July 11, 2020

# Auctionomics review of the ACMA's proposals for the 850/900 MHz band

## Executive Summary

Auctionomics has reviewed the ACMA's *Consultation Paper* for the 850/900 MHz band, related academic literature and examples from past spectrum auctions around the world.

We believe that ACMA's objectives can be best achieved using a simple two-stage Clock Auction design, with an initial multi-round clock stage to allocate generic lots and a subsequent sealed-bid stage to assign specific frequencies. This well-known format makes participation easy for bidders. A variant of this design was used successfully in Australia in 2018, and the variant that we propose was used successfully in the U.S. Broadcast Incentive Auction. The Clock Auction design fulfills the ACMA's objective of supporting efficient allocation and service continuity.

The alternative Sealed-Bid Combinatorial Auction design that is currently preferred by the ACMA offers little benefit over the clock auction we propose, but introduces a number of unnecessary risks and complexities. In particular, we believe the ACMA has underestimated the strategic challenges that a combinatorial, sealed-bid, first-price format would present to bidders within this auction context, and has neglected the discouraging past experience with similar auctions in other countries. The 850/900 MHz band is critical for maintaining effective market competition, and adopting a relatively untested sealed-bid design would make participation difficult for bidders and produce undue risk of an inefficient outcome.

# 1 Introduction

Auctionomics has been commissioned by Optus to prepare a review of the ACMA's *Consultation Paper* for the 850/900 MHz band[1] and to comment on auction design for the sale of 850/900 MHz licenses. The *Consultation Paper* describes the wider context of the upcoming reallocation and offers several potential allocation methodologies, noting some of their strengths and weaknesses. The ACMA ultimately expresses a preference for using a Sealed-Bid Combinatorial Auction with a first price rule (SBCA).

This document explores the merits and shortcomings of two of the ACMA's proposed auction designs: a Clock Auction with Assignment Stage (CA) and the SBCA. We first discuss the advantages of the standard CA and a proposed variant, which we believe is the most appropriate design for the ACMA's sale of 850/900 MHz licenses. We then compare the CA with the SBCA, and consider the arguments that the ACMA offers in its *Consultation Paper* to support the adoption of the SBCA. Continuing our exploration of these formats, we summarize and evaluate a 2019 working paper by Bedard et al.[2] that compares the SBCA to a simultaneous multiple-round auction (SMRA) for the purposes of the ACMA's 850/900 MHz reallocation, but in a simplified setting. Finally, we summarize the performance of the SBCA in previous auctions.

# 2 Auction Design Alternatives

## 2.1 Clock Auction with Assignment Stage

We consider a simple Clock Auction with Assignment Stage (CA) to be the best auction format for the upcoming sale of 850/900 MHz licenses. A version of this design is presented as *Option 3* in the ACMA's consultation paper, and was used by the ACMA for its sale of 3.6 GHz licenses in 2018. In the initial *allocation stage* of the CA, bidders express demand for generic lots in successive rounds, with the auctioneer raising the prices of lots for which demand exceeds supply until there is no excess demand for any lot. Different types of generic lots are treated separately (for example, the ACMA's reallocation might offer 850 MHz lots and 900 MHz lots). There are no provisional winners at the end of each round. In the subsequent *assignment stage*, bidders can win specific frequencies for the generic lots that they have acquired, through a single sealed-bid auction in which bidders can only be assigned contiguous lots.

This format offers a number of advantages. Bidders pay identical prices for identical lots in the allocation stage. The ascending format allows price and allocation discovery, which frees bidders from the need to guess about other bidders' strategies, and thereby promotes efficiency. In particular, under the CA design, bidders with high values can follow a straightforward bidding strategy that does not require them to anticipate competitor behavior. The CA format has been widely used in a wide variety of different countries and environments, including the recent U.S. Broadcast Incentive Auction. Bidders in Australia

[1] Australian Communications and Media Authority, *Draft spectrum re-allocation recommendation for the 850/900 MHz band: Consultation paper*, May 2020 (link)
[2] Nicholas C. Bedard, Jacob K. Goeree, Philippos Louis, and Jingjing Zhang: *The Favored but Flawed Simultaneous Multiple-Round Auction*, February 13 2019 (link)

are familiar with the CA format, and bidders around the world are generally comfortable with it.

This standard clock auction also avoids two forms of 'exposure risk' that emerge in other auction designs, including some SMRA variants. Under the CA format, bidders cannot win non-contiguous licenses, eliminating the possibility that they are left with unusable frequency assignments. By treating different types of licenses separately in the clock rounds, bidders also know at the end of the allocation stage which particular type of lot they are acquiring. For example, the allocation stage in this auction might offer three types of generic lots: 850 MHz licenses[3], an encumbered 900 MHz license[4], and the remaining 900 MHz licenses.

The CA that the ACMA presents at *Option 3*, however, is vulnerable to one remaining form of exposure risk that is created by complementarities in bidder's valuation. Under that standard version of the CA, bidders may end up winning a single lot for which they have no value, or (more generally) a subset of the larger package that they intended to acquire. Although this risk is eliminated by the SBCA format, there are simple design adjustments that can adequately address the exposure risk within the CA format without incurring the disadvantages of package bidding.

One way to address this remaining exposure risk is to allow bidders additional flexibility to reduce demand during the allocation stage of the CA. For example, under such a modification, if a bidder is currently bidding for two lots of spectrum (2x10MHz) of a particular type and the price of that license type increases, the bidder would be allowed to specify that its demand must be reduced from two to zero (and not from two to one). This rule would ensure bidders that, if they bid for 2x10MHz in a round, they will never be obliged to only acquire a single lot (2x5MHz) at higher prices. A similar rule was applied in the U.S. Broadcast Incentive Auction, allowing each bidder to ensure that it would not win only a single lot in the auction. A simple rule of this kind would eliminate the most serious remaining exposure risk in the allocation stage of the clock auction. Although this rule may result in an unsold lot, in the event that there is little demand for small amounts of spectrum and the amount of spectrum on sale cannot accommodate the minimum packages requested by bidders, unsold lots may also arise under the SBCA in exactly the same circumstances.[5] Importantly, if there is sufficient initial demand for licenses, then this rule would never result in two or more licenses of a type being unsold, because it does not permit bidders to reduce demand in any way that could cause such an outcome.

## 2.2 SMRA – a close cousin of the CA

An alternative multiple-round, non-package auction format that could be adopted for the sale of 850/900 MHz licenses is a standard SMRA (the ACMA's *Option 2*), where bidders bid for specific frequencies rather than generic lots (as in the CA), with an additional feature that allows a provisional winner of a single lot of some type to withdraw its provisional

[3] If the lower block of 850MHz, which is not in LTE Band 26 and may therefore be less valuable, is not in the auction.
[4] The uplink in the lower block of 900MHz spectrum could suffer interference from downlink in the upper block of 850 MHz spectrum.
[5] To mitigate the risk of unsold lots, ACMA could introduce a supplementary round of bids for any lot that is not assigned at the end of the allocation stage, prior to the assignment stage.

winning bid, subject to certain constraints. This feature, similar to the one we propose under the CA design, also limits the exposure risk within a non-combinatorial design that permits price discovery.

Traditional SMRAs with each individual license receiving separate bids had the disadvantage that a bidder could win non-adjacent licenses in the same band, which is nearly always inefficient. For that reason, these auctions have mostly given way to two-stage auctions with an allocation stage to determine quantities and an assignment stage that ensures adjacency. For two-stage designs, clock auctions are preferred because each winning bidder pays the same price for each type of license.

### 2.3 Disadvantages of the Sealed-Bid Combinatorial Auction

The ACMA has also proposed an alternative design, the Sealed-Bid Combinatorial Auction with a first-price rule (SBCA), and has expressed a preference for this format in its consultation paper. There are, however, several serious problems with the SBCA.

First, formulating a bidding strategy is complex under a combinatorial, first-price, sealed-bid auction format. Sealed bids maximize bidder uncertainty about the prices they must pay to acquire any package. They require bidders to compare values and likely prices of a large number of packages, before the auction, and with very limited information. The number of packages that bidders must assess grows exponentially with the number of lots for sale. If there are many relevant combinations and budgets play an important role, then forecasting competitors' likely bids, determining optimal strategies in response, and managing corporate approval processes are daunting tasks. But even if only a few types of lots are offered, bidders are required to evaluate and bid for a large number of packages in the SBCA, with no indication about the packages that they realistically have a chance of winning or their likely final prices. This complexity tends to discourage participation by smaller and less sophisticated bidders, and generates uncertainty and risk for bidders of all kinds.

Second, bidders may also pay very different prices for identical lots/packages under an SBCA design, which may result in an outcome that is considered 'unfair.' Our experience from past spectrum actions suggests that this is a very relevant problem that should not be neglected. Bidders that are concerned about comparative performance may bid inefficiently – and quite differently than the "net-value-maximizing" bidder model often considered in abstract environments.

Additionally, both winners and losers may experience regret under the SBCA format. For example, a winning bidder may discover after the auction that the price it paid was much higher than the value that was required to win. Alternatively, a losing bidder may discover that it could have won many licenses at a price that it was willing to pay, but failed to do so because it made an incorrect estimate of competitors' bids.

Finally, compared to other alternative open auction formats, the SBCA is a relatively untested and little-used format, which is unfamiliar to many bidders. The SBCA's historical record for spectrum sales is not encouraging and highlights the difficulty bidders have in formulating optimal bids. Most notably, in the 2013 Norwegian spectrum auction, Tele2, then the third-largest mobile operator, failed to anticipate the possibility of a credible new

entrant and acquired zero spectrum in the sealed-bid auction.[6] Tele2 ceased operations in Norway shortly thereafter. This example succinctly illustrates the problems with the SBCA format, and the reason that open-bidding is important. In order to promote certainty, efficiency and fair competition, bidders need sufficient opportunity to react to their competitors' behavior. In a sealed-bid auction, differences in information about competitors and their values can drive outcomes and contribute to substantial inefficiency.

# 3 The ACMA's Preferred View

The ACMA's consultation paper offers a preliminary view that the SBCA format is appropriate for the allocation of the 850/900MHz band because it (i) supports efficient allocation objectives and (ii) supports service continuity objectives. We do not agree with this assessment.

## 3.1 Supporting efficient allocation objectives

The ACMA's consultation paper considers the performance of alternative auction designs under specific assumptions. One of the ACMA's key assumptions is that valuation complementarities may be very strong, making bidders vulnerable to the exposure risk. However, even under a standard SMRA, the presence of complementarity alone is not sufficient to conclude that there is an exposure risk. To suffer a serious exposure problem in an SMRA, there must also be insufficient lots for each bidder to acquire its minimum needs, bidders must be unable to forecast final prices sufficiently well to protect against winning a single lot or another valueless package, *and* resale markets must operate too inefficiently to correct the initial misallocation. With sufficient spectrum on offer and the availability of simple improvements to the CA format that can mitigate the small remaining exposure risk, it would be unwise to implement the unfamiliar and historically problematic SBCA design.

The ACMA further asserts that price discovery is not important because of "complementarities between lots and the relatively small quantity of spectrum on offer." We disagree with this claim: indeed, price and allocation discovery are *especially* important in the presence of complementarities, because complementarities make it more important to identify relevant opportunities and pursue a corresponding bidding strategy. This is even more critical when the spectrum on sale is scarce and sufficiently valuable for bidders that budget limits become relevant, because in this case it is particularly important that bidders identify potentially relevant packages and because errors will have a significant effect on their future profits and operations. In order to be able to participate most effectively in an auction with these characteristics, bidders require dynamic information about the overall price levels and about competitors' quantity demands for licenses. We also disagree with the assertion that there is less need for price discovery because "potential bidders are already aware of the capabilities and therefore likely market value of the spectrum." Awareness of the "market value" of available spectrum does not necessarily provide a correct estimation of its likely price in a given auction, which often depends on temporary factors and may greatly exceed or fall short of such market value.

The ACMA also asserts that the first-price rule is "simple and transparent" and less complex than a second-price rule. But complexity is not just about the arithmetic of the price

[6] ZDNet, *Norway's 4G auction wraps with mystery winner – and one big loser*, December 10 2013 (link)

computation. As we have argued, first-price auctions are especially complex for bidders and, absent price discovery, force bidders to base their bids on poorly-founded guesses about opponents' behavior.

### 3.2 Redefining efficiency

A related concern is the measure of efficiency to which the ACMA aspires. We note that the ACMA is guided by the objective of the *Radiocommunications Act 1992*[7] to "maximise, by ensuring the efficient allocation and use of the spectrum, the overall public benefit derived from using the radiofrequency spectrum." This concept of maximizing the public benefits from the use of the spectrum is a broader definition of 'efficient allocation' than the simple maximization of winners' values. We imagine such a definition might be based on the value that a particular allocation of spectrum rights would provide to the wider society or economy, and would account for differences in measures such as network deployment, service offerings and market competition.

The ACMA also invokes 'auction efficiency' as a guiding principle, but this notion is not clearly defined. The consultation seems to equate efficiency with minimization of "strategic demand reduction," but it does not demonstrate either that the SBCA should necessarily be expected to produce less 'bid shading' than other designs or that bid shading is necessarily damaging. For the first, bid shading is an essential feature of a first-price auction, because bidders always have an incentive to bid less than their valuations. For the second, bid-shading in a spectrum auction can promote efficiency in the retail market by preventing firms from denying their competitors the opportunity to purchase critical spectrum.

More generally, the efficiency and competitiveness of a market is a function of overall holdings, rather than the results of a single auction. Price and allocation discovery during an auction ensure bidders can win at least some portion of – for example – critical 5G spectrum or low band spectrum. However, as the Norwegian example amply demonstrates, it is certainly possible for a single auction using sealed-bid design to produce both strategic demand reduction (Tele2's low bid) and an extremely inefficient ex-post outcome resulting in the exit of one competitor from the market.

These larger market concerns underline the importance of price discovery for bidders. In the absence of price discovery, it is almost impossible for bidders to accurately predict competitors' attitudes towards risk and the 'strategic' value they may place on particular outcomes.

### 3.3 Supporting service continuity objectives

An additional concern expressed by the ACMA is the need to ensure service continuity through the reallocation the 900 MHz band. Although the 900 MHz band is very lightly used at present by Telstra, it is used by VHA and Optus to provide 3G services to consumers and businesses. The argument made in support the SBCA design that "parties could be provided with a reservation of an amount of spectrum, rather than a specific block" would apply equally to a Clock Auction. In the CA, this could simply be achieved by reserving one or more generic lots in the Allocation Stage. Bidders would then be able to express their

[7] *Radiocommunications Act 1992* (link)

interest in specific frequencies during the Assignment Stage.[8] Hence, the CA, using a simple modification to mitigate a modest exposure problem, provides a more straightforward way of meeting the reallocation objectives without the risks and downsides of a combinatorial auction.

## 4 Review of *'The Favored but Flawed Simultaneous Multiple-Round Auction'* by Bedard et al.

Support for the adoption of an SBCA design for this reallocation has also been provided by a 2019 working paper by Bedard et al., which directly assesses whether the SBCA is a better choice for the ACMA's sale of 850/900 MHz licenses than an SMRA. We understand that this paper has not yet been subjected to peer review, but for the purposes of this analysis we tentatively assume that its experimental findings are valid.

The paper analyzes a simplified and extreme setting, with three bidders competing for five (almost identical) lots of 900MHz spectrum. Each bidder is assumed to strongly prefer either exactly two lots (type X bidders) or exactly three lots (type Y bidders).[9] Bidders face no budget constraints and their payoffs are set equal to the value of the lots acquired minus the price paid, with no regard to the prices paid by their competitors and no opportunity to resell unwanted lots.

*Result #1* of Bedard et al. is that, both theoretically and experimentally, the SBCA versions lead to higher "efficiency" than the SMRA versions, where "efficiency" is defined to be the sum of the values assigned by the winning bidders to the final allocation. Although this notion of efficiency is often used in auction laboratory experiments, it is not the usual or most relevant notion for a regulator, who is typically more interested in maintaining or improving competitive balance in the consumer market that the bidders serve. The paper finds that most of the value difference between auction designs arises when bidders in the SMRA design win only one of the lots on sale, rather than the minimum number they require to obtain a valuable package. By design, no bidder who wants a multi-license package ever wins only one license in the SBCA. Similarly, a bidder who wants a minimum of three lots may win only two lots in the SMRA designs, but not in the SBCA designs.

*Result #2* is that the 'SMRA-2' delivers the highest revenues among the four tested designs. If the real situation were similar to what was tested in the laboratory and actual bidders expected experimental findings like Results #1 and #2 to hold in practice, then one should expect them to resist designs like the SMRA-2 in favor of the SBCA.

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[8] We believe that the CA we propose would fully address the service continuity issue. In addition, the draft reallocation determination 850/900 proposes that incumbent operators have until the end of 2023 to migrate services even if they did not acquire spectrum in the band. Given that Optus and VHA would likely be seeking to move from 3G to a more efficient technology in this timeframe, we do not see any significant technical issues if the frequencies changed.

[9] For a 'type X bidder without A' (see Table 1), the value of a single lot is between 4% and 6% of the total value of 2 lots. (These calculations are based on our understanding that the numbers in the table represent per-lot values.)

## 4.1 Assessing the simplified setting

A clear and convincing takeaway from Bedard et al.'s analysis is that, in special environments like the one they describe, the SBCA has a significant advantage compared to the SMRA: it eliminates the SMRA's so-called "exposure risk," which is the risk that a bidder may win a single, or few, unwanted lot(s).

There are, however, other important elements and possibilities that are not addressed within the very special setting of Bedard et al., and that should play an important role in assessing whether the SBCA is indeed the best mechanism for the ACMA's reallocation of the 850/900 MHz band:

- The SBCA has major disadvantages, as described above;
- The actual environment for the sale of the 850/900 MHz band (the number and types of lots on sale and characteristics of bidders' valuations) is significantly different and more complex than that considered in the paper;
- Results from lab experiments omit features that may be important in real-world environments;
- Beyond the SMRA considered in the paper, there are other open, non-package, auction mechanisms that appear more appropriate for the sale of the 850/900 MHz band and that have a number of advantages compared to both the SBCA and the SMRA that Bedard et al. consider, including our proposed Clock Auction with Assignment Stage.

We have highlighted the disadvantages of the SBCA above. Below, we expand upon each of the other elements in turn.

## 4.2 Applicability in a more complex environment

The relevance and the scope of problems with the SBCA that we anticipate for the ACMA auction do not emerge in the experimental results of Bedard et al. This is because their paper considers a setting that is oversimplified compared to the actual sale of 850/900 MHz band. In particular, Bedard et al. assume that only 900 MHz lots are offered for sale, that bidders' preferences are simple, and that complementarities in bidders' valuations are extreme.

In the actual sale of 850/900 MHz band, both 900 and 850 MHz lots will be sold, and even lots within the same bands have meaningfully different characteristics depending on their position in relation to bidders' existing spectrum in the related spectrum bands.[10] There are also known interference issues around the lowest frequency 900 MHz lot. Bidders' preferences are usually much richer, and (at least some) bidders are likely to treat 850 and 900 MHz lots as (imperfect) substitutes. Furthermore, it is extremely unlikely that any bidder has zero marginal value for another lot in addition to its most-desired package, and no valuation whatsoever for a subset of its most-desired package, as is assumed in the theoretical analysis of Bedard et al. We expect that, in the planned 850/900MHz spectrum

[10] Notice that, unlike in the experiments of Bedard et al., there is likely to be a considerable number of possible packages in the sale of sale of the 850/900 MHz band. Moreover, in the theoretical analysis of the simplified setting, bidders only need to submit one bid in the SBCA – clearly an unrealistic feature.

auction, most bidders will not have complementarities as strong as those assumed in the experimental treatments.

Results obtained in a simplified setting do not generally carry over to more complex and realistic environments. The simplifying assumptions eliminate many of the factors that are often crucially important in real spectrum auctions. In particular, the simplified setting includes no bidder budget limits, no comparative performance of the kind that publicly traded firms face, and no ability to transact after the auction to undo allocational inefficiencies. Importantly, more complex environments tend to exacerbate the problems of the SBCA that we have discussed, and to favor open auctions that are more familiar to bidders, that allow them to adopt simple bidding strategies, and that offer relevant information during the auction.

### 4.3 External validity of experimental results

In addition, experimental results may generally be poor approximations of outcomes in real-world auctions. There are several reasons for this; in addition to those described above, bidders in lab experiments are also quite different from bidders in an actual spectrum auction. In the lab, bidders are students seeking to win low-value prizes in an abstract, simple and controlled environment.

By contrast, in an actual spectrum auction, bidders have different and richer preferences, interact in a much more complex environment and are subject to a number of constraints (technical, legal, organizational, budgetary and otherwise) that are neglected in a lab experiment. Finally, bidders in major spectrum auctions must justify their plans and eventual bids to senior management, which may result in significantly different behavior.

### 4.4 The SMRA is not the best alternative format to compare against

The SMRA formats that Bedard et al. compare to the SBCA are arguably not the best open, non-package design alternative in the presence of complementarities and exposure risks. In particular, there are three types of exposure risk that emerge in the versions of the SMRA considered by Bedard et al. First, in an SMRA where bidders bid for specific lots,[11] a bidder risks winning a non-contiguous combination of lots. This is clearly an undesirable property of an auction design for the sale of 850/900 MHz band. Fortunately, this risk can be easily eliminated using a properly designed assignment stage, as would be employed in our proposed Clock Auction with Assignment Stage.

Second, in an SMRA in which different types of lots are not sold separately in the allocation stage,[12] at the end of the allocation stage a bidder is unsure whether it is acquiring a more or less valuable lot. In this case, a bidder runs the risk of overpaying for a less valuable lot. Again, this undesirable feature can be easily eliminated by treating different type of lots separately in an allocation stage, as in our proposed CA design.

Third, under the SMRA that Bedard et al. use for comparison, the fact that a provisional winner at end of a round is never allowed to withdraw its bid exacerbates the exposure risk. The reason for this is that if a bidder is declared provisional winner of a lot and no other

[11] Including the SMRA-1 in Bedard et al.
[12] Including the SMRA-2 in Bedard et al.

bidder ever bids on that lot, the provisional winner has no opportunity to modify its demand for that lot, regardless of the evolution of the auction for other lots. Clearly, this is an undesirable property when bidders' valuations for different lots are interdependent. In short, the fact that a provisional winning bid can never be withdrawn dramatically reduces bidders' flexibility in adjusting their demand as the auction proceeds and they discover relevant information about which package they are most likely to win and at which price.

In a setting with strong complementarities – and a supply of licenses that cannot easily accommodate bidders' minimum required packages – this feature makes it likely that a bidder will end up with a single lot, for which it has no (or very little) valuation, just as the experiment found. This has a dramatic effect on efficiency. In addition, the risk of such an undesirable outcome is likely to induce bidders to bid especially cautiously. This may also reduce the ACMA's revenue. To mitigate these concerns, it is possible to grant bidders some flexibility in reducing their demand without constraints, in specific cases, as in our proposed CA.

Because of these issues, the stark efficiency superiority of the SBCA obtained by Bedard et al. hinges on the comparison with their specific versions of the SMRA. We believe that, even in the simplified experimental environment that favors the SBCA, alternative formats like the CA that we have proposed would have performed much better in terms of efficiency, while retaining a number of clear, practical advantages with respect to the SBCA.

# 5 The Sealed-Bid Combinatorial Auction in Practice

## 5.1 Auctions for mobile licenses

Evidence from the use of the SBCA format for spectrum sales demonstrates that the potential problems that we have described are not merely theoretical. A 2014 report[13] by the GSMA describes several instances in which a combinatorial first price design has produced poor outcomes. Among the realized inefficiencies are price disparities in the 2011 French 800 MHz auction, the 'winner's curse' in the 1998 Brazil auction, and the aforementioned knock-out of an incumbent bidder in the 2013 Norwegian multiband auction.

## 5.2 Irish 26 GHz Point to Point (P2P) licenses

We have also investigated the successful use of an SBCA in Ireland by ComReg to auction a portion of the 26 GHz band.[14] Existing licenses held by the mobile operators were about to expire, and the format was chosen for the allocation of new licenses.

There are meaningful differences between the ComReg sale and the ACMA's reallocation of the 850/900 MHz band. The licenses sold by ComReg were not for mobile spectrum, but for Point to Point fixed links only, and all licenses were identical and within a single band, with no impaired blocks. These facts drastically reduced the number and diversity of relevant packages. Notably, the SBCA format used a second-price rule, rather than first-price rule. The market context was also quite different: ultimately, only 15 of the 19 licenses were

[13] GSMA, *The Cost of Spectrum Auction Distortions*, p. 17 (link)
[14] ComReg, *26 GHz Spectrum Award - Response to Consultation and Decision* (link)

awarded (leaving excess supply)[15] and the total amount to be paid over the 10-year license duration by all winners (around €5m) was extremely low compared to core mobile spectrum. In short, the Irish context – which included under-demanded, identical licenses that had low, predictable values – was sufficiently different that it is not appropriate to draw inferences about the potential performance of the SBCA in the ACMA's upcoming reallocation.

It is also important to note that ComReg did not use a SBCA for the auction of 3.6 GHz spectrum, nor are they planning to do so in their upcoming multi-band auction. Indeed, ComReg's auction advisors DotEcon state themselves when considering an auction of licenses in the 400MHz band that: *"the situation is rather different from other recent awards (such as the 26 GHz award) where ComReg has been able to use a sealed-bid approach due to modest common value uncertainty."*[16] We agree with this assessment, and do not believe that ComReg's use of an SBCA design within that different context offers evidence to support its adoption in Australia for the 850/900 MHz band.

### 5.3 Auctions in other industries

We note briefly that similar caution should apply as well when considering auction formats that have been used for products that are quite different than spectrum licenses. The SCBA has been used for fisheries and energy auctions, and may well be an appropriate design for those contexts. This does not indicate, however, that an SBCA will be effective in achieving the ACMA's objectives within the different and more complex environment of the 850/900 MHz reallocation.

## 6 Conclusion

The ACMA has expressed a preference for using an SBCA design in its upcoming reallocation of the 850/900 MHz band. This design, however, requires bidders to accurately predict opponent behavior in order to bid effectively, while at the same time providing bidders with no information to guide those predictions and their behavior during the auction. This greatly increases the likelihood of unintended, unfair and inefficient ex-post outcomes. The ACMA's consultation paper does not correctly account for these real-world complexities, nor does it place sufficient weight on the barriers to effective participation that bidders would experience under an SBCA design. Moreover, the limited available evidence suggests that the SBCA's flaws are likely to materialize in practice.

Instead, a Clock Auction with Assignment Stage better meets the objectives of the ACMA, is more straightforward for bidders, and has already been used successfully both in Australia and in a large number of other spectrum auctions. This alternative and less risky design fully meets the ACMA's objectives to support efficient allocation and service continuity.

[15] ComReg, *Results of the 26 Ghz Spectrum Award 2018* (link)
[16] ComReg / DotEcon, *DotEcon Report - Award of Licences for the use of Radio Frequencies in the 400 MHz band* (link)

## Biographies

### Prof. Paul Milgrom

Auctionomics was co-founded by the godfather of auction theory, Paul Milgrom. He is the Shirley R. and Leonard W. Ely, Jr. Professor of Economics at Stanford University. Professor Milgrom is a Distinguished Fellow of the American Economic Association and a member of both the National Academy of Sciences and the American Academy of Arts and Sciences. Among his major prizes are the 2008 Nemmers Prize, the 2012 BBVA Foundation Frontiers of Knowledge Award, the 2014 Golden Goose Award, the 2018 CME Group-MSRI Prize in Innovative Quantitative Applications, and the 2018 John Carty Award from the National Academy of Sciences.

Professor Milgrom was one of the inventors of the Simultaneous Multiple Round auction design, which was adopted by the FCC in 1994 as its principal method for auctioning radio spectrum. This design has been copied and adapted worldwide for auctions of hundreds of billions of dollars' worth of radio spectrum, electricity, natural gas, and other assets. He has advised regulators in the U.S., U.K., Canada, Australia, Germany, and Mexico on the implementation and improvement of spectrum auction design, including advice about new combinatorial auction designs; he co-invented the Combinatorial Clock Auction format and invented the MaaX sealed bid auction format.

Professor Milgrom and Auctionomics led the design of the FCC's recent Incentive Auction, which repurposed 70 MHz of low-band spectrum for mobile broadband use. The Incentive Auction required solving 2.7 million interference constraints; it ultimately raised over $19 billion in revenue and paid out $10 billion to TV broadcasters to relinquish spectrum rights.

### Prof. Marco Pagnozzi

Marco Pagnozzi is Associate Professor of Economics at the University of Naples Federico II. He has a Ph.D. in Economics from Oxford University and a Doctorate in Applied Mathematics from the University of Naples Federico II. His research focuses on auction theory, industrial organization and information economics. He has published scientific papers in numerous academic journals, including American Economic Journal: Microeconomics, Economic Journal, Games and Economic Behavior, International Journal of Industrial Organization, RAND Journal of Economics, Journal of Economics & Management Strategy and Journal of Industrial Economics. Marco has been consulted by governments in several countries on the design of auctions for spectrum licenses, privatizations, electricity markets, natural gas, greenhouse gas emission allowances, bank services, medical services and exporting licenses. He has advised on bidding strategies in spectrum auctions and takeover contests in Australia, Belgium, Egypt, Italy, Netherlands, Pakistan, Portugal, Sweden, Switzerland and the U.K.

### Dr. Andy Hudson

An engineer with broad experience in the telecoms and technology sectors, Andy has a particular interest in spectrum (auctions and valuation) and the impact of new technology (5G, AI, IoTand Big Data). Andy spent 12 years at Vodafone, where he held various senior product development and corporate strategy roles. As Head of Spectrum, he was

responsible for managing spectrum policy and auctions across the entire Vodafone Group. He led over twenty spectrum auctions around the world (including Turkey, Italy, Germany, India, Spain, Italy, Greece, Australia, Romania, NL and UK) from strategy/business case development to Plc. Board level sign-off and in-country implementation. He was also Director of Spectrum Policy at the UK regulator and Global Head of Policy at the GSMA. Andy holds a doctorate in Engineering Science from Oxford University.

### Andrew Vogt

A Harvard graduate, Andrew is an experienced analyst who has worked closely with our strategists in providing analytical tools for the Canadian 2500, AWS, 700 and GCNET WAN spectrum auctions, Morocco, Senegal and European Spectrum auctions and has been most recently involved in setting up auction systems in the auction ad space. Andrew also has experience with bond auctions. Before joining Auctionomics, he worked in the securities information field.