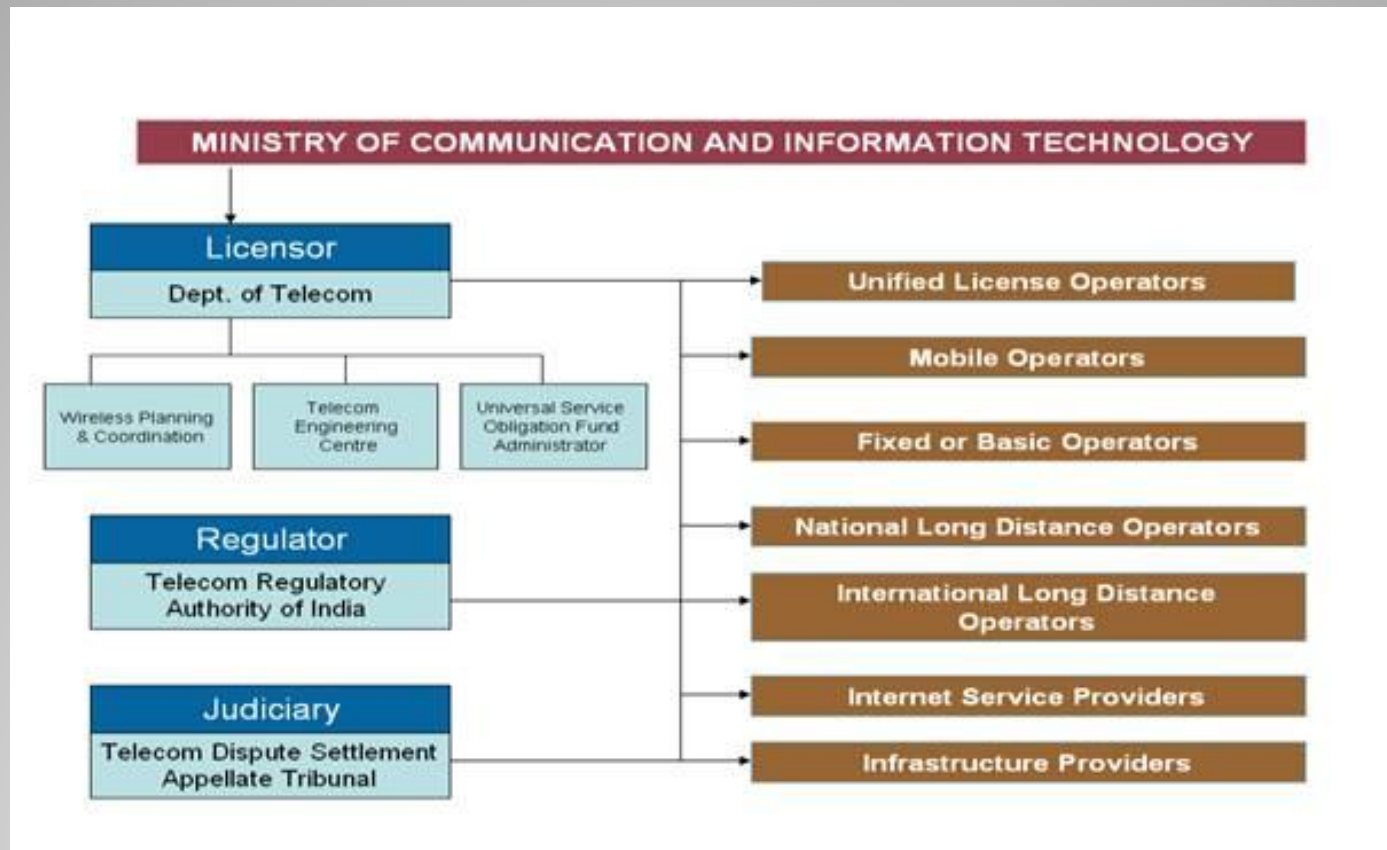# Spectrum Management and Pricing in India

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Agenda

- *Context*

- The Report on 2010 Value of Spectrum in the 1800 MHz Band, January 2011

- Conclusions

Telecommunication Industry: Institutional Framework in India

- The current cellular license (from 2001 onwards) comes bundled with spectrum of 4.4 MHz in case of GSM technology

- A contentious issue is the amount of spectrum that a licensee can be assigned beyond 4.4 MHz

- What is the criteria for assignment of additional spectrum?

- Is holding beyond 6.2 MHz illegal?

- Licensees have been awarded spectrum beyond 6.2 MHz in GSM technology based on orders of DoT from time to time

- The spectrum availability in India is far short of the requirements;

- TRAI recently recommended a cap on the maximum spectrum a licensee can hold. Limit on spectrum is practiced in UK, USA, and New Zealand

Spectrum availability and allocation in India

- The **Lalwani Committee constituted in 2003** recommended allocation of spectrum based on subscriber linked criteria (SLC).

- **Source of Problem?**

GSM Subscriber Base Criteria

Service Area	Minimum subscriber base (in Lakh) required for allotment of different amounts of GSM spectrum.					
	4.4	6.2	8	10	12.4	15
Metros (Delhi & Mumbai)	No criteria	3	6	10	16	21
Metros (Chennai & Kolkata)	No criteria	2	4	6	10	13
Category A	No criteria	4	8	14	20	26
Category B	No criteria	3	6	10	16	21
Category C	No criteria	2	4	6	9	12

Spectrum availability and allocation in India

- *Spectrum assigned beyond contracted amount will be paid for at the current price. This will be equally applicable to the service providers who are already holding the excess spectrum and those who will be assigned beyond the contracted amount in future."*

- *The limit on spectrum to be assigned to a service provider will be 2X8MHz for all service areas other than in Delhi and Mumbai where it will be 2X10MHz. Similarly for CDMA spectrum the limit on spectrum will be 2X5MHz for all service areas and 2X6.25 MHz in the Metro areas of Delhi and Mumbai.*

TRAIs Recommendations

Spectrum Requirement for India in 2014

Service	Total Requirement (MHz)	Remark
2G	274	GSM: 2 X 100 MHz CDMA: 2 X 37 MHz
3G	100	Assuming 5 operators each with 2 X 10 MHz
BWA	100	20 MHz each for 5 operators
LTE & Broadcasting	108	Including Mobile TV

Estimated by TRAI

Spectrum Availability in 2014

Frequency Band	Total available for Telecom by 2014
824-844	20
869-889	20
890-915	18.6 – 21.8
935-960	18.6 – 21.8
1710 – 1785	55-75
1805-1880	55-75
1880-1900	0-20 (after co-ordination)
1920-1980	60-25
2110-2170	60
2300-2400	60
2500-2690	40
3300-3400	100 (ISPs)

Estimated by TRAI

Current spectrum requirement and availability in India

GSM Spectrum requirement in various service areas up to specified limits

S.No.	Circle	Available GSM Spectrum	No. of Operators	Operators with MHz						Additionally Required Spectrum for quantum upto (MHz)				Spectrum already allocated	Balance available spectrum
		A		12.4	10	8	6.2	4.4	Nil	4.4	6.2	8	10	B	C=A-B
1	Delhi	57.2	12	1	2	1		3	5	22	36.4	50.8	68.8	53.6	3.6
2	Mumbai	74.8	11	1	3			7			12.6	25.2	39.2	72.4	2.4
3	Kolkata	78.4	10		2	1	1	6			10.8	23.4		60.4	18
4	Maharashtra	69.4	12		2	1	1	8			14.4	30.6		69.4	0
5	Gujarat	60.4	11		1	1	2	7			12.6	28.8		60.4	0
6	AP	83.6	12		2	1	1	8			14.4	30.6		69.4	14.2
7	Karnataka	79.2	12		2	1	1	8			14.4	30.6		69.4	9.8
8	Tamil Nadu	87	11		3	1		7			12.6	25.2		67	20
9	Kerala	89.2	11		1	1	2	7			12.6	28.8		61.2	28
10	Punjab	63.2	12			2	2	8			14.4	32.4		63.2	0
11	Haryana	63.8	12			1	3	8			14.4	34.2		63.8	0
12	UP - West	61.2	11		1	1	2	7			12.6	28.8		61.2	0
13	UP - East	62.4	11		1	2	1	7			12.6	27		62.4	0
14	Rajasthan	63.8	12			2	2	8			14.4	32.4		63.8	0
15	M.P.	93.6	11		1	2	1	7			12.6	27		63	30.6
16	West Bengal	57.4	10			1	3	6			10.8	27		53	4.4
17	H.P.	57.6	11		1		2	8			14.4	32.4		57.6	0
18	Bihar	71.2	12		2	1		9			16.2	32.4		66.8	4.4
19	Orissa	77.4	11		1	1	1	8			14.4	30.6		59.4	18
20	Assam	59.4	10		1		3	6			10.8	27		55	4.4
21	North East	57.6	10		1		2	7			12.6	28.8		53.2	4.4
22	J&K	49.4	10			1	1	8			14.4	30.6		49.4	0

Note: In stray cases, Spectrum allocated varies slightly from the above tranches

- The price of spectrum was last discovered through the bidding for the 4th Cellular license in 2001

- One can argue the auction price paid by winning operators in 2001 was a combination of the right to do business in a market with limited competition as well as a one-time price paid for 4.4 MHz of spectrum

- Technology and market conditions have changed significantly since then

TRAI sought to determine the price of 2G spectrum in the 1800 MHz band

- 3G auction prices (2010) can be used to arrive at a shadow price for 2G after applying a correction factor based on technical and commercial realities.

- Two different approaches that directly estimate the value of spectrum for the year

Report on the 2010 economic value of spectrum in the 1800 MHz band

- The problem of computing the value is divided into two parts a) Contracted spectrum (up to 6.2 MHz) and b) Incremental spectrum (beyond 6.2 MHz)

- **Contracted**: Determining the NPV over the license period of 20 years of the cash flow that a mature operator in March 2010 would command by virtue of holding a block of spectrum

  ○ *Cash Flow for Contracted spectrum = Revenue[1] – (License Fee[3] + Spectrum Charge[3] + Network Cost[2] + Administration, Marketing, & Personal Cost)*

    1 : Revenue = ARPU (adjusted for VLR) * No. of subscribers (VLR – based on fair share calculation for 6.2 MHz)

    2: Network Cost = Total cost of all BTS including rental and electricity costs

    3 : License Fee and Spectrum charges calculations are based on recommendations by TRAI (% of AGR)

  ○ *Value of Spectrum = Price + NPV over 20 years of (Price *20%[4])*

    4: 20% is the assumed rate of return on investment of operators

- **Incremental** : In order to calculate the price of incremental 2G spectrum beyond 6.2 MHz, the additional cash flow from moving to 8 MHz is estimated using a trunking efficiency factor for increased subscribers and increased estimate for Base Transceiver Stations (BTSs). The method for estimating cash flows is the same as that for contracted spectrum , except that cash flows with 6.2 MHz (contracted spectrum) is subtracted from the annual cash flows for any year to arrive at the incremental value.

Method 1: Cash Flow from Spectrum

- The *opportunity cost principle* has been adopted to derive the value of spectrum which is treated as an essential input for the supply of mobile services The other input is BTS. These two factor inputs are the independent variables in the estimation of a production function to 'produce' mobile traffic of minutes of use (MoU). Subscriber numbers are used as a proxy for MoU.

- The Cobb-Douglas function popularly used for supply side estimation of telecom services growth and efficiency, has been employed. The production function is specified as follows: $X = Ay^{\beta}z^{\gamma}$

  Where,

  ◦ X refers to mobile subscriber base, Y = allocated amount of spectrum, Z = deployed mobile infrastructure such as BTS.

  ◦ Beta (β) and Gamma (γ) values reflect the percentage change in subscriber base for a unit percentage increase in spectrum and BTS respectively, and are parameters to be estimated. A captures the magnitude of technical change.

- Given the paucity of spectrum data in the 0-6.2 MHz range for the reference period 2007-10, this method best lends itself to estimating the value of incremental spectrum, rather than a block of spectrum. In the light of the complementary strengths of the two methods, a simple average of their derived values is taken to calculate the price of incremental spectrum

Method 2: Substitution Approach

Findings :

- The value of contracted spectrum is lower than that of incremental spectrum. One reason could be, that the estimate for contracted spectrum does not factor trunking efficiency of spectrum and the proportion of revenue spent on administration and marketing. Also, given the extra costs of starting up, it is appropriate to charge for increased efficiencies only at later stages of the operators life cycle.

- The price of spectrum beyond 6.2 MHz in the 1800 MHz band is 136% of the price of 3G on a pan India basis. The price of contracted 6.2 MHz of spectrum in the 1800 MHz band is 53% of the price of 3G spectrum on a pan India basis.

- The prices of contracted 2G spectrum is lower in Metros and Category A circles and higher in Category B circles. Also, the ratio of the value of 2G spectrum to the value of 3G spectrum is the lowest in metros, and increases as we move to lower category circles. This is because 3G spectrum is most valuable relative to 2G spectrum in metros, as data services are expected to pick up. Also the current 2G spectrum holding in these circles are considered enough to meet the expected needs

- The variation of 3G prices across circles is far higher than 2G, indicating varying attractiveness for 3G across circles.

The general pattern for both contracted and incremental spectrum appears to conform to an intuitively acceptable truth

Service Area	Price of contract spectrum 1800 MHz per MHz 2010 (Rs. Crore)	Price of incremental spectrum 1800 MHz per MHz 2010 (Rs. Crore)	Auction price of 3G spectrum per MHz 2010 (Rs. Crore)
Delhi	149.78	249.73	663.39
Mumbai	101.11	157.34	649.41
Kolkata	49.48	47.60	108.85
Maharashtra	117.14	374.47	251.56
Gujarat	149.87	355.37	215.21
Andhra Pradesh	153.77	431.95	274.63
Karnataka	136.16	345.92	315.98
Tamil Nadu	187.38	426.05	292.99
Kerala	73.98	232.16	62.50
Punjab	72.86	180.56	64.40
Haryana	14.5	107.90	44.52
Uttar Pradesh (W)	60.11	252.55	102.81
Uttar Pradesh (E)	151.76	318.76	72.91
Rajasthan	106.03	278.84	64.21
Madhya Pradesh	87.71	254.45	51.67
West Bengal, A&N	44.79	216.96	24.73
Himachal Pradesh	9.34	28.12	7.45
Bihar	51.04	153.69	40.69
Orissa	24.33	73.26	19.40
Assam	10.40	31.33	8.30
North East	10.61	31.95	8.46
Jammu & Kashmir	7.60	22.89	6.06
Total	**1,769.75**	**4,571.87**	**3350.12**

The economic modeling exercise yield estimates of relative magnitudes rather than of exact values

Conclusions:

- Estimating annual value of spectrum is a tricky exercise at the best of times. Access to data becomes crucially important, but equally if not more important is access to business plans and forecasts of service providers who invest in the market.

- The two models adopted in this report complement each other, since the production function calculates the value of spectrum as an opportunity cost, a sort of 'macro' approach, while the start up model is closely tied to the firm's business plan or cash flows.

- The values are in a broad range; given that we are trying to estimate a value that bidders would have placed had spectrum been auctioned, it is not unreasonable to expect variation between different approaches

It is not possible to predict with certainty the precise values of spectrum that would emerge in an auction

Questions?

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