The Manager
Major Spectrum Allocations Section
Spectrum Management Policy Branch
PO Box 78
Belconnen ACT 2616

Dear Sir or Madam,

Draft allocation instruments for 3.6 GHz band (3575–3700 MHz) metropolitan and regional lots auction - Consultation paper

On behalf of Airspan Spectrum Holdings Ltd and Dense Air Limited, I thank you for the opportunity to comment on draft instruments related to the auction of the 3.6 GHz bands of the radiofrequency spectrum in Australia.

This submission addresses matters that span both currently open public consultation processes and I will be grateful if you could make a copy available to the Spectrum Planning Section of Spectrum Planning and Engineering Branch.

ASH has previously made submissions to the ACMA regarding the *Future use of the 3.6 GHz band - Options paper*, and *Future use of the 3.6 GHz band - Highest value use assessment - Quantitative analysis* published in June 2107.

Airspan Spectrum Holdings Ltd ("ASH") and Dense Air Limited

Airspan Spectrum Holdings (ASH) is a special purpose vehicle (SPV) established to acquire spectrum assets globally as a "wholesale neutral-host" operator for small cell networks to support 5G evolution.

True 5G service concepts depend on massive "densification" of evolving mobile networks.

In markets where ASH obtains spectrum, the company seeks to establish operating companies to build wholesale neutral-host shared networks using small cell architecture to provide network densification as a service to mobile network operators (MNOs).

These operating companies are called "**Dense Air**". The Dense Air business model is currently in operation in Ireland, Portugal and Belgium with plans to expand further internationally. The small-cell products used by Dense Air are today being deployed by Sprint in the USA and Reliance Jio in India and are providing dramatic efficiency improvements.

We would like to bring this type of deployment to Australia.

This submission:

- makes the case for small cells as a service (ScaaS) being an essential part of 5G evolution;
- notes that with only minor amendments, the proposed ACMA allocation and technical framework could be adjusted to facilitate ScaaS in Australia;
- provides some recommendations as part of the formal consultation processes.

Small Cells

Mobile telecommunications systems operate using the best modulation scheme that can be negotiated between tower and handset. This depends on signal quality which in turn is a function of range from the tower and accompanying propagation loss and multi-path degradation.

Close to the tower, sophisticated 256/64 QAM modulation are possible providing very high data rates. As distance increases from the tower and the signal is degraded, the system defaults to lower-order modulation schemes like QPSK at the cell edge. This reduces bit throughput for large parts of cell coverage.

All macro LTE networks have typically poor *average* spectral efficiency over their coverage area. This is exacerbated at higher frequencies.

Small cells operate over a limited area coverage at lower powers and enable high spectrum re-use. This allows local access using high-order modulation schemes that emulate being close to the tower. This raises the bit/Hz efficiency of the entire cell.

Small cells dramatically improve the spectral efficiency of mobile network macro cells using comparatively little extra bandwidth compared to the efficiency gain.

Small cells are critical to realising the data potential of 5G services because they allow the productivity of spectrum (in terms of bits/Hz) to be raised for large parts of the coverage area.

The evolution towards 5G service concepts is not possible without "massive densification" of mobile networks and small cell architecture provides the planned mechanism to provide this densification.

Attached for your consideration is a presentation that shows how small cells raise the productive efficiency of spectrum allocation and describes the magnitude of these gains that has been obtained in service, and why Neutral Host networks are a fundamental part of 5G and why Australian government policy should support this by enabling Small Cell operators like Dense Air to acquire spectrum.

Wholesale Neutral-Host Networks

Small cell operation requires dedicated licensed spectrum, typically 20 MHz bandwidth, in closely similar bands to macro-cell operations.

It is not rational in either economic or spectral efficiency terms for every mobile operator to have its own dedicated 20 MHz channel for small cell operations. In Australia there is simply not enough spectrum being offered in the 3.6 GHz bands to support this. Even in Europe, with as much as 350 MHz on offer in some countries, it makes little sense.

Since small cells operate at low power facilitating aggressive spectrum re-use, only one channel is typically required to be available in an area for all networks in the mobile ecosystem to benefit.

It is this realisation that is the basis of the wholesale dedicated neutral-host model being deployed in other countries. It uses a single 20 MHz channel in an area to deploy small-cell operations for MNOs as a wholesale "carrier's carrier".

This is the model that Dense Air applies.

Public Policy Concerns

Radiofrequency spectrum is a valuable public resource. There is a compelling public interest in requiring spectrum to be used in the most productive and efficient way possible. It was thought for a long time that purely economic allocation systems would tend to allocate spectrum to the mostly highly value use. This works well when comparing "like-with-like".

However, the experience with mobile networks around the world shows that the "mostly highly value use" for individual carriers (as opposed to the mobile ecosystem) tends to be for homogenous macro-cellular networks.

On the other hand, the macro-cell architecture is not, in our view the most *technically* efficient deployment, especially for the evolution to 5G and the requirement to make the networks denser to maximise customer data bandwidth.

Improvements in productive efficiency are possible if traditional macro networks are overlaid with a small cell network. This raises the productivity at macro-cell edges and greatly improves bit throughput over the macro-coverage area.

The productivity improvement derives from a mix of macro-networks overlayed with massively dense infill to boost the productivity at cell edges. The productivity improvement more than offsets the additional spectrum allocated, especially if the spectrum is operated under a wholesale neutral host model.

While the technical efficiency gains are clear, the economic approach of traditional allocation methods do not allow the gains to be realised, because the architectures are not able to be compared "like-with-like".

This is the challenge in public policy.

In traditional spectrum allocations, the radiofrequency spectrum is treated as a "raw" resource to be allocated to its most highly valued use, irrespective of that use. Traditional allocation seeks technological neutrality. Perversely, it is this approach that reduces the incentives to apply small cell overlays. For an MNO the most highly valued use of the spectrum bandwidth is to deploy a macro-cell network, even if this does not provide the highest level of technical efficiency.

There is not enough spectrum available for every operator to apply a small-cell overlay and few would do it anyway. In Australia, it would require 60 to 80 MHz for a small cell overlay when only 125 MHz is on offer.

It is not rational for every operator to maintain its own small-cell overlay.

Without separate provision for small cell architecture, we believe that the economics of major network carriers will block out the deployment of small cells, notwithstanding their technical benefit.

Our experience in our home market in the United Kingdom, where ASH and Dense Air are headquartered, illustrates this well. ASH participated in the UK's 2.3 and 3.4 GHz Spectrum Award conducted by OFCOM early in 2018. ASH failed to obtain spectrum in that auction. The prices in the UK set a new industry benchmark for 2.3 GHz and 3.5 GHz TDD spectrum. The eventual price paid was US$224m (£168m) for our target acquisition of 20 MHz. Dense Air had budgeted US$100m fro this auction, but this was not sufficient to obtain even 20 MHz of spectrum.

The small cell business case cannot compete with the business case of mobile network operators (MNOs). It is a *complementary* solution with entirely different economic structures to the MNO business and it is therefore not "like-for-like".

5G requires a more nuanced policy response.

ASH recommends that the best solution is to provide for a set-aside for low-power small cell architecture as a complement to the allocation, rather than as a substitute for macro-cell dominated networks which is economically infeasible.

An Opportunity for Small Cells

The plan put forward by ACMA in the draft instruments as the technical "option #2" provides the foundation of a response to the small cell opportunity.

ASH suggests the opportunity can be enhanced to better support the introduction of small cells, with only minor adjustments.

The default option #2 presented in the draft instruments provides for a contiguous block of 15 MHz with separate and lower power limits compared with most of the allocation offer. The power limits are purportedly to resolve a potential misalignment of TDD frames in the absence of agreement about the framing ratio and therefore the likely absence of timing synchronisation. The measures are described as an interim limitation, pending resolution of the synchronisation issue.

The power limits create an opportunity for small-cell low-power systems. The limits create a distinct business case away from the homogenous macro-cell architecture.

ASH proposes three small amendments to this proposal:

- expand the power-limited offer to 20 MHz (an additional 5MHz);
- reconsider the power limit to explicitly support small-cell architecture in the 20 MHz;
- require the power limit to apply for the duration of the licence.

ASH recommends that 20 MHz is necessary to align with the 5G-NR channel structure of 20 MHz.

While the power limit proposed is justified by ACMA for other reasons, ASH notes that a power limited block of 20 MHz would be compatible with small-cell architecture using 20 MHz channels consistent with the defined path towards 5G-NR.

In this submission, we urge that it is in Australia's national interest consistent with the statutory goals of spectrum management to include a carve-out for small-cell architecture as part of the path to 5G services.

The benefit in spectrum productivity and efficiency is well documented.

We believe that it is in Australian consumers' interests to embrace the small-cell revolution to allow much higher bandwidths and more diverse locations.

Comments on the Draft Instruments

ASH supports many of the proposals outlined in the draft instruments.

Primarily, we support the "option 2" technical framework, suitably adapted as we recommend for a carve-out of 20 MHz with power restrictions.

This would provide an opportunity for "small-cell" development in the 3.6 GHz bands. ASH recommends this be committed as part of the long-term structure of the band.

ASH separately offers some comment in this submission on the allocation design, based on our experience in radiofrequency spectrum auctions in other countries. The proposed design of "enhanced simultaneous ascending auction" could be improved by simplification. We offer below a proposal for a simple, cheap, fast design that meets all the theoretical goals of sound multi-object auctions. Like the current ACMA proposal, it involves three macro-stages, separating assignment in the last stage from allocation.

Allocation Areas

ASH does not have any comment regarding the area definitions proposed in the draft marketing plan.

There has been substantial consultation over this. In its previous submission, ASH was not strident about any of the issues, nor did we raise concerns that have not been satisfactorily addressed. The area definitions are not contentious.

Allocation Bands

ASH endorses the creation of a carve-out of a contiguous spectrum based, but again we believe that 1 x 15 MHz band is inconsistent with the evolution to 20 MHz channels for 5G-NR. Left as 1 x 15 MHz it will be probably be left under-utilised as low-utility orphan.

ASH does, however, support this block being offered as a sole product in each market area.

ASH acknowledges ACMA's goal to ultimately transition to a homogenous technical framework based on network synchronisation of the TDD downlink/uplink frames. ASH accepts that network synchronisation may alleviate the need for strict power limits across the band.

ASH however recommends that the power limits be retained for the life of the licences to promote the business opportunity for wholesale neutral-host small cells networks. Small cells operate at low levels of power in small confined areas and operate to maximise spatial re-use.

Noting that 5G-NR operates optimally on 20 MHz channels, we note that the ACMA offer of 125 MHz will probably leave 5 MHz fallow anyway. ASH also notes that the band structure from the original 3.4 GHz allocations is not supportive of the 5G-NR radio plan.

The amount of spectrum on offer in the current process could easily be re-defined as 1 x 20 MHz for small-cells complementing 5 x 20 MHz for MNO macro-cells.

This would better align with the evolution to 5G-NR.

A neutral host operation would allow any MNO to access "Small cells as a Service" (ScaaS) in locations where the macro cell or micro cell coverage is poor and/or locations where cells would not be deployed due to issues with the economics or macro-cell performance. This would improve the customer experience.

Australia might then (depending on the auction outcome) be able to make provision for ScaaS and leverage the significant spectral productivity gains that are being experienced in other countries.

Draft Spectrum Licences

ASH notes that the form and structure of the draft Spectrum Licences and the conditions mostly follow precedent, save for modifications to the technical framework on which the TAG is providing ongoing advice.

ASH prefers that the licence definition follow the technical objectives described above for an expanded and gently modified (as described above) option #2.

We wish to place on record one significant issue in the context of small-cell operation. This is the threshold for exemption from the requirement for device registration.

While the small cell systems that ASH and other operators deploy may operate at low powers, these are not low enough to meet the registration exemption threshold in the draft spectrum licence currently set at 28 dBm across the occupied bandwidth.

The deployment of small cells (as can be seen from the attached presentation) depends on *dynamic* deployment of devices in a rapidly reshaping network. It should also be obvious that tens of thousands of these devices are likely to be deployed.

The small-cell technology deployed by Sprint USA[1] is also intended to be fully customer portable and operate "plug-n-play". Some deployments will be on poles, perhaps only a few hundred metres apart.

Small cell deployment depends critically on real time "big data" analysis of compromises in service delivery in macro-cell networks.

It follows that the coordination of devices will be in direct concert with macro-cell operators.

ASH believes that full device registration requirement and attendant certification by accredited persons will be a very difficult (if not unworkable) for such a low-impact dynamic concept as small cell deployment.

It is not something that we encounter anywhere else in the world.

The proposal will clutter the ACMA database with large volumes of low-value non-critical dynamic data that is of no real benefit in coordinating devices. ASH argues that its in-house "big data" will be far more sophisticated and granular than that required for the ACMA database.

ASH believes that this requirement that should be substantially modified for small cell operations by adding small cells to the exemption clause.

An alternative would be simply to permit a mass and blanket registration covering the whole licence area.

ASH has no concern about how the desired liberalisation is enacted, but the current requirement for registration of dynamic small cells seems to be regulatory excess for little public gain.

We will be able to assist with engineering input to assist negotiating a more practical exemption limit if ACMA wishes.

S.145 Determinations/Advisory Guidelines

ASH notes that a great deal of work on the technical matters in relation to the s.145 Determination and the Advisory Guidelines has been done and continues to be done by the Technical Advisory Group convened by ACMA. ASH expects that this group should be advising on the framework necessary to support migration to 5G-NR.

ASH acknowledges that the draft instruments will have been crafted with input by the MNOs and cellular mobile vendors via the TAG and therefore will be predicated on higher powers and wide-area operations and technical coordination scenarios.

Small cell operations inherit from the 4G LTE Advanced and future 5G-NR radio standards, and so small cell operations will always be technically compatible with them. As these systems operate at lower powers, they "fit within the envelope" of high power MNO operations.

The major requirement of small cells is to be able to operate in licenced ("protected") spectrum where we can carefully manage potential interference scenarios.

The envelope of technical requirements for MNO operations described in the draft Determinations and Guidelines provides small cell operation with ample headroom.

Since the systems are intended to operate over small areas at low powers, the power-limited technical framework described as "Option 2" should provide sufficient headroom for small cell operations.

[1] Sprint's "Magic Box".

Again, we urge ACMA to consider offering 20 MHz as a sole product in each market area with these power limits to provide an opportunity for small cell radio architecture to perform its role in improving the bit efficiency of the whole Australian mobile telecommunications industry and to provide a viable migration path to 5G-NR.

Allocation Design

ASH has experience from both the design-side and from participation in radiofrequency spectrum auctions around the world.

ASH notes that there is a lot of theory and many varied attempts to secure sound theoretical outcomes. We note that a small collective of theorists seem to appear repeatedly around the world, using national governments as a test bed for their latest design fad. We wryly note that they have done well by the Australian taxpayer, in the past.

ASH has considered the proposed design in the Schedules to the draft allocation Determination and believes there is a better, simpler, faster method that meets the theoretical objectives of sound multi-object design without theorising to a ridiculous extent.

ASH proposes a design that features similar objects selling for similar prices, that the prices themselves are economically efficient, that the market clears and that risks to bidders such as incomplete packages (i.e. exposure risks) are minimised. ASH also believes that there should be adequate careful incremental price discovery to inform efficient pricing.

Our proposal retains the three proposed phases of the auction proposed in the draft Determination:

- an initial primary allocation;
- a process to clear any residual quantities of *lots* in areas;
- and then assignment (which is essentially a "packing-order" problem).

Assignment is a technical issue with the goal being to minimise discontinuities across boundaries (and thus wasteful inefficient interference scenarios). For the most part, ACMA should determine assignments to the greatest extent possible to minimise these *dis*continuities. Only when this is done should there be a place for economic preferences being expressed.

Since ASH has a goal to obtain a single block of 20 MHz, and operate small cells with low powers, discontinuities across spatial boundaries are of no practical concern to the company.

For this reason, we do not propose detailed commentary on the assignment approach.

Primary Allocation

ASH favours contingent package bid auctions, but it does not favour the pure clock-combinatorial design. We have experience bidding under this design in Ireland. The design, while not inherently complex, is made to be complex by suites of rules regarding activity, revealed preferences and pricing.

ASH also supports the Vickrey nearest minimum core pricing rule, but we do not believe it is necessary or appropriate in an ascending bid auction. Such a rule might promote theoretical purity in the minds of academic advisers, but it is useless for a bidder making practical bidding decisions, as we can demonstrate with an example (and with hard data, if you wish).

Our primary objection is that the second-price rule does not allow certainty in the *primary allocation* when a bidder is budget constrained. This is an issue for most bidders. It is unique to the primary allocation.

A pure CCA requires the resolution of the best revenue combination from all bids made, in every bidding round including the application. It therefore requires the second-price rule so that the winners

pay no more than their bid and no less than the opportunity costs of the highest valued losers they displace.

While this is theoretically sound, it introduces complexity and it leads to unintended consequences for bidders in an auction process[2] as can be demonstrated.

In Ireland, ASH had a fixed budget, approved by our investors. Our team made bids during the primary stages up to the limit of budget approval, seeking always to maximise the bandwidth to be acquired. The team adjusted the demand profile continuously to obtain as much spectrum as possible within the budget.

After the conclusion of the "primary" stage and pricing setting, we found that our financial commitment as a function of the second-price rule was well below what our budget provided. Had we known the extent of the effect, we perhaps could have bid for more spectrum within budget, however the effect of the second-price rule in the Irish design was unknowable. We therefore had to minimise the risk of exceeding out budget, so we could only ever bid as much as the budget permitted.

On the plus side of CCA, ASH does favour the risk mitigation for bidders that a contingent package bid auction provides. In the Irish auction, we were able to make bids for a mix of quantities of products in different markets with each bid made on an all-or-nothing basis.

This is a valuable feature for bidders.

ASH notes that the process of gradual ascending bids for quantities tends to emulate the second price-nature of an English Open Oral Outcry auction. Prices will trend towards efficiency, without necessarily achieving theoretical purity.

The *practical* inefficiency imposed on ASH by the second price rule in Ireland was of the order of 5 - 10% - far higher than offsetting any gains in theoretical purity.

So much for theory.

Contingent package bidding has unnecessarily been conflated with combinatorial resolution.

In our experience this should not be necessary.

Design Preference

Primary Allocation

ASH favours a simple "ascending contingent package bid" design for the primary allocation.

The ascending bid feature provides a mechanism for gradual price discovery which mostly negates the requirement for second-price methods and all their attendant rules.

The contingent package element allows bidders to build a package with full knowledge of current prices that will apply if the auction closes at that time, and bidders can progressively modify their preferred package as information about prices is further discovered. Gradual price-discovery emulates the English Open Oral Outcry design which is well known and robust. This would be a "pay your bid" design, but for winners it is in fact a pseudo second-price, at the point where excess demand is removed.

The auction manager would set prices for each product in a clock round according to an increment formula. Bidders would respond by notifying their demand quantity of each product at the posted prices for each product. The bid would be expressed as a collection of quantities of products at a single calculated price.

Only one bid would be permitted per round.

[2] But not necessarily in a tender process. See below.

After the round ends, the auction manager would calculate the aggregate demand for each product.

Prices for a product would increment only if aggregate demand for that product exceeded supply. Prices would never fall, except perhaps in the case of a product in the opening round where demand was less than supply during the application stage. In this case the prices could decrease until demand to exceed supply is attracted, and then revert to ascent.

The ACMA design in the draft instrument provides some arbitrariness on the part of the auction manager to set prices. In the interests of transparency and certainty, we recommend that price setting be done by formula and be set in the rules rather than left to administrative discretion. This allows bidders to forecast their worst-case bid values well into the future over the clock schedule.

Being able to forecast prices allows the auction to be speeded up considerably. If price setting is formulaic, it is possible to forecast worst-case price movements well into the future. This then allows bidders to identify key trigger points at their private budget levels. In the experience of the ASH team in Ireland, near 80 per cent of the team's time-on-site was spent waiting for progress. Design improvements would allow the auction to be speeded considerably so that rounds of 30 minutes would be possible. This would permit 16 rounds per 8-hour day.

If the aggregate demand on a product exceeds the supply quantity for the class, the price would increment for the next clock round.

If the demand falls below supply levels, then the price would hold constant and not increment.

If any one product incremented, then another round would be scheduled for all products. Bidders would need to make a fresh bid for all the products they wanted to win (i.e. contingent package bidding) to stay in the game, but that would only be at incremental cost for products where the price did rise.

Once there is no excess demand in any product, the primary phase would cease.

At that stage, all bids represented in the final round would be guaranteed an allocation at the prices bid (which we note are close to theoretically efficient "second prices").

ASH does not believe it is necessary to "flog the horse" of economic efficiency any further than this, for to do so simply introduces other *practical inefficiencies*.

This proposed design departs from the pure CCA design that we encountered in Ireland (and has been used in Australia) because there would be no combinatorial optimisation to determine winners, and there would be no second-price calculation. We note that the gradual price increment emulates to an extent the second price nature of English Open Oral Outcry auctions.

Activity Rules

ASH is concerned that ACMA proposes in the draft Determination to perpetuate arbitrary "points-based" activity rules.

This form of activity rule has origin in the early 1990s and from the design competition that led to the simultaneous multiple round ascending (SMRA) auction design being adopted by US FCC.

There is a wealth of evidence, including from Australian auctions, that highlight its fundamental flaw.

In the SMR design (which Australia adopted in 1995, following the FCC's lead), bidders bid on specific (not generic) products and the activity rules worked to apply the same activity credit whether one bid on an expensive item in a collection or a less expensive one. This met the design goal to promote "honest bidding", and it also provided an incentive for price equalisation across identical lots with the same points rating. In an SMR auction, identical items are priced independently.

Newer designs promote price-equivalence by bidding on quantities of a class, rather than items in a class. It is here that the design flaw manifests. ASH notes that the flaw can be observed in Australian spectrum auction experience. It was most seriously manifest in our direct experience in Ireland.

The arbitrary setting of points value is based on administrative assessment of *relative* value across a range of products. For example, in Australia, a product class in Sydney might have a different "lot rating" to the same product class offered in Melbourne and this would reflect an *assumption* about relative values based on population and density and culture and statistics.

As is demonstrated repeatedly by data from around the world including Australia, as soon as bidding starts *all bets are off*. The data nearly always sees a *divergence* between the arbitrarily assigned relativities and the actual expressed relativities reflected in prices bid.

This has grave consequences for the integrity of the auction.

In Ireland, our team was able to subvert the pricing algorithm on at least two occasions by leveraging the divergence between arbitrary set values and actual values.

It should be obvious that one can "park" eligibility points on relatively low value products as this divergence takes hold with manageable risk. ASH does not believe this was ever anticipated by the proponents of generic-lot designs as they simply copied over the points-based approach.

As an alternative ASH recommends a "cash-based" activity rule, where the activity is measured in terms of the true relative value being revealed through bidding rather than via arbitrary administrative values where the relativities quickly depart from reality.

ASH believes this is more sustainable in terms of theory and is obviously better in practice if it mitigates "tricky" strategies.

Moreover, it is incredibly simple to implement, and delivers better efficacy in promoting truthful bidding.

"Cash-based" eligibility uses actual values of bids to induce truthful bidding and maintain the true market relativities – indeed, as we noted from our experience in Ireland it would do this much better than an arbitrary points-based system where the correlation between the points value and actual value across products began diverging very early in the process.

After each round is completed, the auction manager would recompute prices for the next bidding round for all products. This should be formulaic and transparent. Each bidder's bid in the previous round would be *revalued* at the new prices. This would become the bidder's eligibility in the next round. It would allow the bidder to exactly replicate its last bid but not increase it (i.e. in this case it would act in the way that points-based systems do). It meets the core design objective – to compel bidders to be active and truthful.

Since the design is a contingent package bid design, there is no need for any provision for bid withdrawal rules or for price-reduction rules.

In a case where a bidder did not bid up to the full extent permitted by its cash-based eligibility, a portion of the difference would be forfeited (for example, 80 % of the difference, allowing 20% to be retained). Such a rule would provide the sort of flexibility that the original Milgrom-Wilson design provided with its eligibility percentages for distinct stages of the auction.

> *For example, a bidder has eligibility to bid to the value of $100,000 and price increments are set at 5%.*
>
> *The bidder bids for lots with a value of only $80,000. It's $80,000 bid would be revalued for the next round to $84,000 plus 20% of the $20,000 difference. Its eligibility in the next round would therefore be $88,000.*

In that next round, its unchanged bid would now be for $84,000, but now with a $4,000 difference compared with the eligibility, of which $800 could be retained.

In the round after, its bid is revalued to $88,200 plus the $800. The eligibility would be $88,200 plus $800 = $89,000.

Cash-based eligibility is a far better rule for it prevents the divergence between eligibility points relativities and market value relativities that allows gaming behaviours to allow eligibility to be "parked" at little cost.

It is simpler to implement and simpler to understand for bidders.

At the same time, it meets the theoretical goals that activity rules were designed to achieve.

It's a better simpler more effective mousetrap.

Secondary Allocation

ASH notes that the draft Determination provides for secondary allocation by auction.

Again, we believe there is a faster simpler and more robust process available. It's a process that is easier for bidders.

At the end of the primary allocation, it should be obvious that some quantities in some markets may not be allocated. These are *residual lots* and should desirably be cleared. It is these lots that ACMA acknowledges may need to be subject to a further allocation process.

The CCA design attempts to mitigate residual lots through combinatorial resolution of all bids made, but even this model risks that the market will not clear. CCA therefore provides for a "supplementary round" that allows bidders to submit further demand/price vectors to be added to the optimisation process. In that design, the supplementary round is part of the primary allocation.

The CCA requires all manner of complex rules in the supplementary round to constrain bids within previously revealed preferences regarding price and eligibility. It is no wonder that ACMA now resists the design.

The rules are a theoretician's delight, but they fail at a practical level for bidders because they introduce complexity, risk and uncertainty regarding outcomes. In Ireland, despite knowing that we had probably secured some of our goals at the end of the clock stage, we still felt it necessary to reprice some bids and make new ones in the hope that we would still be able to meet our goals and not be displaced by an aggressive bid from others.

From this lesson, we believe ACMA should reduce complexity and promote certainty for bidders at every stage while retaining a goal of theoretical efficiency.

An auction is not necessarily the best mechanism.

A key advantage to be leveraged at this stage is that there will be contemporary information available to all the bidders about market clearing prices for the primary allocation. There is therefore no need for any further price discovery and therefore no need for an auction.

Since there is a large amount of information revealed about near-to-efficient prices from the primary allocation stage, it would be a fool of a bidder who bid too much for residual lots knowing those prices. A sound second price-design further promotes truthfulness.

In the absence of a need for further price-discovery, a tender can be used to clear the market. Tenders are quick, simple and easy to resolve.

ASH advocates using the techniques for a tender that we have separately argued are inappropriate and unnecessary during an ascending bid price-discovery. The circumstances are different once price-discovery has been achieved.

ASH proposes that the market for residual lots is best served by a sealed-bid (one shot) *combinatorial tender* that does adopt a *second-price rule*.

It's simple.

Tenders can be run quickly and, if the first iteration does not achieve full clearance, a second and subsequent tenders can be quickly scheduled to progressively clear residual lots.

Tenders are fast. They can be defined in a web-based system quickly and bidding can be opened for however long is appropriate (perhaps a few hours). They can can be solved quickly and winners and prices published immediately. Our advisers have experience with such a design and that expertise is available to ACMA, in Canberra.

This is where combinatorial resolution and second-price processes do come into their own, and such a process would require fewer complex rules. For example, there would be no need for:

- pricing rules since there is information about prices available – bidders should be free to set their own price;
- activity rules, because it is a one-shot process – bidders either participate, or not as they desire;
- revealed preference rules – because the allocation would be discrete and stand-alone, and the primary stage would already have settled most of the allocation.

Bidders would make contingent package bids for quantities up to the limit of the residual lots available but would always be constrained by any bidding cap that applied over the whole allocation.

Bidders would be able to submit multiple logical "OR" bids[3].

All the bids would be subject to combinatorial resolution, to find the combination of bids within supply limits that maximises revenue. The logical "OR" bids can be constrained by a rule that says that a "winning combination may contain only one bid from a bidder".

A second-price algorithm would then be applied to assure that winners paid no more than their winning bid and no less than the opportunity cost of the highest valued losing bids.

Assignment

As we noted above, assignment is a technical issue, not an economic one.

The only time that an economic resolution via an auction would be appropriate is when all the technical issues have been optimised.

ASH does not propose to comment further on assignment, for if ACMA follows our various other recommendations, especially regarding a set-aside with restrictive power limits to support small cells, it is unlikely we would be affected.

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[3] Contingent package bids are logically an "AND" bid. For example, "I want two stones AND one packet of gravel for 10 shekels." The tender design described would offer multiple "OR" bids such as "I want two stones AND one packet of gravel for 10 shekels OR I want one stone AND two packets of gravel for 15 shekels (but not both)".

Summary and Conclusions

ASH is considering participating in the opportunity, in the hope of being able to introduce in Australia a neutral-host operating offering small cells as a service, complementing the mobile network operators to provide massive densification of their networks.

ASH supports a set-aside of 20 MHz to facilitate small-cell neutral host networks in a way that facilitates migration to 5G-NR. The 15 MHz reduced power offering described by ACMA does not provide such a migration path. ASH believes that in the context of 5G-NR (based on 20 MHz channels) 120 MHz would provide scope for 5 macro-cell operations plus one small cell shared network operator.

ASH does support a power constraint as proposed for the current set-aside, building on the power constraint already proposed for the 15 MHz, but seeking to provide this for the duration of the licences to cement the place of small cell networks in the mobile telecommunications ecosystem, allowing a path to massive densification of the network commensurate with 5G service concepts.

Separately, we suggest that ACMA could go some way to simplifying the allocation process to make it easier, lower risk and faster for bidders. We also propose dispensing with arbitrary points-based activity rules in favour of activity rules that reflect true market relativities.

ASH's technical and market advisers are at your disposal at any time to assist with further understanding of the pathways to 5G and the place of small cells and how they work to raise spectral efficiency. Similarly, we can offer further detailed exposition of our experiences with allocation methods which inform the recommendations we have made.

Please let me know if I can provide any further advice or assistance at psenior@denseair.com

ASH also has representatives in Sydney and advisers in Canberra who can be available on request.

Yours sincerely,

Paul

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