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Research Paper

Methods for spectrum Assignment ,Pricing and Sensing Mechanism

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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. 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 2.5 + 2.5 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.

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 licence". 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 defence services for their mobile communication usage. This paper deals about drawbacks of existing spectrum allocation Methods, different category of pricing Scheme, Sensing Mechanism and Proposed New Mechanism.

Keywords-CDMA, GSM, FCFS, Lottery, BeautyContest and Auction.

Introduction

The word 'Spectrum' basically refers to a collection of various types of electromagneticradiations (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.

The 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 licence.

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 favoured technology-neutral allocation on the grounds that an efficient technology should not be penalised.National Frequency Allocation PlanThe 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 bands.applicants.

I. Drawbacks of Existing Allocation Methods :

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.

Disadvantages:

üAll band Applicants need to wait for long time even they need Limited amount of Spectrum.

üPriority given only for senior basis not for Severity (Emergency Use).

B.Beauty contest

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 licences.

Disadvantages:

üIt is difficult to keep the selection procedure objective,A beauty contest tends to favor established companies, who can cite a track record in support of their case.

ü The selection procedure can be a lengthy process and evaluating against them can both be difficult processes.

ü Risk of confusion among bidders who may not clearly understand regulatory priorities and Encourages applicants to minimize resources devoted to other important priorities (i.e. rollout, coverage etc.)

üHard to achieve in practice, requires an accurate list of the whole population scattered over a wide area.

C.Lottery

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

Disadvantages:

üHard to achieve in practice, requires an accurate list of the whole population and expensive to conduct as those sampled may be scattered over a wide area.

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:

üAvoidance of collusion between participants to avoid high prices

üEncouraging a sufficient number of bidders, particularly new market entrants

üSetting of appropriate reserve prices

üPotential market structure

üDefault after winning the auction

üType 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.

Disadvantages:

üAuctions are not appropriate where the number of bidders is likely to be less than the number of licenses.

üAn auction requires careful preparation by both the awarding authority and applicants if it is to be successful.

Drawbacks in Existing Spectrum Sensing

Unlicensed (secondary) user cannot protect.

üAvailable spectrum looks scarce

üMeasurements show the allocated spectrum is vastly underutilized.

Drawbacks 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. In India, existing 2G licensing framework imposes the following levels/fees on a UASL/CMTS licensee seeking to provide access services using wireless technologies:-

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

ØDetermination of upfront charges for spectrum

Presently the UAS licence 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,

·**(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.

·**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.

ØDetermination 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.

·Incentive spectrum fees

An incentive fee attempts to use price to achieve spectrum management objectives by incentivising 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.

·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.

·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 licence-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.

Drawbacks of Existing Spectrum Pricing

Prices are used as an important mechanism to ensure the spectrum resources are used efficiently by users.

· An important issue can arise when the regulator uses both administrative and market-based systems for different spectrum segments, and this is the issue of price adjustment and alignment. For example, how spectrum prices should be adjusted in adjacent bands when auctions take place indicating a rise in the opportunity cost of spectrum and equally should prices fall along the lines of **mark-to-market valuation adjustments.**

· We discuss where spectrum is assigned by means of a lottery: a winning ticket chosen at random will carry with it a spectrum award. This is a 'non-pricing' method of assignment. However we note it here (and advise against it), as the lottery winner will often wish to turn the licence into cash (if is he or she is allowed to do so) by trading it on a markets.

We then consider in some detail how prices for spectrum licences can emerge through an auction process, reviewing different types of auction and their likely outcome. Auctions are a well-know means of using market-generated prices to assign spectrum at the time of its first issue by the spectrum regulator. Where subsequent or secondary trading of licences is allowed, procedures will emerge ·which set the prices for such trades, and these may also include auctions. We review the conditions for such trading successfully to emerge.

Proposed Methods for Spectrum Assignment ,Pricing ,Sensing :

Usage-based methods of allocation under open access of Spectrum. Allocation of spectrum measure the "extent of use" of transmission resources. The primary objective of this usage-based methods is to provide a summary of techniques used for

designing fair and equitable access fees for the recovery of fixed transmission costs. The discussion is thus organized under algorithms for transmission usage evaluation.

The broad goals and objectives of usage based spectrum pricing are:

·Covering the costs of spectrum management activity borne by the spectrum management authority or regulators;

·Ensuring the efficient use of the spectrum management resource by ensuring sufficient incentives are in place;

·Maximizing the economic benefits to the country obtained from use of the spectrum resource;

·Ensuring that users benefiting from the use of the spectrum resource pay for the cost of using spectrum;

·Providing revenue to the government or to the spectrum regulator.

· This section on spectrum pricing explains these possibilities in greater detail. We start with a discussion of prices or charges set to recover the cost of running a spectrum regulatory agency. We then discuss spectrum usage fees which are charged to recover a spectrum resource rent and ensure spectrum is utilized on an efficient basis.

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 in usage based Transmission cost. The unlicensed (secondary) user needs to ensure that the licensed (primary) user is protected, i.e., that no secondary user is harmfully interfering any primary user operation, Scarcity and Utilized known Easier. Prices are used as an important mechanism to ensure the spectrum resources are used efficiently by users Spectrum sensing can be used to detect the presence (or absence) of a primary user. In these regulations, spectrum sensing plays a major role.

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