

Methods for Spectrum Assignment, Pricing and Access in Dual Technologies

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Abstract--*In India, mobile service operators have always had to scramble for more spectrum allocation. However, in the last two years, the fight for spectrum has further intensified, mainly because the mobile subscriber base has grown at a very fast pace. Spectrum is like oxygen for mobile operators and lack of it leads to call drops (calls being disconnected) and congestion in the network. This paper deals about Various Methods used to allocate spectrum and different category of pricing Scheme and Accessed in Dual Technologies.*

Keywords--*CDMA, GSM, FCFS, Lottery, Beauty Contest and Auction.*

I. INTRODUCTION

The word 'Spectrum' basically refers to a collection of various types of electromagnetic radiations (electromagnetic waves) of different wavelengths. In India, the radio frequencies are arbitrarily confined between 9kHz and 3000 GHz and are being used for 40 different types of services like fixed communication, mobile communication,

Broadcasting, radio navigation, radiolocation, fixed and mobile satellite service, aeronautical satellite service, radio navigational satellite service etc. An electromagnetic wave propagated by an antenna is also known as a radio wave. Radio waves have different frequencies and electronic receivers, like the FM car radio you can tune into for receiving specific signals on its frequencies. The mobile or cellular phone is also a radio receiver, though an extremely sophisticated one, that picks up and transmits radio signals which carry voice, data or even video.

A. How is spectrum allocated in other countries?

In most other countries, the concept of allocating an initial amount of spectrum to an operator and increasing it at a later date is not the normal practice. Operators abroad have typically received the full amount of spectrum they are to be allocated in a specific band when they are first awarded a mobile license.

B. Why is there a controversy over allocation of more spectrums in India?

Since spectrum allocation here is based on technology and subscriber numbers, there are

differences between GSM and CDMA players. CDMA operators get half the spectrum GSM operators get because they are more efficient users of spectrum. The Telecom Regulatory Authority of India (Trai) in its recommendations on spectrum allocation has favored technology-neutral allocation on the grounds that an efficient technology should not be penalized. National Frequency Allocation Plan (NFAP) forms the basis for development and manufacturing of wireless equipment and spectrum utilization in the country. It contains the service options in various frequency bands for India and also provides the channeling plan in different band applicants.

II. METHODS OF SPECTRUM ASSIGNMENT

Methods of doing this involve dividing the existing spectrum in usable blocks and then awarding through a market or non-market based assignment approach.

A. First-come-first-served-Basis Seniority:

Eligibility criteria may be set. Blocks of spectrum may be assigned to eligible seekers on the first-come-first served basis. No further request can be entertained when the available spectrum is exhausted.

B. Beauty contest - Merits/ needs:

In a comparative process or beauty contest method, the qualifications of each of the competing spectrum applicants are formally compared based on established and published national criteria like coverage, number of BTS proposed to be deployed for this coverage, Grade of service, level of customer service.. Beauty contests were used to award majority of initial GSM licences in Europe and around half of the 3rd Generation (3G) mobile licenses.

C. Lottery

In a lottery, licensees are selected at random from among all competing spectrum applicants.

D. Auction

Auctions represent a form of assignment mechanism where the applicants determine the value to be charged.

In an auction, spectrum is allocated by bidding among competing spectrum applicants. Auctions award

spectrum to those who value it the most. However for a positive outcome of auction method, it is necessary that there are sufficient viable bidders. Wherever there are insufficient bidders, it is important that the reserve price set by the Government/Regulator reflects as closely as possible the economic value of the spectrum. Auctions might also be used if the spectrum packages to be offered differ and the spectrum is valued differently by the bidders. The key to the success of an auction is the design, which must address a number of concerns, and objectives, some of which are given below:

- ✓ Avoidance of collusion between participants to avoid high prices
- ✓ Encouraging a sufficient number of bidders, particularly new market entrants
- ✓ Setting of appropriate reserve prices
- ✓ Potential market structure
- ✓ Default after winning the auction
- ✓ Type of auction i.e. single stage vs. multi-stage.

Several types of auctions have been used by different countries: Sealed-bid auction, Ascending-price auction (English format), Descending-price auction (Dutch format), Simultaneous multiple round auction and Anglo-Dutch Auction. FCC, USA has pioneered simultaneous ascending auction methodology. Ascending price auctions have been used in Canada, Australia, UK, Germany and Austria.

III. SPECTRUM PRICING

A. Objective of Spectrum Pricing

In general, the role of pricing in a market is to guide the users in making decisions to use the spectrum resource more efficiently. It follows that the approach to pricing should reflect the scarcity besides incentivizing efficiency in use. It is important to decide upon the objectives that the pricing policy should achieve. These objectives are generally a combination of following principles:

To promote efficient use of scarce resource of radio spectrum, where it serves as a means to ensure that those using the spectrum do not acquire more than they need to provide a service.---Prevent users from stockpiling spectrum that they do not really need; Reflecting market value of spectrum in the wake of scarcity, to ensure its efficient utilization. Recovering the costs associated with managing the spectrum. Increasing roll-out of services

To facilitate access to radio spectrum particularly to innovative technologies and services Provide an incentive to move to alternative bands when this would be desirable; To afford opportunity for equal competition Present Pricing Policy in India: 3.20 In India, existing 2G licensing framework imposes the

following levels/fees on a UASL/CMTS licensee seeking to provide access services using wireless technologies:-

- Entry fee for acquiring a license
- License fee as a percentage of Adjusted Gross Revenue (AGR) paid on a quarterly basis
- Spectrum usage charges as a percentage of AGR paid on a quarterly basis

B. Methods of spectrum pricing

1) Determination of upfront charges for spectrum

Presently the UAS license fee (which includes the charge for initial spectrum) has been administratively determined based on the prices discovered through a market based mechanism applicable for the grant of license to the 4th cellular operator. There are broadly two methods for determination of spectrum pricing,

2) Administrative Incentive Pricing (AIP)

The administrative assignment of spectrum is often supplemented by imposing charges for its use. These charges can take the form of simply setting fees sufficient to recover the costs of spectrum management. Alternatively, they could be incentive based prices that could encourage efficient utilization of spectrum. One way to do this would be to set a charge equal to an estimate of what the spectrum might be worth in the market context. Prices are set by the government reflecting the opportunity cost of spectrum while incorporating potential 'incentive' to encourage efficient use reflecting spectrum scarcity. One of the predominant methods in this category is Beauty contest or comparative selection-Beauty contest or comparative selection fixes the price of the spectrum to ensure optimum utilization by awarding spectrum to the users(s) who score the highest against a group of preset criteria.

3) Market-based prices

Prices can also be discovered through an authentic market transaction such as an auction or secondary trading. The underlying concept of spectrum pricing is that the price should be based on the amount of spectrum used and on the value of the spectrum to its users. A market price is a fair payment criterion for the use of scarce resources. Proper pricing and assignment principles would also encourage investment in more spectrally efficient technologies.

4) Determination of annual spectrum usage charges

Some of the common methods that are applied to determine annual charges are:

Spectrum fees based on users' gross income

A fee can be charged based on a percentage of the gross income of a company. The value of the gross

income used in the fee calculation must be directly related to the company's use of the spectrum to avoid difficulty in the accounting and auditing processes. This is simple to calculate but does not promote spectral efficiency if revenues are not proportional to quantity of spectrum used.

A variation of this method is to allow some deductions, like pass through revenues, from the gross income to calculate *adjusted gross revenue*. A percentage of this adjusted gross revenue is then charged as spectrum fee. This method is currently used in India.

5) *Incentive spectrum fees*

An incentive fee attempts to use price to achieve spectrum management objectives by incentivizing efficient use of spectrum. Assignment fee levels are not dependent on cost-based limitations but the fee structure approximates the market value of the spectrum. The overall aim of incentive fees is to encourage more efficient spectrum use, with the intention of bringing the demand for spectrum into equilibrium with its supply by encouraging users to move to more spectrally efficient equipment; handing back spectrum they do not need and moving to a less congested part of the spectrum.

6) *Opportunity cost fees*

An opportunity cost fee tries to simulate the market value of the spectrum. This process may require financial analysis, estimations of demand or market studies to achieve a valuation, and considerable expertise.

7) *Charges based on cost recovery*

In the case of charge based cost recovery, the fees depend on the actual costs incurred by the regulatory authority in the licensing of the networks/ services concerned and associated management of the radio spectrum. There will be additional "indirect" costs such as international activities or work on license-exempt services that cannot be directly attributed to a service that is licensed. Annual spectrum usage charge In many other countries besides an initial upfront charge determined administratively or through auction there is an annual spectrum usage charge. It needs to be deliberated upon by the stakeholders whether there should be an annual spectrum charge in case the market based regime is ushered in. If yes, then whether this charge should depend on the amount of spectrum held or should it be uniform.

IV. ACCESS TO DUAL TECHNOLOGY

A. *How is spectrum allocated to different technologies?*

In India, allocation is handled by the Wireless Planning & Coordination (WPC) wing of the department of telecommunications (DoT).

The two primary technologies in use today are GSM and CDMA. Both operate in different spectrum bands on account of their different technological requirements.

The following spectrum bands are in use in India:

- **GSM:** Frequency bands 890-902.5 MHz paired with 935-947.5 MHz and 902.5-915 MHz paired with 947.5-960 MHz has been allocated to GSM technology. Initially, GSM operators are allocated a chunk of 4.4 Mhz and subsequent allocations are in multiples of 0.6 Mhz. This makes it a total of 25 + 25 MHz.
- **CDMA:** For CDMA, the frequency band earmarked is 824-844 MHz/869-889 MHz A total band of 20+20 MHz The allocation for CDMA, therefore, is slightly lower than that for GSM. CDMA operators are demanding that they be allocated as much spectrum as GSM which the latter is opposing.

B. *What is the criteria for spectrum allocation?*

The difference in allotments to GSM and CDMA operators is because CDMA technology is considered more efficient than GSM. The government has adopted an incremental approach to spectrum assignment, with the amount of spectrum assigned based on the number of subscribers. However, this is generally not regarded as the best approach

The service providers to offer access services using combination of technologies (CDMA, GSM and/or any other) under the same license". As per these recommendations, "A licensee using one technology may be permitted on request, usage of alternative technology and thus allocation of dual spectrum. Mobile telephone service providers in India use GSM and CDMA technologies. GSM technology works in the frequency bands of 900 and 1800 MHz in India and CDMA technology works in the 800 MHz band. 800, 900 and 1800 MHz bands were earlier allotted to the defense services for their mobile communication usage

V. CONCLUSION

All wireless devices such as a radio, cellular phone or radio frequency identification device for radio monitoring of products require spectrum. The amount of spectrum needed depends on the sophistication of the technology and the total number of devices in use—the amount of traffic generated. In short, as the use of wireless devices grows, the requirement of spectrum grows. Unfortunately, the spectrum available is limited. To understand how useful spectrum sharing could be for the growth of cellular telephony, we have to understand its advantages and disadvantages. Increased traffic and,

therefore, increased spectral efficiency is a clear advantage. The absence of a formal licensing procedure not only saves considerable time but also increases the flexibility in the use of a cellular phone in terms of application variety and possible Assignments, Pricing and Dual Access of Spectrum are needed.

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