Consultation Paper No. 10/2017

Telecom Regulatory Authority of India

Consultation Paper

on

Auction of Spectrum in 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz, 2500 MHz, 3300-3400 MHz and 3400-3600 MHz bands

28th August 2017

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Written Comments on the Consultation Paper are invited from the stakeholders by 25th September 2017 and counter-comments by 3rd October 2017. Comments and counter-comments will be posted on TRAI's website www.trai.gov.in. The comments and counter-comments may be sent, preferably in electronic form, to Shri Syed Tausif Abbas, Advisor (Networks, Spectrum and Licensing), TRAI on the email ID advmn@trai.gov.in.

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CHAPTER–I: INTRODUCTION

1.1 The Department of Telecommunications (DoT), through its letter dated 19th April 2017 **(Annexure-1.1)**, informed that the Government is planning to auction the right to use of spectrum in 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz, 2500 MHz, 3300-3400 MHz and 3400-3600 MHz bands in the next auction be held in 2017. DoT has requested the Authority to provide its recommendations on applicable reserve price, quantum of spectrum to be auctioned and associated conditions for auction of spectrum in these bands for all service areas under the terms of clause 11(1)(a) of TRAI Act 1997 as amended.

1.2 Earlier, on a reference from DoT, the Authority had sent its recommendations on Valuation and Reserve Price of Spectrum in the 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz and 2500 MHz bands on 27th January, 2016 and, subsequently on back reference from DoT, the Authority sent its recommendations on 18th April 2016. Spectrum auction was held in October 2016 wherein about 60% of total spectrum remained unsold. In the present reference dated 19th April 2017, DoT has proposed to auction spectrum in these bands again. In addition, DoT has included two more bands i.e. 3300-3400 MHz and 3400-3600 MHz.

1.3 In this Consultation Paper, background information about 3300-3400 MHz (3.3 GHz) and 3400-3600 MHz (3.4 GHz) bands, which are proposed to be auctioned for the first time, is given in detail. Since spectrum auctions in other bands have been held earlier, detailed background information was given in earlier consultation papers issued at the relevant times. However, information mainly about present availability of spectrum in these bands is given in this paper.

BACKGROUND

700 MHz band (698-806 MHz)

1.4 The 700 MHz (3GPP band B28) band is being adopted as a prime band for Long Term Evolution (LTE) technology by a number of countries in the Asia-Pacific (APAC), Middle East, Europe and Latin American region. As of April 2017, 40 operators have launched commercial services using band B28 or compatible European bands (CEPT 700)[1].

1.5 Considering the growing adoption of B28 band plan, the Authority, in its recommendations on "IMT – Advanced Mobile Wireless Broadband Services" dated 19th March 2013, recommended that *"APT700 band plan should be adopted for the 700 MHz spectrum band (698-806 MHz) with FDD based 2x45 MHz frequency arrangement*." In its recommendations dated 15th October 2014 on 'Valuation and Reserve Price of Spectrum: Licences Expiring in 2015-16', the Authority recommended that *the Government should immediately take action on the Authority's recommendations of March 2013 on the adoption of APT700 in the country and the Government should also announce the roadmap for the auction of spectrum in 700 MHz band.*

1.6 In its recommendations dated 27th January 2016 on 'Valuation and Reserve Price of Spectrum in 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz and 2500 MHz bands', the Authority recommended that *the FDD based 2 x 45 MHz based frequency arrangement, referred to B28 band plan, should be adopted in the 700 MHz spectrum band. It was also recommended that entire available spectrum (2x35 MHz) in the 700 MHz band should be put to auction in the upcoming auction.*

1.7 DoT accepted TRAI's recommendations and 2x35 MHz spectrum in the 700 MHz band in the B28 band-plan was put to auction in October 2016. However, the entire spectrum was unsold. Therefore, DoT has sought fresh recommendations from TRAI on the reserve price,

[1] Global Mobile Association's (GSA) report *Evolution from LTE to 5G* April 2017.

quantum of spectrum to be auctioned and other related issues for 700 MHz band.

800/900/1800 MHz Bands

1.8 1800 MHz (3GPP band B3) is the mainstream choice for LTE in most regions and has the potential to be a global - band for LTE deployments. As per Global Mobile Association's (GSA) January 2017 report, 274 operators have commercially launched LTE1800 systems in 119 countries/territories either as a single band or as part of a multi-band deployment. Band plan B3 has the largest LTE user devices ecosystem. 61.1% of LTE devices can operate in this band. 800 MHz (band plan B5) is another band where significant LTE device eco-system exists (1927 devices). Gradually, LTE device ecosystem is developing in the 900 MHz band also. As per GSA report titled "LTE in 900 MHz (band B8) market status report" of July 2017, 28 LTE900 systems were commercially launched in 19 countries and 26% of LTE user devices can operate in 900 MHz band.

1.9 Earlier, spectrum in the 800/900/1800 MHz bands was used primarily for providing voice service (2G service) in India. Now these bands are being used to deliver high speed data services also. For instance, spectrum in 800 MHz and 1800 MHz band is being used to deploy LTE-FDD network and spectrum in the 900 MHz band is being used for HSPA/WCDMA network.

1.10 Spectrum assignment in 800 MHz, 900 MHz and 1800 MHz was being done administratively till 2008. After Hon'ble Supreme Court of India judgment dated 2nd February 2012, spectrum assignment for access services in all bands is being done through auction process. Since 2012, total five auctions have been held for assignment of spectrum in various access bands. Details of the spectrum auctioned in 800/900/1800 MHz bands since 2012 is given in the Table below:

Table 1.1
Spectrum Auctions Since 2012

Sl. No.	Year	Spectrum bands	Spectrum put to auction	Spectrum sold
1.	November 2012	1800 MHz	295 MHz	127.5 MHz
		800 MHz	95 MHz	No bidder
2.	March 2013	900 MHz	46 MHz (Delhi, Mumbai and Kolkata LSAs)	No bidder
		1800 MHz	57.5 MHz (Delhi, Mumbai, Karnataka and Rajasthan)	No bidder
		800 MHz	95 MHz	30 MHz
3.	February 2014	900 MHz	46 MHz (in 3 LSAs - Delhi, Mumbai and Kolkata)	46 MHz
		1800 MHz	385 MHz	307.2 MHz
4.	March 2015	800 MHz	108.75 MHz	86.25 MHz
		900 MHz	177.8 MHz	168 MHz
		1800 MHz	99.2 MHz	93.8 MHz
5.	October 2016	800 MHz	73.75 MHz (in 19 LSAs)	15 MHz (in 4 LSAs)
		900 MHz	9.4 MHz (4 LSAs-Bihar, Gujarat, UP(E), UP(W))	No bidder
		1800 MHz	221.6 MHz (in all LSAs except Tamilnadu)	174.8 MHz (in 19 LSAs)

1.11 There is some unassigned spectrum in these bands, which will be put for auction in the upcoming auction.

2100 MHz Band (1920-1980 MHz/2110-2170 MHz)

1.12 3G services were introduced in India using the spectrum in the 2100 MHz band (3GPP band B1). First auction for spectrum in 2100 MHz band was held in 2010. In that auction, three blocks (each block of 2x5 MHz) in 17 LSAs and four blocks in the remaining 5 LSAs were awarded. In addition, the Government allocated one block of 2x5MHz spectrum in Delhi and Mumbai to MTNL and in the remaining 20 service areas to BSNL at the winning price achieved in the respective LSAs.

1.13 Second auction in 2100 MHz band was held in March 2015 along with other spectrum bands. Only one block (2x5 MHz) was put to auction in the 17 LSAs. The spectrum remained unsold in 3 LSAs viz Delhi, Mumbai and Andhra Pradesh. Meanwhile, Defence had agreed, in principle, for swapping of 15 MHz spectrum in 2100 MHz band with 1900 MHz band in all LSAs. Therefore, additional 3 slots of 2x5 MHz

in 2100 MHz became available for commercial assignment; which were put to auction in October 2016 along with unsold spectrum of 2015 auction. However, only 85 MHz spectrum in 12 LSAs was sold and 275 MHz spectrum in 21 LSAs remained unsold. Summary of the spectrum awarded in 2100 MHz spectrum through various auctions held so far is given in the table given below:

Table 1.2
Spectrum Auctions Since 2010

Sl. No.	Year	Spectrum put to auction	Spectrum sold
1	2010	355 MHz (15 MHz in 17 LSAs, 20 MHz in 4 LSAs)	355 MHz
2	2015	85 MHz (5 MHz in 17 LSAs)	70 MHz
3	2016	360 MHz (in 22 LSAs)	85 MHz (in 12 LSAs)

2300 MHz band (2300 -2400 MHz)

1.14 Spectrum in 2300 MHz band (3GPP band B40) is being used to offer high speed data services using TD-LTE technology. The TD-LTE ecosystem is well established with 3,074 user devices i.e. over 39% of LTE devices support TD-LTE mode. Amongst TDD bands, 2300 MHz band supports maximum number of devices (77% of TDD devices) followed by 3GPP band B38 (2570-2620 MHz) which supports 61.4% of TDD devices[2].

1.15 In India, the spectrum in the 2300 MHz band was first time assigned for commercial use through an auction conducted in the year 2010. In that auction, the Government put to auction two blocks (each of 20 MHz unpaired) in this band in each of the 22 LSAs and entire spectrum was sold.

1.16 The spectrum in this band was auctioned again in the auctions held in October 2016. Two blocks, each of 10 MHz unpaired, in the 2300 MHz band were put to auction in 16 LSAs and again the entire spectrum was sold.

[2] GSA Report: Status of the LTE Ecosystem, April 5, 2017

2500 MHz band (2500 -2690 MHz)

1.17 As of April 2017, 19 TD-LTE systems are commercially launched in the 2500 MHz band (3GPP band B41) in Angola, Cambodia, Cameroon, Canada, China, Ghana, Iraq, Japan, Malawi, Trini & Tobago, Uganda, and USA.

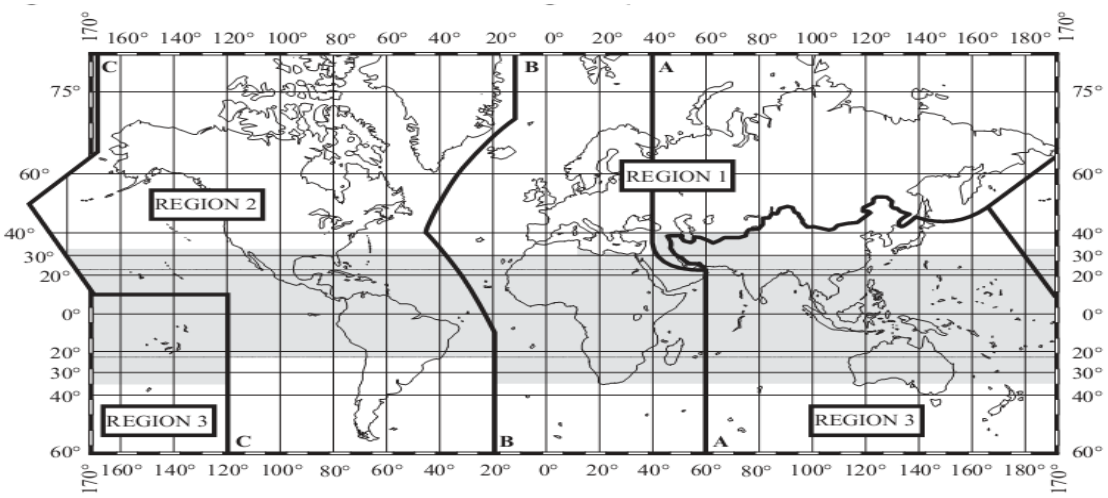
1.18 In India, the Government, in the year 2009, allocated one block of 20 MHz spectrum in 2500 MHz band in Delhi and Mumbai to MTNL and in the remaining 20 service areas to BSNL at the winning price achieved in respect of 2300 MHz band in the 2010 auctions. Later on, MTNL surrendered its spectrum in this band in both Delhi and Mumbai while BSNL surrendered it in 6 LSAs (Kolkata, Maharashtra, Gujarat, Andhra Pradesh, Tamilnadu and Karnataka). The only auction in this band was held in October 2016. In that auction, a total of 600 MHz in the 2500 was put to auction in all the 22 LSAs, out of which, 370 MHz spectrum was sold in the 20 LSAs.

New bands for auction: 3300-3400 MHz and 3400-3600 MHz band

1.19 In accordance with Resolution 223 of World Radiocommunications Conference (WRC) 2015[3], frequency band 3300-3400 MHz is identified for the implementation of International Mobile Telecommunications (IMT). In entire Region 1 and Region 2, 3400-3600 MHz band have been identified for IMT services[4]. In Region 3, many countries including China, India, Japan and Korea have identified this band for the IMT services, which implies that there is nearly global harmonization in the 3400-3600 MHz band. The ITU regions 1, 2 and 3 in the World map are defined as per Chart 1.1:

[3] WRC-15 was held during November 2015.
[4] For the allocation of frequencies, the world has been divided into three Regions.

Chart 1.1



1.20 Provisions in National Frequency Allocation Plan (NFAP) 2011 read as under:

Requirement of Broadband Wireless Access (BWA) applications may be considered in the frequency band 3.3-3.4 GHz on a case-by-case basis. **(Foot Note IND65)**

The requirement of IMT including Broadband Wireless Access (BWA) in the frequency band 3400-3600 MHz may be considered on a case-by-case basis subject to availability of spectrum in this band and appropriate protection from out of band emission to the networks in the FSS in the frequency band 3600-4200 MHz. **(Foot Note IND66)**

1.21 Through its reference dated 19th April 2017, DoT has, for the first time proposed to include 3300-3400 MHz band and 3400-3600 MHz band amongst the bands to be auctioned in the forthcoming auction and has sought TRAI's recommendations on the reserve price and other related issues for these two bands.

1.22 The Authority vide its letter dated 15th May 2017 had sought additional information on some of the issues from WPC. However, despite reminders, WPC has not provided the information sought till date. However, to avoid delay, this Consultation Paper has been finalised based on information available with the Authority.

STRUCTURE OF THE CONSULTATION PAPER

1.23 The paper is divided into four Chapters. This Chapter provides background to the subject. Chapter-II discusses the availability of spectrum in the 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz, 2500 MHz, 3300-3400 MHz and 3400-3600 MHz bands. It also deals with policy issues such as roll-out obligations, spectrum cap, preferable block-size for auction etc. Chapter-III discusses the different alternative approaches to valuation of spectrum in the 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz, 2500 MHz, 3300-3400 and 3400-3600 MHz bands and fixation of reserve price. The issues for consultation have been listed in Chapter-IV.

CHAPTER-II: AUCTION RELATED ISSUES

A. SPECTRUM AVAILABILITY

Availability of spectrum in the various spectrum bands viz. 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz, 2500 MHz, 3300-3400 MHz and 3400-3600 MHz bands has been discussed below.

700 MHz

2.1 As per the APT700 band plan, 45 MHz spectrum (FDD/paired) can be utilised in this band. However, as per the information provided by DoT, 35 MHz (paired) spectrum is available for commercial purpose in each of the 22 LSAs in this band. The entire available spectrum (35 MHz) was put to auction in 2016. However, there was no bid received in any of the LSAs. Therefore, 35 MHz in each LSA totalling 770MHz on pan-India is available for commercial use that can be put to auction.

800 MHz Band

2.2 In the auctions held in October 2016, a total of 73.75 MHz spectrum was put to auction in the 800 MHz band in 19 LSAs, out of that 15 MHz was sold in 4 LSAs. The remaining unsold 58.75 MHz spectrum in 19 LSAs is available for the forthcoming auction. Details of availability are given in Table 2.1 below:

Table 2.1

Spectrum availability in 800 MHz Band

LSA	Total spectrum put in Oct 2016 auction	Spectrum sold	Spectrum that remained unsold	Total spectrum available for auction
	A	B	C=A-B	D=C
	MHz	MHz	MHz	MHz
DEL	2.5	0	2.5	2.5
MUM	5	0	5	5
KOL	2.5	0	2.5	2.5
MH	7.5	0	7.5	7.5

GUJ	6.25	5	1.25	1.25
AP	7.5	0	7.5	7.5
KTK	2.5	0	2.5	2.5
TN	2.5	0	2.5	2.5
KL	2.5	0	2.5	2.5
PB	6.25	3.75	2.5	2.5
HR	1.25	0	1.25	1.25
UP (W)	2.5	0	2.5	2.5
UP (E)	3.75	1.25	2.5	2.5
RAJ	7.5	5	2.5	2.5
MP	2.5	0	2.5	2.5
WB	1.25	0	1.25	1.25
HP	3.75	0	3.75	3.75
BH	2.5	0	2.5	2.5
OR	3.75	0	3.75	3.75
AS	0	0	0	0
NE	0	0	0	0
J&K	0	0	0	0
Total	**73.75**	**15**	**58.75**	**58.75**

900 MHz Band

2.3 In the auctions held in October 2016, a total of 9.4 MHz spectrum was put to auction in the 900 MHz band in 4 LSAs viz. Bihar, Gujarat, UP(W) and UP(E). No bid was received for the spectrum in this band. Therefore, entire spectrum (9.4 MHz) is available for auction.

2.4 M/s Aircel, whose service licence in Tamil Nadu (incl. Chennai), is expiring in December 2018, is holding administratively assigned spectrum in 900 MHz and 1800 MHz bands as given below:

Table 2.2

Spectrum becoming available due to expiry of licence of M/s Aircel

Service Area	**900 MHz band**	**1800 MHz band**
Tamil Nadu excluding Chennai	7.8 MHz	2.0 MHz
Chennai Only	6.2 MHz	2.4 MHz

2.5 Due to expiry of licence of M/s Aircel in December 2018, 900 MHz band spectrum to be released is 7.8 MHz in Tamil Nadu (excluding

Chennai) and 6.2 MHz spectrum in Chennai. Therefore, 6.2 MHz in 900 MHz band can be put to auction in entire Tamil Nadu service area. In addition, there is availability of 1.8 MHz only in part of the Tamil Nadu service area that can also be put to auction. The principle of charging partial spectrum has been prescribed in earlier Notice Inviting Applications (NIAs)[5].

2.6 Taking into account the spectrum to be released due to expiry of service licence of M/s Aircel in Tamil Nadu service area, the availability of spectrum in 900 MHz band that may be put to auction in the forthcoming auction will be as given below:

Table 2.3
Spectrum availability in 900 MHz Band

Sl. No.	Service Area	Total spectrum available for auction
1.	Bihar	4.6 MHz
2.	Gujarat	3.0 MHz
3.	Tamil Nadu	6.2 MHz
4.	UP (East)	0.6 MHz
5.	UP (West)	1.2 MHz

1800 MHz Band

2.7 In the auctions held in October 2016, a total of 221.6 MHz spectrum was put to auction in the 1800 MHz band in all the LSAs except Tamil Nadu. Out of which, 174.8 MHz spectrum was sold in 19 LSAs. The remaining unsold 46.80 MHz spectrum in 13 LSAs is available for the forthcoming auction.

[5] **Notice Inviting Applications – August 2016:** For the LSAs, where the spectrum is not available in some of the districts, while the bids will be sought for spectrum in entire LSA, the bid amount will be collected only for the spectrum available and the balance collected as and when spectrum is made available in each District, the amount being pro-rated to the population of that district(s) (as of census of 2011) and the balance period (of the 20 years). Bid amount as mentioned above will be collected subject to the condition that the amount to be collected in future at the time of providing balance spectrum would be the balance prorated bid amount indexed on the SBI PLR prevalent for the period between finalisation of bid price and actual assignment made.

2.8 As can be seen from Table 2.2, spectrum becoming available due to expiry of licence of M/s Aircel in December 2018 in 1800 MHz band is 2.0 MHz in Tamil Nadu (excluding Chennai) and 2.4 MHz in Chennai. As per an agreement reached with Ministry of Defence, 55 MHz spectrum shall be assigned for commercial mobile service in each LSA. Total spectrum assigned for commercial telecom services in Tamil Nadu in the 1800 MHz band has exceeded by about 4.4 MHz beyond 55 MHz. Therefore, DoT has proposed that spectrum becoming available due to expiry of licence of M/s Aircel in the 1800 MHz band in Tamil Nadu LSA won't be put in the forthcoming auction.

2.9 In view of the above, the availability of spectrum in 1800 MHz band that may be put to auction in the forthcoming auction is as given below:

Table 2.4

Spectrum availability in 1800 MHz Band

LSA	Total spectrum put in Oct 2016 auction	Spectrum sold	Spectrum that remained unsold	Total spectrum available for auction
	A	B	C=A-B	D=C
	MHz	MHz	MHz	MHz
DEL	12.8	2	10.8	10.8
MUM	5	5	0	-
KOL	4	4	0	-
MH	13.4	12	1.4	1.4
GUJ	13	11.4	1.6	1.6
AP	4.4	2.4	2	2
KTK	4.2	0	4.2	4.2
TN			-	-
KL	2	0.6	1.4	1.4
PB	15.4	11	4.4	4.4
HR	7.4	7.4	0	-
UP (W)	14.6	14.6	0	-
UP (E)	5.4	5.4	0	-
RAJ	11	11	0	-
MP	4.6	4.6	0	-
WB	18.4	17.6	0.8	0.8
HP	11.4	5.6	5.8	5.8
BH	12.2	11.8	0.4	0.4

OR	1.4	0	1.4	1.4
AS	19.8	16.8	3	3
NE	9.2	9.2	0	-
J&K	32	22.4	9.6	9.6
Total	**221.6**	**174.8**	**46.8**	**46.8**

2100 MHz Band

2.10 In the auctions held in October 2016, a total of 360 MHz spectrum was put to auction in the 2100 MHz band in all the 22 LSAs. Out of which, 85 MHz spectrum was sold in 12 LSAs. The remaining unsold 275 MHz spectrum in 21 LSAs is available for the forthcoming auction as given below:

Table 2.5

Spectrum availability in 2100 MHz Band

LSA	Total spectrum put in Oct 2016 auction	Spectrum sold	Spectrum that remained unsold	Total spectrum available for auction
	A	B	C=A-B	D=C
	MHz	MHz	MHz	MHz
DEL	20	5	15	15
MUM	20	5	15	15
KOL	15	0	15	15
MH	15	5	10	10
GUJ	15	0	15	15
AP	20	0	20	20
KTK	15	0	15	15
TN	15	10	5	5
KL	15	5	10	10
PB	15	5	10	10
HR	15	5	10	10
UP (W)	15	0	15	15
UP (E)	15	10	5	5
RAJ	15	15	0	0
MP	15	0	15	15
WB	15	0	15	15
HP	20	0	20	20
BH	20	10	10	10
OR	20	5	15	15
AS	15	0	15	15

NE	15	0	15	15
J&K	15	5	10	10
Total	**360**	**85**	**275**	**275**

2300 MHz Band

2.11 In the auctions held in October 2016, a total of 320 MHz spectrum was put to auction in the 2300 MHz band in 16 LSAs. Entire spectrum was sold. Therefore, at present, no vacant spectrum is available in this band.

2.12 The 2300 MHz band encompasses a total of 100 MHz spectrum. Out of which, 60 MHz[6] in 16 LSAs and 40 MHz in 6 LSAs have been assigned to the TSPs. There are several point-to-point links of PSUs and State Electricity Boards working in the remaining portion of spectrum in this band. As per an agreement with Ministry of Defence, 20 MHz in the 2300 MHz band is to be assigned to the Defence. Remaining 20 MHz in the 16 LSAs and 40 MHz in the 6 LSAs can be made available for commercial telecom services subject to the relocation of existing users to some other bands.

2500 MHz Band

2.13 In the auctions held in October 2016, a total of 600 MHz spectrum (40 MHz in 8 LSAs and 20 MHz in 14 LSAs) was put to auction in the 2500 MHz band. Out of which, 370 MHz spectrum was sold in 20 LSAs. The remaining unsold 230 MHz spectrum in 12 LSAs is available for the forthcoming auction as given below:

[6] 40 MHz spectrum in each of the 22 LSAs was assigned through the 2010 auction. In 2016 auction, 20 MHz spectrum was assigned in 16 LSAs.

Table 2.6

Spectrum availability in 2500 MHz Band

LSA	Total spectrum put in Oct 2016 auction	Spectrum sold	Spectrum that remained unsold	Total spectrum available for auction
	A	B	C=A-B	D=C
	MHz	MHz	MHz	MHz
DEL	40	20	20	20
MUM	40	20	20	20
KOL	40	20	20	20
MH	40	30	10	10
GUJ	40	30	10	10
AP	40	10	30	30
KTK	40	0	40	40
TN	40	0	40	40
KL	20	20	0	0
PB	20	10	10	10
HR	20	20	0	0
UP (W)	20	20	0	0
UP (E)	20	20	0	0
RAJ	20	20	0	0
MP	20	20	0	0
WB	20	20	0	0
HP	20	10	10	10
BH	20	10	10	10
OR	20	20	0	0
AS	20	20	0	0
NE	20	20	0	0
J&K	20	10	10	10
Total	**600**	**370**	**230**	**230**

3300-3400 MHz Band

2.14 As of now, in India, assignments in the 3300-3400 MHz band are being made to various Internet Service Providers (ISPs) in various districts of a service area. Their assignments are being renewed on annual basis. In its reference, DoT has mentioned that the entire 3300-3400 MHz band can be made available for telecom services subject to relocation/shifting of existing operations of the ISPs in 3300-3400 MHz band to other bands. DoT also mentioned that a case for harmonisation/vacation of this band is being initiated and it is

expected that entire band will be made available for telecom services by the end of this year. Accordingly, DoT has proposed to include 100 MHz in all the 22 LSAs in the 3300-3400 MHz band for the forthcoming auction for access services.

3400-3600 MHz Band

2.15 Out of the 200 MHz band available in this band, 25 MHz spectrum (3400 MHz - 3425 MHz) is identified for ISRO's use in Indian Regional Navigation Satellite System (IRNSS). The remaining 175 MHz (3425 MHz - 3600 MHz) spectrum is available for access services and the same can be put in the forthcoming auction.

B. Timing of Auction

2.16 DoT, in its reference has mentioned that the Government is planning to auction right to use of spectrum in various spectrum bands in the next auction likely to be held in 2017. As mentioned earlier that the last auction for access spectrum was held in October 2016. However, around 60% spectrum remained unsold and, it is learnt that, the spectrum acquired in the said auction is yet to be deployed fully. Moreover, the Telecom Industry is presently undergoing consolidation phase as some of TSPs have filed merger of their companies/licences while a few licensees have traded their entire spectrum holding and closed their services. DoT in one of its communications has indicated that about Rs 3.08 lakh crore is due over the next 11 years on account of deferred payment plans opted by TSPs for the purchase of spectrum rights in the recent auctions. It is also indicated in the letter that the telecom industry also owes about Rs 4.60 lakh crore to various financial institutions and banks. Due to hyper competition, concerns have been expressed about the financial health of the sector, its revenue growth and the capability of the companies to meet their contractual commitments etc.

2.17 In view of the above, the issue for the consultation arises as to when the next round of access spectrum should be held.

Issue for Consultation

Q.1 (a) In your opinion when should the next access spectrum auction be held?

(b) If the spectrum auction is held now, should the entire spectrum be put to auction or should it be done in phased manner i.e. auction for some of the bands be held now and for other bands later based on development of eco system etc?

Please give your response band wise and justify it.

C. Identification of 3300-3400 MHz and 3400-3600 MHz bands for IMT/5G

2.18 There is clear evidence, both globally and within India, that demand for mobile broadband (MBB) to continue to increase exponentially. Ericsson, for example, has recently identified MBB as the key driver of global mobile subscriber growth. In its report "Cisco Visual Networking Index: Forecast and Methodology, 2016–2021, dated June 7, 2017"[7], CISCO has calculated that global mobile data traffic is expected to increase nearly sevenfold between 2016 and 2021. It forecasts that mobile data traffic will grow at a compound annual growth rate (CAGR) of 46 percent from 2016 to 2021, reaching 48.3 Exabyte's[8] per month by 2021. Further advancements of LTE and the emergence of 5G capabilities will provide new opportunities for growth in mobile broadband and other industries. This will drive demand for additional spectrum, to enhance existing networks and introduce 5G services.

2.19 Consideration of additional spectrum allocations to the mobile service on a primary basis and identification of additional frequency bands for International Mobile Telecommunications (IMT) in accordance with

[7] http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/complete-white-paper-c11-481360.html

[8] 1 Exabyte=10^9 GigaByte(GB)

Resolution 233 (WRC-12) was one of the main agenda items of WRC-15. After elaborate discussions during WRC-15, agreement was reached to make additional frequency bands available for IMT in various parts of the world. Also, there was enhanced level of harmonisation level in the frequency bands already identified for IMT by some countries/regions. A gist of the agreement reached in WRC-15 for additional frequency allocations for IMT is given in the Table below.

Table 2.7

Identification of additional frequency allocations/bands for IMT in WRC15

Band Name	**Global Harmonization Status**	**Remark**
470 – 694/698 MHz (600 MHz)	Identified by some countries in Americas and APAC.	New Regional band Identified.
694 – 790 MHz (700 MHz, Region-1)	Quasi Global Harmonisation (except some Administrations in Region 3.	WRC-15 moved 700 MHz band from a regional (Americas, Asia pacific) to a global one.
1427 – 1518 MHz (L-band)	Quasi Global Harmonisation. (Except some Administrations in Region 1 in the 1452-1492 MHz band)	New band Identified.
3300 – 3400 MHz	Identified by some administrations in all three ITU Regions.	New band Identified.
3400 – 3600 MHz	Quasi Global Harmonisation (except some administrations in Region 3)	
3600 – 3700 MHz	Identified by some administrations in Europe and Americas	New band Identified.
4800 – 4990 MHz	Identified by some administrations in APAC and Americas.	New band Identified.

3300 - 3400 MHz Band

2.20 The 3300-3400 MHz portion of spectrum has already been identified for IMT[9] in 45 countries in regions such as Africa (33 countries) in Region 1, Latin America (6 countries) in Region 2, and the Asia Pacific Africa (6 countries) in Region 3. India is one of them. There is also strong interest from China in identifying the band for IMT and it is making progress in domestic coordination towards the IMT identification in 3300 - 3400 MHz, 4400-4500 MHz, and 4800-4990 MHz frequency bands in Chinese Regulations on the Radio Frequency Allocation. This suggests that a viable ecosystem could develop for mobile broadband systems in this band, noting that this band is already a WiMAX profile band, which has been deployed in some countries. It is pertinent to note that this band is part of the frequency range 3300-4200 MHz, which is gaining high attention for early 5G introduction.

3400-3600 MHz band

2.21 At World Radio-communication Conference 2007 (WRC-07), the spectrum 3400-3600 MHz was identified for use by IMT systems in countries indicated in by footnotes 5.430A, 5.431A, 5.432A, 5.432B and 5.433A to the Radio Regulations under specific conditions outlined in those footnotes. These included around 80 countries in Region1 and Rep. of Korea (Rep. of), Japan, Pakistan, Bangladesh, China, India, Iran (Islamic Republic of), New Zealand and French Overseas Communities in Region 3.

2.22 As a result of WRC-15 agenda item 1.1; many changes have been made in the allocation of 3400-3600 MHz band. Entire 3400–3600 MHz frequency range for IMT has been identified in all of Region 1 and Region 2. In addition, 3600–3700 MHz frequency range has been identified for IMT in Canada, Columbia, Costa Rica and the US. In Region 3, it was left upto individual jurisdictions to designate 3400-

[9] *http://www.acma.gov.au/~/media/Spectrum Transformation and Government/Issue for comment/IFC 22 2015/Mobile broadband work program February 2016 update docx.docx*

3600 MHz band for IMT purpose, if it so desired. India is one of the 11 countries in Region 3 (Australia, Bangladesh, China, India, Iran, Korea, Japan, New Zealand, Pakistan, Philippines and Singapore) which allocated some or the entire 3400 to 3600 MHz band to IMT via footnotes to the ITU Table of Frequency Allocations for Region 3. WRC-15 did not designate any spectrum above 3600 MHz in any part of Region 3.

2.23 Internationally, there appears to be growing interest in use of the 3400–3800 MHz band for Mobile Broadband (MBB). Development in some of the countries regarding the use of this band has been discussed in **Annexure 2.1**. This is evident from the recent outcomes of WRC-15, as well as from moves to identify the bands for MBB in Europe, US and Japan. It is also supported by industry-driven technology standardisation for LTE and Wi-Fi in the band. It is emerging as a candidate band globally for LTE-Advanced-Pro technology as well as a potential 5G band. There are strong indications that economies of scale for MBB equipment in the 3400-3600 MHz band are likely to develop. It offers large potential bandwidths while being relatively underutilised today.

2.24 As mentioned earlier that as spectrum in frequency range 3300-4200 MHz is likely to emerge as primary band for early 5G introduction, therefore a number of countries in different regions are taking action in order to reach 200-400 MHz of contiguous bandwidth in the 3300-4200 MHz frequency range for 5G. This will be the largest contiguous bandwidth for IMT below 6 GHz. Parts of the 3300-4200 MHz range is being considered for early trials in a number of countries/regions in the world: trials in the 3400-3800 MHz frequency band are being prepared for 2018 in Europe; there are ongoing trials in China (3400-3600 MHz) and Japan (3600-4200 MHz). Trials are also planned in Australia (3400-3600 MHz).

D. Band plans

2.25 A harmonised frequency arrangement facilitates economies of scale resulting in the availability of affordable equipments. Therefore, it is essential to follow an internationally harmonised band plan in each of the frequency bands. Band plans for various spectrum bands, which were part of part of the earlier auction process, are as given in the table below. As can be noted that there are no band plans finalised for 3300-3400 MHz and 3400-3600 MHz bands, simply for the reason that they are being proposed to be auctioned for the very first time.

Table 2.8

Band plans adopted in India for various spectrum bands

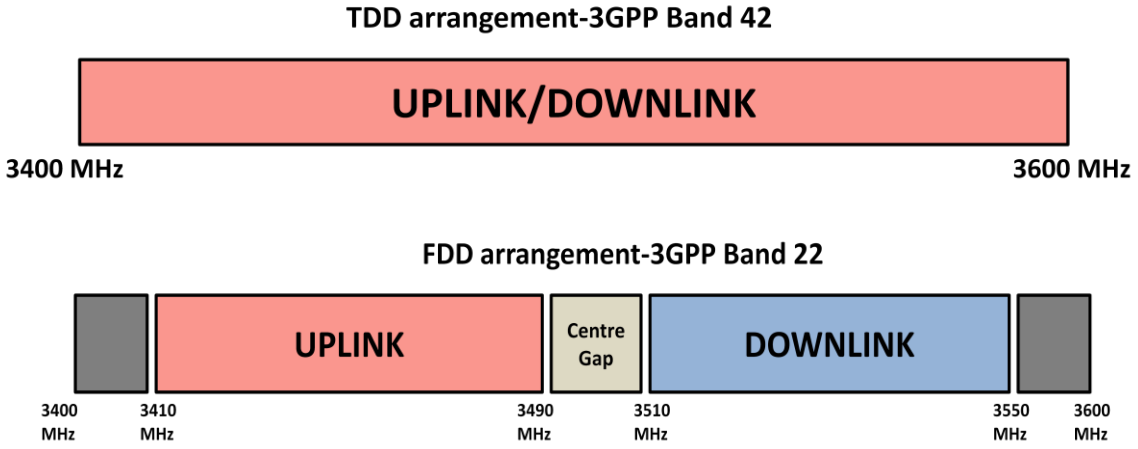
Band	Uplink Frequency (MHz)	Downlink Frequency (MHz)	3GPP band no.	Duplexing Scheme
700 MHz	703 -748 MHz	758-803 MHz	28	FDD
800 MHz	824-844 MHz	869-889 MHz	5	FDD
900 MHz	890-915 MHz	935-960 MHz	8	FDD
1800 MHz	1710-1785 MHz	1805-1880 MHz	3	FDD
2100 MHz	1920-1980 MHz	2110-2170 MHz	1	FDD
2300 MHz	2300-2400 MHz		40	TDD
2500 MHz	2500-2690 MHz		41	TDD

2.26 Being a recently identified band for IMT, there is no band plan for 3300-3400 MHz, APT Wireless Group (AWG) has started working on harmonized frequency arrangements for recently identified IMT bands including 3300-3400 MHz band[10]. However, 3400-3600 MHz band has been identified for IMT by a number of countries in WRC-2007. 3GPP has already identified the 3400–3600 MHz frequency ranges as LTE band. Both TDD and FDD arrangements are defined for the 3400–3600 MHz band (Fig.2.1). Band B22 denotes the FDD arrangement with frequency range 3410-3490 MHz as uplink and 3510-3590 MHz as downlink. Band B42 represents the TDD arrangement in the frequency range 3400-3600 MHz band.

[10] 5G Spectrum Recommendations by 5GAmericas, April 2017

Chart 2.1

TDD and FDD arrangements defined for the 3400–3600 MHz band



2.27 There are specifications for both TDD and FDD in this band. However, there is strong momentum for TDD systems in this band. In May 2014, the European Commission adopted Decision 2014/276/EU[11] which stated that the preferred duplex mode of operation in the 3400-3600 MHz sub-band shall be Time Division Duplex (TDD). This Decision is binding on Member States. Accordingly, any award of the 3400-3600 MHz band has to be compliant with the Commission Decision. OFCOM is planning to auction spectrum in the 2300 MHz and 3400 MHz spectrum bands. For the spectrum in 3400 MHz band, the harmonised frequency arrangement proposed by OFCOM is based on a block size of 5 MHz on a Time Division Duplex (TDD) basis[12].

2.28 GSA reported that, as of January 2017, there are already 24 commercial networks (Fixed Wireless Broadband-FWBB/Mobile Broadband MBB) globally in 15 countries operating in 3GPP Bands 42 and/or Band 43 (3600 – 3800 MHz). These include networks in Bahrain, Belgium, Canada, Iran, Ireland, Canada, Italy, Jordan, Nigeria, Peru, Philippines, Slovak Republic, Spain, Tanzania and UK[13]. GSA also reported that the ecosystem for bands 42 continues to grow with 96 devices operate in this band.

[11] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014D0276&qid=1414427840029&from=EN

[12] The award of 2.3 and 3.4 GHz spectrum bands Information Memorandum dated 26th October 2015.

[13] GSA (Global Mobile Suppliers Association) Report on Evolution to LTE, Jan 2017

E. Block Size

2.29 The Block size and the minimum quantity of spectrum to be bid for by Existing Licensee/ New Entrant, in various bands, as per the NIA of September 2016, is given in Table 2.9 below:

Table 2.9

Block size and minimum quantity for bidding as per NIA of September 2016

Spectrum Band	Block Size (MHz)	Minimum amount of spectrum that a bidder is required to bid for	
		Existing licensees (MHz)	New Entrants (MHz)
700 MHz	5 (paired)	NA	5
800 MHz	1.25 (Paired)	1.25	5/ 3.75 (if only 3.75 MHz spectrum was available)/2.5 (if only 2.5 MHz spectrum was available)
900 MHz	0.20 (paired)	0.6	5
1800 MHz	0.20 (paired)	0.6	5 MHz, if at least one chunk of contiguous 5 MHz is available; else, 0.6 MHz
2100 MHz	5 (paired)	5	5
2300 MHz	10 (unpaired)	10	10
2500 MHz	10 (unpaired)	10	10

2.30 For spectrum bands in Table 2.9 above, same block sizes are proposed for the upcoming auction. As far as block size in the 3300-3400 MHz and 3400-3600 MHz bands is concerned, not many recent international instances are available. In November 2016, OFCOM has issued a consultation paper, as part of its ongoing consultation process relating to its planned auction of spectrum in the 2300 MHz and 3400 MHz bands. A total of 190 MHz worth of spectrum comprising of 40 MHz in the 2300 MHz band (2350 MHz-2390 MHz) and 150 MHz in the 3400 MHz band (3410 MHz-3480 MHz, 3500 MHz-3580 MHz) will be put to auction[14]. The harmonised frequency arrangement proposed by OFCOM is based on a block size of 10 MHz in the 2300 MHz band and 5 MHz in the 3400 MHz band on a Time Division Duplex (TDD) basis. To protect bidders against the risk of acquiring unwanted smaller amounts of spectrum, OFCOM proposed to allow them to specify a minimum requirement of up to 20 MHz (i.e.

[14] The 40 MHz of spectrum is held by UK Broadband[14] in the 3.4 GHz band (3480 to 3500 MHz and 3580 to 3600 MHz) which was awarded through an auction in 2003 for 15 years period.

four 5 MHz lots) in the Simultaneous Multiple Round Auction (SMRA) auction format. A bidder, who ended the auction as the standing high bidder on fewer lots than what had specified in its minimum requirement for a given category, would not be assigned any lots in relation to these bids.

2.31 Earlier, the 3400-3600MHz band was used by a number of countries for broadband wireless access (BWA) service. In the Canada, spectrum in the 3400-3600 MHz band was offered through auctions in held in February 2004[15] in the 3 paired frequency blocks of size 2x25 MHz, viz 3475-3500 MHz/3575-3600 MHz, 3500-3525 MHz/3600-3625 MHz, 3525-3550 MHz/3625-3650 MHz and 1 unpaired frequency block of size 25 MHz viz. 3550-3575 MHz[16]. Total 849 spectrum licences in 172 service areas across the country were offered.

2.32 In Europe, a European Commission (EC) decision for harmonised conditions was made in May 2008, making the band 3400-3600 MHz available from 2008. There have been authorisations in Austria, Belgium, Czech Republic, France, Germany, Hungry, Ireland, Italy, Macedonia, Norway, Portugal, Sweden, Switzerland and the UK (by UK Broadband) for wireless broadband. Details of spectrum awarded in this band in some of these countries are placed at **Annexure 2.1**. In most cases, two blocks with a duplex spacing of 100 MHz were grouped to one package. For instance, in UK, two blocks each of 20 MHz with a duplex spacing of 100 MHz were assigned to broadband wireless applications. In Germany, the 3400-3600 MHz band was auctioned in December 2006 for BWA. Four packages were offered. Each packages offered a pair of 21 MHz block of spectrum separated by 100 MHz spacing.

2.33 Several countries in Latin America (Region 2) had also auctioned spectrum in the 3400-3600 MHz band for BWA purpose. In Mexico and Peru, the spectrum from 3400-3600 MHz was divided into 8

[15] Later on auctions were held in January 2005 and June 2009 for the residual spectrum blocks including those returned by the successful bidders.

[16] http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf08346.html

blocks of 25 MHz each. The blocks were auctioned off individually, but acquired in pairs by operators. The result was 4 paired bands with 100 MHz offset between the low and high band.

2.34 As mentioned earlier there is possibility of 3300-3400MHz and 3400-3600 MHz spectrum bands being used for new 5G mobile services. Though it is not yet clear what the optimum channel size for 5G will be, there are views that large contiguous blocks of spectrum – perhaps with channels of 40-100 MHz wide may be desirable. However, offering spectrum in the bigger chunks take away the flexibility from the TSPs who may like to acquire lesser spectrum. One possible option could be to offer the spectrum in smaller block size but impose a condition that bidders will have to bid for minimum 'n' number of such blocks, which would avoid the fragmentation of spectrum and at the same time, there will be flexibility for TSPs to decide how much spectrum they like to have beyond the minimum quantum of spectrum. Considering that there is strong momentum for TDD systems in the 3400-3600 MHz band, one option could be to offer blocks in the sizes of 5 MHz or 10 MHz (unpaired) with the condition that the bidder will have to bid for atleast 20 MHz or 40 MHz. Another alternative could be to offer spectrum in these bands in the higher block size, say 20 MHz.

2.35 It is essential to freeze the frequency arrangement before finalising the block size in any band. As discussed above, there is no standard band plan available as on date in the 3300-3400 MHz band. In the 3400-3600 MHz band, both FDD and TDD frequency arrangements have been defined by 3GPP and stakeholders opinion have been sought on the preferable frequency arrangement in each of these bands. Therefore, comments of the stakeholders on the preferable block size are sought keeping in mind both the possibilities i.e. frequency arrangement could be FDD or TDD.

2.36 In view of the forgoing the issues for consultation are:

Issues for Consultation

Q.2 Do you agree that in the upcoming auction, block sizes and minimum quantity for bidding in 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz and 2500 MHz bands, be kept same as in the last auction? If not, what should be the band-wise block sizes? Please justify your response.

Q.3 What should be optimal block sizes and minimum quantity for bidding in (a) 3300-3400 MHz and (b) 3400-3600 MHz bands, keeping in mind both the possibilities i.e. frequency arrangement could be FDD or TDD? Please justify your response.

F. Obligations to Roll-out Network

2.37 Given the fact that spectrum is a limited resource and should be used in an effective and efficient manner, roll-out obligations are mandated for the spectrum assigned to the TSPs. Roll-out obligations mandated in the NIA of September 2016 are discussed in the following paras.

Metro LSAs

2.38 In the NIA of September 2016, roll-out obligations in respect of Metro Service Areas for the spectrum in the 700 MHz, 800 MHz, 900 MHz, 1800 MHz bands mandated street-level coverage of 90% of the service area one year from the effective date of licence or the date of assignment of spectrum won in the auction process, whichever is later[17] while the licensee who acquired the spectrum in the 2100 MHz, 2300 MHz or 2500 MHz bands, was required to provide the street-level coverage in at least 90% of the LSA within five years.

Non-Metro LSAs

2.39 In the NIA of September 2016, following roll-out obligations for non-metro LSAs were prescribed for the spectrum in the 700 MHz, 800 MHz, 900 MHz, 1800MHz bands:

[17] For this purpose, 900 & 1800MHz bands are treated as the same band.

Table 2.11

Roll-Out Obligations as per NIA of September 2016 for Spectrum in 700 MHz, 800 MHz, 900 MHz and 1800 MHz Bands

Phases of the Roll out	Roll Out Requirement	Time Period*
Phase 1	Coverage of 10% DHQs/ Towns	by the end of one year
Phase 2	Coverage of 50% DHQs/ Towns	by the end of three years
Phase 3	Coverage of 10% BHQs	by the end of three years
Phase 4	Coverage of additional 10% BHQs (Cumulative 20% BHQs).	by the end of four years
Phase 5	Coverage of additional 10% BHQs (Cumulative 30% BHQs).	by the end of five years

* From effective date of license or date of assignment of spectrum won in this auction process whichever is later.

2.40 For the spectrum in the 2100 MHz band, the following roll-out obligations for non- metro LSAs were prescribed:

Table 2.12

Roll-Out Obligations as per NIA of September 2016 for Spectrum in 2100 MHz Band

Roll-out Phase	Roll Out Requirement	Time Period*
Phase 1	Coverage of 50% of DHQs in the LSA out of which 15% of DHQs/Towns should be in rural SDCA.	by the end of three years
Phase 2	Coverage of additional 10% DHQs	by the end of four years
Phase 3	Coverage of additional 10% DHQs	by the end of five years

* From effective date of license or date of assignment of spectrum won in this auction process whichever is later.

2.41 Roll-out obligations for non-metro LSAs for the spectrum in 2300 MHz and 2500 MHz band required that at least 50% of the rural SDCAs are covered within five years of the effective date[18] using the 2300 MHz /2500 MHz band spectrum.

2.42 As per the NIA provisions, the requirement of roll-out obligation would be treated as fulfilled once the required number of district headquarters or block headquarters are covered by use of any technology in any band held by a licensee. Therefore, the licensee was

[18] From the effective date of license or date of assignment of spectrum won in this auction process whichever is later.

not required to fulfil these roll-out obligations separately in respect of each of these bands.

2.43 As mentioned earlier spectrum in 3300-3400 MHz and 3400-3600 MHz bands is proposed to put to auction for the first time in the country, there is no precedence of roll-out obligations available for the spectrum in these bands.

2.44 Internationally, OFCOM is planning to auction 190 MHz of spectrum in the 2300 MHz and 3400 MHz bands. On 21st November 2016, OFCOM issued a consultation paper[19] which sets out proposed Regulations for the award by auction of radio spectrum licences in the 2300 and 3400 MHz bands. OFCOM do not propose any roll-out obligations for the spectrum in any of these bands as "*the technical characteristics of 2.3 and 3.4 GHz spectrum mean that it is suited to adding capacity, but is not an effective means of extending existing levels of mobile coverage.*"

2.45 Keeping in mind the primary objective of increasing broadband penetration in rural areas and reducing the urban-rural divide, the special focus should be given for the coverage in smaller towns and villages. As the high frequency spectrum waves do not travel longer due to higher propagation loses, these are not suitable for extending mobile coverage to uncovered/remote areas. As relatively large bandwidth is available in the high frequency bands, these can be used to enhance the network capacity wherever required. Therefore, one option could be that very lenient roll-out obligations, say limited to covering 50% DHQs in phases, to be attached with these bands. Instead, lower frequency bands, particularly 700 MHz band where entire available spectrum will be put to auction, could be used to proliferate mobile networks in smaller towns in line with TRAI's recommendations dated 27th January 2016, which are reproduced below:

[19] OFCOM Consultation Paper on "Award of the 2.3 and 3.4 GHz spectrum bands: Competition issues and auction regulations" dated 21 November 2016

"*The Authority recommends that the following roll-out obligations should be imposed for licensees who acquire access spectrum in 700 MHz band:*

- *All towns/villages having population of 15,000 or more but less than 50,000 to be covered within 5 years of effective date of allocation of spectrum for access services and all villages having population of 10,000 or more but less than 15,000 to be covered within 7 years of effective date of allocation of spectrum.*
- *To prevent, duplication of infrastructure, a TSP should also be permitted to fulfil the obligations by sharing network of other operator to the extent permissible as per guidelines/instructions applicable from time to time. A licensee should be allowed to cover any town/village as part of roll-out obligations using intra-service area roaming amongst TSPs having 700 MHz band spectrum, subject to the condition that at least one-third of the towns/villages shall be covered without intra-circle roaming.*
- *.....*"

(Para 2.97 of the Recommendations dated 27th January 2016)

2.46 Another option could be to impose roll-out obligations in 3300-3400 MHz and 3400-3600 MHz similar to what has been imposed on the other spectrum bands in last auction say 800/900/1800 MHz band i.e. covering 50% DHQs and 30% BHQs in phases.

In view of the forgoing the issues for consultation are:

Issues for Consultation

Q.4 Do you think that the roll-out conditions for 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz and 2500 MHz stipulated in the last auctions held in October 2016 are appropriate? If no, what changes should be made in the roll out obligations for these bands?

Q.5 Should there be any rollout obligations in 3300-3400 MHz and 3400-3600 MHz bands? If yes, what should these be? Please justify your response.

G. Spectrum Cap

2.47 As per the NIA provisions of the recent auction, the overall spectrum cap for each of the service areas is calculated as 50% of the total spectrum assigned for telecom services in a particular band (intra-band cap) and 25% of the total spectrum assigned for telecom services put together (inter-band cap) in 700 MHz, 800 MHz, 900 MHz, 1800

MHz, 2100 MHz, 2300 MHz and 2500 MHz bands. While calculating spectrum caps, the spectrum being put to auction was also taken into account.

2.48 It is clear that the above definition does not include 3300-3400 MHz and 3400-3600 MHz bands as these were never put to auction. Now, since these bands are also proposed to be auctioned, above provision of spectrum cap needs to be reviewed. One obvious alternative is to extend NIA provisions of the last auction to 3300-3400 MHz and 3400-3600 MHz bands also i.e. 50% of the spectrum assigned in each of the 700 MHz/800 MHz/900 MHz/1800 MHz/2100 MHz/2300 MHz/2500 MHz/3300-3400 MHz and 3400-3600 MHz bands as intra-band cap and 25% of the total spectrum assigned in all these bands put together (inter-band cap) in each service area. This will ensure that in each LSA, atleast 2 TSPs get spectrum in 3300-3400 MHz and 3400-3600 MHz bands. Alternatively an option could be to impose additional band specific limit of say 75 MHz in 3400-3600 MHz band, which would ensure that in each LSA, atleast 3 TSPs are able to acquire spectrum in this band. Another option could be to treat 3300-3400Mhz and 3400-3600MHz bands as one band for the purpose of imposing intra-band spectrum cap and a band specific limit, say 75 MHz, is imposed on the combined holding in 3300-3400 MHz and 3400-3600 MHz. This will ensure that atleast 4 TSPs get the spectrum in these bands.

2.49 OFCOM is planning to auction 190 MHz of spectrum in the 2300 MHz and 3400 MHz bands. On 21st November 2016, OFCOM issued a consultation paper[20] which sets out proposed Regulations for award by auction of radio spectrum licences in the 2300 and 3400 MHz bands. OFCOM reports that of the total amount of mobile spectrum that is currently useable, BT (and its wholly owned subsidiary EE) holds 45%; Vodafone has 28%; O2 holds 15%; and H3G, 12%. Given its dominant holding, OFCOM has proposed that BT/EE will be

[20] OFCOM Consultation Paper on "Award of the 2.3 and 3.4 GHz spectrum bands: Competition issues and auction regulations" dated 21 November 2016

prohibited from participating in the auction for 2300 MHz frequencies. This cap will prevent a worsening of the current extent of asymmetry in terms of immediately useable spectrum. The regulator, however, is less concerned with the planned distribution of the 3400 MHz band, as it is not immediately usable. OFCOM expects that the band may come into play as TSPs approach the 5G era, and 'specifying limitations on spectrum holdings at this point might constrain an operator's ability to innovate'. Therefore, OFCOM has proposed no spectrum cap for the spectrum in 3400 MHz band.

Issue for Consultation

Q.6 Is there a need to prescribe spectrum cap in bands 3300-3400 MHz and 3400-3600 MHz? If yes, what spectrum cap provisions should be kept for 3300-3400 MHz and 3400-3600 MHz spectrum bands? Should these bands be treated as same or separate bands for the purpose of calculation of spectrum cap?

CHAPTER-III: THE VALUATION AND RESERVE PRICE OF THE SPECTRUM

3.1 The spectrum is a scarce natural resource and is an essential ingredient to provide wireless telecom service and its supply for telecom services is very limited. With the growth in the telecommunication services, it has become increasingly valuable. It has been argued that the use of spectrum is both rivalrous and excludable. If certain quantum of spectrum is available for providing the telecom services and if some amount of such spectrum is used by one TSP, then, due to its limited availability, only remaining portion of the spectrum shall be available for other TSP(s), hence it is rivalrous. The consumption of spectrum is excludable because if a TSP offers interference free wireless telecom service with the use of the present technology, the spectrum has perforce to be excludable. Unlike many other natural resources, it can be repeatedly used and hence does not deplete but if not used at a particular point of time, the same cannot be stored for future use as it is perishable.

3.2 The supply of the spectrum is limited because of its scarcity, rivalry in use and excludability in consumption as spectrum is also used for other purposes of national interest such as defence, space applications etc. The demand for the spectrum for telecom services is derived from the goods and services that require spectrum as resource. Demand for spectrum is an important element to decide the value of the spectrum as the demand depends on certain external factors such as willingness to buy, requirement and paying capacity of the spectrum user i.e. the telecom service provider (TSP) who uses it for providing wireless telecom services to consumers of such services.

3.3 Thus, interplay of demand and supply of spectrum results in revelation of market value of the spectrum through auction process, which ensures the most efficient allocation of spectrum as scarce natural resource, justifying the principle that spectrum is acquired through auction by those who value it the most. Due to limited

availability of spectrum, its valuation and efficient allocation is a big challenge for its custodian.

3.4 It is well recognized that the economic valuation of spectrum depends on a number of variables. In functional form, one may posit that valuation of spectrum (V) is a function of available Market Information (I); Technological Factors (T); Macro and Micro Economic Variables (E) and can be portrayed as;

$$V = f(I, T, E)$$

Based on the functional relationship defined above, different approaches/methodologies were adopted in the past to arrive at spectrum value estimates.

3.5 In CMTS/ UASL licences granted till 2008 by the DoT, the spectrum was bundled with the licence. From 2010 onwards, the Government as well as the telecom industry in the country have perceived spectrum in economic terms considering spectrum to be a key input for providing telecom services and the wireless services occupying a greater space than wire-line. Exploding demand for mobile broadband services has increased the need for allocation of greater amounts of spectrum. Also, in some cases the validity period of spectrum allocation would be over and hence a need for reallocation of spectrum. These developments necessitate that spectrum rights are assigned to those who are able to use them efficiently and effectively and the Government gets optimum revenue from the auction process of this scarce public natural resource. The auction of spectrum of 2100 MHz (3G) and 2300 MHz (BWA) bands was done by the DoT in 2010 for the first time and since then spectrum allocation is being done through auctioning.

3.6 For determination of economic value of spectrum through auction, fixing reserve prices for various spectrum bands closer to their fair market value is very crucial. The factors influencing the valuation of spectrum have been discussed in detail in paras 3.1 to 3.8 of Recommendations of the Authority on Valuation and Reserve Price'

dated 9th September, 2013. For ready reference these are described in **Annexure 3.1**.

3.7 In October 2016, DoT conducted the last auction of spectrum in the bands 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz and 2500 MHz. The spectrum auction started on 1st October 2016 and ended after 31 clock rounds on 6th October 2016. Comparative statement (spectrum band wise) showing the valuation and reserve price recommended by the Authority, reserve price as fixed by the Government and auction determined/realized price in October 2016 auction has been shown in Table 3.1 to Table 3.7.

Table 3.1
Auction of 700 MHz Spectrum held in October 2016

(Rs. in crore)

LSA	Valuation per MHz arrived at by TRAI	Reserve Price per MHz recommended by TRAI	Reserve Price (RP) per MHz fixed by DoT	Remarks (Auction Price v/s DoT Reserve Price)
Delhi	1595	1595	1595	No Bid Received
Mumbai	1192	1192	1192	No Bid Received
Kolkata	596	596	596	No Bid Received
Andhra Pradesh	971	971	971	No Bid Received
Gujarat	952	952	952	No Bid Received
Karnataka	740	740	740	No Bid Received
Maharashtra	1272	1272	1272	No Bid Received
Tamilnadu	900	900	900	No Bid Received
Haryana	186	186	186	No Bid Received
Kerala	334	334	334	No Bid Received
Madhya Pradesh	331	331	331	No Bid Received
Punjab	308	308	308	No Bid Received
Rajasthan	364	364	364	No Bid Received
U. P. (East)	459	459	459	No Bid Received
U.P. (West)	384	384	384	No Bid Received
West Bengal	183	183	183	No Bid Received
Assam	158	158	158	No Bid Received
Bihar	248	248	248	No Bid Received
Himachal Pradesh	64	64	64	No Bid Received
J&K	52	52	52	No Bid Received
North East	44	44	44	No Bid Received
Orissa	152	152	152	No Bid Received

Note: In 700 MHz band, spectrum could not be sold in any of the LSAs as no bid was received.

Table 3.2

Auction of 800 MHz Spectrum held in October 2016

(Rs. in crore)

LSA	Valuation per MHz arrived at by TRAI	Reserve Price per MHz recommended by TRAI	Reserve Price (RP) per MHz fixed by DoT	Auction Determined Price per MHz (P_{ADP})	Remarks (Auction Price v/s DoT Reserve Price)
Delhi	848	848	848	No Bid Received	
Mumbai	727	727	727	No Bid Received	
Kolkata	200	160	160	No Bid Received	
Andhra Pradesh	606	606	606	No Bid Received	
Gujarat	356	285	285	335	Higher than RP
Karnataka	478	303	303	No Bid Received	
Maharashtra	799	799	799	No Bid Received	
Tamilnadu	506	360	360	No Bid Received	
Haryana	71	57	57	No Bid Received	
Kerala	304	243	243	No Bid Received	
Madhya Pradesh	408	408	408	No Bid Received	
Punjab	149	119	119	137	Higher than RP
Rajasthan	255	204	204	232	Higher than RP
U. P. (East)	273	219	219	219	Equal to RP
U.P. (West)	228	182	182	No Bid Received	
West Bengal	103	82	82	No Bid Received	
Assam	89	82	Not Auctioned	-	-
Bihar	170	136	136	No Bid Received	
Himachal Pradesh	30	24	24	No Bid Received	
J&K	34	28	Not Auctioned	-	-
North East	35	25	Not Auctioned	-	-
Orissa	72	57	57	No Bid Received	

Note: DoT put to auction spectrum in 19 circles in 800 MHz band; spectrum was sold only in 4 LSAs. In 3 LSAs P_{ADP} exceeded RP and in 1 LSAs, P_{ADP} was equal to RP.

Table 3.3

Auction of 900 MHz Spectrum held in October 2016
(Rs. in crore)

LSA	Valuation per MHz arrived at by TRAI	Reserve Price per MHz recommended by TRAI	Reserve Price (RP) per MHz fixed by DoT	Remarks (Auction Price v/s DoT Reserve Price)
Gujarat	673	673	673	No Bid Received
U. P. (East)	776	776	776	No Bid Received
U.P. (West)	739	739	739	No Bid Received
Bihar	444	444	444	No Bid Received

Note: In 900 MHz band, spectrum could not be sold in any of the LSAs as no bid was received.

Table 3.4

Auction of 1800 MHz Spectrum held in October 2016
(Rs. in crore)

LSA	Valuation per MHz arrived at by TRAI	Reserve Price per MHz recommended by TRAI	Reserve Price (RP) per MHz fixed by DoT	Auction Determined Price per MHz (P_{ADP})	Remarks (Auction Price v/s DoT Reserve Price)
Delhi	399	399	399	399	Equal to RP
Mumbai	298	298	298	489	Higher than RP
Kolkata	149	149	149	151	Higher than RP
Andhra Pradesh	243	243	243	243	Equal to RP
Gujarat	238	238	238	238	Equal to RP
Karnataka	185	185	185	No Bid	
Maharashtra	318	318	318	318	Equal to RP
Tamilnadu	225	225	Not Auctioned	-	-
Haryana	49	47	47	49	Higher than RP
Kerala	94	83	83	83	Equal to RP
Madhya Pradesh	103	83	83	83	Equal to RP
Punjab	96	77	77	77	Equal to RP
Rajasthan	114	91	91	92	Higher than RP
U. P. (East)	144	115	115	133	Higher than RP
U.P. (West)	104	96	96	100	Higher than RP
West Bengal	57	46	46	46	Equal to RP
Assam	48	40	40	40	Equal to RP
Bihar	101	62	62	62	Equal to RP
Himachal Pradesh	16	16	16	16	Equal to RP
J&K	33	13	13	13	Equal to RP

North East	25	11	11	11	Equal to RP
Orissa	48	38	38	No Bid Received	

Note: DoT auctioned spectrum in 21 circles in 1800 MHz band, spectrum could be sold in 19 LSAs. In 6 LSAs P_{ADP} exceeded RP and in 13 LSAs, P_{ADP} was equal to RP.

Table 3.5

Auction of 2100 MHz Spectrum held in October 2016

(Rs. in crore)

LSA	Valuation per MHz arrived at by TRAI	Reserve Price per MHz recommended by TRAI	Reserve Price (RP) per MHz fixed by DoT	Auction Determined Price per MHz (P_{ADP})	Remarks (Auction Price v/s DoT Reserve Price)
Delhi	692	554	554	554	Equal to RP
Mumbai	576	461	461	461	Equal to RP
Kolkata	122	116	116	No Bid Received	
Andhra Pradesh	340	272	272	No Bid Received	
Gujarat	294	258	258	No Bid Received	
Karnataka	401	328	328	No Bid Received	
Maharasthra	427	341	341	341	Equal to RP
Tamilnadu	413	344	344	344	Equal to RP
Haryana	69	55	55	55	Equal to RP
Kerala	222	177	177	177	Equal to RP
Madhya Pradesh	154	123	123	No Bid Received	
Punjab	114	91	91	91	Equal to RP
Rajasthan	162	140	140	140	Equal to RP
U. P. (East)	137	110	110	110	Equal to RP
U.P. (West)	139	111	111	No Bid Received	
West Bengal	65	52	52	No Bid Received	
Assam	57	46	46	No Bid Received	
Bihar	108	86	86	86	Equal to RP
Himachal Pradesh	25	20	20	No Bid Received	
J&K	27	11	11	11	Equal to RP
North East	31	12	12	No Bid Received	
Orissa	48	38	38	38	Equal to RP

Note: In 2100 MHz band, spectrum could be sold only in 12 LSAs. P_{ADP} was equal to RP in all LSAs where spectrum was sold.

Table 3.6

Auction of 2300 MHz Spectrum held in October 2016

(Rs. in crore)

LSA	Valuation per MHz arrived at by TRAI	Reserve Price per MHz recommended by TRAI	Reserve Price (RP) per MHz fixed by DoT	Auction Determined Price per MHz (P_{ADP})	Remarks (Auction Price v/s DoT Reserve Price)
Delhi	179	143	143	143	Equal to RP
Mumbai	183	146	146	146	Equal to RP
Kolkata	42	33	33	33	Equal to RP
Andhra Pradesh	84	68	68	68	Equal to RP
Gujarat	49	39	39	61	Higher than RP
Karnataka	123	98	98	98	Equal to RP
Maharashtra	73	58	58	63	Higher than RP
Tamilnadu	165	132	132	132	Equal to RP
Haryana	10	8	Not Auctioned	-	-
Kerala	21	16	16	18	Higher than RP
Madhya Pradesh	10	8	8	8	Equal to RP
Punjab	26	21	Not Auctioned	-	-
Rajasthan	8	6	Not Auctioned	-	-
U. P. (East)	11	9	Not Auctioned	-	-
U.P. (West)	15	12	Not Auctioned	-	-
West Bengal	6	5	5	5	Equal to RP
Assam	3	2	2	2	Equal to RP
Bihar	8	6	6	6	Equal to RP
Himachal Pradesh	2	1	1	1	Equal to RP
J&K	2	1	Not Auctioned	-	-
North East	2	1	1	1	Equal to RP
Orissa	5	4	4	4	Equal to RP

Note: In 2300 MHz band, spectrum could be sold in 16 LSAs. In 3 LSAs P_{ADP} exceeded RP and in 13 LSAs, P_{ADP} was equal to RP.

Table 3.7

Auction of 2500 MHz Spectrum held in October 2016

(Rs. in crore)

LSA	Valuation per MHz arrived at by TRAI	Reserve Price per MHz recommended by TRAI	Reserve Price (RP) per MHz fixed by DoT	Auction Determined Price per MHz (P_{ADP})	Remarks (Auction Price v/s DoT Reserve Price)
Delhi	143	143	143	143	Equal to RP
Mumbai	146	146	146	146	Equal to RP
Kolkata	33	33	33	33	Equal to RP
Andhra Pradesh	68	68	68	68	Equal to RP
Gujarat	39	39	39	39	Equal to RP
Karnataka	98	98	98	No Bid Received	
Maharashtra	58	58	58	58	Equal to RP
Tamilnadu	132	132	132	No Bid Received	
Haryana	8	8	8	8	Equal to RP
Kerala	16	16	16	16	Equal to RP
Madhya Pradesh	8	8	8	8	Equal to RP
Punjab	21	21	21	21	Equal to RP
Rajasthan	6	6	6	6	Equal to RP
U. P. (East)	9	9	9	9	Equal to RP
U.P. (West)	12	12	12	12	Equal to RP
West Bengal	5	5	5	5	Equal to RP
Assam	2	2	2	2	Equal to RP
Bihar	6	6	6	6	Equal to RP
Himachal Pradesh	1	1	1	1	Equal to RP
J&K	1	1	1	1	Equal to RP
North East	1	1	1	1	Equal to RP
Orissa	4	4	4	4	Equal to RP

Note: In 2500 MHz band, spectrum could be sold in 20 LSAs. P_{ADP} was equal to RP in all the 20LSAs.

3.8 It can be observed from the Table 3.1 to Table 3.7 that only in some LSAs the achieved / auction determined price (P_{ADP}) in October 2016 auction was higher than the Reserve Price (RP) set by DoT across various spectrum bands. However, in most of the LSAs across various spectrum bands, the achieved auction determined price was equal to the reserve price recommended by TRAI. Spectrum in 700 and 900 MHz remained unsold as no bids were received.

VALUATION OF SPECTRUM: CURRENT REFERENCE OF DOT

3.9 Out of the spectrum bands currently referred for reserve price, many have been put to auction in the past. However, spectrum in 3300-3400 and 3400-3600 MHz bands will be put to auction for the first time. As informed by DoT, in 3300-3400 MHz and 3400-3600 MHz fresh available spectrum would be put for auction, while in the other spectrum bands spectrum put to auction is the sum of spectrum available due to expiry of licence or spectrum that remained unsold in previous auctions.

3.10 The determination of valuation and setting of reserve price of a spectrum band is dependent on the availability of information such as cost, revenue and non financial information like quantity of spectrum available pertaining to that band. Unlike the spectrum bands (800 MHz/900 MHz/1800 MHz/2100 MHz), where abundant historical information – both financial and non-financial is readily available, it is not the case for 700/2300/2500/3300-3400 and 3400-3600 MHz bands. The Authority has been giving its recommendation since 2013 on valuation and reserve price of 700/800/900/1800/2100 /2300/2500 MHz spectrum bands following a bottom-up approach (LSA-wise valuation using LSA-specific inputs) using different valuation approaches and the last recommendations were given in January, 2016. In case of 3300-3400 MHz and 3400-3600 MHz bands, the appropriate approach for valuation needs to be decided as they are being auctioned for the very first time.

NEED FOR FRESH EXERCISE OF VALUATION VERSUS USE OF OCTOBER 2016 AUCTION DETERMINED PRICES (800/1800/2100/2300/2500 MHz BANDS)

3.11 Through the current reference, DoT has sought recommendations from TRAI on reserve price for auction of right to use spectrum for all 22 LSAs in 700 MHz, 2300 MHz, 3300-3400 and 3400-3600 MHz bands, 19 LSAs in 800 MHz band, 5 LSAs in 900 MHz, 13 LSAs in

1800 MHz band, 21 LSAs in 2100 MHz band and 12 LSAs in 2500 MHz band.

3.12 In October, 2016, DoT conducted spectrum auction for 700 MHz (in 22 LSAs), 800 MHz (in 19 LSAs), 900 MHz (in 4 LSAs), 1800 MHz (in 21 LSAs), 2100 MHz (in 22 LSAs), 2300 MHz (in 16 LSAs) and 2500 MHz spectrum (in 22 LSAs). The comparative statement of reserve price recommended by TRAI, reserve price fixed by DoT and the auctioned price of different spectrum bands offered for auction in October, 2016 has been shown in the tables 3.1 to 3.7 in the preceding paras. The spectrum band wise summary of quantity of spectrum put on auction and quantum of spectrum sold in the auction held in October 2016 has been shown in the table below:

Table: 3.8

Band wise quantity of spectrum put on auction and bids received in October 2016 Auction				
Spectrum Band	**Quantity put on auction (in MHz) / (LSAs)**	**Quantity Sold***	**Quantity sold**	**Number of LSAs where no bid was received**
		(In MHz)/ (LSAs)	**(%)**	
700 MHz	770	NIL	0%	22
	(22 LSAs)	(0 LSAs)		
800 MHz	73.75	15	20%	15
	(19 LSAs)	(4 LSAs)		
900 MHz	9.4	NIL	0%	4
	(4 LSAs)	(0 LSAs)		
1800 MHz	221.6	174.8	79%	2
	(21 LSAs)	(19 LSAs)		
2100 MHz	360	85	24%	10
	(22 LSAs)	(12 LSAs)		
2300 MHz	320	320	100%	-
	(16 LSAs)	(16 LSAs)		
2500 MHz	600	370	62%	2
	(22 LSAs)	(20 LSAs)		

** Fully or Partially*

3.13 From the above table, it is evident that in the auction conducted by DoT in October, 2016, the spectrum was sold in most of the LSAs either partially or fully. The status of sale of spectrum and the comparison of demand (D) & supply (S) price for the various spectrum bands in October 2016 auction has been given in **Annexure 3.2**. However, no auction could take place in 700 MHz and 900 MHz bands as no bids were received for these spectrum bands in the auction held in October 2016.

3.14 Around 18 months have passed since the Authority made its Recommendations in January 2016 on valuation and reserve price of 700/800/900/1800/2100/2300/2500 MHz spectrum and a period of only 9 months has passed since DoT has conducted the auction in October 2016. Hence, the variables and inputs (financial information) used in different approaches for valuation of spectrum would not have changed substantially. The only significant difference in the estimation would arise from factoring in the prices discovered in the October 2016 auction which can also be considered while determining the valuation of various spectrum bands for forth coming auction.

RELEVANT CLAUSE IN NIAs ON INDEXATION OF AUCTIONED DETERMINED PRICE

3.15 The Authority notes that the Notice Inviting Applications (NIA) of 25th February 2010 for 'Auction of 3G and BWA Spectrum' includes the following clause:

> "Para 4.7: If a further round of auction for 3G spectrum or BWA spectrum takes place within 12 months from the date of completion of the current round or the relevant Auction, the Reserve Price in such a round will be the same as the Successful Bid Amount in the current round of the relevant Auction for the respective service area"

3.16 Further, the Authority has stated in Para 3.50 of its Recommendations of 11th May 2010 on 'Spectrum Management and Licensing Framework' that:

> "Para 3.50*:* Government should bring additional blocks into 3G services at the earliest and offer the same at the highest price being discovered through the present auction to the remaining bidders in

the order of bids. If, however, more than a year lapses from now for this exercise, a fresh auction needs to be conducted."

3.17 NIAs of 28th September 2012 (for 1800 MHz and 800 MHz) and 30th January 2013 (for 1800 MHz, 900 MHz and 800 MHz) for auction of spectrum included a clause which states that:

"Para 2.3: Existing CMTS/UAS/UL(AS) licensees can liberalise their existing spectrum holding in 1800 MHz band after payment of auction determined price."

3.18 NIA of 12th December 2013 for 'Auction of Spectrum in 1800 MHz and 900 MHz band' and NIA of 9th January 2015 for 'Auction of Spectrum in 2100 MHz, 1800 MHz, 900 MHz & 800 MHz Bands' included the following clauses:

"Para 2.3: .....Existing CMTS/UAS/UL licensees can liberalise their existing spectrum holding in 1800 MHz band for the balance validity period of spectrum assignment after payment of auction determined price prorated for the balance validity period of the Spectrum Assignment.

In case more than one set of auction determined prices are available, the latest auction determined prices available at the time when the TSP wants to liberalise its spectrum holding, would be applied.

If the auction determined price is more than one year old then the prevailing market rates would be determined by indexing the last auction price at the rate of SBI PLR....".

3.19 All the above clauses talks about the use of auction determined price for either as reserve price for the subsequent auction or for liberalisation of administratively assigned spectrum, if it is not more than one year old. Therefore, one view could be that the price revealed through an auction process should remain valid for assignment of spectrum in that band if done within one year of the auction of that band for the respective service area and, in such a case, there may not be a need for new exercise for valuation and RP or indexation of auction price for that spectrum band. However, none of the NIAs for auction of spectrum (November 2012, March 2013, February 2014, March 2015 and August 2016) contain any explicit clause that the auction determined price in a spectrum band shall be the RP for the next round of spectrum auction if it takes place within one year

(unlike what was incorporated in the NIA dated 25th February 2010 for 'Auction of 3G and BWA Spectrum').

3.20 In absence of uniform NIA conditions on adoption of auction determined prices (indexed or not) for subsequent round of auction, adoption of October 2016 auction prices (duly indexed) only as value of spectrum in respective bands may not be an appropriate valuation approach in the current exercise. In addition to this, no bids were received for 700 MHz, 900 MHz spectrum bands in the auction held in October 2016. In past, the Authority has also considered adoption of indexed/ non-indexed auction determined prices for valuation and reserve price (if these were available) as one of the valuation methods. This may not be of much help for valuation and reserve price of 700 MHz, 3300-3400 MHz and 3400-3600 MHz spectrum bands but could be used as one valuation model for other spectrum bands.

3.21 With regard to the use of various valuation methodologies/ approaches for the valuation of various bands, the Authority in September 2013 and subsequent Recommendations had acknowledged that there are different approaches to estimate the value of the spectrum. All of these approaches have their merits as well as demerits and the prudence suggests that rather than depending on the valuation arrived at using any one approach it would be better to rely on a number of such approaches to arrive at a final reasonable valuation. The details of the valuation approaches followed for the valuation of various spectrum bands (700/800/900/1800/ 2100/2300/2500 MHz) by the Authority in the past is placed at **Annexure 3.3.**

3.22 Since the Authority has given its recommendations on the valuation and reserve price of aforementioned spectrum bands in January 2016 and the auction has been held as recently as in October 2016, the following questions arise for consultation:

Issues for Consultation

Q.7 Whether the prices revealed of various spectrum bands in the October 2016 auction can be taken as the value of spectrum in the respective band for the forthcoming auction in the individual LSA? If yes, would it be appropriate to index it for the time gap since the auction held in October 2016. If indexation is to be done then at what rate?

Q.8 If the answer to above question is negative then, whether as per the practice adopted by TRAI in the previous valuation exercise, the valuation for respective spectrum bands be estimated on the basis of various valuation approaches/methodologies (Referred in Annexure 3.3) including those bands (in a LSA) for which no bids were received or spectrum was not offered for auction?

VALUATION OF 700 MHz SPECTRUM

3.23 The frequencies around 700 MHz have been termed as 'golden frequencies' because of the excellent propagation characteristics of the band and lesser cost/ effort in deploying the mobile networks and offering BWA and other mobile services[21]. The 700 MHz band being a low-frequency spectrum holds the advantage of mobile signal travelling relatively longer distances which would result in reduction in operating costs (OPEX) and Investment (CAPEX) of covering less populated regions (e.g. in rural and remote areas) as well as providing enhanced indoor coverage compared to use of higher frequencies where additional cell sites / towers would be required to be deployed to gain equivalent levels of coverage.

3.24 Like other spectrum bands such as 800 MHz/900 MHz/1800 MHz/2100 MHz spectrum band, the valuation exercise for 700 MHz spectrum is dependent on the availability of cost, revenue and other financial and non- financial information. Since 700 MHz spectrum was put to auction in India for the first time in October 2016 and no bids were received in the auction, there is no data available to show the market perceived value of spectrum in this band. Therefore, the

[21] 'Exploring the value and economic valuation of spectrum' – ITU 2012

valuation approach of this spectrum band could be based on comparative values by using relative technical efficiency factor of other spectrum band. The report of ZTE[22] on "APT 700 MHz Best Choice for Nationwide Coverage[23]" provides a comparative uplink edge rate from dense urban to rural environments and the coverage radius of a single site utilizing 700 MHz spectrum and 1800 MHz spectrum. The report indicates that 700 MHz spectrum band has comparative advantage over 1800 MHz band both in terms of UL cell range as well as coverage area. Therefore, 700 MHz band could be considered as a preferred band for deployment and providing services keeping all other things constant.

3.25 The Authority in its past two recommendations on 700 MHz band including January, 2016 has used relative technical efficiency factor of other spectrum band to determine the value of 700 MHz spectrum band. In view of the above, the following questions arise for consultation in this regard:

Issues for Consultation

Q.9 Whether the value of 700 MHz spectrum should be derived by relating it to value of other bands by using technical efficiency factor? If yes, with which spectrum band this band be related and what efficiency factor or formula should be used? Please justify your views with supporting documents.

Q.10 Else, what valuation approach should be adopted for the valuation of 700 MHz spectrum band? Please support your valuation approach with detailed methodology and related assumptions.

VALUATION OF THE 2300 MHz SPECTRUM

3.26 The valuation of spectrum, being a scarce natural resource, is dependent on the availability, cost, revenue and other financial and nonfinancial information pertaining to this band. Although the auction of 2300 MHz band was done in 2010 for the first time, the

[22] A Chinese multinational telecommunications and systems company

[23] http://www.gsma.com/spectrum/wp-content/uploads/2013/07/ZTE-LTE-APT-700MHz-Network-White-Paper-ZTE-June-2013.pdf

commercial telecom services utilizing 2300 MHz band have been partially operational in the second quarter of 2016. Therefore, unlike other spectrum bands (800 MHz/900 MHz/1800 MHz/2100 MHz), adequate information in the case of the 2300 MHz spectrum band is not available with the Authority at this stage.

3.27 In January 2016 recommendations, the Authority, due to non-availability of any financial or non-financial information, has estimated the valuation of 2300 MHz spectrum by indexing the market revealed prices of 2010 auctions using a suitable indexation factor. As the NIA of 25th February 2010 (Para 4.7) for the 'Auction of 3G and BWA Spectrum' stipulates that in case of auction within 1 year from date of completion of relevant auction, the reserve price would be same as successful bid amount for the respective LSA. Again for the current valuation exercise paucity of relevant data continues for the 2300 MHz spectrum band. In view of above, the stakeholders are requested to respond to the following question:

USE OF TECHNICAL EFFICIENCY FACTOR

3.28 In the past, one of the approaches for the valuation of spectrum in 800/ 900/ 1800/ 2100 MHz bands was based upon the relative technical efficiency of these bands. Similarly, one of the approaches for valuation of 2300 MHz spectrum band could be to establish relative values with other spectrum bands using technical efficiency factor. As already discussed, network built around a higher frequency spectrum costs more than a network built around a lower frequency spectrum, with other things remaining constant. This is because the higher frequency signal covers lesser distance and, therefore, requires more number of cell sites. This factor has an important bearing on the value of different bands of spectrum and has consistently been used as one of the approaches of valuation of spectrum.

3.29 The Authority in its January 2016 recommendations derived the value of one spectrum band using the technical efficiency factor to relate it

to value another spectrum band (s) as financial and non-financial information in the case of the 2300 MHz spectrum band is not available with the Authority.

Issues for Consultation

Q.11 Whether the value of October 2016 auction determined prices be used as one possible valuation for 2300 MHz spectrum for the current valuation exercise? If yes, would it be appropriate to index it for the time gap since the auction held in October 2016? Please justify your response with supporting documents/ report(s), if any.

Q.12 Whether the value of the 2300 MHz spectrum should be derived by relating it to the value of any other spectrum band by using technical efficiency factor? If yes, which band and what rate of efficiency factor should be used? If no, then which alternative method should be used for its valuation? Please justify your response with rationale and supporting documents.

VALUATION OF THE 2500 MHz SPECTRUM BAND

3.30 The spectrum in 2500 MHz band has been auctioned for the first time in October 2016. The commercial operations have yet to take place in this band. Previously, DoT has allotted the one block in the 2500 MHz spectrum to the PSUs viz., BSNL and MTNL at a price equal to auction determined price of 2300 MHz band in 2010 auction. Like a few other spectrum bands that are proposed for auction, in this band also, there is little data available with regard to revenue, investment and cost to form a basis for the valuation. A scan of the on-line information reveals that world-over 2500 MHz spectrum band is considered less valuable as compared to lower frequency bands as International bench marking of value / spectrum allocation price.

3.31 Considering the fact that (a) there is little specific financial/ non-financial data available in the 2500 MHz band, and (b) DoT has already equated value of this band to value of 2300 MHz band discovered in 2010 auction while assigning one block to BSNL/MTNL, the Authority after detailed public consultation exercise and weighing

various factors adopted same approach in valuation exercise in its recommendations of January 2016.

Issue for Consultation

Q.13 Whether the valuation of 2500 MHz spectrum should be equal to value of similarly placed spectrum band? If no, then which alternative method should be used for its valuation? Please justify your response with rationale and supporting documents.

VALUATION OF 3300-3400 /3400-3600 MHz SPECTRUM BANDs

3.32 With regard to DoT's reference for valuation and determination of reserve price of spectrum bands 3300-3400 and 3400-3600 MHz, DoT has stated in its aforementioned letter that the spectrum bands 3300-3400 and 3400-3600 MHz are proposed for providing access services. Again, the valuation of 3300-3400 MHz and 3400-3600 MHz spectrum bands is also dependent on the availability of cost, revenue and other financial and non-financial information pertaining to this band. However, unlike the other spectrum bands (800 MHz/900 MHz/1800 MHz/2100 MHz), both financial and non-financial information, is not available in the case of the 3300-3400 MHz and 3400-3600 MHz spectrum bands.

Issue for Consultation

Q.14 Whether the valuation of the 3300-3400 MHz spectrum bands and 3400-3600 MHz spectrum bands should be derived from value of any other spectrum band by using technical efficiency factor? If yes, what rate of efficiency factor should be used? If no, then which alternative method should be used for its valuation? Please justify your response with rationale and supporting documents.

OTHER POSSIBLE VALUATION APPROACHES

3.33 In addition to the various valuation approaches discussed above in respect of 700/800/900/1800/2100/2300/2500/3300-3400/3400-3600 MHz bands, there could be other suitable approaches.

Issue for Consultation

Q.15 Is there any other valuation approach than discussed above or any international auction experience/ approach that could be used for arriving at the valuation of spectrum for 700/800/900/1800/2100/2300/2500/3300-3400/3400-3600 MHz bands? Please support your suggestions with detailed methodology and related assumptions.

VALUATION OF SPECTRUM: SINGLE APPROACH *VERSUS* MULTIPLE APPROACHES

3.34 Since September, 2013, the Authority has been attempting various approaches (specific to the particular spectrum band) to arrive at the valuation of different spectrums bands and to determine the reserve price of different spectrum bands for the auction of various bands of spectrum from time to time. These approaches have been discussed in the forgoing paras and also summarised in Annexure 3.3 for each spectrum band. It cannot be deterministically decided that which one of the valuation approach would be the right approach in various approaches adopted by the Authority for the valuation of spectrum because each approach of valuation has certain merits and certain drawbacks. Further, it is also not certain that any of these values can actually materialise in the market place.

3.35 Accordingly, the Authority since September 2013 has taken a consistent view that instead of following a deterministic approach, it is best to work with a probabilistic average valuation (using simple mean) of the valuations obtained through the different approaches attempted for valuation of a particular spectrum band. Further prudence suggests that rather than depending on the valuation arrived at using any one approach, it would be better to rely on a

number of such approaches to arrive at a final reasonable valuation and then determine reserve price based on such valuation.

3.36 The Authority in the valuation exercise done in January 2016 has used probabilistic average valuation (simple mean) of the valuations obtained through the different approaches attempted for valuation of a particular spectrum band and the same has been accepted by the Government. Would it be justified to use any other methodology for determining the value of particular spectrum band instead of average valuation approach?

Issues for Consultation

Q.16 Whether value arrived at by using any single valuation approach for particular spectrum band should be taken as the appropriate value of that band? If yes, please suggest which single approach/ method should be used. Please justify your response.

Q.17 In case your response to Q16 is negative, will it be appropriate to take the average valuation (simple mean) of the valuations obtained through the different approaches attempted for valuation of a particular spectrum band, as adopted by the Authority since September 2013 recommendations? Please justify your response.

RESERVE PRICE ESTIMATION

3.37 With regard to auction of spectrum, the term reserve price (RP) refers to the minimum amount that the owner of spectrum will accept as the winning bid in an auction. RP is the starting point for an ascending price auction and bidding is a means to price discovery. The Reserve Price should encourage aggressive participation from new entrants to increase competition. The traditional auction theory is based on the premise that the RP is used for two reasons: (i) to ensure the minimum amount that the owner of an item would get form the bid (ii) avoidance of collusion. The RP prevents the auction bid to be won at a price lower than the minimum price the owner is intending to accept. It is important to note that RP set lower than the expected value of the object will enable price discovery and the final bid price is likely to be

higher than the RP depending on other factors such as supply and demand situation, amount of availability of that item in future etc. On the other hand a high reserve price for spectrum is likely to reduce spectrum demand and it also reduces the opportunities for price discovery. Some of the objectives for the Auction and use of RP are as under:

a. Obtain a market determined price of Spectrum of various spectrum bands through a transparent process;
b. Ensure efficient use of spectrum and avoid hoarding;
c. Stimulate competition in the sector;
d. Promote rollout of the respective services;
e. Avoidance of Collusion;
f. Maximise revenue proceeds from the Auctions within the set parameters.

3.38 Further, the concepts of auction efficiency, revenue maximization and RP, along with international practices and detailed analysis about the ratio adopted between the reserve price for the auction has been discussed in detail (Chapter IV) in the Consultation Paper on "Valuation and Reserve Price of Spectrum" dated 23rd July 2013.

3.39 It is pertinent to mention here that in the NIA of January 2015, Government modified the RP recommended by the Authority for 1800 MHz and 800 MHz spectrum bands for Metro/ Category 'A' LSAs and have set these equal to 100% instead of 80% of the average valuation of respective spectrum band.

3.40 Since as a general principle the Authority has been consistently recommending from September 2013 onwards that the RP should be fixed at 80% of the average valuation of the spectrum band, the following questions arise in this regard for consultation:

Issues for Consultation

Q.18 Is it appropriate to recommend Reserve price as 80% of the value? If not, then what should be the ratio adopted between the reserve price for the auction and the valuation of the spectrum in different spectrum bands and why?

Q.19 Whether the realized / auction determined prices achieved in the October 2016 auction for various spectrum bands can be taken as the reserve price in respective spectrum bands for the forthcoming auction? If yes, would it be appropriate to index it for the time gap since the auction held in October 2016? If yes, then at which rate the indexation should be done?

CHAPTER-IV: ISSUES FOR CONSULTATION

Q.1 (a) In your opinion when should the next access spectrum auction be held?

(b) If the spectrum auction is held now, should the entire spectrum be put to auction or should it be done in phased manner i.e. auction for some of the bands be held now and for other bands later based on development of eco system etc?

Please give your response band wise and justify it.

Q.2 Do you agree that in the upcoming auction, block sizes and minimum quantity for bidding in 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz and 2500 MHz bands, be kept same as in the last auction? If not, what should be the band-wise block sizes? Please justify your response.

Q.3 What should be optimal block sizes and minimum quantity for bidding in (a) 3300-3400 MHz and (b) 3400-3600 MHz bands, keeping in mind both the possibilities i.e. frequency arrangement could be FDD or TDD? Please justify your response.

Q.4 Do you think that the roll-out conditions for 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz and 2500 MHz stipulated in the last auctions held in October 2016 are appropriate? If no, what changes should be made in the roll out obligations for these bands?

Q.5 Should there be any rollout obligations in 3300-3400 MHz and 3400-3600 MHz bands? If yes, what should these be? Please justify your response.

Q.6 Is there a need to prescribe spectrum cap in bands 3300-3400 MHz and 3400-3600 MHz? What spectrum cap provisions should be kept for 3300-3400 MHz and 3400-3600 MHz spectrum bands? Should these bands be treated as same or separate bands for the purpose of calculation of spectrum cap?

Q.7 Whether the prices revealed of various spectrum bands in the October 2016 auction can be taken as the value of spectrum in the respective band for the forthcoming auction in the individual LSA? If yes, would it be appropriate to index it for the time gap since the auction held in October 2016. If indexation is to be done then at what rate?

Q.8 If the answer to above question is negative then, whether as per the practice adopted by TRAI in the previous valuation exercise,

the valuation for respective spectrum bands be estimated on the basis of various valuation approaches/methodologies (Referred in Annexure 3.3) including those bands (in a LSA) for which no bids were received or spectrum was not offered for auction?

Q.9 Whether the value of 700 MHz spectrum should be derived by relating it to value of other bands by using technical efficiency factor? If yes, with which spectrum band this band be related and what efficiency factor or formula should be used? Please justify your views with supporting documents.

Q.10 Else, what valuation approach should be adopted for the valuation of 700 MHz spectrum band? Please support your valuation approach with detailed methodology and related assumptions.

Q.11 Whether the value of October 2016 auction determined prices be used as one possible valuation for 2300 MHz spectrum for the current valuation exercise? If yes, would it be appropriate to index it for the time gap since the auction held in October 2016? Please justify your response with supporting documents/ report(s), if any.

Q.12 Whether the value of the 2300 MHz spectrum should be derived by relating it to the value of any other spectrum band by using technical efficiency factor? If yes, which band and what rate of efficiency factor should be used? If no, then which alternative method should be used for its valuation? Please justify your response with rationale and supporting documents.

Q.13 Whether the valuation of the 2500 MHz spectrum should be equal to value of similarly placed spectrum band? If no, then which alternative method should be used for its valuation? Please justify your response with rationale and supporting documents /report(s)/ detailed methodology, if any.

Q.14 Whether the valuation of the 3300-3400 MHz spectrum bands and 3400-3600 MHz spectrum bands should be derived from value of any other spectrum band by using technical efficiency factor? If yes, what rate of efficiency factor should be used? If no, then which alternative method should be used for its valuation? Please justify your response with rationale and supporting documents.

Q.15 Is there any other valuation approach than discussed above or any international auction experience/ approach that could be used for arriving at the valuation of spectrum for 700/800/900/1800/2100/2300/2500/3300-3400/3400-3600

MHz bands? Please support your suggestions with detailed methodology and related assumptions.

Q.16 Whether value arrived at by using any single valuation approach for particular spectrum band should be taken as the appropriate value of that band? If yes, please suggest which single approach/ method should be used. Please justify your response.

Q.17 In case your response to Q16 is negative, will it be appropriate to take the average valuation (simple mean) of the valuations obtained through the different approaches attempted for valuation of a particular spectrum band, as adopted by the Authority since September 2013 recommendations? Please justify your response.

Q.18 Is it appropriate to recommend Reserve price as 80% of the value? If not, then what should be the ratio adopted between the reserve price for the auction and the valuation of the spectrum in different spectrum bands and why?

Q.19 Whether the realized / auction determined prices achieved in the October 2016 auction for various spectrum bands can be taken as the reserve price in respective spectrum bands for the forthcoming auction? If yes, would it be appropriate to index it it for the time gap since the auction held in October 2016? If yes, then at which rate the indexation should be done?

ANNEXURES

Annexure 1.1

Reference received from the Department of Telecommunications

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

No. L-14006/01/2017-NTG

To,

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

Subject: TRAI Recommendations on the Reserve Price for auction of right to use spectrum in 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz, 2500 MHz, 3300-3400 MHz and 3400-3600 MHz bands.

Sir,

Government of India is planning to auction of right to use aforesaid bands in the next auction likely to be held this year (2017). The status of availability of spectrum in these bands is as under:-

2. **700 MHz Band:**

2.1 TRAI had made its first recommendation on the reserve price and other related issues for 700 MHz band (along with other bands) in April 2012. Thereafter, band plan for 700 MHz was recommended by TRAI in March 2013.

2.2 DOT made another reference to TRAI to give fresh recommendations on the reserve price and other related issues for 700 MHz band considering the development took place Since April 2012. TRAI gave its recommendations on the reserve price and other related issues for 700 MHz band (along with other bands) on 27th January 2016.

2.3 TRAI in its recommendation has suggested that the reserve price of 700 MHz should be 4 times of 1800 MHz. It was observed by DOT that the TRAI recommended Reserve Price of 700 MHz band is lower than that recommended for 900 MHz for UP (E), UP (W) and Bihar service areas. Similarly, the recommended Reserve Price of 700 MHz band for MP is lower than that recommended for Reserve Price of 800 MHz band.

2.3.1. DOT made a back reference vide letter dated 1st April 2016 and pointed out above observation and mentioned that valuation based only on technical efficiency with other bands will not be correct approach. As it denotes all other factors i.e. development stage of ecosystem, market preference towards any particular band,

timing of auction, etc., technical efficiency based evaluation can be one of the possible valuation but not the only one. The market revealed value and the trends it a better indicator of value placed to the spectrum. TRAI has also not indicated whether the various factors as indicated by it or valuation has been taken into consideration while arriving the reserve in 700 MHz band as 4 times of 1800 MHz band.

2.3.2. It was also pointed out that as far as propagation characteristics are concerned, it is more near to 800/900 MHz and the LTE (FDD) is available only in 42 countries.

2.3.3. TRAI vide aforesaid reference, was also requested to reconsider whether all available spectrum in 700 MHz band be put to auction or the spectrum of 35+35 MHz be split in two phases i.e. 20 + 20 MHz in first phase and 15+15 MHz in second phase also.

2.4 In response, TRAI observed that in the case of 700 MHz band which is being auctioned for the first time, the Authority did not have any historical data – financial as well as non-financial relating to this band. There is no denying the fact that technical propagation characteristic wise 700 MHz is nearer to 800/900 MHz band than 1800 MHz band. Moreover, it is also a fact that as per international trends 700 MHz band will be primarily used for LTE technology and presently 1800 MHz is the most deployed band for LTE technology. Therefore, the Authority has decided to benchmark the reserve price of 700 MHz with reference to 1800 MHz band and not 800/900 MHz band. In view of the above and keeping in view its recommendations of April 2012, the Authority has recommended the reserve price of 700 MHz as four times the 1800 MHz band. As it has not benchmarked reserve price of 700 MHz band with reference to either 800 or 900 MHz, therefore the contention of DOT that in some LSAs the recommended reserve price is lower than the reserve price of either 800 or 900 MHz band is not relevant. TRAI also reiterated its earlier recommendations that entire available spectrum (2*35 MHz) in the 700 MHz band should be put to auction in the upcoming auction.

2.5 GOI had accepted the above recommendation and the entire available spectrum (2*35 MHz) in the 700 MHz was put to auction in 2016 Auction at the proposed Reserve Price of respective LSAs. However, the entire spectrum was unsold in 2016 Auction. Thus, it indicates that the reserve price was not accepted by the market.

In view of above development, TRAI may consider and give fresh recommendation on the reserve price, quantum of spectrum to be auctioned and other related issues for 700 MHz band. The details of available spectrum in various LSAs are enclosed as Annexure-I.

3. 800 MHz Band:

3.1 A total quantum of 73.75 MHz spectrum was put to auction in 800 MHz band in the block size of 1.25 MHz in 19 LSAs in October 2016 auction. Out of 73.75 MHz spectrum, 15.0 MHz spectrum was sold in 4 LSAs only and the remaining 58.75 MHz

of spectrum was unsold in 19 LSAs. Out of these 4 LSAs where bids were received, only in 3 LSAs bids was higher than the Reserve Price. The details are given as below:

S. No.	Detail	Quantum of spectrum & No. of LSAs	Name of LSAs
1.	Spectrum put to Auction	73.75 MHz in 19 LSAs	All the LSAs except Assam, J&K and NE
2.	Spectrum sold	15.0 MHz in 4 LSAs	Gujarat, Punjab, Rajasthan, and UP (E)
3.	SP > RP	3 LSAs	Gujarat, Punjab and Rajasthan
4.	Unsold spectrum	58.75 MHz in 19 LSAs	All the LSAs except Assam, J&K and NE

3.2 The unsold spectrum of 58.75 MHz spectrum in 19 LSAs is available for the forthcoming auction.

In view of above development, TRAI may consider and give fresh recommendation on the reserve price and other related issues for 800 MHz band. The details of available spectrum in various LSAs are enclosed as Annexure-I.

4. 900 MHz Band:

4.1 A total quantum of 9.4 MHz (FDD) spectrum was put to auction in 900 MHz band in the block size of 0.2 MHz in 4 LSAs [Bihar, Gujarat, UP(East) and UP(West)] in October 2016 auction. No bids were received in Auction 2016. Entire unsold spectrum of 9.4 MHz is available for forthcoming auction.

4.2 It may be mentioned that service license of M/s Aircel Limited in Tamil Nadu (including Chennai) service area is expiring in December 2018. M/s Aircel is holding administratively assigned spectrum in 900 MHz and 1800 MHz bands as given below:

Service area	900 MHz	1800 MHz
Tamil Nadu excluding Chennai	7.8 MHz	2.0 MHz
Chennai only	6.2 MHz	2.4 MHz

4.2.1 Spectrum to be released due to expiry would be 7.8 MHz in Tamil Nadu (Excluding Chennai) and 6.2 MHz in Chennai. Therefore, 6.2 MHz spectrum in 900 MHz band can be put to auction in Tamil Nadu (including Chennai service area). This amounts to partial spectrum in Tamil Nadu LSA including Chennai. The principle of charging partial spectrum has been prescribed in various Notice for Inviting Applications (NIAs).

4.3 It may further be mentioned that spectrum allotted in 1800 MHz band in Tamil Nadu service area has been exceeded about 4.4 MHz beyond 55 MHz allocated for

telecom services in the band. Spectrum to be released due to expiry of service license in 1800 MHz band will not be proposed to put in the forthcoming auction. This spectrum will be given to Defence.

4.4 It is proposed spectrum to be released due to expiry of service license of M/s Aircel Limited in Tamil Nadu (including Chennai) service area in 900 MHz band may be included in the forthcoming auction.

4.5 The availability in 900 MHz band after taking into account would be increased to 15.6 MHz as per detail given below:

S. No.	Service Area	Available Spectrum
1.	Bihar	4.6 MHz
2.	Gujarat	3.0 MHz
3.	Tamil Nadu	6.2 MHz
4.	UP(East)	0.6 MHz
5.	UP(West)	1.2 MHz

In view of above development, TRAI may consider and give fresh recommendation on the reserve price and other related issues for 900 MHz band. The details of available spectrum in various LSAs are enclosed as Annexure-I.

5. 1800 MHz Band:

5.1 A total of 221.6 MHz (FDD) spectrum was put to auction in 1800 MHz band in the block size of 0.2 MHz in all the LSAs except Tamil Nadu. Out of which, 174.8 MHz spectrum was sold in 19 LSAs and the remaining 46.8 MHz spectrum was unsold in 13 LSAs. Out of these 19 LSAs where spectrum was sold, only in 6 LSAs bids was higher than the Reserve Price and entire spectrum was sold only in 8 LSAs. A detail is given below:

S.No.	Detail	Quantum of spectrum & No. of LSAs	Name of LSAs
1.	Spectrum put to Auction	221.6 MHz spectrum in 21 LSAs	All LSAs except Tamil Nadu
2.	Spectrum sold	174.8 MHz in 19 LSAs	All LSAs except Tamil Nadu, Odisha and Karnataka
3.	Fully Qty. Sold	8 LSAs	Haryana, Kolkata, MP, Maharashtra, Mumbai, NE, Rajasthan, UP (E) & UP (W)
4.	SP > RP	6 LSAs	Haryana, Kolkata, Mumbai, Rajasthan, UP (E) & UP (W)
5.	Unsold spectrum	46.8 MHz in 13 LSAs	AP, Assam, Bihar, Delhi, Gujarat, HP, J&K, Karnataka, Kerala, Maharashtra, Odisha, Punjab and West Bengal

5.2 Therefore, unsold spectrum of 46.8 MHz in 13 LSAs is available for the forthcoming auction.

In view of above development, TRAI may consider and give fresh recommendation on the reserve price and other related issues for 1800 MHz band. The details of available spectrum in various LSAs are enclosed as Annexure-I.

6. 2100 MHz Band:

6.1 A total of 360 MHz spectrum was put to auction in 2100 MHz band in the block size of 5.0 MHz in all the 22 LSAs in the October 2016 auction. Out of which, 85 MHz spectrum was sold in 12 LSAs and the remaining 275 MHz spectrum in 21 LSAs was unsold. In all 12 LSAs bids was received at the Reserve Price and in 1 LSA i.e. Rajasthan, entire spectrum was sold. A detail is given below:

S.No.	Detail	Quantum of spectrum & No. of LSAs	Name of LSAs
1.	Spectrum put to Auction	360.0 MHz in 22 LSAs	All the 22 LSAs
2.	Spectrum sold	85.0 MHz in 12 LSAs	Bihar, Delhi, Haryana, J&K, Kerala, Maharashtra, Mumbai, Odisha, Punjab, Rajasthan, TN, & UP (E).
3.	Fully Qty. Sold	1 LSA	Rajasthan
4.	SP > RP	0	
5.	Unsold spectrum	275 MHz in 13 LSAs	All the LSAs except Rajasthan

6.2 Therefore, unsold spectrum of 275 MHz in 21 LSAs is available for the forthcoming auction.

In view of above development, TRAI may consider and give fresh recommendation on the reserve price and other related issues for 2100 MHz band. The details of available spectrum in various LSAs are enclosed as Annexure-I.

7. 2300 MHz Band:

7.1 A total of 320 MHz spectrum in 2300 MHz band in the block size of 10 MHz in 16 LSAs was put to auction. Entire spectrum was sold. Therefore, no unsold spectrum is available in this band for forthcoming auction.

7.2 It may be mentioned that 2300 MHz band is spread from 2300 MHz to 2400 MHz making a total of 100 MHz spectrum. Out of this 100 MHz spectrum, 40 MHz spectrum each in all the 22 LSAs was sold in the spectrum auction held in May 2010.

Another 20 MHz spectrum each was put to auction in 16 LSAs in October 2016 auction and entire spectrum was sold.

7.3 There are several point to point links, assigned to PSUs and State Electricity Boards long back, are working in the remaining 40 MHz spectrum in this band. Out of this 40 MHz spectrum in the band, 20 MHz spectrum Pan India is to be given to Defence and the remaining 20 MHz spectrum in 16 LSAs and 40 MHz spectrum in 6 LSAs could be made available for telecom services subject to relocation of existing users to some other band. At present, no vacant spectrum is available.

In view of above development, TRAI may consider and give fresh recommendation on the reserve price and other related issues for 2300 MHz band. The details of available spectrum in various LSAs are enclosed as Annexure-I.

8. 2500 MHz Band:

8.1 A total of 600 MHz spectrum was put to auction in 2500 MHz band in the block size of 10.0 MHz in all the 22 LSAs in the October 2016 auction. Out of which, 370 MHz spectrum was sold in 20 LSAs and the remaining 230 MHz spectrum in 12 LSAs was unsold. Out of these 20 LSAs where spectrum was sold, only 1 LSA i.e Kerala, bid price was higher than the Reserve Price. Moreover, entire spectrum, put to auction, was sold 10 LSAs. A detail is given below:

S.No.	Detail	Quantum of spectrum & No. of LSAs	Name of LSAs
1.	Spectrum put to Auction	600.0 MHz in 22 LSAs	All the 22 LSAs
2.	Spectrum sold	370.0 MHz in 20 LSAs	All the LSAs except Karnataka and Tamil Nadu
3.	Fully Qty. Sold	10 LSAs	Assam, Haryana, Kerala, MP, NE, Odisha, Rajasthan, UP (E), UP (W) & WB
4.	SP > RP	1 LSA	Kerala
5.	Unsold spectrum	230 MHz in 12 LSAs	AP, Bihar, Delhi, Gujarat, HP, J&K, Karnataka, Kerala, Kolkata, Maharashtra, MP and Punjab

8.3 Therefore, unsold spectrum of 230 MHz in 12 LSAs is available for the forthcoming auction.

In view of above development, TRAI may consider and give fresh recommendation on the reserve price and other related issues for 2500 MHz band. The details of available spectrum in various LSAs are enclosed as Annexure-I.

10. New Bands for auction:

10.1 The spectrum bands 3300-3400 MHz and 3400-3600 MHz are proposed for providing access services. The details of availability and other related issues in these two bands are as under:

10.2 3300-3400 MHz Band:

10.2.1 Allotment of spectrum in this band has been given to various Internet Service Providers (ISPs) up to 2012 in various districts of a service area. Their assignments are being renewed on annual basis.

10.2.2 It may be mentioned that some of the ISPs, assigned spectrum in this band (3300-3400 MHz), have also been assigned spectrum for internet services in some other bands (e.g. 2.7-2.9 GHz, 5.7 GHz and 10.0 GHz). Details of the assignments are placed in the file. The entire band can be made available for telecom services subject to relocation/ shifting of existing operations of the ISPs in 3300-3400 MHz to other bands. A case for harmonisation/ vacation of this band is being initiated and it is expected that entire band will be made available for telecom services by the end of this year.

10.2.3 Therefore, it is proposed to include 100 MHz in all the 22 LSAs in 3300-3400 MHz band in the forthcoming auction.

10.2.4 Recommendation of the TRAI for Policy for the rates of SUC (Spectrum Usage Charges), percentage AGR etc. applicable to the ISPs is already sought vide letter No. P-11014/032012- PP (pt) dated 25-06-2014 and last input provided vide letter of even no. dated 02-03-2016. TRAI is requested to provide recommendation on the issue of allotment of spectrum to ISPs, in general.

10.3 3400 – 3600 MHz:

10.3.1 The entire band is of 200 MHz. Out of this 200 MHz available spectrum, 25 MHz spectrum (i.e. 3400 -3425 MHz) is identified for ISRO's use in Indian Regional Navigation Satellite System (IRNSS). The remaining 175 MHz (3425-3600 MHz) spectrum is available for access services and the same can be put in the forthcoming auction.

10.4 It may be mentioned that as per National Frequency Allocation Plan 2011, these two frequency bands have already been identified for IMT services. Provisions in NFAP are as under:

> *IND65: Requirements of Broadband Wireless Access (BWA) applications may be considered in the frequency band 3.3 – 3.4 GHz on a case-by-case basis.*
>
> *IND66: The requirement of IMT including Broadband Wireless Access (BWA) in the frequency band 3400-3600 MHz may be considered for coordination on a case-by-case*

basis subject to availability of spectrum in this band and appropriate protection from out of band emission to the networks in the FSS in the frequency band 3600- 4200 MHz.

10.5 As per Recommendations ITU-R M.1036-5, the following two plans have been proposed for 3400-3600 MHz band.

(i) Time Division Duplex (TDD): 3400 – 3600 MHz (200 MHz)
(ii) Frequency Division Duplex (FDD): 3410-3490/3510-3590 MHz (80+80 MHz)

10.5.1 As per the final acts of World Radiocommunications Conference (WRC) 2015 that the frequency band 3300-3400 MHz is identified for the implementation of International Mobile Telecommunications (IMT) in accordance with Resolution 223 (Rev. WRC-15). WRC 2015 was held during November 2015. No ITU recommended band plan is yet available for 3300-3400 MHz band.

In view of above development, TRAI may consider and give recommendation on the reserve price quantum of spectrum to be put to auction, block size, band plan and other related issues for 3300-3400 MHz and 3400-3600 MHz bands.

11. The consolidated list of License Service Area wise availability of spectrum in various bands is at Annexure-I.

12. TRAI is, therefore, requested to:

(a) Provide recommendations on applicable reserve price, quantum of spectrum to be auctioned and associated conditions for auction of spectrum in 700 MHz, 800 MHz, 900 MHz, 2100 MHz, 2300 MHz, 2500 MHz, 3300-3400 MHz and 3400-3600 MHz bands for all the LSAs under the terms of clause 11 (1)(a) of TRAI Act, 1997 as amended by TRAI Amendment Act 2000.

(b) Any other recommendations deemed fit for the purpose of forthcoming spectrum auction in 2017.

This issues with the approval of the competent authority.

Christopher
19/4/17

(V. J. Christopher)
Sr. Deputy Wireless Adviser to the Govt. of India

Available spectrum in various bands

S. No.	Name of LSA	FDD Bands					TDD Bands		No Band Plan	
		700 MHz	800 MHz	900 MHz	1800 MHz	2100 MHz	2300 MHz	2500 MHz	3300 MHz*	3400 MHz**
1	Andhra Pradesh	35.00	7.50		2.00	20.00		30.00	100.00	175.00
2	Assam	35.00			3.00	15.00			100.00	175.00
3	Bihar	35.00	2.50	4.60	0.40	10.00		10.00	100.00	175.00
4	Delhi	35.00	2.50		10.80	15.00		20.00	100.00	175.00
5	Gujarat	35.00	1.25	3.00	1.60	15.00		10.00	100.00	175.00
6	Haryana	35.00	1.25			10.00			100.00	175.00
7	Himachal Pradesh	35.00	3.75		5.80	20.00		10.00	100.00	175.00
8	Jammu & Kashmir	35.00			9.60	10.00		10.00	100.00	175.00
9	Karnataka	35.00	2.50		4.20	15.00		40.00	100.00	175.00
10	Kerala	35.00	2.50		1.40	10.00		0.00	100.00	175.00
11	Kolkata	35.00	2.50			15.00		20.00	100.00	175.00
12	Madhya Pradesh	35.00	2.50			15.00			100.00	175.00
13	Maharashtra	35.00	7.50		1.40	10.00		10.00	100.00	175.00
14	Mumbai	35.00	5.00			15.00		20.00	100.00	175.00
15	North East	35.00				15.00			100.00	175.00
16	Odisha	35.00	3.75		1.40	15.00			100.00	175.00
17	Punjab	35.00	2.50		4.40	10.00		10.00	100.00	175.00
18	Rajasthan	35.00	2.50						100.00	175.00
19	Tamil Nadu	35.00	2.50	6.20		5.00		40.00	100.00	175.00
20	Uttar Pradesh (East)	35.00	2.50	0.60		5.00			100.00	175.00
21	Uttar Pradesh (West)	35.00	2.50	1.20		15.00			100.00	175.00
22	West Bengal	35.00	1.25		0.80	15.00			100.00	175.00
	Total	**770.00**	**58.75**	**15.60**	**46.80**	**275.00**		**230.00**	**2200.00**	**3850.00**

Christopher
19/4/17

Annexure 2.1

Use of 3400-3800 MHz band in some of the countries

Australia:

2.1 Considering that the use of both the 1500 MHz and 3600 MHz bands for MBB services has progressed around the world, the Australian Communications and Media Authority (ACMA) has released a discussion paper *"Future use of the 1.5 GHz and 3.6 GHz bands"* in October 2016 that looks at the possibilities of refarming the 1427–1518 MHz band (1.5-GHz band) and 3575–3700 MHz (3.6-GHz) bands for additional spectrum for Mobile Broadband (MBB) services.

2.2 Those bands are currently used by a variety of services, including satellite and fixed-broadband services in the 3600 MHz band. In Australia, FSS usage of the 3600–4200 MHz frequency range is on a primary basis, while use of the 3400–3600 MHz frequency range is on a secondary basis.

Canada

2.3 In September 2003, the Minister of Industry initiated a competitive licensing process for spectrum licences in the 2300 MHz and 3500 MHz bands. In February 2004, the Department launched a simultaneous multiple round ascending (SMRA) auction that resulted in 392 of the 849 licences being awarded to successful bidders, for a total of $11.2 million. The remaining 457 licences were made available through a two-phase residual auction process. Phase I was initiated in August 2004, which awarded 144 licences totalling $876,000. Phase II of the auction was launched on January 10, 2005, and closed on January 27, 2005. Phase Two awarded 306 spectrum licences to 12 companies that bid a total of $56.6 million. Ten residual licences were made available through the auction process held in 2009[24].

[24] Licensing Framework for the Auction of Residual Spectrum Licences in the 2300 MHz and 3500 MHz Bands, May 1, 2009

2.4 In December 2014, Industry Canada (the Canadian radiofrequency spectrum regulator) announced plans to introduce a flexible-use band plan in the 3475–3650 MHz band that would allow both fixed broadband and MBB services to operate.[25] Canada also has arrangements for wireless broadband services in the 3650–3700 MHz frequency range.[26] The Canadian Table of Frequency Allocations[27] provides no allocation for the fixed-satellite service (FSS) in the 3400–3500 MHz frequency range. It indicates that in the 3475–3500 MHz frequency range, in certain locations, radiolocation service has priority over the mobile service and in the 3500–3650 MHz frequency range, the FSS must be located in areas, so as not to constrain the implementation of fixed wireless access and mobile systems.

Europe

2.5 EC Decision 2008/411/EC[28], as amended by EC Decision 2014/276/EU, identifies the 3400–3600 MHz and 3600–3800 MHz frequency ranges for MBB applications within Europe.

2.6 The 3400–3800 MHz band is seen as having high potential for the early launch of 5G services in Europe. In June 2016, the Radio Spectrum Group of the European Commission released a consultation on spectrum related aspects for 5G. This paper promoted the 3400–3800 MHz band as being suitable for the early introduction of 5G, potentially before 2020. Submissions to this paper were largely supportive of this proposal. Incumbent operators also re-iterated the need to share it with existing FSS.

UK

2.7 Ofcom is planning to auction 190 MHz of spectrum in the 2300 MHz and 3400 MHz bands. The first proposal was published in October

[25] Decisions Regarding Policy Changes in the 3500 MHz Band (3475–3650 MHz) and a New Licensing Process, Industry Canada, 18 December 2014, http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf10914.html.
[26] Wireless Broadband Services (3650-3700 MHz), Industry Canada, http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/h_sf09570.html.
[27] *Canadian Table of Frequency Allocations, http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf10759.html.*
[28] Available on the European Communications office (ECO) website at: www.erodocdb.dk/Docs/doc98/official/pdf/ECCDEC1106.PDF.

2015 for consultation. On 21st November 2016, OFCOM issued a consultation paper[29] which sets out sets out proposed Regulations for the award by auction of radio spectrum licences in the 2300 and 3400 MHz bands.

2.8 The frequencies to be released in this award comprise 40 MHz of spectrum within the 2300 MHz band (2350-2390 MHz) and 150 MHz of spectrum within the 3400 MHz band (at 3410-3480 MHz and 3500-3580 MHz). A further 40 MHz of spectrum in the 3400 MHz band is currently held by UK Broadband Limited (3480-3500 MHz and 3580-3600 MHz). If UK Broadband chooses to participate in the auction and to apply for a replacement licence, 190 MHz contiguous spectrum will be available for allotment in 3400 MHz band.

2.9 The 3400 MHz spectrum will be made available throughout the whole of the UK. The 3400 MHz band has been included as part of a wider 3400-3800 MHz band identified by the European advisory body, the Radio Spectrum Policy Group, as the "primary band suitable for the introduction of 5G use in Europe".

2.10 **Reserve Price:** Ofcom has set reserve prices of £10m per 10 MHz lot of the 2300 MHz band, and £1 million for a 5 MHz block in the 3400 MHz band, giving a total reserve price of £70m for the 190 MHz of spectrum to be awarded. Ofcom proposes to auction the spectrum in lots of 10 MHz for the 2300 MHz band and 5 MHz for the 3400 MHz band.

Japan

2.11 At WRC-07, Japan identified the 3400–3600 MHz band for IMT. In 2014, the Japanese regulator allocated three 40 MHz lots in the 3480–3600 MHz band for MBB services.[30] In Japanese Frequency Assignment Plan, there are no allocations for the FSS in the 3400–3456 MHz frequency range. Instead, there are primary fixed and

[29] OFCOM Consultation Paper on "Award of the 2.3 and 3.4 GHz spectrum bands: Competition issues and auction regulations" dated 21 November 2016

[30] Refer to Table 3 and Annex 10-3 of the May 2015 update to the Japanese *Frequency Assignment Plan*.

mobile service allocations, which are used for commercial telecommunications and broadcast auxiliary service applications. Primary allocations to the FSS are in the 3456–4200 MHz frequency range for the purpose of commercial telecommunications and public services.

US

2.12 The US has developed arrangements for MBB services in the 3550–3700 MHz frequency range. These arrangements define a three-tiered spectrum authorisation framework to support shared access to the 3550–3700 MHz frequency range by a variety of services, including radiolocation services, FSS and MBB services.

Annexure 2.2

Details of spectrum awarded in 3400 MHz band in some of European countries for BWA purpose

Country	**Uplink frequency range [MHz]**		**Downlink frequency range [MHz]**		**Duplex arrangement**	**Duplex separation for FDD**	**Block sizes [MHz]**
Austria	3410	3494	3510	3594	FDD, TDD	100 MHz	21, 28, 35, 42
Belgium	3450	3500	3550	3600	FDD, TDD	100 MHz	25
Bosnia & Herzegovina	3450	3494	3510	3594	FDD	100 MHz	21
Czech Republic	3410	3480	3510	3580	FDD, TDD	100 MHz	3.5
France	3432.5	3495	3532.5	3595	FDD, TDD	100 MHz	15
Germany	3410	3494	3510	3594	FDD, TDD	100 MHz	21
Hungary	3410	3494	3510	3594	FDD, TDD	100 MHz	14
Ireland	3410	3500	3510	3600	FDD, TDD	100 MHz	11, 25, 35
Italy	3425	3494	3525	3600	FDD, TDD	100 MHz	21
Macedonia	3410	3500	3510	3594	FDD, TDD	100 MHz	31.5, 14
Norway	3413.5	3500	3513.5	3600	FDD, TDD	100 MHz	3.5
Portugal	3410	3438	3510	3538	FDD, TDD	100 MHz	28
Sweden	3410	3494	3510	3594	FDD, TDD	100 MHz	28
Switzerland	3410	3497.5	3510	3597.5	FDD, TDD	100 MHz	17.5, 21, 28
United Kingdom	3480	3500	3580	3600	FDD, TDD	100 MHz	20

Annexure-3.1

Extracts from Recommendations on 'Valuation and Reserve Price' dated 9th September 2013

Factors that influence the valuation of spectrum

3.1 Spectrum is a scarce natural resource: it is finite and limited by geographical range. Unlike other natural resources which are exhaustible, electromagnetic spectrum cannot be depleted: it is renewable unlike trees in a deforested area, or coal that has been mined.

3.2 Owing to its limited availability, the need for its efficient allocation is appreciated. Pricing of spectrum is important to avert any "tragedy of the commons" problem. If every individual (spectrum user) tries to reap the greatest benefit from a finite common resource, the demand for the resource will overwhelm supply. Every individual who consumes an additional unit directly imposes a cost on others who can no longer enjoy commensurate benefits. Allocation of spectrum through auction leads to efficiency as spectrum is sold to those who value it the most.

3.3 The consumption of spectrum is both rivalrous and excludable. Though it has the potential to be reused and reallocated, its consumption or use by one service provider entails a smaller amount of spectrum available for another to employ as it is scarce; hence, it is rival. To ensure interference-free operations by service providers, spectrum has perforce to be excludable. Several restrictions prevail on the supply side due to its attributes of overall scarcity and rivalry and excludability in consumption.

3.4 The supply of spectrum is also relatively inelastic as the Government controls when spectrum licenses will expire to make it available for re-auction and when new spectrum will be released and how much. Not all spectrum bands that can be utilized is auctioned. Much spectrum is also used by the Government for non-market purposes like defence. Developing technologies that can function in new bands or function more effectively in existing bands can however alter the supply side dynamics of spectrum allocation.

3.5 The demand for spectrum as a natural resource is not a direct one like for most commodities. It is derived from the demand for final goods and services that are produced using spectrum as an input. There are many different users of spectrum supplying these final goods and services (e.g. telecom service providers (TSPs), broadcasters, aeronautical users, scientists, the military, etc.). In the case of TSPs, it is telecom consumers who, through their demand for telecommunication services,

create a demand for spectrum. The greater the demand for telecom services, the greater will be the demand for spectrum by the TSPs. The demand for spectrum is a derived demand. Valuation of spectrum is determined to a large extent by its demand which, in turn, depends on the willingness and ability to pay off a large number of spectrum users or TSPs who use it as an input in the production of telecom services.

3.6 Telecom services have evolved significantly over the last 35 years, from simple generation mobile voice telephony in the 1980s to complex 4G technology supporting voice and data transmissions. Over this period, consumers have increasingly demanded extended coverage, faster data transmission rates and more advanced, data-intensive mobile applications. In response, TSPs have deployed ubiquitous, high-capacity radio networks based on state-of-the-art technologies thereby increasing the demand for radio spectrum considerably.

3.7 In a broader sense, the demand for telecom services is influenced by variables like prevailing tele-density, GDP growth rate, unemployment rate, inflation rate, investment in infrastructure and technology, socioeconomic characteristics of different age groups of the population etc. If the prevailing tele-density is low, then there is scope for increasing service penetration. A higher GDP growth rate would invariably point to increased demand for these services; equally, high unemployment and inflation will push demand in the other direction. The usage of services can slow down if economic growth turns sluggish and the sense of personal well-being of the individual is reduced. If people feel poorer either due to a fall in income or a rise in prices, demand for telecommunications services can fall. The prospects of future growth also affect the volume of consumption of telecommunications services in an economy. Consumption levels can rise in a high growth economy as people anticipate higher future incomes. Actual economic conditions as well as potential for economic growth can have an impact on the valuation of spectrum. For example, in Bihar the tele-density is only 45.72%. This implies that more than half the population in the State does not have direct access to telecom services. But with the State witnessing a high GSDP growth rate and huge infrastructure investments, there is immense scope for increase in demand for telecom services in this region.

3.8 It is worthwhile to note that the demand for telecom services need not always get transformed into or get reflected in the demand for spectrum. Though metro cities like New Delhi and Mumbai have immense potential for enlarging the subscriber base due to the continuous inflow of population to these cities, spectrum allotted to these metro circles was left unsold in a recent auction. This is because

even though consumers create the demand for telecom services, the decision to buy spectrum and, hence, the demand for spectrum is actually made by the TSP. Though the potential market for tele-services might be large, if, say, the average revenue per user is unremunerative, the TSP will not find it profitable to increase operations in the LSA and will not demand the spectrum.

Annexure-3.2

Status of Sale of Spectrum in October 2016 Auction

LSA	700 MHz		800 MHz		900 MHz		1800 MHz		2100 MHz		2300 MHz		2500 MHz	
	% of spectrum sold of spectrum put for auction	D and S of spectrum[31]	% of spectrum sold of spectrum put for auction	D and S of spectrum	% of spectrum sold of spectrum put for auction	D and S of spectrum	% of spectrum sold of spectrum put for auction	D and S of spectrum	% of spectrum sold of spectrum put for auction	D and S of spectrum	% of spectrum sold of spectrum put for auction	D and S of spectrum	% of spectrum sold of spectrum put for auction	D and S of spectrum
Delhi	0%	No Bid	0%	No Bid	-	-	16%	D<S	25%	D<S	100%	D=S	50%	D<S
Mumbai	0%	No Bid	0%	No Bid	-	-	100%	D>S	25%	D<S	100%	D=S	50%	D<S
Kolkata	0%	No Bid	0%	No Bid	-	-	100%	D>S	0%	No Bid	100%	D=S	50%	D<S
Andhra Pradesh	0%	No Bid	0%	No Bid	-	-	55%	D<S	0%	No Bid	100%	D=S	25%	D<S
Gujarat	0%	No Bid	80%	D>S*	0%	No Bid	88%	D<S	0%	No Bid	100%	D>S	75%	D<S
Karnataka	0%	No Bid	0%	No Bid	-	-	0%	No Bid	0%	No Bid	100%	D=S	0%	No Bid
Maharasthra	0%	No Bid	0%	No Bid	-	-	90%	D<S	33%	D<S	100%	D>S	75%	D<S
Tamilnadu	0%	No Bid	0%	No Bid	-	-	-	-	67%	D<S	100%	D=S	0%	No Bid
Haryana	0%	No Bid	0%	No Bid	-	-	100%	D>S	33%	D<S	-	-	100%	D=S
Kerala	0%	No Bid	0%	No Bid	-	-	30%	D<S	33%	D<S	100%	D>S	100%	D=S
Madhya Pradesh	0%	No Bid	0%	No Bid	-	-	100%	D=S	0%	No Bid	100%	D=S	100%	D=S
Punjab	0%	No Bid	60%	D>S*	-	-	71%	D<S	33%	D<S	-	-	50%	D<S
Rajasthan	0%	No Bid	67%	D>S*	-	-	100%	D>S	100%	D=S	-	-	100%	D=S
U. P. (East)	0%	No Bid	33%	D<S	0%	No Bid	100%	D>S	67%	D<S	-	-	100%	D=S
U.P. (West)	0%	No Bid	0%	No Bid	0%	No Bid	100%	D>S	0%	No Bid	-	-	100%	D=S

[31] D (Demand)> S (Supply) indicates that the auction determined price was higher than the reserve price in these LSAs. D = S and D < S indicate LSAs where the auction determined price did not exceed the reserve price.

* Indicates LSAs where the quantity left unsold was below the minimum quantity to bid. Therefore these LSAs have been treated at par with those all LSAs where demand > supply.

^ Blank cell represent LSAs where no spectrum was put on auction

West Bengal	0%	No Bid	0%	No Bid	-	-	96%	D<S	0%	No Bid	100%	D=S	100%	D=S
Assam	0%	No Bid	-	-	-	-	85%	D<S	0%	No Bid	100%	D=S	100%	D=S
Bihar	0%	No Bid	0%	No Bid	0%	No Bid	97%	D<S	50%	D<S	100%	D=S	50%	D<S
Himachal Pradesh	0%	No Bid	0%	No Bid	-	-	49%	D<S	0%	No Bid	100%	D=S	50%	D<S
J&K	0%	No Bid	-	-	-	-	70%	D<S	33%	D<S	-	-	50%	D<S
North East	0%	No Bid	-	-	-	-	100%	D=S	0%	No Bid	100%	D=S	100%	D=S
Orissa	0%	No Bid	0%	No Bid	-	-	0%	No Bid	25%	D<S	100%	D=S	100%	D=S
	22 LSAs where spectrum was put on auction but no bid received		4 LSAs out of 19 LSAs where bid received		4 LSAs where spectrum was put on auction but no bid received		8 LSAs out of 21 LSAs where bid received		1 LSAs out of 22 LSAs where bid received		16 LSAs where spectrum was put on auction bid received for all 16 LSAs		10 LSAs out of 22 LSAs where bid received	

Annexure 3.3

Methodologies and Approaches previously used for Spectrum Valuation

Spectrum Band	Valuation Approach/ Methodology	Date and Para Number of Recommendation on Valuation and Reserve Price of Spectrum
1800 MHz	Producer Surplus Model	Annexure 4.2 of September 2013 Recommendations
	Production Function Approach	Annexure 4.3 of September 2013 Recommendations Para 3.32 of October 2014 Recommendations Para 3.32 of January 2016 Recommendations
	Revenue Surplus Model	Annexure 3.3 of October 2014 Recommendations Para 3.36 of January 2016 Recommendations
	Use of Last auction determined price	Para 3.64 and Annexure 4.4 of September 2013 Recommendations Para 3.26 of January 2016 Recommendations
	Market Data Analysis: Single variable correlation or multiple regression	Para 4.2 to 4.10 and Annexure 4.1 of September 2013 Recommendations
800 MHz	Producer Surplus Model	Annexure 3.2 of February 2014 Recommendations Annexure A of Authority's response of 27 November 2014 to reference received from DoT on February 2014 Recommendations
	Technical Efficiency Approach	Para 3.1 to 3.4 of December 2013 Consultation Paper
	Potential Growth in Data Services	Annexure 3.3 of February 2014 Recommendations Annexure A of Authority's response of 27 November 2014 to reference received from DoT on February 2014 Recommendations
	Use of Auction Determined	Para 3.68 of February 2014

Spectrum Band	Valuation Approach/ Methodology	Date and Para Number of Recommendation on Valuation and Reserve Price of Spectrum
	Prices of 900 MHz in valuation of 800 MHz band	Recommendations Para 3.42 of January 2016 Recommendations
	Market Data Analysis: Single variable correlation or multiple regression	Annexure 4.1 of September 2013 Recommendations Para 3.16 of January 2016 Recommendations
900 MHz	Technical Efficiency Approach	Para 4.45 to 4.47 of September 2013 Recommendations
	Economic Efficiency Approach	Annexure 4.5 of September 2013 Recommendations Annexure 3.5 of October 2014 Recommendations
	Use of Auction Determined Prices of 800 MHz in valuation of 900 MHz band	Para 3.42 of January 2016 Recommendations
	Market Data Analysis: Single variable correlation or multiple regression	Annexure 4.1 of September 2013 Recommendations Para 3.16 of January 2016 Recommendations
2100 MHz	Technical Efficiency Approach	Para 3.8 to 3.10 of December 2014 Recommendations Para 3.6 and 3.7 of December 2014 Consultation Paper
	Data Usage Growth Model	Para 3.20 - 3.21 December 2014 Consultation Paper Annexure 3.4 of December 2014 Recommendations Para 3.49 of January 2016 Recommendations
	Producer Surplus Model	Annexure 3.3 of December 2014 Recommendations
	Use of Last auction determined	Para 3.5 - 3.7 of December 2014

Spectrum Band	Valuation Approach/ Methodology	Date and Para Number of Recommendation on Valuation and Reserve Price of Spectrum
	price	Recommendations Para 3.26 - 3.27 of January 2016 Recommendations
700 MHz	Use of Reserve Price of 1800 in valuation of 700 MHz band	Para 3.75 of January 2016 Recommendations
2300 MHz	Indexation of last available auction prices	Para 3.80 to 3.81 of January 2016 Recommendations
2500 MHz	Equal to recommended Reserve Price of 2300 MHz	Para 3.85 of January 2016 Recommendations

Note: The data and information used as inputs in above mentioned valuation approaches/models will be updated with available latest data and information.