Analysis of the 3G and BWA Auctions in India

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Abstract

Simultaneous Ascending Auction, SAA, was introduced by Federal Communications Commission (FCC) in 1994 and has been the most popular/ successful auction method ever since for objects exhibiting complementary behavior. India also adopted the Simultaneous Ascending Auctions for its 3G and Broadband Wireless Access (BWA) that ended after 183 and 117 rounds respectively, grossing a total of ₹106262 crores across 22 circles. In this paper we present the auction methods as used in the Indian 3G & BWA auctions, arguing over its efficiency and achieved goals followed by the future road map.

Index Terms

3G & Broadband Auctions, Spectrum Auctions

I. Introduction

The development of telecommunications in any country is hinged on the availability of spectrum and its allotment to the service providers. Globally, various methods have been adopted for allotment of this scarce resource. Some of the methods employed in allocation of spectrum are [1]:

1) Administrative Process
2) Lottery
3) First Come First Serve (FCFS)
4) Auctions

Administrative process, also known as “beauty contests”, has been adopted by many Asian countries such as Japan, Singapore, South Korea and Hong Kong [1]. In this system the government invites proposals from the aspirants and evaluation is done against broadly set out multiple criteria, subsuming therein policy objectives of the government. The governments have adopted various evaluation criteria for assessment of offers, which may include economic feasibility of the proposal, effect on telecom industry, concentration of market power, etc. But weights of these criteria being subjective and internal to the licenser, the process may lead

to allotment of one of the most valuable public resource to a service provider who may not be the most deserving and competent candidate to roll-out the intended services. Moreover, assessment of bids takes exceedingly long time as the criteria of evaluation are not precisely specified against which the applicants can submit their proposals.

The disadvantages of this procedure were attempted to be overcome by adopting a lottery system in some of the countries including the USA [1]. Though, the time taken to select a successful applicant is reduced, but, this option may result in selection of an applicant having no relation with the competencies required to deliver the intended services. Moreover, this procedure also promotes participation by applicants who are only interested in making profits by reselling the acquired licenses. The advantage of quick selection is nullified by disadvantages of non-serious applicants getting selected, besides huge loss of potential revenue to the government and delay introduced in acquisition of licenses by capable firms to roll out the services.

Some countries introduced the procedure of First Come First Serve (FCFS) for allotment of spectrum licenses. The FCFS ostensibly purports to overcome the arbitrariness of lottery system, but practically it is equally random in manifestation. What is meant by 'first come' can be camouflaged to favor some bidders. In India, in recent past, this system had been adopted in allotment of 2G spectrum licenses by the government. The entire allocation of 2G spectrum through this method has been at the center of controversy and the issue has gone to litigation leading to possibility of cancellation of awarded licenses. This method has proved to be a failure if seen from the perspective of a credible policy regime.

A fairer and transparent way of allotment of spectrum licenses by way of auctioning was first used by New Zealand government [1] in the year 1990 followed by various others. This method has been used successfully towards realising considerable revenue for the government and making the telecom market competitive in price and offerings. Spectrum Auctions has been the most preferred method in majority of 2G and 3G spectrum allocations across the world.

In this paper we present the auction methods as used in the Indian 3G & BWA auctions by the Department of Telecommunications (DoT), arguing over its efficiency and achieved goals. In Section II, we present the value auctions provide; the efficiency as derived by the society and the revenue for the government. In Section III we mention the rules as used by the DoT followed by the data interpretration for the bid behavior of participants as observed from

publicly available data using methods similar to [10] in Section IV. In the subsequent sections we present our analysis and observations on the outcome and attempt an examination on the factors of social efficiency discussing how a few different approaches in auction design could have offered improved overall efficiency. Finally, we discuss what should be the direction for future spectrum allocation and management regime in India.

II. Auctions - Government Revenue And Social Value

Auction has been one of the preferred methods to identify the businesses who will value a resource most and also accrue substantial revenue to the governments. It is performed for oil drilling rights, electricity distribution, electricity generation from natural resources, spectrum allocation or any such activity where the ownership is national and government or an entity is mere caretaker of such rights.

As put forth by the US regulator FCC, "*since a bidder's ability to introduce valuable new services and to deploy them quickly, intensively, and efficiently increases the value of a license to that bidder, an auction design that awards licenses to those bidders with the highest willingness to pay promotes the efficient use of the spectrum*" [7]. An auction works with very simple method of making the bidder commit his business plan with real money. It is the only possible method to extract efficiency, promote competition and realize full economic value for the auctioneer while remaining fair and transparent in the allocation process. The efficacy of auction method largely depends upon the design of auction process. The policy goals of the government can also be incorporated in the auction design.

For spectrum allocation, auctions could be a mechanism to decide entry, maximize social efficiency, revenue maximization or price discovery. Further, the design of each auction differs in the intent it serves. A lot depends on the outcome since the financial aspect of the roll out will depend on the prices the spectrum retailer paid for the allocations. Auctioneers intend to invite for maximum participation in any auction, with suitable incentives to entrants so that the eventual competition will lead to optimal price discovery and thereby a suitable allocation scheme. Auction is central to entry and price discovery but the price in an auction depends on various factors and not limited to the demand supply but the emotions and "exuberance" of participating agents. Hence, the concept of price discovery is dependent upon the time of auctions, the prevailing economic situation and its interplay with telecom, regulatory environment and especially in the Indian context, the political structure. Hence, price reached in any given auction is no indication of its past value or its future projection.

Simultaneous Ascending Auction (SAA) was introduced in 1994 by Federal Communications Commission (FCC) [11] and has been the most popular & successful auction method ever since for objects exhibiting complementary behavior. India too followed the SAA that ended with 183 rounds for 3G and 117 rounds for BWA, grossing a little more than ₹106262 crores for about "970MHz" of cumulative bandwidth across India's 22 telecom circles. At current subscription levels, this amounts to a combined contribution of about ₹4.65/subscriber per month towards the spectrum cost over a 20 year period. Spectrum license fees payable also include spectrum usage charge, varying from 3% to 8% from 3G licensees as well as annual spectrum charge of 1% from BWA licensees of the Adjusted Gross Revenue for each service provider. With the intent of revenue maximization, the said process aggregated a sum far beyond the expectations of the auctioneer and hence could be termed a success.

Spectrum auctions in India were carried out with the objective of revenue maximization, competition stimulation as well as promote 3G roll-out and reduce 2G congestion [2].

III. Indian Auctions - Design Adopted

The 3G and BWA auctions in India consisted of two stages - a clock round which determined the winner for each circle followed by a frequency band identification stage. The frequency identification stage consisted of randomly allocating a slot to the winning bidder. The clock round had an initial eligibility criterion and in order to be eligible for any of the 22 circles, the bidder had to pay an earnest money deposit. The eligibility points and deposits required, available from [2], are mentioned in Table I.

TABLE I
Eligibility Conditions

Service Area Type	**Eligibility Points**	**Deposit**
Delhi, Mumbai and Category A	32	₹40 crores
Kolkata and Category B	12	₹20 crores
Category C	7.5	₹3 crores

The bidding rules for the auctions were duly announced and available at DoT website [2]. In each round, a bidder had to maintain a minimum activity (bid) that was a percentage of its eligibility, since otherwise its eligibility was reduced in subsequent rounds. This percentage was 80% initially and increased to 90% and then to 100%. This activity rule was kept to ascertain a minimum speed to the auctions. The bidding was for each circle and hence the

bidder could decide in each round its cumulative payment and decide its strategy over the next few rounds. This would certainly help in the exposure problem and unpleasant surprises. For any circle, bidding would end if the number of bids in the current round was less than the licenses available and the activity requirement for that circle is 100%.

For 3G auctions, there were 183 rounds over 34 days, with about 5 rounds every day yielding total revenue of ₹50968 crores from the auction and an additional ₹16751 crores from BSNL/MTNL combined. For BWA auctions, there were 117 rounds over 16 days grossing ₹38500 crores for the government.

IV. Data Interpretation

We depict the bid behaviors for 3G participants in Figure 1. The behavior of bidders has some correlation and also many bidders held similar budgets for same geographical areas (evident from their exits). We also observe that there may not have been any specific budget for a circle but to each bidder, *the total payment was the major constraint*. The budget-constraints for majority of the participating agents are also evident from Figure 1.

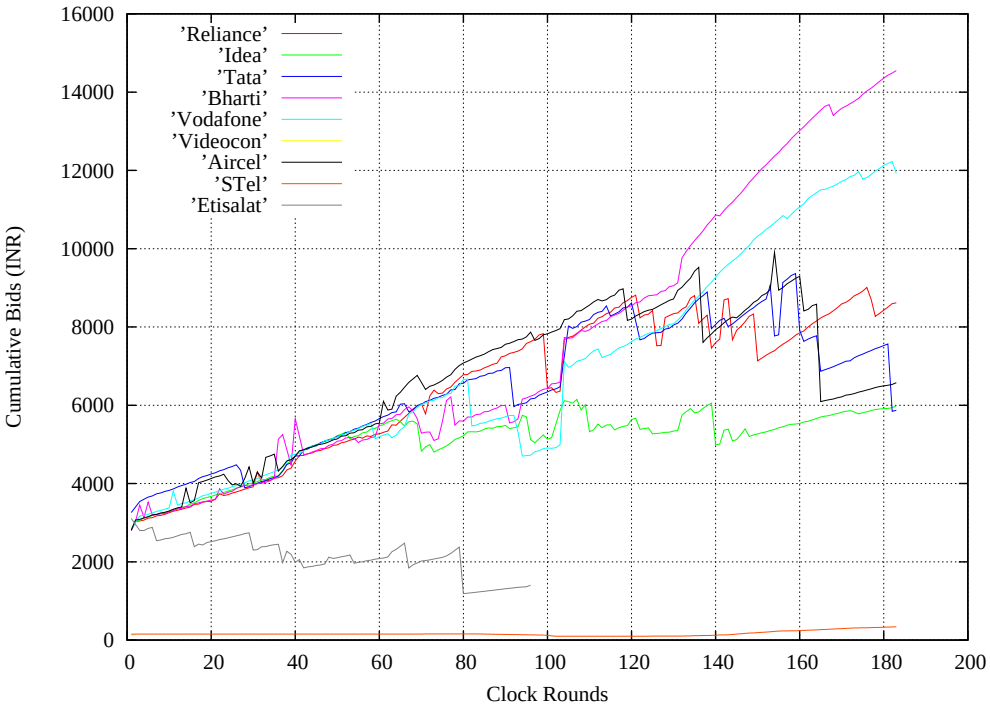

Fig. 1. 3G Auctions - Bid Behaviour

Excluding Videocon, that did not participate in the bidding, Etisalat had a behaviour that was not analogous to expectations. Its behavior depicts reducing cumulative valuation with every round. Eventually Etisalat withdrew from all circles. Idea seems to have played its budget constraint of ₹6000 crores very well, re-aligning every few rounds. Both Tata and

Aircel also eventually paid around ₹6000 crores failing to win the metro circles against Vodafone, Reliance and Bharti. The budget constraints for all bidders except Bharti and Vodafone are clearly visible. In each circle, the bidding seems to have a distinct signature (Figure 2,3,4) with some circles opening aggressively – UP (E) and Rajasthan, very early on, UP(W) and Madhya Pradesh (MP) a little after that. Kolkata and Punjab picked up steam only after round 150 and maintained a slow, almost linear rate till then. Similarly Maharashtra saw some momentum around round 100 and Karnataka picked up interest after round 130. This momentum also defined the exits for other players. Orissa too picked up momentum quite late and was aggressively contested with Bharti narrowly missing out to STel. Some key exits are given in Table II.

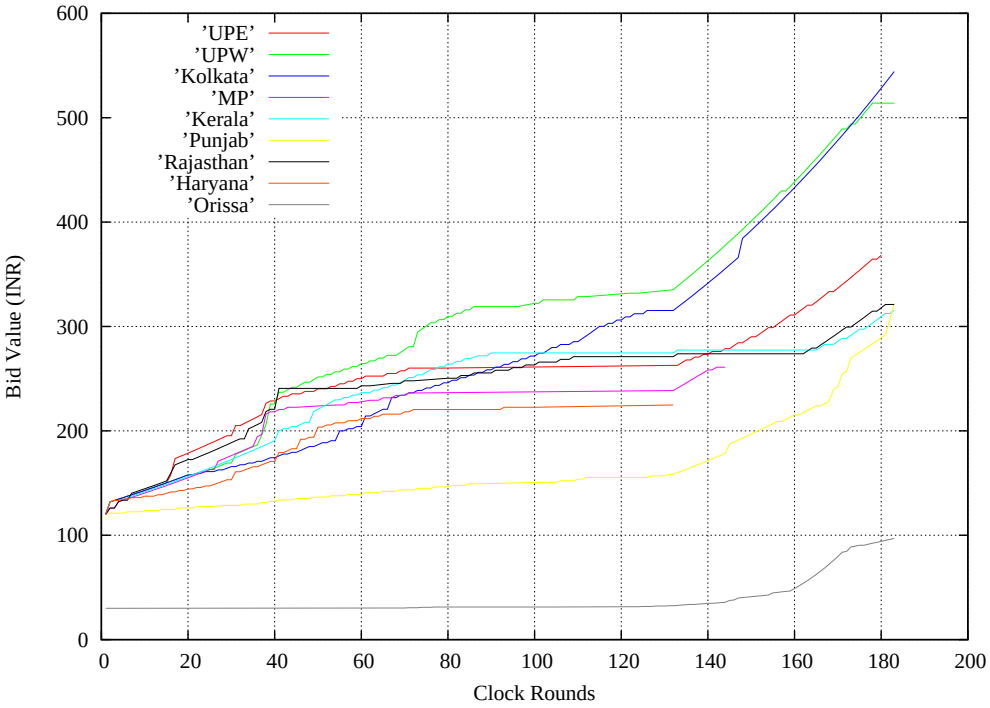

Fig. 2. 3G Auctions - Service Area Bids

As the bids extended into round 100 with the end nowhere in sight, each of the large service providers had their cumulative total cross above ₹5500 crores. With the initial cumulative target being about ₹35000 crores, this seems to have led to a shift in the strategies implemented by the bidders. Idea withdrew from Metros of Mumbai & Delhi at clock round 100 and Vodafone decided to exit Andhra Pradesh (102) and the more aggressively contested UP(W) to focus on the metros, Maharashtra, Gujarat as well as UP(E) and West Bengal (WB). Tata exited Tamil Nadu (106) to concentrate on metros which too it eventually lost. Idea focused on non-metro areas targeting the regions like UP(E) and UP(W), Maharashtra, Gujarat and Andhra Pradesh. Bharti Airtel, the most aggressive among all bidders was seen

focusing on the Metros and sacrificed Gujarat (109), Haryana & Kerala (75) while continuing to bid for Kolkata upto the very end (exit in round 181).

TABLE II
KEY EXITS FOR SERVICE PROVIDERS

Service Provider	**Exits (Clock Round)**
Vodafone	Kerala, Andhra & UP(W) (100) MP (42)
Idea	WB(7), Rajasthan (30), Delhi & Mumbai (100), Karnataka, Kolkata, TN (140-150)
Tata	UP(E)(25),TN(60), Kolkata (110), Mumbai(160)
Aircel	Rajasthan, MP, Haryana, UP(W) (<100), Gujarat(125), Delhi & Mumbai (160)
Reliance	Haryana(75), Kerala(84), Maharashtra(101), Andhra(120), Gujarat, TN, Karnataka, Jammu(<150)
Bharti	Kerala & Haryana(75), Gujarat(100), MP, Maharashtra(150)
STel	Assam & North East (80)

As observed above and in Figure 3, we notice that Bharti, which was expected to win a pan-India license, seems to have changed plans to withdraw from Haryana and Kerala early. This set the possibility that no single bidder would be winning a pan-India license and set stage for a potential roaming among operators for 3G services.

For Karnataka circle, bids near clock round 130 changed pattern and we notice Idea and Reliance quitting at around 140. Also in UP(E) and UP(W), it became evident that UP(W) will have a higher license cost than UP(E) at clock round 80 and we see Aircel withdrawing around round 84 and Vodafone around 100.

After 183 clock rounds, the winners were decided and India had 9 service providers over 22 circles sharing a total of 93 allocations. Out of this, 22 allocations were for the corporatised government incumbents, Bharat Sanchar Nigam Limited (BSNL) and Mahanagar Telephone Nigam Limited (MTNL) combine and they had to meet the price of winning bidder in each circle. The price for a pan-India 3G spectrum license for BSNL and MTNL aggregated to ₹16751 crores.

STel and Idea (Figure 1) seemed to have a strict realization of their budget constraints as evident from the disciplined strategy followed. STel concentrated in Category C and while it withdrew from Assam and North East, it went on to win Himachal, Bihar and Orissa. Idea shuffled its portfolio, withdrawing from Mumbai and Delhi thereby freeing budget locked up in those expensive circles, to concentrate on other promising low valued circles. Aircel bid

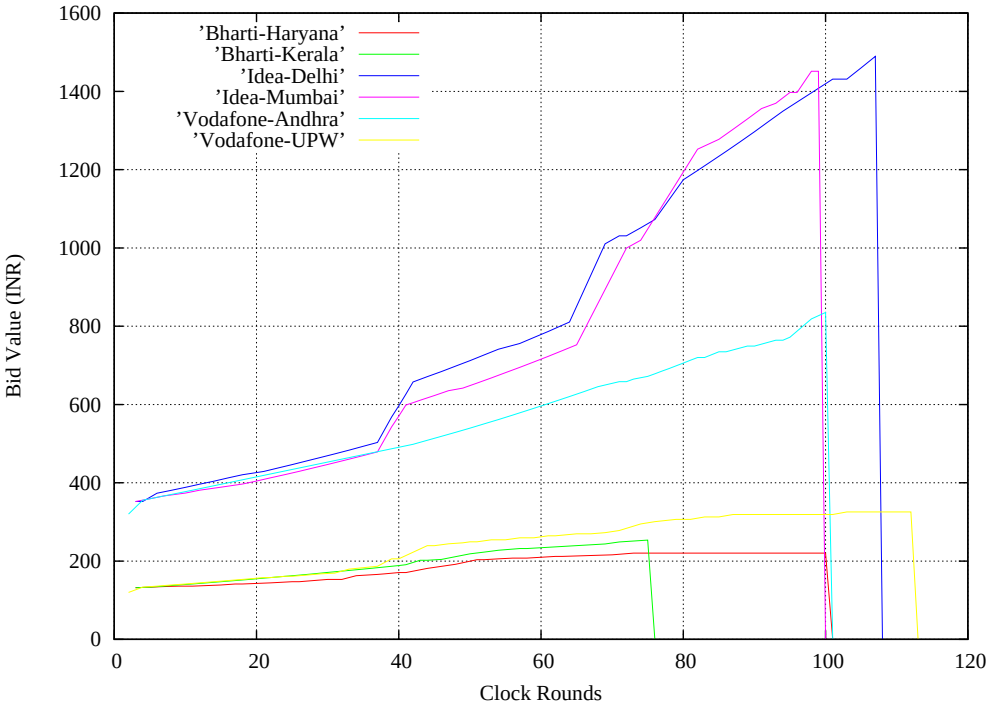

Fig. 3. 3G Auctions - Circle participations withdrawn near round 100

on gaining circles with highest population densities. Reliance too seems to have remained close to a maximum and withdrawing whenever the cumulative sum exceeded this maximum.

TABLE III

ADDRESSABLE MARKET FOR EACH WINNER

Service Provider	**Total Subscriber Base in winning circles (April 2010) (Addressable Subscriber)**	**₹/(Addressable Subscriber)**
STel	47 Million	71
Aircel	238 Million	273
Idea	205 Million	281
Tata	180 Million	325
Reliance	180 Million	477
Bharti	225 Million	546
Vodafone	194 Million	598

The subscriber densities (April '10), a maximum addressable market for each of the winners, is provided in Table III [3]. Bharti, Vodafone and Reliance seem to have paid high, but this is due to their winning Mumbai and Delhi that has a population of 1.7 and 1.6 Million respectively while Aircel won Bihar, UP(E), Tamil Nadu and Andhra each of the circles with a subscriber base exceeding 3 Million[1].

[1]Tamil Nadu in 3G is the GSM circle of Tamil Nadu merged with Chennai

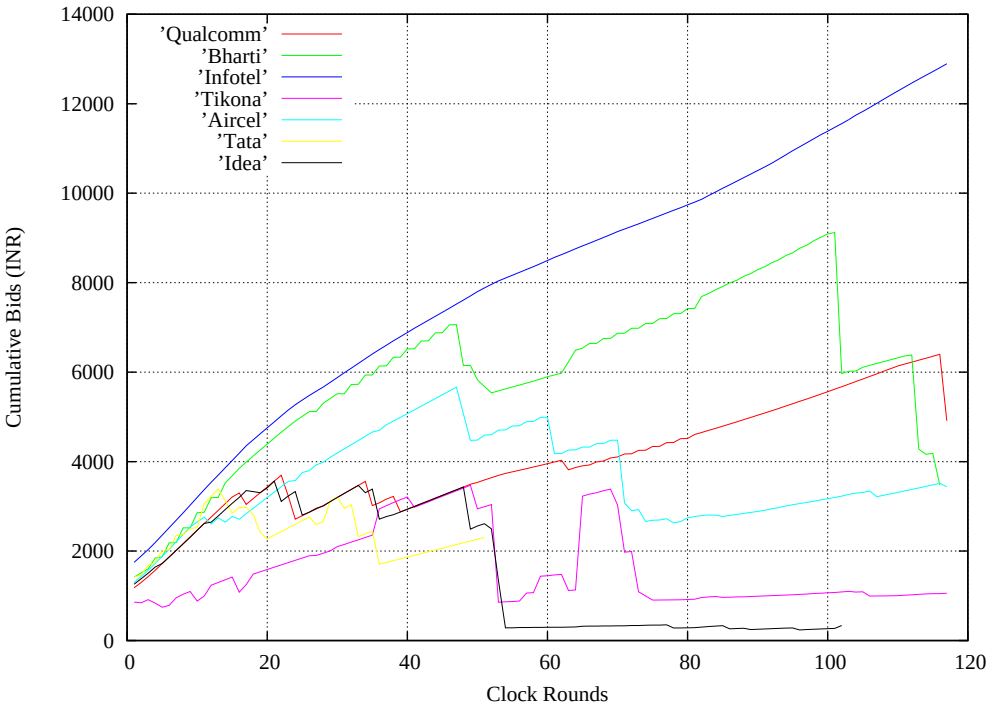

Fig. 4. BWA Auctions - Bid Behaviour

Unlike in 3G, in BWA auctions we observe very focused and consistent behavior from Infotel which seemed determined in winning a pan-India license. The bidding pattern for Infotel, Figure 4, shows a deterministic plan unlike other bidders both in 3G and BWA auctions. BWA auctions demonstrate, in Figure 4, almost every other bidder re-aligning to new valuations and implementing a different strategy near round 50. Qualcomm was the other consistent buyer, exiting up on few key circles near the end of the auctions.

In BWA auctions, Delhi and Mumbai contributed more than 50% to the total revenues. Also, Karnataka and Kolkata yielded revenues in BWA almost equivalent to 3G auctions while Tamil Nadu BWA revenues were far higher to those from 3G.

V. Analysis

In order to arrive at justification for valuations in each of these 22 circles we correlate 3G circle valuations to the Average Revenue Per User (ARPU) and subscriber densities, as available from [3]. The GSM revenues in Figure 5 were calculated based on data available from Cellular Operators Association of India (COAI) for ARPU and subscriber density for each circle. Figure 5 illustrates that 3G valuations for any given circle are not based on GSM revenues and the high valuations for Delhi and Mumbai are not aligned to the revenues available from these circles. Also, Tamil Nadu (with Chennai included) has the highest GSM revenues but the contribution of this circle to 3G auction revenues is only about 9%.

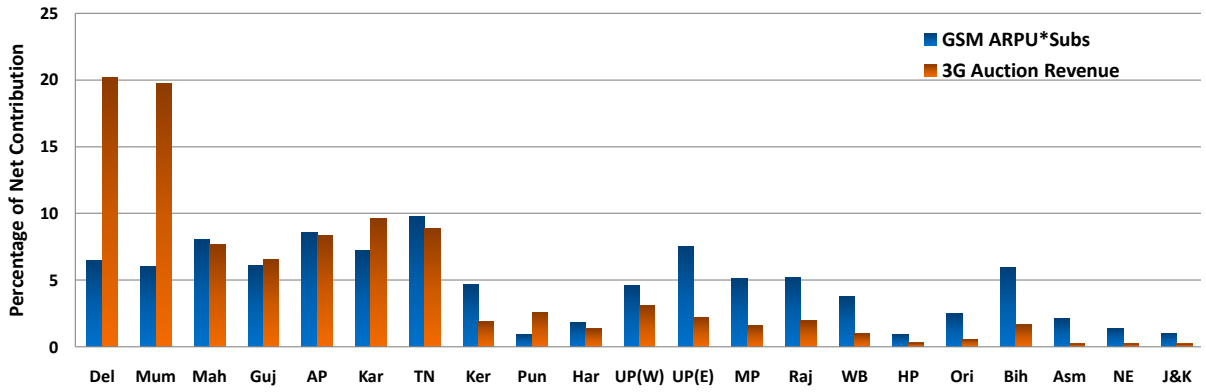

Fig. 5. Circle-wise comparison of GSM vs 3G Auction revenues

Using circle valuations, given in Table I, as benchmark reference we compute the valuations for each of the service providers in Table IV.

TABLE IV

SPECTRUM VALUATION PARAMETER CALCULATION

Circle Category	**Valuation (377 is the total valuation for 22 circles)**
Category A & Metro	32/377 = 0.085
Category B & Kolkata	12/377 = 0.032
Category C	7.5/377 = 0.02

Using the above table as a benchmark valuation, we have computed the value of winners as shown in Table V.

The ratios are against the Metro winners since as per intial auction valuations Mumbai and Delhi are valued similar to the Category A circles while market value, as determined by the participants, for them was significantly higher.

We have used a measure called Spectrum Valuation Index (SVI) (computation shown in Table V) which is the ratio of valuation of licenses (by the licenser) for a given number of territories to the normalised price (with reference to price paid by BSNL & MTNL combine for a pan-India license) for acquiring the permits for those territories. The SVI is not an absolute measure but a derived parameter with which we attempt to give a normalized comparative figure.

An SVI of 1 (eg: BSNL & MTNL combine) indicates winning all circles and paying the winning price as valued by the auction, however for partial winners SVI indicates the ratio of initial valuations, as set by the auction manager, to final valuations in their winning circles.

TABLE V

SPECTRUM VALUATION INDEX (SVI)

Service Provider	**Winning Circle Valuation [A]**	**Price as a fraction of Pan-India (Amount paid / 16751) [B]**	**SVI (Ratio of A/B)**
Aircel	0.5133	0.3880	1.32
Bharti	0.6194	0.7340	0.84
BSNL+MTNL	1.0000	1.0000	1.00
Idea	0.4854	0.3444	1.41
Reliance	0.4483	0.5125	0.87
STel	0.0597	0.0202	2.96
Tata	0.4456	0.3501	1.28
Vodafone	0.5517	0.6936	0.79

A higher value indicates a better yield with respect to the prevailing valuation. In Table V, we find STel with an SVI > 2 but since the coverage footprint is too less, we did not think it appropriate to compare it with other participants. Among other participating service providers Idea, Aircel and Tata have a higher coverage as well as an SVI > 1 which indicates they may have derived better returns for their payments as against Vodafone, Bharti and Reliance. However, since it is expected that Mumbai and Delhi would be significant markets, these circles could be strategically important. We also observe that no two service providers cover entire India. This should bring interesting coalitions for 3G roaming. Reliance, Tata and Aircel are the only 3 service providers that cover all 22 circles. Even with a possible coalition of Tata, Aircel and Reliance we notice that if Mumbai and Delhi are assumed to be of the same value as other category A circles then Aircel brings in an almost 50% of marginal contribution to the coalition.

VI. DISCUSSION

In the UK UMTS auctions an entrant was allowed to tie-up with an incumbent for 2G voice roaming [5]. There were no provisions for new entrants to the 3G space in India. In India it seemed difficult for any new entrant to establish voice as well as data services on the more expensive 3G spectrum. For an incumbent, 3G is complementary to 2G as the cost of rolling out 3G services is only incremental compared to huge investment required in infrastructure for the new entrant. Considering this it seems the auction strategy, while discussing statutory requirements for new entrant, did not encourage participation of new entrants.

The objectives for Government of India as mentioned on DoT website, were clear and in following order:

1) Maximize Revenue for the government.
2) Ensure efficient use of spectrum and avoid hoarding.
3) Stimulate competition in the sector, promote 3G roll-out and help resolve 2G congestion issues.

The auction strategy seems to have focused more on maximizing revenue for itself and resolving 2G congestion issues which affect only incumbents. The auction design showed no signs of accommodating a potential new entrant which may not be a method to maximize social efficiency.

It is evident that an incumbent values the allocation more than a new entrant and the new entrants would bid for licenses more as substitutes, assuming them to be budget constrained, whereas an incumbent would view them as complimentary, seeking to maximize footprint. Substitute would mean the marginal value of obtaining a particular object 'ɑ' is smaller if the set of objects already owned is larger. Essentially if S and T are packages of interest to buyer 'i' and they are substitutes,

$$\mathbf{S} + \mathbf{T} > \mathbf{S} \cup \mathbf{T}$$

whereas, if S & T are complimentary packages,

$$\mathbf{S} + \mathbf{T} \leq \mathbf{S} \cup \mathbf{T}$$

With some incentives to new entrants for participation, the efficiency could have been further increased since for complements the marginal value of obtaining a particular object 'ɑ' is larger if the set of objects already in hand is large [3].

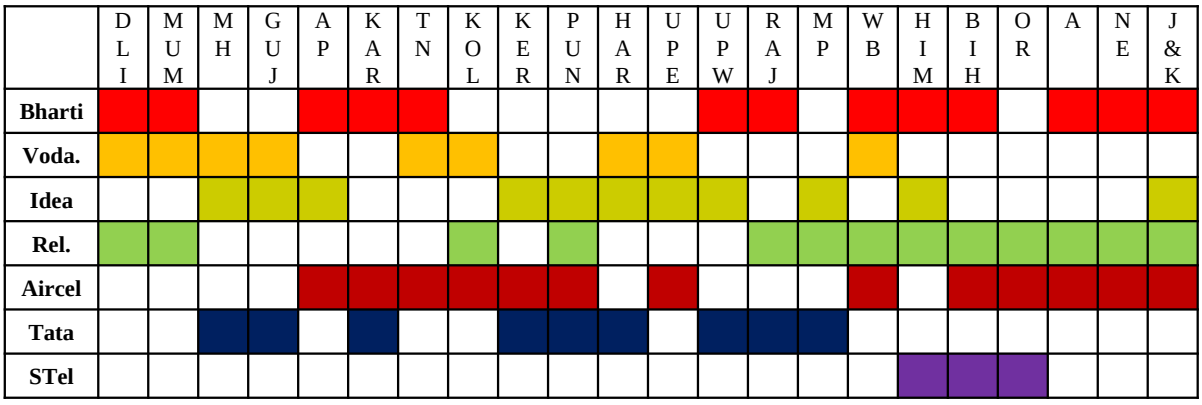

Fig. 6. Bit-Map Chart of Allocation of Licenses in All Circles

The most significant result for the Indian 3G auction is that there is not a single pan-Indian winner. Looking at the bit-map chart in Figure 6 we see that Reliance, Aircel and Tata as well as Idea, Vodafone and Bharti (barring Orissa) present a great combination to service entire India with a roaming pact. While SAA is not optimum for multiple packaged bids, the SAA is immensely amenable to modifications and all auction designers for UK and FCC have urged all implementers to adapt the auction design to local requirements. Moreover, with only one package of pan-India there is no computational complexity involved for the adaptation.

A small sized winner like STel complements Tata & Vodafone and is a potential acquisition target. This benefits the large companies immensely since they can wait for 5 years, the stipulated roll-out period, to decide the market conditions. However this leads to a possible loss in spectrum revenue.

Overall the 3G auctions, while generating revenues that were higher than expectations, could have a fairer design to allow nascent players and also attained higher efficiency with pan-India licenses. A forward step taken by the government towards a flexible spectrum management regime was to make the BWA auctions technology agnostic i.e. BWA could be rolled-out using WiMax/ LTE technologies.

VII. Summary and Future Directions

The 3G and BWA auctions in 2010 in India have aggregated significant revenues for the government. LTE which seems to be the popular choice for BWA, is also a technological evolution for 3G and technically can serve the same market segments. We believe the BWA auctions could have been scheduled, at-least for the metro markets, at a more opportune time in future once the market expectations from 3G deployments were fully realized. Moreover, a single pan-India licensee, in-order to safe guard its interests, would have contested opportunistic pacts among other operators thereby keeping the policy designers/ DoT free for better tasks.

Post-auction conduct of the licensees is an indicative of the understanding that auction design could have been better. This belief emanates from the fact that quite a few operators have not been able to launch the services or are becoming potential acquisition targets. The valuations for the recent spectrum auctions has been higher than expectations and the participants seem to have managed the payments as well. While the UMTS auctions in

many other European markets failed, in India these have yielded significant interest and participation. The aims of the auction do seem to have been fulfilled and the impact of policy design will be evident only in the long term.

India's spectrum allocation regime has primarily been statically assigned as well as technology and geography specific. The use of spectrum remains inflexible and does not provide enough incentive for undertaking innovation which may lead to greater commercial and social value of the scarce resource. Moreover, the degree of discretion to the operator in use of spectrum has been minimal and it is mandated by the licensing conditions. The licensing conditions also dictate what service to use in which band. The spectrum management policy should be so open as to harness ever evolving technologies. It is imperative that the framework is made flexible and given long term perspective insofar as policy directions are concerned.

Growing economic development of the country is putting tremendous pressure on telecommunications requirements, and its geographic vastness makes the use of wireless technologies not only essential but without any second recourse. There is insatiable demand for internet and data services for a huge market of social, educational and economic activities. Thus it is inescapable to suggest that spectrum allocation is made technology neutral so that the service providers are at liberty to invest on innovations for its best use. The limits that may be imposed should be confined to managing interference and the aggregate spectrum held by the operators in a particular licensed service area.

For spectrum auction in a given geography, the government would need to ensure markets competition so as to further consumer welfare and overall benefits to the society. Hence, it needs to draw, in consonance of the competition policy of the country, limits on the amount of spectrum that a single bidder can acquire. Such limits would need to be put in place so that an operator does not acquire an amount of spectrum beyond certain limits either by the way of winning an auction or by mergers and acquisitions in the market, in order to ensure effective competition from other providers of similar services.

Moreover, spectrum allocation in India has been rather static also in terms of its ownership. With increasing competition and the dynamic nature of technologies deployed, it becomes imperative that these (static) allocations be allowed to arrive at an optimal re-allocation by means of short and long term spectrum trading. Spectrum sharing and trading would help reduce the in-efficiencies that normally creep into the static allocations.

Finally, we submit that the telecommunications industry operates in a highly dynamic and complex environment in terms of preferences and technologies. For any economy, telecommunications is an enabling factor and therefore policy regime for its development has to be the top agenda for the policy-makers. A lot depends upon the long term policy landscape for development of competitive environment and imbibing of confidence amongst operators to continue investing in the sector with assurance of reasonable returns on their investment. Though as a result of uncertainties surrounding any decision, licensing and regulation framework cannot be a one-shot game, nevertheless, there has to be a predictable policy framework for spectrum allocation and its management along with possibilities of modulation in framework as the market emerges.

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