Telecom Regulatory Authority of India

सत्यमेव जयते

Recommendations

on

Valuation and Reserve Price of Spectrum: 2100 MHz Band

31st December, 2014

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CONTENTS

CHAPTER–I: INTRODUCTION

The Reference from the Department of Telecommunications (DoT)

1.1 The Department of Telecommunications (DoT), through its letter dated 16th October 2014 **(Annexure 1.1)**, communicated that the Government was planning auction of right to use spectrum in the 2100 MHz, 2300 MHz and 2500 MHz bands, preferably along with the auction of spectrum in the 800 MHz, 900 MHz and 1800 MHz bands[1]. The DoT sought TRAI's recommendations in terms of clause 11(1)(a) of TRAI Act 1997 as amended on :

- The applicable reserve price for 2100 MHz, 2300 MHz and 2500 MHz bands for all the Licence Service Areas (LSAs), both where spectrum was available in the entire LSA as well as where spectrum was only partially available in an LSA; and
- The auction of the right to use spectrum in a band with varying validity period (less than 20 years) so that the expiry of the validity period of the right to use spectrum in a band in an LSA occurs at same time.

1.2 Subsequently, through its letter of 27.11.2014 (**Annexure-1.2**), the DoT requested TRAI to expedite the process for its recommendations on the reserve price of 2100 MHz band and related issues so that the auction of spectrum being released by Defence could be conducted along with the auction of spectrum in the 800/900/1800 MHz bands scheduled in February 2015.

1.3 2100 MHz band is a globally harmonized band for provision of high speed data services and its adequate availability will be critical for meeting the national objectives of 'Digital India' and National Telecom Policy- 2012. Globally, this band is primarily being used for data

[1] The licences given in 1995-96 are due to expire in 2015-16. These licensees hold spectrum in 900 and 1800 MHz bands. The spectrum held by them is to be put to auction. The DoT also indicated that unassigned spectrum in the 800 MHz band will also be put to auction.

services (HSPA/HSPA+[2]). HSPA is a leading broadband technology with 572 commercial networks available in 213 countries. Most 3G/HSPA systems use 2.1 GHz spectrum (3GPP[3] band 1).

1.4 This is the second occasion when spectrum in the 2100 MHz band will be put to auction. Earlier in 2010, 20-25 MHz spectrum in this band was assigned in every LSA through an auction process.

1.5 The Authority issued a Consultation Paper (CP) on "Valuation and Reserve Price of Spectrum: 2100 MHz Band" on 2nd December 2014. The CP is confined to the 2100 MHz band alone as the objective was to expedite the consultation process and come up with reserve price recommendations expeditiously, as requested by the DoT. The Authority will separately take up other matters referred by the DoT in its letter dated 16th October 2014.

1.6 In response to the CP, TRAI received 14 comments and 4 counter-comments from stakeholders. These were placed on TRAI"s website www.trai.gov.in.

1.7 An Open House Discussion (OHD) was held on 22nd December 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.

1.8 The Recommendations are presented in four chapters. The introductory chapter furnishes a brief background to the recommendations. The second chapter discusses the availability and utilization of spectrum in the 2100 MHz bands, roll-out obligations and the spectrum caps. The third chapter deals with the valuation and reserve price of spectrum. The fourth chapter contains a summary of the Recommendations.

[2] HSPA-High Speed Packet Access, HSPA+- Evolution of HSPA.
[3] 3rd Generation Partnership Project

CHAPTER–II: AVAILABILITY AND UTILIZATION OF SPECTRUM

Availability of Spectrum in the 2100 MHz band

2.1 At present, out of 2x60 MHz available in the 2100 MHz band, 4 blocks of 2x5 MHz (total 2x20 MHz) have been assigned in all the LSAs while a fifth block has been assigned in five LSAs (Punjab, Bihar, West Bengal, Jammu & Kashmir and Himachal Pradesh).

2.2 In its reference of 16th October 2014, the DoT did not specify the quantum of spectrum to be put to auction in the 2100 MHz band. It only stated that, at present, no spectrum was available with the DoT in this band. The DoT further stated that discussions with Defence were under way for release of one block of 5 MHz of spectrum in the 2100 MHz band and this spectrum would be put to auction only after release of spectrum by Defence. The possibilities are that Defence may release spectrum with availability either for the entire LSA or on a partial basis.

2.3 In response to a specific query from TRAI, the DoT responded through its letter of 14th November 2014, intimating that deliberations with Defence for vacation of spectrum in the 2100 MHz band were in process and any of the following three scenarios was possible.

Scenario I: Spectrum may not be released by Defence; then no spectrum would be available in the 2100 MHz band for auction. In case no spectrum is released by Defence in 2100 MHz in the timeline for the forthcoming auction, the same will not be included in the NIA.

Scenario II: Defence has released 20 MHz (4 blocks of 5 MHz each) out of 25 MHz (5 blocks of 5 MHz each) in 2100 MHz band allocated to DoT under the MoU with Defence (in

1920-1980 MHz) on a pan-India basis and one more block of 5 MHz in 5 LSAs. This is the spectrum that was auctioned in 2010. Discussions with Defence are under way to release one block of 5 MHz in the remaining 17 LSAs. It is possible that 5 MHz spectrum may be released by Defence in 17 LSAs; then, only one block of 5 MHz spectrum will be available in 17 LSAs in 2100 MHz.

Scenario III: Deliberations for swapping 2100 MHz band spectrum (allocated to Defence as per MoU) with an equal amount of spectrum in the 1900 MHz band are also in process[4]. Thus, in addition to the release of 5 MHz spectrum in 17 LSAs, Defence may release 15 MHz (3 blocks of 2x5 MHz) on a pan-India basis by swapping 2100 MHz spectrum for 1900 MHz spectrum.

2.4 The Table below summarizes the spectrum currently assigned and the spectrum that may be available under three possible scenarios in the 2100 MHz band.

Table 2.1

S.No.	LSA	Spectrum currently assigned to TSPs	Additional spectrum likely to be available		
			Scenario I	Scenario II	Scenario III
		MHz	MHz	MHz	MHz
1	DEL	2x20	Nil	2x5	2x20
2	MUM	2x20	Nil	2x5	2x20
3	KOL	2x20	Nil	2x5	2x20

[4] The DoT and Defence have agreed to share 300 MHz bandwidth in the 1700-2000 MHz band with each retaining 150 MHz. The DoT's share consists of 2x55 MHz (i.e. 110 MHz) in 1800 MHz band (1710-1765 MHz/1805-1860 MHz). It also includes 15 MHz (1900-1907.5 MHz/1980-1987.5 MHz) of spectrum in the 1900 MHz band. The remaining 25 MHz spectrum of the total 150 MHz earmarked for commercial use is used as uplink frequencies in the 3G spectrum band (1920-1980 MHz / 2110-2170 MHz). The issue that is being discussed here is swapping of 2x7.5 MHz spectrum in the 1900 MHz band (earmarked for DoT) with 15 MHz of spectrum in the 1920-1980 MHz band (earmarked for Defence) which, along with corresponding downlink frequencies in 2110-2170 MHz band, will make additional 3x5 MHz of 2100 MHz band available for commercial use.

4	MH	2x20	Nil	2x5	2x20
5	GUJ	2x20	Nil	2x5	2x20
6	AP	2x20	Nil	2x5	2x20
7	KTK	2x20	Nil	2x5	2x20
8	TN	2x20	Nil	2x5	2x20
9	KL	2x20	Nil	2x5	2x20
10	PB	2x25	Nil	Nil	2x15
11	HR	2x20	Nil	2x5	2x20
12	UP (W)	2x20	Nil	2x5	2x20
13	UP (E)	2x20	Nil	2x5	2x20
14	RAJ	2x20	Nil	2x5	2x20
15	MP	2x20	Nil	2x5	2x20
16	WB	2x25	Nil	Nil	2x15
17	HP	2x25	Nil	Nil	2x15
18	BH	2x25	Nil	Nil	2x15
19	OR	2x20	Nil	2x5	2x20
20	AS	2x20	Nil	2x5	2x20
21	NE	2x20	Nil	2x5	2x20
22	J&K	2x25	Nil	Nil	2x15
	Total	**2x465**	**Nil**	**2x85**	**2x415**

2.5 A few stakeholders suggested that the entire 2x60MHz spectrum identified internationally in the 2.1GHz band must be made available for commercial use in line with a number of other countries in the Asia-Pacific region and also in Europe. Some of them submitted that all out efforts will be required at the highest political levels to ensure this outcome. Some were of the view that, as an immediate measure, at least an additional 2x20 MHz should be made available to be auctioned together with the spectrum in the 800, 900 and 1800 MHz bands in February 2015. One stakeholder suggested that 2100 MHz spectrum won by STEL in three service areas (Bihar, Orissa and Himachal Pradesh) may also be put to auction because of the cancellation of its licence. Another stakeholder suggested that excluding the geographical use of 2100 MHz spectrum by Defence, spectrum in the rest of the service area, may be auctioned in the form of partially available spectrum, much in the same manner as partial 1800 MHz spectrum was auctioned in February 2014.

2.6 As brought out in its recommendations on 'Valuation and Reserve Price of Spectrum : Licences Expiring in 2015-16' dated 15th October 2014, it is vitally important to auction spectrum in the 2100 MHz band along with spectrum in the 900 MHz band. The reasons for doing so have been explained in detail in paras 2.41 and 2.42 of these recommendations and are reproduced below.

".....there is not a single TSP which has 3G spectrum in <u>all</u> the LSAs. Also, as per the licence terms and conditions, the TSPs can offer subscription of their 3G services in only those LSAs where they have 3G spectrum. However, this issue is under litigation in the Hon'ble Supreme Court on an appeal by the DoT against TDSAT judgment.

Pending resolution of the above issue, a number of TSPs have requested the Authority to facilitate the release of additional spectrum in the 2100 MHz band so that they can have pan-India 3G spectrum (apart from an add-on to their existing spectrum holdings). In the absence of spectrum in the 2100 MHz band, these TSPs would have no choice but to bid for the 900 MHz band spectrum. Though it cannot be inferred that if the 2100 MHz band spectrum is made available, then these TSPs would not like to have 900 MHz band spectrum; but, surely, their dependence on 900 MHz would not be that much. In view of the above, it is critical to make additional spectrum available in the 2100 MHz band." (Para 2.41 and 2.42 of recommendations dated 15th October 2012)

2.7 In its response dated 24th November 2014 to the DoT's back-reference on the Authority's recommendations of 15th October 2014, the Authority stated that:

"The Authority is of the view that swapping of spectrum in 2100 MHz band with Defence in lieu of spectrum in the 1900 MHz band should be done quickly, so that it (2100 MHz) can be put to auction in the upcoming auction of 900/1800 MHz band. It should be noted that once agreement is reached with Defence for the swapping of spectrum, the actual release of spectrum will be required only at the expiry date of the licences."

2.8 The Ministry of Defence (MoD) has informed TRAI that the proposal for release of 15 MHz of spectrum in 2100 MHz band on a pan-India basis in lieu of an equal amount of commercial spectrum in the 1900 MHz band has been agreed to in principle and this has also been conveyed to the DoT. The only issue that remains is the actual implementation of the plan. The Authority would like to re-emphasize that the 15 MHz

of spectrum[5] in the 2100 MHz spectrum being vacated by Ministry of Defence, by swapping spectrum in the 1900 MHz spectrum, should be auctioned in view of the in-principle agreement reached with MoD, even if it is not available immediately. This is because actual assignments do not have to be made immediately. These can be carried out after the auctions once the release of spectrum is cleared by MoD. It is useful to recall that, even in 2010, the actual assignment of spectrum in the 2100 MHz band was done a few months later after the completion of auction. The relevant NIA provision is quoted below for ready reference.

"*It may be noted that after assignment of 3G Spectrum, the licensees shall be allowed to utilise the spectrum for commercial operations only from 1st September, 2010. However, in the mean time, they can take steps to enable launch of commercial operations*"

2.9 The issue of 2100 MHz spectrum which was assigned to STEL and stands available due to cancellation of its licence in three service areas viz. Bihar, Orissa and Himachal Pradesh, is sub-judice. The DoT has not included this in the quantum of spectrum that it intends to auction. The Authority is not aware of the exact status of the case. However, it is of the view that spectrum cannot be kept unutilized for an indefinite period of time. Keeping spectrum unutilized is a waste of natural resources and also results in a revenue loss to the Government in terms of licence fee, spectrum usage charges and various other levies. Therefore, the Authority is of the view that the DoT should take necessary measures to ensure that spectrum which has become available due to cancellation of licence of STEL is also auctioned in the upcoming auction.

2.10 In view of above, **the Authority reiterates its recommendations that spectrum in the 2100 MHz band should be put to auction along with the 800/900/2100 MHz band. Furthermore, the 15**

[5] MoD has agreed to vacate 15 MHz in the 2100 MHz uplink (1920-1980 MHz). This, along with the corresponding 15 MHz in the 2100 MHz downlink (2110-2170 MHz) will make 3 blocks of 2x5 MHz in this band available for commercial use.

MHz of spectrum (which are equivalent to 3 blocks of 2x5 MHz when paired corresponding downlink spectrum) in the 2100 MHz spectrum being vacated by Ministry of Defence, in lieu of spectrum in the 1900 MHz spectrum, should be auctioned in view of the in-principle agreement reached with MoD, even if it is not available immediately. This is because actual assignments do not have to be made immediately. The actual date of assignment may be given in the NIA. The Authority also recommends that the DoT should take all measures to ensure that the 2100 MHz spectrum which was earlier assigned to STEL in three service areas viz. Bihar, Orissa and Himachal Pradesh is also put to auction.

Roll-out obligations

2.11 To ensure efficient use of spectrum and provide a reasonable level of service to a wide cross-section of customers, roll-out obligations were mandated in the NIA of 25th February 2010 for the auction of 2100 MHz spectrum. In the Metro LSAs, the licensee was required to provide street-level coverage in at least 90% of the LSA within five years of the effective date[6]. In Category A, B and C LSAs, the licensee had to ensure that, within five years of the effective date, at least 50% of the District Headquarters (DHQ) in the service area are covered, of which at least 15% of the DHQs should be rural Short Distance Charging Areas (SDCA). The licensee was permitted to cover any other town in a District in lieu of the DHQ. Coverage of a DHQ/town would mean that at least 90% of the area bounded by the municipal/local body limits gets the required street-level coverage.

2.12 In this background, stakeholders were requested to suggest if any changes are required in the roll-out obligations in the forthcoming auction or whether the same (2010) roll-out obligations should be mandated.

[6] The Effective Date is the later of the date when the right to use awarded spectrum commercially commences and the date when the UAS licence, if applicable, is granted to the operator.

2.13 In response, a number of stakeholders suggested that there should not be any change in roll-out obligations viz. continue with the obligations, as prescribed in 2010, making them applicable for the 2100 MHz spectrum to be auctioned in February 2015. One such stakeholder submitted that, ideally, there should not be any roll-out obligations attached to auctioned spectrum. However, if roll-out obligations are to be prescribed, they should be the same as prescribed in the 2010 auction.

2.14 One stakeholder suggested that roll-out obligations mandated as part of 900/1800 MHz spectrum should be applicable for all spectrum bands which are henceforth auctioned. This would result in moving towards uniform minimum roll-out obligations for all technology and spectrum bands. However, according to the stakeholder, this should be made applicable only to those TSPs who win 2100 MHz spectrum for the first time in any LSA.

2.15 Some stakeholders submitted that any operator who has a block of 5 MHz in a service area (acquired during auction of 2010) and acquires more blocks in the same service area in the upcoming auction should not have any additional roll-out obligation except those that it would be obliged to complete as part of the roll-out obligations for the first block acquired during 2010.

2.16 Many stakeholders highlighted the problems being faced by licensees in meeting roll-out obligations associated with the spectrum assigned in 2010. These stakeholders pointed out that the DoT issued a provisional TSTP (Test Schedule Test Procedure) on 04.09.2012. The industry had specific concerns on implementation of the proposed TSTP which were brought to the attention of DoT. These concerns are yet to be resolved. The DoT has not issued the final TSTP till date. The stakeholders also submitted that the list of Rural SDCAs was released by the DoT in Dec 2013 for 17 LSAs i.e. more than 3 years after the allocation of spectrum. However, since the list contained numerous errors, the DoT was

apprised of the discrepancies; a clarification on the same is still awaited. Moreover, the DoT has not issued the list of rural SDCAs in respect of a few LSAs. The stakeholders requested to get these issues resolved. Some of them requested that there should be clarity on these issues related to roll-out obligation before the forthcoming auction.

Analysis

2.17 In 2010, spectrum in the 2100 MHz band was put to auction for the first time. There was no measure available to gauge demand at that point of time. Therefore, a period of 5 years was justified for meeting prescribed roll-out obligations. There have been a number of changes since. All the TSPs are rolling-out their 3G networks steadily and the data demand has picked up. Now, it would not be correct to allow a period of 5 years for licensees to roll-out the networks. Therefore, the Authority is of the view that the same network roll-out may be prescribed as roll-out obligation but within a shorter timeframe.

2.18 The Authority concurs with the views expressed by some stakeholders that a TSP, which already has a block of 2x5 MHz in the 2100 MHz band in an LSA and acquires additional block(s) in the LSA through the upcoming auction, should not be mandated to comply with the roll-out obligations prescribed above again. It would continue to be bound to the same roll-out obligations that were prescribed when it acquired the first block of spectrum in 2010 irrespective of the number of blocks it acquires later in the same band.

2.19 TSTP which prescribes the process and method for measurements and tests to be carried out to ensure the required roll-out of the 3G network is critical for roll-out testing. Therefore, it should be finalised at the earliest but, in any case, no later than the conduct of the February 2015 auction. Also, there should be absolute clarity as to what is to be covered as part of roll-out obligations. Therefore, the list of rural SDCAs along with names of the towns in these SDCAs should be made part of the NIA. This is required so that the bidders make an informed decision.

2.20 In view of the above, **the Authority recommends that:**

(i) The roll-out obligations that were mandated in the 2010 auctions for spectrum in the 2100 MHz band should be applicable for the upcoming auction of 2100 MHz band; however, a period of 3 years (instead of 5 years) should be prescribed to meet these obligations.

(ii) A TSP, which already has a block of 2x5 MHz in the 2100 MHz band in an LSA and acquires additional block(s) in the LSA through the upcoming auction, should not be mandated to comply with the roll-out obligations prescribed above again. It would continue to be bound to the same roll-out obligations that were prescribed when it acquired the first block of spectrum in 2010.

(iii) TSTP (Test Schedule Test Procedure) which prescribes the process and method for measurements and tests to be carried out to ensure the required roll-out of the 3G network should be finalised at the earliest but, in any case, no later than the conduct of the February 2015 auction.

(iv) The list of rural SDCAs along with names of the towns in these SDCAs should be made part of the NIA.

Spectrum Cap

2.21 In the auctions held in 2010, no single bidder was allowed to bid for more than one block (2x5 MHz) of spectrum in an LSA. In recent auctions held for spectrum in the 800/900/1800 MHz bands, the spectrum cap for an operator in each of the LSAs in a band was prescribed as 50% of the total spectrum assigned in a band subject to a maximum of 25% of the total assigned spectrum across all bands[7] for

[7] 800MHz, 900 MHz, 1800MHz, 2100 MHz, 2300MHz and 2500 MHz spectrum bands.

telecom services. Spectrum put to auction was also counted for calculating the spectrum cap.

2.22 In this background, stakeholders were requested to suggest (a) whether a bidder be allowed to bid for more than one block of spectrum, in case a sufficient quantum of spectrum (more than one block in LSA) is put to auction; (b) whether the spectrum caps (of 50% of total spectrum in a band/25% of total spectrum assigned across bands) prescribed in recently held auctions in the 800/900/1800 MHz bands should also be prescribed for the upcoming auctions in the 2100 MHz band; and (c) in case only one block of 5 MHz of spectrum in the 2100 MHz band is available in an LSA, should only those TSPs be allowed to participate who do not have 2100 MHz spectrum in that LSA at present.

2.23 There were mainly two distinct views expressed by stakeholders in their responses. One set of stakeholders submitted that there should be no restriction on the number of blocks that bidders should be allowed to bid for subject to compliance with the spectrum caps of 25% of total commercially assigned access spectrum and 50% of the spectrum in the band. These stakeholders argued that, in order to ensure sufficient competition in the market for provision of affordable quality of service, there is a need that no artificial barriers/ restrictions are created for participation in the auction; further, any restriction on bidding would be against the principles of fairness and transparency in the auction and could actually lead to suppressing demand resulting in smaller revenues to the exchequer. Some of these stakeholders submitted that the spectrum caps of "50% of total spectrum in a band/25% of total spectrum assigned across bands" in an LSA, should be applied to <u>all</u> upcoming auctions including the 2100 MHz band. They further submitted that the same spectrum caps be made applicable across policies such as Mergers and Acquisitions, Spectrum Trading etc.

2.24 Another set of stakeholders were of the view that participation in the 2100 MHz auction should be confined to those TSPs who do <u>not</u> have

2100 MHz spectrum in that LSA at present. Moreover, any such bidder should be allowed to bid for only one block of spectrum i.e. spectrum holding in the 2100 MHz band should be restricted to 5 MHz (including the spectrum allocation in 2010) for any TSP in an LSA. According to one such stakeholder, none of the existing operators who currently provide 3G services have a pan-India footprint and there is a need for at least 64 more blocks of spectrum to enable all these players to complete their pan-India footprint. Therefore, according to this stakeholder, the spectrum cap of 50% of total spectrum in a band should be substituted by 5 MHz cap in the 2100 MHz band; however, the cap of 25% of total spectrum assigned across bands prescribed in recently held auctions in the 800/900/1800 MHz bands should be used for the upcoming auctions in the 2100 MHz band.

2.25 One stakeholder argued that bidding rules for the upcoming auctions of 2100 MHz spectrum should be consistent with the 2010 auction rules limiting bidding by any new operator to one block. The stakeholder also submitted that existing 3G operators should not be eligible to bid for one more block of spectrum because acquisition of large contiguous blocks of spectrum would provide them a competitive edge and further skew the market.

Analysis

2.26 In 2010, the Government put to auction four blocks (2x5 MHz) in 5 LSAs (Punjab, Bihar, West Bengal, Jammu & Kashmir and Himachal Pradesh) and three blocks in the remaining 17 LSAs. In addition, BSNL/MTNL was assigned one block of 2x5 MHz at the auctioned determined prices. The list of successful bidders are given in Table 2.2 below[8]:

[8] Apart from the operators mentioned in the Table, one block (2x5MHz) was also won by STEL in three LSAs, viz. Bihar, Orissa and Himachal Pradesh. However, the UAS license issued to STEL was subsequently cancelled.

Table 2.2

Service Area wise list of operators having spectrum in 2100 MHz band

S.No.	Type	LSA	MTNL	BSNL	Vodafone	Bharti	RTL	Aircel	Tata	Idea
1	Metro	DEL	Yes		Yes	Yes	Yes			
2	Metro	MUM	Yes		Yes	Yes	Yes			
3	Metro	KOL		Yes	Yes		Yes	Yes		
4	A	MH		Yes	Yes				Yes	Yes
5	A	GUJ		Yes	Yes				Yes	Yes
6	A	AP		Yes		Yes		Yes		Yes
7	A	KTK		Yes		Yes		Yes	Yes	
8	A	TN		Yes	Yes	Yes		Yes		
9	B	KL		Yes				Yes	Yes	Yes
10	B	PB		Yes			Yes	Yes	Yes	Yes
11	B	HR		Yes	Yes				Yes	Yes
12	B	UP (W)		Yes		Yes			Yes	Yes
13	B	UP (E)		Yes	Yes			Yes		Yes
14	B	RAJ		Yes		Yes	Yes		Yes	
15	B	MP		Yes			Yes		Yes	Yes
16	B	WB		Yes	Yes	Yes	Yes	Yes		
17	C	HP		Yes		Yes	Yes			Yes
18	C	BH		Yes		Yes	Yes	Yes		
19	C	OR		Yes			Yes	Yes		
20	C	AS		Yes		Yes	Yes	Yes		
21	C	NE		Yes		Yes	Yes	Yes		
22	C	J&K		Yes		Yes	Yes	Yes		Yes
		Total	**2**	**20**	**9**	**13**	**13**	**13**	**9**	**11**

2.27 As discussed in para 2.3, the exact quantum of spectrum in the 2100 MHz that will be put to auction is not known and there are wide variations in the likely availability of spectrum in different scenarios. If only one spectrum block of 2x5 MHz is put to auction (scenario 2), there would be very stiff competition. 3-4 existing TSPs, who already have one block of 2100 MHz spectrum, would like to augment their spectrum holding while other 2-3 TSPs would like to extend their 2100 MHz footprint in those LSAs where they currently do not hold any block of this spectrum. Participation by those TSPs, who do not have 2100 MHz block anywhere in the country, cannot also be ruled out. The scarcity of available spectrum (one one block) will push auction prices through the roof. However, as mentioned in preceding para, the Ministry of Defence

(MoD) has informed TRAI that the proposal for release of 15 MHz of spectrum in 2100 MHz band on a pan-India basis in lieu of an equal amount of commercial spectrum in the 1900 MHz band has been agreed to in principle and this has also been conveyed to the DoT. Therefore, the Authority does not agree with either scenario 1or 2 envisaged by the DoT.

2.28 In case sufficient spectrum (3-4 blocks of 2x5 MHz) is available for auction (scenario 3); total spectrum earmarked for commercial operations in the 2100 MHz band would be 40 MHz. In such a situation, the present spectrum caps of 50% of total spectrum in a band will imply that a TSP will be eligible to acquire 3 blocks (if it already has one block) or 4 blocks (if it has no spectrum presently). This gives rise to the possibility that one TSP can acquire the entire spectrum that may be put to auction in an LSA. Surely, this cannot be an intended outcome of the auction. This will give a rise to a situation where post-auction, in an LSA, one TSP will be having 20 MHz of spectrum in the 2100 MHz band and all other TSPs (at most 3 others) providing data services will be having only 5 MHz of spectrum in 2100 MHz band. With 20 MHz of spectrum, the TSP will have a clear edge over the others as it can provide higher data speed at a far lower price than its competitors. This may result in churning of data subscribers from other TSPs and concentration of subscribers with one TSP in the LSA. This is not a desirable situation neither from the point of view of competition in the market nor from the regulatory perspective.

2.29 To rule out any such possibility, one possible solution could be that, if more than one block of spectrum are put to auction, then, in addition to the existing caps (50% of the total spectrum in a band/25% of the total spectrum assigned across bands), an auction-specific cap is placed that no bidder would be permitted to bid for more than half of the spectrum in an LSA. This will not be for the first time that an auction-specific cap is being placed. In the auctions held in 2010, no single bidder was allowed to bid for more than one block (2x5 MHz) of spectrum in an

LSA. This cap will provide an opportunity to a TSP already holding 5 MHz spectrum in 2100 MHz band to increase its spectrum holding up to 15 MHz and at the same time it will also facilitate that a TSP who is presently not holding any spectrum in 2100 MHz band to acquire up to 10 MHz of spectrum which is minimum required for providing good data speed. By placing this cap, it will also ensure that a TSP having ability to pay will not be able to corner the entire spectrum and skew the market in its favour. However, if 15 MHz is put to auction then this restriction would lead to maximum of 7.5 MHz by a TSP wherein block size of 5 MHz is permissible which may lead to wastage of spectrum. Therefore, keeping in view that in some LSAs 15 MHz and in some LSAs 20 MHz would most likely to be available to be put to auction, the Authority is of the view that in the upcoming auction of 2100 MHz band spectrum, an auction-specific cap should be placed that no bidder would be permitted to bid for more than 2 blocks (10 MHz) in an LSA if 3-4 blocks are available in that LSA.

2.30 **The Authority recommends that in upcoming auction of 2100 MHz band spectrum, an auction-specific cap should be placed that no bidder would be permitted to bid for more than 2 blocks in an LSA if 3-4 blocks are available in that LSA.**

Contiguity of Spectrum

2.31 A few stakeholders stated that contiguous dual carriers can support higher data rates and deliver a superior broadband experience to end users. This is possible by using Dual Carrier –HSPA (DC-HSPA) technology. However, the key pre-requisite of the technology is to have contiguous carriers in 2100 MHz band. This is also critical considering that there are no commercial devices in the market that can support DC-HSPA with discontinuous carrier allocation. This is why at a global level, allocations of two or more carriers have been made to operators so that carriers are contiguous. In the view of these stakeholders, there should be a provision to realign current assignments to ensure that all

operators who win a second carrier in any LSA are assigned a contiguous block of 10 MHz. Also, in case operators bid for more than one block of spectrum, allocation of contiguous blocks should be ensured.

2.32 Another stakeholder, while arguing that operators should get contiguous allocations, further submitted that, at the very minimum, operators should be enabled to have all their allocation within the bandwidth of 20MHz – by either granting them fresh spectrum in the range of the earlier spectrum or by reshuffling their earlier allocation. This is required because most radio equipment supports only 20 MHz of Instantaneous Bandwidth9 (IBW). Otherwise, higher IBW supporting Radio (in Node Bs) would be required which would result in inefficiencies for TSPs like increase in cost (OPEX and CAPEX), increased design devices complexities and increased power consumption etc.

Analysis

2.33 Use of Dual-cell HSPA network, as defined in 3GPP[10] Rel 8, results in better user experience and better utilization efficiency (better cell average throughput) due to the gain from pooling as compared to two single- HSPA carriers. Devices are available for DC-HSPA in the 2100 MHz band with contiguous carriers. Although 3GPP later releases support Multi- Cell HSDPA (Non-Contiguous Multi carrier in same Band), it requires devices and radio modules with higher IBW and there is no ready eco-system for it. Weak global demand for Non-contiguous DC-HSPA devices limits economies of scale benefits.

2.34 Deployment of 42 Mbps DC-HSPA+ technology for even better user experience is the major trend in 2014. 166 DCHSPA+ networks (29% of HSPA networks) have been commercially launched in 86

9 Instantaneous Bandwidth refers to the range of frequency that a radio equipment can support.
10 3rd Generation Partnership Project (3GPP) Release 8 of the standard defines dual carrier operation in HSPA networks.

countries[11]. It is important to align with global spectrum allocation practices to reduce costs of production and facilitates mass penetration of mobile broadband.

2.35 In view of the preceding paras, the Authority concurs with the views expressed by stakeholders that, to make optimal use of spectrum, it is important that spectrum in the 2100 MHz band is allocated in contiguous blocks to TSPs. The Authority is of the view that if any TSP is assigned two blocks of 2x5 MHz in the 2100 MHz band in the upcoming auction, it should be assigned contiguous carriers only. Also, TSPs should be permitted to realign their spectrum holding amongst themselves so that they may make their spectrum holding contiguous. Such an approach would benefit TSPs when any TSP having one carrier in the 2100 MHz band gets an additional carrier which is not contiguous. This would also help TSPs in bringing the assigned carriers within IBW of 20 MHz.

2.36 In view of the above, **the Authority recommends that**

(i) If any TSP is assigned two blocks of 2x5 MHz in the 2100 MHz band in the upcoming auction, it should be assigned contiguous carriers only.

(ii) TSPs should be permitted to realign their spectrum holding amongst themselves with mutual agreement.

Interference Free Spectrum

2.37 After the 2100 MHz auction in 2010, 4-5 carriers of 5 MHz each were assigned to TSPs in the LSAs. The carrier frequencies assigned for the uplink were 1959-1964 MHz, 1964-1969 MHz, 1969-1974 MHz and 1974-1979 MHz. In a few LSAs, carriers in the frequency range of 1935-1940 MHz and 1928-1933 MHz were also assigned. (See Table below for reference)

[11] Global Mobile Supplier Association (GSA) report of 22nd October 2014 on GSM/3G Market/Technology Update.

Table 2.3

S.No.	LSA	Spot I	Spot 2	Spot 3	Spot 4	Spot 5
		MHz	MHz	MHz	MHz	MHz
1	DEL		1959-1964	1964-1969	1969-1974	1974-1979
2	MUM		1959-1964	1964-1969	1969-1974	1974-1979
3	KOL		1959-1964	1964-1969	1969-1974	1974-1979
4	MH		1959-1964	1964-1969	1969-1974	1974-1979
5	GUJ		1959-1964	1964-1969	1969-1974	1974-1979
6	AP		1959-1964	1964-1969	1969-1974	1974-1979
7	KTK		1959-1964	1964-1969	1969-1974	1974-1979
8	TN		1959-1964	1964-1969	1969-1974	1974-1979
9	KL		1959-1964	1964-1969	1969-1974	1974-1979
10	PB	1935-1940	1959-1964	1964-1969	1969-1974	1974-1979
11	HR		1959-1964	1964-1969	1969-1974	1974-1979
12	UP (W)		1959-1964	1964-1969	1969-1974	1974-1979
13	UP (E)		1959-1964	1964-1969	1969-1974	1974-1979
14	RAJ		1959-1964	1964-1969	1969-1974	1974-1979
15	MP		1959-1964	1964-1969	1969-1974	1974-1979
16	WB	1928-1933	1959-1964	1964-1969	1969-1974	1974-1979
17	HP	1935-1940	1959-1964	1964-1969	1969-1974	1974-1979
18	BH	1935-1940	1959-1964	1964-1969	1969-1974	1974-1979
19	OR		1959-1964	1964-1969	1969-1974	1974-1979
20	AS		1959-1964	1964-1969	1969-1974	1974-1979
21	NE		1959-1964	1964-1969	1969-1974	1974-1979
22	J&K	1935-1940	1959-1964	1964-1969	1969-1974	1974-1979
	Total					

2.38 In response to the CP, some TSPs submitted that they have experienced interference while deploying networks, and reported this to the DoT/WPC. Interference has been reported in some parts of Punjab, Gujarat, J&K and Haryana LSA. One TSP submitted that the interference in the Jammu region is so high that it has not been able to launch services in that region. These TSPs stated that, till date, the issue remains unresolved and that interference has severely impacted the quality of services in these LSAs leading to extreme customer dissatisfaction. They have requested that affected licensees should be assigned alternate spectrum from the pool of newly available 2100 MHz spectrum and then the remaining interference free spectrum be

put to auction. Some stakeholders submitted that:

(a) spectrum put to auction must be guaranteed to be interference-free, and;

(b) there should be a suitable framework of compensation, in case the spectrum is found to be unusable.

2.39 Although the issue raised by these stakeholders was not part of the CP, the Authority has examined the views expressed by the stakeholders. The Authority is of the view that the once rights for exclusive use of spectrum are being assigned through auction, it has to be ensured that the spectrum is interference-free. Moreover, if interference is reported by any licensee, its timely resolution is of utmost importance. In the present case, the issue has been hanging fire for 2 years or more. As reported by the TSPs, they are not able to use spectrum in some part of the LSA; this is clearly not acceptable to any licensee who has paid market price to acquire the right to use the spectrum.

2.40 Through its letter dated 18th December 2014, Wireless Planning & Coordination Wing (WPC) of the DoT informed TRAI that in order to resolve the interference, Wireless Monitoring Organisation (WMO), field unit of WPC Wing, has carried out extensive monitoring in the respective LSAs and confirmed presence of interference and also located the source of interference which is emanating from Pakistan in the frequency band 1960-1980 MHz. Pakistan Administration was requested through Ministry of External Affairs (MEA) to take necessary remedial measures to mitigate interference. In response to this, Pakistan Administration informed that Frequency Allocation Board, Government of Pakistan, has stated that they have already instructed their operators to adopt appropriate mitigation technique in order to curtail the spill-over of signals along the border areas. WPC further informed that to resolve the 3G interference in cross-border areas, the matter is again being taken up with the Pakistan

Administration.

2.41 The Authority is of the firm view that the interference problem reported by some TSPs should be resolved without further delay. These TSPs have paid substantial amount for this spectrum and if they are not able to use the spectrum for the last two years due to interference issue, then it is gross injustice to them. The Authority is of the view that this issue of interference needs to be resolved before putting fresh spectrum blocks to auction in these LSAs; further, it is imperative to ensure that the spectrum blocks being put to auction are interference-free.

2.42 In view of the above, **the Authority recommends that the issue of interference, reported in the 2100 MHz band in some LSAs, needs to be resolved before putting fresh spectrum blocks to auction in these LSAs. Further, it is imperative to ensure that spectrum blocks being put to auction are interference-free.**

Increasing the permissible power limit of 3G Node B

2.43 In response to the CP, some stakeholders submitted that current guidelines of RF power from DoT on transmit power (RF) from the BTS is 20W at the output of the BTS port. According to the stakeholders, the BTS transmit power guidelines for mobile networks were introduced in 1995 when GSM was the most common network. Since then technologies have evolved; however, transmit power regulations have not been reviewed and the same norms are being followed for all new technologies such as 3G and LTE.

2.44 These stakeholders stated there is a significant difference between GSM (narrowband technology) and 3G/LTE (broadband technology) which necessitates different treatment of RF Power related to these technologies. GSM has continuous power transmission irrespective of the traffic in the BTS. In contrast, 3G/LTE has discontinuous power transmission and only pilot power, which is typically 10% of the total

transmit power, is continuous and the total power transmitted is based on the amount of voice and data traffic in the Node B. 3G and LTE which are wideband technologies, need higher transmit power for coverage and capacity. An increase in power is a means to increase the capacity of the Node B in 3G/LTE and thus improve customer experience. Global deployments in US, Europe, China and APAC markets for 3G/LTE are using 40W to 80W of transmit power in the BTS irrespective of bands (3G in 900 and 2100, LTE-FDD in 1800, 800, 2100, 900 band, LTE-TDD in 2300, 2600 band) to take care of growth in mobile broadband traffic. Therefore, these stakeholders requested the Authority to review the maximum permissible power form a node.

Analysis

2.45 It is true that the power radiated is one of the factors that determines the capacity of the HSPA/LTE deployments. An increase in power radiated results in enhanced signal strength which implies higher order modulation and, therefore, better user experience. It also helps increase average throughput of the cell. On the flip side, however, chances of interference to nearby cells rise and this will necessitate re-optimisation of the network by the TSP.

2.46 India has adopted strict limits for radiation from Base Transceiver Station (BTS), as below, which is 1/10th of the international norms. The EMF exposure limit and safe distance from the tower (exclusion zone) etc. are determined as per peak traffic measurement. Increasing the maximum permissible power of a node will impact EMF radiation. Power radiation from mobile handset also depends on the power radiated by the node. A detailed technical study needs to be carried out to evaluate the impact on EMF radiation and other related aspects if enhanced power levels are to be permitted from base station for HSPA/HSPA+ or LTE technologies. The Authority does not have field information and is not equipped to carry out this study. Therefore, the

Authority is not making any specific recommendation on the issue. However, the Authority is of the view that the DoT should carry out the EMF impact study within a period of 6 months and decide on the plea of the TSPs to enhance the power limits.

2.47 In view of the above, **the Authority recommends that the DoT should carry out the EMF impact study and decide within a period of 6 months whether the power radiation limits from base stations can be enhanced beyond the present limits of 20 Watts for HSPA/HSPA+ or LTE technologies.**

CHAPTER-III: THE VALUATION AND RESERVE PRICE OF SPECTRUM

Background

3.1 The present Recommendations on the applicable Reserve Price (RP) for auction of spectrum in the 2100 MHz band are being given in the backdrop of the DoT's stated intention to conduct auctions for this band along with the auction of 1800 MHz, 900 MHz and 800 MHz bands scheduled in February 2015. As noted in Chapter I of the CP, the previous auction of 2100 MHz spectrum (often referred to as the 3G band) was conducted by DoT in May 2010; the auction realized prices were many times more than the RP set for that auction. It was also noted in the CP that the 2010 auction was conducted in a supply-constrained scenario. Further, the demand for spectrum was conditioned by both irrational exuberance and excessive competition engendered by entry of new licencees in 2008. The changes occurring over time in the underlying demand, supply and market expectations in the sector and the larger economy have important effects on auction outcomes. As discussed in the Authority's Recommendations of 9th September 2013 on Valuation and Reserve Price of Spectrum, fluctuating market interest for 3G spectrum has been observed in other countries as well. The Recommendations adverted to the pioneering work by Paul Klemperer on 3G auctions in Europe in 2000 and 2001[12] to illustrate how, in less than a period of two years, the market sentiment towards 3G auctions changed. Table 3.1 of the September 2013 Recommendations (reproduced below) indicated the revenues from European 3G mobile spectrum auctions that varied significantly across countries. The sum of Klemperer's arguments is that the exuberance of early auctions is replaced by more informed and realistic bidding in subsequent auctions. This brings out the inherent risk of failure if prices for subsequent auctions in India are

[12] Klemperer, Paul (2001), "How (not) to Run Auctions: The European 3G Telecom Auctions", available at http://economics.ouls.ox.ac.uk/11928/1/hownot.pdf.

exclusively benchmarked to prices realized in the 3G auctions. In 2010, the competitive pressure to buy spectrum was especially high in Metro and Category 'A' LSAs; the contribution of Metro LSAs was almost 43% of the total auction-determined price and that of Category 'A' LSAs was another 40% of the total. That is to say, 83% of the total bid values can be ascribed to Metro and Category 'A' LSAs, leaving a paltry 17% of the bid value for all the other LSAs.

TABLE 3.1
REVENUES FROM EUROPEAN 3G MOBILE SPECTRUM AUCTIONS
(Euros per capita)

Year 2000		**Year 2001**	
Austria	100	Belgium	45
Germany	615	Denmark	95
Italy	240	Greece	45
Netherlands	170		
Switzerland	20		
UK	650		

3.2 The 2010 auction was the first and only instance of allocation of spectrum in this band in India. Roll-out of services also started after 2010, and separate aggregates for usage and revenue in the case of the 2100 MHz band have not been maintained. As such, unlike in the case of the other spectrum bands, extensive financial and non-financial information pertaining to the 2100 MHz band is not available. Alternative valuation approaches were proposed in the CP in the context of this limited information availability. At the same time, previous auction experience as well as technical and economic factors were kept in view when posing alternative methods for consultation.

Use of 2010 Auction Determined Prices

3.3 As discussed in the CP, one approach to the valuation of 2100 MHz band for the forthcoming auction could be to utilise the price information revealed in the 2010 auction. The approach could factor in the elapse of time (since the previous auction) by indexing the market revealed prices using a suitable indexation factor. In this context, the following question was raised:

Q5: Should the indexed value of May 2010 auction determined prices of 2100 MHz spectrum be used as one possible valuation for 2100 MHz spectrum in the forthcoming auction? If not, why not? And, if yes, what rate should be adopted for the indexation?

3.4 Most stakeholders have not favoured indexation of 2010 auction price as a possible valuation approach for the 2100 MHz spectrum. The most cited reasons given by stakeholders in support of their position are: the supply-constrained scenario of the 2010 auction; excessive competition engendered by entry of new licencees in 2008; the experience with the unsuccessful auctions of November 2012 and March 2013 where past market prices (of the 2010 3G auction) were used to set RP; and changes in the sector's techno-economic factors since the 2010 auction. One stakeholder was in favour of this approach and suggested indexation of 2010 auction price based on Income Tax Cost Inflation Index (CII) or SBI PLR. Another stakeholder stated that though indexation is not the best methodology, in view of the limitations of the other methodologies, indexation of 2010 auction prices using SBI PLR can be used in a valuation exercise.

Analysis

3.5 The comments of the stakeholders on the issue have been examined. The arguments marshaled against the use of the 2010 auction prices point to the many changes in the techno-economic landscape since the time that auction was conducted; they also draw attention to the peculiar demand-supply position for spectrum at that time, viz., severe supply constraints, excessive demand, etc. In short, these arguments essentially seek to jettison past experience in favour of a forward-looking approach. At the same time, however, arguments have been made by stakeholders (see discussion below on technical efficiency) in support of linking the price of 2100 MHz spectrum to the recommended or market-revealed price of 1800 MHz spectrum in recent auctions. The contradiction between seeking a forward-looking approach (ignoring past 2010 auction experience) and yet relying on the discovered prices in the recent past (1800 MHz auction) is

palpable. There can be no denying that the 2010 auction of 2100 MHz spectrum was supply-constrained. Equally, however, prices revealed then remain the only available indicator of market-determined prices for the 2100 MHz band. While the circumstances attending the 2010 auction may have been different from those obtaining for the forthcoming auction, the competitive landscape in the Indian telecom sector in terms of the TSPs seeking to provide access services remains broadly the same. It is difficult, if not impossible, to precisely quantify how much context affected the revealed market prices in the 2010 auction; at the same time, it is also true that the market players could be expected to factor in their previous experience while approaching the forthcoming auction. Auction design, by definition, must primarily be geared to prevent collusive, entry-deterring and predatory behavior, while at the same time being sensitive to the particular context in which the auction is being held[13].

3.6 It is also necessary to note that the Authority's approach in recent RP-setting exercises is not to benchmark RP to any single previous market price; a number of methodologies have been used to arrive at a bouquet of valuations that prospective bidders may place on the spectrum on offer, and subsequently arrive at an average valuation that forms the basis for RP. As such, the Authority is of the view that prices revealed in the last auction cannot be ignored as they are an outcome of a competitive bidding process. Therefore, the 2010 auction price can be taken as one of indicative values of the 2100 MHz spectrum for the forthcoming auction.

3.7 On indexation, the Authority notes that the question of what rate should be adopted for indexation has not elicited much response from stakeholders. SBI PLR has been used by the Authority for indexation of historical spectrum prices in the past spectrum valuation exercises. One stakeholder has responded that the indexation methodology based on SBI PLR should be used, as done in the Authority's

[13] Klemperer, Paul (2002), "What Really Matters in Auction Design", *Journal of Economic Perspectives*, 16(1), pp. 169-189.

Recommendations of 23rd April 2012. Another stakeholder responded that different methods were available for indexing spectrum valuation and that the Income Tax Cost Inflation Index or PLR can be used to compute the indexed value. The Authority has considered the issue in the light of stakeholders' comments. The Authority notes that in the banking sector, the 'base rate system' has replaced the benchmark PLR system with effect from 1st July 2010, and would be applicable for all new loans and for those old loans that come up for renewal[14]. The Authority is of the view that the base rate represents the most realistic rate at which indexation should be carried out. Therefore, **the Authority has decided to use the indexed value of May 2010 auction determined prices as one of the possible valuations in the current exercise of valuing 2100 MHz spectrum.** The indexed value of 2010 auction price of 2100 MHz spectrum using the SBI Base Rate is given in **Annexure 3.1**.

Technical Efficiency

3.8 As indicated in the CP, as a general principle (with other things remaining constant), a network built around lower frequency spectrum costs less than a network built around higher frequency spectrum. This factor has an important bearing on the value of different bands of spectrum. One way of valuing 2100 MHz spectrum could be to establish relative values with 1800 MHz spectrum using proportional factors based on relative technical efficiency. In this context, the following question was raised in the CP:

Q6. Should the value of the 2100 MHz spectrum be derived on the basis of the value of the 1800 MHz spectrum using the technical efficiency factor (0.83) as discussed above?

3.9 Most stakeholders were in favour of valuation of 2100 MHz spectrum using the relative technical efficiency factor. Some stakeholders suggested that the valuation of the 2100 MHz spectrum based on the

[14] See Reserve Bank of India, "Guidelines on the Base Rate", RBI/2009-10/390, April 9, 2010.

value of the 1800 MHz spectrum is the best approach; no other approaches need be attempted. One stakeholder commented that the 4G eco-system is less developed for 2100 MHz band (compared to 1800 MHz band), and, therefore, the value of the 2100 MHz spectrum in LSAs where 1800 MHz spectrum was sold in February 2014 auction should be fixed at 70% of the 1800 MHz spectrum auction price and for the remaining LSAs (where 1800 MHz spectrum was not fully sold) at 50% of the 1800 MHz spectrum auction price. One stakeholder commented that the 2100 MHz band is primarily going to be used for data-only services; therefore, there is merit in linking it to the per MHz price discovered for the 2300 MHz band spectrum in 2010, which was auctioned as a data-only spectrum. Some stakeholders have not favoured the valuation approach based on the technical efficiency factor alone.

Analysis

3.10 Stakeholders' comments have been examined. *Ceteris paribus*, there can be no gainsaying that the 1800 MHz band possesses a greater technical efficiency than the 2100 MHz band. Physics tells us that 1800 MHz spectrum will always have better propagation characteristics than 2100 MHz spectrum. This approach does not incorporate economic efficiency and potential usage of spectrum in providing different types of services; thus, it cannot be taken as the only approach to value 2100 MHz spectrum. However, it can definitely be used as one possible valuation approach acknowledging the technical efficiency relationship between 2100 MHz spectrum and 1800 MHz spectrum. Consistent with its earlier estimation exercises of other bands, **the Authority has decided to use the valuation worked out using 0.83 times of the average valuation of 1800 MHz spectrum as one of the possible valuations of 2100 MHz spectrum.** The values based on this approach are indicated in **Annexure 3.2**.

Estimating the value of spectrum based on producer surplus on account of additional spectrum

3.11 Spectrum can also 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 for determining the opportunity of cost savings to an average TSP in the RAN upon getting additional spectrum (opportunity/MHz).

3.12 The following question was raised in the CP:

Q7: Should the value of spectrum in the 2100 MHz band be estimated on the basis of the producer surplus model outlined in Chapter III? Please provide your views on the assumptions made. Please support your response with justification, calculations and relevant data along with the results.

3.13 The Authority received a number of comments from stakeholders on this methodology. One stakeholder, while agreeing with the argument that additional spectrum can result in avoidable cost/ producer surplus, has pointed out that the model can lead to overestimation because of (i) the difficulty in predicting demand for data over a 20-year period; and, (ii) the fact that 2100 MHz band may not necessarily be the only spectrum to meet such demand for data. Some concerns have been raised arguing that technical value alone is not sufficient to estimate spectrum valuation and that this method may give a lower price for 2100 MHz since it ignores the revenue-earning potential of the spectrum band through provision of data. Another stakeholder has mentioned that there is little merit in a bottom-up valuation as a method for setting RP of spectrum. One stakeholder has opined that, in order to determine the number of subscribers using 3G data, it

would be better to assume fair market distribution instead of estimating it on the basis of the Herfindahl-Hirschman Index (HHI) of the segment.

Analysis

3.14 Most of the comments of the stakeholders are general and diffuse in nature. Regarding the issue of difficulty in predicting the demand of data growth raised by a stakeholder, it may be noted the Authority has used projections (not predictions) for the growth of subscriber base and data usage per subscriber on the basis of the trends available with it. Regarding the issue of the method being technical in nature, it may be noted that the model has been designed to estimate the cost savings in RAN to the average TSP having 5MHz spectrum in 2100 MHz band upon acquiring additional 5 MHz of spectrum in 2100 MHz band. On the issue of the need for a bottom-up valuation, it may be noted that the Authority has been using the bottom-up approach in its spectrum valuation exercises. As far as the issue of appropriateness of HHI to estimate the subscriber base of the average TSP is concerned, it may be noted that the HHI is a widely-used method to measure market concentration in a relevant market and, thereby, the size of an average market player. The Authority, in its recent spectrum valuation exercises, has used HHI for estimating the subscriber base of average operator in an LSA.

3.15 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 Authority is aware that any valuation methodology would have inherent limitations and no one method can exactly mimic the real world perfectly. The Authority is, therefore, of the view that valuation methodologies that are logically consistent and yield viable results should be appraised with an open mind. Accordingly, the Authority decided to estimate the value of 2100 MHz spectrum based on the producer surplus model using available

data and industry benchmarks. The detailed methodology used in this model and results obtained are at **Annexure 3.3. The Authority has decided to use the results of the producer surplus model as one of the possible valuations for the 2100 MHz spectrum.**

Model based on Growth in Data Usage

3.16 The approach based on growth in data usage is premised on the assumption that the NPV of the projected revenue surplus over 20 years (net of related expenses/costs) would potentially represent the maximum amount which a buyer would be willing to pay for acquiring the spectrum. In this model, the valuation of 2100 MHz spectrum is derived from the projected data revenue from the perspective of an access service provider (providing 2G services but having no 2100 MHz spectrum) willing to invest the net revenue potential from 3G subscribers over the licence time horizon of 20 years for acquiring 2100 MHz spectrum. The business model adopted by different service providers would influence the respective valuations if firm-level calculations are adopted. Hence, aggregate data of the 3G data segment has been used in the valuation exercise using this approach.

3.17 The following question was raised in the CP in this background:

Q8: Should the value of spectrum in the 2100 MHz band be estimated on the basis of the growth in data usage outlined above? Please provide your views on the assumptions made. Please support your response with justification, calculations and relevant data along with the results.

3.18 Some stakeholders have recognized the potential of 2100 MHz spectrum in view of the estimated growth in data usage, the expected revenue and the preferred band for delivering better data services. One stakeholder has commented that, in future, more and more data would be served through 2100 MHz spectrum and, to reflect this, the valuation of 2100 MHz should be 3 times the value of 800 MHz spectrum in 'Metro' and 'A' LSAs and 2.5 times in 'B' and 'C' LSAs. Further to the introduction of advanced carrier aggregation technology

in 2100 MHz band, provision of data services will be done in a more efficient manner, and, therefore, the 2100 MHz band ought to command an additional premium of 25% over the estimated valuation in Metro and Category 'A' LSAs. Another stakeholder submitted that the data growth in 3G has happened over the past one year and for any purposeful modeling, data over a longer period is required, duly accounting for the likely fall in voice revenues due to the proliferation of 'Over The Top' (OTT) players.

3.19 One stakeholder has commented that this approach assumes that the 2100 MHz spectrum is either the only spectrum or the best spectrum to meet future demand for data usage and disregards other mobile technologies and bands such LTE and WiFi. It has been further submitted that the market share estimate of the TSP that secures spectrum is arbitrary and that estimating Capex on a per subscriber basis is simplistic.

Analysis

3.20 The comments of the stakeholders have been examined. It is not correct to argue (as some have) that the model assumes that all future demand of data services will be catered to only by the 2100 MHz band. In fact, the model assumes that, in future, with the deployment of next generation technologies like LTE and new bands (700 MHz/2500MHz), the 2100 MHz spectrum will not be able to retain its present share in data usage (and revenue); therefore, a moderated/ tapering annual growth rate of 3G subscribers (using internet) has been incorporated, after noting that in the last 12 months, 3G subscribers have witnessed quarterly growth ranging between 12% and 24%. On the share of voice services in revenue from 2100 MHz spectrum, it is no doubt true that, in India, the 2100 MHz band is used for both voice and data services. However, keeping in view the growth of the non-voice revenue segment, no growth in voice ARPU has been considered in the model. Capex per subscriber taken in the

model represents the investment for coverage as well as increase in capacity.

3.21 No stakeholder has suggested any alternative assumptions for incorporation in the model. It would be misplaced to argue that an additional premium of 25% should be applied on the estimated valuation in this model for Metro and category 'A' LSAs. The model is a bottom-up approach attempting to arrive at one possible value of the 2100 MHz spectrum based on available information, data and current trends. Like any other economic model (involving assumptions and a degree of abstraction), this approach too has its limitations. However, the fact remains that the proposed model based on growth in data usage is a feasible alternative approach to estimate the value of 2100 MHz spectrum from the perspective of a TSP providing 2G services and willing to acquire 2100 MHz spectrum in the expectation of targeted/ projected revenue from data services and profitability. **The Authority has, therefore, decided to use the results of the model based on growth in data usage, as one of the possible valuations of 2100 MHz spectrum.** The detailed methodology and assumptions used in this model and the results obtained are at **Annexure 3.4**.

Valuation of Spectrum: Single Approach *versus* Multiple Approaches

3.22 As discussed above, the Authority has assessed the value of 2100 MHz using a number of alternative approaches. All the approaches for valuing 2100 MHz spectrum have their own merits and drawbacks. Any of these valuations could actually materialize in the market place. In this context, the following question was raised in the CP:

Q9: Would it be appropriate to value the 2100 MHz spectrum as the simple mean of the values arrived from different valuation approaches as discussed above? If no, please suggest with justification that which single approach should be adopted to value the 2100 MHz spectrum?

3.23 Some stakeholders supported the valuation of 2100 MHz spectrum as the simple mean of different valuation approaches adopted. Some stakeholders commented that since the valuation of 1800 MHz has been derived after taking an average of different valuation approaches, there is no merit in working out the value of 2100 MHz again by taking an average of similar approaches. They argue that, instead of averaging different approaches, the valuation of 2100 MHz should be fixed at 0.83 times of 1800 MHz spectrum value. One stakeholder, while favouring average valuation based on different approaches, has commented that the average should be based on median rather than mean. One stakeholder has commented that it would not be appropriate to value 2100 MHz spectrum based on the simple mean of different valuation approaches. It has been further argued that if the Authority decides to determine the valuation based on the simple mean, only the valuations obtained from the indexed value of 2010 auction prices and the model based on growth in data usage should be considered.

Analysis

3.24 The Authority has carefully considered the comments of stakeholders. The approaches (other than the one based on 2010 auction prices) adopted in the current valuation exercise of 2100 MHz spectrum are bottom-up approaches based on available LSA specific data/ information on 3G service segment (using internet), whereas in the valuation exercise of 1800 MHz spectrum, base data/information was of the 2G GSM segment. Taking 0.83 times of 1800 MHz spectrum alone as the sole value of 2100 MHz spectrum ignores the economic efficiency and potential usage of spectrum in providing different types of services. The Authority has been of the consistent view that it is simply not possible to say deterministically that one valuation approach is the 'right' approach. Each valuation model has strengths and limitations. 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. Given that the average estimation is done on only four valuations, it is the Authority's view that the arithmetic mean is the most realistic estimator. Therefore, on the assumption of equal probability of occurrence of each valuation (as was done in the previous Recommendations[15]), **the Authority has decided to adopt an average valuation of 2100 MHz spectrum as the simple mean of the valuations obtained from the four different approaches.** A Table containing the mean value (average valuation) of 2100 MHz spectrum using different approaches is at **Annexure 3.5.** Accordingly, the recommended average expected value of 2100 MHz spectrum for each LSA is tabulated below:

TABLE 3.2
RECOMMENDED AVERAGE VALUE PER MHz of 2100 MHz BAND
(Rs. in crore)

LSA	Category	Average Value per MHz of 2100 MHz
Delhi	Metro	557.35
Mumbai	Metro	424.63
Kolkata	Metro	96.62
Andhra Pradesh	A	228.72
Gujarat	A	243.70
Karnataka	A	300.97
Maharashtra	A	284.23
Tamilnadu	A	324.47
Haryana	B	54.41
Kerala	B	134.09
Madhya Pradesh	B	105.07
Punjab	B	81.84
Rajasthan	B	104.53
U. P. (East)	B	102.44
U.P. (West)	B	120.07
West Bengal	B	37.73

[15] 9th September 2013 for 1800 MHz spectrum and 900 MHz spectrum, 22nd February 2014 for 800 MHz spectrum and 15th October 2014 for 1800 MHz spectrum and 900 MHz spectrum

Assam	C	36.01
Bihar	C	82.10
Himachal Pradesh	C	13.00
Jammu & Kashmir	C	17.76
North East	C	18.99
Orissa	C	40.05
Pan India		**3408.78**

Reserve Price Estimation

3.25 A reserve price (RP) is the minimum amount that the owner of an item up for auction would be willing to accept as the winning bid in the auction. It prevents the auction from being won at a price lower than the minimum the owner is willing to accept. The objectives of increasing revenue and avoiding collusion among bidders need to be balanced. While a low RP may lead to a collusive outcome and a loss of revenue, a high RP may result in spectrum remaining unsold.

3.26 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 RP 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 RP is only the starting point in the process of price discovery. It was also observed that RPs should be lower than estimates of valuation to encourage competitive bidding and price discovery.

3.27 In the present exercise for fixing the RP for the 2100 MHz band, the following question was posed in the CP:

Q10: What should be the ratio adopted between the reserve price for the auction and the valuation of the spectrum of 2100 MHz band?

3.28 Many stakeholders agreed that RP should be 80% of the valuation. One stakeholder commented that RP should be set 20%-40% below estimated value. Another stakeholder has commented that 2100 MHz is not the core and critical spectrum and given the tremendous risks and uncertainties associated with predicting data growth, far greater caution be exercised in setting RP. Yet another stakeholder has commented that RP should be set equal to spectrum valuation for 'Metro' and category 'A' LSAs and in remaining LSAs, RP should be fixed at 80% of valuation of the spectrum.

Analysis

3.29 The Authority has noted that in the Notice Inviting Applications (NIA) for "Auction of Spectrum in 1800 MHz and 900 MHz Bands" of 12th December 2013, the DoT fixed the RP for Metro and Category 'A' LSAs equal to the average valuation arrived at in the Authority's Recommendations in this regard of 9th September 2013. The Authority would like to caution against mechanically taking the same approach in the case of the recommended RPs for 2100 MHz band (by making RP equal to average valuation in Metro and Category 'A' LSAs). The Authority has been of the consistent view that RP should not be fixed too close to the estimate of valuation. RP is the starting point for an ascending price auction and bidding is the means to price discovery. RP set too close to estimations of valuation may discourage participation by bidders. It may be noted that the average valuation of 2100 MHz spectrum has been derived as the arithmetic mean of four approaches, including by indexing the 2010 auction-determined prices using SBI Base Rate. If RP is set equal to valuation, this is likely to asymmetrically affect the bidding process in the Metro and Category 'A' LSAs, given the significantly larger contribution of these LSAs to the total auction-determined price in 2010, as discussed in paragraph 3.1 above. As such, **the Authority strongly urges that the reserve prices for the forthcoming 2100 MHz auction should be retained as recommended below**.

3.30 The Authority has also carefully considered the comments of the stakeholders. The Authority is of the view that RP is not the eventual realized price in the auction; it is the starting point for an ascending price auction. An RP set lower than the expected value of the object will enable price discovery and the final bid price is likely to be much higher than the RP. Consistent with its earlier Recommendations, **the Authority is of the view that the reserve price for the forthcoming auction of 2100 MHz spectrum be fixed at 80% of the average valuation. The prices arrived at on this basis are indicated in Annexure 3.6.**

3.31 The Authority, in its recent Recommendations, has been conscious of the need to give a fillip to penetration of telecom services in the North East for improving the economic well-being of the region, given its peculiar geography, needs and particular circumstances. To accelerate the pace of investment in telecom infrastructure in the LSA, the Authority is of the view that the reserve price for spectrum in the North East LSA should be kept at 50% of the reserve price arrived at as above. **The Authority accordingly recommends that the reserve price for North East LSA may be fixed at a discount of 50% on the price given in Annexure 3.6**.

3.32 **Accordingly, the Authority recommends that the reserve price for 2100 MHz spectrum in each LSA should be as in column (4) of Table 3.3 below:**

TABLE 3.3

RECOMMENDED RESERVE PRICE PER MHz IN 2100 MHz BAND

(Rs. in crore)

(1)	(2)	(3)	(4)
LSA	**Category**	**Reserve Price (as calculated)**	**Recommended Reserve Price (Rounded off)**
Delhi	Metro	445.88	446
Mumbai	Metro	339.70	340
Kolkata	Metro	77.30	77

Andhra Pradesh	A	182.98	183
Gujarat	A	194.96	195
Karnataka	A	240.78	241
Maharashtra	A	227.38	227
Tamilnadu	A	259.57	260
Haryana	B	43.53	44
Kerala	B	107.27	107
Madhya Pradesh	B	84.06	84
Punjab	B	65.47	65
Rajasthan	B	83.62	84
U. P. (East)	B	81.95	82
U.P. (West)	B	96.05	96
West Bengal	B	30.19	30
Assam	C	28.81	29
Bihar	C	65.68	66
Himachal Pradesh	C	10.40	10
Jammu & Kashmir	C	14.21	14
North East	C	7.60	8
Orissa	C	32.04	32
Pan India		**2719.43**	**2720**

CHAPTER-IV: SUMMARY OF RECOMMENDATIONS

4.1 The Authority reiterates its recommendations that spectrum in the 2100 MHz band should be put to auction along with the 800/900/2100 MHz band. Furthermore, the 15 MHz of spectrum (which are equivalent to 3 blocks of 2x5 MHz when paired corresponding downlink spectrum) in the 2100 MHz spectrum being vacated by Ministry of Defence, in lieu of spectrum in the 1900 MHz spectrum, should be auctioned in view of the in-principle agreement reached with MoD, even if it is not available immediately. This is because actual assignments do not have to be made immediately. The actual date of assignment may be given in the NIA. The Authority also recommends that the DoT should take all measures to ensure that the 2100 MHz spectrum which was earlier assigned to STEL in three service areas viz. Bihar, Orissa and Himachal Pradesh is also put to auction.

(Para 2.10)

4.2 The Authority recommends that:

(i) The roll-out obligations that were mandated in the 2010 auctions for spectrum in the 2100 MHz band should be applicable for the upcoming auction of 2100 MHz band; however, a period of 3 years (instead of 5 years) should be prescribed to meet these obligations.

(ii) A TSP, which already has a block of 2x5 MHz in the 2100 MHz band in an LSA and acquires additional block(s) in the LSA through the upcoming auction, should not be mandated to comply with the roll-out obligations prescribed above again. It would continue to be bound to the same roll-out obligations that were prescribed when it acquired the first block of spectrum in 2010.

(iii) TSTP (Test Schedule Test Procedure) which prescribes the process and method for measurements and tests to be

carried out to ensure the required roll-out of the 3G network should be finalised at the earliest but, in any case, no later than the conduct of the February 2015 auction.

(iv) The list of rural SDCAs along with names of the towns in these SDCAs should be made part of the NIA.

(Para 2.20)

4.3 The Authority recommends that in upcoming auction of 2100 MHz band spectrum, an auction-specific cap should be placed that no bidder would be permitted to bid for more than 2 blocks in an LSA if 3-4 blocks are available in that LSA.

(Para 2.30)

4.4 The Authority recommends that

(i) If any TSP is assigned two blocks of 2x5 MHz in the 2100 MHz band in the upcoming auction, it should be assigned contiguous carriers only.

(ii) TSPs should be permitted to realign their spectrum holding amongst themselves with mutual agreement.

(Para 2.36)

4.5 The Authority recommends that the issue of interference, reported in the 2100 MHz band in some LSAs, needs to be resolved before putting fresh spectrum blocks to auction in these LSAs. Further, it is imperative to ensure that spectrum blocks being put to auction are interference-free.

(Para 2.42)

4.6 The Authority recommends that the DoT should carry out the EMF impact study and decide within a period of 6 months whether the power radiation limits from base stations can be enhanced beyond the present limits of 20 Watts for HSPA/HSPA+ or LTE technologies.

(Para 2.47)

4.7 The Authority accordingly recommends that the reserve price for North East LSA may be fixed at a discount of 50%.

(Para 3.31)

4.8 The Authority recommends that the reserve price for 2100 MHz spectrum in each LSA should be as given in Table below:

TABLE

RECOMMENDED RESERVE PRICE PER MHz IN 2100 MHz BAND

(Rs. in crore)

LSA	Category	Recommended Reserve Price
Delhi	Metro	446
Mumbai	Metro	340
Kolkata	Metro	77
Andhra Pradesh	A	183
Gujarat	A	195
Karnataka	A	241
Maharashtra	A	227
Tamilnadu	A	260
Haryana	B	44
Kerala	B	107
Madhya Pradesh	B	84
Punjab	B	65
Rajasthan	B	84
U. P. (East)	B	82
U.P. (West)	B	96
West Bengal	B	30
Assam	C	29
Bihar	C	66
Himachal Pradesh	C	10
Jammu & Kashmir	C	14
North East	C	8
Orissa	C	32
Pan India		**2720**

(Para 3.32)

Abbreviation

S.No.	Abbreviation	Expansion
1.	2G	Second Generation
2.	3G	Third Generation
3.	3GPP	3rd Generation Partnership Project
4.	ARPU	Average Revenue per User
5.	BSNL	Bharat Sanchar Nigam Limited
6.	BTS	Base Transceiver Station
7.	CAPEX	Capital Expenditure
8.	CII	Income Tax Cost Inflation Index
9.	CP	Consultation Paper
10.	DC-HSPA	Dual Carrier HSPA
11.	DHQs	District Headquarters
12.	DoT	Department of Telecommunications
13.	EMF	Electromagnetic Field
14.	FDD	Frequency Division Duplex
15.	GSA	Global Mobile Supplier Association
16.	GSM	Global System for Mobile Communication
17.	HHI	Herfindahl Hirschman Index
18.	HSDPA	High Speed Downlink Packet Access
19.	HSPA	High Speed Packet Access
20.	HSPA+	Evolution of HSPA+
21.	IBW	Instantaneous Bandwidth
22.	LSA	Licence Service Area
23.	LTE	Long Term Evolution
24.	MEA	Ministry of External Affairs
25.	MoU	Memorandum of Understanding
26.	MTNL	Mahanagar Telephone Nigam Limited

Abbreviation

S.No.	Abbreviation	Expansion
27.	NIA	Notice Inviting Application
28.	NPV	Net Present Value
29.	OHD	Open House Discussion
30.	OPEX	Operating Expenditure
31.	PLR	Prime Lending Rate
32.	PSU	Public Sector Undertaking
33.	QoE	quality of experience
34.	RAN	Radio Access Network
35.	RF	Transmit Power
36.	RP	Reserve Price
37.	RTL	Reliance Telecom Limited
38.	SBI PLR	State Bank of India – Prime Lending Rate
39.	SDCA	Short Distance Charging Area
40.	TDD	Time Division Duplex
41.	TDSAT	Telecom Disputes Settlement & Appellate Tribunal
42.	TRAI	Telecom Regulatory Authority of India
43.	TSP	Telecom Service Provider
44.	TSTP	Test Schedule Test Procedure
45.	WiFi	Wireless Fidelity
46.	WMO	Wireless Monitoring Organisation
47.	WPC	Wireless Planning & Coordination Wing

Annexure 1.1

Government of India
Ministry of Communications and IT
Wireless Planning and Coordination (WPC) Wing
Sanchar Bhawan, 20, Ashok Road, New Delhi - 110001

No.L-14006/01/2014-NTG Dated: October 16, 2014

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 the Reserve Price for auction of right to use of Spectrum in 2100 MHz, 2300 MHz and 2500 MHz bands - reg.

Sir

The undersigned is directed to state that the Government is planning auction of right to use of spectrum in 2100 MHz, 2300 MHz and 2500 MHz bands, preferably along with the auction of spectrum in 800 MHz, 900 MHz and 1800 MHz bands. The status of availability of spectrum in these three bands is as under:

2.1 2100 MHz band:

At present, no vacant spectrum is available with the Department in 2100 MHz band. Discussions with Defence are underway for release of one block of 5 MHz of spectrum in 2100 MHz and the possibilities are that the Defence may release spectrum with the availability either for entire service area or partial basis(i.e. released spectrum will not be available for entire service area). Spectrum in 2100 MHz band will be put for auction only after release of spectrum by Defence.

2.2 2300 MHz and 2500 MHz Bands:

Details of availability of spectrum in these two bands are attached at Annexure.

3. Further, the department has so far conducted spectrum auction in different bands since 2010 with a validity period of 20 years of right to use spectrum. The administratively assigned spectrum in 800 MHz, 900 MHz and 1800 MHz bands is co-terminus with expiry of service licenses. This has created a situation where TSPs are providing services in a service area, having spectrum with different validity period of right to use spectrum even in the same band.

3.1 The feasibility of auctioning varying validity periods of right to use spectrum (less than 20 years) so that expiry of validity period of right to use spectrum in a band in a service area occurs at same time may also be considered.

4. TRAI is, therefore, requested to provide recommendations on the following in terms of clause 11(1)(a) of TRAI Act 1997 as amended by TRAI Amendment Act 2000.:

(a) Applicable reserve price for 2100 MHz, 2300 MHz and 2500 MHz bands for all the services areas in both the cases i.e. spectrum available in entire service area and spectrum partially available in a service area.

(b) Auction of right to use of spectrum in a band with varying validity periods(less than 20 years) so that expiry of validity period of right to use spectrum in a band in a service area occurs at same time.

(R. B. Prasad)
Joint Wireless Adviser

Annexure

Details of availablity of Spectrum in 2300 MHzand 2500 MHz bands

S. No.	Service Area	Frequency spot in 2300 MHz Band	Frequency spot in 2500 MHz Band		Total Available Spectrum in (MHz)
1	Andhra Pradesh	2325.0-2345.0	2535-2555	2635-2655	60
2	Assam	2347.5-2367.5	2535-2555		40
3	Bihar	2357.5-2377.5	2535-2555		40
4	Delhi	2350.0-2370.0	2535-2555	2635-2655	60
5	Gujarat	2350.0-2370.0	2535-2555	2635-2655	60
6	Haryana		2535-2555		20
7	Himachal Pradesh	2367.5-2387.5	2535-2555		40
8	Jammu & Kashmir		2535-2555		20
9	Karnataka	2350.0-2370.0	2535-2555	2635-2655	60
10	Kerala	2350.0-2370.0	2535-2555		40
11	Kolkata	2355.0-2375.0	2535-2555	2635-2655	60
12	Madhya Pradesh	2352.5-2372.5	2535-2555		40
13	Maharashtra	2355.0-2375.0	2535-2555	2635-2655	60
14	Mumbai	2355.0-2375.0	2535-2555	2635-2655	60
15	North East	2347.5-2367.5	2535-2555		40
16	Orissa	2378.0-2398.0	2535-2555		40
17	Punjab		2535-2555		20
18	Rajasthan		2535-2555		20
19	Tamil Nadu	2357.5-2377.5	2535-2555	2635-2655	60
20	Utter Pradesh (East)		2535-2555		20
21	Utter Pradesh (West)		2535-2555		20
22	West Bengal	2355.0-2375.0	2535-2555		40
		320 MHz	440 MHz	160 MHz	920 MHz

Annexure 1.2

Government of India
Ministry of Communications and IT
Wireless Planning and Coordination (WPC) Wing
Sanchar Bhawan, 20, Ashok Road, New Delhi – 110001

No.L-14006/01/2014-NTG Dated: 27.11.2014

To,

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

Subject: TRAI's recommendations on the Reserve Price for Auction of Right to Use of spectrum in 2100 MHz band.

I am directed to say that the Department had requested TRAI's recommendations on the reserve price of spectrum in the 2100 MHz band vide its letter No. L-14006/01/2014-NTG dated 16.10.2014. Government is taking action to release some spectrum presently with Defence for commercial use.

2. It is requested that TRAI may kindly consider an expedited process for its recommendations on the reserve price of 2100 MHz band and related issues so that auction of the spectrum being released by Defence may be conducted along with auction of spectrum in 1800 MHz, 900 MHz and 800 MHz bands scheduled in February 2015.

(R. B. Prasad)
Joint Wireless Adviser

Annexure 3.1

VALUATION OF 2100 MHZ SPECTRUM BASED ON 2010 AUCTION PRICES

(Rs. in crore)

LSA	**Category**	**Achieved Price per MHz of May 2010**	**Indexed value per MHz of 2100 MHz** (using SBI Base Rate)
Delhi	Metro	663.40	965.35
Mumbai	Metro	649.41	945.00
Kolkata	Metro	108.85	158.40
Andhra Pradesh	A	274.60	399.59
Gujarat	A	215.20	313.15
Karnataka	A	316.00	459.83
Maharashtra	A	251.60	366.12
Tamilnadu	A	293.00	426.36
Haryana	B	44.60	64.90
Kerala	B	62.40	90.80
Madhya Pradesh	B	51.60	75.09
Punjab	B	64.40	93.71
Rajasthan	B	64.20	93.42
U. P. (East)	B	73.00	106.23
U.P. (West)	B	102.80	149.59
West Bengal	B	24.80	36.09
Assam	C	8.20	11.93
Bihar	C	40.60	59.08
Himachal Pradesh	C	7.40	10.77
Jammu & Kashmir	C	6.00	8.73
North East	C	8.40	12.22
Orissa	C	19.40	28.23
Pan India		**3349.87**	**4874.59**

Annexure 3.2

VALUATION OF 2100 MHZ SPECTRUM BASED ON TECHNICAL EFFICIENCY

(Rs. in crore)

LSA	Category	Average Valuation (per MHz) - 1800 MHz [16]	Valuation per 2100 MHz at 0.83 times of average valuation of 1800 MHz band
Delhi	Metro	364.00	302.12
Mumbai	Metro	272.00	225.76
Kolkata	Metro	73.00	60.59
Andhra Pradesh	A	169.32	140.54
Gujarat	A	237.80	197.37
Karnataka	A	184.75	153.34
Maharashtra	A	290.35	240.99
Tamilnadu	A	225.41	187.09
Haryana	B	39.84	33.06
Kerala	B	93.86	77.90
Madhya Pradesh	B	86.03	71.41
Punjab	B	88.38	73.35
Rajasthan	B	107.36	89.11
U. P. (East)	B	121.66	100.97
U.P. (West)	B	94.95	78.81
West Bengal	B	43.90	36.44
Assam	C	36.10	29.96
Bihar	C	76.89	63.82
Himachal Pradesh	C	11.86	9.84
Jammu & Kashmir	C	30.78	25.55
North East	C	26.33	21.85
Orissa	C	29.22	24.25
Pan India		**2703.78**	**2244.13**

[16] See Recommendations dated 15th October 2014 on 'Valuation and Reserve Price of Spectrum: Licences Expiring in 2015-16'

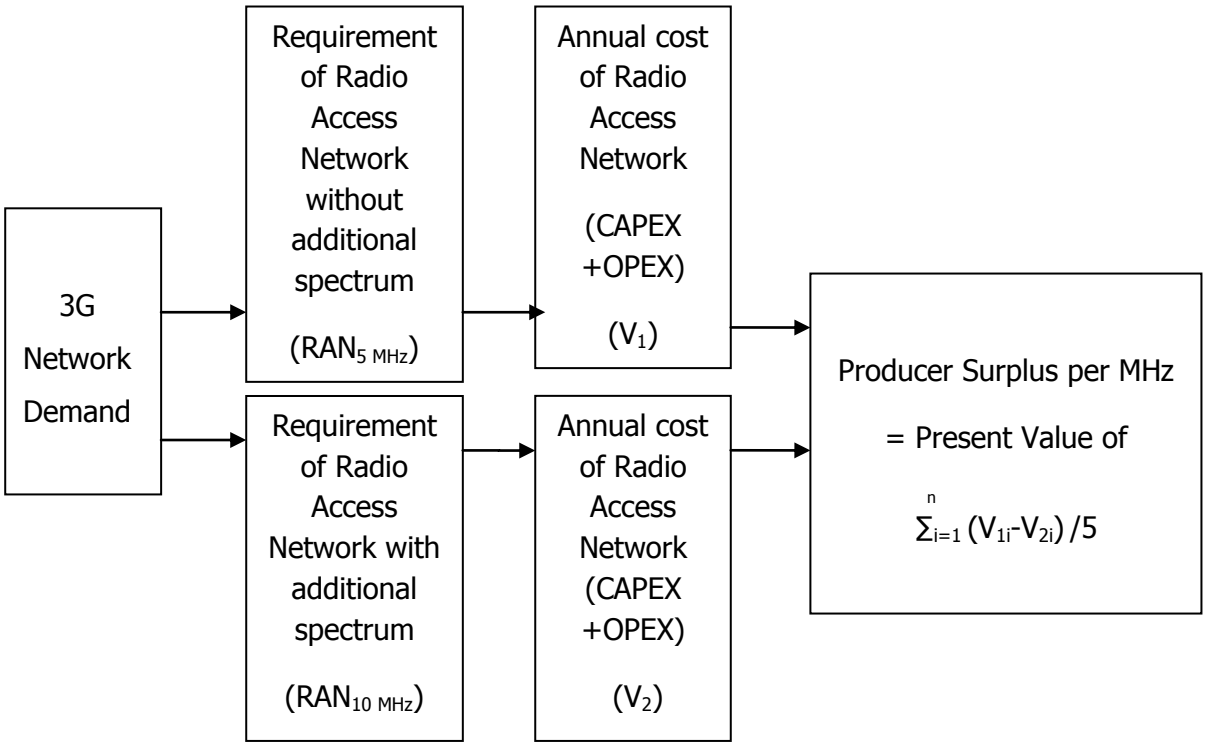
Annexure 3.3

VALUATION OF SPECTRUM IN 2100 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) 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 diagram of the model is given below:

Block Schematic Diagram of the Producer Surplus Model



2. For the purpose of estimation of value of spectrum in 2100 MHz, only the expenditure upon RAN (more specifically, upon Node Bs) 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 on RAN. On the other hand, additional spectrum would have no impact on the cost of core network.

(ii) 3G RAN consists of Node Bs, Radio Network Controllers (RNCs) and transmission media to connect them. A Node B operating in a particular spectrum band is characterized by the following two parameters -

(a) Maximum traffic carrying capacity

(b) Maximum coverage (i.e. adequately covered area)

(iii) A TSP having spectrum in 2100 MHz band would install a new Node B to cater to either or both -

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

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

(iv) Thus a TSP would, generally, install a new Node B in order to meet:

(a) New capacity requirements

(b) New coverage requirements

(v) A TSP having spectrum in 2100 MHz would get no additional benefit of coverage in case he gets additional spectrum in 2100 MHz band. However, owing to an inverse relationship between the quantum of spectrum available and number of Node Bs required to meet a particular level of demand, the TSP would need to install fewer additional Node Bs in future in capacity constrained areas if he acquires additional spectrum in 2100 MHz band. Thus, it is clear that additional spectrum in 2100 MHz band would help the existing TSPs in reducing their expenditure on the Node Bs only.

3. Accordingly, requirement of the Node Bs in the two scenarios i.e. (i) with 5 MHz of spectrum and (ii) with 10 MHz of spectrum has been estimated in order to arrive at the savings in the expenditure upon Node Bs.

4. Since 3G spectrum in the 2100 MHz band is being put to use primarily for data (Internet) usage, this model takes into account (i) the number of subscribers using 3G data and (ii) 3G data usage per month by such subscribers to compute 3G network demand.

5. Clearly, the value of producer surplus would vary with the TSPs depending upon his projected demand (i.e. subscriber base and data usage per subscriber), cost of operation of Node Bs (OPEX and CAPEX), and profile of its subscribers in various LSAs. In order to arrive at the expected value of producer surplus for a hypothetical average TSP, an average TSP having an average level of projected demand (i.e. subscriber base using 3G data and 3G data usage per month by such subscribers) and average cost of operation of Node Bs (CAPEX and OPEX) in each LSA has been considered. Data has either been provided by the TSPs or industry benchmarks have been adopted.

6. In the model, the present values (PVs) of the expenditures (CAPEX + OPEX) on Node Bs to be incurred during the next 20 years for the two cases described above i.e. with 5 MHz of spectrum and 10 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 on acquiring additional 5 MHz of spectrum in 2100 MHz band

= Present Value of (expenditure on Node Bs in the next 20 years with only 5 MHz of spectrum in 2100 MHz band ***minus*** *expenditure on Node Bs during the next 20 years with 10 MHz of spectrum in 2100 MHz band)*

Methodology

7. The following steps have been used for estimation of producer surplus in case a TSP having 5 MHz spectrum in 2100 MHz band acquires additional 5 MHz of spectrum in 2100 MHz band:

   (i) Estimation of network demand (i.e. demand of 3G data in busy hour) of an average TSP in each LSA

   (ii) Estimation of no. of Node Bs in each LSA in the two scenarios

      (a) With 5 MHz spectrum

      (b) With 10 MHz spectrum

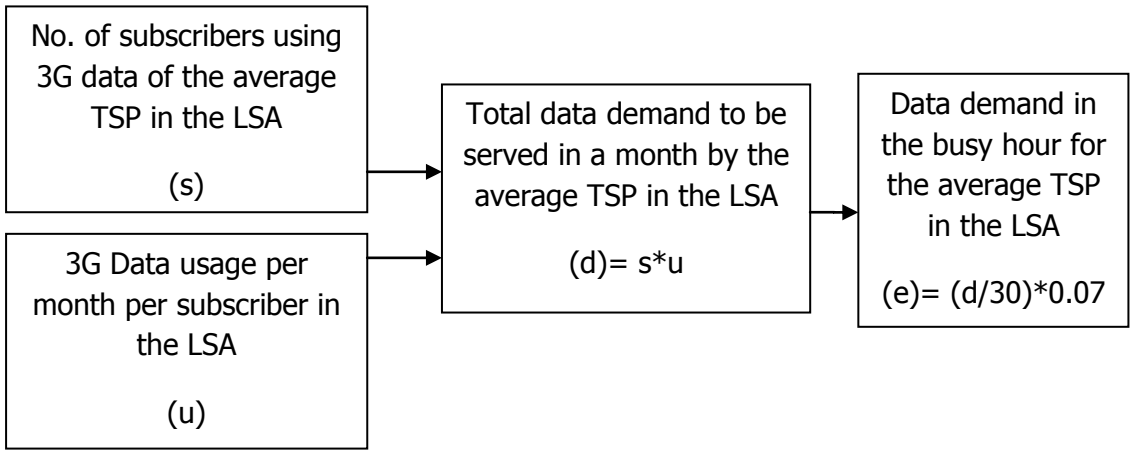
   (iii) Estimation of Annual Cost of Node Bs in the two scenarios

   (iv) Estimation of producer surplus per MHz

Estimation of Network Demand of an Average TSP

8. The following schematic diagram summarizes the method of estimating network demand of an average TSP in each LSA separately.

Block Schematic Diagram of
Estimation of Network Demand of an average TSP



9. As described in the above block schematic diagram, the busy hour network demand of an average TSP in each LSA has been estimated on the basis of no. of subscribers using 3G data and average 3G data usage per month by such subscribers as below.

Busy hour network demand of the average TSP in an LSA
= (No. of subscribers using 3G data of the average TSP in the LSA multiplied by Average 3G data usage per month by such subscribers in the LSA divided by 30) multiplied by 7%

10. Here the busy hour load as a percent of total usage of 3G data in a day has been assumed to be 7%.

11. The method of computing the number of subscribers using 3G data of the average TSP in the LSA and average 3G data usage per month by such subscribers has been described below.

12. **Determination of Subscriber Base using 3G data of the average TSP**: The number of subscribers (using 3G data) of the average TSP in an LSA as on 31.03.2014 has been estimated using the Herfindahl-Hirschman Index (HHI) as below.
The subscriber base of average TSP as on 31.03.2014 in an LSA
*=Total number of subscribers using 3G data in the LSA * HHI of this segment in the LSA/ 10000*

13. **Determination of 3G data usage per month per subscriber (using 3G data) of the average TSP**:
The 3G data usage per month per subscriber (using 3G data) of the average TSP
= Total 3G data usage in the LSA in the month divided by total number of subscribers using 3G data in the LSA

14. The following growth rates have been considered for the number of subscribers using 3G data and 3G data download per month by such subscribers.

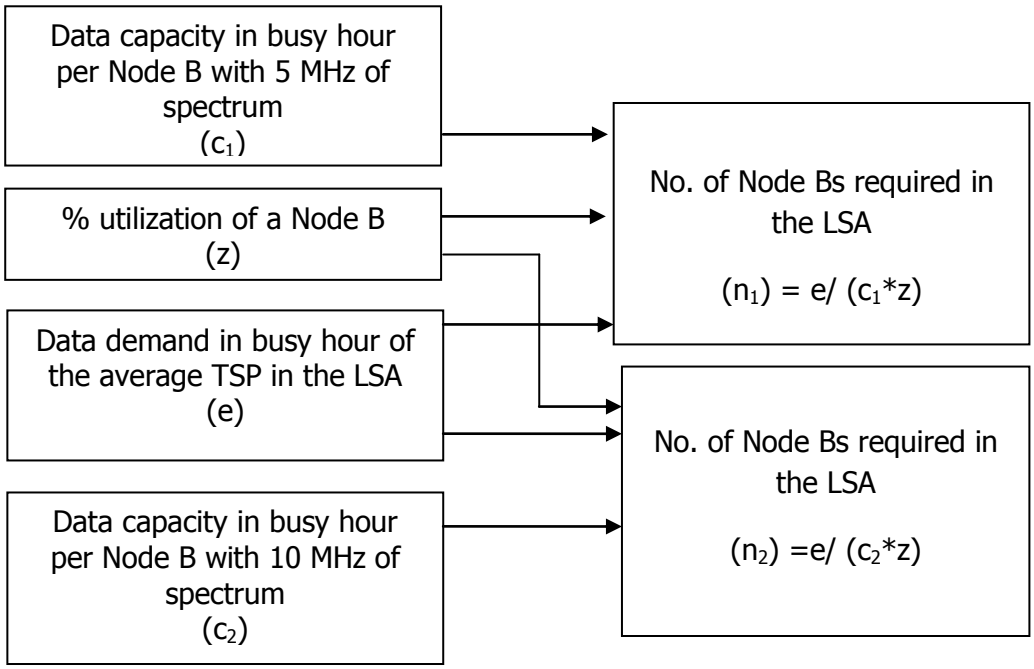
Projected Growth Rates

Year	Growth of subscribers using 3G data	Growth of Data usage per month per subscriber using 3G data
2013-14	Base Year	Base Year
2014-15	16%	20%
2015-16	16%	20%
2016-17	14%	16%
2017-18	14%	16%
2018-19	12%	12%
2019-20	10%	12%
2020-21	8%	10%
2021-22	8%	10%
2022-23	4%	10%
2023-24	4%	8%
2024-25	3%	8%
2025-26	3%	8%
2026-27	2%	6%
2027-28	2%	6%
2028-29	1%	6%
2029-30	1%	4%
2030-31	0.5%	4%
2031-32	0.5%	4%
2032-33	0.5%	2%
2033-34	0.5%	2%
2034-35	0.5%	2%

Estimation of Number of Node Bs in the two Scenarios

15. A block schematic diagram showing the method to determine the number of Node Bs of the average TSP in each LSA is as follows.

Block Schematic Diagram of Determination of Number of Node Bs of the average TSP in the LSA



16. The data capacity of a Node B in a busy hour has been assumed to be growing in step of 5% every year from the data capacity of 1.6 GB per 5 MHz of spectrum in F.Y 2014-15. Further, the percent utilization of a Node B has been assumed to be growing in step of 4% every year from the present level of utilization of 50% in F.Y. 2014-15 to 74% in the F.Y. 2020-21 beyond which the level of utilization of Node B has been assumed to be 75%.

Estimation of Annual Cost of Node Bs in the two scenarios

17. In order to estimate the annual cost (OPEX and CAPEX costs) of the Node Bs for the average TSP in each LSA, the following steps have been taken:

(i) The Capital Cost (Gross Block) of a Node B and its associated equipment has been considered to be Rs. 10 Lakh.

(ii) The annual operating cost of a Node B and its associated equipment in the network in an LSA has been computed on the basis of the proportion of annual operating cost of RAN to the Gross Block (GB) of Plant and machinery of RAN in the LSA as reported by the TSPs who were offering GSM (including 3G) services in all LSAs in F.Y. 2013-14 in their accounting separation Reports (ASR).

Annual operating cost of a Node B and its associated equipment in an LSA = Rs. 10 Lakh * (Total annual operating costs of RAN of TSPs in the LSA)/ (Total Gross Block of Plant and machinery of RAN of TSPs in the LSA)

18. It has been assumed that the capital cost and annual operating cost per Node B shall remain to be the same over time.

19. **Useful Life of Node B Equipment** has been taken as 10 years.

20. **Determination of total annualized CAPEX Cost of Node Bs of the average TSP:** Based on the number of Node Bs required to cater to

the network demand by the average TSP, total annualized CAPEX cost of the Node Bs for the average TSP in each LSA in each year (during the next 20 years) has been computed using Straight line depreciation @10% and prevalent cost of capital @15%.

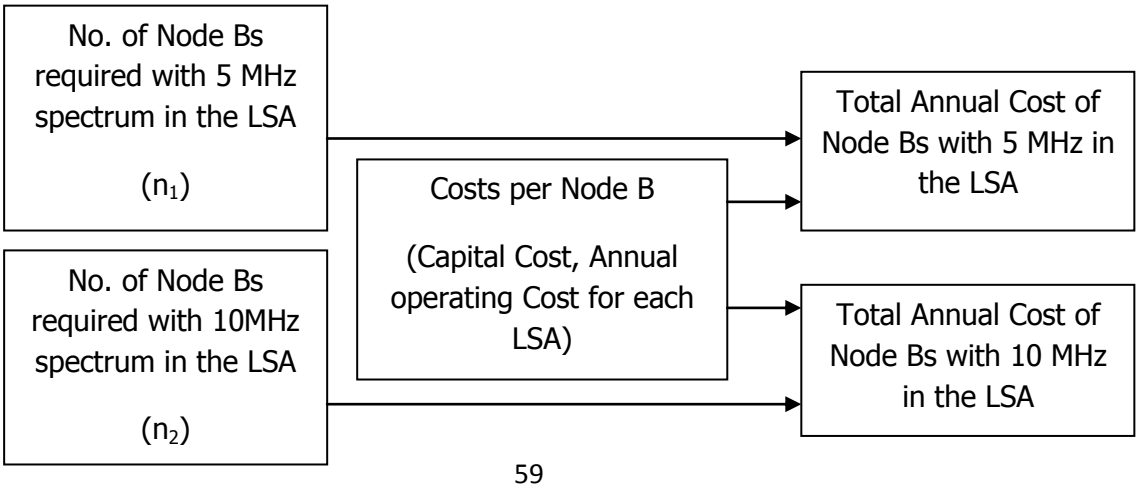
21. **Determination of total annual OPEX Cost of the Node Bs of average TSP:** Based on the number of Node Bs required to cater to the network demand and annual operating cost per Node B, the total annual OPEX cost of Node Bs for the average TSP in each LSA in each year (during the next 20 years) has been computed.

22. **Determination of Total Annual Cost of Node Bs:** The total annual cost on the Node Bs in each LSA in each year (during the next 20 years) has been computed by summing up the annualized CAPEX cost and annual OPEX cost as below:

The Total annual cost of Node Bs for the average TSP in an LSA
= Total annualized CAPEX cost of Node Bs for the average TSP in the LSA <u>plus</u> total annual OPEX cost of Node Bs for the average TSP in the LSA

23. The following block schematic diagram summarizes the method of computing the annual costs of Node Bs for average TSP in the two scenarios.

Block Schematic Diagram for Estimation of Total Annual Cost of Node Bs for the Average TSP in the two scenarios



Estimation of Producer Surplus per MHz

24. The producer surplus upon getting an additional spectrum of 5 MHz has been estimated as below:

Producer Surplus upon getting an additional spectrum of 5 MHz in 2100 MHZ band in an LSA

= Present Value of (expenditure on Node Bs in the next 20 years with only 5 MHz of spectrum in 2100 MHz band minus expenditure on Node Bs in the next 20 years with 10 MHz of spectrum in 2100 MHz band)

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

Results

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

Producer Surplus per MHz

(Rs. in crore)

S. No.	Name of LSA	Category	Producer Surplus per 2100 MHz
1	Delhi	Metro	206.78
2	Mumbai	Metro	184.79
3	Kolkata	Metro	49.10
4	Andhra Pradesh	A	160.80
5	Gujarat	A	187.56
6	Karnataka	A	265.46
7	Maharashtra	A	231.78
8	Tamilnadu	A	312.34
9	Haryana	B	60.17
10	Kerala	B	229.28
11	Madhya Pradesh	B	151.19
12	Punjab	B	76.65
13	Rajasthan	B	134.88
14	U. P. (East)	B	97.28
15	U.P. (West)	B	145.12
16	West Bengal	B	53.30
17	Assam	C	52.37
18	Bihar	C	118.60
19	Himachal Pradesh	C	12.09
20	Jammu & Kashmir	C	27.07
21	North East	C	28.47
22	Orissa	C	74.95
Pan India			**2860.03**

Annexure 3.4

MODEL BASED ON GROWTH IN DATA USAGE

ASSUMPTIONS

Using the figures submitted by TSPs for F.Y. 2013-14 as base figures for this exercise, the following assumptions are made in arriving at the valuation of 2100 MHz spectrum using this approach:

(i) A bottom-up approach has been adopted for each LSA.

(ii) The model assumes that TSPs who have spectrum in other bands but not in 2100 MHz spectrum, will procure 2100 MHz spectrum on the basis of its revenue potential from data services.

(iii) The hypothetical TSP (having 2G spectrum in an LSA but not holding 2100 MHz spectrum in that LSA) -named TSP 'X' is the potential bidder. TSP-'X' would bid for a block of 5 MHz in 2100 MHz spectrum. It is presumed that the hypothetical TSP will roll-out for 2100 MHz and will be in position to offer services after one year of acquiring spectrum i.e. 2016-17.

(iv) In F.Y. 2016-17, TSP-'X' will acquire 10% share of industry 3G subscribers (using internet services). This share will increase in a staggered manner to 20% in twentieth year.

(v) Data usage charge per MB has been taken same for 3G band and 2G bands (in the absence of segregated revenue information). The Data ARPU from 2100 MHz band for subsequent years has been projected on the basis of the year-wise data download growth rates as adopted by the Authority in its Recommendations of October 2014 on valuation of 900 MHz spectrum and 1800 MHz spectrum.

(vi) The share of revenue from voice services in 2100 MHz spectrum has been taken at 10% in view of the fact that the 2100 MHz spectrum is projected and used as an efficient band for

providing data services. However, no growth in voice ARPU has been projected.

(vii) It has been assumed that data tariffs will decline by 5% every year up to the F.Y. 2018-19 and stabilize thereafter as taken in the Recommendations of February 2014/ November 2014 on 800 MHz spectrum.

(viii) The growth 3G subscribers (using data/ internet) is assumed to be the same as in the producer surplus model (one other approach of spectrum valuation).

(ix) The projected revenue from 2100 MHz spectrum is calculated as the product of projected Data ARPU and projected average number of 3G subscribers (using internet services) plus the projected revenue from voice services.

(x) Additional costs (e.g., network operating and maintenance cost including rental costs for infrastructure services etc.) will be incurred for deploying 2100 MHz spectrum.

(xi) Investment (Capex) required per 3G subscriber (denoted as 'I_S') excluding spectrum auction fee and one time licence fee, has been estimated as Rs 1200 per subscriber since the investment requirement is for an incremental 3G subscriber.

(xii) Capital investment for the first year (2016-17) would be equal to the 3G subscribers multiplied by the investment required per subscriber. For subsequent years, additional capital investment is calculated on the basis of the number of incremental subscribers. Capital investment per year can be projected for a period of 20 years in the following manner:

$$\text{Capital investment (year 2016-17)} = N_{S\,(2016\text{-}17)} \times I_S$$

$$\text{Capital Investment}_n \text{ (subsequent year)} = [N_{S(n)} - N_{S\,(n\text{-}1)}] \times I_S$$

Where n = (year 2016-17, 2017-18,..., 2034-35)

(xiii) Useful life for the capital investments is assumed to be 10 years.

(xiv) Return on capital investment (net) is allowed @ 15%.

(xv) Revenue surplus (i.e. revenue net of costs and return on capital investment) is calculated for 20 years. The NPV of revenue surplus is computed using a discounting factor of 12.5%.

(xvi) To calculate the value per MHz of the 2100 MHz spectrum for each LSA, the NPV of net revenue potential of that LSA is divided by the 5MHz (assumed MHz that TSP 'X' would bid for).

RESULTS

Based on the above assumptions the value of 2100 MHz spectrum (per MHz) using model based on growth in data usage are as follows:

TABLE A
Valuation of 2100 MHz (Per MHz)

(Rs. in crore)

Sl.No.	Name of LSA	Category	Valuation per 2100 MHz band
1	Delhi	Metro	755.15
2	Mumbai	Metro	342.97
3	Kolkata	Metro	118.39
4	Andhra Pradesh	A	213.95
5	Gujarat	A	276.74
6	Karnataka	A	325.25
7	Maharashtra	A	298.03
8	Tamilnadu	A	372.07
9	Haryana	B	59.51
10	Kerala	B	138.38
11	Madhya Pradesh	B	122.60
12	Punjab	B	83.64
13	Rajasthan	B	100.71
14	U. P. (East)	B	105.29
15	U.P. (West)	B	106.74
16	West Bengal	B	25.11
17	Assam	C	49.76
18	Bihar	C	86.88
19	Himachal Pradesh	C	19.31
20	Jammu & Kashmir	C	9.70
21	North East	C	13.41
22	Orissa	C	32.78
Pan India			**3656.37**

Annexure 3.5

VALUATION (PER MHz) USING DIFFERENT APPROACHES – 2100 MHz SPECTRUM

(Rs. in crore)

LSA	Category	Indexed Achieved Price - May 2010 auction	0.83 times of average valuation of 1800 MHz band	Producer Surplus Model	Approach based on growth in data usage	Average (mean) Value
Delhi	Metro	965.35	302.12	206.78	755.15	**557.35**
Mumbai	Metro	945.00	225.76	184.79	342.97	**424.63**
Kolkata	Metro	158.40	60.59	49.10	118.39	**96.62**
Andhra Pradesh	A	399.59	140.54	160.80	213.95	**228.72**
Gujarat	A	313.15	197.37	187.56	276.74	**243.70**
Karnataka	A	459.83	153.34	265.46	325.25	**300.97**
Maharashtra	A	366.12	240.99	231.78	298.03	**284.23**
Tamilnadu	A	426.36	187.09	312.34	372.07	**324.47**
Haryana	B	64.90	33.06	60.17	59.51	**54.41**
Kerala	B	90.80	77.90	229.28	138.38	**134.09**
Madhya Pradesh	B	75.09	71.41	151.19	122.60	**105.07**
Punjab	B	93.71	73.35	76.65	83.64	**81.84**
Rajasthan	B	93.42	89.11	134.88	100.71	**104.53**
U. P. (East)	B	106.23	100.97	97.28	105.29	**102.44**
U.P. (West)	B	149.59	78.81	145.12	106.74	**120.07**
West Bengal	B	36.09	36.44	53.30	25.11	**37.73**
Assam	C	11.93	29.96	52.37	49.76	**36.01**
Bihar	C	59.08	63.82	118.60	86.88	**82.10**
Himachal Pradesh	C	10.77	9.84	12.09	19.31	**13.00**
Jammu & Kashmir	C	8.73	25.55	27.07	9.70	**17.76**
North East	C	12.22	21.85	28.47	13.41	**18.99**
Orissa	C	28.23	24.25	74.95	32.78	**40.05**
PAN INDIA		**4874.59**	**2244.13**	**2860.03**	**3656.37**	**3408.78**

Annexure 3.6

PRICE ARRIVED AT @ 80% OF AVERAGE VALUATION OF 2100 MHZ SPECTRUM

Sl.No.	Name of LSA	Category	Price @80% of average valuation
1	Delhi	Metro	445.88
2	Mumbai	Metro	339.70
3	Kolkata	Metro	77.30
4	Andhra Pradesh	A	182.98
5	Gujarat	A	194.96
6	Karnataka	A	240.78
7	Maharashtra	A	227.38
8	Tamilnadu	A	259.57
9	Haryana	B	43.53
10	Kerala	B	107.27
11	Madhya Pradesh	B	84.06
12	Punjab	B	65.47
13	Rajasthan	B	83.62
14	U. P. (East)	B	81.95
15	U.P. (West)	B	96.05
16	West Bengal	B	30.19
17	Assam	C	28.81
18	Bihar	C	65.68
19	Himachal Pradesh	C	10.40
20	Jammu & Kashmir	C	14.21
21	North East	C	15.19
22	Orissa	C	32.04