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RADIO FREQUENCIES SPECTRUM AUCTION OF 2015 AND ITS IMPACT ON INDIAN MOBILE SERVICE PROVIDERS

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ABSTRACT

Government of India auctioned the rights to use certain specific radio spectrum frequencies in various service areas in first half of 2015. These radio frequencies are in the 2100 MHz, 1800 MHz, 900 MHz and 800 MHz bands.This auction was remarkable in term of revenue and to rollout new services. The Auction was a Simultaneous Multiple Rounds Ascending (SMRA) e-auction, conducted over the Internet. This auction was very important to existing service providers to renew their, to be expiring licenses and to new operators who are planning to launch new services. This paper covers details of radio frequencies which were on offer in this auction, post auction radio frequencies allocation, major service providers‟ holding in service areas and service providers‟ plan. This paper explains the possible future of LTE services in India with current radio spectrum. *Keywords: Spectrum Auction, DoT, RJIL, LTE, VoLTE*

INTRODUCTION

India's telecommunication network is the second largest in the world based on the total number of telephone users. Telecom Regulatory Authority of India is tariffs deciding and policy making authority. Department of Telecommunication (DoT) on behalf of Government of India auctions license to use radio spectrum frequencies in telecom service areas in India. 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, and 2300
MHz are main radio frequencies band for wireless telecommunication services in India.

A. Indian Telecom Circles

India has been logically divided into 22 telecom circles which are also known as service areas. Theses service areas have been categorised in four categories. This categorisation is based upon teledensity and revenue potential.

- Metros
- A Category
- B Category
- C Category

India has 971 million telecom subscribers and teledensity of 77.58. Urban subscribers are 51% of total subscribers. Private operators‟ market share is
~90%. Wireless subscribers are 944 million and Wire- line subscribers are 27 million. India is mainly GSM driven market; there are 890.43 million GSM subscriber and rest are CDMA based wireless subscribers. Urban teledensity is 148 and rural teledensity is 46. Monthly average revenue per user (ARPU) for access services is 119 INR.

Figure 1. Indian Telecom Circles

	Category	Number	Teledensity	Revenue Potential
	Metros	3 Metros	Very High	Very High
	A-Category	5 States/Regions	High	High
	B-Category	8 States/ Regions	Medium to High	Medium to High
	C-Category	6 States / Regions	Low	Low

Figure 2. Indian Telecom Circles Categorization

B. Indian Telecom Licenses

Department of Telecommunication, Government of India has defined our types of license. i.e.

- Data Service
- Carrier Service
- Access Service
- Unified Access Service
- CMTS
- Unified License

Data Service License

This license requires to provide Internet services. Videsh Sanchar Nigam Limited (VSNL) started Internet services in India since 15th Aug 1995.

Carrier Service License

PMRTS, Satellite Phone, Audio Taxi, Voice Mail, Long Distance call, Radio Paging, Maritime Satellite, Private Lease Circuit, Captive mobile radio trunk etc. service are coming under this license.

Access Service License

- Unified Access Services

Unified Access Services operators are free to provide, within their area of operation, services which cover collection, carriage, transmission and delivery of voice and/or non-voice messages over Licensee's network by deploying circuit and/or packet switched equipment. This Licensee an also provide voice mail, audiotex services, video conferencing, videotex, e-mail , closed user group as value added services over its network to the subscribers falling within its service area on non-discriminatory basis.

- Cellular Mobile Telephone Service

Cellular operators are free to provide, within their area of operation, all types of mobile services including voice and non-voice messages, data services and public call offices utilizing any type of network equipment, including circuit and/or package switches that meet the relevant standards.

A unified access services licensee can provide wireline as well as wireless services in a service area. Wireless services include full mobile, limited mobile and fixed wireless services. Basic and cellular services licensees are permitted to migrate to unified access services licence regime.

Unified License

Telecommunication systems have been changing very fast and there are frequent technical convergences too.
Voice, data, video and other service are being served by single network. TRAI has decided to form single license to enhance affordability, increase access, delivery of multiple services and reduce cost. National telecom policy 2012 introduced unified license to maintain One Nation-One License.

C. Indian Telecom History

Indian postal & telegraph is one of the world‟s oldest. First electric telegraph line was started in 1850 between Calcutta and Diamond harbour. First wireless telegraph station was established in 1902 between Sagar Island and Sandhead. Radio telegraph system was established between UK and India in 1927. Radiotelephone was introduced in 1933. First subscriber trunk dialling route was commissioned between Lucknow and Kanpur in 1960. First optical fibre system was commission in Pune in 1979. First mobile service started in 1995. Internet introduced in India in1995.

D. Indian Telecom Timeline

1991 - The government allowed private telecom companies to manufacture telecom switches for telephone exchange

1992 - The Department of Telecommunication (DoT) invited bids for licenses for cellular service across the four metros.

Bombay: BPL Telecom and Maxtouch
Delhi: Bharati Telecom and Sterling
Calcutta: Usha Martin and Modi Telstra
Madras: Skycell RPG and Cellular

1993 - The DoT commissioned ICICI to study and prepare a report on the possibility of private participation in the telecommunication sector.

1994 - National Telecom Policy, 1994.

1995 - DoT allowed bidding for cellular licences and wireline licenses. Spectrum was bundled with the telecom service provider license. India was logically divided into 21 circles (excluding four metros). Department of Telecommunication awarded two licences in each circle one to the state operator and the other to the private operator. The potential service providers in order to be eligible for bidding for licences had to partner up with a foreign company. Total 34 licences were issued. The term of the licence was fixed at ten years which was revised to 15 years.

1998 - Internet services were rolled out in 1995 by Videsh Sanchar Nigam Limited (VSNL).

1999 - New Telecom Policy, 1999 has been introduced. New telecom policy allowed the migration of the licensees from a fixed licence fee regime to a revenue arrangement scheme. Policy allowed the government as the third operator in the circle.

2000 - The government issued licence for national long distance telephony. There are 32 companies other than BSNL, the incumbent, which have been granted licences for national long distance services.

2001 - Licences for basic telephone services using wireless in local loop (WLL) have been introduced. This was the first time that the first-come-first-serve scheme was implemented for issuing licences. A bid for cellular licence for a fourth operator was introduced.

2002 - Department of Telecommunication issued licence to private operators for international long distance telephony (ILD) services. The licence was valid for a term of 30 years.

2003 - Calling party pays (CPP) has been introduced. Under CPP, no charges can be levied on receiving a call in the home circle. Unified access service licensing (UASL) regime was introduced by DoT.

2007 - Department of Telecommunication allowed issuing of licences for operating on dual technologies that is CDMA and GSM. DoT also allowed single licence to Internet Service Providers (ISP) but restriction was put in VoIP.

2011 - The government introduced mobile number portability (MNP).

2012 - National Telecom Policy, 2012 introduced Unified Licensing Regime. Under the regime, service operators can provide converged services. The spectrum has been delinked from the licence.

SPECTRUM AUCTION 2015

A. Indian Telecom Spectrum Auction Timeline

1991 ~ 2000 – There was first license auction in 1991. It was for 2 service providers each in 4 metros. Each service provider has been allocated 4.5 MHz bandwidth in 900 MHz band. 8 CMTS license were provided for 4 metro cities to 8 private companies in 1994. Service has been started since 1995. There were 34 licenses for 18 telecom service areas allocated to 14 private companies during 1995 to 1998. There were maximum two licenses for CMTS in each service areas. These licensees were to pay fixed amount of license fees annually based on the agreed amount during the bidding process. Subsequently, they were permitted to migrate to New Telecom Policy (NTP) 1999 regime wherein they are required to pay license fee based on revenue share, which was effective from 1st August, 1999.

2001 – There was bid for fourth operator in each circle on first come first serve basis. License for basic telephone services using wireless in local loop (WLL) also introduced.

2008 – This year is known for telecom scam/ 2G scam. Many service providers got license on 2001 scheme and at 2001 price. Supreme Court of India cancelled many licenses which were given under this auction.

2010 – This auction was to rollout 3G service and Wireless broadband (BWA). 2100 MHz and 2300 MHz band frequencies were on auction. There was 5MHz bandwidth in 2100 MHz band was on auction because it was a new service i.e. 3G rollout. Other than BSNL/MTNL 3 ~ 4 service providers got license in

each service area. Tata Teleservices became first service provider provided 3G services in India. 2100 MHz band cost at this auction was USD 0.32 /MHz/Population. There was 20MHz bandwidth in 2300 MHz band for auction. It was for Wireless broadband service rollout. 2300 MHz band cost at this auction was USD 0.06 /MHz/Population. Infotel got BWA license in all 22 circles. Result was declared on 12th June 2010. RIL has acquired Infotel on 11th June 2010. Service roll-out duration was 5 years since allocation i.e. June 2015.

2012 – This auction was for 1800 MHz & 800 MHz bands for GSM & CDMA services respectively. The Supreme Court of India has cancelled allocation for many service providers in Feb-2012. Service providers who earlier got license in 1991 supposed to renew their licenses to continue service. 102 out of 140 spectrum blocks went under auction bid. There was no bid for 800 MHz band.

2013 – This auction was for 900 MHz, 1800 MHz and 800 MHz band. This auction was held in Jan-2013 to promote competitiveness in CDMA i.e. 800 MHz band. There was no bid for 900 MHz and 1800 MHz bands. SSTL alone bid for 800 MHz band.

2014 – This auction was held in Feb-2014 and meant for 900 MHz & 1800 MHz bands. Auction unit were 1MHz paired for 900 MHz band and 200 KHz paired for 1800 MHz band. Bharti Airtel & Vodafone were providing GSM services on 900 MHz band since 20 years (1994 auction) and their licenses about to expire. They supposed to renew their licenses to continue service. RJIL won license for 14 circles for 1800 MHz band.

2015 – Department of Telecommunication auctioned license to use radio frequencies for 20 years in 800 MHz, 900 MHz, 1800 MHz, 2100 MHz bands this year. Auction unit were 1.25 MHz paired for 800 MHz band, 200 KHz paired for 900 MHz band, 200 KHz paired for 1800 MHz band, and 5 MHz paired for 2100 MHz band. The reasons for this auction were chance to renew license whose license expire 2015-16, competitiveness and new entrants. New entrant needed to bid min 5MHz bandwidth in 800 MHz, 900 MHz and 1800 MHz bands. Licensee whose license expires in 2015-16 needed to bid min 5MHz bandwidth. Existing 900 MHz band spectrum holder, whose license is not expiring in 2015-16 needed to bid min 0.6 MHz.

Band	Block Unit	Spectrum	Reason
800 MHz	1.25 MHz (paired)	5 MHz	TDD LTE
900 MHz	200 KHz (paired)	4.4 to 15.6 MHz	Expiry of existing license
1800 MHz	200 KHz (paired)	1 to 19 MHz	Expiry of existing license Unsold spectrum from last auction
2100 MHz	5 MHz (paired)	1.25 to 11.25 MHz	5th Block in 17 circles

Figure 3. Spectrum Auction 2015

Circle	1800 MHz	900 MHz	800 MHz	2100 MHz
AP	3.8 MHz	14 MHz	6.25 MHz	5MHz
Aasam	-----	6.2 MHz	11.25 MHz	5MHz
Bihar	2 MHz	6.2 MHz	5 MHz	-----
Delhi	-----	-----	3.75 MHz	5MHz
Gujrat	3.4 MHz	14 MHz	2.50 MHz	5MHz
Haryana	8.0 MHz	12.4 MHz	7.50 MHz	5MHz
HP	10.2 MHz	12.4 MHz	8.75 MHz	-----
J&K	-----	-----	8.75 MHz	-----
Karnataka	1.8 MHz	14 MHz	1.25 MHz	5MHz
Kerala	1.0 MHz	12.4 MHz	-----	5MHz
Kolkata	7.0 MHz	-----	1.25 MHz	5MHz
MP	-----	12.4 MHz	6.25 MHz	5MHz
MH	-----	14 MHz	3.75 MHz	5MHz
Mumbai	-----	-----	7.50 MHz	5MHz
NE	8.4 MHz	8.8 MHz	11.25 MHz	5MHz
Orissa	16.2 MHz	6.2 MHz	7.50 MHz	5MHz
Punjab	1.6 MHz	15.6 MHz	3.75 MHz	-----
Raj	10.4 MHz	12.4 MHz	-----	5MHz
TN	19 MHz	-----	1.25 MHz	5MHz
UP-East	4.2 MHz	6.2 MHz	3.75 MHz	5MHz
UP-West	2.2 MHz	6.2 MHz	1.25 MHz	5MHz
WB	-----	4.4 MHz	1.25 MHz	-----

Figure 4. Frequency Bandwidth on Auction in 2015

800 MHz band radio frequencies were prime focus because it is one of the most suitable LTE service band in India. Reliance Jio is planning to roll out Pan-India LTE services by 2015 and this band acquisition was very much required to roll out LTE services. Other service providers‟ license was expiring this year & next year so they have to acquire respective radio frequencies license to continue services. 900 MHz band in focus as it is prime spectrum and its auction gave maximum money to government in this auction.

B. Final Allocation

Spectrum auction results were announced and it was high revenue generating, competitive auction. Total bid amount was USD 17.6 billion. Tata Teleservices also bought top up spectrum in the circles where their 800MHz licences will be expiring in 2018, to secure the continuity of their operations in these circle. The newly won 800MHz spectrum by Reliance Communication ensures that it has at least 5MHz of spectrum in each of the 22 circles in this band which will enable it to expand its Pro3 Rev.B footprint and launch FD-LTE in the future. Reliance Communication became first operator to possess pan India contiguous 800MHz band spectrum. RJIL got 800MHz spectrum in 10 circles and 1800MHz spectrum in 6 circles. Idea won back 900 MHz spectrum across 9 circles.

LTE SERVICE IN INDIA

A. LTE bands in India

LTE B3, B5, B40 are for LTE services in India. Airtel is providing TD-LTE service in many cities. Aircel is providing TD-LTE service in 6 circles. Reliance Jio has LTE band #40 licenses for all 22 circles and 1800 MHz band licenses in 18 service areas and 800 MHz band licenses in 10 service areas for FD-LTE services.

Duplex Mode	LTE Band	UL	DL
FDD	LTE Band #3	1710 MHz ~ 1785 MHz	1805 MHz ~ 1880 MHz
FDD	LTE Band #5	824 MHz ~ 849 MHz	869 MHz ~ 894 MHz
TDD	LTE Band #40	2300 MHz ~ 2400 MHz	2300 MHz ~ 2400 MHz

Figure 5. LTE Bands in India

B. Reliance Jio Spectrum Holding

RJIL has LTE band #40 i.e. 2300 MHz band licenses in all 22 circles. RJIL has LTE band #3 i.e. 1800 MHz band licenses in 18 circles. RJIL has LTE band #5 i.e. 800 MHz band licenses in 10 circles.

C. Importance of 800 MHz

Lower frequency bands are comparatively better then higher frequency bands. Following three parameters explain

- Propagation Loss
- Link Performance
- Coverage

Circle	2300 MHz	1800MHz	800 MHz
AP	20MHz	5.8Mhz	--
Aasam	20MHz	5.4MHz	5MHz
Bihar	20MHz	--	5MHz
Delhi	20MHz	5.4MHz	--
Gujrat	20MHz	6MHz	--
Haryana	20MHz	4MHz	5MHz
HP	20MHz	5.4MHz	5MHz
J&K	20MHz	--	5MHz
Karnataka	20MHz	5MHz	--
Kerala	20MHz	5MHz	--
Kolkata	20MHz	10MHz	--
MP	20MHz	6.4MHz	5MHz
MH	20MHz	5MHz	--
Mumbai	20MHz	6.6MHz	5MHz
NE	20MHz	6.4MHz	5MHz
Orissa	20MHz	5MHz	5MHz
Punjab	20MHz	--	--
Raj	20MHz	10MHz	--
TN	20MHz	6.8MHz	--
UP-East	20MHz	5MHz	3.75MHz
UP-West	20MHz	--	--
WB	20MHz	5.6MHz	--

Figure 6. RJIL - Spectrum Licenses

The propagation loss of radio waves increases with the frequency. High frequency bands have a larger propagation loss.

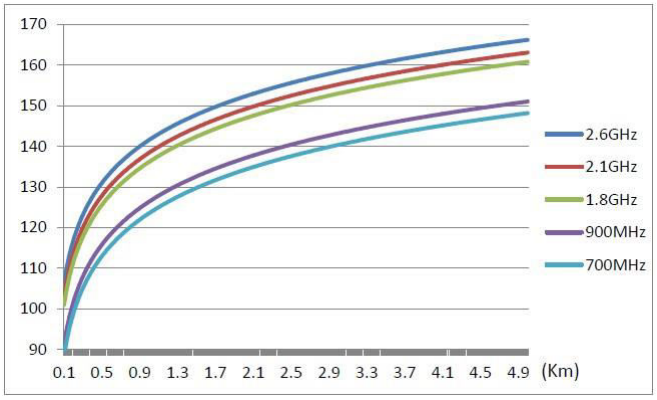

Figure 7. Propogation Loss & Propogation Distance

Link performance is usually characterized by SINR with guaranteed BLER. Frequency effects on the link performance are mainly manifested in the Doppler shift disparity with a certain moving speed and,

eventually, effects on SINR. SINR performance impact between the frequency bands is very limited.

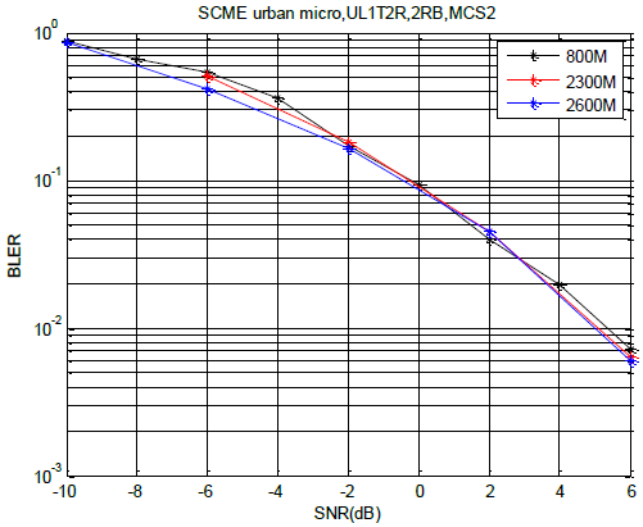

Figure 8. Link Performance Curves

Coverage area of lower frequency cell is significantly higher than coverage area of higher frequency cell. For 800 MHz band UL cell range is 1.09 km and coverage area 2.33 km^2 in urban area. While 2300 MHz band UL cell range is 0.51km and coverage area 0.50 km^2 in same urban area. This mean service provider has to install more network infrastructure to serve same coverage area if service provider is serving on higher band. More network infrastructure directly increases capital expenditure (CAPEX) and operation expenditure (OPEX).

Another issue with higher frequency band is lower in-building penetration. This mean network signal strength is not good inside building. Lower network signal strength directly affects quality of service.

D. Reliance Jio Infocomm Limited LTE Plan

RJIL has pan India licenses for band#40. LTE Band#40 for TD-LTE has indoor penetration and higher capex & opex issues. To overcome these issues RJIL may plan for FD-LTE at band #3 & #5. RJIL has 20 circles license for FD-LTE. RIL chief announced RJIL LTE service launch plan during annual general meeting. Low tariff, low cost device, high quality service have announced by RIL chief.

CONCLUSION

Government of India has received record revenue i.e. one lac ten thousand crore by this spectrum auction. This auction was a simultaneous multiple rounds ascending e-auction. There were 115 rounds on biding and transparent bid mechanism. LTE service rollout on lower frequency band made this auction higher revenue generating and competitive. 800 MHz and 900 MHz bands were in focus. 900 MHz band generate highest revenue. Service providers who got licenses for 800 MHz are planning to rollout FDD- LTE services. LTE band#3 and #5 based FDD-LTE and LTE band #40 based TD-LTE services are being roll-out by Indian service providers. Allocated frequencies are non- contiguous and in order of 5MH bandwidth so Carrier Aggregation will be one of the technical requirements to serve higher throughput. Many of service providers do not received LTE band#3, band#5 pan India so small cell & HetNet formation will also be a used during network planning.

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