



Spectrum Auction Design in New Zealand

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Introduction

1. The allocation of scarce common resources is a difficult task.¹ Ownership structures that facilitate trade are not present and need to be created, valuation is difficult and, as with any government decision, allocation is subject to political sensitivities. Since 1996 New Zealand almost exclusively has used the simultaneous ascending auction for the competitive allocation of spectrum.² Although this process has been refined over time, issues still remain and recent discussions with the USA have stimulated discussion around how to commercially allocate radio spectrum.

2. This report builds on the *Review of Radio Spectrum Policy in New Zealand (2005)* through considering how New Zealand has competitively allocated radio spectrum, factors pertinent to auction design, and alternative options for competitive allocation. The report specifically sets out to answer Issue 4.4 of the review – What are the relative merits of different types of auction, and are some types more suitable than others for the various spectrum markets?

3. CRA International was engaged to review an earlier draft of this report; their comments have been incorporated into the final version where appropriate.

¹ In ITU Radiocommunications terminology, frequencies are *allocated* to *services*, and then within that *allocation to services*, *assignment* of frequencies within an allocation to *users*. In this paper, however, the term “allocation” is used in its economic sense, rather than in its formal Radiocommunications sense.

² The simultaneous ascending auction (SAA) format also is referred to as the simultaneous multiple round (SMR) auction format and the simultaneous multiple round ascending auction.

Spectrum Management in New Zealand

4. The widespread market reforms of the 1980s were extended to radio spectrum management in 1989 with the introduction of the Radiocommunications Act (the Act). The Act and its regulations permitted the creation of property rights around spectrum and the ability to trade these rights. This process for the allocation and trading of spectrum is referred to as the "management rights regime" or MRR.³ The Act itself is silent on the allocation method allowing for both competitive and non-competitive processes. It has been government policy, however, for the initial allocation to be subject to an open competitive process based on the assumption that this would result in spectrum going to its highest value use.

5. The MRR is modelled on the Torrens system for land transactions, with a Registrar and Register of Radio Frequencies. Rights offer security of tenure, and may be recorded as depreciable assets, with legal boundaries (such as conditions of use and protection from interference). Rights take two forms:

- management rights – created over a range of frequencies, they are nation wide and provide the right to grant spectrum licences within the defined range of frequencies; and,
- spectrum licences – licences are granted within a wider management right and represent the right to transmit.

6. When creating a management right the Crown has two options for disposal or use of this asset – retaining the management right and allocating spectrum licences within it (e.g. 88.8 to 106.63 MHz for FM radio broadcasting), or allocating the management right itself (e.g. 890.0 MHz to 899.8 MHz used for cellular services). Of the spectrum below 30 GHz, approximately 5 GHz (17%) has been converted to the MRR. This increases to 33% if you only consider that spectrum (15 GHz) which is allocated to Fixed, Mobile and Broadcasting services.

7. Spectrum has been transferred to the MRR where demand for spectrum was expected to exceed its availability.⁴ In this situation a competitive market allocation process is seen as the most appropriate way to ensure that spectrum achieves its highest value use, and to promote competition in the down stream market in which it is used. In this way the MRR promotes government's policy objectives for spectrum, which broadly encompass:

- promoting competition;
- maximising the value of spectrum to society; and
- satisfying increasing demand.

³ For further information see the Radio Spectrum Management website [www.rsm.govt.nz].

⁴ The timing of this move is one of balancing the risk of transferring spectrum to the MRR too early and creating artificial demand, versus, transferring spectrum too late and having the added complexity of the band being highly populated with incumbents. This issue will be considered in the discussion paper *Radio Spectrum Allocation Programme*, expected to be published in the second half of 2005.

8. Where the Crown creates Management rights or grants spectrum licences, an allocation method must be determined.⁵ Requirements of the allocation process can be summarised as follows:

- It is a market based allocation process.
- It allocates at a price that reflects the market value of the product.
- It allocates in a manner that is competitively neutral and transparent.

9. In addition to the objectives above, thought needs to be given to:

- the cost to government in carrying out the allocation and cost to bidders to participate;
- performance, e.g. duration of allocation process, reliability, fairness to all parties, and the return to the Crown;
- economic efficiency – allocating spectrum to the highest value use;
- the ability to accommodate additional policy instruments, if necessary, designed to address any externalities, public goods, or other social/cultural objectives; and
- assisting the development of secondary markets or diversified market structures.

10. It must be remembered that the achievement of policy objectives involves not only determining the appropriate allocation method but also correctly defining the rights – e.g. if the policy objective of the allocation process is to allow new entrants into the market this will not be met if they can then go on to sell the rights to incumbents because the rights definition failed to prevent such reselling.

11. As outlined in the *Review of Radio Spectrum Policy in New Zealand (2005)*, the Crown may also decide to retain a proportion of the rights to meet social and cultural objectives; the allocation of such spectrum is not covered in this report but is important to note that non-commercial allocation (such as comparative hearings or direct allocation) may be used to meet public policy goals. Spectrum has been withheld from the commercial allocation process for the following purposes:

- Achieve public broadcasting goals: to cater for cultural diversity and diversity of interest, to strengthen the national or regional identity and to uphold the principles of the Treaty of Waitangi.
- Improve Telecommunications infrastructure, e.g. project probe aims to increase broadband access in schools, rural populations and community groups who would otherwise be unable to gain affordable access through commercial provision.

12. Allocations can either be direct to government agencies, e.g. spectrum reserved to meet obligations under the Treaty of Waitangi. Where spectrum has also been put aside

⁵ The Crown may also decide to retain a proportion of the rights to meet non-commercial policy objectives (see paragraphs 11-12); the allocation of such spectrum is not covered in this report.

to meet public broadcasting objectives in radio and television, mutually exclusive applications are often received and a comparative hearing (or beauty contest) is used as the allocation mechanism.

13. Compared to market based allocation mechanisms, comparative hearings are not as economically efficient as they may not allocate the spectrum to those with the highest valuation encouraging efficient spectrum use and provision of services consumers most want. Expenditure is also required to prepare the application and to increase their probability of winning, lobbying and litigation can occur. These expenditures, while they might result in the applicant obtaining the licence, are largely unproductive unlike money that is paid for a licence under a commercial allocation method which can be recycled through the economy.

14. Comparative hearings can also lack transparency due to the number of selection criteria involved and the possibility of lobbying compared to a commercial allocation process.

Market Based Allocation Methods

15. Market based allocation methods include resource pricing⁶ and auctions. Both methods place a cost on the use of a resource to encourage efficient utilisation.

16. With the creation of a market for a resource the question of value arises. Valuation methods are available to provide some guidance particularly where resource pricing is going to be used; however, the use of auctions means this is not always necessary as auctions do not require the government to have knowledge about value. Businesses themselves are seen to be in the best position to value the resource. However, when a market is thin, the government may use a valuation method to set a reserve price to ensure a fair return to the Crown. Similarly a valuation method could be used to determine if a more costly and complex allocation method is worth perusing.

17. When spectrum rights are defined well, with proper auction design and implementation, auctions allocate resources to the parties with the highest valuations; therefore it is assumed that the resource will be put to its most valuable use. From a societal viewpoint this will result in allocative efficiency where the highest bidders' values reflect society's value for the resource.

18. Auctions typically involve either a large number of sellers and one buyer (often referred to as a reverse auction or procurement auction), or a large number of buyers and one seller. In the private sector both forms are commonly used in the exchange of goods and services. In the public sector, the former auction is much more prevalent with the government being the sole purchaser. Both types of auctions – if designed and implemented appropriately – reduce information and transaction costs, provide for an effective price discovery mechanism, bring transparency to the process, generate societal value for the money, and encourage open and effective competition.

19. The second type of auction is increasingly used by nations for the allocation of such common resources as radio spectrum, water, and air (in the form of pollutant emission rights). Here nations have created property rights around resources that have traditionally been common goods in order to control their use and provide a mechanism for them to be used where they are most valued.

⁶ While not strictly "market based" by definition, this form of administrative pricing is intended to mimic a market price.

Spectrum Auctions in New Zealand

20. Radio spectrum auction methods have changed over the years, generally following increased understanding of participants' characteristics, spectrum demand, and technological developments.

Past Auction Methods

21. Radio spectrum was initially sold in New Zealand using a second price tender system, which involved interested parties submitting a sealed bid, with the bidder who submitted the highest bid winning the auction and paying the second highest offer price. The logic behind requiring the highest bidder to pay the second highest bid was that it encouraged participants to bid their true valuation of the spectrum; whereas in a first-price auction, the incentive is to bid a price just higher than the estimate of the highest valuation among the bidder's rivals, which means that bidders must undertake the complex task of estimating rivals' valuations, in addition to assessing their own business case.

22. The results of the second price tenders held in New Zealand attracted some criticism as the return to the Crown was below what some people considered to be the true value of the spectrum. This may have resulted from:

- very thin markets at the time of the auction resulting in large differences between first and second placed bids (in one case the high bid was \$100,000, while the second place bid was only \$6);
- lack of information concerning the value of the spectrum; and
- instances where only nominal bids were placed and no reserves were set, meaning that some licences were essentially given away.

23. With the unintended results from the second price tender system, New Zealand moved to a first price tender system in 1991. This method was well understood by participants, easily administered and did not draw the same criticisms as the second price tenders in relation to the return to the Crown.

24. The first price tender system does, however, have problems, the most notable being the notion of "bidders regret". Bidders regret can roughly be described as the winning bidder placing a value on the item that is out of line with other bidders' valuations and therefore making the unhappy discovery that it has over-estimated the item's value and that it has paid more than the item's value and/or that it could have been obtained at a lower price.

25. Participants in both types of tenders felt that they resembled a lottery, as they only had one opportunity to bid for each lot and, given that information on the market value was limited, if they miscalculated there was no opportunity to adjust their bids.

26. Both the second and first price tender systems also create problems where spectrum licences being offered are considered to be complementary or substitutable. Exposure risks occur for bidders that see licences as complementary (i.e., synergies between the licences result in their group value being greater than the sum of their individual values)

and a bidder does not win all the licences they wished to obtain. Morten and Spiller (1998) describe exposure risk as:

Anytime a bidder submits a bid that exceeds the stand-alone value of a licence, it runs the risk of paying a price for an individual licence that is above its stand-alone value if it fails to win one or more of the complementary licenses.

27. Where licences are substitutable, bidders in a sequential or single round auction are not able to switch between licences to allow them to obtain a licence at the lowest price that will meet their needs.

Current Auction Methods

28. New Zealand adopted the simultaneous ascending auction in 1996 and has used this system for six out of the last eight auctions. In 2002/2003 a simple closed tender was used for the allocation of one management right that remained unsold in two previous auctions. In 2004 outcry auctions were used for the allocation of three spectrum licences that had been unsold in a previous simultaneous ascending auction.

Simultaneous Ascending Auction

29. A simultaneous ascending auction (SAA) is essentially several outcry auctions held at the same time - bidding is held over multiple rounds where all lots are auctioned at the same time. Interested parties have the opportunity to bid on all available lots, bidding on lots is simultaneously closed when no new valid bids are received on any lot. Bidding rules aim to prevent participants from colluding, to decrease competition, and to ensure the auction is not drawn out over an unreasonable length of time.

30. By auctioning the lots at the same time over multiple rounds additional information is provided to participants in the form of other bidders' valuations. This addresses concerns that tenders often operate as a lottery owing to lack of information and bidders' inability to reassess their valuation and change their bids. This form of price discovery also limits the winner's curse as the highest bids are announced at the end of each round.

31. The mechanics of the SAA coupled with an auction rule allowing the withdrawal of bids, enable bidders who see the licences as substitutable to move from lot to lot (or between groups of lots), based on their relative price. Similarly, as bidders are able to assess their ability to obtain a group of lots they see as complementary, they can modify their bidding strategy or withdraw from the auction as the situation dictates.

32. In New Zealand the SAA was last used in Auction 6 (2003) to allocate AM, FM, and analogue television broadcasting licences. The licences were split into four schedules and four separate SAAs were held at the same time. The licences were grouped according to their substitutability. The bidding rules used in Auction 6 allowed control over:

- Bidding rounds – duration of bidding rounds and the period between rounds outlined in a time schedule, may be changed by the auction manager.
- Minimum bids – ability to specify a minimum bid above the highest standing bid as well as setting reserve prices.

- Withdrawal of bids – once a bidder withdraws three bids in a Schedule they will no longer be permitted to bid in that schedule.
- Bidder activity – bidders will be disqualified from making further bids if they fail to either be the standing high bidder or make a valid bid, in any two consecutive rounds in any schedule.

33. The overarching objective of the auction process, ensuring that spectrum licences went to those who valued them the most, was generally met in Auction 6. However bidding tactics resulted in two licences remaining unsold after the standing high bidders withdrew their bids and the remaining eligible bidders were not interested in these licences. This suggests that the SAA rules may need to be refined. Semi-commercial and non-commercial participants, who have not been able to obtain Crown reserved spectrum, criticised the method of allocation as they were unable to win licences given their financial constraints. The duration of the auction was also a week longer than expected.

Remaining Issues

34. While SAAs have been successful, issues of exposure, efficient allocation, parking,⁷ and collusion still remain, although they are not always experienced in New Zealand. These issues are discussed below.

35. Exposure issues remain in SAA systems as limits are placed on the number of withdrawals in order to ensure that the auction ends in a timely fashion and to limit collusion. If participants fail to obtain all the complementary licences they seek they may be left to pay more than their resulting valuation of the licence(s) acquired. This may also result in another bidder who has a higher valuation not being able to obtain the licence, resulting in an efficiency loss.

36. Activity rules used to date in New Zealand, in which the activity measure is not linked to the size (e.g. total coverage based on a MHz x population basis of licences) of the licences, have been criticised as creating a problem referred to as "parking". This tactic may also result in participants who are genuinely interested in the licence being "parked on", paying a higher price for the licence than what would have otherwise been required, or missing out all together. In other countries' auctions (e.g. Australia, Canada, the USA) where activity measures and rules are linked to the relative size of licences, parking is a much less pronounced phenomenon.

37. Collusion has not been seen as a major problem in New Zealand but, overseas, bidding methods have been used to signal intentions to other participants, often around indicating preferred licences and corresponding market splitting.⁸ Thus, the winning bids are below the winning bidders' valuations, lowering the return to the seller.

⁷ "Parking" refers to a bidder placing a bid on an item that it does not really want to win (and has little chance of winning "accidentally") in order to preserve its ability to bid later on an item that it does want. A bidder engages in a parking strategy to avoid tipping its hand to other bidders and to avoid driving up the price on the items it does want. It also provides the opportunity for the bidder to react to competitors' bidding on their desired lots by bidding on lots held by that competitor.

⁸ Market splitting involves bidders reducing their demand (sometimes significantly) for items so as to close the auction at relatively low prices. The bidder gives up the possibility of winning more items, but it expects

Outcry Auction

38. On 8 October 2004 three oral outcry auctions (collectively referred to as auction 7) were held to allocate three FM broadcasting licences. An auction house was contracted to auction the licences sequentially, with a reserve price of \$1,000. This method was preferred to other options, including the simultaneous ascending auction, as it could be quickly organised and was administratively simple and inexpensive. Furthermore, the expected value of the licences was not high and the rules were easily understood by participants.

39. The auction process was deemed a success with the three licences of similar coverage being allocated at approximately the same price to three different bidders. This outcome supported Chan's (2003) assertion that where identical items are being sold and bidders only demand one licence, winning bids in sequential auctions will tend to converge.

to pay a sufficiently lower price for the items it does win that it more than compensates for the lost opportunity to win more items.

Overseas Auction Methods

40. The use of auctions is common overseas for the competitive allocation of licences. Where multiple licences are available that have strong complementary or substitutable attributes, the SAA is the method most commonly used. Where there is only one licence, ascending auctions are often preferred due to the additional information provided to participants in the form of other bids. In some cases, however, single-shot sealed bid auctions are preferred for single licences to attract more bidders than might otherwise participate, to mitigate possible collusive behaviour, and if implementation costs would be lower.

41. Differences in the implementation of the SAA design exist from country to country, but most now replicate the USA design. In New Zealand's case there are differences in rules around the mechanics of the auction, in particular the rules around bidder activity and the withdrawal of bids.⁹

USA

42. In the USA SAA design, the activity rule is based on participant eligibility. Each licence is given a value in bidding units (based on coverage and bandwidth – e.g. MHz*pops). Participants are required to indicate the maximum number of bidding units that they hope to acquire - their initial eligibility. A deposit based on the bidder's initial eligibility is also required. The activity rule is given as a percentage of the participants' eligibility; participants must either submit bids or hold the standing high bid on licences with bidding units totalling (or exceeding) the required level. If a bidder does not meet the activity requirement their maximum bidder eligibility is decreased. The required activity level rises over the course of the auction. In the early rounds bidders may be required to be active on say, 60 percent of their initial eligibility level in order to maintain that level for the next round. Near the end of the auction the requirement may be set at or near 100 percent. A set number of activity waivers are provided to minimise the impact of human errors and technical problems, and to provide bidders the opportunity to take a "time out" to assess strategy or seek guidance from senior management.

43. The USA design for the withdrawal of bids allows any number of withdrawals in a round,¹⁰ but limits the number of rounds in which withdrawals can be made. Withdrawals relating to high bids may incur a penalty payment depending on any subsequent bid withdrawals and the price the licence is sold. The general principle is to ensure the auctioneer is no worse off if the ultimate selling price of a licence is below the value of a withdrawn bid and to encourage sincere bidding.

44. Spectrum auctions in the USA are conducted by the Federal Communications Commission (FCC). The USA was the first country to use the SAA to auction spectrum and has led many of the developments in the auction rules.

⁹ See paragraph 32 for some comments on the New Zealand rules.

¹⁰ Bid "withdrawals" within a bidding round – in contrast to across rounds – sometimes are referred to as cancelled or replaced bids.

45. Where multiple licences are to be auctioned the FCC uses the SAA. When one licence is being offered, the FCC has continued to use an ascending auction design, with the bidding rules adjusted to meet the requirements of a single licence being offered, for instance, requiring the activity level to be set at 100% from the outset.

46. In 2003 the FCC completed its first package bidding auction (Auction 51) which allocated five of the six licences available to one bidder. Bidding between the two eligible bidders concluded in two days after three rounds. The FCC has included features in its latest auction software to allow package bidding in their SAA. Package bidding would allow participants to place a single bid for a group of licences rather placing a bid for each licence within that group (see paragraphs 54 to 57 for further discussion). The FCC has envisaged a SAA with package bidding for licences in the upper 700 MHz band. The auction date, however, has been progressively moved back and at this stage no date is set.

Australia

47. The agency involved in spectrum allocation in Australia is the Australian Communications and Media Authority (ACMA), which replaced the Australian Communications Authority (ACA) and the Australian Broadcasting Authority (ABA).

48. When allocating spectrum licences, ACMA states that it will use the most appropriate auction design for the licences being allocated; both the English open oral outcry auction and the SAA have been used. The SAA has been used for the 2 GHz and 3.4 GHz auctions, while the outcry auction is most often used in relation to broadcasting licences.

United Kingdom

49. The United Kingdom has carried out four spectrum auctions, the last in 2003 for 3.4 GHz FWA. In each case the SAA method was used. In the Spectrum Framework Review, published in November 2004, Ofcom (UK's spectrum regulator) indicated that their preferred method of spectrum allocation (particularly where demand was likely to exceed supply) is by way of auction. For each future auction an assessment and consultation process will be undertaken to determine the most appropriate method of auction to suit the spectrum/licences in question and the make up of the likely bidders. A caveat was included that where there were strong policy reasons for an auction not to be used then alternative allocation methods would be considered.

50. For the allocation of the spectrum: 1781.7-1785 MHz paired with 1876.7-1880 MHz, Ofcom has proposed to hold a single round closed tender. Participants will be allowed to bid on only one licence (all licences are identical) but will be allowed to value the licence differently in relation to the total number of licences awarded, ranging from five to ten. The total number of licences awarded will be the option which results in the highest aggregate revenue, with those participants with the highest bids for that option winning a licence and paying their bid amount. In this way the allocation process determines the number of licences in the market and the winning bidders.

Canada

51. A framework for spectrum auctions in Canada was produced in 1998 and was revised in 2001. It sets out the three broad conditions to be met in determining whether an auction will be used as the spectrum assignment mechanism. These conditions are:

- demand for spectrum exceeds the available supply;
- government policy objectives can be fully met through the various means available;
and
- reliance on market forces to select licensees is deemed to be in the public interest.

52. Industry Canada has chosen the SAA as the general auction design, however, as the theory and practice related to spectrum auctions will continue to evolve, new developments in auction design such as combinatorial bidding will continue to be examined and adopted when appropriate.

53. The last spectrum auction held in Canada was in 2005 for spectrum in the 2300 MHz and 3500 MHz Frequency Bands, a SAA format was used.

Other Auction Types

Package (Combinatorial or Bidding)

54. Package or combinatorial bidding methods can be incorporated into auction design. Package bidding allows participants to place a bid on a group of lots rather than having to bid on each lot in that group. Where there are strong complementarities among the lots and these complementarities vary by bidder,¹¹ this form of bidding is attractive to both participants and the government because:

- participants avoid exposure problems due to not being able to back out of failed aggregations; and
- the government avoids potentially inefficient allocations due to failed aggregations.

55. Issues that are hindering the adoption of package bidding include the following:

- there are many ways and interrelated rules to implement package bidding, and to date theory and experiments provide only limited guidance as to how to design and conduct effective package bidding practice;
- depending on how the package bidding is conducted, there can be a loss in transparency for bidders, and also it may be difficult for bidders to specify their bids;
- the computational difficulties in arriving at an optimal solution (the number of possible combinations equals $2^n - 1$ where n is the number of lots); and
- coordinating bids and the associated free rider problem¹² when used in an ascending auction design.

56. Package bidding has been used in the tender for Fixed Wireless Access spectrum in Nigeria. Here limits were placed on the combinations that could be submitted in order to lessen the computation demands. It was a single round auction so the problem of coordinating bids and the associated free rider problem did not arise. In general, if the allowed combinations are pre-specified and limited in number, or the allowed combinations are logically structured (e.g. nested items), the more straightforward can be the package bidding design. Knowing how strong the complementarities are and how they vary across the bidders may be essential.

57. The FCC introduced a new software system (ISAS) in February 2005 that includes a bidding system that allows for multiple types of auctions (e.g. SAA or SAA with package bidding), however the package bidding feature has yet to be used.

¹¹ For example, some lots are substitutes for one bidder but are complements for another bidder. Or one bidder strongly prefers one combination of lots while another bidder strongly prefers another combination of lots that overlaps with the first bidder's preferred combination.

¹² The free rider problem in this situation occurs when the standing high bidder has placed a package bid and one or more of the other participant(s) interested in the licences rely on others to increase their bids to dislodge them.

58. In June 2005 the FCC sought input into the design of its economic experiments to examine the performance properties of its designs for conducting simultaneous multiple round auctions of spectrum licenses both with and without combinatorial bidding. Some general comments received included that the Clock or clock proxy auction should be considered and that a closer examination of the threshold problem in relation to smaller participants should occur. The outcome of this process is yet to be published.

Clock Auction

59. In a clock auction, participants indicate their demand at the stated price and the seller adjusts the price monotonically changing until demand equals supply. A clock auction (ascending or descending) is commonly used where one product has been divided into some number of identical units, or multiple products have been divided into some number of identical units (simultaneous clock auction).

60. For simultaneous and single product auctions the clock price mechanism simply replaces the participants' need to submit a price bid, as they now indicate their willingness to purchase in terms of quantity. The seller controls the price until the auction stops when demand equals supply.

61. Controlling the price limits the ability of participants to signal to each other, thereby reducing the possibility of collusion.

62. The clock-proxy auction design developed by Ausubel, Cramton and Milgrom combine the price discovery, simplicity and speed of a clock auction with the efficiency and collusion deterrence of a proxy auction final round. The initial clock phase reveals information to bidders, thus mitigating the winner's curse. The final sealed-bid proxy round entices weaker bidders to enter the auction and helps to preclude certain types of undesirable strategic behaviour.

Comment

63. In theory, package bidding appears to be the most promising change to the SAA as it reduces exposure risk for those seeking to obtain complementary licences, while retaining the ability of participants who see the licences as substitutes to switch from licence to licence. The difficulties outlined in paragraph 55 relate to design and implementation considerations and once addressed package bidding should run smoothly. However, one should not under-estimate the difficulty in practically implementing a package auction whenever more than a handful of lots are being auctioned.

64. Clock and clock proxy designs could be applied where identical lots are being auctioned; however, the introduction of a new method is questionable when the SAA can fulfil a similar function. The applicability of a clock auction in a spectrum context also can be questioned on the grounds that there rarely will be circumstances in which "identical lots" are offered. Even where several technically identical blocks are offered over a geographic area, bidders may not view them as completely substitutable because they would wish to pair a block with its counterpart in other areas, e.g. if I have Block A in Auckland, I also want Block A in Wellington. Also the control of price to limit collusion can be adopted into a SAA design (through the use of "non-discretionary bidding") without the added complication that demand might drop to zero with the change in price.

Variables Impacting on Auction Design

65. This section will summarise aspects that have a particular applicability to auction design.

Bidders' Valuations

66. The way bidders form valuations for lots varies from independent private valuations to common valuations. Bidders' position on this range influences what form the auction should take.

67. Private value is specific to a particular bidder and is not correlated with other bidders' valuations. An auction design that reveals others' bids is not a necessary feature on a pure private values context.

68. Common value is that part of a lot's value that is correlated among bidders. The winner's curse – the risk of "over-bidding" – is important when common value is present and tends to cause bidders to bid below what they would otherwise bid. Information made available to bidders that improves their confidence in their valuations and bids – such as round by round results in an ascending auction format – tends to encourage bidders to bid up to their maximum willingness and ability to pay.

69. Generally the value placed on the resource will be based upon both private information (for example the cost of production) and common set of factors affecting all parties (such as the future market price of the end service/good).

Bidders' Symmetry

70. The appropriate auction design can depend on how symmetrical the bidders are. For example, if bidders vary substantially in their valuations, budgets, and information, or if there is a large dominant bidder perceived by other bidders as being inclined to win at any cost simply by countering bids by other bidders, then a sealed-bid auction may be preferable over an open ascending auction. In this scenario weaker bidders, or those who perceive themselves as being weaker, would be more attracted to a sealed-bid auction because they are more confident they could win and win at a profitable price. However, this does raise the possibility of an inefficient outcome if the weaker bidder wins.

Bidder Collusion

71. Explicit collusion occurs when bidders agree to coordinate their bidding behaviour so as to reduce prices below competitive levels. Tacit collusion occurs when bidders coordinate their behaviour without an explicit agreement in place. Bid signalling, and strategic demand reduction involving two or more bidders, are examples of tacit collusion in an auction.

72. In addition to generally prohibiting explicit collusion (most nations' competition laws prohibit collusion in general, and in some cases "bid rigging" specifically) some auction rules also serve to limit the ability of participants to signal to each other, such as placing limits on the withdrawal of bids and controlling the form of valid bids. Limiting information about the identity of bidders (reporting all bids or only high bids in each round without identifying bidders) can also make collusion more difficult.

73. Particular auction designs, like ascending auctions, are more prone to collusion through signalling than single round auctions such as tenders. Single round auctions also are less prone to collusion as bidders are unable to retaliate within the auction against parties who “cheat” on a collusive arrangement.

Bidder Participation

74. Bidder participation is an important consideration in the design of auctions as it can impact on the level of revenue achieved and provide information on the value of spectrum for later auctions or for resource pricing. Increasing the number of participants increases the depth of valuations, such that the resulting auction value is more reflective of the actual value.

75. Encouraging participation can also impact on competition in the downstream market and improve efficiency. Auction designs that are only attractive to incumbents discourage other participants and therefore possible competition in downstream markets. Preserving the market power of incumbents may not be the socially optimal choice if the existing market is not competitive. Where the level of downstream competition is in question, it may be appropriate to set a cap (including a cap of zero in some cases) on the number of lots certain (e.g. an incumbent with market power) or all bidders can win.¹³

Participation Costs

76. The level of bidder participation can be affected through costs outside that of paying the winning bid for the resource. These costs include those associated with forming a valuation, preparing bids and participating in the auction. As the cost of participating in the auction increases, the value placed on the resource decreases, lowering the number of potential participants.

77. If the cost of forming valuations is high this could reduce the numbers willing to participate. In such cases, it is in the seller’s best interest to reveal as much information as they have to assist in the valuation. Also, where a level of commonality in valuation is present, some form of ascending auction design may be appropriate and adopting this auction format would help mitigate the high costs of forming valuations.

78. Bid preparation costs include the method of submitting bids, calculation of bids, and interpretation of previous results. These costs influence the attractiveness of participating. A method used to reduce these costs includes limiting what bids can be submitted. In some cases bid options are provided at certain increments above the previous high bid, say 5%, 10% and 15%. If each round’s results are to be publicly announced they should be in an accessible format.

79. Other participation costs could include requiring deposits, cost of travel, the purchase of computer software, the duration of the auction and post auction procedures.

¹³ The cap could be extended to the amount of spectrum within a band that any party can control, regardless of how it was obtained (whether in a government auction or the secondary market).

Strategic Announcements

80. Bidder participation can also be affected by strategic motives. Bidders known to have large financial resources could influence the participation of others by publicly announcing their intention to win the auction and thus hopefully deterring competition and acquiring the resources cheaply and possibly limiting the competition in the down stream market for which the resource is used.

Auction Type

81. The type of auction can impact on participation, particularly through allowing the aforementioned effects to be prevalent. The use of well known and tested methods can ease the cost of participation, leading to higher participation, whereas the use of a new method can have the opposite effect unless this is outweighed by the benefits of the new design.

82. Ascending type auctions provide valuable information reducing the cost of bid preparation and lessening the winner's curse. However, this type of auction can discourage participation when a financially strong bidder is present as the chance of winning the resource decreases and potential bidders opt out to avoid the cost of participation.

83. Single-round tenders may encourage a greater number of participants as there is a greater chance of winning. However the cost of preparing valuations may be greater due to the lack of information in the form of other participant's bids. Participants may also discount their bids to avoid the winner's curse.

Lot Structure

84. Lot structure can also affect participation. Matching lots to the number of incumbents in an ascending auction does not encourage new entrants to participate as the possibility of winning could be deemed low. Large groupings of resources, rather than a number of smaller lots that can be aggregated, discourage the participation of smaller bidders, through both budget constraints and not allowing business cases built on smaller bundles. Conversely lots still need to support a feasible business case on their own and there are costs to participants when attempting to aggregate licences.

Relationship among Lots

85. The number of lots and their interrelationship has to be factored into the auction design. Lot characteristics can be summarised as follows.

Substitutable

86. Lots are perfect substitutes for a bidder if the bidder is indifferent between them. For example, a bidder may be indifferent between 10 MHz lot A in Auckland and 10 MHz Lot B in Auckland; the lots are substitutes for the bidder, and it will choose between them purely on the basis of price.

Complementary

87. Complementary lots are those where the value of the group of lots is greater than the sum of the individual values of the constituent lots. In this situation, unless package bidding is available, bidders can only express the synergy value by including it in their bids on one or more of the individual lots. Allowing bid withdrawals reduces the risk of the exposure problem that occurs when a bidder has placed a bid on one lot greater than its valuation for that individual lot and then cannot win the complementary lots.

Substitutable and/or Complementary

88. In some cases it may not be clear if lots are substitutable or complementary; they may be both and could be viewed differently by different individuals. Fortunately auction designs used for the allocation of complementary licences also accommodate substitutable licences.

Neither Substitutable nor Complementary (or Only One Lot Is Being Sold)

89. In this case a single, independent auction can be held for each lot in question. One caveat to that is if a bidder is interested in the lots in two or more of the auctions and the bidder has a budget constraint. With separate auctions, a bidder will need to guess how much it should allocate its budget across the auctions in case the prices across the auctions will prove to constrain its budget.

Future Auction Design in New Zealand

90. No one auction design is best in all situations. The form future auctions should take is dependent upon many factors, with each situation needing to be independently assessed in light of policy decisions, technical considerations, and the characteristics of participants. The examples below illustrates why each situation needs to be independently assessed.

91. Auction 6 (schedule 2) disposed of 45 FM broadcast licences through out the country, only two were won by participants not acquiring any other licences. It is reasonable to assume that some of the bidders would find synergies in having multiple licences, supporting the use of the SAA. However, an auction of similar licences in the future but with the participants subject a one licence spectrum cap and where licences were not seen to be substitutes, could mean another auction design is appropriate. Although the SAA rules could be adjusted to meet this requirement, local outcry auctions may be just as effective, and have been shown to allocate the licences over a much shorter period, lowering the cost to the participants. Where there are multiple identical licences to be auctioned in an area then a SAA could be considered.

92. The planning for the allocation of the 3.5 GHz spectrum licences demonstrated the difficulty in weighting the various factors pertinent to auction design. Government policy objectives impacted on participation and desired aggregations through limiting the number of licences that can be won, contiguity conditions, and bidder eligibility. Feedback on the lot design and the nature of the fixed wireless services to be provided by the licensees indicated that synergies exist among licences; therefore from an allocative efficiency view some form of simultaneous auction could have been appropriate, ideally incorporating package bidding. However the characteristics of the participants also needed to be taken into account. Many of the participants are small and medium sized enterprises that may not have the resources at their disposal to deal with a long and complicated auction process. The tension between these two requirements needed to be reconciled during the auction design process. Given the expected low value of these licences, the cost of altering and testing the auction software, the cost to participants of a lengthy internet based auction, and the availability of national and international market information, a single round closed tender auction with package bidding has been chosen.

93. Assuming a new spectrum allocation will be required for the development of 4G cellular technologies, auction design will need to cope with possible competition issues. Auction design and lot structure need to ensure that there is an efficient allocation but also credible bidding to ensure a fair return to the Crown. This market is dominated by strong incumbent cellular providers. Thus, either through lot specification or auction design, an opportunity needs to be created for others to effectively compete for the spectrum.

Conclusion

94. The commercial allocation of spectrum in New Zealand has attempted to ensure spectrum is allocated to those with the highest valuation, assuming that this would result in it being put to its most valuable use.¹⁴ The current practice of assessing each situation as it arises enables the auction design to accommodate the changing profiles of the participants and relationships among lots. This practice is in line with other countries and seems to be appropriate.

95. The SAA remains the most appropriate method for allocating lots with complementary or substitutable characteristics. Alternative auction rules and mechanics can be tested to attempt to shorten the duration of the auction and to limit the use of "gaming" strategies like "parking". When designing future SAAs consideration should be given to:

- non-discretionary bidding to reduce the cost and time taken to prepare bids, and limit the ability of participants to signal each other;
- reviewing the method by which minimum valid bids are calculated to allow the price to increase more rapidly when competition is high;
- reviewing how the number of rounds per day is determined; and
- reviewing the rules and penalties for the withdrawal of standing high bids to deter "gaming" by participants.

96. The Ministry will continue to monitor the use of package bidding in the SAA by the FCC should be monitored with the view of assessing its applicability for future allocations in New Zealand. Where lots are shown to be strongly complementary and the complementarities vary across bidders, in theory package bidding can bring increased efficiencies and reduce the participation costs for bidders seeking to acquire groups of licences; however it is yet to be fully tested.

97. Where the assessment of a proposed allocation indicates that the SAA is not appropriate other auction methods should be considered, as illustrated by the planning of the allocation of the 3.5 GHz spectrum licences where a combinatorial tender will be used. Similarly the outcry auction can still be appropriate where licences are neither complementary nor substitutable (and issues related to bidders' budget constraints are not significant), or if they are substitutable they are essentially identical and participants only demand one licence. In the USA an Internet based SAA design has been used to replace the outcry auction, however the cost to modify the software and host such an auction in New Zealand may not be justified due to the associated revenue stream.

¹⁴ In limited cases allocation has been qualified to take into account the market structure, public good aspects and externalities.

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