The Process of Mobile Spectrum Allocation and its impact on Electronic Commerce and Mobile Commerce

How the air around you is sold for Billions of Dollars?

Spectrum being a very scarce natural resource of a country has to be judicially used for the purpose of nation building and the allocation process to telecom operators should be very transparent and ethical. There are various ways of how spectrum can be allocated and there is no best way that can be adopted universally. The market situation, Government policies, competition etc determine the price of the spectrum and this is purely a regulatory or a government decision to sell spectrum to telecom companies. The different allocation methods, their implications with case studies across the globe is analysed and presented in this paper. The reason why spectrum allocation should be fair and transparent and the cost should be reasonable is analysed and described.
1. Spectrum

The frequency spectrum is a representation of the frequency domain. In a signal frequency spectrum different bands are used for different purposes. These purposes can be simple power lines, to radio frequencies, TV, Satellite, Mobile phones, X-Rays, Gamma-Rays, etc. Our focus is towards Mobile Spectrum. They have a large range of possible frequencies that change in between the different generations of mobile devices. A question one might ask is how the different bands are assigned for the providers, which is a process called spectrum allocation. This paper has the objective to explore the different methods of spectrum allocation, focusing mostly on the auction method, the different types of auction and the outcome in using each method.

2. Mobile Device Generations

Before moving on to the spectrum allocation, we will first cover briefly the different generations in mobile devices. 1G, was the first generation of mobile devices. This had analog telecommunication standards that were replaced by the 2G devices. The main difference between these two generations was that 1G was analog, while 2G began the digital mobile telecommunications. As a result of having its conversations digitally encrypted, the second generation services gave more clarity to the conversation compared to its predecessor. New services were also added to the mobile devices, such as text messaging, multimedia messaging and internet access. Its radio frequency bands were 900MHz and 1800MHz. The third generation was an improvement of the second one, which included an even bigger improvement in the quality of the conversations, and its networks having greater coverage and speed. It’s radio frequency bands were of 2100MHz combined with 900MHz. The fourth and most recent generation, also known as 4G, guarantees even faster speeds, lower latency and reduced network congestion compared to its predecessor. Its radio frequency bands are of 1800MHz.

3. Spectrum Allocation

Spectrum allocation is the process of assigning specific bands to companies that wish to own them and that meet a certain criteria. This has been an issue since mobile devices started operating. Choosing which company is best suited for a specific band’s license is not at all a simple process. If not well managed, there is a big chance of corruption in the process, the assignment to a company which is not best suited for the license, and many other issues.
4. Spectrum Allocation Methods\textsuperscript{[11]}

There are three methods of spectrum allocation, including the spectrum auction. The spectrum auction is a spectrum allocation method in which the government will sell the rights and licenses to transmit signals over specific bands of the spectrum through an auctioning system. In other words, companies who wish to acquire the band’s license will bid for it, and at the end the company with the highest bid will be assigned to that band.

The next method is known as the Administrative Process of Beauty Contests. In this method, all companies who are interested in obtaining the band’s license make a proposal on how they intend to use it. A regulator will hear all the proposals and in the end will chose the company with the most attractive proposal. Unfortunately this process has a series of issues such as the fact that it is extremely time consuming in order for the regulator to hear all the proposals. It also has the down side of being vulnerable to corruption as the competitors will in various ways try to influence the regulator’s decision.

The third method is known as the lottery. When using this method, the license winners are randomly selected. Though it may be a lot faster than any of the other spectrum allocation methods, it’s down side is the fact that the winners aren’t always the best suited to have the license. This could easily backfire shortly after the license is awarded to the winner and because of this; the lottery method is a lot less used than the other ones.

5. Spectrum Auction

With all the necessary details covered, we can finally go into the spectrum auction method. As shown in the table [Appendix], this process was widely adopted in the end of the 2000s by developed and developing countries. The reason why it’s starting to be more widely adopted is due to its advantages over the methods described previously. These advantages include the fact that a well-designed auction achieved an efficient allocation of the spectrum, it isn’t as time consuming or as vulnerable to favoritism and corruption as the beauty contests could be. On top of that, the auction system can raise large amounts of money to support public finances.

5.1. Auction Aim

The objectives of the auction process differ from country to country. In the broad aspect, we can classify it into three fold. The primary objective is efficiency in which the resource should be allocated to the most valuable company who can effectively use the spectrum. Secondary objective is competition and facilitating the competitiveness on the market is essential for the success of the auction. The more the
competitiveness, the more the efficient of the process and more the revenue it would generate. The third objective is revenue and the revenue earned from the auction can be used by the government to spend it on the public infrastructure. Europe earned about $100 billion from the 3G auction head in 2000\textsuperscript{[6]}. FCC earned about $40 billion out of the auction conducted from 1991 to 2001\textsuperscript{[2]}.  

5.2. Auction Types\textsuperscript{[6]}

5.2.1. Sealed Bid Auctions

5.2.1.1. First-Price Sealed Bid Auction

In this auction, each bidder is asked to submit a bid. The highest bidder wins the auction. Buyer pays the amount equal to his bid. Since, this auctioning method doesn't facilitate the information sharing; each bidder submits his bid independent of the other bidders. Mostly bidder with highest amount wins the bidding as they bid to their actual valuation.

5.2.1.2. Second-Price sealed Bid Auction (Vicerey Auction)

In second price sealed bid auction also the bidder places a bid on the object. But the winner has to pay the second highest bid amount rather than first highest as in first price sealed bid action. This method was introduced by Vicerey (1961). He showed that optimal strategy for every bidder is to bid to his true valuation. A bidder with valuation (\(V_i\)) can either bid in two ways.

1) Other bidders may be bidding higher than his bid, so he may end up in bidding more than his actual valuation. So, when the bidder \(V_1\) wins the bid, (s) he may end up in paying more than his valuation, which is not optimal.

2) Other bidders may be bidding less than what bidder \(V_1\) might bid. In both case the optimal strategy would be to bid to his actual valuations. This kind of bidding process is seen on eBay, but not widely used in telecom auctioning.

5.2.2. Open Bid Auctions

5.2.2.1. Ascending Auction \textsuperscript{[4]}

In this auction, bidding starts with lowest price, bidder increases the price till one player left on the bidding. The last bidder wins the bidding and pays the amount. This can be potentially silent and be active on the last round of auction. This phenomenon is quite common in ascending auction. Strong players can play dominant role in this type of auction. It can facilitate predatory/collusive behaviours within the bidders. New entrants to the market or the weak players may be get equivalent opportunity to compete with the incumbents in the market.
5.2.2.2. Dutch auction

Dutch flowers in Netherlands were sold using this type of auction. Auctioneer sets the highest bid amount and lowers continuously till some bidder’s shows interest. Like the first priced auction, each bidder expresses the interest at which (s) he wants to buy. Like the Ascending price action, the bidder should have good evaluation of the price of the spectrum or else he may not get the license or end up losing the money. Since the bidder who wins pays the highest price, it's technically equal to first price sealed bid auction.

5.2.2.3. Clock Ascending Price Auction

In this mechanism, the seller starts the auction at a lower price. Bidder expresses their willingness to buy at each stage. When there is more than one bidder, the seller increases the price of the spectrum by pre-calculated bid increment, and the whole process continues till there is only one player left on the auction. As the winner pays the last highest price, it's technically equal to second price closed auction.

5.2.3. Open Bid Vs. Closed Bid Auction

The prime advantage of the open-bid type is it reveals the information about valuation. This promotes the efficient assignment of licenses, since the bidder has more information. Since the bidder has information about the other bidders, strong bidders usually bid aggressively. On the other hand the advantage of sealed-bid auction is it guarantees highest revenue, the bidders on sealed-bid auctioning type can generate revenue only by placing highest bid with open bidding, and the tacit agreement between the bidders is possible. Advantage of revealing more information outweighs the risk of collusion. This may be deciding factor among these bidding process.

5.2.4. Sequential Vs. Simultaneous Auctions\(^7\)

Actions for several circles can be put into sequentially or simultaneously. Sequential action limits the information about other spectrum blocks. So, the bidder must guess the prices of the future auction while bidding for the current auction. In sequential auction, the bidder cannot switch back from the previous license that he won, to other auction in later bid. In Simultaneous auction, a large collection of related licenses is up for auction on the same time. It’s more transparent, efficient than sequential auctions. The Swiss wireless-local-loop auction conducted in March 2000 illustrated the difficulties of sequential sale. Three nationwide licenses were sold in a sequence of ascending auctions. The first two licenses were for a 28 MHz block; the third was twice as big (56 MHz). Interestingly, the first license sold for 121 million Swiss francs, the second for 134 million Swiss francs, and the third (the large license) sold for 55 million Swiss francs. The largest license sold for just a fraction of the prices of the earlier licenses \(^2\).
5.2.5. Consideration in Auction Design

There are many factors which complicates the auctioning design process. It's essential to know some of the important factors for successful auction design.[5]

5.2.5.1. Reserve Price

It's the minimum amount the winner needs to bid for the spectrum. It guarantees minimum revenue for the government. It discourages frivolous participation, as it guarantees minimum revenue, it would be good strategy for the government in case of weak competition in auction, and inadequate reserve price increases the predation or collusion. Strong bidders have always participated aggressively, when the reserve price is low, it would increase the collusion. In 2000, The Swiss ran an ascending auction for four licenses, and attracted considerable initial interest from potential bidders. But weaker bidders were put off by the auction and at least one company hired bidding consultants and then gave up after learning that the ascending-bidding rules would give the company very little chance against stronger rivals. Government changed the bidding rules on the last minute and it permitted joint bidding. So, the number of contestants went down from 9 to 4. Each one of them won the auction at reserve price. Government tried to change the auction rules, but the legal commitments restrained it from modifying the bidding rules.[3]

5.2.5.2. Collusion

Another major consideration on auctioning is the collusive behaviour. Bidders can implicitly or explicitly collude to keep the auction price down. In 1999, Germany auctioned ten blocks of license on simultaneous method. Mannesmann and T-Mobile were only the two bidders. Mannesmann bid 18.8 million for the first block of 1-5 and 20 million for second block of 6-10. Auctioning had an activity rule that every participant had to bid 10% more than the previous round. T-Mobile bid less than Mannesmann on the first round. But T-Mobile said, the bid price of Mannesmann for block 1-5 considered as offer, as the 10% of first block is about 20 million, each player won one block of license. This is a type of collusive behaviour.[2] These kind of collusive behaviours mostly couldn't be legally challenged or proved.

5.2.5.3. Predatory Behaviour

Strong bidder always has the tendency to be aggressive on the auction. They try to be dominant and suppress the other weaker bidders. A bidder who buys assets that are complementary to assets for sale in a future auction or who simply bids very aggressively in early auctions can develop a reputation for aggressiveness. For example, before bidding for the California phone license, Pacific Telephone
announced in the Wall Street Journal that “if somebody takes California away from us, they’ll never make money”- this could be interpreted as a threat of predatory pricing.[1]

5.2.5.4. Mergers and Acquisition

This is another factor in the competition law and commonly observed in auctions. It can be post-auction (takeover agreements after assignment) or pre-auction (mergers before auction). They are strategic in nature and can potentially be detrimental to the transparency of the auction process.

5.2.5.5. Associated Bidding

It's a competition issue. When the company is jointly owned by two or more operators, it complicates their bidding as individual player in the auction process. Various countries handle the associated bidding behaviours differently. In 2000 UK 3G auctioning, government restricted no more than two players on the bidding can bid for the auction. Cellnet was jointly owned by BT and Securicor. BT finally bought the shares of Securicor, which helped the other two bidders to participate on the auction process. This kind of pre-auction is not usually required, but when it's required to limit the competitiveness of the market, it can be used.[1]

6. Beauty Contest and Lotteries

The Beauty Contests and Lotteries are opaque processes in spectrum allocation where there is lot of bureaucracy involved. The evaluation criteria, specification and eligibility conditions may or may not be stated clearly and hence this leads to political and legal controversy sometimes. In the beauty contest process there are also concerns that the State owned telecom operators are favored in place of private or foreign telecom operators. It is widely believed that this type of spectrum allocation has very less financial gain for the government and hence it's not filling public coffers.

7. Market Outcomes

7.1. The problem of Entry

Facilitation of the new comers to the market is essential for the healthy competition. More the bidders on the market, more efficient would be the auction and it results in more revenue. But the new comers have the challenge to fight with the incumbents. The incumbents are already established on the market, they have good infrastructure and customer base. Unless government reserves few license for the new players, it is always difficult to get into the market. The Market structure is very complex in most of the countries and there is always a significant risk in entering as a new operator competing with existing operators. They will also have to share the
infrastructure, make new agreements for roaming facilities and share many other resources with existing careers \[10\].

7.2. Royalties or lump-Sum payments

The way how the payments to spectrum auctions is made is a matter of debate. The royalty system of payment promotes new entrants. That would encourage the new entrants to share the risk with the government and hence give them a confidence to invest and operate. This can be either a variable royalty or a profit based royalty. This also poses a risk to the government when the company fails in the market. Some companies make predictive promises and they don’t deliver. Both Royalty and Lump-Sum payments can be chosen based on the requirement. Economically efficient policy and pricing is not always possible because of the realistic problems in evaluation of costs.

7.3. Number of Licenses

More operators are needed in the market to increase competition and that should be a market decision and not a generic political decision as that would be the key in serving the users need properly and in proper time rather than filling public coffers alone. License without Spectrum or Spectrum without License is again a mutually exclusive situation and that situation would result in no operation of the mobile company and to manage this there is a need for streamlined allocation of licenses.

8. Consequences in Spectrum Allocation

8.1. Mobile Operators

Mobile operators are not able to pay spectrum costs because of the high prices that they have to pay after the auction due to competition. They have funding problem when it comes to financing their day to day activities as the spectrum cost is a future investment in most of the cases. They could not maintain, upgrade existing services, contracts and they earn less revenue from earlier generation products. There is a huge job loss and wider financial implications because of the decrease in Market capital since the share markets and the overall economy doesn’t encourage such a situation. Also the market is flooded with competition and its saturated market \[8\].
8.2. Governments

Governments make money for selling air and they promote State-Owned telecom companies in the process by giving them spectrum for free or at a low cost and selling the spectrum to very high prices to private companies thinking that the revenues would go for public schemes and earn huge revenue for the government to spend on \cite{9}.

8.3. Shareholders

Share prices drop even if the company wins the spectrum in the auction and share prices also drop if they lose the auction. The shareholders feel that their investments are going to government and filling public coffers and the growth of telecom companies is comparatively lower than other industries and the spectrum costs play a key role in this. Less growth in revenue and saturation of the market also add to the worries of Shareholders.

8.4. Mobile Commerce

Spectrum is lifeline of the mobile commerce as this acts as the prime carrier for the mobiles to operate and different data services like 3G, 4G and beyond would have to work in the respective spectrums.

8.5. Mobile Users

Users are the ultimate beneficiaries as the services like mobile internet or any other value added service proves beneficial for the user. Users need mobile internet at a cheaper cost and with greater speed and coverage. This can be achieved by using the proper spectrum allocation to telecom operators and regulating them to provide customers with the best quality of service.

9. Conclusion

Penetration Rate of Mobile Phones essential and it is directly influenced by the fair pricing of spectrum. A strong evaluation criterion is needed in Beauty contests. The number of operators increases tele-density. The entry of new operators influence the way the market situation favors the user. Organic competition cuts costs for the users for the mobile services they get and this boosts mobile usage in developing countries. Using Spectrum auction to earn Public income comes at a cost and governments should realize that and be sensible and judicial in setting realistic pricing for auctions so that there are mutual benefit for the government and operators. Ultimate beneficiaries are the users and mobile commerce and the need for Spectrum is high as there is ever increase in the number of users and the services they require.
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Appendix:

Table 1- illustrating the countries that used the auction allocation method from the years 2000 to 2007

| Year | Countries                                      |
|------|------------------------------------------------|
| 2000 | Australia                                      |
| 2001 | Germany<br>Italy<br>Netherlands<br>Poland<br>Switzerland<br>United Kingdom |
| 2002 | Australia<br>Belgium<br>Canada<br>Czech Republic<br>Denmark<br>Greece<br>Israel<br>Singapore<br>Slovenia<br>United States |
| 2004 | Saudi Arabia                                   |
| 2005 | Argentine<br>Latvia<br>Bulgaria                |
| 2006 | Egypt<br>Georgia<br>Macau                      |
| 2007 | Nigeria<br>Brazil                              |
Table 2- illustrating the countries that used the beauty contest method from the years 1999 to 2007.

| Year | Countries                  |
|------|----------------------------|
| 1999 | Finland                    |
| 2000 | Ireland, Japan, South Korea, Norway, Portugal, Spain, Sweden |
| 2001 | France                     |
| 2002 | Luxembourg, Malaysia, Slovakia |
| 2003 | Bahrain, Estonia, Indonesia |
| 2004 | Croatia, Hungary, Romania  |
| 2005 | Philippines                |
| 2007 | Russia                     |