Mobile Spectrum Auctions

Vali Lalioti
BBC
201 Wood Lane,
London W12, U.K.
+44.7 64355283
vali.lalioti@bbc.co.uk

ABSTRACT

This paper is part of the author's MBA Negotiation Analysis project at the Solvay Business School, Brussels, Belgium.

1. INTRODUCTION

In January 2008 the last "beachfront property in ether" [1], the 700MHz spectrum, is auctioned in the US, which is returned by broadcasters switching to digital. This is not just another spectrum auction. It is of high value because waves at that spectrum travel far and can pass through thick walls. This makes it a valuable spectrum for mobile operators as it can deliver most innovative services that are expected to create growth in this industry. This means that the regulator is particularly interested that the auction results in 1) high overall revenue and 2) a distribution of spectrum to bidders that value it most. It is for these reasons that this US auction is particularly interesting to study and analyse, in the context of the MBA Negotiation course.

Additionally, the upcoming auctions in Europe, of similar spectrum to be released by broadcasters switching to digital, raises the debate on best auction designs that deliver along these two objectives. This report summarises the history and auction rules that govern the US spectrum auctions and provides insights into the reasons behind choices of particular auction types. It also examines the effects of a number of parameters that contribute to the rules of the current US 700MHz spectrum auction.

2. US SPECTRUM AUCTIONS

US Spectrum is regulated by the Federal Communications Commission (FCC) [2]. It was created in 1934 as independent government agency, directly responsible to Congress, directed by 5 commissioners appointed by the Presidents and confirmed by the Senate. It regulates interstate and international communications by radio, television, wire, satellite and cable.

In 1993, FCC was given the authority to use competitive bidding and since 1994 it has conducted spectrum auctions through an online auctioning system. Prior to this the Commission relied upon comparative hearings and lotteries to select a single licensee from a pool of mutually exclusive applicants for a license.

Two main advantages of auctions systems led to this decision. Firstly, auctions are found to more effectively allocate spectrum to those that value them the most and secondly, the average time from initial application to license grant is reduced to less than one year, with the public receiving the direct financial benefit from this. In doing so the Commission adapted almost all of the rules from two proposals for simultaneous ascending auctions [5]. It was the economic analysis that dictated this new design and through the years it was proven to realise some of the theoretical advantages claimed in the economic theories.

The US auctions are open to an eligible company or individual that submits an application, upfront payment and found to be qualified bidder by the Commission. In preparation for these auctions, the regulators define the rules and auction process. Additional issues affecting a spectrum auction are any restrictions imposed by the regulators in terms of technology and services to be offered by the owners of the spectrum. Information sharing options and anti-collusion rules apply [4]. Furthermore, there could be interim and end-of-term construction benchmarks as in the current US spectrum auction.

In terms of the process and depending on the auction design, number of bidders, and the number of licenses being offered, an auction might run anywhere from one day to several weeks. Auctions are typically conducted Monday through Friday during normal business hours (US Eastern Time). The first day of an auction generally opens with long bidding periods, typically two bidding rounds lasting one or two hours each, followed by round results. As the auction continues, the Commission generally increases the number of rounds per day and decreases the duration of the rounds. Bidders drop out of the auction when licenses in which they are interested exceed the value they are willing to pay. The auction continues until all bidding activity stops. Round results are released within approximately 15 minutes after each round closes. They are available for downloading, both to bidders and to the general public and detailed analysis can be carried out through the Auction Tracking Tool, provided by FCC or through a common spreadsheet program.

3. THEORETICAL BASIS

The two most popular types of US spectrum auctions are simultaneous ascending and package type of auctions [9]. These are both variations of the English or ascending-auction type and below are described in more detail.

3.1 Simultaneous Multiple-Round (SMR) Auctions

In a simultaneous multiple-round (SMR) auction, all licenses are available for bidding throughout the entire auction, thus the term "simultaneous." Unlike most auctions in which bidding is continuous, SMR auctions have discrete, successive rounds, with the length of each round announced in advance by the Commission.

After each round closes, round results are processed and made public. Only then bidders learn about the bids placed by other bidders. This provides information about the value of the licenses to all bidders and increases the likelihood that the licenses will be assigned to the bidders who value them the most. The period between auction rounds also allows bidders to adjust their bidding strategies. In an SMR auction, there is no preset number of rounds and the auction closes with a round in which all bidder activity ceases.

3.2 Package Bidding

The SMR auction design can be modified to allow combinatorial or "package" bidding. With package bidding, bidders may place bids on groups of licenses as well as on individual licenses. This approach allows bidders to better express the value of any synergies (benefits from combining complementary items) that may exist among licenses and to avoid the risk of winning only part of a desired set.

In general, package bidding is appropriate when there are strong complementaries among licenses for some bidders and the pattern of those complementaries varies among bidders.

High complementarities can create an “exposure problem”, so bidders might be hesitant to bid high if there is a risk of obtaining only part of the desired spectrum. Under these circumstances, package bidding yields an efficient outcome, ensuring that licenses are sold to those bidders who value them the most.

Package bidding might create other problems though, if small bidders are unable to coordinate a response to an aggressive package bid by a large bidder. This is known as the “threshold problem” and it is important to put mechanisms in place that avoid this type of predation.

Package bidding procedures are also designed to allow the auction to proceed at an appropriate pace, encourage straightforward bidding, and permit bidders to employ flexible backup strategies.

3.3 Discussion

Economic theory and practice has shown that ascending auctions are particularly likely to allocate the prizes to the bidders who value them the most, as the bidder with higher value can always bid again to top a lower-value bidder that might have bid higher initially. There are also particularly suited in the case of complementaries between the auctioned objects. A simultaneous ascending auction makes it more likely that bidders will win efficient bundles than in a pure sealed-bid auction in which they can learn nothing about the opponents’ intentions.

According to the Revenue-Equivalence theorem [12], in the benchmark model each of the English, Dutch, first-price sealed-bid and second-price sealed-bid auctions yield the same price on average. However, that doesn’t imply that the outcomes of the four auction forms are always exactly the same. As we know from the course in an English or second-price auction the price equals the valuation of the bidder with the second highest valuation, while in first-price sealed-bid or Dutch auctions the price is the expectation of the second-highest valuation conditional on the winning bidder’s own valuation – these are only equal on average.

The benchmark case above has the following assumptions: 1) the bidders are risk neutral, 2) the independent-private-values assumption applies, 3) the bidders are symmetric 4) payment is a function of the bids alone and 5) the number of bidders is exogenous [13]. However, few of the assumptions used in economic theory auction analysis are true in real life. Additionally, outside issues such as the market structure, might result in one type been preferred over another in similar spectrum auctions. The realities of the current US spectrum auction and how parameters such as restrictions, information and privacy and overall design might effect revenue maximization for the auctioneer are analysed in the next section.

4. US 700MHz Spectrum Auction Case

The FCC main objectives from the 700 MHz band plan and service rules is to promote the creation of a nationwide, interoperable broadband network for public safety and to facilitate the availability of new and innovative wireless broadband services for consumers. To achieve this FCC changed a number of parameters in this auction.

In particular, privacy was reintroduced and information on bidders’ names and bids is not published until after the end of the auction. Spectrum is also packaged in several bands and restrictions apply on two of the spectrum bands auctioned. One is for creating a public/private partnership to better manage public safety spectrum use in emergencies. This means that the winner will be required to negotiate an agreement with US public-safety agencies, build out a nationwide network and then give those agencies priority use during emergencies.

The other important restriction is for the commercial spectrum block C to be open. Therefore, the licensee is required to allow customers, device manufactures, third party application developers and others to use devices and applications of their choice. The open-access provisions are mainly the result of Google’s lobbying. Google is not just defending the consumer's interests, but its own: the auction is part of a larger battle over how revenues from wireless advertising and services will be divided up between the carriers and Google. However, if the reservation price is not met for this spectrum the regulator will re-auction the spectrum with changes or without these restrictions.

The five criteria, as described in the course, that help chose among the different types of auctions are: 1. expected price, 2. avoid buyer collusion, 3. minimize transaction costs, 4. efficient allocation and 5.maximize expected price. These are used below to check how simultaneous multiple-round auctions rank along these criteria and how the current auction rules are changed to aligned better with these criteria.

4.1 Expected Price

Simultaneous multiple-round auctions, as a derivative of English auction (ascending auction), is likely to give V(2) as the expected price, where V(2) is the valuation of the second highest bidder. In the current auction this is likely to be a relatively high price, as it is considered key spectrum because of its qualities and also because of the current highly competitive nature of the industry. Convergence and new entrants in this industry are likely to raise the stake and the final price in this auction.

4.2 Avoid Buyer Collusion

To maximize revenue though, it is key to ensure high number of bidders. Unfortunately, this type of auction is poor exactly in that respect, as it can allow bidders to collude, deter entry or

depress bidding of rivals. This was evident in Germany's 1999 spectrum auction, were signalling was used [13]. An auction rule stipulated that in the next round bids should be at least 10% higher than the highest bids of the previous round. One of the two strongest bidders was therefore able to signal, through the price offered in the first bid, its intensions to the second strongest bidder. So one company bid 20m DM for the spectrum there were interested in (say band B) and 18.18m in the other (say band A). Because 18.18 plus 10% is 20m DM it was perceived as a signal to the second bidder to bid 20DM for package A but stop bidding for the other band B.

Signalling is just one example of collusion, ascending auctions can also facilitate collusion by offering a mechanism for pushing rivals, as for example in a multi-license US spectrum auction in 1996-1997. In that, one bidder bid higher than the uncontested high bidder in one region, as a punishment bid, signalling that the other should drop out from another region that was more of interest to the first bidder. This is often called the "punishment" mechanism.

Predation is also particularly easy in SMRs and a good example of how "weaker" bidders can be discouraged by "stronger" ones is the November 2000 Swiss sale of four 3G mobile licenses. Despite the initial numerous interested bidders, in the end weaker bidders realized that the rules were against them and dropped out. Last-minute joint-bidding was permitted in the rules almost encouraging predation and collusion. Thus the sale price was mostly determined by the reserve price. The end result was 1/30th of the UK per capita revenue in a similar auction and 1/5th of what the Swiss had hoped for.

Privacy was reintroduced in the current US auction to minimize collusion, predation and the opportunities for signalling or punishment. However, Google used signalling through the press that they are willing to bid at least $4.6 billion, to ensure that the spectrum will remain open. Therefore, they signalled that they are willing to meet the regulators reservation price, so that the spectrum is not re-auctioned without the open platform restrictions.

4.3 Minimise Transaction Costs

To increase number of bidders and maximize revenue a lot also depends on the costs of bidding and the valuations of different bidders. FCC through their online system is trying to minimise costs to bidders. It also ensures through training that this is an open and easy system to be used by anyone with access to internet and is eligible to bid. Furthermore, potential bidders must submit a refundable deposit that is used to purchase the eligibility (bidding units) required to place bids in the auction. Prior to an FCC auction, each license being auctioned is assigned a specific number of bidding units, and the upfront payment is used to buy the right to bid on those bidding units.

The number of bidding units purchased with the upfront payment defines the maximum number of licenses a bidder can bid in each round. Therefore, pre-payment is reduced, since it depends on number of licences to bid per round rather than on the overall number of licenses that a bidder wishes to bid for. This reduces costs of entry and allows smaller firms to compete.

4.4 Maximise Expected Price

The "winners curse" is another issue that might depress bidding in some ascending auctions and "leave money on the table". The winners' curse" is the situation where the winner is the one with the most overestimated valuation. It usually happens when bidders have similar valuations but different information about the actual value. Knowing the "winners curse" problem bidders are likely to bid cautiously, which disadvantages the weaker firms that need to be extra cautious. This results in a bias towards the stronger bidders and a lower than anticipated final price.

A relevant example is the 1995 US Los Angeles license auction for mobile-phone broadband licenses. Pacific Telephone, which operated in local fixed-line telephone business in California, had advantages over competitors (customer base, brand name, own market). The result was that bidding resulted in a low price. By contrast, in Chicago where the local operator was not eligible, the final price was much higher than in LA, although the LA area is overall perceived as of higher value.

In the current auction privacy was probably reintroduced to avoid collusion as well as the risk of leaving money of the table. However, privacy makes it difficult to fully explore complementarities and opportunity to produce efficient bundling, as it is not clear who else is interested in similar bundles and opponents' intentions are not known.

4.5 Efficient Allocation

In economic terms efficient allocation is concerned with reaching competitive equilibria, with an allocation to bidders that value the relevant spectrum the highest. In some auctions, the structure of the industry cannot be ignored by the regulator. Klemperer describes some of the obvious distortions in [13], including for example prevention of entry of smaller firms resulting an over-concentrated industry. Spectrum auctions are a good example where a number of issues play into this efficient allocation, over and above efficiency in a pure theoretical economic sense. For example the market structure, public service considerations and socio-political issues, also need to be taken into consideration.

In the current 700MHz spectrum auction, efficient allocation here also means that public service objectives, as well as open-access objectives need to be met.

It is obvious, from the above "breaking news", that in the first case market and public service restrictions could create difficulties in efficiently allocating the spectrum. It seems though that the second case is an example where due to the dynamics of the market and new entrants from other industries it is likely that the reservation price would be met. However, in this case Google's signalling of its intention to meet the reservation price is likely to result in the final price being determined by the reservation price, as other strong bidders are unlikely to bid much higher than this. This is also confirmed by the above news.

The US auction introduced a further requirement on meeting interim and end-of-term construction of 35% of the geographic area within 4 years and 75% of the population within 10 years respectively.

Failing to meet these benchmarks will mean licensees keeping only what they use and the rest will become available to other potential users. This is somewhat contradictory as it introduces further obstacles to entry for smaller firms. However, from an efficient allocation point of view, it is important for the regulator to ensure that the final winners are able to deliver along these benchmarks.

5. CONCLUSIONS

The tailoring of the auctions to the specific market/case is evident in the last UK auction of 3G spectrum, which won a phenomenal amount of revenue for the UK regulator and hence the british citizen. In the UK, Ofcom is the independent regulator and competition authority for the communications industries, with responsibilities similarly across television, radio, telecommunications and wireless communication services [3]. The particular 3G auction, started with a plan to sell 4 licenses, and as there were 4 incumbends well positioned to deter any new firms from entering, an ascending auction might not have been the best design. Therefore, that auction run as an Anglo-Dutch auction – starting with an ascending auction (Anglo) continuing with a sealed-bid auction (Dutch) when only 5 bidders were left in the auction, with the additional rule that the final price couldn't be less than the price that was reached through the ascending auction part.

This changed slightly when an additional license was also to be auctioned. As Ofcom wanted to ensure that at least one new entrant would bid for this, bidders were not allowed to win more than one license. This resulted in 9 new entrants and an extremely successful auction of a final revenue of 22.5bl pounds.

Latest news on the US spectrum auction underway show that "there has been heavy bidding on the regional licenses in the B block, with total bids of over $9 billion, well in excess of the $1.4 billion total reserve price. But bidding on the D block, at $472 million, is well under the $1.3 billion reserve price. And E block bidding stands at $821 million, below the $904 million reserve price".

Would an auction, similar to the UK one above, have resulted in a higher final price for all blocks in the current US auction? As Milgrom concludes: "Economic theory was used in designing the simultaneous ascending auction… but in designing real auctions there are important practical questions for which current economic theory offers no answers." Auction design is a kind of engineering activity and it is the interplay between economic theory and engineering activity that will lead to new more efficient designs in the future.

6. REFERENCES

[1] Economist, "Airwaves for sale: is the last big chunk of radio spectrum worth bidding for?", January 26th 2008.

[2] Federal Communications Commission (FCC), USA, http://wireless.fcc.gov/uls/index.htm?job=home

[3] Office of Communications, OFCOM http://www.ofcom.org.uk/media/news/2008/01/nr_20080131

[4] FCC, Service Rules for the 698-746, 747-762 and 777-792 MHz Bands http://wireless.fcc.gov/auctions/default.htm?job=anti_collusion

[5] P. Milgrom, "Putting Auction Theory to Work: The Simultaneous Ascending Auction", Department of Economics, Stanford University, CA, USA. April, 1999.

[6] P. Milgrom and R.J. Weber, "The value of information in a sealed-bid auction", Northwestern University, IL, USA, Journal of Mathematical Economics 10 (1982), 105-114, North-Holland Publishing Company, 1982.

[7] R. Engelbrecht-Wiggans, P. Milgrom and R. J. Weber, "Competitive bidding and proprietary information", Journal of Mathematical Economics 11 (1983) 161-169, North-Holland publishing Company, 1983.

[8] Reuters, Bidding stalls in Us wireless-spectrum auction, January 30 2008. http://news.zdnet.co.uk/communications/0,1000000085,39292504,00.htm

[9] J. K. Goeree, C. A. Holt, and J. O. Ledyard, An Experimental Comparison of the FCC's Combinatorial and Non-Combinatorial Simultaneous Multiple Round Auctions , the Wireless Telecommunications Bureau of the Federal Communications Commission, July 2006

[10] Reuters, January 2008, Bidding stalls in US wireless-spectrum auction, http://news.zdnet.co.uk/communications/0,1000000085,39292504,00.htm?r=14

[11] US. National Spectrum Manager's Association, http://www.nsma.org/

[12] R. P McAfee and J. McMillan, Auctions and Bidding, Journal of Economic Literature, Vol. XXV (June 1987), pp. 699-738

[13] P. Klemperer, What really matters in Auction Design, Journal of Economic Perspectives, Vol. 16, No 1, Winter 2002, pg. 169-189.