International Frequency Registration Board (**IFRB**), and the International Radio Consultative Committee (**CCIR**).

4. WARC may deal with all of the radio communications services, or it may deal with specific radio communications services such as space, maritime, or aeronautical. Each WARC updates the Radio Regulations(**RRs**) which allocate radio spectrum use on a worldwide basis except where regional requirements differ and are agreed. The Figure 1 shows the three recognized regions.

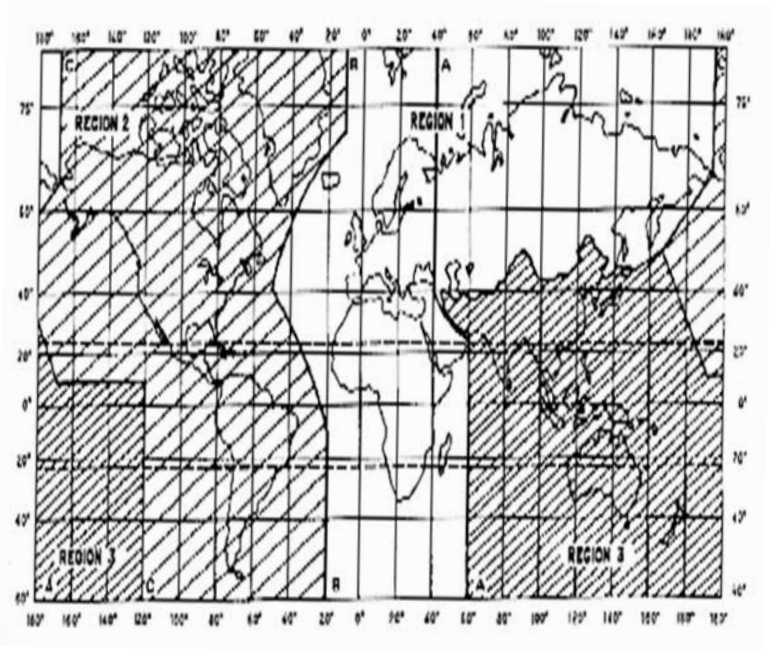

Figure 1 : The Three Recognized Regions as per ITU

In addition, the tropical area centred on the equator has additional provisions to offset it's higher electrical noise. The IFRB records ITU member nation frequency assignments. It advises the WRCs and member nations on technical matters on harmful interference and radio spectrum use. The IFRB serves as the office of record of frequency assignments in priority and adjudicates interference conflicts among member nations. The CCIR provides technical criteria on frequency sharing and examines technical and operational questions about international radio use. It also addresses technically related questions pertinent to ITU member nations and forthcoming WRCs. The findings of the CCIR serve a significant influence on the state-of-the-art and as a basis for RRs. However, these findings are recommendations rather than having an obligatory treaty status.

Spectrum Management at Regional Level: Asia Pacific Telecommunity

5. The APT is an organisation of Governments, telecom service providers, manufactures of communication equipment, research & development organisations and other stake holders active in the field of communication and information technology and it serves as the focal organisation for communication and information technology in the Asia Pacific region. The APT now has 34 Members, 4 Associate Members and 111 Affiliate Members. Throughout the years, APT has been able to help the members in their preparation for global conferences such as the World Telecommunication Development Conference (WTDC), WRC, World Summit on the Information Technology (WSIS), and the ITU meetings as well as promoting regional harmonization for these events. The APT Conference Preparatory Group for WRC (APG) is an important activity of APT. APG was started in 1996 with the objective of harmonizing views and developing common proposals from the Asia-Pacific region for the World Radio Conference (WRC). The main objective of APG is to take regional preparation to harmonize the views of the members and to develop common proposals for submission to the ITU World Radio Conference (WRC).

Spectrum Management at National Level

6. The Wireless Planning & Coordination (WPC) Wing of the Ministry of Communications, created in 1952, is the National Radio Regulatory Authority responsible for Frequency Spectrum Management, including licensing and caters for the needs of all wireless users (Government and Private) in the country. It exercises the statutory functions of the Central Government and issues licenses to establish, maintain and operate wireless stations. WPC is divided into major sections like Licensing and Regulation (LR), New Technology Group (NTG) and Standing Advisory Committee on Radio Frequency Allocation (SACFA). SACFA makes the recommendations on major frequency allocation issues, formulation of the frequency allocation plan, making recommendations on the various issues related to International Telecom Union (ITU), to sort out problems referred to the committee by various wireless users, Site clearance of all wireless installations in the country etc. The Figure 2 above shows the EM spectrum with radio portion highlighted and listing all the uses of radio spectrum that are managed by services. Exceptions to these allocations may be footnotes for specific countries or reservations made by that country at the WRCs.

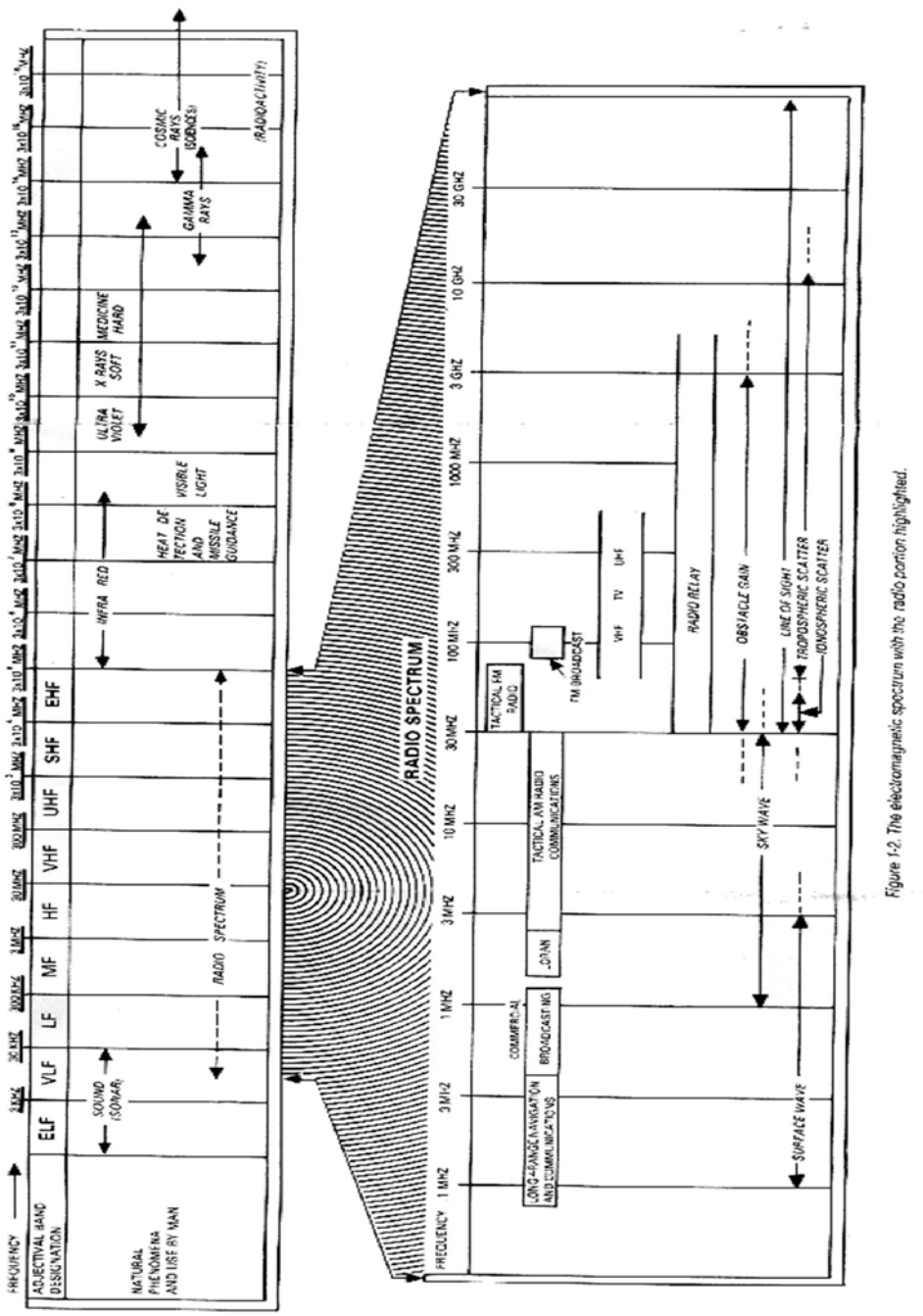

Figure 1-2. The electromagnetic spectrum with the radio portion highlighted.

Figure 2 : The Uses Of Radio Spectrum
That Are Managed By Services

7. TRAI (Telecommunication Regulatory Authority of India) was set up by an act of the Parliament, in 1997. The Telecommunication Regulatory Authority of India acts as an independent regulator of the business of telecommunications in the country. The mission of TRAI (Telecommunication Regulatory Authority of India) is to create and nurture such conditions that encourage the growth of the telecommunications sector in India so that the country can play an important role in the world telecommunications society. The main objective of TRAI is to form a transparent and fair policy environment that encourages fair competition. The Authority recommends the timing and need for the introduction of a service provider that is new, ensures successful inter- connection and technical compatibility between various service providers, and suggests the conditions and terms on which license would be provided to a service provider

National Frequency Allocation Plan

8. The National Frequency Allocation Plan (NFAP) forms the basis for development and manufacturing of wireless equipment and spectrum utilization in the country. It contains the service options in various frequency bands for India and also provides the channeling plan in different bands. Some of the typical frequency bands allocated for certain types of radio services in India are as given below:-

Sr. No	Radio Service	Frequency Band
(a)	Radio Navigation	9 – 14 kHz
(b)	Mobile (Distress & Calling)	495 – 505 kHz
(c)	Broadcasting	526.5 – 1606.5 kHz
(d)	Maritime Mobile	2065 – 2107 kHz 2170–2178.5 kHz 2190.5 – 2194 kHz
(e)	Fixed, Mobile, Broadcasting Radio Astronomy	610 – 806 MHz
(f)	Mobile, Fixed, Broadcasting	890 960 MHz
(g)	Mobile satellite	942 – 960 MHz

(h)	Radio Location	1350 – 1400 MHz
(i)	Mobile, Fixed, Space operation, space research	1710 – 1930 MHz

Table 1: Frequency Bands Allocated For Certain Types Of Radio Services In India

Spectrum And Mobile Telephone Services

9. Mobile telephone service providers in India use GSM and CDMA technologies. GSM technology works in the frequency bands of 900 and 1800 MHz and CDMA technology works in the 800 MHz band. 800, 900 and 1800 MHz bands were earlier allotted to the defence services for their mobile communication usage. However, upon the launch of mobile communication services for public, coordination was sought from the Ministry of Defence **(MoD)** to make the spectrum available for mobile services. Since the mobile communication technologies provide international roaming facilities, it is essential to allocate spectrum in the common bands which are being used the world over. Also, the mobile handsets being used are imported hence conform to the GSM 900/1800 bands. If radio frequencies are allotted in other bands then handsets will not be compatible with it and new handsets will have to be developed which will be costlier and therefore the cost of mobile communication services will also increase.

10. Initially, as per global norms, **35 MHz** spectrum in 900 MHz band (880 – 915 / 925 – 960 MHz) and **75 MHz** in the 1800 MHz band (1710 – 1785 / 1805 – 1880 MHz) was earmarked for Cellular (GSM) services. However, in India 900 MHz band and 1800 MHz band were being used by defense for their operational use. Hence in India, only 25 MHz was opened up in the 900 MHz band and in that portion also , government agencies were using 4-5 MHz of the said band (for eg for Railways' train safety systems.) The minimum amount of spectrum required for launching GSM services is 2 x 4.4 MHz for TDMA having a carrier of 200KHz. 1.8 MHz was add on spectrum to meet

additional requirement of spectrum by TSPs (without paying any additional amount). This brought the total requirement of spectrum for each operator to 6.2 MHz (4.4+ 1.8) for launching Cellular (GSM) services with TDMA. So effectively only three (03) telecom operators could be adjusted in this band with 6.2 MHz each being assigned to each of them. Later on in 2001, when the requirement for introducing a fourth telecom operator was felt, at that time DoT again approached Defence for spectrum in the 1800 MHz band. Ministry of Defence then decided to vacate some spectrum in the 1800 MHz band to accommodate the fourth fourth telecom operator.This spectrum was however vacated in small parts by Defence and auctioned to the 4th operator by DoT ,as and when the spectrum was available. The value of the spectrum varied for each telecom circle but the overall average value of the spectrum at that time was Rs 1658 Crores for 6.2 MHz or Rs 267 Crores per MHz.

11. A CDMA carrier requires 1.23 MHz (30 KHz X 41 = 1.23 MHz). Also a gap of 300 KHz or 600KHz is required to cater for if two carriers or four carriers are together respectively. For wide bandwidth normally four carriers are taken together. For CDMA services, 20 MHz spectrum in the 800 MHz band (824 – 844 / 869 – 889 MHz) was available. In this 20 + 20 MHz spectrum, 14 CDMA carriers of nominal 1.23 MHz each (or of 1.25 MHz each, considering the gap bandwidth) are possible for assignment to service providers. Spectrum for the roll out of 3G services (voice, data and video) was to be allotted through e- auction in the 2.1 GHz (1920 – 1980 / 2110 – 2170 MHz) band. However, the spectrum required for the launch of 3G services was at that time yet to be vacated by the Defence Services. Defence Ministry had agreed to a spectrum vacation timetable. Ministry of Defence (MoD) then signed a memorandum of understanding (**MoU)** with Ministry of Communication & IT (**MoC&IT**), agreeing to vacate spectrum needed for 2G and 3G licensees over a three-year period. The defence forces agreed to initially release 10 MHz of spectrum suitable for 3G services, and a further 5MHz for 2G service with immediate effect. The MoD agreed to subsequently release the remainder of its held spectrum in a phased manner upon completion of a fibre-optic network (called Network for Spectrum or **NFS**), being built for it, by state-owned Bharat Sanchar Nigam Ltd

(BSNL) and Mahanagar Telephone Nigam Ltd (MTNL). For the new network, these two telcos were required to install around 40,000km of Core Network and 20,000 km of Access Network of fibre-optic cable, connecting 219 Army stations, 33 Navy stations and 162 Air Force stations across the country.

Spectrum Allotment Procedure

12. Any telecom company that wants to offer services in any of the 22 telecom circles in India, as explained in Figure 3 below, must purchase a **Unified Access Services License** (**UASL**) to operate that circle. (**UASL** was converted to **Universal License (UL)** after 2012 Supreme Court decision on 2G scam delinked spectrum from licences. The UAS, introduced in November 2003, is valid for a period of 20 years, which can be extended by an additional 10 years once, per licence per circle.[1] As per the earlier policy, a mobile network operator that was awarded a licence to operate in any of the 22 telecom circles in India was allocated frequencies in that circle for a fixed time period. After the expiry of the licence, the company was required to bid again to renew the licence. Only in certain cases were licences awarded **Until Further Notice (UFN)**. The new telecom policy announced by the government in 2011. As a result, when an operator renews its licence it must also pay separately for spectrum.[2] The NTP 2011 has since been replaced by National Digital Communication Policy (NDCP) of 2018.

SN	Telecom Circle Name	Circle Type
1	Delhi Metro Telecom Circle	Metro
2	Mumbai Metro Telecom Circle	Metro
3	Kolkata Metro Telecom Circle	Metro
4	Gujarat Telecom Circle	A
5	Karnataka Telecom Circle	A
6	Tamil Nadu Telecom Circle	A
7	Andhra Pradesh Telecom Circle	A
8	Maharashtra Telecom Circle	A
9	Haryana Telecom Circle	B
10	Punjab Telecom Circle	B
11	Kerala Telecom Circle	B
12	Rajasthan Telecom Circle	B
13	West Bengal Telecom Circle	B
14	Uttar Pradesh (West) Telecom Circle	B
15	Madhya Pradesh Telecom Circle	B
16	Uttar Pradesh (East) Telecom Circle	B
17	Bihar Telecom Circle	C
18	Northeast Telecom Circle	C
19	Assam Telecom Circle	C
20	Orissa Telecom Circle	C
21	Himachal Pradesh Telecom Circle	C
22	Jammu & Kashmir Telecom Circle	C

Fig 3 : The 22 Telecom Circles in India

13. Spectrum auction in the real sense was carried out only in 2010. Prior to that only licenses were auctioned (till 2001) ,with spectrum bundled along with it. Thus it can be said that the first telecom spectrum auction in India was held in 1994. As per Industry experts this auction was a beauty contest as various telcos displayed their portfolios and offerings for rolling out cellular services in the country. Auctions were held again in 1997, 2000, and 2001. Spectrum in the 900MHz band was auctioned in all these years except in 2001. In 2001, the license was bundled with 2x4.4 MHz of spectrum in 1800 MHz band. It can thus be said that 1800 MHz band spectrum was auctioned for the first time in 2001. Following the 2001 auction, the government abandoned the practice of auctions in favour of an administrative allocation model. The larger aim was possibly to develop India's telecom infrastructure.[3] The final allocation of 900 MHz took place in 2004, through the new model. This policy resulted in spectrum being allocated at far lower prices than had been done through auctions.\

14. Thus in the case of licensed telecom service providers spectrum was initially allotted in accordance with the relevant provisions of the service license agreements. Initially govt promoted additional free spectrum if TSPs could achieve certain target number of subscribers However, due to an exponential increase in the number of mobile subscribers additional spectrum was required by the mobile operators. Serving a larger number of subscribers requires, either a larger amount of spectrum or an increase in the number of base stations. Therefore, additional spectrum is required at some stage as a techno economic solution to meet the growth of mobile services. Department of Telecommunications had evolved guidelines for the allotment of extra spectrum, based on the justification and fulfillment of the prescribed criteria. The subscriber-based criteria have been formulated taking into account demographic characteristics of different categories of service areas, average traffic per subscriber, number of base stations in a specified area etc. Spectrum is allotted subject to completion of coordination and availability at a particular location. The utilisation of spectrum for commercial purposes began with the release of a limited amount of spectrum in 1994 and later in1995.

15. The first auction was held in 1994. The government divided the country into 23 telecom circles (subsequently reduced to 22 telecom circles as at present) and awarded licences and spectrum to two operators per circle. In the **four** metro circles - Chennai, Delhi, Kolkata and Mumbai, the DoT fixed several prerequisites for potential bidders to meet in order to be eligible for the auction. (Chennai metro circles has since been merged into the Tamil Nadu telecom circle). The criteria included financial resources, reliability, and investment in research, as well as specific details such as rate of network rollout, pricing, quality, and competitiveness.[14]. The management of spectrum in the country, till the year 2007-2008, can thus be divided into the following four stages, as brought out in succeeding paragraphs.

First Stage – Auctioning Scarce Spectrum(1995-2003)

16. The Indian government auctioned the licenses with a 2 × 4.4 MHz of start-up spectrum from the 900MHz band Global Systems for Mobile (GSM) based mobile services in 1995, for the remaining 19 telecom circles (less the 04 Metro Circles). Two operators were selected for each Licence Service Area (LSA). The government possibly assumed that no Indian company, at the time, had the financial resources and technical knowledge to provide large scale mobile services, thus in these circles, the government required that all potential bidders must have foreign partner in order to be eligible.[14][15]. However one firm was awarded multiple licences. Thus besides raising concerns about the possibility of a monopoly if a single company secured multiple licences, the process exposed unforeseen problems with the design and rules of the auction. The auction rules were altered to prohibit a single company from operating in more than 3 circles. The auction for the 900 Mhz band was held again under the new rules.[14]

Service Area	Subscriber base* (In Lakh) supported by GSM spectrum in MHz. (eligibility for allotment of next step)										
	2 X 4.4	2X 6.2	2X 7.2	2X 8.2	2X 9.2	2X 10.2	2X 11.2	2X 12.2	2X 13.2	2X 14.2	2x 15 @
Metro Service Areas	5	15	18	21	26	32	40	48	57	65	
Telecom Circles as Service Area Category 'A' & B	8	30	41	53	68	82	90	98	107	116	
Category 'C' Circles	6	20	31	42	52	62	70	78	87	96	

Table 2: Subscriber base* (In Lakh) supported by GSM spectrum in MHz

17. During the Spectrum auctions were held again in 1997 and 2000, state-owned operators MTNL and BSNL were both allocated 2 × 4.4 MHz of start-up spectrum in the 900 MHz band in 1997 and 2000 respectively to commence GSM services. [14]. Thus, the third operator license was awarded along with 2 × 4.4 MHz of start-up spectrum in the 900 MHz band. The fourth operator licence was issued in 2001 using a three-stage auction procedure [4]and a start-up spectrum of 2 × 4.4 MHz in 1800 MHz was given to the winning bidder. In addition to the entry fees, licensees were required to pay a percentage of annual revenue as spectrum charges.

18. Further allocation of spectrum beyond the start-up spectrum levels was based on availability and justification and attracted additional revenue share as spectrum charges. The contractual rights of spectrum holders were incrementally established through a series of government orders. In 2002, the subscriber linked spectrum allotment procedure referred to as **Subscriber Based Norms (SBN)** was introduced, which laid down a road map up to allotment of 2 × 12.5 MHz of spectrum per operator in each LSA.

Second Stage – Wireless in Local Loop (WLL) (2003-06)

19. During 2000-01, the government also liberalised the **Basic Telecom Services** (**BTS**) market, which provided traditional landline based services. In 2000, BTS operators approached the government with a proposal to provide *Local Access Loop* (or Wireless in Local Loop or **WLL** as it was popularly referred to) at much lower cost using the alternative **Code Division Multiple Access (CDMA)** wireless technology. After a couple of years of litigation between the BTS and GSM mobile operators, the Indian government announced **Unified Access Service (UAS)** licences in November 2003 that allowed basic service license holders to provide full mobility based services with a stipulated entry fee based on the bid price paid by the fourth operator in 2001. The fixed fee based license (as opposed to auction based) theoretically allowed any number of mobile licences to be provided and implicitly de-linked spectrum allocation from licensing. Though firms were awarded licences after paying the required entry fee, they were given start-up spectrum only as and when available. Following the entry of two or three CDMA based mobile operators in each LSA, one or two new firms also paid the stipulated entry fee and got licences to operate GSM services in certain LSAs.

20. In 2005, the Telecommunications Regulatory Authority of India (**TRAI**) reviewed the spectrum allocation process taking into account spectrum availability and efficient techniques for utilisation of assigned spectrum. TRAI stated that the spectrum held by the GSM and CDMA operators was well below international averages. (This could possibly have been the reason for the drop in Quality of Services at times). It was recommended that existing operators be given adequate spectrum before considering allocating spectrum to new service providers especially since “there is adequate competition in almost all service areas”. TRAI continued to maintain that there was a shortage of 2G spectrum. The entitlement of incumbents naturally extended to future 3G spectrum since in a spectrum scarce environment, 3G could be considered as an extension of 2G.1 It also followed that the scarce resource of spectrum need not be spread too thin. Table 3 below shows the revised Subscriber base* (In Lakh) supported by CDMA Spectrum in MHz.

Service Area	**Subscriber base * (In Lakh) supported by CDMA spectrum in MHz. (eligibility for allotment of next step)**				
	2X2.5 MHz (2 carriers)	2X3.75 MHz (3 Carriers)	2X5 MHz (4 carriers)	2X6.25 MHz (5 Carriers)	2X7.5 MHz (6 carriers) @
Metro Service Areas.	5	20	30	50	
Telecom Circles as Service Area for Category 'A' and 'B' circles.	8	50	80	100	
Telecom Circles as Service Area for Category 'C' circles.	6	40	60	80	

Table 3: Revised Subscriber base* (In Lakh) supported by CDMA Spectrum in MHz

Third Stage – Stricter Criterion for Allocation of Spectrum (2006-08)

21. As technological progress took place, it began to be believed that if used maximally, spectrum held by incumbents was sufficient for meeting their near term requirements. Meanwhile, additional spectrum was also being vacated by the Defence. As a result, in keeping with the principle of maximal usage of spectrum, new Subscriber Based Norms **(SBN)** were defined, incumbents kept out of fresh allocations, 3G treated as a separate service from 2G and the cap on the number of operators removed. As mentioned in the TRAI recommendation on 3G spectrum [TRAI 2006], "the Defence Services have agreed to vacate 2 × 20 MHz in the 1800 MHz band, in addition to 25 MHz in the 2.1 GHz UMTS band. The availability of additional spectrum in the 1800 MHz band

provides sufficient room for growth of 2G services for the medium term." Therefore, "the authority has recommended that the government should not treat the allocation of 3G spectrum in continuation of 2G spectrum". The TRAI (2007) recommendation that no cap be placed on the number of telecom access providers in the country allowed more new firms to enter the market by paying the low fixed entry fee.

Fourth Stage – Policy on 3G (2008)

22. The government announced the policy for 3G mobile services in August 2008. In line with TRAI's recommendation [TRAI 2006], the government opted for a simultaneous ascending auction for allotment of a start-up spectrum of 2×5 MHz in the 2.1 GHz band with specified reserve prices for different categories of LSAs. It may be noted that 2×5 MHz is the minimum carrier requirement for providing 3G services using **Wideband Code Division Multiple Access (WCDMA)** technology in the 2.1 GHz band. The 3G policy also states that 2×1.25 MHz carriers will be allotted to UAS licensed CDMA operators at a price equal to the highest bid received for 2.1 GHz band, prorated for 2×1.25 MHz.

Period of Growth In Indian Telecom Sector

23. Post 2008, there was a boom in the telecom sector and the Indian telecom scenario was on the upswing. A large No of telecom spectrum auctions were carried out during the period 2010-2016, which have been summarized in the subsequent paragraphs. In 2010, 3G and 4G telecom spectrum were auctioned in a highly competitive bidding. The winners were awarded spectrum in September and Airtel was the first private operator to launch 3G services in India.[16] Airtel, Idea, Reliance Communications, S Tel, Tata Teleservices & Vodafone Essar participated in the auction. Though BSNL and MTNL did not participate in the auction, were also awarded spectrum.[17]BSNL paid the government Rs 101.87 billion (equivalent to Rs 170 billion or US$2.4 billion in 2018) for spectrum in 20 circles and MTNL got spectrum for 3G services in 2 circles, Delhi and Mumbai.[18] The Government earned Rs 677 billion

(equivalent to Rs 1.1 trillion or US$16 billion in 2018) from 3G spectrum auction and broadband wireless spectrum auction generated a revenue of Rs 385 billion (equivalent to Rs 650 billion or US$9.0 billion in 2018) for a total revenue of Rs 1,062 billion (equivalent to Rs 1.8 trillion or US$25 billion in 2018) from both auctions. The 2010 auction took place over 34 days and consisted of 183 rounds of bidding. The most expensive telecom circle was Delhi at a price of Rs 33169 million per operator. The five most expensive circles were Delhi, Mumbai, Karnataka, Tamil Nadu and Andhra Pradesh. They accounted for 65.56% of the total bids.[18][19]

24. **2012 Spectrum Auction**. In 2012, the DoT auctioned 2G spectrum in both GSM and CDMA bands. The government put on sale 271.25 MHz of spectrum.[20] The 1800 MHz band and 800 MHz band were being used for GSM and CDMA services respectively. Eleven blocks having 1.23 MHz each in the 1800 MHz frequency band were auctioned, except in Mumbai and Delhi where only eight blocks were available. Three of the eleven blocks, in each circle, were reserved for new telecom players or operators whose licences had been cancelled by the Supreme Court on 02 February 2012, following the 2G spectrum case. New players and companies affected by the Supreme Court verdict were required to win at least 4 blocks in each circle to start or continue their operations in that circle. Existing players whose licences were not affected by the Supreme Court verdict could bid for only 2 blocks in each circle. This applied to all circles of Airtel and Vodafone, and in some circles for Idea.[21] Three blocks of 1.25 MHz frequency each in the 800 MHz band were also available for auction.[22] Initially, only Videocon Telecommunications Limited and Tata Teleservices (Tata DoCoMo CDMA) had applied to participate in the auction for spectrum in 800 MHz band (CDMA). Both companies however withdrew their applications before 05 November, the last date for withdrawal of applications. Videocon was announced as a pre-qualifier in the bidding process by the DoT on 29 October, but withdrew its application on 02 November.[23] Tata Teleservices was also announced as a pre-qualifier on 29 October, but withdrew its bid later. The withdrawals meant that there were no bidders left and the CDMA spectrum auction was subsequently cancelled.[24] The final list of bidders was announced on 06 November. This was followed by a mock auction

on 07 and 08 November and the e-auction of 1,800 MHz band began on 12 November.[25] The companies which participated in the auction for spectrum in 1800 MHz band (GSM) were Airtel, Idea, Vodafone, Videocon, Telewings, TATA.

25. The auction took place over two days (12 Nov 12 to 14 Nov 12) and consisted of 14 rounds. The government received bids worth a total of Rs 94.07 billion (US$1.3 billion), far lower than its target of Rs 280 billion. No one bid on the India-wide spectrum, which had a reserve price of Rs 140 billion.[26] Bids were tendered on 102 of the 140 blocks being offered. Delhi, Mumbai, Karnataka and Rajasthan circles did not receive any bids. The erstwhile Minister of Communications and Information Technology (**MoC&IT**) Mr Kapil Sibal had said that there would be an auction for the unsold spectrum and the procedure to be followed for that auction would be decided in another few weeks. [27][28]

26. **2013 Spectrum Auction**. In the 2013 spectrum auction, the Government planned to auction 50 MHz of airwaves in the 1800 MHz band and 76.25 MHz of spectrum in the 800 MHz band.[29] The Government put CDMA spectrum worth Rs 64 billion (US$890 million) up for auction[30][31] and fixed the price of 900 MHz, two times higher than 1800 MHz.[32] DoT issued notice inviting applications for spectrum auction on 30 Jan 2013, and the last date for submitting an application was 25 February 2013.[33] The auction for all three bands was planned to begin on 11 March 2013. However, no bidders expressed interest in the 1800 MHz and 900 MHz bands and as a result, the auction for those bands was postponed indefinitely. The auction for spectrum in 800 MHz band proceeded as planned on 11 March.[34] No companies tendered bids for spectrum in 1800 MHz and 900 MHz bands. The sole bidder for spectrum in the 800 MHz band was Sistema ShyamTele Services Limited (SSTL), under the brand name MTS.[35] The extremely high reserve price was possibly the reason why there were initially no bidders for this high value spectrum. Vodafone Group's CEO Vittorio Colao stated, "The problem is that in India there is a misperception of what is the value of spectrum. The reserve prices

are set too high. India has very low prices and very low revenues so we cannot afford to pay high price for spectrum. We have told them [Indian government] a number of times that the order of magnitude that they have in mind just does not make sense".[32]

27. The auction was held on 11 March and lasted little over 4 hours.[36] Auction rounds were scheduled to begin between 0900 hrs and 1900 hrs IST.[30] The table below shows the prices per block for each of the 11 telecom circles in which spectrum was put up for auction. The participant in the auction, MTS, won spectrum in 8 circles and did not bid for 3 circles. No spectrum was put up for auction in the remaining circles of India.[37]

Circle	Delhi	Gujarat	Karnataka	Kerala	Kolkata	Mumbai
Price/ Block in Rs/ US$	Rs 4,505 million ($63 million)	1,462 million ($20 million)	2,146 million ($30 million)	425 million ($5.9 million)	739 million ($10 million)	*No bid*
Circle		Tamil Nadu	UP (West)	West Bengal	Mahara-htra & Goa	U P (East)
Price/ Block in Rs/ US$		Rs 1,989.6 million ($28 million)	Rs 698 million ($9.7 million)	Rs 168 million ($2.3 million)	*No bid*	*No bid*

Table 4 :Prices Per Block For The 11 Telecom Circles In Which Spectrum Was Put Up For Auction

28. **2014 Spectrum Auction**. In 2014, the Dot auctioned spectrum in the frequency range of 900 Mhz and 1800 MHz. The Telcos which participated in the auction were Airtel, Vodafone India, Idea, Aircel, Reliance Communications, Reliance Jio, Tata Teleservices and Telewings. The telcos primarily intended to use this to provide 2G services and augment it with 3G in certain circles. The winners were awarded spectrum in February. The Government earned Rs 612

billion (US$8.5 billion) from the spectrum auction. The government put on sale 307.2 MHz of 1800 and 46 MHz of 900 MHz-wide spectrum. The licences are valid for 20 years. Vodafone and Bharti were already using 900 MHz frequency and had to renew before their license expire in November 2014. Reliance Jio, the only company to have all-India 4G license entered into voice service and won in 14 circles in 1800 MHz frequency.[38] Companies also planned to provide 3G and 4G services on the spectrum.[39] The auction took place over 10 days and consisted of 68 rounds of bidding. The most expensive telecom circle in both 900 & 1800 MHz frequencies[40] was Delhi at a price of Rs 7409.6 million and Rs 728 million per operator. Delhi and Mumbai together accounted for 57% of the total bids.[41][42]

29. **2015 Spectrum Auction**. The 2015 spectrum auction concluded on March 25, after 19 days and 115 rounds of bidding.[43] Spectrum in the 800 MHz, 900 MHz, 1800 MHz and 2100 MHz bands was auctioned. The Telcos which participated in the auction were Airtel, Vodafone India, Idea, Aircel, Reliance Communications, Reliance Jio, Aircel, Tata Teleservices and Telewings Communication Sevices . The Government accrued a total of Rs 109,874 crore (US$15 billion)[44] from the auction. Approximately, 11% of the spectrum available for auction remained unsold.[45]

30. **2016 Spectrum Auction**. The 2016 spectrum was held from 01 October 2016. This was facilitated to a large extent by the harmonization of frequency spectrum in the 1800-2100 MHz band, during which the defence and commercial telecom operations shifted to their respective portions of this band. This mammoth exercise was carried out over a period of five- six months , in five phases , covering all the 22 Telecom Circles or Liscenced Servive Areas (LSA). Considerable amount of contiguous frequency spectrum was freed up and made available to be offered for auction. A total of 2354.55 MHz of spectrum ranging across the seven bands of 700 MHz, 850 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz and 2500 MHz was put up for sale across 22 different circles. *This was the first auction in India in which 700 MHz band spectrum was put on auction*.[46] Bharti Airtel, Vodafone, Idea Cellular, Reliance Communications, Tata Teleservices, Aircel and Reliance Jio had applied to participate in the

auction. Telenor did not participate.[47] Only 40% of the spectrum put up for auction was sold as the Telcos reportedly said that the base price set was high. [48]

31. **2017 Spectrum Auction**. In 2017, the government initiated auction of 5G spectrum for the first time. Spectrum in bands over 3000 MHz(3300 to 3600 MHz) were proposed be sold in the auction. Previously unsold spectrum in the bands 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz, and 2500 MHz was also to be auctioned.[49] 700 MHz spectrum especially had an extremely high reserve price (USD 1 Bn per 5 MHz, which was possibly the reason why there were no bidders for this high value spectrum. Though TRAI completed consultation with stake holders, however no further action had happened probably because of the industry's demand to push back the spectrum sale.[50]

32. **2018 Spectrum Auction**. In 2018, in view of the extremely high reserve price of spectrum, which possibly resulted in there being no bidders for certain high value spectrum, the government was expected to lower the price of 700 Mhz band, which went completely unsold in 2016. Government's focus was expected to be in 5G bands. Telecom regulator TRAI had recommended the 700MHz, 800MHz, 900MHz, 1800MHz and 3300-3600MHz bands to be auctioned as 5G bands.[51]

Issues Meriting Deliberation

33. **Optimal versus Maximal Use of Spectrum**. The formulation of spectrum policy in India began under conditions of very limited availability of spectrum. In the initial phase the policymaker's requirement of maximal usage of spectrum with the associated SBN was justified. However, as spectral efficiency increased and additional spectrum got released, more nuanced definitions of efficiency needed to be applied in order to promote the growth of the industry. The single-minded agenda on maximizing the number of subscribers per unit of spectrum ignores the importance of efficiently using other inputs like Base Transceiver Stations (**BTSs**). The specific interpretation

of technical efficiency used by the government has resulted in high reuse of spectrum and hence, more BTSs and cell towers. In some circles, the inter-site distance between cell towers is less than 100 metres, which is one of the lowest in the world leading to iron-clad structures clogging some of the cities. This implies that unit costs decline with an increase in the scale of operation, at least over the range of subscriber minutes observed in the industry to date. In view of this, the policymaker should allow accumulation of spectrum, where such accumulation leads to lower costs without increased threat of cartelisation. This would allow operators to integrate operations and aggregate spectrum holdings to take advantage of economies of scale.

34. **Efficient Use of Mobile Infrastructure**. Under utilisation of BTSs leads to an increased demand for spectrum. There are several new technologies to ensure optimal yield from BTSs. These include:-

(a) Implementation of in-building solutions such as Femtocell to improve the efficiency of BTSs;

(b) Single antenna interference cancellation that can improve downlink bandwidth of GSM networks without changes to network configurations; and

(c) Utilisation of smart antenna arrays that can confine channels to narrow beams thus improving capacity gain.

The government should monitor the optimal use of base stations in the same way it monitors the use of spectrum. Prescribing SBN for BTSs is one possible option, though challenges of administering and monitoring would need to be addressed. Further, the government must do more to promote infrastructure sharing. While it has allowed both passive (towers, rental places) as well as active (antenna, feeder cable, node B, radio access network and transmission systems) infrastructure amongst service providers in order to effectively use the radio access network infrastructure, incentives in the form of lower regulatory levies need to be provided to improve adoption, thus improving the efficiency of the **Radio Access Networks (RANs)**.

35. **Spectrum Pricing**. The government had chosen to provide the UAS licence for up-front fixed fees along with a revenue sharing agreement. The revenue share of government is increased by a percentage point on every fresh allocation of spectrum. SBN are used to determine eligibility for fresh spectrum. The fixed fee has been benchmarked to the fee paid by the fourth cellular operator in the auction of 2001. A benchmarked price is appropriate only if the object being sold (in this case, a license) is the same and the market conditions are similar. The fee paid by the fourth operator in the auction process was specifically for a **Cellular Mobile Telephone Service (CMTS)** license along with start-up spectrum. The UAS allows the licensee to provide access services using non-spectrum related technologies such as wireline service as well. As per the guidelines of the UAS license: The unified access services cover collection, carriage, transmission and delivery of voice and/or non-voice messages over licensee's network in the designated service area and includes provision of all types of access services. The access service includes but not limited to wireline and/or wireless service including full mobility, limited mobility and fixed wireless access. The UAS license is therefore a super set of the CMTS license and its price cannot be equated with the price paid for a CMTS license. Further market conditions in 2003, and even more starkly, in 2007 were quite different from those in 2001. Let alone factoring the increased value of spectrum in the booming telecom sector, the government did not even factor inflation to arrive at the 2003 and 2007 prices. Inappropriate benchmarking had resulted in under pricing of spectrum during that period. Under-pricing spectrum leads to a tendency of hoarding and therefore, should be avoided. The confusion regarding the CMTS and UAS licences has cut both ways since UAS licensees providing CDMA services and applying for a GSM license in 2007 had to pay exactly the same amount that they paid when they were issued the CDMA-UAS license. In fact, as per the above argument, only the charge for GSM spectrum should have been levied. Though UAS implicitly separated licensing from spectrum, license fee needs to be separated from spectrum fee for pricing both licences and spectrum appropriately (in case a fixed fee method is chosen).

36. **Regulatory Certainty**. Telecommunication licences should balance regulatory certainty with the flexibility necessary to address future changes in technology, market structure and government policy. The fixed fee is paid by the UAS licensees without any firm guarantee on the date of allocation. It therefore involves a promise to allocate spectrum at an uncertain point in the future. Further, the SBN represents a very complicated future contract in spectrum with an additional clause of the seller having the right to renegotiate the terms by strengthening the SBN. This contract was very non-transparent and difficult to convert into monetary terms for the purpose of decision-making by the involved parties. Moreover, there was no injunction on the regulator for an orderly step-by-step change of SBN in response to technological changes. Thus, the government decision on strengthening of SBN by an order of six to 15 times increased the price of spectrum from nil to infinity (since the incumbents became ineligible for fresh allocation). This did not represent a very conducive environment for business decision-making. In addition three important regulatory decisions, which totally altered the Telecom scenario were Spectrum sharing and trading, Liberalisation of Spectrum and harmonization of spectrum. These policies have changed the game a lot leading to mergers and acquisitions, consolidating the market to current situation of four stable (as of now) telecom operators. This situation is akin to what prevails in other developed nations and is likely to remain. Due to harmonization of spectrum , it became more effective and valuable for deploying next gen technologies. More on these in the subsequent paragraphs.

37. **Spectrum Liberalisation**. Till 2008, spectrum had been assigned in 800 MHz or 900/1800 MHz band depending upon whether licensee is deploying CDMA or GSM technology. Therefore, the spectrum assigned in 800/900/1800 for 2G mobile services was bound with the technology chosen by the licensee. There was however no such restriction on the spectrum which was assigned through auction. Therefore, spectrum assigned through auctions is liberalised spectrum. Administratively assigned spectrum in 800 MHz, 900 MHz and 1800 MHz was un-liberalised spectrum. At the time of expiry of validity of licence period (20 years), it was put to auction. All the bidders were treated alike and neither were any reservation of spectrum for incumbents made in 900/1800

MHz band nor was any priority given to them. After auction, spectrum assigned in 800/900/1800 MHz was liberalised spectrum. TSPs holding administratively assigned spectrum were permitted to convert their spectrum holding to liberalised spectrum by paying market determined price prorated for the balance licence period.

38. At the start, the price of spectrum liberalization was set in line with the most recent reserve price recommended by TRAI. This was to be the provisional price and any balance, was to be paid by the operator after the market price had been derived from past auctions. In case of non-availability of auction-determined prices (which was the case in many circles), the comparable price to be charged for liberalization was decided by the government after completion of future auctions. In this fashion, spectrum in 800/900/1800 MHz was converted into liberalised spectrum in phases. This allowed telecom operators to use any technology to deliver mobile services like 3G and 4G. Besides, they were able to introduce new technologies and share and trade it with other operators for its efficient use. Spectrum liberalization also helped operators increase efficiency & quality of services

39. **Spectrum Harmonisation**. Spectrum harmonisation refers to uniform allocation of radio frequency bands across regions and de-conflicting the commercial requirements and those of the Defence, especially in border areas, where the Defence holds the radio waves. Harmonisation leads to usage of bands into contiguous blocks, leading to efficient utilisation of spectrum. Harmonisation was required to be carried out as it could have facilitated additional 3G airwaves for commercial use. The Cabinet in January 2015 had approved setting up a 'Defence Band', by which it was making available the remaining airwaves (apart from using spectrum into its own use) for commercial use in areas like telecom and broadcasting. The Cabinet had also approved swapping of 15MHz of 3G spectrum between the Defence and Telecom ministries. However, the required spectrum bands were required to be harmonised before being made available for commercial use, because the same were being actively used by the commercial and Defence agencies. There was thus a requirement to migrate the live commercial and Defence links into their respective portions of the now

delineated portions of the 1800MHz to 2100 MHz band as without this the upcoming auctions due in 2016 would not have been possible. The same was carried out in five stages and was achieved over a period of five months. This thus facilitated the conduct of the spectrum auctions which made available additional 3G airwaves for commercial use.

40. **Number of UAS Licences Issued.** Though at present **UASL** does not exist anymore and it is now called Unified Licence (**UL**) only., yet in 2007-08 the same was in vogue hence the need to explain the same. The UAS license regime (or UL in present context) de-linked license from spectrum in the sense that it allowed the possibility of giving licences without present availability of spectrum. However, it included a promise to provide 2×4.4 MHz of start-up 2G spectrum "as and when available". In 2007-08, the government could not properly take into account the availability of 2G GSM spectrum while granting licences. In theory, the maximum available GSM spectrum in the 900 and 1800 MHZ bands was 100 MHz. In practice, in India, only 60-70 MHz could at that time be used. Over 40 MHz was already in the possession of incumbents. The remainder was insufficient for even the start-up needs of the six to nine new entrants, let alone the incremental spectrum required thereafter. The government can possibly be faulted for not restricting the total number of licences granted (or alternatively, not de-linking license from spectrum) based on its knowledge of spectrum availability.

41. **Policy on 3G**. The migration from 2G to 3G requires the setting up of new infrastructure by operators and the purchase of 3G compatible handsets by end users. 2G services can continue to be provided using 3G spectrum and equipment, but 3G services cannot be provided in a 2G environment. The government at that time viewed 3G as a high value service distinct from 2G and formulated allocation policies accordingly. The policy announcement on 3G spectrum marked the culmination of almost three years of wait following the TRAI recommendations on allocation and pricing of spectrum for 3G presented on September 27, 2006. The delay in the 3G policy was in a sense responsible for the rush for licences in 2007, when entrants unsure of the 3G allocation rushed to get 2G spectrum that was promised along with the UAS license.

42. Seen independently of the policy legacy, the 3G policy had several salutary features. These include the separation of the license from the spectrum, the choice of an auction mechanism to reveal the current market value and the opening of doors to foreign participants. However, the under pricing of 2G spectrum in 2007 and the auction determined price of 3G spectrum in 2008 resulted in a new entrant to the Indian market paying much higher prices for entry through the 3G route as opposed to entry through the 2G route. While we may overlook the case of global entrants who have deeper pockets than their Indian counterparts, we cannot turn a blind eye to UAS license holders who would not have been able to get the promised 2G spectrum due to non-availability and therefore had to bid for 3G spectrum to be able to provide even voice services. Regarding the details of the auction procedure recommended, TRAI advocated that the lowest bidder in each stage of the auction be placed in the wait list for spectrum. However, it also mentioned that the size of the wait list should take spectrum availability into account. It was imperative for the government to limit the length of the wait list in order to avoid the impasse in the allocation of 2G spectrum. In case of 2×1.25 MHz carrier in 800 MHz, TRAI recommended a single stage auction if more UAS-licensed CDMA operators are interested. TRAI also explicitly specified that the 2G subscriber base should not be taken in to account for 3G spectrum allocation as 3G is a different service from 2G. However, DoT policy states that 2×1.25 MHz be given to the operator having maximum 2G subscriber base. There appeared to be inconsistency in the method of allocation stated by TRAI and DoT where DoT appears to have apparently flouted its stated policy of treating 2G and 3G as distinct services. The 3G policy announcement was silent on the road ahead after the last allocation. A clear road map of spectrum availability, use of the auction mechanism for allocation, and rationalization of the subscriber based norms to serve as a low hurdle of eligibility to participate (as opposed to requiring maximal usage) would be appropriate.

43. **Technology Neutrality** .The introduction of CDMA based mobile service during 2001-03 was clouded by the legal battles between the incumbent GSM and BTS operators. Given their defensive position and the prevailing paradigm of maximal usage, the CDMA mobile service providers were allotted

a lower start-up spectrum block (2.5 MHz as compared to 4.4 MHz for GSM) as they were considered more efficient. Parity was established between the two technologies in terms of the number of subscribers each could reach with the spectrum allotted to them. The definition of parity was tantamount to handicapping a more efficient player by restricting access to a necessary resource. In an environment where maximal usage is no longer relevant, the correct definition of parity is "equal access to resources" to be used as inputs. Such an approach would create a truly level playing field in which the respective technologies would be able to compete. Promoting such competition would also economize on the use of spectrum. The only qualification to this conception of parity could be the threat of monopoly power. However, if anything, the strengthening of CDMA service could increase competition in an industry that is currently largely dominated by the GSM players. As per TRAI recommendations, both types of operators should have the same amount of startup spectrum and be held to the same subscriber based norms.

44. **Level Playing Field** . As pointed out by TRAI, the ratio between actual subscriber base and subscribers that should be serviced as per the SBN is much larger for private operators compared to government operators, indicating that private operators are having to stretch spectrum much more than government operators. In some LSAs, this ratio is even less than one for some government operators, indicating that these government operators were given spectrum despite not meeting the SBN.

45. **Spectrum Usage Charges (SUC)**. The spectrum assets given by the govt to the telco operator are used by him to generate revenue and the govt levies SUC from the operator. In addition some percentage of the revenue earned is given by the telco operator to the govt and the balance available with the telco operator (after paying the liscence fee and SUC) is called the **Adjusted Gross Revenue (AGR)**. A portion of the AGR is also given by the telco operator to the govt as his contribution for the Universal Service Obligation (USO) fund and another portion of the AGR goes towards payment of taxes. The telco operators often raise this as a matter of double taxation and the issue is under mediation with the government.The USO fund to the tune of Rs 40,000 Crores is available

with the govt which can be gainfully used for improving of the telecom services and infrastructure, especially in areas with poor teledensity and in rural areas.

4G and 5G Spectrum Auctions .

46. The telecom industry has invested considerable capital expenditure but of late the revenues have reduced and the telcos are facing challenges in managing payments. To provide partial relief to the Telcos, the government has agreed to accept deferred payments. The auction of the spectrum, specially targeted towards provisioning of 4G and 5G services is also likely to be held in late 2019. Both these measures will also give more time for the financially stressed telecom sector to stabilize fully as the industry is reeling under a debt of nearly Rs 8 Lakh Crores. TRAI has recently recommended the starting price for spectrum in 4G bands of 700 MHz, 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz and 2500 MHz besides 5g airwaves in the 3300 MHz- 3600 MHz bands. TRAI has suggested that 8600 MHz of airwaves be offered to Bharti Airtel, Vodafone India-Idea Cellular, Reliance Jio Infocomm, to fetch over Rs 5 Lakh Crores, if all the bandwidth offered is sold at the reserve price. The Dot is to take the final decision on the pricing and timing before sending it to the union cabinet for approval. DoT would want to possibly avoid a situation where airwaves, especially the 5G ones as well as the ones in the premium 700 MHz band- whose starting price was reduced 43% from the last sale – go unsold once again as this would adversely impact the roll out of 5G services in the country.

Conclusion

47. Spectrum policy in India while having been very successful in nurturing the growth of industry, suffered from the lack of a long-term vision and absence of a holistic perspective that considers all the relevant factors before making policy decisions. The trajectory of spectrum policy in India has been marked by many flip flops: on SBN, spectrum pricing, 3G policy and competing technologies. The Spectrum Management Committee, set up by the Govt in 1999, was to provide a blueprint for spectrum allocation and management.

However, the committee was not very specific about using auctions as an allocation mechanism. To date, there are different mechanisms for allocating spectrum for various services. For the fourth cellular operator, spectrum and service areas were auctioned, while those providing WLL (LM) are to get the spectrum based on a fixed entry fee and it would be allocated on a first come first serve basis subject to completion of rollout conditions. This would result in two services that both require spectrum (incidentally in adjacent bands) to be treated differently. The resulting uncertainty was harmful for the industry. A clear defined, consistent policy is the need of the hour and the National Digital Telecom Policy (**NDCP**) -2018 and National Frequency Allocation Plan (**NFAP)** 2019 are a step in the right direction.

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