Telecom Regulatory Authority of India

सत्यमेव जयते

Recommendation

on

Reserve Price for Auction of Spectrum in the 800 MHz Band

22nd February, 2014

CONTENTS

CHAPTER-I

INTRODUCTION

1.1 The Department of Telecommunications (DoT), through its letter dated 12th December 2013 **(Annexure-1.1)** sought TRAI's recommendations on reserve price for 800 MHz band in all the service areas in terms of clause 11(1)(a) of the TRAI Act 1997 as amended by TRAI Amendment Act 2000. The Authority has finalized these recommendations in response to the DoT 's said reference.

BACKGROUND

1.2 The Hon'ble Supreme Court of India in its Judgment dated 2nd February 2012 in the Writ Petitions no 423/2010 and 10/2011, directed TRAI to make fresh recommendations for the grant of licence and allocation of spectrum in the 2G band in 22 Licence Service Areas (LSAs) by auction.

1.3 In its recommendations on 'Auction of Spectrum' dated 23rd April 2012, the Authority recommended Rs. 3622 crore per 2x1 MHz as the reserve price for the spectrum in the 1800 MHz band on a pan-India basis price, which was derived on the basis of the price realized in the auction for 3G spectrum (2100 MHz band) held in May 2010. The reserve price for spectrum in 800/900 MHz bands was fixed at twice the reserve price for 1800 MHz spectrum, keeping in view their relative efficiencies and international experience.

1.4 In response to the DoT's back-reference, the Authority, in its recommendations dated 12th May 2012, stated that, in respect of 800 MHz, the amount of spectrum available for auction in some LSAs was less than 5 MHz. As such, it was not possible with this quantum of spectrum (< 5 MHz) for a Telecom Service provider (TSP) to offer all services that a truly liberalised spectrum is capable of. For that, a minimum block size of 5 MHz was essential. Therefore, the Authority would be open to the Government fixing the reserve price of 800 MHz

spectrum at 1.3 times the 1800 MHz reserve price, only where 5 MHz spectrum is not being made available.

1.5 In August 2012, the Cabinet approved the reserve price of Rs.14,000 crore for 2x5 MHz (Rs. 2800 crore per MHz) pan-India spectrum in the 1800 MHz band. The Cabinet also approved the reserve price in 800 MHz band at 1.3 times that of 1800 MHz band (Rs. 3640 crore per MHz) based on the recommendation of the Empowered Group of Ministers (EGoM).

1.6 Auctions for spectrum in the 1800 MHz and 800 MHz bands were held in November 2012. For 1800 MHz spectrum, spectrum was sold in all the LSAs except Delhi, Mumbai, Karnataka and Rajasthan. A total of 127.5 MHz of spectrum was sold out of total 295 MHz of spectrum that was put up for auction in the 1800 MHz band. However, there was no bidder for spectrum in the 800 MHz band.

1.7 Subsequently, the Government reduced the reserve price for 800 MHz band spectrum in all LSAs by 50 percent[1] to Rs. 1820 crore per 2x1 MHz from the previous reserve price of Rs 3,640 crore per 2x1 MHz. In addition, the reserve price of spectrum in the 1800 MHz band was reduced by 30% in respect of the LSAs where no spectrum was sold in the auction of November 2012. Thereafter, the Government conducted the second auction in March 2013. In this auction, spectrum in the 800 MHz band for all 22 LSAs, the 900 MHz band for the three metros (Delhi, Mumbai and Kolkata) and the 1800 MHz for Delhi, Mumbai, Karnataka and Rajasthan LSA was put up for sale. There were no bidders for the spectrum in the 900 MHz and 1800 MHz bands. However, for the spectrum in 800 MHz band, M/s Sistema Shyam Tele-Services Limited (SSTL) was the sole applicant and it obtained spectrum in eight (8) LSAs, all at the reserve price.

[1] As per the press release on Union Cabinet's approval of Revised Reserve Price for the Auction of Spectrum in 800 MHz band (CDMA) and Pricing of Spectrum for current spectrum holding in 800 MHz band(CDMA) by existing operators issued on 17th Jan, 2013 available at pib.nic.in

1.8 The Government decided to conduct another auction in the 800 MHz, 900 MHz and 1800 MHz bands. The EGoM, in its meeting held on 26th June 2013, directed the DoT that before conduct of the next auction of spectrum, recommendation of TRAI be obtained on reserve price. Accordingly, on 10th July 2013, the DoT sought the Authority's recommendations on reserve prices for auction of spectrum in the 800 MHz, 900 MHz and 1800 MHz bands. After carrying out a consultation process with the stakeholders, the Authority gave its recommendations on 'Valuation and Reserve Price of Spectrum' on 9th September, 2013.

1.9 In its recommendations of 9th September 2013, the Authority recommended reserve prices for the 1800 MHz band and 900 MHz bands. However, in the 800 MHz band, the Authority noted that the subscriber base of CDMA had diminished by around 30% over a period of three years. Moreover, in the auction held in November 2012, there was no participation in the bidding for the 800 MHz band. In March 2013, only one quashed licensee (SSTL) took part in the auction and acquired spectrum in 8 LSAs despite the fact that earlier it was holding licences in 21 LSAs. The Authority was of the opinion that it would be desirable to explore alternate usage in line with international practice rather than allocate spectrum in the 800 MHz band, at a far lower price than its true value, for a technology whose eco-system was diminishing worldwide. Therefore, the Authority recommended that the feasibility of adoption of E-GSM should be explored in a time-bound manner. The Authority also recommended that the auction in the 800 MHz band should not be carried out now. On 11th October, 2013, the DoT sought clarification/reconsideration on some of the recommendations. After considering the comments given by the DoT, the Authority furnished its response to the Government on 23rd October 2013. In its response, the Authority reiterated its recommendations and stated that the DoT should not summarily reject the recommendations on a cursory examination without first fully exploring the feasibility of the adoption of E-GSM for efficient utilization of spectrum in the 800 MHz band.

1.10 On 12th November 2013, the DoT informed the Authority that *"These recommendations have been considered by the Government. With regard to E-GSM band, it has been viewed that apportioning spectrum in the 800 MHz band for E-GSM, 10 MHz of spectrum would remain unutilized. Besides, the E-GSM band requires vacation of spectrum by Defence services to ensure availability of adequate spectrum which is likely to take time and keeping spectrum in the 800 MHz band unsold would result in foregone revenues for Government. It would be appropriate to put the spectrum to auction and allow market forces to determine the appropriate technology solution using the liberalised spectrum. Therefore, it has been decided that 800 MHz band will be put to auction in the next round of auction of spectrum."*

DOT'S FRESH REFERENCE DATED 12TH DECEMBER 2013

1.11 The Department of Telecommunications (DoT), through its letter dated 12th December 2013 **(Annexure-1.1)** sought TRAI's recommendations on reserve price for 800 MHz band in all the service areas in terms of clause 11(1)(a) of the TRAI Act 1997 as amended by the TRAI Amendment Act 2000.

1.12 Keeping in view the decision of the DoT (para 1.10) to go ahead with the auction of 800 MHz band rather than wait for the adoption of E-GSM band, the Authority decided not to pursue the matter for adoption of E-GSM any further and started the consultation process for setting the reserve price for spectrum in the 800 MHz band.

1.13 To prepare a comprehensive Consultation Paper (CP) on the subject, on 13th December 2013, the Authority, sought some information from the DoT which inter-alia include feasibility of shifting operations of defence from 925-935 MHz band to 834-844 MHz band, the rationale for putting a smaller quantum of spectrum on auction in the last auction and details of the quantum of spectrum now proposed to be auctioned in all the LSAs. The DoT, in its reply dated 20th December 2013 (**Annexure 1.2)** furnished the information. The DoT also informed the Authority that *"The consultation with the Ministry of Defence on the*

feasibility of shifting their existing frequency assignments from 925-935 MHz band to 834-844 MHz band was undertaken. Defence has intimated that due to their operational requirements, it is not feasible to migrate the equipment to other bands in a definite time frame."

1.14 In the said letter of 20th December 2013, the DoT also stated that "*the decision to auction spectrum in 800 MHz band is policy of the Government in terms of the Section 25 of the TRAI Act, 1997 as amended from time to time.*" However, the DoT, through letter dated 24th December 2013 **(Annexure 1.3)** has clarified that "*There is no intention of the Government to issue direction under Section 25 of TRAI Act. The recommendations for reserve price for auction of spectrum in 800 MHz band in all service areas has been sought under clause 11 (1) (a) as was mentioned in this Ministry's letter of even No. dated 12th December 2013."*

1.15 The CP was issued on 30th December 2013. In response to the CP, TRAI received 14 comments and 5 counter-comments from stakeholders. These were placed on TRAI's website www.trai.gov.in.

1.16 An Open House Discussion (OHD) was held on 27th January 2014. After considering the written comments and counter-comments received from stakeholders, views expressed during the OHD and after carrying out its own analysis, the Authority has finalised these recommendations.

1.17 The recommendations are presented in four chapters. Introductory chapter provides a brief background to the subject. The second chapter discusses the availability of spectrum in the 800 MHz band and its block-size for the auction. The third chapter deals with the various methodologies that have been used to arrive at the valuation of the spectrum in the 800 MHz band. Derivation of the reserve price of the spectrum in the 800 MHz band on the basis of the valuation of the spectrum has also been covered in the third chapter. The fourth chapter contains a summary of the recommendations.

CHAPTER-II

AVAILABILITY OF SPECTRUM IN THE 800 MHz BAND AND THE ECO-SYSTEM

AVAILABILITY OF SPECTRUM[2]

2.1 As per the information provided by the DoT, the current availability of spectrum in the 800 MHz band and its allocation amongst different TSPs is as given below[3]:

TABLE 2.1 **(in MHz)**

Sl. No.	LSA	BSNL	HFCL	MTNL	SSTL	TTSL	RCL/ RTL	Total spectrum holding
1	Delhi			2.5	3.75	3.75	5	15
2	Mumbai			2.5		3.75	5	11.25
3	Kolkata	2.5			3.75	2.5	5	13.75
4	Maharashtra	2.5				2.5	5	10
5	Gujarat	2.5			3.75	2.5	3.75	12.5
6	Andhra Pradesh	2.5				2.5	5	10
7	Karnataka	2.5			3.75	2.5	5	13.75
8	Tamilnadu	2.5			3.75	2.5	5	13.75
9	Kerala	3.75			3.75	2.5	5	15
10	Punjab	2.5	2.5			2.5	3.75	11.25
11	Haryana	2.5				2.5	3.75	8.75
12	UP (West)	2.5			3.75	2.5	5	13.75
13	UP (East)	2.5				2.5	5	10
14	Rajasthan	2.5			5	2.5	3.75	13.75
15	Madhya Pradesh	2.5				2.5	5	10
16	West Bengal	2.5			3.75	2.5	3.75	12.5
17	Himachal Pradesh	2.5				2.5	2.5	7.5
18	Bihar	2.5				2.5	5	10
19	Orissa	2.5				2.5	3.75	8.75
20	Assam	2.5					2.5	5
21	North East	2.5					2.5	5
22	J&K	2.5					2.5	5
	Grand Total	**51.25**	**2.5**	**5**	**35**	**50**	**92.5**	**236.25**

[2] The spectrum in the 800 MHz band is a paired spectrum. Therefore, any quantum of spectrum, mentioned in this chapter actually refers to is paired spectrum only. E.g. 5 MHz spectrum means 2x5 MHz spectrum.

[3] Considering the carrier size as 2x1.25 MHz. Actual carrier size is 2x1.23 MHz

2.2 In the CP, it was stated that Tata Teleservices (TTSL) had offered to surrender spectrum holding beyond 3.75 MHz in Delhi and Mumbai and beyond 2.5 MHz in other LSAs. In its response to the CP, TTSL has confirmed that it has completed the surrender of spectrum. Therefore, in Table 2.1, the spectrum surrendered by TTSL has been taken into account.

2.3 The 800 MHz band (824-844 MHz/869-889 MHz) is of 2x20 MHz in size. Taking a carrier size as 1.25 MHz, this translates into 16 carriers. However, in the existing channel plan, there is a guard band at the start and end of the band, totaling to 0.98 MHz. Also, there is a provision of inter-operator guard band (typically 0.6 MHz) between two TSPs. Therefore, total spectrum requirement for the guard band depends on the number of TPSs that have been assigned spectrum in this band and also whether the TSPs have contiguous spectrum or it is distributed across the band. This is why in all the LSAs, the actual availability is only 13-14 carriers, out of a possible 16 carriers in 20 MHz of spectrum. As per the information received from WPC, CDMA carrier assignments to various TSPs in the 800 MHz band are summarized in the Table below[4]:

Table 2.2
Spectrum Availability in the 800 MHz Band

Sl. No.	LSA	Total No. of Carriers	Total No. of Carriers assigned till date	No. of Carriers available currently
1	Delhi	14	12	2
2	Mumbai	14	9	5
3	Kolkata	13	11	2
4	Maharashtra	14	8	6
5	Gujarat	14	10	4
6	A.P.	13	8	5
7	Karnataka	14	11	3
8	Tamilnadu	14	11	3
9	Kerala	14	12	2
10	Punjab	13	9	4
11	Haryana	14	7	7

[4] Spectrum surrendered by the TTSL has been taken into account.

12	UP (West)	14	11	3
13	UP (East)	14	8	6
14	Rajasthan	12	11	1
15	M.P.	13	8	5
16	West Bengal	14	10	4
17	H.P.	14	6	8
18	Bihar	14	8	6
19	Orissa	14	7	7
20	Assam	14	4	10
21	North East	14	4	10
22	J&K	14	4	10
	Grand Total	**302**	**189**	**113**

2.4 As shown in Table 2.1, both the PSUs i.e. MTNL and BSNL also hold spectrum in the 800 MHz band in all LSAs of the country. They are holding 2 carriers in each LSA except in Kerala where BSNL is holding 3 carriers. Considering the fact that there has been (i) a continuous decline in the subscriber base of both the PSUs, and, (ii) the combined CDMA subscriber base of both the PSUs is only 2% of the total CDMA subscribers, the Authority, in its recommendations of 9th September 2013, expressed the view that BSNL may be allowed to retain a single carrier (of 1.25 MHz) in 800 MHz band so as to cater to its R-DEL (Rural Direct Exchange Line) subscribers and MTNL should vacate all the carriers of 800 MHz band assigned to it in both Delhi and Mumbai.

2.5 In response to the CP, MTNL has stated that withdrawal of both of its carriers in the 800 MHz band will render its CDMA licence redundant and it would be discrimination against MTNL. It further stated that as it has already surrendered the BWA spectrum, it would like to keep spectrum in the 800 MHz band for deployment of 4G technology in future.

2.6 The Authority in not convinced with the arguments given by MTNL. It is a matter of fact that the 800 MHz spectrum assigned to MTNL is grossly underutilized; such a situation cannot be allowed to continue. Also, MTNL had not paid for the 800 MHz band spectrum. In respect of the spectrum holding by BSNL, the Authority had recommended that it should be permitted to retain only one carrier in all the LSAs. The

Authority, however, noted that in Assam, North-East and Jammu and Kashmir, BSNL is the only TSP which is providing CDMA services. As, there are plenty of carriers available in these LSAs for assignment, the Authority is of the opinion that BSNL may be permitted to retain both its carriers in Assam, North-East and Jammu and Kashmir LSA, while in the remaining LSAs, BSNL may be allowed to retain only a single carrier (of 1.25 MHz) in 800 MHz band to cater to its R-DEL subscribers. On the assumption that (a) MTNL vacates its entire spectrum holding in the 800 MHz band, and, (b) BSNL retains only one CDMA carrier in all the LSAs except in Jammu and Kashmir, Assam and North-East LSAs, where it can retain both the carriers, the LSA-wise availability of the carriers in the 800 MHz band is given in Table below. (**Annexure 2.1** depicts the actual carrier assignments)

Table 2.3

Sl. No.	LSA	No. of Carriers currently available	No. of carriers assigned to BSNL /MTNL	No. of additional carriers that may be available	Total No. of carriers likely to be available
1	Delhi	2	2	2	4
2	Mumbai	5	2	2	7
3	Kolkata	2	2	1	3
4	Maharashtra	6	2	1	7
5	Gujarat	4	2	1	5
6	Andhra Pradesh	5	2	1	6
7	Karnataka	3	2	1	4
8	Tamilnadu	3	2	1	4
9	Kerala	2	3	2	4
10	Punjab	4	2	1	5
11	Haryana	7	2	1	8
12	UP (West)	3	2	1	4
13	UP (East)	6	2	1	7
14	Rajasthan	1	2	1	2
15	Madhya Pradesh	5	2	1	6
16	West Bengal	4	2	1	5
17	Himachal Pradesh	8	2	1	9
18	Bihar	6	2	1	7
19	Orissa	7	2	1	8
20	Assam	10	2	0	10
21	North East	10	2	0	10
22	J&K	10	2	0	10
	Grand Total	**113**	**45**	**22**	**135**

SPECTRUM TO BE PUT UP FOR AUCTION

2.7 As discussed above, there are currently 113 carriers available in the 800 MHz band. If the recommendation about the surrender of the entire spectrum by MTNL in both Delhi and Mumbai and the partial spectrum surrender by BSNL is accepted by the Government, then 22 additional carriers will also become available. In its reference dated 10th July 2013, the DoT had proposed only 46 carriers to be put-up for auction as shown in the Table below.

Table 2.4

Sl. No.	LSA	No. of carriers proposed to be put up for auction[5]
1	Delhi	0
2	Mumbai	3
3	Kolkata	0
4	Maharashtra	3
5	Gujarat	0
6	A.P.	2
7	Karnataka	0
8	Tamilnadu	0
9	Kerala	0
10	Punjab	2
11	Haryana	4
12	UP (West)	0
13	UP (East)	4
14	Rajasthan	0
15	M.P.	4
16	West Bengal	0
17	H.P.	4
18	Bihar	4
19	Orissa	4
20	Assam	4
21	North East	4
22	J&K	4
	Grand Total	**46**

2.8 As can be seen from the Table above, the DoT was proposing to auction spectrum in the 800 MHz band in only those LSAs where there was no

[5] As per the DoT's reference dated 10th July 2013.

bidder in the March 2013 auctions. However, in its reference dated 12th December 2013, the DoT has requested TRAI to furnish its recommendations on reserve prices for the 800 MHz band in all the service areas. In its letter of 20th December 2013, the DoT has intimated that "the quantum of spectrum in 800 MHz band to be put to auction will be decided by the Government after receipt of TRAI Recommendations on Reserve Price".

2.9 In view of the above, stakeholders were requested to comment on what quantum of spectrum in the 800 MHz band should be put up for auction. The stakeholders were also asked to suggest the block size in which this spectrum should be auctioned. The issue of block size is relevant as apart from CDMA and EVDO technologies, there are other technologies also such as HSPA, LTE etc that can be deployed in the 800 MHz band and these technologies require different carrier sizes as shown in the Table below:

Table 2.5

Technology	**Carrier Size**
CDMA	1.25 MHz
WCDMA	5 MHz
LTE	1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 20 MHz

2.10 In response, some stakeholders (mainly TSPs providing only GSM services) stated that there is hardly any demand in the 800 MHz band as the CDMA subscriber base is diminishing. Further, subscribers per MHz being served by spectrum in the 800 MHz band is significantly smaller than that compared to 900 MHz band spectrum. Lastly, they said that the Adjusted Gross Revenue (AGR) per MHz of 800 MHz band spectrum is far less than that from 900 MHz band spectrum; and there is scarcity of spectrum in the sub-1 GHz band. Therefore, in the opinion of these stakeholders, 800 MHz band should first be reconfigured and then auctioned as E-GSM band only. These TSPs have also commented that adoption of the E-GSM band would have no impact on the

continuity of existing services as it would merely entail shifting of frequencies already assigned to the TSPs. These TSPs were of the view that the current assignment of 7 MHz of spectrum to the defence and other 448 assignments to the captive users in the 925-935 MHz band are being used in some limited areas. Therefore, the non-availability of E-GSM spectrum in a few pockets should not be a bar for its use in the majority of locations.

2.11 TSPs operating in the 800 MHz band are, in general, against the adoption of E-GSM band. One such TSP claimed that the DoT has already decided against the adoption of E-GSM band and has decided to auction the spectrum with the present configuration. It further added that adoption of E-GSM is not feasible because of the lack of a global ecosystem. Moreover, with no possibility of redeployment of current CDMA customers to another band, the availability of sufficient spectrum in the band to achieve meaningful E-GSM deployment is very low

2.12 Regarding the quantum of spectrum to be put for auction, a number of stakeholders suggested that the entire spectrum in the 800 MHz band available with the DoT should be put-up to auction. Some of these stakeholders pointed out that in the February 2014 auction, the DoT has put the entire spectrum in the 1800 MHz for auction, and, therefore, a similar approach should be adopted for the spectrum in the 800 MHz band. Some stakeholders also suggested that the spectrum vacated by TTSL and excess spectrum with BSNL/MTNL should also be auctioned. However, some other TSPs were of the opinion that whatever spectrum is readily available with the DoT should be put for auction, as the PSUs may not be in a position to vacate the 800 MHz band spectrum in the near future. One view expressed was that the spectrum held by CDMA operators, in excess of the subscriber-linked criteria of 17th January 2008, may be taken back and put to auction.

2.13 A few stakeholders suggested that spectrum should be put for auction in only those LSAs where it is available in contiguous blocks of 5 MHz. These stakeholders further commented that where 5 MHz contiguous spectrum is currently not available, it may be better to first realign the frequencies through reassignment so as to get contiguous 5 MHz slots before the auction. The argument given in support of contiguous 5 MHz slots is that the quantum of spectrum should be seen from the perspective of adoption of future technologies like LTE and UMTS. To use this frequency for future technologies, it is imperative that adequate amount of spectrum is made available in contiguous blocks of 5MHz. This will also ensure that the maximum value is obtained by the Government through bidding.

2.14 On block size, most stakeholders were of the view that the block size in the 800 MHz band should be kept as 1.25 MHz. One stakeholder argued that DoT in the last two auctions of November 2012 and March 2013 for 800 MHz band had fixed the block size of 1.25 MHz. Thus, in the opinion of the stakeholder, there was no reason to fix any other block size for this band.

2.15 Some stakeholders also suggested prescribing the minimum quantum of spectrum for which an existing TSP and a new entrant may bid. A few TSPs suggested that the new entrants or existing TSPs who do not currently hold spectrum in the 800 MHz should be required to bid for at least 4 blocks (5 MHz), whereas existing TSPs with spectrum holding in the 800 MHz band should be allowed to bid for a minimum of 1 block. Some stakeholders suggested that the existing operators should be allowed to bid for a minimum of 1 block of spectrum, however, new operators should be required to bid for a minimum of 2 blocks.

2.16 One TSP, which has spectrum in the 800 MHz band, commented that Next Generation technologies, like LTE need a minimum channel bandwidth of a contiguous 5 MHz for efficient spectrum utilization. Non-contiguous spectrum causes significant inefficiencies in the

delivery of LTE services, leading to slower speed and increased service delivery costs for both network operators and consumers. It also stated that the spectrum efficiency reduces sharply if the quantum of contiguous spectrum is less than 5 MHz.

Analysis

2.17 On the issue of adoption of E-GSM band, the Authority has made it clear in the CP that *"In view of the examination by the DoT on feasibility of adoption of E-GSM in the 800 MHz band, the Government's rejection of the recommendations in this regard and its decision to auction this band as it is, the Authority has decided not to pursue this further."*

2.18 Before recommending the issue of quantum of spectrum to be put for auction in the 800 MHz band and its block size, the Authority examined the eco-system in the 800 MHz band.

ECO SYSTEM IN THE 800 MHz BAND

2.19 In the 3GPP[6] table of IMT spectrum bands, band no. 5 is 824-849 MHz (Uplink)/869-894 MHz (Downlink) and is referred to as the 850 MHz band. In India, 824-844/869-889 MHz band, which is a sub-set of the 850 MHz band, is referred to as the 800 MHz band. Now, the 850 MHz band has been adopted by a number of countries in the Americas, Australia and Asia to provide cellular mobile services. Earlier, spectrum in the 850 MHz band was mainly used for CDMA technology. However, TSPs in a number of countries have deployed WCDMA/HSPA technology in this band also. Lately, LTE (Advanced)[7] has also been deployed in the 850 MHz band in a few countries. A list of some of the operators, who have deployed HSPA in the 850 MHz band, is given in Table 2.6.

2.20 Though most of the HSPA mobile networks operate in the 2100 MHz band, there is a significant device eco-system of HSPA technology in the 850 MHz band also. 46% of devices available for HSPA networks can

[6] The 3rd Generation Partnership Project.
[7] Long Term Evolution/Long Term Evolution (Advanced)

operate in the 850 MHz band. Most of these devices are capable of operating in multiple bands i.e. apart from the 850 MHz band, these devices can operate in other bands such as 2100 MHz band and 1900 MHz band, which makes roaming feasible. Band-wise availability of HSPA devices is shown in Table 2.2. Form-factor wise distribution of the HSPA devices[8] in the 850 MHz band is given in Chart 2.1.

Table 2.6

HSPA 850 Networks

Continent	Country	Operator
Americas	Brazil	Claro
		TIM Brasil
		Telemig Celular
		Vivo
	Canada	Bell Mobility
		Fido
		Rogers Wireless
		Sask Tel
		Telus
	Chile	Movistar
	Colombia	Comcel
	Costa Rica	ICE
	Dominican Republic	Claro
	Ecuador	Claro
	EI Salvador	Tigo
	Mexico	Telcel
		Iusacell
	Nicaragua	Claro
	Peru	Claro Peru
		Movistar
	Turks & Caicos Island	Islandcom
	United States	AT & T Mobility
Asia	Israel	Pelephone
	Philippines	SMART
	Thailand	DTAC
		True Move
Oceania	Australia	Telstra
		Vodafone
	New Zealand	Telecom

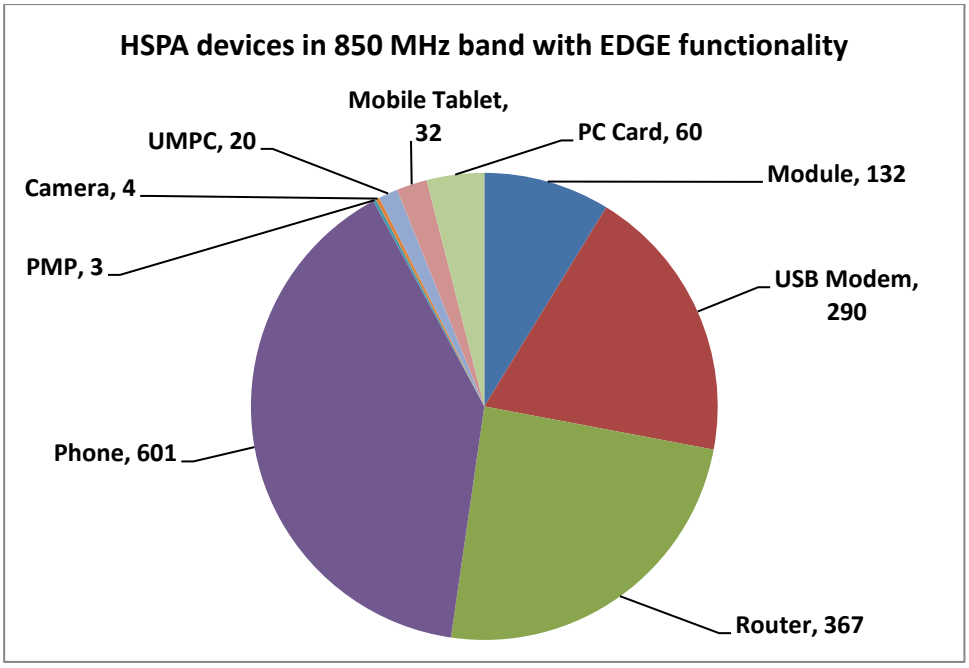
Table 2.7

3GPP band	Frequency in MHz	No. of Devices (Aug 2012)[9]
1	2100	3011 (92%)
5	850	1545 (46%)
1,2,5	850/1900/2100	1120 (34%)
1,5	850/2100	1304 (39%)
8	900	978 (29%)
4	AWS (1700/2100)	208 (6%)

[8] GSA 2013, www.gsacom.com

[9] Note: One device can support multiple bands.

Chart 2.1



2.21 HSPA+ and HSPA carrier aggregation (Dual-carrier HSPA+) are the further evolutions of HSPA technology. In HSPA+, using the multiple antenna array, peak downlink speed upto 28 Mbps can be achieved. Dual-carrier HSPA+ allows the aggregation of two adjacent carriers (Release 8). It is also possible to aggregate two carriers in separate spectrum bands (Release 9). In Release 10, it is possible to aggregate 4 carriers in two separate spectrum bands. 3GPP Release 9 and Release 10 specify the following pairs of bands for the HSPA dual band and dual carrier.

Table 2.8

Band Number	Band Name	Frequencies (MHz)
1+8 (ITU Region 1)	IMT Core Band GSM 900	1920-1980/2110-2170 880-915/925-960
2+4 (ITU Region 2)	PCS 1900 AWS	1850-1910/1930-1990 1710-1755/2110-2155
1+5 (ITU Region 3)	**IMT Core Band 850**	**1920-1980/2110-2170 824-849/869-894**
1+11 (ITU Region 3)	IMT Core Band 1500 (Japan)	1920-1980/2110-2170 1428-1453/1476-1501
2+5 (ITU Region 2)	PCS 1900 850	1850-1910/1930-1990 824-849/869-894

2.22 Telstra (the operator in Australia) offers HSPA+ mobile broadband services in the 850 MHz band. In fact, it provides dual mode LTE/HSPA+ services for seamless operation across the 1800 MHz band and 850 MHz bands. A large number of operators are providing newer generation of evolved networks such as HSPA+ and Dual-carrier HSPA+ (DC HSPA+) in 850/900/1900/2100 MHz bands as may be seen in the Table below:

Table 2.9

Technology	No. of networks*	No. of countries	No. of devices (Aug 2012)
DC HSPA+ (42 Mbps)	145 (i.e. 27% of total HSPA networks)	75	172
HSPA+ (28 Mbps)	338 (i.e. 63% of total HSPA networks)	148	442
HSPA with 7.2 Mbps and above	446 (i.e. 84% of total HSPA networks)		2265
Total HSPA networks	**532**	**203**	**3847**

***Multi-band networks e.g. 900/2100 MHz, 850/2100 MHz etc. are counted as single networks.

2.23 There are many spectrum bands in which LTE networks are being deployed globally and currently there are 263 commercially launched LTE networks in 97 countries[10]. As per the GSA (Global mobile Suppliers Association) report of December 2013, 1240 LTE user devices have been launched in the market by 120 suppliers, including 87 Category 4 devices[11]. The 850 MHz band is also among the prominent LTE bands. Although the number of countries where LTE850 networks have been commercially launched is very few, there are 189 devices presently available in this band. The LTE devices ecosystems in different spectrum bands is given in the Table below[12]:

Table 2.10

LTE-FDD

3GPP band	Frequency	No. of networks	No. of Devices
3	1800	115	412
7	2600	71	448
20	800 (Europe)	31	314

[10] GSA's "Evolution to LTE Report" - 5th December 2013 by GSA
[11] Category 4 (Cat 4) offers an enhanced user experience supporting a peak downlink data rate up to 150 Mbps and peak uplink up to 50 Mbps.
[12] GSA's Report "Status of the LTE Eco System" -7th November 2013

12,13, 17	700 (US specific)	42	289
1	2100	<10	305
4	AWS (1700/2100)	21	279
5	850	<5	189
8	900	<5	174

LTE-TDD

3GPP band	**Frequency**	**No. of networks**	**No. of Devices**
40	2.3 GHz	12	184
38	2.6 GHz	9	197
42	3.5 GHz	3	15

Several devices are multi-band and multi-mode (FDD and TDD)

2.24 Two operators viz. SK Telecom and LG U+ in South Korea have launched their LTE services using 2x10 MHz spectrum in the 850 MHz in 2011 providing a maximum download speed of 150 Mbps. A year later, both these operators have commercialized Multi-Carrier (MC) service for the first time in the world. Along with its carrier in the 850 MHz band, SK Telecom used an additional 2x10 MHz carrier in the 1800 MHz band whereas LG U+ utilised a combination of carriers in the 850 MHz band and the 2100 MHz band for the MC Service.

2.25 SK Telecom launched the world's first LTE-Advanced (LTE-A) service in June 2013 by using Carrier Aggregation (CA) technology providing a user having maximum download speed of 150 Mbps with a Cat 4 user device. Carrier Aggregation (CA) technology maximizes the peak data rate and throughput by combining two carriers in different spectrum bands. A month later, LG U+ launched the LTE-A service. SK Telecom has also announced its plans to launch quad-band LTE devices (850 MHz, 1800 MHz, 2.1 GHz and 2.6 GHz) in the near future.

2.26 Philippines is another country where LTE services have been commercially launched in the 850 MHz band. Smart Communications commercially launched LTE service on August 25, 2012 in Metro Manila using the 2.1 GHz band. Subsequently, to extend coverage, commercial LTE service was launched using spectrum in the 1800 MHz and 850 MHz bands in September 2012.

2.27 KDDI Japan is using its 850 MHz spectrum along with 2100 MHz spectrum for providing LTE services. ITC, a CDMA player in Ukraine, is considering deploying LTE in 850 MHz spectrum. In Brazil, Algar Telecom (CTBC) has conducted LTE trials in 850 MHz and 1800 MHz. The Malaysian regulator, MCMC, is also consulting on re-farming 850/900/1800 MHz. In the USA, LTE deployments typically use 700 MHz (primarily band 13 or band 17) or AWS (band 4). However, it is quite likely that, in future spectrum in other bands including 850 MHz band may be refarmed for newer technologies such as LTE/LTE-Advanced.

2.28 From the foregoing paras, it is evident that the use of spectrum in the 800 MHz band is not restricted to only CDMA technology, but (a) it can also be used for WCDMA/HSPA technology as a significant eco-system of WCDMA/HSPA devices is available in this band (b) Most of the devices, which are capable of working in the 800 MHz band, can also operate in other bands (e.g. 2100 MHz band), which makes the roaming feasible (c) Number of operators are providing newer generation of evolved networks such as HSPA+ and Dual-carrier HSPA+ (DC HSPA+) in the band. Dual-carrier HSPA allows the aggregation of two carriers (d) Very high speed mobile broadband services have also been launched in South Korea using LTE and LTE –Advanced technology in this band. Therefore, it is quite likely that, more countries may deploy LTE/LTE-Advanced in this band, and (g) Eco-system for other technologies may also evolve in this band in the medium and long-term period.

BLOCK SIZE AND CONTIGUITY

2.29 For the CDMA and EVDO technology, 1.23 MHz is the prescribed carrier size. For HSPA, 5 MHz is the carrier size. LTE and LTE-A employ OFDM modulation with flexible contiguous component carriers from 1.4, 3, 5, 10, 15 and 20 MHz. LTE-A aims to allow carrier aggregation up to 100MHz. While the LTE technology allows combining multiple smaller blocks of spectrum, the larger the contiguous block of spectrum, the better is the spectral efficiency and the higher the cell

throughput. The LTE channel bandwidths below 5 MHz are only intended for existing 2G bands to migrate from 2G to LTE. These narrow bandwidths allow LTE services to be introduced progressively in these bands. However, a minimum of 5 MHz of bandwidth is required to get optimum system performance. Small channel bandwidths (<5MHz) are less efficient due to higher proportional signalling overheads, lower OFDM frequency diversity and less trunking efficiency and, hence, reduced multi-user gain.

2.30 In view of above, the Authority is of the opinion that instead of relying only on CDMA and EVDO, alternate uses of the 800 MHz band should be envisaged. The spectrum assignment should facilitate the adoption of not only EVDO, but other technologies such as HSPA, LTE, LTE-A etc. Fragmented and smaller chunks of spectrum will not only lead to reduced efficiency in the use of spectrum but also pose a hindrance to the adoption of latest technologies in line with international usage. Therefore, large contiguous blocks (at least 5 MHz) and sufficient quantum of spectrum should be made available to the operators to achieve better efficiencies and throughputs. However, before reaching any conclusion on the actual block size, in which spectrum in the 800 MHz band should be put on auction, it is essential to examine whether the spectrum is available in the contiguous blocks of 5 MHz (i.e. 4 carriers).

2.31 As mentioned in Table 2.3, 4 carriers in the 800 MHz band are likely to be available in all the LSAs except in Kolkata and Rajasthan. Out of these 22 LSAs, in 6 LSAs viz. Haryana, Himachal Pradesh, Orissa, Assam, North-East and Jammu and Kashmir, 8 or more carriers are available. However, only in 5 LSAs viz. Mumbai, Maharashtra, MP, Assam and North-East, are 4 contiguous carriers available at present. To make 4 carriers contiguous in the remaining LSAs, some realignment of the frequencies through reassignment to the existing TSPs will be required.

2.32 In response to the CP, a number of TSPs have given their comments on the feasibility of realignment of the present carrier assignment in the 800 MHz band to make the available carriers contiguous. Two of the TSPs (vis. TTSL and RCOM), who are operating in the 800 MHz band have commented that there will be significant impact on the TSPs providing CDMA services to their customers, in case carriers of the TSPs are shifted to carve out 5 MHz contiguous spectrum. These TSPs have cited the following reasons:

- The process of shifting is cumbersome and will be much more intense as the customers will be impacted across multiple circles. It may lead to customer dissatisfaction and complaints. In case new channels are not present in existing Preferred Roaming List (PRL), pan-India, PRL[13] upgrade will be needed which requires considerable time. Relocation of frequency will impact existing FWT services, non 'Removable User Identity Module (R-UIM)' based handsets and the dongles used for data services as these devices will become non-workable due to inability to retune the frequencies over the air. These subscribers will have to visit operators' premises for the manual PRL updates.
- Change in frequency will require changes in the BTS module/filter which will involve high capex and major service disruption. Most of the operators have stopped support for these equipments.
- CDMA operators would find it difficult to meet the QoS parameters.
- All statutory and mandatory regulatory clearances like revised frequency allocations, Standing Advisory Committee on Frequency Allocations (SACFA) clearances, wireless operating licences etc will have to be redone.

[13] The Preferred Roaming List (PRL) is a database residing in a wireless device that contains information used during the system selection and acquisition process. In the case of 'Removable User Identity Module (R-UIM)' based CDMA devices, the PRL resides on the R-UIM. The PRL indicates which bands, sub-bands and service provider identifiers will be scanned and in what priority order. Without a PRL, the device may not be able to roam, i.e. obtain service outside of the home area.

2.33 Another TSP (viz. SSTL), which operates in the 800 MHz band, commented that harmonization of spectrum in the 800 MHz band into contiguous blocks would lead to efficient utilization of spectrum. It would ensure that there is minimum spectrum wastage for guard-bands and channel allocation in contiguous spots would lead to cost optimization in network rollout. The TSP also proposed to reallocate 1.26 MHz carrier as opposed to current allocation of 1.23 MHz and do away with the current guard band of 600 KHz between operators. It also suggested that BSNL, TTSL and RCOM should be shifted to either sub-band "A" or "B" to help free up contiguous 2x5 MHz in either of the 2 sub-bands and SSTL may be shifted to either of the freed up 2x5 MHz slot and other contiguous block may be put for auction. The TSP further suggested that the harmonization through channel reallocation would require re-configuration of network and certain RDEL devices (mainly MTNL/BSNL) as per the new configuration plan. The cost of reconfigurations is expected to be a small fraction of the benefits which are likely to be. It emphasized that the cost for reconfiguration of networks would be a fraction of the additional proceeds from the harvested spectrum and these should be fully supported from auction proceeds. It suggested that harmonization of spectrum into contiguous blocks should be carried out immediately after auction results and all TSPs should be allowed a maximum of 6 months to reconfigure network in new assigned frequencies.

2.34 A few GSM operators also commented on the issue of reconfiguration of frequencies in the 800 MHz band. According to these TSPs, this exercise would not have any impact on the continuity of services and require retuning of small number of filters, the cost of which is negligible. Moreover, such realignments of frequencies have been unilaterally undertaken by the DoT in the 1800 MHz band.

2.35 From the above discussion, it is obvious that reconfiguration of frequencies in the 800 MHz band will require retuning of BTS RF filters as well as reconfiguration of the subscriber handsets. Very old BTSs

equipped with mechanical filters can be tuned in only 'A' or 'B" band[14] for which the filter was designed. The second generation of RF equipment can work in either of the bands (A or B), whereas the even later set of RF equipment, can work in any 10 MHz of range. Therefore, if the retuning requirement is kept limited to either within 'A' band or within 'B' band, then retuning of the RF filters will be possible even for the oldest type of equipment. However, if frequency reconfiguration requires a change of band (i.e. from band 'A' to band 'B' or vice-versa), then the older version (first generation) equipment will require a change of filters. The other two subsequent generations of equipment will require only retuning of the filters.

2.36 As far as impact of reconfiguration of frequencies on subscriber handsets is concerned, R-UIM based handsets and dongles can be reconfigured over the air (OTA) using one of the existing carriers. If a TSP has two carriers and both the carrier frequencies are to be changed, the R-UIM based handsets and dongles can be reconfigured in two steps, i.e. first one carrier and then the second carrier. Reconfiguration of Fixed Wireless Terminal (FWT) and very old handsets will have to be done manually.

2.37 Although, it may not be possible in all cases but the impact of channel reconfiguration on the TSP (i.e. BTS equipment) can be minimized if the realignment of frequencies is kept limited to a sub-band (i.e. 'A' or 'B'), in which it currently holds the frequencies. Also, efforts should be made that the TSP continues to hold at least one of its existing carriers. If it is required to change all its carriers, then sufficient time should be given to the TSPs to notify the subscribers through OTA or otherwise.

2.38 The Authority has examined the feasibility of reconfiguring the allocated frequency so as to make contiguous allocations. It has found that reconfiguration of frequencies in the 800 MHz band to make available

[14] 'A' band can use frequencies 824.04-834.99/ 869.04 to 879.99 MHz whereas 'B' band uses frequencies 835.02-844.98/ 880.02 to 889.98.

spectrum contiguous can be quite easily done and with minimum disruption (A specific illustration is given in the **Annexure 2.2**[15]). In most cases, it will require only retuning of the BTS RF filters, over the air reconfiguration of SIM based handsets and dongles, and manual reconfiguration of the FWT and older handsets. The dongles, which remain inactive during the over the air reconfiguration will also be required to reconfigured separately. However, the efforts and the expenditure required in the exercise is certainly not going to be significant. In contrast, the advantages accruing from such realignment will be very significant. Clearly, reconfiguration is both feasible, and relatively inexpensive. And, making available contiguous blocks in 5 MHz will unlock much greater value.

2.39 The purpose of making 5 MHz contiguous is to facilitate the adoption of newer technologies. Not only, would it pave the way for the adoption of newer technologies like HSPA, HSPA+, LTE, LTE-A etc to achieve better efficiencies and throughputs in the 800 MHz band but also enable the Government to realise the optimal value of the spectrum. Therefore, only after the reconfiguration of frequencies and making available at least one chunk of contiguous 4 carriers (i.e. 5 MHz of contiguous spectrum) should the spectrum be put to auction and new entrants should be allowed to bid for at least 5 MHz of spectrum. Alternatively, the NIA for the auction may clearly stipulate that only contiguous blocks of 5 MHz will be sold. However, the reconfiguration of the frequencies should be worked out while auction is underway so that the reassignment is possible to be effected on completion of the auction. However, existing TSPs in the 800 MHz band, may require an additional one or two carriers to augment their existing stock of spectrum. Therefore, the Authority is of the view that the a new entrant i.e. the TSP which does not have any spectrum holding in the 800 MHz band, must bid for a minimum of 4 carriers, whereas an existing TSP i.e. a

[15] This is just an illustration only of one of the possible ways to make at least 4 available contiguous.

TSP having some spectrum holding in the 800 MHz band should be permitted to bid for a minimum 1 block of spectrum.

2.40 **In view of the above discussion, the Authority recommends that:**

a. **The DoT should take back from MTNL its entire spectrum holding in the 800 MHz band,**

b. **BSNL should be allowed to retain only one CDMA carrier in all the LSAs except in Jammu and Kashmir, Assam and North-East LSAs, where it can retain both the carriers. The DoT should take back other carriers assigned to BSNL in the 800 MHz band.**

c. **The entire available spectrum with the DoT in the 800 MHz band should be put to auction.**

d. **At least one chunk of contiguous 5 MHz spectrum (i.e. 4 carriers) should be carved out <u>before</u> the auction. The carrier reassignment, if required, may be carried out amongst the existing TSPs in the 800 MHz band to make at least 4 contiguous carriers available. Alternatively, the NIA for the auction may clearly stipulate that only contiguous blocks of 5 MHz will be sold. However, the reconfiguration of the frequencies should be worked out while auction is underway so that the reassignment is possible to be effected on completion of the auction.**

e. **Spectrum in the 800 MHz band should be auctioned in a block size of 1.25 MHz.**

f. **A new entrant i.e. a TSP which does not have any spectrum holding in the 800 MHz band must bid for a minimum of 4 carriers. However, an existing TSP i.e. a TSP having some spectrum holding in the 800 MHz band should be permitted to bid for a minimum 1 block of spectrum. New entrants must be assigned the earmarked contiguous carriers only.**

CHAPTER- III

THE VALUATION AND RESERVE PRICE OF SPECTRUM

THE CONTEXT

3.1 At the very outset, it is important to place in stark relief the events that have occurred since the time spectrum in the 800 MHz band was last auctioned (in March 2013) and why these events have a direct bearing on the valuation of spectrum in this band today.

3.2 To recap, in its Recommendations of April 2012, the Authority valued spectrum in the 1800 MHz band on a top-down basis starting from a pan-India price that was decomposed into prices for the 22 LSAs in the same proportion as actual prices discovered for those LSAs in the auction for 3G spectrum (2100 MHz band) held in May 2010, after factoring in the relative efficiencies of the 1800 MHz band vis-à-vis the 2100 MHz band and adjustment for price escalation for one year. 80% of the resultant price was recommended as the reserve price for spectrum in the 1800 MHz band. Keeping in view their relative efficiencies, the reserve price for spectrum in the 800/900MHz bands was fixed at twice this value.

3.3 In its Recommendations of 12th May 2012, the Authority noted that, in some LSAs, the amount of spectrum available in the 800MHz band was less than 5 MHz and as such, it was not possible to offer all services with this spectrum that a truly liberalised spectrum is capable of. The reserve price of the 800 MHz spectrum could be fixed at 1.3 times the 1800 MHz reserve price only where 5 MHz spectrum in this band was not being made available. The Government further reduced this reserve price by 50% for the March 2013 auction. There was a single bidder and that too only for 8 LSAs.

3.4 Since then, the Authority has specifically addressed the question of valuing spectrum in the 1800 MHz band (and the 900 MHz band for the

three metros). The methodology adopted by the Authority was bottom-up to determine a value for spectrum in each LSA, the sum total of which would be the effective pan-India spectrum valuation. These specific valuations then led to a reserve price based on those valuations.

3.5 The second major event has been the auction of February 2014 which has enabled price discovery for all 22 LSAs in the 1800 MHz band and for the 900MHz band in three metro LSAs. The relative success of the auction is vindication of both the valuation based reserve price as well as the bottom-up processes through which the valuation was made in the first place.

3.6 Some segments of the media have erroneously referred to the most recent auctions as "2G auctions". In actual fact, they were auctions of spectrum in the 900 and 1800 MHz bands both of which have hitherto been bands on which 2G was the technology rolled out. But it is clear to all that the purchase of the 900 and 1800 MHz spectrum and the valuations now discovered have little to do with 2G. In fact, the recurring theme in both print and visual media is that the spectrum is to be deployed for 3G and 4G services viz. HSPA, HSPA+, FD-LTE and this fact has also been clearly indicated by some of the TSPs themselves.

3.7 These events have a direct bearing on how we proceed to value 800 MHz spectrum today. First, even if one wanted to believe, for a moment, that 800 MHz spectrum would continue to be used for the next 20 years exclusively for 2G type (CDMA) services, and if one were to presume that the 1800 MHz spectrum too would be applied for 2G, then the technical efficiency advantages between the 800 and 1800 MHz band spectrum would clearly need to be factored in the valuation exercise. Second, now that the 1800 MHz spectrum prices have been discovered, no valuation for any future auction can proceed further without taking into account these discovered prices in the valuation. Third, if anything,

the methodologies used in valuing spectrum on a bottom-up basis appear to have found favour with the market. There is, therefore, good reason for the Authority to persevere with this approach precisely because it seems to work. These considerations have guided the decisions and recommendations of the Authority in the valuation of the 800 MHz spectrum.

VALUATION OF 800 MHZ SPECTRUM

3.8 In Chapter III of the CP, various approaches to the valuation of 800 MHz spectrum had been discussed. In responding to the questions raised in the Chapter, most stakeholders, while offering some comments on the specific issues connected with each method of valuation, have, by and large emphasized, (and in some cases, have confined themselves to) two divergent but definite views regarding valuation and the reserve price for 800 MHz spectrum.

3.9 The first set of responses, emanating from existing holders of 800 MHz spectrum (CDMA operators), proceed broadly on the premise that whilst operators require additional spectrum in the band to serve customers and expand CDMA service offerings, there are certain intrinsic techno-commercial problems associated with the 800 MHz spectrum band in India that tend to attenuate its valuation. These responses primarily point to the problems of (1) the lower quantum of spectrum availability in the band compared to the 900/1800 MHz GSM bands, and, (2) the lack of contiguity in making up at least 5 MHz of spectrum in the 800 MHz band so as to ensure its use as liberalized spectrum. The overall supply constraints and non-contiguity are perceived as increasing the transaction costs associated with the 800 MHz band, thereby reducing its value. These responses also broadly argue that the valuation of the 800 MHz band should not be linked to the potential growth-path that may become available with the introduction of LTE services in the band, since the smaller cell sizes that are necessary for LTE or LTE Advanced data and non-voice services (especially in dense urban and suburban

areas) preclude coverage benefits that would have otherwise accrued due to propagation characteristics of the 800 MHz band. They also argue that the 1800 MHz band is internationally coming to be preferred as the default band for LTE and as such, the valuation of the 800 MHz band should be at a discount to that of the 1800 MHz band. Factors such as the supply constraints, non-contiguity, the poor device ecosystem for 800 MHz, and the absence of a clear migration path to 4G make out a case, according to these stakeholders, for valuing the 800 MHz band at a level lower not only to the 900 MHz band, but indeed lower even than the 1800 MHz band. According to them, the reserve price of 800 MHz spectrum should be pegged at 0.65 times the latest 1800 MHz reserve price, as this was the ratio adopted by the Government between 800 MHz and 1800 MHz in the March 2013 auction.

3.10 The opposite view that has emerged is that alternative uses of the 800 MHz band need to be factored in while arriving at its valuation. In other words, the valuation exercise should be driven by the technological potential of the spectrum rather than by viewing it merely as a CDMA spectrum band. According to these stakeholders, this is particularly salient in the context of the declining demand for the use of 800 MHz spectrum for CDMA as evidenced in the recent surrender of spectrum by one service provider. As such, according to this view, the physical characteristics of this sub-1GHz band that make it attractive for deploying E-GSM and LTE services should form the basis for its valuation on par with the 900 MHz band. It is argued that the problems of non-contiguity, attrition of coverage benefits especially in dense urban and suburban areas, and even supply constraints, exist in the case of the 900 and 1800 MHz bands as well. In fact, according to the proponents of this view, some assignments in the 1800 MHz band also suffer from non-contiguity; however, achieving contiguity by reassignment of frequencies is simpler in the case of the 800 MHz band (because of frequency reuse) than is the case of the 1800 MHz band.

Further, they point out that one CDMA service provider already has contiguous spectrum of 5 MHz in the band in most service areas. It is argued by these stakeholders that the valuation methodology for spectrum in the 800 MHz band should be similar to that adopted by the Authority in the most recent valuation of the 900 MHz band in the interest of consistency and simplicity.

3.11 In a nutshell, one group of stakeholders is of the view that the reserve price of 800 MHz spectrum should be fixed at 0.65 times of the reserve price of 1800 MHz spectrum; the other group opines that the valuation of 800 MHz spectrum should be the same as that of 900 MHz. Both views are absolute, and each stands at an extreme. It is evident that, in either case, the holders of these views believe that there is no reason for a separate and independent assessment of the value of 800 MHz spectrum. The Authority is of the opinion that neither of these two extreme positions is tenable. The Authority notes that the views expressed have their genesis in legacy issues and the path-dependency occasioned by the differential growth in telecom services across technologies and spectrum bands. The rather stark differences in opinion between different service providers reflect not merely a lack of interest in obtaining a fair and equitable regulatory valuation of the 800 MHz spectrum but also a deep-seated anxiety to deny any economic edge to a competitive rival.

3.12 The auction of spectrum in the 900 MHz and 1800 MHz bands concluded on 13 February, 2014 and has yielded market prices in all LSAs where the respective spectrum was put on the block. The price discovered for the 900 MHz spectrum in the three metro LSAs is a market-based indicator of the intrinsic value of sub-1 GHz spectrum with similar physical characteristics and technological potential. Spectrum acquired at the market clearing price in this band can potentially be deployed for 3G services by the TSPs in addition to voice services. Acquisition of spectrum in the 1800 MHz band by existing TSPs (and new entrants) is an indicator of the attractiveness of the

band for deployment of FD-LTE services (in addition to TD-LTE services to be deployed on the 2.3GHz band) in a carrier aggregation framework. The 800 MHz band is already deployed to deliver EVDO services. Lastly, given that the 800 MHz band too is a potential FD-LTE band with increasing device support, and has far superior propagation characteristics over the 1800 MHz spectrum, one can assume that the value of spectrum in the 800 MHz band will be higher than the value of the 1800 MHz spectrum as revealed in the February 2014 auction. In general, there can be no question of valuing the 800 MHz spectrum below the 1800 MHz discovered price in the February 2014 auction.

3.13 In the Authority's view, there is a need for an objective valuation of the 800 MHz band with due regard for scientific facts, the state of technology and economic and market realities. In this backdrop, the Authority has proceeded with the examination of the various alternative ways of determining the value of spectrum in the 800 MHz band that were discussed in the CP. The two divergent stakeholder views outlined earlier also stand reflected in the responses to specific questions on alternative valuation approaches; in the following analysis, these comments are assessed for relative merit in the context of the specific approach or methodology that is under discussion.

3.14 Another point needs to be made before the different valuation methodologies are appraised. It has been the stated position of the Authority that spectrum valuation and setting a reserve price is part science and part art, and that there cannot be a single 'correct' valuation or reserve price. No single approach can completely and exactly capture every variable that influences the valuation of spectrum. The Authority, as in its previous Recommendations of 9th September 2013, had decided to adopt a reasonable average valuation based on the outputs of various methodologies which, in the Authority's opinion, had a high probability of realization in the actual world. This approach was validated by the results of the February 2014 auctions.

In the present recommendations for valuation of 800 MHz spectrum also, the Authority has followed a similar approach.

3.15 One of the estimation methods used in the valuation of the 1800 MHz spectrum was by correlating the sale prices achieved in similar LSAs with known relevant variables. However, unlike in the case of the valuation of 1800 MHz spectrum, there is very little empirical data from previous auctions in the case of spectrum in the 800 MHz band. In the March 2013 auction for 800 MHz spectrum, spectrum was actually sold only in 8 LSAs. The number of data points is, therefore, inadequate to do any kind of meaningful market data analysis either by using single variable correlation or by establishing any relationship based on regression analysis as was done during the last exercise for 1800 MHz spectrum (see the Recommendations of 9th September, 2013).

3.16 However, the value of 800 MHz spectrum in the current exercise could be derived from the value of 1800 MHz spectrum based on a comparison of relative technical efficiency. This valuation approach was previously adopted in the case of the 900 MHz spectrum (also a sub-1 GHz band) in the Recommendations on 'Valuation and Reserve Price of Spectrum' of 9th September 2013.

TECHNICAL EFFICIENCY

3.17 To value the 800 MHz band, one possible approach is to use the relative technical efficiency of the 800 MHz band over the 1800 MHz band. As per ITU, both 800 MHz and 900 MHz have been identified as IMT bands. There is a growing interest in deploying UMTS in the 800 MHz and 900 MHz frequency bands in order to reduce the cost of coverage for mobile communications services, particularly in rural areas. The coverage in 900 MHz is roughly double that in 1800 MHz. The reduction in capital and operational expenditure could be as much as 40%. Operations in the 800 MHz band enjoy similar advantages.

3.18 In TRAI's recommendations on 'Spectrum Management and Licensing Framework' dated 11th May 2010, the Authority recommended that the price of spectrum in the 900 MHz band be fixed at 1.5 times that of the 1800 MHz band. Further, in the Recommendations on the "Auction of Spectrum" dated 23rd April, 2012, it was discussed that the sub-1GHz (800/900 MHz) bands are far more efficient in terms of their propagation characteristics as compared to spectrum in 2100 MHz and other higher frequency bands. The Authority recommended that the reserve price in 800 and 900 MHz bands should be at least 2 times that of 1800 MHz band. This view was reiterated with respect to the 900 MHz band in the recommendations on 'Valuation and Reserve Price of Spectrum' of 9th September, 2013. And, one of the methodologies used for valuing the 900 MHz spectrum specifically used a multiplier of 2 on technical efficiency considerations.

3.19 In this context, the following question was raised in the CP:

Should the value of 800 MHz spectrum be derived on the basis of the value of 1800 MHz spectrum using technical efficiency factors as discussed above?

3.20 A large number of stakeholders are of the view that considering the technical characteristics and efficiency of the 800 MHz band, the Authority should adopt a uniform approach for determining the valuation of 800 MHz as has been used for valuing spectrum in 900 MHz for the auction in February 2014. One stakeholder has argued that if the proposed 800 MHz spectrum is to be sold as liberalized spectrum (i.e., technology neutral) and the TSP is free to deploy any technology like CDMA, LTE etc., the value of spectrum should be at par with that of 900 MHz spectrum. Further, one of them has opined that 880 – 890 MHz in this band should be considered for auction as E-GSM band. The rest of the band should be auctioned as 800 MHz for other usage. One other view was that the technical efficiency factor should be used for valuing 800 MHz, but it should be applied over 2100 MHz band valuations, rather than 1800 MHz band valuations.

3.21 Some stakeholders have opposed the approach of valuation of 800 MHz spectrum by using the concept of relative technical efficiency over the 1800 MHz band. In their view, the Authority's argument that 800 MHz is more advantageous vis-à-vis 1800 MHz band for area coverage is not valid in today's network deployment scenario for dense urban and suburban areas where inter-tower distances are between 400 metres and 600 metres. Also, the limited availability of spectrum in 800 MHz (only 20 MHz (paired)) with restricted contiguity as compared to 1800 MHz (55 MHz paired) is a major reason why deployment of LTE in multi-carrier mode i.e. 2*5 MHz is not a feasible option in the 800 MHz band. Further, given the small global scale of adoption of 800 MHz band at around 3% as compared to other popular bands, the device ecosystem for LTE is unlikely to develop at the same scale as in other bands to meet the Indian market's needs. Some others have argued that the value of 800 MHz spectrum should be derived independently i.e. independent of valuation of the other bands viz. 1800 or 900 MHz bands.

3.22 The Authority has examined and analyzed the comments of the stakeholders. The 800 MHz band spectrum intrinsically possesses a greater technical efficiency than 1800 MHz band in terms of cell range and coverage as has already been stated in the CP and in previous recommendations of the Authority. This technical efficiency factor could lie anywhere between 1.5 times to 2 times. The higher intrinsic technical efficiency of the 800 MHz band is indisputable. Propagation characteristics of the 800 MHz band are far superior to those of the 1800 MHz band. The laws of physics cannot (and will not) change at will of those wishing to advance a self-serving cause. Whether the spectrum is used in an urban, semi-urban or rural setting is an entirely different question which has a bearing on cost trade-offs; in fact, this very method of valuation had been addressed by the Authority in valuing 900 MHz spectrum in the Recommendations of 9th September 2013. The Authority had also clarified in the CP that the method could

not be applied to 800 MHz due to a lack of empirical data. In any event, the aim of allocating spectrum is not to limit its use to dense or semi-urban areas only, but to cover the entire geographical territory of the country including large swathes of rural areas.

3.23 Similarly, the argument that the cell size is mandatorily reduced in the deployment of LTE and LTE Advanced is an inherent feature of the technology deployed; it has nothing to do with the intrinsic technical efficiency of the spectrum band, which the technical efficiency method of valuation attempts to capture. Given the same technology, say LTE, the coverage area of the 800 MHz cell will be larger than that of the 1800 MHz spectrum cell, due to the superior propagation characteristics of the former. Also, even in urban settings, 800 MHz spectrum would have deeper penetration and therefore better in-building coverage.

3.24 As already discussed in an earlier chapter, the problem of non-availability of contiguous spectrum in 800 MHz band can be resolved by the Government by re-assignment of frequencies among the existing/prospective TSPs in the 800 MHz band. This reassignment is essential for ensuring the efficient use of spectrum in the 800 MHz band.

3.25 The stakeholders who have stated that there is a poor eco-system for LTE 850, have considered the eco-system in 850 MHz for LTE services only; they have not considered the eco-system on 850 MHz for UMTS, where there are as many as 1545 devices available. The band-wise availability of WCDMA devices has already been indicated in Chapter I of the CP (also see paras 2.19 to 2.28 of these Recommendations).

3.26 It is also interesting to note that the stakeholders who have contended that there is a poor eco-system in 850 MHz have also stated, in their counter comments on the use of E-GSM band, that any attempt to create 880-890 MHz as an E-GSM band would be retrograde as *this band can be used more efficiently for LTE deployment provided*

frequencies are re-assigned in a contiguous band (emphasis added)! This is a stark internal inconsistency; it casts doubts on both the true convictions and intentions of the holders of this view.

3.27 In view of the foregoing discussion, the Authority is of the view that one method to assess the value of 800 MHz spectrum could be to take it as 1.5 times and 2 times of the value of 1800 MHz spectrum, as had been adopted for 900 MHz in the Recommendations of 9th September, 2013.

3.28 The value of 800 MHz spectrum using technical efficiency factors of 1.5 times and 2 times over the value of 1800 MHz spectrum are at **Annexure-3.1**. The estimates of valuation of the 1800 MHz band in those LSAs where the market price has been revealed in the auction that concluded on 13 February, 2014 have been replaced by the respective prices determined in the auction.

3.29 A related question that had been raised in the CP was, whether, while estimating the relative value of 800 MHz spectrum as compared to the value of 1800 MHz spectrum, a lower efficiency factor of 1.3 times could be employed, as was done in the November 2012 auction.

3.30 In the response to DoT dated 12th May, 2012 (on the back reference received on Recommendations on 'Auction of Spectrum' dated 23rd April, 2012), the Authority had observed that in case the amount of spectrum available for auction in the 800 MHz band was less than 5 MHz it will not be possible for a TSP to offer all services that a truly liberalized spectrum can. Therefore, the Authority would be open to the Government fixing the reserve price of 800 MHz spectrum at 1.3 times (in place of 2 times) the 1800 MHz reserve price. In the auction held in November 2012, the Government decided to put up for sale a maximum of 3 blocks each of 1.25 MHz (3.75 MHz) of 800 MHz spectrum in 21 LSAs[16]. The reserve price was pegged at 1.3 times the reserve price of

[16]In some LSAs an additional block of 1.25 MHz of 800 MHz spectrum was on offer as "top-up" spectrum for a new entrant who was a provisional winning bidder to bring him to a total allocation of 2.5 MHz.

1800 MHz spectrum. There were no bidders for 800 MHz spectrum in the November 2012 auction.

3.31 The issue requires to be considered in the context of the Government's position (communicated in DoT's letter dated 20th December 2013) that the quantum of spectrum in the 800 MHz to be put to auction will be decided by it separately. In the previous auction the availability of spectrum was limited to 3 carriers only in each of the 21 LSAs; hence, it was not possible to deploy the latest technologies to provide all kinds of services. In case the Government now puts up for auction spectrum of 5 MHz or more in LSAs where such spectrum is available, a participant in the auction can acquire 5 MHz and provide all the services that are possible on a truly liberalized spectrum. In view of the above, the following question was raised in the consultation paper:

Is there any case for application of a lower efficiency factor (1.3) over the valuation of 1800 MHz spectrum, for determining the valuation of 800 MHz, as was done in the previous auction? If yes, give detailed reasons for the same.

3.32 Most stakeholders are of the view that there is no case for the application of a lower efficiency factor (1.3) over the valuation of the 1800 MHz band. Some stakeholders opined that the application of efficiency factor of 1.3 for the 800 MHz band over the valuation of 1800 MHz spectrum, for data services, would be grossly exaggerated and should not be applied. In their view, the lack of infrastructure and a well-developed device eco-system for CDMA/EVDO/ UMTS/LTE in the 800 MHz band are among the important factors that impact 800 MHz valuation. Further, the lack of spectrum contiguity, limited multi carrier growth/expansion capability, limited user and network equipment availability, lack of harmonization internationally and a diminishing subscriber and vendor base across the world also affect the valuation.

3.33 One of the stakeholders has argued that the multiple of 1.3 recommended by TRAI in 2012 was not on account of lower technical

efficiency, but was based on an erroneous view that with less than 5 MHz it was not possible to offer all services that a "truly liberalised" spectrum can. According to this stakeholder, it is not clear how this view was taken since as far back as in year 2009, CDMA operators were offering 3G EVDO services in 800 MHz band. Further, this incorrect understanding has clearly been belied as the operator who acquired 800 MHz in the March 2013 auctions is openly offering 3G plus services viz. the 800 MHz spectrum is erroneously referred to as 'CDMA spectrum', since it is being used for delivering 3G Plus services.

3.34 The Authority has carefully considered and examined the comments of all stakeholders. The Authority noted that a majority of the stakeholders opined that there is no merit in the valuation of 800 MHz spectrum by using the factor of 1.3 over the value of 1800 MHz spectrum. The Authority after a detailed analysis is of the view that there is no case for a lower efficiency factor (1.3) over 1800 MHz band for valuing 800 MHz band. In the event the spectrum available for auction is in contiguous blocks of 5 MHz (which is eminently feasible as discussed in Chapter II), it can very well be used to provide services as truly liberalised spectrum.

3.35 An operator who had already purchased spectrum in the last auction could acquire a total of 5 MHz or more if it buys additional spectrum and would be able to provide all the services possible on truly liberalized spectrum. The Authority had noted in the CP that in such a case, there would be an anomaly in the sense that one of the TSPs, (SSTL), if it reaches a holding of 5 MHz by now buying additional spectrum in the 8 SSAs in which it had earlier purchased spectrum in 2013, would have acquired 3.75 MHz spectrum (out of 5 MHz) in the previous auction at a price that was 50% of the recommended reserve price for a sub-5 MHz sale. The Authority opined that suitable ways to deal with this anomaly may have to be devised including placing restrictions on participation in the 8 LSAs where spectrum was sold in the auction held in March 2013. In its response to the CP, SSTL has

stated that the apprehension regarding consolidation of spectrum in the 800 MHz band is not valid as spectrum available with SSTL is non-contiguous spectrum and the allocated frequencies are spread across the band and cannot be used to deploy advanced LTE networks or even CDMA based EVDO services across frequencies as carrier aggregation beyond certain bandwidth is not possible.

3.36 In the current exercise it is still not known how much spectrum in the 800 MHz band is proposed to be put on the block for auction. The Authority's view on non-contiguity has already been clearly articulated in earlier paras. The problem of non-availability of contiguous spectrum in 800 MHz band can easily be resolved by the Government by suitable re-assignment of frequencies among TSPs. In the light of these facts, it would be prudent to adopt the efficiency of sub-1 GHz band that is based on intrinsic technical efficiency factors without attenuating the value on the consideration of limited availability of carriers.

3.37 The Authority is therefore of the view that a lower efficiency factor (1.3) over the valuation of 1800 MHz spectrum, for determining the valuation of 800 MHz, should not be applied.

INDEPENDENT VALUATION OF 800 MHz

3.38 The technical efficiency (in relation to 1800 MHz) arguments have merit in that they are simple in construct, transparent and easily comprehensible. However, other independent approaches that take into account ground level economic, geographic and demographic differences in different LSAs and provide valuation for the spectrum based on operational benefits/savings are also possible. The underlying premise in the technical efficiency approach is that, technically, 800 MHz and 900 MHz are assumed to be equally efficient. While this could be one approach for valuing 800 MHz spectrum, there is also a case for considering valuation of 800 MHz spectrum as an independent and separate exercise.

3.39 In India, when the initial allocations of spectrum for mobile services were made from 1994 onwards, 800 MHz spectrum was set aside for CDMA technology while 900/1800 MHz spectrum was allocated for the deployment of GSM technology. TSPs deploying GSM technology were initially allocated spectrum in the 900 MHz band; subsequently, as the availability of 900 MHz spectrum was exhausted, allotments of spectrum for GSM technology were made in the 1800 MHz band. One way of viewing the valuation of 900 MHz spectrum in India (and this methodology had been adopted by the Authority in the Recommendations of "Valuation and Reserve Price of Spectrum" of 9th September 2013) is to consider it as a substitutable resource (carrying an economic premium due to better coverage capabilities) for 1800 MHz spectrum for the provision of mobile services using GSM technology. The substitutability of 800 MHz and 1800 MHz spectrum is possible only when 800 MHz is deployed for LTE. Since deployment of LTE on 1800 MHz has not commenced in India, no empirical data is available as a basis for carrying out the economic premium calculations as was done in the case of 900 MHz spectrum.

3.40 Secondly, the direction of evolution of services in the 800 MHz and 900 MHz bands has been somewhat different. In the Indian market, GSM technology grew faster than the CDMA technology and took control of the major market share in terms of revenue and subscribers, providing predominantly voice services. International experience also indicates that, in the initial stages of development of mobile telephony, GSM is a preferred band. Thus the eco-system for GSM technology is much better developed than that for CDMA technology. However, it is also true that the Average Revenue per User from data (data-ARPU) of CDMA services is higher than the data-ARPU of GSM services (the reverse is true for non-data-ARPU). As noted in the CP, this suggests that the current business strategy of TSPs operating in the 800 MHz band is to use the spectrum for data services. Since the 800 MHz band will also be a band

for deployment of LTE, there is a strong case for valuation of 800 MHz spectrum on the basis of expected revenues from data services.

3.41 It is in this background that two separate approaches were mooted in the CP to arrive at value estimates for the 800 MHz band: (i) Valuation based on producer surplus on account of additional spectrum and (ii) Valuation based on potential growth in data services.

ESTIMATING THE VALUE OF SPECTRUM BASED ON PRODUCER SURPLUS ON ACCOUNT OF ADDITIONAL SPECTRUM

3.42 Spectrum can be valued on the basis of the producer surplus when additional spectrum is allotted to an existing TSP. As there is an inverse relationship between the quantum of spectrum allocated and the expenditure on radio access network (RAN) required for serving a particular level of demand, the allocation of additional spectrum to an existing TSP will create a producer surplus. The model is a bottom-up approach to determine the opportunity of cost savings to an average TSP in the RAN upon getting additional spectrum (opportunity/MHz).

3.43 The following question had been raised in the CP:

Should the value of spectrum in 800 MHz be assessed on the basis of producer surplus on account of additional spectrum? If you are in favour of this method, please furnish the calculation and relevant data along with the results.

3.44 The Authority received a number of comments from stakeholders on this methodology. A few stakeholders have stated that the engineering value may not always be a good indicator of the prices eventually discovered through auctions as it is not an appropriate representation of the full economies of the cellular business. While the producer surplus approach offers a close assessment of the network requirements and costs thereof, it overlooks the revenue potential of the market under consideration as well as the non-network costs of running a wireless business. Hence, it provides only a limited view of the business dynamics and consequent price an operator would be

willing to pay for spectrum. It has also been argued that the producer surplus model is voice-centric since it assumes the value of spectrum vis-à-vis the number of BTSs to be installed whereas in a mixed environment of data and voice services, characteristic data points (voice and data usage) required to determine producer surplus are not available. On the other hand, a few TSPs have opined that TRAI should adopt the same economic principles (probabilistic average valuation obtained through the method of simple mean and using technical and economic efficiency parameters) for computing the value of spectrum as used in TRAI's Recommendations of 9th September, 2013.

3.45 Taking into account all of the above, it can be said that the method has not been strongly supported by the stakeholders. A similar refrain was heard from all TSPs earlier when the Authority was considering recommendations for the 900 MHz spectrum. However, the Authority is of the view that the model can be built on LSA specific data relating to demand, subscriber growth, market concentration and spectrum availability. The producer surplus model is a bottom-up model premised on the inverse relationship between the quantum of spectrum allocated and the expenditure on RAN required to serve a particular level of demand. It uses the MOU per subscriber per month as one of the factors in estimating the network demand and in this process not only voice MOU but also MOU derived from the conversion of SMS and data usage are taken into account in the calculation. As such, the model cannot be termed voice-centric and the producer surplus can be derived even in a mixed environment of voice and data. The Authority is aware of the fact that any valuation methodology would have inherent limitations and no one method can exactly capture the real world situation. Economic modeling involves both assumptions and a degree of abstraction; it should be able to capture key aspects, provide a reasonable approximation thereto, and thereby provide insights. The Authority is of the view that valuation methodologies that are logically consistent and yield viable results should be appraised with an open

mind. Accordingly**,** the Authority has decided to run estimations of the value of 800 MHz spectrum based on the producer surplus model using available data and industry benchmarks.

3.46 The detailed methodology used in this model and results obtained are at **Annexure-3.2.**

ESTIMATING THE VALUE OF 800 MHz SPECTRUM BASED ON POTENTIAL GROWTH IN DATA SERVICES

3.47 It is a known fact that in India, there are not many takers for CDMA technology. In fact, revenue from CDMA voice services has shown a declining trend over the last 3 years. However revenue from data services presents a different picture. The total wireless revenue (Σ WR) comes from GSM and CDMA services. The total wireless revenue also has two components: a) revenue from non-data services e.g. voice and b) revenue from data services ($\Sigma WR = \Sigma WR^{ND} + \Sigma WR^{D}$). It is interesting to note while CDMA accounts for only 5% share of total wireless revenue from non-data services ($\Sigma WR^{ND}_{CDMA} / \Sigma WR^{ND} = 5\%$), it accounts for almost 25% share of total wireless revenue from data services ($\Sigma WR^{D}_{CDMA} / \Sigma WR^{D} = 25\%$). In most LSAs, the data ARPU of CDMA services is higher than the data ARPU of GSM services. The reverse is true in respect of non-data ARPU. This suggests that the current business strategy of TSPs operating in the 800 MHz band is to use the spectrum for data services. This is primarily because TSPs are deploying EVDO technology for delivering data services on "CDMA" spectrum. As mentioned earlier, for one of the CDMA operators in India (SSTL), non-voice revenue as a percentage of total revenue has increased from 16.6% in 2010 to 36% in 2012 and data card subscribers increased by 75% between 2010 and 2012. There is also an opportunity for the operator (SSTL) to migrate to HSPA, HSPA+, FD-LTE technology on this band. Since 800 MHz will also be the band for deployment of LTE, thus the Authority feels that there is a good case for

valuation of 800 MHz spectrum on the basis of expected revenues from data services.

3.48 In view of above, the following question had been raised in the CP:

Should the value to be paid for 800 MHz spectrum be based upon the potential growth in data services? If yes, please state whether you agree with the assumptions made.

3.49 The Authority received a number of comments from stakeholders on this methodology. Some stakeholders agreed with the approach. One stakeholder stated that in times to come TSPs will have to rely on enhanced and efficient data usage to recover the cost of spectrum. Hence, it becomes logical to factor the potential growth in data services. One stakeholder quoted Cisco's Visual Networking Index according to which projected mobile data traffic in India, to reach a 900 petabytes per month by 2017, up from 15 petabytes per month in 2012. Some stakeholders opined that value of spectrum in the 800 MHz band should be equal to, if not more than, the value of spectrum in the 900 MHz band.

3.50 On the other hand, some other stakeholders opined that there is no merit in linking the 800 MHz spectrum value based upon the potential growth in data services as there exists limited opportunity for growth in data in CDMA. Some stakeholders stated that the 800 MHz spectrum being auctioned is non-contiguous and cannot be used to deploy LTE efficiently. Some stakeholders stated that the data services in other bands are at a nascent stage and with the deployment of LTE in 1800/2300 MHz, HSPA in 900 MHz and future auction of 700/2500 MHz, the share of data revenue from 800 MHZ in the next 20 years is likely to reduce. Further, there are non-wireless technologies like landline and leased line connections and with the introduction of Fiber to Home (FTTH), there will be a significant increase in data usage on landline based services. Thus the correct assumption regarding share of 800 MHz in data revenue would be between 4% - 6% rather than 25% (as assumed in the CP). Some stakeholders also opined that the

assumption that revenue per unit (data and non- data usage) will remain the same over the 20 next years is not correct. In fact the general market trend is that when data usage increases, tariffs fall and do not remain constant. Therefore, the Authority should consider factoring in a fall in tariff by 5% to 8% every year in the exercise.

3.51 As is evident, the comments received are of a divergent nature. The Authority has carefully examined the opinions and comments of the stakeholders. Stakeholders' opinion that there exists only a limited opportunity for growth in data in CDMA does not hold good as the 800 MHz spectrum to be offered in the forthcoming auction will be of a liberalized nature. As stated earlier, the Authority does not consider the current non-availability of contiguous spectrum as an insurmountable obstacle to the deployment of next generation technologies like LTE on this band. This non-availability of contiguous spectrum in 800 MHz band can be simply and easily resolved by the Government by re-assignment of frequency among the existing/prospective TSPs in 800 MHz band.

3.52 The Authority also noted that a few stakeholders had not concurred with assumptions (a) regarding the share of 800 MHz band in revenue from data services and (b) that revenue per unit for data and non-data usage will remain the same. The Authority is aware that in fact almost all TSPs who acquired licenses for 3G services have started the services though the BWA licenses are at an initial stage. Services in 700 MHz/2500 MHz band, once deployed, will increase competition. However, it is also true that a clear roadmap and time horizon for deployment of these bands has not yet been announced by the Government. Further, it is necessary to emphasize that the proposed model based on potential growth of data services does not predict the revenue from data services or the share of 800 MHz in the revenue, but only attempts to project through extrapolation such revenue and the likely revenue share of the 800 MHz in view of current market trends and share of currently deployed spectrum bands. It does not purport to

take into account the services/possible uses and revenues that new bands (700 MHz/2500MHz) may generate. In understanding how a prediction and a projection might differ, the following figures may be instructive. At present, the wireless data traffic in India is around 35 petabytes per month. As per the projections in the valuation approach, wireless data usage is about 45 to 50 petabytes per month by 2017-18. On the other hand, as stated by one stakeholder, Cisco's Visual Networking Index which forecasts the data traffic usage in India states that such usage may reach 900 petabytes per month by 2017. Thus, it is clear that the projected usage in the model is very conservative and leaves sufficient headroom for proliferation of data usage both in the existing 900/1800/2300 MHz bands as well in other bands such as 700 and 2500 MHz, if indeed the high-growth predictions adverted to by the stakeholders are realised. In these circumstances, it is not unreasonable to assume that 800 MHz spectrum will continue to hold its share of data revenues projected on a "business-as-usual" basis for existing bands, over the 20 year valuation period. However, it is also true that the uptake of data usage in 3G has grown rapidly in recent months (about 20 percent between July and November 2103) while total data usage in CDMA has remained more or less static. Allowing for persistence of such a trend for some time until data services on the 800 MHz band reach their full potential, the assumption regarding the share of the 800 MHz band in data revenue has been revised downwards from 25 percent to 10 percent over the valuation period.

3.53 As far as the stakeholders' views that the revenue per unit ought to reflect a decreasing trend, the Authority notes that presently in India, retail tariff is under forbearance and TSPs fix tariffs based on their business model/competition in the market. It is also clear that there is an inverse relationship between quantity demanded of a product/service and its price. While projecting the revenue for data services, there could be a case for building in reductions in tariff. However, a TSP's tariffs are a dynamic response to cues emanating from

the market and may vary even over the very short term. TSPs are no longer in a 'race to the bottom' in their effort to garner market share, and voice tariffs are not in free fall. Tariff strategies of different TSPs may entirely diverge based on their areas of operation, market estimation, level of competition, and other business variables. There are palpable indications that consolidation is about to take place in the sector and that the number of TSPs is set to come down. The view that increase in data usage will always go hand in hand with tariff reduction may not be valid in all market scenarios. Data tariffs in India, while higher than voice tariffs, are generally low by international standards, and these cannot be expected to decline continuously throughout the next 20 years. Under the circumstances, it has been assumed in the model that data tariffs will decrease by 5% every year for a period of 5 years starting from 2014-15, and stabilize thereafter.

3.54 From a detailed reading of the stakeholders' comments, it appears that the main concerns raised by them with respect to this model are non-technological in nature (i.e. related to assumptions of share in revenue and constant revenue per unit, non-contiguity in frequencies etc.). These concerns have been discussed in detail in the foregoing analysis. Any modeling exercise is fraught with uncertainties and the assumptions made cannot be foolproof, but can only be extrapolated from existing data and trends. The Authority is therefore of the view that estimations of the value of 800 MHz spectrum based on projected growth in data services in the wireless service segment can be included in the valuation.

3.55 The detailed methodology used in this model and results obtained are at **Annexure 3.3.**

COMPARISON WITH INTERNATIONAL PRICES

3.56 An alternative approach that was explored by the Authority in the CP was the possibility of using international data as a value estimator for 800 MHz spectrum. Adopting international prices as benchmarks for

the value of spectrum was discussed in the Authority's recommendations on "Valuation and Reserve Price of Spectrum" of 9th September, 2013. It was concluded that international comparison could be adopted as a "sense check" on the value of spectrum on a pan-India basis rather than as a benchmark for its value.

3.57 The main challenge in this approach, as explained in the CP, is to identify the factors that influence spectrum value and account for inter-country differences in value of spectrum. While it may not be feasible to control for each and every factor, some major variables that may impact the value and for which data is available, are population, Gross Domestic Product (GDP), GDP per capita, tele-density, subscriber base and ARPU.

3.58 A multiple variable regression was attempted using empirical data available on prices of spectrum in a cross-section of countries and variables such as population, GDP, GDP per capita, tele-density, subscribers and ARPU in these countries. The coefficient estimates (both intercept as well slope) from the above regressions were not statistically significant. The standard errors for the coefficient estimates were also high, suggesting that the explanatory variables do not have a significant relationship with the prices (dependent variable). An alternative approach discussed in the CP, was mapping of LSAs to countries by comparing the values of the above-stated variables in each LSA, with their corresponding values in different countries.

3.59 In view of the above, the following question was raised in the CP:

Should the value of spectrum in the LSAs in India for 800 MHz be determined by utilizing the data on international prices? What other variables do you suggest for arriving at robust value estimates using the multiple regression approach? Is there any alternate approach for valuation of spectrum in 800 MHz using the data on international auctions?

3.60 Most stakeholders are of the view that the valuation of the 800 MHz band utilizing available data on international prices realized in auctions

of similar frequency bands will not be realistic, considering that other countries deploy different technologies (LTE/ WCDMA) as compared to India (CDMA), and they also have different market and economic conditions. Many of them opined that simply benchmarking against price per MHz in Purchasing Power Parity (PPP) terms is not the right way, as it ignores factors like quantum of spectrum offered, competition in the market, ARPU levels, profitability etc., resulting in wrong estimations. Further, the spectrum to be auctioned in 800 MHz is fragmented and non-contiguous and not efficient for LTE deployment. Some stakeholders have argued that international valuation could be used for estimating 800 MHz valuation only if the quality of spectrum is similar and allows deployment of next generation technologies like LTE. Further, one of them has pointed out that in the sample of values shared in the CP, there is a huge difference in the realized prices of different countries. It is difficult to establish any common list of parameters when differences are so large.

3.61 There is merit in the comments of the stakeholders. Apart from glaring disparities in the values of the key variables such as GDP, GDP per capita, and ARPU, conditions in the Indian market are really not comparable with those in the sample countries for which data is available. India is a low-ARPU high-subscriber market. The size of the market is large, yielding higher revenues even though ARPU is low. The Authority after detailed analysis is of the opinion that it would be wise to adhere to the same view on using international prices as was taken in the previous Recommendations of 9th September 2013 on "Valuation and Reserve Price of Spectrum". Rather than attempting to derive spectrum price in India directly from international prices, the latter can be used, at best, as a “sense check” on the value of spectrum assessed through other approaches.

3.62 In the light of the above, the Authority is of the view that valuation of 800 MHz spectrum in India should not be done on the basis of international prices realised in various countries.

OTHER APPROACHES

3.63 To obtain insights into alternative approaches to the valuation of spectrum, the following question was raised in the CP:

Apart from the approaches discussed above, is there any alternate approach for valuation of spectrum in 800 MHz that you would suggest? Please support your answer with detailed data and methodology.

3.64 One stakeholder has suggested that Ofcom's (UK) Additional Spectrum Methodology (ASM) could be considered as an alternative approach to the valuation of spectrum. It is observed[17] that Ofcom intended to use the ASM as an approach to revise annual license fees (ALF) for 900 MHz and 1800 MHz spectrum after the conclusion of the UK 4G auction for 800 MHz and 2.6 GHz spectrum in January 2013. The amounts bid for the 800 MHz and 2.6 GHz licences were utilized to set the ALF to reflect the full market value of 900 MHz and 1800 MHz spectrum. The auction price of 800 MHz was used for assessing market value of 900 MHz and auction price of 800 MHz and 2.6 GHz for assessing market value of 1.8 GHz. DotEcon Ltd., a UK based consultancy firm, was tasked by Ofcom to develop software modules to develop price points based on the UK 4G auctions using alternative approaches including ASM. The Authority observes that the UK 4G auction was a combinatorial clock auction using a second-price approach and cannot be directly compared to any of the recent auctions for spectrum in India. The ASM methodology, therefore, cannot be fruitfully employed as an alternative approach for spectrum valuation in the forthcoming 800 MHz spectrum auction.

3.65 None of the stakeholders has suggested any practical and robust alternative approach that could be used for valuing 800 MHz spectrum in India. One stakeholder suggested that the Discounted Cash Flow (DCF) method should be used for calculations, assuming a pragmatic, average operator, having a fair share of the market. The stakeholder

[17] See *800 MHz and 2.6 GHz linear reference prices and additional spectrum methodology: Report prepared for Ofcom*, September 2013 (London: DotEcon Ltd) [available at www.dotecon.com]

also stated that it had done an extensive analysis based on different models for calculation of reserve price of 800 MHz spectrum and would be willing to share the same with the Authority; however, the stakeholder has not discussed any method in detail nor provided any calculations.

3.66 The problems in estimating a valuation for the average 'ideal' operator using DCF methodology were discussed in the Recommendations of 9th September, 2013. Such a model would be based on predictions rather than historical data and require assumptions to be made about significant variables, with the results depending entirely on the assumptions made. The Authority is not in favour of using this method.

3.67 It may also be mentioned that individual stakeholders' positions were also not consistent across the issues raised in the CP. Some stakeholders have used arguments to critique one valuation approach and negated those very arguments to oppose another approach. For example, it is not internally consistent for the same stakeholder to criticize the producer surplus approach to the valuation of 800 MHz spectrum as voice-centric and therefore not applicable to a data band, and, at the same time, to state that the valuation approach based on growth in data services is also irrelevant since the spectrum will primarily be used for providing voice services!

3.68 The Authority noted that subsequent to the consultation process, the auction of spectrum in the 900 and 1800 MHz bands concluded on 13 February, 2014. The auction has *inter alia* yielded market prices for spectrum in the 900 MHz band in Delhi, Kolkata, and Mumbai circles. It has been the articulated position of the Authority that market-based valuation of spectrum is one amongst a range of possible estimation approaches. Where empirical data on prices of similar assets is available, it can be utilized in combination with other approaches such as technical efficiency and economic efficiency approaches to arrive at a probabilistic basic valuation that may be a better estimate of the asset's

value than that yielded by a purely deterministic approach. As has already been noted, there are strong arguments supporting the view that the technical efficiency of the 800 MHz band is similar to that of the 900 MHz band in their comparison with the 1800 MHz band in terms of enhanced coverage/capacity and related reduction in capital and operational expenditure. The 800 MHz and 900 MHz bands have been identified as IMT bands by ITU and there is a growing interest in deploying UMTS in these bands. As such, the Authority is of the view that where auction determined market prices of either of these bands are available, these prices can be utilized as one amongst the range of valuations of spectrum in the other band. Given that the February 2014 auction has revealed the market prices of 900 MHz in Delhi, Kolkata, and Mumbai LSAs, these prices have also been used in arriving at the probabilistic average of spectrum valuation of 800 MHz spectrum in these 3 LSAs.

3.69 As discussed above, the Authority has assessed the value of 800 MHz spectrum using a number of alternative approaches. As already acknowledged in the previous Recommendations of the Authority of 9th September 2013 on 'Valuation and Reserve Price of Spectrum', there are uncertainties and limitations in all the approaches and therefore, the Authority is of the view that rather than follow a deterministic approach, it is best to work with a probabilistic average valuation that captures the range of possible valuations that have been attempted. On the assumption of equal probability of occurrence of each valuation, an expected average valuation for 800 MHz spectrum can be calculated as the simple mean of the various valuations that have been attempted. As in the recommendations of 9th September 2013, the Authority has therefore decided to utilise the average expected valuation obtained through the method of the simple mean. **Annexure 3.4** is a LSA- wise tabulation of the values for 800 MHz obtained through various approaches and the simple mean of these values. The average valuations of 800 MHz spectrum are also tabulated below:

TABLE 3.1

VALUE PER MHz IN 800 MHz BAND

(Rs. in crore)

LSA	Category	Value per MHz
Delhi	Metro	**562.78**
Mumbai	Metro	**440.16**
Kolkata	Metro	**126.87**
Andhra Pradesh	A	**240.34**
Gujarat	A	**264.56**
Karnataka	A	**248.35**
Maharashtra	A	**352.56**
Tamilnadu	A	**308.57**
Haryana	B	**37.96**
Kerala	B	**86.77**
Madhya Pradesh	B	**80.46**
Punjab	B	**78.58**
Rajasthan	B	**73.56**
U. P. (East)	B	**104.90**
U.P. (West)	B	**116.46**
West Bengal	B	**58.06**
Assam	C	**33.48**
Bihar	C	**76.39**
Himachal Pradesh	C	**16.51**
Jammu & Kashmir	C	**10.58**
North East	C	**9.43**
Orissa	C	**31.18**
Pan India		**3358.49**

RESERVE PRICE ESTIMATION

3.70 A reserve price is the minimum amount that the owner of an item up for auction will accept as the winning bid in the auction. The reserve

price prevents the auction from being won at a price lower than the minimum the owner is willing to accept. A reserve price is used primarily for two reasons: a) to increase revenue from the auctions, and b) to avoid collusion. These two objectives need to be balanced. While a low reserve price may lead to a collusive outcome and loss of revenue, a high reserve price may result in spectrum remaining unsold. The computation of an optimal reserve price requires information regarding the range of possible valuations of the spectrum and the probability of each valuation being realized. Reserve prices are designed to protect the owner of an auctioned item from an unfavourable outcome. However, auction bidders dislike reserve prices because they reduce the possibility of winning the auction at a bargain price, and because a reserve price creates uncertainty over the price that must finally be paid to win the auction.

3.71 The concept of auction efficiency, revenue maximization, reserve price in an auction and international practices were discussed in detail in the Authority's Consultation Paper dated 23rd July 2013 on 'Valuation and Reserve Price of Spectrum'. Subsequent to that consultation, the Authority in its Recommendations of 9th September 2013 on 'Valuation and Reserve Price of Spectrum' decided that the reserve prices should be fixed at 80% of the average valuation for the 900 and 1800 MHz spectrum auctions. While making this recommendation, the Authority had noted that the reserve price is only the starting point in the process of price discovery. It was also observed that the reserve prices should be lower than estimates of valuation to encourage competitive bidding and price discovery. However, special circumstances, if any, arising in any of the markets in which spectrum is being sold need to be kept in mind while fixing reserve prices.

3.72 In the present exercise of fixing the reserve price for the 800 MHz band, the following question had been asked in the CP:

What should be the ratio adopted between the reserve price for the auction and the valuation of the spectrum? Would it be optimal to fix reserve price equal to valuation of spectrum?

3.73 Most stakeholders opined that the recommended ratio of 80% as per the Authority's Recommendations of 9th September 2013 on 'Valuation and Reserve Price of Spectrum' is fair and reasonable. They submitted that the Authority should maintain its earlier stand and the ratio between reserve price of 800 MHz and valuation of spectrum for 800 MHz should be kept at 80%. Some stakeholders have argued that to cater to the large uncertainty in value estimates, the reserve prices should be set conservatively e.g., at 50 % of estimated marginal valuations; at this level most of the incentives for collusion between operators should disappear, and prices should normally rise to the "market-clearing" market-determined price. Some stakeholders drew the Authority's attention to the last auction for 800 MHz spectrum in which there was only a single bidder; if this lack of competition was to persist, spectrum in 800 MHz could once again be sold at the base or reserve price and therefore, it would be prudent to fix the reserve price equal to the valuation of spectrum. One stakeholder opined that given the superior propagation characteristics of 800 MHz spectrum over 900 MHz spectrum, the reserve price for 800 MHz should be equal to, if not more than, the reserve price for 900 MHz .

3.74 The Authority has carefully considered all the comments received from the stakeholders. Considerations pertaining to auction efficiency, revenue maximization and international practices weighed with the Authority when it recommended that reserve prices should be fixed at 80% of the valuation of spectrum for 1800 MHz (see Recommendations of 9th September, 2013). To briefly recapitulate, the reserve price should not be fixed too close to the estimate of valuation, so as to encourage participation, enable competitive bidding and lead to price discovery. Equally, too low a reserve price can engender collusion amongst participants. This is why a balance has to be truck.

3.75 Now, for reasons of sheer consistency alone, the Authority could adopt the 80% factor for setting reserve price, as was done in the case of the 900 MHz and 1800 MHz Recommendations. It is important to recognize, however, that this was premised on the basis that there would be a number of competitive bidders participating in the auction. One cannot, of course, predict *a priori* who will or will not participate in the forthcoming auction. If indeed more than one TSP decides to bid for the 800 MHz spectrum, then setting the reserve price on the basis adopted for the 900 MHz and 1800 MHz spectrum auctions would indeed be conducive to price discovery. If that was not the case, economic theory would suggest setting the reserve price at full valuation. Why? If for instance there is a single bidder for an object in an auction and a reserve price is set, then that reserve price becomes the auction determined price because there is no other competitive bidder.

3.76 Unlike 900/1800 MHz spectrum, in the case of the 800 MHz spectrum, path-dependency has ensured that competition amongst TSPs using this band is more limited than in the GSM bands. Of the 2-4 TSPs (including PSUs) using CDMA technology in this band, one TSP has recently surrendered spectrum in the 800 MHz band; another TSP holds spectrum in ample quantities (5 MHz in some LSAs). Neither TSP participated in the auctions of November 2012/ March 2013. The PSUs too are unable to show aggressive intent in expanding the scope of services or acquiring spectrum in this band. These facts indicate the possibility that there may not be any significant measure of competitive bidding for acquiring spectrum in the 800 MHz band.

3.77 On the other hand, the rationale for setting reserve price lower than valuation is premised on the considerations explained below.

a) The computation of an optimal reserve price requires information on the range of possible valuations of the spectrum and the probability of each valuation being realized. As pointed out in the Recommendations of 9th September, 2013, it is

difficult, if not impossible, to calculate the complete range of possible valuations; however, an average valuation as a simple mean of available estimates can be computed. This average valuation itself could be taken as a reserve price. The drawback of this method is that there is no way of knowing whether the theoretical optimum i.e. the mid-point of the complete range of valuations has been achieved. The danger is that it may end up fixing the reserve price on a higher side resulting in failed auction.

b) The 800 MHz band has enormous potential for deployment of new technologies. As discussed in chapter II, the use of spectrum in the 800 MHz band is not restricted to only CDMA technology, but (a) it can also be used for WCDMA/HSPA technology as a significant eco-system of WCDMA/HSPA devices is available in this band (b) Most of the devices, which are capable of working in the 800 MHz band, can also operate in other bands (e.g. 2100 MHz band), which makes the roaming feasible (c) Number of operators are providing newer generation of evolved networks such as HSPA+ and Dual-carrier HSPA+ (DC HSPA+) in the band. Therefore, there is a distinct possibility that apart from the incumbent operators in the 800 MHz band, others too may wish to bid for spectrum in this band specially if it available in contiguous blocks of 5 MHz. A lower reserve price will encourage participation and allow the discovery of the market value of the spectrum.

3.78 Equally, the mere fact of competitive bidding is no assurance that the valuation will be realized, even if reserve prices are set below it. Competition is not the sole determinant for taking bid prices above reserve price and ensuring sale of spectrum. It is interesting that in the recently concluded auctions for the 1800 MHz, in spite of robust participation of bidders, spectrum was sold at the reserve price in 11 out of 22 LSAs; out of these 11 LSAs, quantities of spectrum remained

unsold in 10 LSAs. In as many as 7 LSAs, the sale was at a reserve price that was kept at 80% or less of the valuation.

3.79 In view of the above and taking the entirety of the circumstances into consideration and consistent with the decision taken by the Authority in the Recommendations of 9th September 2013, the Authority is of the opinion that balance of convenience lies in erring towards caution. **Therefore, the Authority recommends that the reserve price for the forthcoming auction of 800 MHz spectrum should be fixed at 80% of the average valuation.**

3.80 **The recommended reserve prices for the forthcoming auction are tabulated below:**

TABLE 3.2
RESERVE PRICE PER MHz IN 800 MHz BAND

(Rs.in crore)

LSA	Category	Reserve Price per MHz (as calculated)	Recommended Reserve Price per MHz (rounded off)
Delhi	**Metro**	**450.22**	**450**
Mumbai	**Metro**	**352.13**	**352**
Kolkata	**Metro**	**101.49**	**101**
Andhra Pradesh	**A**	**192.28**	**192**
Gujarat	**A**	**211.65**	**212**
Karnataka	**A**	**198.68**	**199**
Maharashtra	**A**	**282.05**	**282**
Tamilnadu	**A**	**246.85**	**247**
Haryana	**B**	**30.37**	**30**
Kerala	**B**	**69.41**	**69**
Madhya Pradesh	**B**	**64.37**	**64**
Punjab	**B**	**62.86**	**63**
Rajasthan	**B**	**58.85**	**59**
U. P. (East)	**B**	**83.92**	**84**
U.P. (West)	**B**	**93.17**	**93**

West Bengal	**B**	**46.45**	**46**
Assam	**C**	**26.79**	**27**
Bihar	**C**	**61.12**	**61**
Himachal Pradesh	**C**	**13.20**	**13**
Jammu & Kashmir	**C**	**8.46**	**8**
North East	**C**	**7.55**	**8**
Orissa	**C**	**24.94**	**25**
Pan India		**2686.79**	**2685**

CHAPTER- IV

SUMMARY OF THE RECOMMENDATIONS

4.1 The Authority recommends that:

a. **The DoT should take back from MTNL its entire spectrum holding in the 800 MHz band,**

b. **BSNL should be allowed to retain only one CDMA carrier in all the LSAs except in Jammu and Kashmir, Assam and North-East LSAs, where it can retain both the carriers. The DoT should take back other carriers assigned to BSNL in the 800 MHz band.**

c. **The entire available spectrum with the DoT in the 800 MHz band should be put to auction.**

d. **At least one chunk of contiguous 5 MHz spectrum (i.e. 4 carriers) should be carved out before the auction. The carrier reassignment, if required, may be carried out amongst the existing TSPs in the 800 MHz band to make at least 4 contiguous carriers available. Alternatively, the NIA for the auction may clearly stipulate that only contiguous blocks of 5 MHz will be sold. However, the reconfiguration of the frequencies should be worked out while auction is underway so that the reassignment is possible to be effected on completion of the auction.**

e. **Spectrum in the 800 MHz band should be auctioned in a block size of 1.25 MHz.**

f. **A new entrant i.e. a TSP which does not have any spectrum holding in the 800 MHz band must bid for a minimum of 4 carriers. However, an existing TSP i.e. a TSP having some spectrum holding in the 800 MHz band should be permitted**

to bid for a minimum 1 block of spectrum. New entrants must be assigned the earmarked contiguous carriers only.

4.2 The Authority recommends that the reserve price for the forthcoming auction of 800 MHz spectrum should be fixed at 80% of the average valuation.

4.3 The recommended reserve prices for the forthcoming auction are tabulated below:

TABLE
RESERVE PRICE PER MHz IN 800 MHz BAND

(Rs.in crore)

LSA	Category	Reserve Price per MHz (as calculated)	Recommended Reserve Price per MHz (rounded off)
Delhi	Metro	450.22	450
Mumbai	Metro	352.13	352
Kolkata	Metro	101.49	101
Andhra Pradesh	A	192.28	192
Gujarat	A	211.65	212
Karnataka	A	198.68	199
Maharashtra	A	282.05	282
Tamilnadu	A	246.85	247
Haryana	B	30.37	30
Kerala	B	69.41	69
Madhya Pradesh	B	64.37	64
Punjab	B	62.86	63
Rajasthan	B	58.85	59
U. P. (East)	B	83.92	84
U.P. (West)	B	93.17	93
West Bengal	B	46.45	46
Assam	C	26.79	27
Bihar	C	61.12	61
Himachal Pradesh	C	13.20	13

Jammu & Kashmir	**C**	**8.46**	**8**
North East	**C**	**7.55**	**8**
Orissa	**C**	**24.94**	**25**
Pan India		**2686.79**	**2685**

Annexure-1.1

Government of India
Ministry of Communications & IT
Department of Telecommunications
WPC Wing, Sanchar Bhavan, New Delhi 1

No.: L-14006/03/2013-NTG Dated 12.12.2013

To

The Secretary,
Telecom Regulatory Authority of India,
Mahanagar Doorsanchar Bhawan,
Jawahar Lal Nehru Marg, (Old Minto Road),
New Delhi 110002.

Subject: TRAI recommendations on reserve price for 800 MHz band in all the service areas.

Sir,

Undersigned is directed to state that it has been decided to conduct another round of auction of spectrum for 800 MHz band in all the service areas.

2. The EGoM in its meeting held on 22nd November, 2013, directed the Department to request the TRAI to recommend reserve price for 800 MHz band in all the service areas to enable auction.

3. TRAI is, therefore, requested to furnish their recommendations on reserve price for 800 MHz band in all the service areas in terms of clause 11(1)(a) of TRAI Act 1997 as amended by TRAI Amendment Act 2000.

Yours faithfully,

(R.B.Prasad)
Joint Wireless Adviser

Annexure-1.2

Government of India
Ministry of Communications and IT
Department of Telecommunications
(WPC Wing)

No. L-14006/03/2013-NTG Dated the 20th December, 2013

The Secretary,
Telecom Regulatory Authority of India,
Mahanagar Doorsanchar Bhawan,
Jawahar Lal Nehru Marg,
(Old Minto Road),
New Delhi – 110 002

Sub: TRAI Recommendations on Reserve Price for auction of spectrum in 800 MHz band.

Sir,

I am directed to refer to your letter No. 103-9/2013-NSL-II dated 13th December, 2013 on the above subject. The information sought is as below, on issues raised in Para 8 of your above referred letter:

(a) The consultation with the Ministry of Defence on the feasibility of shifting their existing frequency assignments from 925-935 MHz band to 834-844 MHz band was undertaken. Defence has intimated that due to their operational requirements, it is not feasible to migrate the equipment to other bands in a definite time frame.

(b) It was decided in June 2012 by the Government to put to auction three (3) blocks each of 1.25 MHz (3.75 MHz) during November, 2012 and March, 2013 auction of 800 MHz band. In addition, it was also decided to make a provision for spectrum of one (1) block of 1.25 MHz, wherever available, for topping up the 3 blocks of spectrum put to auction, to meet the requirement of new entrants, if such an exigency arises. In the service areas of Punjab and Andhra Pradesh,

two (2) blocks of each of 1.25 MHz (2.50 MHz) was put to auction and no spectrum was put to auction in the service area of Rajasthan.

It has now been decided by the Government in November, 2013 to seek TRAI Recommendations for the reserve price in 800 MHz band in all service areas to enable auction. The quantum of spectrum in 800 MHz band to be put to auction will be decided by the Government separately.

(b) Government in June, 2012 decided that in future all spectrum to be assigned shall be liberalised. In other words, spectrum in any band can be used for providing any service within the scope of the respective service licenses using any technology.

2. As far as confirmation sought vide para 7 of the above TRAI letter, it is confirmed that all the details mentioned in para 7 of TRAI letter were placed before the EGoM. Moreover, the decision to auction spectrum in 800 MHz band is policy of the Government in terms of the Section 25 of the TRAI Act, 1997, as amended from time to time. Further, it is worthwhile to mention that Cabinet has directed that the reserve price of spectrum in 800 MHz band be also finalised expeditiously.

Yours faithfully,

(R. B. Prasad)
Joint Wireless Adviser

Annexure-1.3

CONFIDENTIAL

Government of India
Ministry of Communications & IT
Department of Telecommunications
(WPC Wing)

No.L-14006/03/2013-NTG Dated the 24th December, 2013

To

The Secretary
Telecom Regulatory Authority of India,
MahanagarDoorsancharBhawan,
JawaharLal Nehru Marg,
(Old Minto Road),
New Delhi – 110002.

Subject: TRAI recommendation on reserve price for auction of spectrum in 800 MHz.

Sir,

This has reference to DO No.103-9/2013-NSL-II dated 24th December, 2013 addressed to Secretary, Department of Telecommunication regarding recommendations on reserve price for auction of 800 MHz spectrum.

2. There is no intention of the Government to issue direction under Section 25 of TRAI Act. The recommendations for reserve price for auction of spectrum in 800 MHz band in all service areas has been sought under clause 11(1) (a) as was mentioned in this Ministry's letter of even No. dated 12.12.2013.

Yours faithfully

O/C

(R.B. Prasad)
Joint Wireless Adviser

Annexure 2.1

CDMA CARRIERS ASSIGNMENTS (Taking into account the proposed surrender of spectrum by the PSUs)

S. No.	Metro Circles	1	42	83	124	0.6	185	226	267	308	0.6	369	410	451	492	0.6	553	594
		1.23	1.23	1.23	1.23		1.23	1.23	1.23	1.23		1.23	1.23	1.23	1.23		1.23	1.23
		870.03	871.26	872.49	873.72		875.55	876.78	878.01	879.24		881.07	882.3	883.53	884.76		886.59	887.82
1	Delhi	AVAILABLE (MTNL surrendered)	AVAILABLE	AVAILABLE (MTNL surrendered)	SSTL		RCL	RCL	RCL	RCL		AVAILABLE (TTL surrendered)	TTL	TTL	TTL		SSTL	SSTL
		870.03	871.26	872.52	874.02		875.55	876.78	878.01	879.24		881.07	882.3	883.53	884.76		886.59	887.82
2	Mumbai	TTML	TTML	TTML	AVAILABLE (TTML surrendered))		AVAILABLE (MTNL surrendered)	AVAILABLE (MTNL surrendered)	AVAILABLE	AVAILABLE		AVAILABLE	AVAILABLE		RCL		RCL	RCL
		1	42	83								369	410		471		553	594
		870.03	871.26	872.49	873.72		875.55	876.78	878.01	879.24		881.07	882.3		884.13		886.59	887.82
3	Kolkata	AVAILABLE	BSNL	AVAILABLE (bsnl surrendered)	AVAILABLE (TTL surrendered)		TTL	SSTL	TTL	SSTL	SSTL		RCL	RCL	RCL	RCL		
			42				185		288	339	380		451	492	533	574		
		870.03	871.26	872.49	874.32		875.55	877.08	878.64	880.17	881.4		883.53	884.76	885.99	887.22		
A' Service Areas																		
1	AP	AVAILABLE	Vacant	BSNL	AVAILABLE (bsnl surrendered)		AVAILABLE	AVAILABLE (TTL surrendered)	TTL	TTL		RCL	RCL	RCL	RCL		AVAILABLE	AVAILABLE
				78					267	308		369	410	451	492			
		870.03		872.34	873.57		875.55	876.78	878.01	879.24		881.07	882.3	883.53	884.76		886.59	887.82
2	Gujarat	TTL	TTL	SSTL	SSTL		AVAILABLE	AVAILABLE (TTL surrendered)	BSNL	AVAILABLE (bsnl surrendered)		SSTL	AVAILABLE	AVAILABLE			RCL	RCL	RCL
		1	42	93	134				279								512	553	594
		870.03	871.26	872.79	874.02		875.55	876.78	878.37	879.6		881.07	882.3	883.53			885.36	886.59	887.82
3	Maharashtra	AVAILABLE (TTL surrendered)	TTML	TTML	AVAILABLE (TTL surrendered)		AVAILABLE	AVAILABLE	AVAILABLE	Vacant		AVAILABLE (bsnl surrendered)	BSNL	AVAILABLE			RCL	RCL	RCL	RCL
			42	83									388				471	512	553	594
		870.03	871.26	872.49	873.72		875.25	876.48	878.01			880.41	881.64				884.13	885.36	886.59	887.82
4	Karnataka	AVAILABLE	BSNL	AVAILABLE (bsnl surrendered)	SSTL		TTL	TTL	AVAILABLE (TTL surrendered)	AVAILABLE		RCL	RCL	RCL	RCL		SSTL	SSTL		
			42				185	226				369	410	451	492		553	594		
		870.03	871.26	872.49	874.02		875.55	876.78	878.01	879.24		881.07	882.3	883.53	884.76		886.59	887.82		
5	Tamil Nadu	AVAILABLE	BSNL	AVAILABLE (bsnl surrendered)	SSTL		AVAILABLE (TTL surrendered)	TTL	TTL	AVAILABLE		RCL	RCL	RCL	RCL		SSTL	SSTL		
			42					226	267			369	410	451	492		553	594		
		870.03	871.26	872.49	874.02		875.55	876.78	878.01	879.24		881.07	882.3	883.53	884.76		886.59	887.82		

Annexure 2.1 (Continued)

CDMA CARRIERS ASSIGNMENTS (Taking into account the proposed surrender of spectrum by the PSUs)

		1	42	83	124		185	226	267	308		369	410	451	492		553	594
		1.23	1.23	1.23	1.23	0.6	1.23	1.23	1.23	1.23	0.6	1.23	1.23	1.23	1.23	0.6	1.23	1.23
		870.030	871.260	872.490	873.720		875.550	876.780	878.010	879.240		881.070	882.300	883.530	884.760		886.590	887.820
S. No	"B" Service Area																	
1	HARYANA	AVAILABLE	BSNL	AVAILABLE (bsnl surrendered)	AVAILABLE		RCL	RCL	RCL	AVAILABLE		AVAILABLE (TTL surrendered)	TTL	TTL	AVAILABLE		AVAILABLE	AVAILABLE
			42				185	226	267				410	451			553	594
		870.03	871.26	872.49	873.72		875.55	876.78	878.01	879.24		881.07	882.3	883.53	884.78		886.59	887.82
2	MP	AVAILABLE	Vacant	BSNL	AVAILABLE (bsnl surrendered)		AVAILABLE	AVAILABLE	AVAILABLE	AVAILABLE		RCL	RCL	RCL	RCL		TTL	TTL
				75								369	410	451	492		553	594
		870.03		872.25	873.48		875.55	876.78	878.01	879.24		881.07	882.3	883.53	884.76		886.59	887.82
3	PUNJAB	AVAILABLE	HFCL	HFCL	AVAILABLE		BSNL	AVAILABLE (bsnl surrendered)		AVAILABLE		RCL	RCL	RCL			TTL	TTL	AVAILABLE (TTL surrendered)
			42	83	134		213			308		369	410	451			512	553	
		870.03	871.26	872.49	874.02		876.39	877.62		879.24		881.07	882.3	883.53			885.36	886.59	887.82
4	RAJASTHAN	Vacant	BSNL	AVAILABLE (TTL surrendered)			SSTL	SSTL	SSTL	SSTL		TTL	AVAILABLE (bsnl surrendered)		RCL	RCL	RCL		TTL
			37				160	201	242	283		337			451	492	533		594
			871.11	872.94			874.80	876.03	877.26	878.49		880.11	881.94		883.53	884.76	885.99		887.82
5	KERALA	BSNL	AVAILABLE (bsnl surrendered)	AVAILABLE (bsnl surrendered)	SSTL		AVAILABLE	AVAILABLE (TTL surrendered)	TTL	TTL		RCL	RCL	RCL	RCL		SSTL	SSTL
		1			134				267	308		369	410	451	492		553	594
		870.03	871.26	872.49	874.02		875.55	876.78	878.01	879.24		881.07	882.3	883.53	884.76		886.59	887.82
6	UP(E)	AVAILABLE	BSNL	AVAILABLE (bsnl surrendered)	AVAILABLE		AVAILABLE (TTL surrendered)	TTL	TTL	AVAILABLE		RCL	RCL	RCL	RCL		AVAILABLE	AVAILABLE
			42					226	267			369	410	451	492			
		870.03	871.26	872.49	874.02		875.55	876.78	878.01	879.24		881.07	882.3	883.53	884.76		886.59	887.82
7	UP(W)	AVAILABLE	BSNL	AVAILABLE (bsnl surrendered)	SSTL		RCL	RCL	RCL	RCL		AVAILABLE	TTL	TTL	AVAILABLE (TTL surrendered)		SSTL	SSTL
			42		134		185	226	267	308			410	451			553	594
		870.03	871.26	872.49	874.02		875.55	876.78	878.01	879.24		881.07	882.3	883.53	884.76		886.59	887.82
8	WEST BENGAL	AVAILABLE	BSNL	AVAILABLE	TTL		AVAILABLE	SSTL	AVAILABLE	TTL		SSTL	SSTL	RCL	RCL	RCL		AVAILABLE
			42		144					308		359	400	451	492	533		
		870.03	871.26	872.49	874.32		875.55	876.78	878.01	879.24		880.77	882.00	883.53	884.76	885.99		887.82

CDMA CARRIERS ASSIGNMENTS (Taking into account the proposed surrender of spectrum by the PSUs)

		1	42	83	124		185	226	267	308		369	410	451	492		553	594
		1.23	1.23	1.23	1.23	0.6	1.23	1.23	1.23	1.23	0.6	1.23	1.23	1.23	1.23	0.6	1.23	1.23
		870.030	871.260	872.490	873.720		875.550	876.780	878.010	879.240		881.070	882.300	883.530	884.760		886.590	887.820
S. No.	"C" Service Area																	
1	ASSAM	AVAILABLE	BSNL 42	BSNL 83	AVAILABLE		AVAILABLE	AVAILABLE	AVAILABLE	AVAILABLE		RTL 369	RTL 410	AVAILABLE	AVAILABLE		AVAILABLE	AVAILABLE
		870.03	871.26	872.49	873.72		875.55	876.78	878.01	879.24		881.07	882.3	883.53	884.76		886.59	887.82
2	BIHAR	AVAILABLE	BSNL 42	AVAILABLE (bsnl surrendered)	AVAILABLE		TTL 185	AVAILABLE (TTL surrendered)	TTL 267	AVAILABLE		RCL 369	RCL 410	RCL 451	RCL 492		AVAILABLE	AVAILABLE
		870.03	871.26	872.49	873.72		875.55	876.78	878.01	879.24		881.07	882.30	883.53	884.76		886.59	887.82
3	HP	AVAILABLE	BSNL 42	AVAILABLE (bsnl surrendered)	AVAILABLE		AVAILABLE	TTL 226	TTL 267	AVAILABLE		AVAILABLE	RCL 410	RCL 451	AVAILABLE		AVAILABLE	AVAILABLE
		870.03	871.26	872.49	873.72		875.55	876.78	878.01	879.24		881.07	882.30	883.53	884.76		886.59	887.82
4	J&K	AVAILABLE	BSNL 42	BSNL 83	AVAILABLE		NOT AVAILABLE		AVAILABLE	AVAILABLE		AVAILABLE	RCL 410	RCL 451	AVAILABLE		AVAILABLE	AVAILABLE
		870.03	871.26	872.49	873.72				878.31	879.54		881.07	882.30	883.53	884.76		886.59	887.82
5	NE	AVAILABLE	BSNL 42	BSNL 83	AVAILABLE		AVAILABLE	AVAILABLE	AVAILABLE	AVAILABLE		RTL 369	RTL 410	AVAILABLE	AVAILABLE		AVAILABLE	AVAILABLE
		870.03	871.26	872.49	873.72		875.55	876.78	878.01	879.24		881.07	882.3	883.53	884.76		886.59	887.82
6	ORRISSA	AVAILABLE	AVAILABLE (bsnl surrendered)	BSNL 83	AVAILABLE		AVAILABLE	TTL 226	TTL 267	AVAILABLE		RCL 369	RCL 410	RCL 451	AVAILABLE		AVAILABLE	AVAILABLE
		870.03	871.26	872.49	873.72		875.55	876.78	878.01	879.24		881.07	882.30	883.53	884.76		886.59	887.82

Legends:							
	BSNL	Bharat Sanchar Nigam Ltd.	RCL	Reliance Communications Ltd.	TTL	Tata Teleservice Ltd.
	MTNL	Mahanagar Telephone Nigam Ltd.	RTL	Reliance Telecom Ltd.	SSTL	Shyam Telelink Ltd.
	HFCL	Himachal Futuristic Comm. Ltd.			TTML	Tata Teleservice (Mah.) Ltd.

Annexure 2.2

CDMA CARRIERS ASSIGNMENTS AFTER RECONFIGURATION OF CARRIER FREQUENCIES- AN ILLSUTRATION

S. No.	Metro Circles	1	42	83	124	0.6	185	226	267	308	0.6	369	410	451	492	0.6	553	594
		1.23	1.23	1.23	1.23		1.23	1.23	1.23	1.23		1.23	1.23	1.23	1.23		1.23	1.23
		870.03	871.26	872.49	873.72		875.55	876.78	878.01	879.24		881.07	882.3	883.53	884.76		886.59	887.82
1	Delhi	AVAILABLE	AVAILABLE	AVAILABLE	AVAILABLE (SSTL shifted out)		RCL 185	RCL 226	RCL 267	RCL 308		SSTL shifted in	TTL 410	TTL 451	TTL 492		SSTL 553	SSTL 594
		870.03	871.26	872.52	874.02		875.55	876.78	878.01	879.24		880.77	882.3	883.53	884.76		886.59	887.82
2	Mumbai	TTML 1	TTML 42	TTML 83	AVAILABLE		AVAILABLE	AVAILABLE	AVAILABLE	AVAILABLE		AVAILABLE 369	AVAILABLE 410		RCL 471	RCL 512	RCL 553	RCL 594
		870.03	871.26	872.49	873.72		875.55	876.78	878.01	879.24		881.07	882.3		884.13	885.36	886.59	887.82
3	Kolkata	AVAILABLE	BSNL 42	AVAILABLE	AVAILABLE		TTL 185	SSTL	TTL 288	SSTL 339	SSTL 380			RCL 451	RCL 492	RCL 533	RCL 574	
		870.03	871.26	872.49	874.32		875.55	877.08	878.64	880.17	881.4			883.53	884.76	885.99	887.22	
A' Service Areas																		
1	AP	BSNL shifted in	Vacant	AVAILABLE (BSNL shifted out)	AVAILABLE		AVAILABLE	AVAILABLE	TTL 267	TTL 308		RCL 369	RCL 410	RCL 451	RCL 492		AVAILABLE	AVAILABLE
		870.03		872.34	873.57		875.55	876.78	878.01	879.24		881.07	882.3	883.53	884.76		886.59	887.82
2	Gujarat	TTL 1	TTL 42	SSTL 93	SSTL 134		AVAILABLE	AVAILABLE	AVAILABLE (bsnl shifted out)	AVAILABLE		SSTL	AVAILABLE	BSNL shifted in			RCL 512	RCL 553	RCL 594
		870.03	871.26	872.79	874.02		875.55	876.78	878.37	879.6		881.07	882.3	883.53			885.36	886.59	887.82
3	Maharashtra	AVAILABLE	TTML 42	TTML 83	AVAILABLE		AVAILABLE	AVAILABLE	AVAILABLE	Vacant		AVAILABLE	BSNL 388	AVAILABLE			RCL 471	RCL 512	RCL 553	RCL 594
		870.03	871.26	872.49	873.72		875.25	876.48	878.01			880.41	881.64				884.13	885.36	886.59	887.82
4	Karnataka	AVAILABLE	AVAILABLE (bsnl shifted out)	AVAILABLE	AVAILABLE (SSTL shifted out)	SSTL shifted in (TTL shifted out from 875.55)	TTL 226	TTL shifted in	BSNL shifted in 879.54			RCL 369	RCL 410	RCL 451	RCL 492		SSTL 553	SSTL 594	
		870.03	871.26	872.49	874.02	875.25	876.78	878.01				881.07	882.3	883.53	884.76		886.59	887.82	
5	Tamil Nadu	AVAILABLE	AVAILABLE (bsnl shifted out)	AVAILABLE	AVAILABLE (SSTL shifted out)	SSTL shifted in	TTL 226	TTL 267	BSNL shifted in 879.54			RCL 369	RCL 410	RCL 451	RCL 492		SSTL 553	SSTL 594	
		870.03	871.26	872.49	874.02	875.25	876.78	878.01				881.07	882.3	883.53	884.76		886.59	887.82	

Annexure 2.2 (Continued)

CDMA CARRIERS ASSIGNMENTS AFTER RECONFIGURATION OF CARRIER FREQUENCIES- AN ILLSUTRATION

		1	42	83	124		185	226	267	308		369	410	451	492		553	594
		1.23	1.23	1.23	1.23	0.6	1.23	1.23	1.23	1.23	0.6	1.23	1.23	1.23	1.23	0.6	1.23	1.23
		870.030	871.260	872.490	873.720		875.550	876.780	878.010	879.240		881.070	882.300	883.530	884.760		886.590	887.820
S. No	"B" Service Area																	
1	HARYANA	BSNL shifted in	AVAILABLE (bsnl shifted out)	AVAILABLE	AVAILABLE		AVAILABLE (RCL shifted out)	RCL	RCL	RCL (shifted in)		TTL shifted in	TTL	AVAILABLE (TTL shifted out)	AVAILABLE		AVAILABLE	AVAILABLE
		870.03	871.26	872.49	873.72		875.55	876.78	878.01	879.24		881.07	882.3	883.53	884.78		886.59	887.82
2	MP	AVAILABLE	Vacant	BSNL	AVAILABLE		AVAILABLE	AVAILABLE	AVAILABLE	AVAILABLE		RCL	RCL	RCL	RCL		TTL	TTL
		870.03		872.25	873.48		875.55	876.78	878.01	879.24		881.07	882.3	883.53	884.76		886.59	887.82
3	PUNJAB	HFCL (shifted in)	HFCL	BSNL shifted in (HFCL shifted out from 872.49)	AVAILABLE		AVAILABLE (bsnl shifted out)	AVAILABLE		AVAILABLE		RCL	RCL	RCL		TTL	TTL	AVAILABLE (TTL surrendered)
		870.03	871.26	872.79	874.02		876.39	877.62		879.24		881.07	882.3	883.53		885.36	886.59	887.82
4	RAJASTHAN	Vacant	BSNL	AVAILABLE			SSTL	SSTL	SSTL	SSTL		TTL	AVAILABLE	RCL	RCL	RCL		TTL
			871.11	872.94			874.80	876.03	877.26	878.49		880.11	881.94	883.53	884.76	885.99		887.82
5	KERALA	BSNL	SSTL shifted in	AVAILABLE	AVAILABLE (SSTL shifted out)		AVAILABLE	AVAILABLE	TTL	TTL		RCL	RCL	RCL	RCL		SSTL	SSTL
		870.03	871.56	872.79	874.02		875.55	876.78	878.01	879.24		881.07	882.3	883.53	884.76		886.59	887.82
6	UP(E)	AVAILABLE	BSNL	AVAILABLE	AVAILABLE		AVAILABLE	AVAILABLE (TTL shifted out)	TTL	TTL shifted in		RCL	RCL	RCL	RCL		AVAILABLE	AVAILABLE
		870.03	871.26	872.49	874.02		875.55	876.78	878.01	879.24		881.07	882.3	883.53	884.76		886.59	887.82
7	UP(W)	AVAILABLE	AVAILABLE (BSNL shifted out)	AVAILABLE	AVAILABLE (SSTL shifted out)		RCL	RCL	RCL	RCL		BSNL shifted in	TTL	TTL		SSTL shifted in	SSTL	SSTL
		870.03	871.26	872.49	874.02		875.55	876.78	878.01	879.24		880.77	882.3	883.53		885.36	886.59	887.82
8	WEST BENGAL	AVAILABLE	BSNL		TTL shifted in	TTL	AVAILABLE	AVAILABLE (SSTL shifted out)	AVAILABLE	AVAILABLE (TTL shifted out)		SSTL	SSTL	RCL	RCL	RCL		SSTL shifted in
		870.03	871.26		873.09	874.32	875.55	876.78	878.01	879.24		880.77	882.00	883.53	884.76	885.99		887.82

CDMA CARRIERS ASSIGNMENTS AFTER RECONFIGURATION OF CARRIER FREQUENCIES- AN ILLSUTRATION

		1	42	83	124	0.6	185	226	267	308	0.6	369	410	451	492	0.6	553	594
		1.23	1.23	1.23	1.23		1.23	1.23	1.23	1.23		1.23	1.23	1.23	1.23		1.23	1.23
		870.030	871.260	872.490	873.720		875.550	876.780	878.010	879.240		881.070	882.300	883.530	884.760		886.590	887.820
S. No.	"C" Service Area																	
1	ASSAM	AVAILABLE	BSNL 42	BSNL 83	AVAILABLE		AVAILABLE	AVAILABLE	AVAILABLE	AVAILABLE		RTL 369	RTL 410	AVAILABLE	AVAILABLE		AVAILABLE	AVAILABLE
		870.03	871.26	872.49	873.72		875.55	876.78	878.01	879.24		881.07	882.3	883.53	884.76		886.59	887.82
2	BIHAR	BSNL shifted in	AVAILABLE (BSNL shifted out)	AVAILABLE	AVAILABLE		AVAILABLE (TTL shifted out)	TTL shifted in	TTL	AVAILABLE		RCL 369	RCL 410	RCL 451	RCL 492		AVAILABLE	AVAILABLE
		870.03	871.26	872.49	873.72		875.55	876.78	878.01	879.24		881.07	882.30	883.53	884.76		886.59	887.82
3	HP	AVAILABLE	BSNL 42	AVAILABLE	AVAILABLE		AVAILABLE	AVAILABLE (TTL shifted out)	TTL 267	TTL shifted in		RCL shift in	RCL 410	AVAILABLE (RCL shift out)	AVAILABLE		AVAILABLE	AVAILABLE
		870.03	871.26	872.49	873.72		875.55	876.78	878.01	879.24		881.07	882.30	883.53	884.76		886.59	887.82
4	J&K	AVAILABLE	AVAILABLE (BSNL shifted out)	AVAILABLE (BSNL shifted out)	AVAILABLE		NOT AVAILABE		BSNL shifted in	BSNL shifted in		RCL shifted in	RCL 410	AVAILABLE (RCL Shifted out)	AVAILABLE		AVAILABLE	AVAILABLE
		870.03	871.26	872.49	873.72				878.31	879.54		881.07	882.30	883.53	884.76		886.59	887.82
5	NE	AVAILABLE	BSNL 42	BSNL 83	AVAILABLE		AVAILABLE	AVAILABLE	AVAILABLE	AVAILABLE		RTL 369	RTL 410	AVAILABLE	AVAILABLE		AVAILABLE	AVAILABLE
		870.03	871.26	872.49	873.72		875.55	876.78	878.01	879.24		881.07	882.3	883.53	884.76		886.59	887.82
6	ORRISSA	BSNL shifted in	AVAILABLE	AVAILABLE (BSNL shifted out)	AVAILABLE		AVAILABLE	TTL 226	TTL 267	RCL shifted in		RCL 369	RCL 410	AVAILABLE (RCL Shifted out)	AVAILABLE		AVAILABLE	AVAILABLE
		870.03	871.26	872.49	873.72		875.55	876.78	878.01	883.53		881.07	882.30	883.53	884.76		886.59	887.82

Legends:							
	BSNL	Bharat Sanchar Nigam Ltd.	RCL	Reliance Communications Ltd.	TTL	Tata Teleservice Ltd.
	MTNL	Mahanagar Telephone Nigam Ltd.	RTL	Reliance Telecom Ltd.	SSTL	Shyam Telelink Ltd.
	HFCL	Himachal Futuristic Comm. Ltd.			TTML	Tata Teleservice (Mah.) Ltd.

Annexure- 2.2 (Continued)

Carrier shifting in the 800 MHz Band to make the spectrum holding contiguous

Number of TSPs getting affected in making at least 4 carriers contiguous in the 800 MHz band in each LSA is given in the Table below:

Table

Sl. No.	LSA	No. of Operators affected		Remark
		TSP	Extent of Carrier Shifting	
1.	Delhi	SSTL	From sub-band A to B	4 contiguous carriers become available.
2.	Mumbai	No shifting required.		7 vacant carriers are contiguous.
3.	Kolkata	Not Applicable (as no. of available carriers is less than 4)		Only 3 available carriers
4.	AP	BSNL	Within sub-band	4 contiguous carriers become available.
5.	Gujarat	BSNL	From sub-band A to B	4 contiguous carriers become available.
6.	Maharashtra	No shifting required.		4 contiguous carriers are available.
7.	Karnataka	BSNL,SSTL and TTL	Within sub-bands	4 contiguous carriers become available.
8.	Tamilnadu	BSNL and SSTL	Within sub-bands	4 contiguous carriers become available.
9.	Haryana	BSNL,RCL and TTL	Within sub-bands	2 chunks of 4 contiguous carriers become available.
10.	MP	No shifting required.		5 contiguous carriers are available.
11.	Punjab	HFCL and BSNL	Within sub-bands	4 contiguous carriers become available.
12.	Rajasthan	Not Applicable (as no. of available carriers is less than 4)		Only 2 available carriers

13.	Kerala	SSTL	Within sub-band	4 contiguous carriers become available.
14.	UP-E	TTSL	Within sub-band	4 contiguous carriers become available.
15.	UP-W	BSNL and SSTL	Both from Sub-band A to B	4 contiguous carriers become available.
16.	West Bengal	SSTL and TTL	SSTL from A sub-band to B; TTL within sub-band	4 contiguous carriers become available.
17.	Assam	No shifting required.		2 chunks of 4 contiguous carriers are available.
18.	Bihar	BSNL and TTL	Within sub-bands	4 contiguous carriers become available.
19.	HP	TTL and RCL	Within sub-bands	2 chunks of 4 contiguous carriers become available.
20.	J&K	BSNL and RCL	Within sub-band	2 chunks of 4 contiguous carriers become available.
21.	NE	No shifting required.		2 chunks of 4 contiguous carriers are available.
22.	Orissa	BSNL and RCL	BSNL within sub-band; RCL from sub-band B to A	2 chunks of 4 contiguous carriers become available.

Remark: There is some inter-carrier guard band available between available adjacent carriers in some LSAs, which is to be taken into account to determine the actual frequencies of the available contiguous carriers.

Annexure-3.1

VALUATION (PER MHz) OF 800 MHz USING TECHNICAL EFFICIENCY

(Rs. in crore)

Name of LSA	Auction Price per MHz of 1800 MHz spectrum (Feb. 14)	1.5 times of Price of 1800 MHz band	2 times of Price of 1800 MHz band
Delhi	364.00	546.00	728.00
Mumbai	272.00	408.00	544.00
Kolkata	73.00	109.50	146.00
Andhra Pradesh	163.00	244.50	326.00
Gujarat	237.80	356.70	475.60
Karnataka	155.00	232.50	310.00
Maharashtra	290.35	435.53	580.70
Tamilnadu	208.00	312.00	416.00
Haryana	27.00	40.50	54.00
Kerala	52.00	78.00	104.00
Madhya Pradesh	50.40	75.60	100.80
Punjab	54.00	81.00	108.00
Rajasthan	26.00	39.00	52.00
U. P. (East)	64.00	96.00	128.00
U.P. (West)	94.95	142.43	189.90
West Bengal	24.60	36.90	49.20
Assam	36.10	54.15	72.20
Bihar	43.10	64.65	86.20
Himachal Pradesh	6.00	9.00	12.00
Jammu & Kashmir	6.10	9.15	12.20
North East	7.00	10.50	14.00
Orissa	16.00	24.00	32.00
Pan India	**2270.40**	**3405.60**	**4540.80**

Annexure-3.2

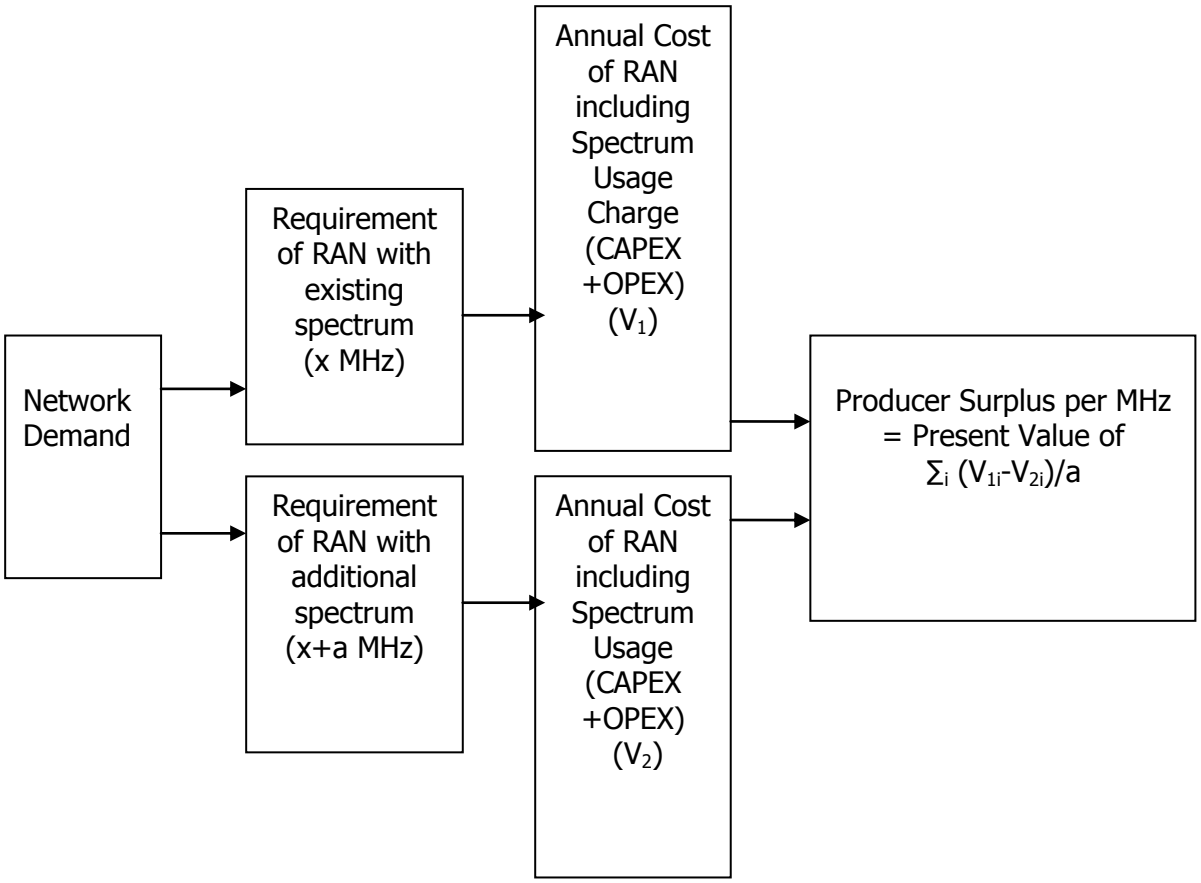
Valuation of Spectrum in 800 MHz Band

Producer Surplus Model

Introduction

1. This model is a bottom-up approach to determine the opportunity of net savings to an average telecom service provider (TSP) upon expenditure in the radio access network (RAN) and spectrum usage charge (SUC) during the next 20 years upon getting additional spectrum. The opportunity of the net savings in expenditure made by the TSP has been termed as 'Producer Surplus'. A block schematic of the model is shown below:

Figure-1 (Block Schematic of the Producer Surplus Model)



2. For the purpose of estimation of value of spectrum in 800 MHz, only the expenditure upon RAN (more specifically, upon Base Transceiver Stations (BTSs)) in urban areas is relevant for the following reasons:

(i) There is an inverse relationship between the quantum of spectrum allocated and the expenditure on RAN required to serve a particular level of demand. In case additional spectrum is allocated to a TSP, he would be able to save upon the expenditure of RAN. Additional spectrum would have no impact on the cost of core network.

(ii) RAN consists of Base Transceiver Stations (BTSs), Base Station Controllers (BSCs) and transmission media to connect them.

(iii) An existing TSP would install a new BTS to cater to either or both -

(a) Capacity constraint i.e. the existing cluster of BTSs in an area is not able to cater to the increased traffic in the cluster.

(b) Coverage constraint i.e. the existing cluster of BTSs is not able to cover the populated area adequately.

(iv) As the urban and rural areas have different population density, capacity constraints owing to increased traffic would arise mainly in urban areas. On the other hand, coverage constraints would arise mainly in rural areas which remain uncovered/under-covered by existing clusters of BTSs. Thus a TSP would, generally, install a new BTS in order to meet:

(a) New capacity requirements in urban areas

(b) New coverage requirements in rural areas

(v) The CDMA operators in India have already been allotted spectrum in 800 MHz spectrum bands. Thus an existing CDMA operator would get no additional benefit of coverage in case he gets additional spectrum in 800 MHz band. However, owing to an inverse relationship between the quantum of

spectrum available and number of BTSs required to meet a particular level of demand, the TSP would need to install fewer additional BTSs in future in capacity constrained areas (i.e. urban areas) in case he gets additional spectrum in 800 MHz band. Thus, it is clear that additional spectrum in 800 MHz band would help existing TSPs in reducing their expenditure on BTSs in urban areas only.

3. Accordingly, requirement of the BTSs in urban areas in the two scenarios i.e. with 'x' MHz of spectrum and with 'x+a' MHz of spectrum has been estimated in order to arrive at the savings in expenditure on BTSs.

4. As per the existing regime for spectrum usage charge (SUC), the SUC levied on a TSP varies with the value of spectrum held by him in an LSA. Accordingly, the SUC in the two scenarios i.e. with 'x' MHz of spectrum and 'x+a' MHz of spectrum has also been estimated.

5. Clearly, the value of producer surplus would vary depending upon the TSP's projected demand (i.e. subscriber base and minutes of usage per subscriber), cost of operation of BTSs (OPEX and CAPEX), spectrum holdings and subscriber profile in various LSAs. Therefore, the average of the values of producer surplus for various TSPs would best capture the expected value of producer surplus upon acquiring additional spectrum in 800 MHz band. Accordingly, in order to arrive at the expected value of producer surplus, an average TSP having an average level of projected demand (i.e. subscriber base and minutes of usage per subscriber), average cost of operation of BTSs (CAPEX and OPEX), average spectrum holdings and average usage profile of subscribers in each LSA has been considered.

6. In the model, the present values (PVs) of the expenditures (CAPEX + OPEX) on BTSs in urban area and SUC to be incurred during the next 20 years for the two cases described above i.e. with 'x'

MHz of spectrum and 'x+a' MHz of spectrum have been estimated for an average TSP. The difference of the PVs in the two cases is the producer surplus:

Producer Surplus= Present Value of (expenditure on BTSs in urban area and SUC during the next 20 years without additional spectrum of 'a' MHz ***minus*** *expenditure on BTSs and SUC during the next 20 years with additional spectrum of 'a' MHz in 800 MHz band)*

Methodology

7. The following steps have been used for estimation of producer surplus in case the TSP acquired '*a*' MHz of spectrum in 800 MHz band:

(i) Estimation of Network Demand in urban areas of an average TSP

(ii) Estimation of No. of BTS in urban areas in the two scenarios

(a) With average spectrum holding

(b) With average spectrum holding + ('*a*' MHz of 800 MHz)

(iii) Estimation of Annual Cost of BTSs in urban areas and SUC in the two scenarios

(iv) Estimation of producer surplus per MHz

Estimation of Network Demand in Urban areas of an Average TSP

8. The demand for network in urban areas of each LSA has been estimated on the basis of no. of urban subscribers and usage per subscriber per month as below:

Busy hour demand of the network in 800 MHz band
*= No. of urban subscribers * No. of MOU per subscriber per month * No. of Busy Hour Erlangs per MOU per month*

9. **Determination of Urban Subscriber Base of the average TSP**: The urban subscriber base of the average TSP in an LSA as on

31.03.2013 has been estimated using the Herfindahl-Hirschman Index (HHI) as below:

The urban subscriber base of average CDMA TSP as on 31.03.2013 in an LSA

*=Total number of urban Subscribers (CDMA) in the LSA * HHI of the CDMA urban segment in the LSA/ 10000*

10. **Determination of MOU**: The minutes of usage (MOU) per subscriber per month in an LSA has been determined as below:

Total MOU = Voice MOU + SMS converted to MOU + Data download converted to MOU

11. The voice MOU and SMS per subscriber per month have been projected on the basis of the information received in TRAI for the quarter ending March 2013. The data download per subscriber per month has been projected on the basis of the information for the month of April 2013. The following growth rates have been considered for the number of subscribers, number of voice MOU per subscriber per month, number of SMS per subscriber per month, amount of data download per subscriber per month:

Table - 1 (Projected Growth Rates)

Year	Growth of subscribers	Growth of Voice MOU per Subscriber	Growth of SMS per Subscriber	Growth of Data Download per Subscriber
2013	Base Year	Base Year	Base Year	Base Year
2014	6%	0%	0%	10%
2015	6%	0%	0%	10%
2016	5%	0%	0%	10%
2017	4%	0%	0%	8%
2018	4%	0%	0%	8%
2019	3%	0%	0%	8%
2020	2%	0%	0%	8%
2021	2%	0%	0%	8%
2022	2%	0%	0%	6%
2023	1%	0%	0%	6%
2024	1%	0%	0%	6%
2025	1%	0%	0%	6%
2026	1%	0%	0%	6%

2027	1%	0%	0%	4%
2028	0.5%	0%	0%	4%
2029	0.5%	0%	0%	4%
2030	0.5%	0%	0%	4%
2031	0.5%	0%	0%	4%
2032	0.5%	0%	0%	4%
2033	0.5%	0%	0%	2%

Estimation of Number of BTSs in Urban Areas in the two Scenarios

12. In order to determine the number of BTSs in urban areas required by the average TSP in each LSA in the two scenarios (with and without additional spectrum) it has been considered that the average TSP has average spectrum holding in each LSA.

13. **Determination of Spectrum Available to the Average TSP:** The spectrum available to the average CDMA TSP in each LSA has been estimated as below:

Spectrum available to the average CDMA TSP in an LSA
= Total CDMA spectrum held by the TSPs in the LSA/No. of CDMA TSPs in the LSA

Based on the spectrum available to the average CDMA TSP, the throughput of a CDMA BTS has been estimated in both the scenarios (with and without additional spectrum) considering 60% utilization.

Estimation of Annual Cost of BTSs in Urban Areas and SUC in the two scenarios

14. In order to estimate the annual cost (OPEX and CAPEX costs) on the BTSs in urban areas of each LSA, the following steps have been taken:

(i) The Capital Cost (Gross Block) as on 31.03.2012 and Annual Operating cost of Radio Access Network (RAN) for the F.Y. 2011-12 for a pan-India CDMA operator have been

adapted from the Accounting Separation Report (ASR) for F.Y. 2011-12.

(ii) Assuming that BTSs (and their associated transmission media) constitute 90% of the cost of the RAN, the Capital Cost (Gross Block) and Operating cost per BTS for an LSA has been estimated as below:

Capital Cost (Gross Block) per BTS as on 31.03.2012 for an LSA

= 0.9*Capital Cost (Gross Block) of RAN/ Number of BTSs

Annual Operating Cost per BTS for F.Y. 2011-12 for an LSA

= 0.9*Annual Operating Cost of RAN/ Number of BTSs

15. Further, the capital cost per BTS has been assumed to be reducing by 5% and operating cost per BTS has been assumed to be increasing by 1% on Y-o-Y basis for the next 20 years.

16. **Useful Life of BTS Equipment** has been taken as 10 years.

17. **Determination of Annualized CAPEX Costs of the BTSs in urban areas:** Based on the number of BTSs required in urban areas to cater to the projected demand and capital cost (Gross Block) per BTS, the capital cost of the BTSs in urban areas has been calculated.

18. Further, straight line depreciation @10% and prevalent cost of capital @15% have been applied to obtain annualized CAPEX cost of the BTSs in urban areas for the average TSP in each LSA.

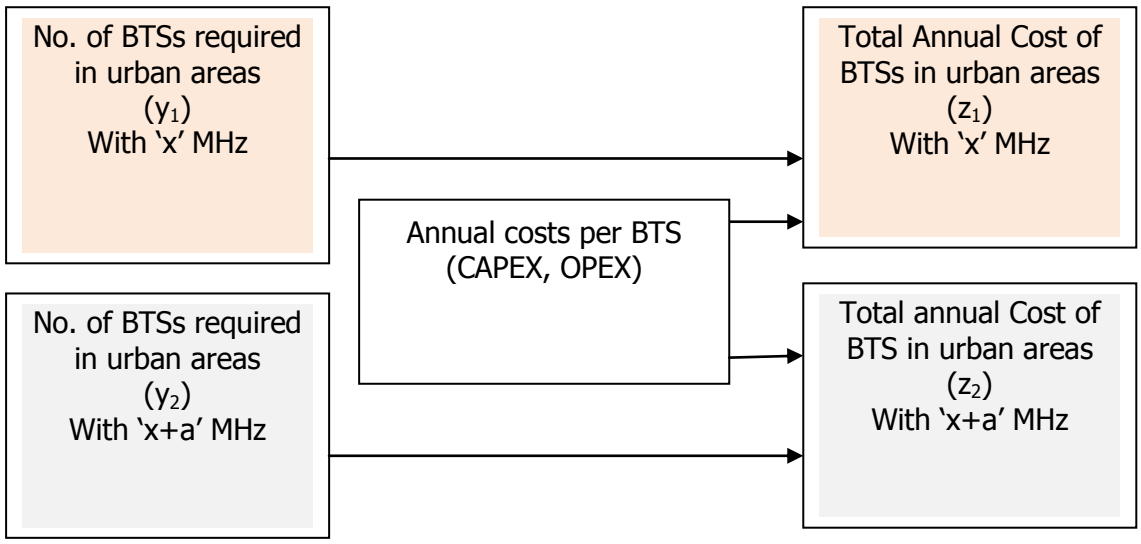
19. **Determination of Annual OPEX Costs of the CDMA BTSs:** Based on the number of CDMA BTSs required in urban areas to cater to the network demand and annual operating cost per CDMA BTS, the annual OPEX cost of CDMA BTSs in urban areas has been determined for the typical operator in each LSA.

20. **Determination of Total Annual Cost on CDMA BTSs in Urban Areas:** The total annual cost on the CDMA BTSs in urban areas in each LSA has been estimated by summing up the annualized CAPEX cost and annual OPEX cost as below:

The Total annual cost on CDMA BTSs in urban areas in an LSA = Annualized CAPEX cost on CDMA BTSs in urban areas + Annual OPEX cost on CDMA BTSs in urban areas

21. The annual costs for CDMA BTS for the average TSP in the two scenarios have been estimated as per the following schematic diagram.

Figure-2 Schematic Diagram for Estimation of Total Cost of BTSs in the two Scenarios



22. **Estimation of SUC in two scenarios:** The spectrum usage charge (SUC) levied on a TSP varies with the value of spectrum held by him in an LSA. Accordingly, the SUC in the two scenarios i.e. with 'x' MHz of spectrum and 'x+a' MHz of spectrum has been estimated for the next 20 years assuming no change in average revenue per user (ARPU) from the present levels.

Estimation of Producer Surplus per MHz

23. The producer surplus upon getting an additional spectrum of 'a' MHz has been estimated as below:

Producer Surplus upon getting an additional spectrum of 'a' MHz in 800 MHZ band in an LSA

= Present Value of (expenditure on BTSs in urban area and SUC during the next 20 years without additional spectrum of 'a' MHz ***minus*** *expenditure on BTSs in urban area and SUC during the next 20 years with additional spectrum of 'a' MHz in 800 MHz band)*

24. In order to arrive at the present value, a discounting rate of 12.5% has been used.

Results

25. The following table presents the producer surplus per MHz.

Table-2: Producer Surplus per 800 MHz

(in Rs. Crore)

Sl.No.	Name of LSA	Category	Producer Surplus per MHz
1	Delhi	Metro	377.55
2	Mumbai	Metro	349.41
3	Kolkata	Metro	94.07
4	Andhra Pradesh	A	153.55
5	Gujarat	A	104.76
6	Karnataka	A	217.78
7	Maharashtra	A	149.37
8	Tamilnadu	A	265.40
9	Haryana	B	24.47
10	Kerala	B	74.52
11	Madhya Pradesh	B	62.62
12	Punjab	B	46.89
13	Rajasthan	B	61.66
14	U. P. (East)	B	96.09
15	U.P. (West)	B	52.81
16	West Bengal	B	92.11

17	Assam	C	1.76
18	Bihar	C	78.59
19	Himachal Pradesh	C	30.95
20	Jammu & Kashmir	C	19.02
21	North East	C	5.26
22	Orissa	C	51.03
Pan India			**2409.64**

Annexure-3.3

Valuation Based on Potential Growth in Data Services

Assumptions

The following assumptions are made in arriving at the valuation of 800 MHz spectrum:

a) Auction of 800 MHz spectrum will be for liberalized use (i.e. any technology, not just CDMA, can be deployed for providing mobile telephony services).

b) 800 MHz spectrum in the coming years will be primarily used for providing data services to customers.

c) Data revenues are a projection through extrapolation keeping in view current market trends, share of currently deployed different bands and their likely deployment for various uses[18]. It is therefore assumed that over the next 20 years, the share of the 800 MHz band in the total revenue from data services has been reduced to 10% from the current levels of around 25%.

d) Share of the 800 MHz band in revenue from non-data (primarily voice) services in each LSA will be constant over the next 20 years.

e) Data download per subscriber will grow, initially at a high rate of 10% in 2014-15 and subsequently at a tapering rate over the next 20 years. Minutes of voice usage per subscriber (MoU) will remain constant over 20 years. The number of subscribers will grow at a tapering rate, starting from 6% in 2014-15. Year wise growth rate for next 20 years have been given in Annexure-3.2.

f) It has been projected that data tariff will go down by 5% every year for a period of 5 years starting from 2014-15 and stabilize thereafter.

g) Revenue streams net of costs associated with operating and maintaining the network are the basis for the valuation.

Methodology

[18] The model does not predict data growth i.e. it does not take into account the services/possible uses and revenues that new bands (700 MHz/2500MHz) may generate.

The model aims to arrive at a valuation of the spectrum based on its revenue potential. The net present value (NPV) of the amount of expected revenue from 800 MHz spectrum represents the valuation that could be placed for acquiring the asset. The potential earnings are calculated individually for each LSA. The NPV of potential revenue earnings over 20 years discounted at 12.50% is taken as one of the indicative values of 800 MHz spectrum that existing TSPs might be willing to pay in each LSA. For calculating the value per MHz, the NPV in each LSA is divided by the total available (as of today) 800 MHz spectrum in that LSA.

Results

The following table presents the estimated value of 800 MHz based on the model of potential growth in data services in wireless service segment:

Valuation based on potential growth in data services

(in Rs. Crore)

Sl.No.	Name of LSA	Category	Value per MHz
1	Delhi	Metro	421.39
2	Mumbai	Metro	336.28
3	Kolkata	Metro	90.13
4	Andhra Pradesh	A	237.33
5	Gujarat	A	121.18
6	Karnataka	A	233.11
7	Maharashtra	A	244.66
8	Tamilnadu	A	240.87
9	Haryana	B	32.86
10	Kerala	B	90.55
11	Madhya Pradesh	B	82.83
12	Punjab	B	78.44
13	Rajasthan	B	141.57

14	U. P. (East)	B	99.49
15	U.P. (West)	B	80.70
16	West Bengal	B	54.04
17	Assam	C	5.83
18	Bihar	C	76.14
19	Himachal Pradesh	C	14.07
20	Jammu & Kashmir	C	1.93
21	North East	C	7.97
22	Orissa	C	17.69
Pan India			**2709.05**

Annexure 3.4

VALUATION (PER MHz) USING DIFFERENT APPROACHES – 800 MHz

(Rs. in crore)

Name of LSA	1.5 times of Price of 1800 MHz band	2 times of Price of 1800 MHz band	Producer Surplus Model	Model based on projected revenue from data services	Auction (Feb. 2014) determined price of 900 MHz	Mean of all approaches
Delhi	546.00	728.00	377.55	421.39	740.96	**562.78**
Mumbai	408.00	544.00	349.41	336.28	563.09	**440.16**
Kolkata	109.50	146.00	94.07	90.13	194.63	**126.87**
Andhra Pradesh	244.50	326.00	153.55	237.33		**240.34**
Gujarat	356.70	475.60	104.76	121.18		**264.56**
Karnataka	232.50	310.00	217.78	233.11		**248.35**
Maharashtra	435.53	580.70	149.37	244.66		**352.56**
Tamilnadu	312.00	416.00	265.40	240.87		**308.57**
Haryana	40.50	54.00	24.47	32.86		**37.96**
Kerala	78.00	104.00	74.52	90.55		**86.77**
Madhya Pradesh	75.60	100.80	62.62	82.83		**80.46**
Punjab	81.00	108.00	46.89	78.44		**78.58**
Rajasthan	39.00	52.00	61.66	141.57		**73.56**
U. P. (East)	96.00	128.00	96.09	99.49		**104.90**
U.P. (West)	142.43	189.90	52.81	80.70		**116.46**
West Bengal	36.90	49.20	92.11	54.04		**58.06**
Assam	54.15	72.20	1.76	5.83		**33.48**
Bihar	64.65	86.20	78.59	76.14		**76.39**
Himachal Pradesh	9.00	12.00	30.95	14.07		**16.51**
Jammu & Kashmir	9.15	12.20	19.02	1.93		**10.58**
North East	10.50	14.00	5.26	7.97		**9.43**
Orissa	24.00	32.00	51.03	17.69		**31.18**
Pan India	**3405.60**	**4540.80**	**2409.64**	**2709.05**	**-**	**3358.49**