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Mr Richard Bean
Acting Chairman
Australian Communications and Media Authority
PO Box 78
Belconnen ACT 2616
AUSTRALIA

Dear Mr Bean

FUTURE USE OF THE 3.6 GHz BANDS

On behalf of Airspan Spectrum Holdings Ltd, thank you for the opportunity to comment on proposals by the Australian Communications and Media Authority (ACMA) to re-farm parts of the 3.6 GHz bands of the radiofrequency spectrum in Australia.

This submission responds to *Issues for Comment* set out in two documents; *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)

ASH is a 100% subsidiary of Airspan Networks Ltd (Airspan).

Airspan designs and manufactures leading edge radio communications equipment. Airspan is a leading vendor of LTE small cells and small cell backhaul technologies. The company was established in 1992 as a product division of DSC Communications and it became a standalone company in 1997 and today has more than 1000 customers in over 100 countries around the world. Airspan has had a product sales and support presence in Australia for most of that time. Airspan is at the forefront of technology and has deep in-house technical expertise in LTE, OFDMA and Wi-Fi techniques. Today Airspan has around 700 employees globally, with over 300 engineers engaged in direct research and development of 4G LTE Advanced and 5G NR products.

Airspan is the world's largest provider of solutions that combine LTE small cells with Gbit/s backhaul solutions and these platforms are shipping at scale into the USA and India. They will be the basis of our 5G products and solution sets. Airspan in the past has been a leading technical contributor to the 4G and 5G standards development is an active member of the Small Cells Forum.

Airspan is on track to deploy around a quarter of a million of our leading edge "AirUnity" 4G-LTE all-wireless small cells in 2017 into Tier 1 networks (Sprint: USA, Reliance Jio: India). These solutions provide the means to substantially increase the spectral efficiency of the 4G LTE Macro RAN[1] deployed by these carriers.

ASH (Airspan Spectrum Holdings) was created as a separate business unit within the Airspan Group in 2016. Our mission at ASH is as an operator, focused on obtaining radio frequency spectrum licences to support Airspan's small-cell vision and to enable "Small Cells as a Service" (SCaaS) offering in various countries around the world. Australia is a key target for ASH and we intend to participate in any upcoming spectrum awards in spectrum suitable for small cells.

In March 2017, ASH participated in an auction in the Republic of Ireland for 350 MHz of spectrum in the 3.4-3.8 GHz band. From our work in Europe, ASH is aware of many other opportunities in these bands that are being pursued, including in the United Kingdom which is progressing plans towards an allocation this year.

ASH is experienced and well placed to inform your decision making about these bands and the direction of the development of 4G/5G small-cell architectures.

ASH was successful in Ireland. It acquired spectrum in all the five metropolitan markets; sufficient for immediate LTE deployment and suitable for migration to 5G services once those solutions become mature. As I write, our deployment is underway.

In this submission, I will draw on outcomes observed in Ireland, particularly relating to spectrum values.

Summary

In this submission, ASH sets out its position on a wide range of issues, as follows:

- 5G should not be consider as a technology *per se*, but rather a feature-set and functionality that embraces many innovative technologies, some of which are already being deployed, and most importantly should be viewed as a major evolution of the network architecture that underpins all 4G deployment today;
- We believe that migration to 5G should be an incremental advance on existing mobile technology; one that paves the way for a transformation and for new economic development. This is not sufficiently acknowledged by ACMA in its "highest valued use assessment";

[1] "radio access network"

- Many of the technologies critical to 5G service concepts are being progressively deployed in bands such as the 3.4-3.8 GHz bands, and this will include the deployment of today's 4G LTE Advanced technology;
- The bands from 3.4-3.8 GHz have been mandated in Europe as a key part of the 5G spectrum mix, and the rest of the world can be expected to follow;
- The LTE Band 42 (3.4-3.6 GHz) should be urgently *replanned* to allow access to coincide with the imminent availability of handset devices that integrate 4G LTE enhancements (expected late 2017 in Japan). These enhancements (such as network densification) are part of the vision being implemented in advance of the 5G new radio (5G-NR) radio architectures[2]. The replanning can be done using existing mechanisms in the *Radiocommunications Act 1992*;
- The LTE Band 43 (3.4-3.8 GHz) should also be replanned to be available to support the next releases of handsets in 2018 and 2019 (Europe), especially handsets that deploy in Band 48 (for the USA). We also expect devices to be able to support 5G-NR from around 2020. It is not as urgent, but will become so as 5G-NR is deployed (5G-NR enables aggregation of bandwidth channels up to 80, 100 and even 160 MHz when combined with other bands);
- There should be no "carve out" of 25 MHz for continued apparatus licensing support – there are better and more efficient mechanisms available in public policy that better deliver equity for all;
- There should, however, be special provision for spectrum licences to support "small cells" and small cells as a service in any release. ASH recommends 40 MHz to complement and enhance (and specifically not compete with) the operations of mobile network operators (MNOs). We believe that this is in the public interest and specifically within ACMA's objectives to enhance the productivity of the radiofrequency spectrum;
- An east-coast satellite coordination and protection zone should be established as a matter of policy, and C-Band receive-only earth stations at Belrose and Oxford Falls should be placed on notice that they should plan to relocate – again, this is not critical now, however 5G-NR will require copious bandwidth to operate to potential;
- Notwithstanding the importance of the evolution towards 5G services to the economy, ASH does not support wholesale spectrum reallocation. In our view, this is a blunt instrument. The *Radiocommunications Act 1992* and a creative approach to tools available in that Act will in our view offer far better public policy outcomes;
- The 3.4-3.8 GHz bands are suitable for extending coverage in currently marginal (low-signal strength) areas by filling in the cell-edge where bit rates fall dramatically. The release of the bands beyond the major metropolitan areas and major regional cities offers the possibility of extending mobile coverage for customers and providers – and we stress that this does not compete with MNOs but rather provides a technology suite to extend their coverage;
- Existing *spectrum* licences in LTE Band 42 should be resumed and re-allocated using a homogenous technical framework to support evolution towards 5G-NR. The licences as they currently exist are not in a configuration that supports 5G-NR (which typically requires integer increments of 20 MHz channels up to of 100 MHz, and as much as 160 MHz[3]). The

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2 For an introduction to 5G-NR development, see the Qualcomm website at https://www.qualcomm.com/invention/technologies/5g-nr

3 5G NR allows very large channels up to 2 GHz in the "millimetre-wave bands", but below 6 GHz will be typically 100 MHz and in some extreme cases up to 160 MHz depending on spectrum availability.

current configuration of the band presents a technical barrier to LTE-5G evolution in band 42.

ASH Welcomes ACMA Planning for these bands

ASH welcomes and applauds ACMA initiating a discussion to re-farm this critical band for mobile technology evolution.

The most critical band today for 4G-LTE deployment and evolution towards 5G-NR is LTE Band 42 (3.4-3.6 GHz), but we note that this band is severely compromised in Australia from past planning and allocation decisions. ASH is concerned that ACMA plans only for 25 MHz to be released in this band. In other countries, especially in Europe, almost the whole band has been released.

The evolution (revolution) of mobile telecommunications towards small-cell centric networks and from the current LTE-4G towards 5G-NR provides a clear economic and technical imperative to correct the disjointed spectrum arrangements in this part of the spectrum.

In this submission, we offer a simple and lawful mechanism for this to be corrected without disadvantage to consumers or incumbents.

Radio chipsets for 4G LTE enhancements in both Band 42 (3.4-3.6 GHz) and LTE Band 43 (3.6-3.8 GHz) are available and shipping today. Handsets incorporating support for Band 42 are expected in mass deployment before the end of 2017. ASH will deploy this technology in our Band 42 allocation(s) in Ireland.

Of most importance to planning is that *customer equipment* with Band 42 radio support is imminent.

Specifically, our understanding is that all major smartphone vendors (such as Apple, Samsung, and Sony) will incorporate radio support for Band 42 and some of the early enhancements on the path to 5G to accompany the deployment of LTE in this band in Japan. We also understand that the next Google Pixel release will include radio support for a partially overlapping Band 48 (3.55-3.7 GHz), specifically to cater to the US Market. Please note the 50 MHz overlap to Band 42.

The combined extent of Bands 42 and 43 is expected to be supported by radio chipsets in handsets from around 2020 to facilitate migration from 4G-LTE to the 5G-NR radio architecture.

Europe has mandated the full band from 3.4 -3.8 GHz (400 MHz) to be made available for 5G[4]. Ireland allocated all but 75 MHz (3.475-3.8 GHz) of these bands in 2017 where ASH participated and won licences. The Czech Republic recently announced completion of an allocation of 200 MHz in Band 43 (3.6-3.8 GHz bands). The UK process for a full allocation is well advanced. Other European nations are in various states of planning.

[4] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014D0276&from=EN

ASH believes that ACMA may have been too timid in its proposal to release only 125 MHz in total and perhaps has been too accommodating of incumbent interests, to the detriment of potential deployment for advances in 4G-LTE, and of more concern to inhibit the scope for evolution towards 5G-NR.

Highest Value Use

Based on participation in the relevant development groups, ASH believes that 5G evolution will allow for delivery of services with very high bandwidths (in the range of hundreds of Mbit/sec) to consumers at low cost and low latency. The 5G vision combines a complementary suite of technologies transparently and seamlessly across a wide range of radiofrequency bands.

These features include massive densification and economic extension of networks already possible with small-cell architecture using 4G-LTE. They extend to migration to the new and advanced 5G-NR radio architecture.

The 3.4-3.8 GHz bands are central to the 5G outlook. The bands offer a suitable quantity of bandwidth to enact the vision (400 MHz) unlike any previous band planned for the mobile service. The bands are still in the "sweet spot" of the spectrum that provides usable propagation characteristics to support mobility and in-building penetration.

The 3.6 GHz bands are therefore unique in terms of bandwidth capacity combined with propagation.

Three themes are central to the development of the 5G suite. These extend far beyond legacy mobile systems and are described as:

- **Enhanced Mobile Broadband** (eMBB);
- **Massive deployment of "Internet-of-Things"** (mMTC); and
- **Ultra-Reliable and Low Latency Communications** (URLCC).

The 5G-NR architecture embodies a conceptual leap. It provides carrier aggregation over multiple radio channels (in sub 6 GHz bands typically up to 160 MHz) to provide massive and flexible bandwidth to consumers. 5G more generally will flexibly deploy across different radio architectures such as WiFi, 4G-LTE and 5G-NR to enable the best rates of data transfer available, and customer bandwidths of several Gbit/sec to the handset are often described. Gigabit radio performance has already been reported in technical trials.

The eMBB vision sees optical-fibre replacement bandwidth (1 Gbit/sec +) being available to handsets, portable devices and fixed installations, anywhere and at any time within coverage. It can be thought of as a "super-WiFi" (it operates in licensed spectrum), but without the limited range. It will be faster to deploy, and does not involve the infrastructure issues, displacement, inconvenience or cost of rolling out fixed optical fibre/xDSL. It will be cheap for consumers and operators alike.

In this European summer, Arqiva will trial 28 GHz 5G technologies as a very-wide bandwidth last mile delivery system in direct competition with fibre/xDSL[5]. The 3.6 GHz bands will support similar performance on 5G-NR using carrier aggregation, and without the need for a fixed out-door installation.

5G heralds the next big revolution in computing/networking to enable the "internet of things" (IoT) and these will be massively *interconnected* and *coordinated* things. MIOT is expected to be a new force for technology and business development. It may be as significant a leap as the very first mobile phone. Already Internet of Things (IoT) development has started and promises improvements in economic efficiency; doing seemingly unimportant things more simply and quickly. Aggregated on a large scale, the improvements are a boon for economic productivity and efficiency. One early example was the early version of the "smart meter". It negated the need for meter-reading staff in the field and provided real time management data to inform consumer choices, saving resources and money. mMTC extends this simple vision far more broadly deeply into the computing "cloud".

URLCC is perhaps the most revolutionary vision. Already there are drones and self-driving cars being developed. 5G is an enabler technology of URLCC, because unlike any of its precursor mobile technologies, it enables the low-latency and the levels of redundancy necessary for seamless coordination between fast-moving objects. URLCC is engineered to support reliable wide-area control, coordination and avoidance systems. This contrasts with control systems today that exist mostly in noisy class-licensed bands.

New stores of economic growth are a likely to be unleased through the adoption of 5G visions.

Taken together, the economic and social benefit of 5G will likely surpass all the incremental benefits of mobile system evolution observed to date.

The highest value use assessment provided by ACMA makes no reference to these wider economic gains that ride the wave of evolving mobile technology. There is not a single reference to businesses such as Facebook, Google, Instagram and other social media which thrive in the environment created by the smart-phone and that today generate economic activity well beyond the immediate value of spectrum to 3G/4G operators. Apple, Facebook and Uber are just three examples of new businesses in the tech-economy spawned from mobile telecommunications.

The ultimate value of 5G to the wider economy is a matter of speculation, however there can be little doubt that it will be significant compared to the comparative value of spectrum to telecommunications operators; which is ACMA's stated measure of value.

ASH asserts a critical point: if spectrum supporting 5G evolution were to be released for free (i.e. with no revenue to Government, and at no cost to operators) these wider economic benefits would still accrue to the nation, and these economic benefits would be far greater than the opportunity cost of leaving incumbents in place.

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5 http://www.telecomtv.com/articles/5g/arqiva-buys-more-28ghz-spectrum-in-uk-as-it-prepares-for-5g-fwa-15775/

That should be ACMA's measure of the planning importance of these bands.

History provides a plethora of lessons on the economic benefit of innovations that ride on the back of mobile systems evolution. We believe that these lessons that have not been adequately reflected in the highest-value use assessment.

Please consider the small increment from the analogue AMPS system to 2G digital GSM. It enabled the advent of the Short Message System (SMS) within the signalling headroom of GSM. This small technical evolution created a cheap accessible messaging system for the masses, stimulating a wave of new business concepts. Few could have imagined the power of this simple innovation at the time. It delivered substantial social and economic gains that were unrelated to the MNO's core business. For example, it made possible the development of the Blackberry system that became a significant multiplier for business communication, extending the economic gains outside the direct operator model.

The revolution from 2G to 3G provided for hundreds of kbits/sec in data capability and paved the way for the development of the early iPhones of Apple, contributing to Apple's now behemoth state as a corporation. Consider the historical importance of the social and economic effects of this technical enhancement and new business ecosystems that were founded on it.

Today, smart phones have morphed into portable computing devices (such as tablets) that are linked into the network cloud using 4G data bandwidths in the realm of Mbits/sec. This allows communication connectivity that rivals that of many fixed installations. It fills the vision of the "Negroponte switch" and has generated a whole new economic paradigm. 4G provides megabit-level data speeds to people on-the-move and makes it possible for business to remain fully connected away from the office via "cloud" computing. This is a boon for economic efficiency and productivity not quantified in the highest value use assessment.

In association with and founded on these technical increments from AMPS to LTE 4G, we have seen the growth of significant new businesses like within companies such as Apple (iPhone and iPad and all the apps they support), Google (Android ecosystem), Amazon, Facebook and all the other social media platforms and new business solutions that have been enabled by smart phones supporting mobile broadband data. These technical ecosystems have created new businesses, new and innovative ways of thinking, substantial social and economic development and significant employment that goes way beyond a simple cost-benefit of the raw radio architecture in the hands of operators.

In that regard, we regard the "highest value use assessment" published by ACMA to significantly undervalue the potential of 5G evolution in the 3.4 GHz bands by focusing only on the value of spectrum to operators. It ignores that many of the innovations envisaged within the 5G concept cannot be deployed at lower frequencies because of bandwidth limitations. There simply is not enough available bandwidth in contiguous blocks to be useful.

This band has important technical characteristics of being capable of a high payload, yet it supports practical useability in the mobile context by having acceptable propagation. It is rare, in that regard.

A more appropriate assessment of cost benefit would extrapolate the business opportunities enabled by mobile technologies and consider the value of new industries likely to spawn, especially in the realm of eMBB, mMTC and URLCC.

ACMA's assessment ignores so many of the benefits to the wider economy that this evolution of telecommunications technology into 5G that these frequency bands bring.

We invite ACMA to consider an alternative review of 5G economics commissioned by Qualcomm Inc that sets out far better the wider economic benefits of quickly embracing 5G[6].

The 3.6 GHz bands are central to enabling that vision. No previous allocation to the mobile service meets the requirement.

Every advance of services described above has been made possible by evolutions in the wireless data connectivity supplied by operators against a backdrop of a truly international business. Evolution to 5G is the next impending international *revolution* in capability. It promises to support further revolutions in business concepts, economic development and social advance.

There is no case to not move ahead.

In the words of Marshall McLuhan, "the medium is the message". ACMA is well advised to look beyond the simple value of spectrum to operators. This coming "medium" of 5G heralds profound change.

I now turn to how ACMA might move ahead.

<u>Proposal to release 125 MHz</u>

ASH notes that while planning release of spectrum in these bands is a welcome development, the release that has been proposed is small, disjointed and marginal in the context of evolving 5G concepts internationally, and inadequate to support the radio techniques heralded by 5G-NR.

Such a limited release is likely to compromise the deployment of 5G service concepts, and so devalue the opportunity for Australia overall.

ASH sees two constraints on the proposal as it stands:

- The presence of existing licences, both apparatus licences but especially spectrum licences in the prime LTE Band 42 inhibiting deployment and entrenching spectrum inefficiency; and
- Satellite C-Band above 3.7 GHz.

ASH believes that the proposal as it stands is too heavily biased towards the interests of existing spectrum licence players, rather than the inevitable wider economic development made possible by having a coherent national 5G plan.

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6 https://www.ihs.com/Info/0117/5g-technology-global-economy.html

The 5G customer bandwidths being described in the literature only become possible through the coincidence of simple ideas. First among these is to use wide-band radio channels for 5G; typically, in units of 20 MHz and aggregated in multiples up to 100 MHz in *contiguous* bandwidth and perhaps up to 160 MHz when combined with 5 GHz license exempt allocations. This is the vision of the 5G-NR radio architecture. Such bandwidth is now only possible for mobiles at frequencies such as this 3.4-3.8 GHz band because of the planning and allocation of the other narrower cellular mobile bands in the past.

A new and important feature of 5G evolution is the small-cell vision of aggressive channel re-use, achieved by shrinking the coverage radii of cells to provide a denser build-out. This is especially valuable at the cell-edge as traditional coverage begins to wane. This feature coincides with the shorter-range propagation of higher frequencies, and using lower powers to offer more aggressive spectrum re-use. The effect is to share the increased bandwidth of a cell among fewer customers. The result is to enable a 5G core vision to massively densify the network. That in turn leads to significant improvements in spectrum productivity and efficiency. This is possible today with 4G-LTE, filling in capacity at cell-edges.

The third mechanism that makes this in-fill possible is to leverage the growth in computing power and lowering of costs that has been a function of “Moore’s Law”. This allows network devices using small cells to be easily integrated and cheap to manufacture, highly capable and easy to deploy; much more so than traditional cellular radio base station equipment.

LTE is planned to evolve to a deployment configuration that is designed to deliver maximum performance in macro-cells assuming N=1 frequency reuse and using the same 60 MHz running on all three sectors (as "60 MHz 3 CC CA"). This departs from historic N=3 reuse that allows efficient spatial re-use by avoiding co-channel interference in immediately adjacent cells. This 60 MHz 3 CC CA configuration cannot, however, address the decay of the signal and the fall in bits/Hz/sec as it propagates away from the cell-site. It is here that small cells weave their magic and it is the reason why small-cells are such an important part of the 5G vision

ASH notes that a three-sector cell deploying 60 MHz channels running 3 CC CA will occupy 60 MHz using TDD.

ASH requests that ACMA carefully note and consider the implication that the proposed release is therefore only able to accommodate two *technically efficient* 60 MHz contiguous carriers within its planned 125 MHz in dense metropolitan areas.

I do not see how that can be competitive with three and potentially four network operators already in the Australian market[7], and with potential new operators like ASH vying to deliver entirely new service concepts such as “SCaaS” in spectrum quarantined for small-cell deployment.

[7] Telstra, Optus, Voda-Hutch and aspirant TPG. ASH notes that one of these incumbent carriers has access to a contiguous holding at 3.4-3.6 GHz band that is larger than 60 MHz; as discussed below.

A corollary is that the existing Australian allocations in the 3.4 GHz bands are inefficient for the deployment of this network configuration; either inhibiting deployment altogether, or leaving substantial amounts of spectrum fallow. This is not in the public interest as it will likely inhibit efficient migration to 5Gs service models.

As seen in Europe and as we observed in Ireland, large operators wishing to provision high capacity to their customers will typically deploy two overlays of this pattern to bring the occupied bandwidth to 120 MHz TDD (again, contrasting with ACMA's proposal to release only 125 MHz in total).

In an arrangement of two 60 MHz overlays the current plan would consume all 125 MHz offered by ACMA by one operator.

The 5G-NR architecture provides for carrier aggregation typically up to 100 MHz as a single virtual channel. Only one of these channels would fit in the proposed ACMA release.

While the ACMA treats the 125 MHz as contiguous, it is not. It comprised two separate releases: one of 25 MHz in LTE Band 42, with one set of economic value assumptions and a separate 100 MHz in LTE Band 43 with different value assumptions.

The difference in value can be observed from the results of the assignment auction in the Republic of Ireland where we and some other winners expressed a value to have our assignment placed in Band 42. We were unable to bid sufficiently highly to secure our first preferred assignment.

Such a comparatively small release of 125 MHz overall will limit the prospects for 5G in this band, contrary to all international trends. That in turn will lead to its devaluation in utility for genuine 5G as a productivity force-multiplier for the nation.

Simply, it cripples the 5G vision, particularly when only 25 MHz is available in the short-term in the most strategically important band today.

It is instructive that in the recent auction in Ireland, all the ultimately winning bidders started with an expectation of securing *at least 120 MHz*. The bidding limits applied by COMREG (ACMA's counterpart in Ireland) provided for up to 150 MHz per operator[8]. Even within this bidding limit, there must have been at least seven (7) bidders hoping to secure 150 MHz to account for the demand that was observed over the first week of the auction[9].

ASH makes a critical point for your consideration: all operators will need to be able to acquire sufficient spectrum in a "5G Band" to support a 5G wide-bandwidth business case - otherwise it will come to little more than "extended 4G-LTE", but operating in a different frequency band.

The 5G technical model leverages wideband carrier aggregation. If operators cannot obtain spectrum quantities that meet the 5G operating concept, then they will be reluctant to express their value in the market.

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8 https://www.comreg.ie/publication-download/3-6-ghz-band-spectrum-award-information-memorandum, Clause 4.12, p.100

9 A presentation by our Team on the COMREG auction can be made available to ACMA on request.

If that happens, then Australia will likely miss some parts of the 5G vision that is being articulated internationally, to the detriment of both Treasury and national productivity and for the country's reputation as a place for innovation.

In that situation, the sorts of valuations that ASH observed in Ireland (already a haven for technology innovation that your Prime Minister would envy) will be illusory, because a true 5G ecosystem won't be technically sustainable.

In direct contrast with ACMA's proposal, the European Union has mandated the whole band from 3.4 GHz to 3.8 GHz (i.e. 400 MHz) be made available for 5G. European nations are all making plans to implement this vision. Europe has set a clear direction towards a well-articulated pan-European vision that Australia would do well to emulate to meet the Prime Minister's innovation rhetoric.

Noting that radio chipsets are already available for LTE Band 42 and customer handsets supporting the band are imminent, ASH supports re-farming this full band from 3.4 - 3.6 GHz (200 MHz). We present below a description of the mechanisms in law to allow this with little detriment to existing operators. This primary band for 5G development is compromised by past planning and allocation, yet it is so important to the evolution that the coherence of the band be resolved.

Handset support for the higher-frequency LTE Band 43 (3.6 – 3.8 GHz) is not as strategically urgent, although we note that the American market will be initially supported in parts of this band by the Google Pixel handset release that includes LTE Band 48 (3.55-3.7 GHz) radios. This band becomes more critical as 5G-NR is deployed, for this new radio architecture will be hungry for bandwidth.

We believe it is important to note that early radio support paves the way for the deployment of technical enhancements, including the 4G-LTE Advanced enhancements that are already being deployed by ASH in Ireland and the USA.

ASH notes there will be major cost savings and certainty for industry and Government alike by planning and implementing action now, rather than having two separate planning and re-farming processes that might lead to further discontinuities in allocation. This is critically important noting the importance of wide bandwidth to the operation of 5G-NR.

ASH believes the end game for this band has a certain inevitability about it. It has already been ordained for Europe and we expect that the rest of the world's major economies will not be wanting to be left behind.

ASH recommends strongly that ACMA develop and adopt a single strategic 5G plan now, with staggered implementation as follows:

- Priority to LTE Band 42 (3.4-3.6 GHz) to be *replanned* and available for access by 2020 because handset availability is imminent to support 4G-LTE Advanced in the band; and
- Band 43 (3.6-3.8 GHz) to be available for access by 2022 to enable headroom for the gradual conversion to the 5G-NR radio architecture.

ASH believes that full access to the 3.4-3.8 GHz bands in major industrialised economies is inevitable as 5G takes hold. Moves in this direction are already underway in the United States where current planning provides only for access up to 3.7 GHz, but where there are loud calls for this to be extended by Congressional mandate; not just by FCC rule-making.

Following the international trend presents low-risk for Australia.

Failing to rationalise the planning of the bands to facilitate 5G-NR will inhibit take-up in Australia of international mobile technologies.

ASH appreciates that under the ITU framework, Australia (Region 3) is not in the same planning region as Europe. ASH also accepts that Region 3, like Region 2 covering the Americas, currently only provides for 5G mobile planning up to 3.7 GHz.

This makes LTE Band 42 *even more critical* to the evolution of 5G in this Region. The importance of C-Band satellite systems to South-East Asia, where alternative higher-frequency satellite bands are prone to rain attenuation in tropical conditions, is accepted. This is not an issue that affects Europe.

Nevertheless, very little prevents Australia from taking a lead role in opening the whole 3.4-3.8 GHz bands to 5G, particularly complimenting deployments with an allocation for low-power small cell architecture which may prove to be less of a threat to the technical compatibility to the fixed satellite service above 3.7 GHz.

The ASH involvement in small cell development sees low operating powers as a natural 5G enabler.

To that end, ASH would be happy to support any technical investigation for coordination with C-Band earth station facilities at Belrose with small cell base equipment that we could lend and support, at cost.

<u>Licence Area Planning</u>

5G in the 3.4-3.8 GHz bands will operate at shorter propagation ranges than those offered in other bands in current deployment for 3G and 4G services. These bands therefore require a denser overlay of infrastructure to obtain coverage, albeit at lower cost per site.

In the small-cell vision, very small radius radio sites can be placed to in-fill coverage where primary cells begin to fail at the cell-edge. In many ways, the small-cell architecture and the highly directional radio techniques enabled as part of LTE development can extend the coverage of traditional mobile telecommunications cells.

For this reason, we believe that to be effective, the licence areas for the proposed allocation should emulate as far as possible the coverage areas of other mobile telecommunications spectrum licences (for example at 1.8 and 2.1 GHz). We stress, this is not to compete with existing "big iron" base stations, but rather to extend their coverage and capacity at the current cell edge where performance becomes increasingly marginal, and do this at very low cost. This will be good for the MNOs and for customers alike.

In terms of the options on which ACMA has sought comment, the area we advocate is not listed as an option. ASH believes that within the evolution of mobile telecommunications in Australia, the area for spectrum licences in these bands should incorporate all the options described as "Area 1" and "Area 2", but would not need to extend all the way to the full extent of "Area 3".

In ASH's view, the best area definition for spectrum licence areas for the 3.4-3.8 GHz bands is to emulate ***exactly*** the licence area coverage of the 2 GHz band (which expands slightly on that of the 1.8 GHz Band) as shown in the hatched area in Figure 2 on page 21 of the ACMA Options Paper.

Our reasons are simple: In the evolution towards 5G, the 3.4-3.8 GHz bands will be a natural complement and extender to existing mobile telecommunications coverage. It is not necessary to extend the area reach of the band area definition further than this. Expanded coverage could be offered by ACMA under apparatus licensing on a case-by-case basis if ever required.

Since the "small-cell" vision works to enhance coverage of existing cells in deployment, the area coverage should not be less that that authorised for existing cellular mobile systems at 2.1 GHz.

ASH also notes that 5G is always at its core a mobile technology. It is important that 5G be considered in the context of major transport corridors and the centres that support those corridors. Once again, the small-cell architecture made possible in these bands offers the ability to extend the coverage of existing cells along these corridors at lost cost.

The area we propose includes the most important East-Coast transport corridors.

We commend this approach to ACMA for the reasons stated.

<u>Spilt Offer</u>

One specific lesson for ACMA that comes for our participation in Ireland is to bring to ACMA's attention a serious error made by COMREG, where it regarded the 3.4-3.8 GHz bands as homogenous. They are not. The bands overall comprise two discrete bands that are separately defined for LTE.

COMREG's decision treated all the spectrum 3.4-3.8 GHz as having homogenous *economic* value – it made no differentiation between LTE Bands 42 and 43 in the market design. Homogeneity, however, was not true for any operator, because the spectrum below the 3.6 GHz threshold holds a higher intrinsic value due to its first-to-market advantage arising from the imminence of supporting handsets.

ASH implores ACMA not to perpetuate the same basic error of market design.

The economic value above and below 3.6 GHz is demonstrably different as a function of the readiness of handset availability. It requires *two separate classes of spectrum* to be offered to market so that this value differential can be properly expressed. That was not possible for us in Ireland, and consequently, we were faced with an enormous risk in bidding. In the end, we were assigned spectrum that has straddled the 3.6 GHz threshold, but with sufficient for us below 3.6 GHz that we can make an immediate start on deployment. In the circumstances, it was the best that we could have hoped.

The ACMA proposed offer is for the specific bands 3.575-3.7 GHz (125 MHz), which straddles the 3.6 GHz threshold. 25 MHz of this exists in the valuable LTE Band 42, while the remaining 100 MHz is defined from LTE Band 43, which has a planning and deployment horizon further into the future.

With its current proposal, ACMA is predicating Australia's national 5G development on the wrong band, while preserving the disjointed inefficient band structure in what should logically be the preferred band (i.e. LTE Band 42 3-4-3.6 GHz).

25 MHz bandwidth in LTE Band 42 cannot support the spectrum efficiency of 4G-LTE enhancements using 3 sectors each of 20 MHz. When using a conventional 20 MHz channel structure (as we can do in the small-cell implementation), it leaves 5 MHz fallow, which is hardly efficient in spectrum management terms.

ASH also notes with concern that incumbent *spectrum* licensees all operate below 3.6 GHz in LTE Band 42 and therefore will have an ***immediate*** first-to-market advantage which is anti-competitive. We feel obliged to bring this to the attention of the Australian Competition and Consumer Commission (ACCC) which has a statutory interest in telecommunications and ACMA's market design.

Some incumbent licensees already have more than the threshold 60 MHz of contiguous bandwidth in major cities and could use this to mount a full 3-sector optimal 4G-LTE Advanced system using 20 MHz channels immediately, and with a clear migration to 5G-NR as soon as they can secure radio access.

ASH is concerned by this substantial advantage being offered to incumbent operators on such favourable terms. It constitutes bad public policy.

ASH proposes how this could be addressed below, solving the issue of equitable and quick access to usable spectrum below 3.6 GHz on a level playing field for <u>all</u> operators.

<u>Apparatus Licence Safe Zone</u>

ACMA requested comments on its proposal for an apparatus licence carve-out from its offer to support legacy apparatus-licensed systems.

ASH rejects this notion on public policy, economic and spectrum management grounds. ASH believes such a proposal is undesirable, unnecessary and inefficient. There are better mechanisms available to allow 5G services to be deployed while dealing with apparatus-licence incumbency.

ACMA expresses in its options paper a separate proposal to implement a long (seven year) spectrum re-allocation period which would provide more than adequate protection for apparatus-licensed services.

We question, though, why it is necessary to have *statutory* safe zones versus *statutory* clearance in the first place, when other models have been demonstrated to work far more efficiently[10].

ACMA should never be in the position of extending corporate welfare for legacy apparatus licensees by creating a safe-haven that excludes access to all others, when it's mission is to advance a much wider public interest in spectrum efficiency.

The wider public interest is in providing an environment where 5G concepts can be realised without inhibition, as Europe has planned.

The national economic interest will be best advanced by creating the broadest possible useful playing field in which 5G services can evolve and prosper.

A statutory "carve-out" to protect legacy systems would inhibit that.

Instead, ASH believes that existing apparatus licence should enjoy continuity in those geographical areas where the deployment of 4G-LTE/5G is not feasible. If an existing licence is not compatible with a proposed new site deployment in the bands, then there is ample room for private negotiations to resolve the issue.

As an example, the fixed point-to-point service provides the same type of communication as LTE currently provides – essentially moving information (as bits) from one place to another. In many cases, LTE public shared infrastructure will do this more cheaply and efficiently than dedicated radio links. ASH sees little economic future for fixed radio links in the 3.4-3.8 GHz bands in the areas where 5G services will most likely operate, and where there will likely be alternative 4G/5G services, or perhaps optical fibre services. If fixed links are present outside of these areas, there will be no obvious need to relocate them *even if they fall within a spectrum licence*.

The scope for private bargaining for clearance on an as-needs basis is high, and it avoids the very blunt-instrument of statutory clearance.

There are many technical alternatives to fixed point-to-point links in these bands, including in other spectrum bands. ACMA already has other powerful mechanisms in law (such as the band planning powers in the *Radiocommunications Act 1992*) to clear the fixed service if this is necessary, and without spectrum reallocation declarations. Again, this is a blunt instrument.

ACMA also has the power to raise apparatus licence fees in this band to change the economics for fixed link operators, using the "administrative incentive pricing (AIP)" model. The ACMA is well familiar with this. AIP formed a foundation of the development of the apparatus licence fee model that has been used in Australian for more than 20 years.

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[10] See a description of the performance of the "overlay" model described by former FCC Chief Economist Tom Hazlett, in Hazlett, T W (2017) *The Political Spectrum – The Tumultuous Liberation of Wireless technology from Herbert Hoover to the Smartphone*, Yale, pp.276-281

ASH believes that ACMA should use this mechanism to create an economic incentive for fixed point-to-point links to seek alternative ways of moving information than these bands, before resorting to the blunt-instrument "spectrum reallocations".

The presence of Wireless Internet Service Providers (WISPs) can similarly can be resolved by reference to Hazlett's "overlay model" without resorting to statutory clearance. Many of these services exist where broadband service delivery is problematic or uneconomic. Some use existing fixed broadband wireless technologies to provide a virtual point-to-point link. Many rely on local community support. Some even rely on overt subsidies.

They are unlikely to create an issue for any operator on the path to 5G in the 3.4-3.8 GHz bands.

ASH advocates a small cell model for these bands, appropriate to high density locations. As such, WISPs present negligible risk to our business model and we see no need at all for statutory clearance or statutory protections. If anything, ASH would prefer to see how we might complement WISP services with our technology to provide better services overall to the community.

ACMA should be realistic about this. Out in the field, if a WISP is competing with 4G-LTE services for data provision today, then the WISP business will have such favourable economics that it is likely to be unaffected as 5G evolves. Alternatively, if a WISP is providing services in an area where existing 4G-LTE has no current offer, then it is less likely that services in these bands will enter that area to compete.

In every case where a spectrum licensee has area coverage of a WISP it will be able to negotiate a private agreement with the WISP to assure continuity of access, or clearance, as the case may require. Similarly, if WISP apparatus licences are granted long term regulatory protection (and ASH regards the seven-year proposed spectrum reallocation period as "long term") then it might as well be protection for the entire practical life of the spectrum licence.

In seven years, *we will soon be debating the imminent arrival of 6G*.

None of this presents any issues for ASH, for it will always be open to a spectrum licence wanting to secure access to deploy equipment to negotiate directly with the protected incumbent.

It is a win-win outcome that does not need intervention from officials to be realised, because all the necessary mechanisms are in place in law. Further, if ACMA creates the right competitive outcome by offering wide bandwidths to support multiple licensees, there will be alternative spectrum licensees for an incumbent WISP to negotiate with for continuity of access.

ASH already notes that an offer of only 125 MHz across the 3.4-3.8 GHz bands may compromise a competitive market.

Carving 25 MHz out of this already very limited offer reduces the utility further, for no advance in value for Australia.

<u>Provision for Small Cell Architecture</u>

While ASH cannot support a statutory carve-out from spectrum licence planning to protect apparatus licences (we prefer their future be dealt with by commercial negotiation), ASH does

specifically support an amount of spectrum being set aside to be allocated as spectrum licences with a technical bias towards small-cell architecture (i.e. with lower powers).

This is because small-cells can dramatically improve the spectral efficiency of existing cellular mobile networks by providing low-power non-interfering in-fill at the cell edge where the transmission scheme of the primary cell drops from 256 QAM to below 16 QAM, reducing the number of bits/sec/Hz that can be supported.

The small-cell systems we deploy at ASH to restore the bits/sec/Hz availability in that area from sometimes as low as 3 to nearly 10 bit/sec/Hz; a substantial improvement in the productive efficiency of deployed spectrum.

Small-cells allow the "densification" of the existing networks, specifically as part of the 5G technical vision. We are already deploying this approach in Ireland, in partnership with Sprint in the USA, and with Reliance in India using 4G-LTE Advanced technology.

ASH recommends that ACMA make specific provision in the 3.4-3.8 GHz bands release for a part to be mandated for small-cell architectures with corresponding power limits. ASH recommends that such provision be made in increments of 20 MHz each and for at least two blocks. Small-cell architecture is an integral part of the evolution of mobile technology towards 5G and is critical to the goal of network densification.

We hope that ACMA will respond to our call to replan LTE Band 42 to support migration to 5G, but if the current proposal stands, then it should be for 1 x 60 MHz allocation, with the remaining 65 MHz planned for lower-power small-cell deployment to support 2 lots of 20 MHz plus one lot of 25 MHz configuration. Small-cell deployments can operate efficiently in 20 MHz.

It also provides the means of advancing ACMA's own objective to enhance spectrum efficiency: far more so than a release solely for MNO take-up to deploy as RANs.

Current Occupancy of the Bands

The ITU Region 3 Allocation and Australian Tables of Frequency Allocation provide for Fixed, Fixed-Satellite and Mobile services in the bands 3.6-4.2 GHz.

ASH appreciates that ACMA has analysed and reported statistics about existing users. As the list is reviewed, there seems to be no class of operator that presents such a national interest that it should be allowed to forestall the development towards 5G in Australia.

Fixed Service

For the fixed (point-to-point and point-to-multipoint) services that are located around the markets where ASH believes evolving 4G-LTE/5G services will be technically viable, there are already alternative bands for radiocommunications, just as there are technical alternatives *to* radiocommunications.

The business need to move information (bits) from one place to another can be met in many ways (e.g. optical fibre), including using public mobile telecommunications.

We see no imperative for the fixed service to remain in the band in the long term, but equally there is no real requirement for statutory clearance, which may inadvertently extend clearance to areas where advanced mobile services would not be technically and economically sustainable.

As noted above, ASH recommends using AIP to create the incentives for fixed-service to move to these alternative means of carriage. This approach would set AIP pricing to reflect the economic opportunity cost to the deployment of 5G *for the nation*. It would negate the need for statutory clearance via "spectrum reallocation". There will always be an opportunity for a private negotiation, including a negotiation that might provide an alternative service using the spectrum licensee's access.

ASH notes a precedent from the past for having short (i.e. two-year) spectrum reallocation periods for the fixed service in prior allocations of spectrum licences in Australia in the 1.8 GHz and 2.1 GHz bands. It was a particularly "blunt" instrument for the affected licensees at the time. It did create free and clear access to the deployment of these bands to 2G and 3G mobile telecommunications, but at the same time some of those licences may not need to have been cleared.

Nothing prevents private third-party agreements under a spectrum licence to enable fixed links to remain *in situ* where they would not interfere with planned 4G/5G cellular operations. Where they would interfere, there is always scope for that to be resolved commercially.

ASH supports private band management and arrangements such as this to enhance the productivity of spectrum.

Fixed Satellite Service

The fixed satellite service space-to-earth segment (downlink) provided for the Australian Table of Frequency Allocations falls between 3.6 and 4.2 GHz. The 3.6-3.7 GHz component (part of LTE Bands 43 and 48) is proposed in the ACMA documents to be re-farmed to the mobile service. We note that the C-Band satellite channel structure commences at 3.625 GHz (i.e. 75 MHz of the C-band is directly affected).

Accommodating that part of the C-Band satellite downlink between 3.625-3.7 GHz presents the same issues as it does for any frequency *above* 3.7 GHz. Any mitigation that is put in place for the 75 MHz above 3.625 GHz will apply with little or no marginal cost to all other services above 3.7 GHz. On that basis, we recommend the ACMA plan all the spectrum 3.4 - 3.8 GHz to ultimately support 5G, including the 3.7-3.8 GHz component, consistent with the 5G vision being articulated in Europe. ASH recommends this for major metropolitan markets ("Area 1") at the very least.

ASH accepts that this may limit the future of satellite-receive earth stations *at some locations*. This is acknowledged by ACMA in its proposal in the options paper to create a satellite earth station protection and coordination zone, and relocate services there.

In general terms, ASH sees the seven-year proposed protection for these facilities as reasonable. If clearance is necessary for public policy reasons, there is no reason why they could not be relocated by 2025, when 5G-NR radio support in LTE Band 43 is predicted to be in place.

ASH recommends that the first mechanism applied should be to plan (and announce) now for the withdrawal of technical protection for the fixed satellite service after seven years. The earth station operators would have the option of installing more discriminatory filtering in the first instance, before resorting to relocation. ASH notes that highly directional earth station dishes will point with high elevation at sites such as Belrose to link with spacecraft in the geostationary orbit, whereas the radiation for the evolving mobile services will tend to horizontal.

This seven-year timetable will depend critically on rationalising LTE Band 42. Without Band 42 being rationalised, the future of Band 43 including the extended C-Band is much more critical to the evolution towards 5G.

There is no special science associated with dismantling and erecting satellite earth station facilities. It is an engineering and construction matter.

East Coast Satellite Earth Station Protection Zone – spatial relocation of satellite facilities

Irrespective of our interest in the 3.4-3.8 GHz bands generally, ASH strongly supports the creation of an East Coast satellite earth station protection and coordination zone to complement the arrangements on the west coast.

ASH recommends that this ought to be developed as a matter of good public policy and Australia's best long-term interests.

Who can forecast the future of radiocommunications and how this might change the radio environment in the Sydney basin?

Nevertheless, before evicting satellite earth stations from the Sydney basin to facilitate access for mobile services, we recommend some technical compatibility studies ought to be conducted to ascertain whether small cell/low power architectures such as those advocated by ASH can co-exist peacefully with these facilities. ASH notes that spectrum sharing is a desirable thing wherever possible, and that the satellites in the geostationary orbit are relatively high in the sky at Belrose.

To assist such a compatibility study, ASH would be happy to lend (with support, and on an at-cost basis) some small cell equipment tuned to these bands for testing and measurement.

Satellite facilities are an important part of the national communication mix, but should not be used as an excuse to delay implementation of other services that the community will value highly in Australia's largest city. Coexistence or otherwise needs to be established with certainty.

The establishment of satellite facilities at Belrose and nearby Oxford Falls in the Sydney metropolitan area was an historical anomaly from a time when UHF spectrum was considered abundant. The Belrose facility was consolidated as an East-Coast base for the AUSSAT satellites in the early 1980s. The first AUSSAT series was conceived before mobile telephony entered the market. Motorola did not introduce its first handset into commercial service until 1983 and by then, AUSSAT's satellites had already been commissioned. The first satellite would be launched in 1985.

As a historical note, Belrose/Oxford Falls is in one of the wettest parts of Sydney and satellite signals using the Ku Band (the original AUSSAT deployment) are known to be prone to rain attenuation.

By and large, mobile telecommunications services using the 3.4-3.8 GHz bands will not be economic to deploy in low population density areas, unless they are used to extend coverage, anchoring on existing services at lower frequency bands. Other bands such as 700 MHz and the traditional suite of mobile bands at lower frequencies are far more appropriate to extend services in these areas.

Ideally, a satellite earth station protection zone would be in an area that is already "radio quiet" with low population density, and be unlikely to see encroaching development. It would ideally be to the west of the Great Dividing Range to take advantage of orographic rain shadow. It would have ready access (say within 45 minutes commute) of a sustaining regional population centre. It would be away from major air corridors. It would likely sit in a natural depression or valley that would provide terrain-based isolation for sensitive receivers.

I note from my own time in Australia that around Canberra, there were once 3 major space earth stations located at Honeysuckle Creek, Orroral Valley and Tidbinbilla supporting NASA's space program. These facilities have now been consolidated at Tidbinbilla. Sites like these meet the criteria suggested above. There is a radio embargo already in place around Tidbinbilla at certain frequencies, and an aviation no-fly zone is in place. That is not to suggest that Tidbinbilla would be the preferred location of a satellite quiet-zone.

There are other regional centres such as Parkes (NSW) that host radioastronomy because they have a relatively quiet radio environment, although any town the size of Parkes will likely generate some radio noise.

While ASH is happy to support technical compatibility investigations around 3.7 GHz at Belrose, we generally support putting all facilities that operate below 3.8 GHz on notice that they will not be protected in the long term. This does not affect services operating in Ku Band.

There should be no impediment to the roll-out of evolution towards 5G in LTE Band 43 and any other future technology as it becomes widely internationally available.

These are valuable bands.

<u>Other Apparatus Licences</u>

In addition to the fixed and fixed satellite services, ASH notes the presence of other apparatus licences supporting independent wireless internet service providers (WISPs).

As 5G technologies become widely available, some existing WISP technologies may become obsolete. The vision for evolution towards 5G fully supports a broadband wireless access model that is more capable and more multi-layered than systems available today. Deployment of some 5G technologies at 700 MHz for example will provide better wide-area coverage than services in the 3.4-3.8 GHz bands. Combinations of evolving 5G technologies in different frequency bands could extend range and coverage in ways that cannot be easily supported using existing technologies currently deployed in the 3.4-3.8 GHz bands. 5G has always been designed to be a multi-platform/multi-radio flexible vision.

In the dense market areas around major metropolitan areas, 5G services using a range of radiofrequency bands will provide better alternatives for the provision of broadband data to

customers than stand-alone WISPs. In less dense regional areas 5G broadband data might become available using any one of a few bands, down to 700 MHz.

In cases where there is little prospect of 3.4-3.8 GHz 4G-LTE/5G operations, there should be no requirement for existing apparatus licences to be displaced and these could be accommodated easily within the existing regulatory framework.

The ACMA options paper makes only fleeting reference to the provisions in law for third-party authorisation that exist and have been used by spectrum licensees in the past. The options paper makes no reference at all to the "overlay model", or of its success in achieving sensible and equitable access without unnecessary displacement.

Third-party provisions allow devices that were previously apparatus-licensed to continue operations under the authority of a spectrum licensee.

ASH will have no intention of displacing any existing apparatus-licensed WISP operating within bandwidth defined in a spectrum licence it obtains (should we be successful), unless that would inhibit ASH deploying its own service. The very nature of ASH business will also welcome WISPs to deploy our technology as our agents where this makes business sense. ASH sees this as a win-win.

The small-cell architecture operating at low power will have a substantial capability and cost advantage compared with any existing WISP; however, such systems are not suitable unless there is a critical mass of population density to support them. The prospect of radio interference too far from small-cells is low.

WISPs typically have emerged in response to a lack of broadband access, and a lack of likelihood of planned access. We do not see them as incompatible.

Clearance for the sake of having unencumbered spectrum is pointless. If ASH can separately generate revenue in otherwise non-productive spectrum, it will welcome this. ASH would be happy to negotiate third-party access for any WISP that we could accommodate technically, on a no-interference basis, on terms no less favourable than offered by the ACMA under apparatus licensing.

Indeed, as "private band managers" in the mould of the original vision of spectrum licensing in Australia, ASH can be expected to have a low-cost structure and significant administrative efficiencies.

The law already provides for spectrum licensees to be private band managers. If one reverts to the original report of the BTCE[11] that informed the development of the Radiocommunications Bill in the late 1980s/early 90s, and to the work of ACMA's precursor[12], the Spectrum Management Agency that implemented spectrum licensing, the idea of "private band management" was a consistent feature. The ideal is closer to the model of the New Zealand spectrum management rights approach. ACMA should be a bold advocate for this model for it improves the efficiency of spectrum management and utilisation.

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11 Australia, Bureau of Transport and Communications Economics (1990) *Occasional Paper 102 – Management of the Radiofrequency Spectrum – An Economic Analysis*, AGPS, Canberra

12 Australia, Spectrum Management Agency (1995), *Implementing Spectrum Licensing*, AGPS, Canberra

Private band management under third-party authorisation rules is an alternative to the blunt instrument of non-discriminatory clearance by the spectrum reallocation declaration method. ASH is open to negotiating continued access where this can be provided for incumbents. It is a short step from that to a model where incumbents have statutory protection, and new spectrum licensees can negotiate their clearance.

This would represent efficient contemporary spectrum management practice.

Prior to the amendments that provided for spectrum reallocation, the former Spectrum Management Agency (SMA) had articulated the business process for dealing with incumbents consistent with the original provisions of law. Those provisions are still active and provide for "conversion"[13] to spectrum licences. Spectrum reallocation was an instrument only added in 1997 by the second telecommunication policy review, that now seems to have become be the default.

ASH supports third-party (or sublicensing) and private negotiation as the best solution for all parties rather than heavy-handed administrative clearance. The winners of spectrum licences have an incentive to offer third party authorisations if doing that would not interfere with their core business. It is a stream of revenue that requires little overhead. They also have a sound incentive to negotiate clearance only where necessary.

As Tom Hazlett shows, this is far more efficient than statutory reallocation and clearance.

Spectrum Values

ASH is concerned at the inappropriateness of some of the spectrum values touted in the "highest value use" paper.

Raising numbers such as are presented risks creating in the minds of Ministers a "target" that becomes linked to the budget expectations. ASH notes how this process resulted in the failed initial allocation at 700 MHz, where the offer did not clear the market. ASH also notes that Australia's current Prime Minister and the Minister for Urban Infrastructure led the attack on what proved to be unrealistic "reserve price" expectations at 700 MHz.

We urge the ACMA to resist this basic error of economics. Allowing it to take root could present political embarrassment.

ASH takes the view that the lower bound price quoted is within realistic expectations based on our experience, but that the upper bound quoted is unsustainably and unrealistically high.

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[13] See ss.52-59 and related provisions for "Conversion Plans" in the *Radiocommunications Act 1992*. In simple terms, the "spectrum denial" of the existing apparatus licence would be modelled in frequency and area dimensions using the protection mechanisms defined for the spectrum licences. Converted spectrum licences would be defined for the spectrum denial and excised from the wider offer, like "holes in swiss cheese". Conversion prices would be set by auction benchmarks. With all rights clearly established, incoming licensees could trade spectrum with new spectrum licensees (and vice versa). The "overlay model" of Hazlett simplifies this process by directly protecting the rights of apparatus licences (as a 15-year spectrum reallocation period would do). New operators would bid for the overly rights to use free spectrum, but protecting the rights of incumbents. They could privately negotiate clearance rights as and when required.

ACMA requested advice on whether there are any other useful benchmarks for price in these bands.

There are two contemporary values that ASH recommends be considered; Ireland (March 2017) and the Czech Republic (June 2017).

Both benchmarks relate to the 3.4-3.8 GHz bands in the European 5G context.

Ireland

As part of our due diligence for investors for the Irish auction, ASH conducted an extensive survey of contemporary price points across Europe and elsewhere. We looked at different mobile telecommunications bands across a range of different countries.

In our assessment at the time, we expected market clearing prices to be in the range EUR 0.005 to 0.03/MHz/pop for Ireland. COMREG set the opening prices for markets with a nation-wide average to just EUR 0.0048/MHz/pop. No doubt, COMREG was informed by similar assessments to ours.

The auction was more competitive than anyone expected. In the final round of the auction (Round 55), the national average price bid set by COMREG was EUR 0.063/MHz/pop (six cents), with Dublin as the most highly valued market at EUR 0.090/MHz/pop (nine cents)[14]. Economically efficient "second price" rules applied by COMREG then reduced the amounts payable by winners to the opportunity cost of the unsuccessful bidders.

These data are expanded in tabular form below, with a conversion from EUR to AUD at an exchange rate of EUR 1 = AUD 1.4966 (valid on the day calculated) and expressed in cents.

	EUR Cents	**AU Cents**
COMREG Opening price*	0.48	0.72
COMREG Closing price*	6.26	9.36
Standard deviation [SD] (all markets)	2.13	3.19
2SD(-) lower bound	2	2.99
2SD(+) upper bound	10.52	15.73

* *national mean price*

Within an optimistic two standard deviations from the national mean, the final auction prices suggest an outer range for Ireland between 3 and 16 Australian cents (/MHz/pop).

Industry heavy-weights Vodafone and Hutchison-Three reduced their spectrum demands from their starting positions in response to price/demand pressures. Such a competitive environment is *unlikely to be replicated* in Australia. Several fixed wireless broadband operators had already been established in Ireland and were keen to safeguard their business, enhancing the level of observed competition. Under current proposed ACMA rules, however, the incumbent spectrum licensees get

[14] Data calculated from ASH records of the prices set by COMREG during the Irish auction. ASH can provide a full briefing on our experience in the Irish auction on request.

a privileged run, reducing the competitive outlook and devaluing the opportunity for others (especially since most of the proposed ACMA offer relates to the lower- valued LTE Band 43).

A vibrant competitive market as seen in Ireland-2017 does not seem as likely in Australia given the history of the band.

Moreover, the reduced utility of such a small disjointed 125 MHz offer proposed by ACMA, may degrade market prospects.

ASH is obliged to reiterate our call for a much broader allocation in keeping with the technical requirements necessary to meet the evolution of the 5G vision. ASH also reiterates our call that the allocation should include a stronger offer of 200 MHz in the first preferred LTE Band 42.

It is the volume of spectrum in the 5G context and the timing of access that creates value for operators and the subsequent flow-on to the wider economy.

Czech Republic

In June 2017, the Czech Republic concluded an auction of five arbitrary blocks of 40 MHz in these bands (total 200 MHz) with a final market-clearing price of CZK 203 million/block. The total revenue, therefore, was CZK 1,015 million. At an exchange rate AUD 1.00 : CZK 17.44 (valid on the day of calculation), this equates to a price of A$0.0276/MHz/pop (i.e. less than 3 Australian cents).

The Czech result is *less than* two standard deviations below the national mean derived from Ireland. It tends to confirm that in ASH's assessment, Ireland was an unexpected outlier.

The ACMA upper bound estimate of A$0.625/MHz/pop falls outside the bounds of credibility when compared with these contemporary 3.4-3.8 GHz benchmarks. It is approximately seven-times (7x) multiple of the national mean value observed in Ireland in March 2017. It is about twenty-two times (22x) the national licence value observed in June 2017 in the Czech Republic.

Such a high value expectation has little credibility on contemporary international benchmarks for this band.

Instead, ASH suggests a benchmark for Australia based on our assessment of the current offer compared to other offers internationally be within the range 2 to 7 AU cents/MHz/pop. ASH observes that this value *may* be able to be enhanced by making the offer more consistent with international trends and more biased towards LTE Band 42; raising the range to 4 to 10 cents/MHz/pop.

The 5G vision and band requirements have been well articulated in Europe for a long time, and all major carriers and regulators have been assessing the opportunities across all European nations. Prices, values and business cases are well understood for this band in Europe.

Notwithstanding the comments above, ASH does not believe this lower assessed value *to operators* diminishes the economic case for conversion of these bands to a configuration that supports international 5G. The real economic value of 5G does not come from the value to operators, but rather from the innovative ideas and business opportunities that the provision of access to this incredible technology by operators will spawn.

As noted above: even if ACMA were to give the spectrum away for free, the likely economic benefit to Australia from 5G developments and new businesses made possible will still accrue and likely dwarf the value to incumbent licensees.

ASH also notes that these economic benefits cannot accrue from re-farming existing cellular mobile bands, because few of these bands support the levels of bandwidth that fulfil the 5G technical vision.

This 3.4-3.8 GHz bands therefore present unique opportunities.

Prices at licence renewal – Existing Spectrum Licences in LTE Band 42

The highest value use assessment notes that the lower bound price (A$0.03/MHz/Pop) used by ACMA was derived from the price set for *non-competitive* renewal of expiring spectrum licences in the 3.4 GHz bands.

The value observed in June in the Czech Republic is marginally lower than this value. The 2SD(-) range from Ireland barely captures it.

ASH questions the appropriateness of the renewal approach taken, and whether that approach has reflected the wider public interest.

The Electronic Communications Committee (ECC) of CEPT first published its decisions regarding the bands 3.4-3.8 GHz bands in 2011. The extension and description of a desirable feature set for a 5th generation of LTE has been a feature of the relevant technical journals for perhaps a decade.

Despite this, existing spectrum licences, deployed in a superseded and inappropriate technical configuration, were renewed by the ACMA in 2015, rather than being market tested in a configuration that could support the evolving 5G vision.

The development of spectrum licensing policy in Australia, backed by economic research at the time[15] and ultimately implemented in law was for spectrum licences to be *re-allocated* [16] (i.e. by market) on expiry *for the very reasons that now create an issue for ACMA*. The law was amended in 1997 to provide for up to 15-year fixed terms (up from 10 years as originally provided) so that licences could better amortise an investment; however, the fixed-term nature of the licences was not amended.

ACMA would have been far better placed to have made a short-term "bridging" renewal[17], providing scope for the whole band to be re-configured and revalued as a contiguous technically and logically coherent block. We note with concern the non-contiguous and piecemeal allocation of 100 MHz in LTE Band 42, yet we observe that long-term plans for the band have been well known internationally for some time. ASH also notes that a new price benchmark will be set by an allocation for 5G evolution, and therefore it was a "courageous" decision to curtail planning in this way.

ASH suggests that good public policy requires market-testing rather than an administrative renewal with prices set by officials, especially when the bands face such an upheaval in their configuration,

15 Australia, BTCE (1990), *op cit*, Appendix III.

16 Australia, Spectrum Management Agency, *op cit*, Chapter 9.

17 There is no minimum term provided for spectrum licences, see s.65(3) of the *Radiocommunications Act 1992*

use and value. It is very hard to argue in the context of the impending 5G evolution that it was *in the public interest* to renew the spectrum licences in that configuration in 2015[18].

Now the ACMA faces a delicate problem that raises two *public interest* concerns having authorised existing licences to be renewed at $0.03/MHz/pop.

On price, ACMA is open to criticism either way: if the market reveals a lower price, those who paid have cause to feel aggrieved. If the market reveals a high price, then the actions of ACMA to renew licences have deprived the Australian Treasury of a better revenue outcome, and the Treasurer (and Australian taxpayers) would be right to feel aggrieved.

A second and far more concerning public interest arises, because the recently renewed licensees now have an immediate and *uncompetitive advantage* in the 5G deployment context. They have immediate access to what will be their "own" spectrum, without any concern for spectrum reallocation periods or clearance in the prime LTE Band 42, for which radio chipsets are available and handsets imminent.

New entrants will be relegated under the current ACMA proposals to Band 43, with supporting handsets one further product cycle away.

ASH takes the view that this imbalance should be properly and strategically addressed as part of the planning for the band, and we note that the law provides a simple mechanism to deal with the issue; to correct the current technical configuration and do that in a way that the public interest is captured.

ASH observes that one of the licensees has hardly used its licences in the band at all; indeed, its licences have hardly been used since original allocation in 2000. This has been a non-productive waste of valuable spectrum resources.

Of most concern in the 5G context is that the original technical plan (which dates to before 2000) provided for four band segments in total, with three of these forming a contiguous band of 67.5 MHz, and separately a band of 32.5 MHz, with the components arranged in different FDD duplex arrangements so that the full 100 MHz allocation was disjointed[19].

Efficient LTE 4G Advanced and 5G-NR deployments are most efficiently constructed out of units of 20 MHz channels. The 32.5 MHz "orphan" in the current plan can support only one 20 MHz channel, but not two. Using older technology based on 10 MHz LTE-4G operating channels in that block would leave 2.5 MHz not deployed.

Allowing this to continue in such a valuable band is not efficient spectrum management.

ASH notes that there also is a band-gap in the FDD arrangements from 3.4925-3.5425 GHz currently left "fallow" in the original plan. This too should be corrected. There once were users in that band

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18 As required by s.81(2)(b) of the *Radiocommunications Act 1992*

19 ACMA defines the existing 3.4 GHz band spectrum licence allocations with respect to the original allocation, as (a)3425-3442.5 MHz, (b)3442.5-3475 MHz, (c)3475-3492.5 MHz (total contiguous = 67.5 MHz) and separately (d)3542.5-3575 MHz (32.5MHz). 50 MHz duplex was for pair a-c, 100 MHz was for pair b-d.

gap at the time of its original planning in the late 1990s, but they have had plenty of time to relocate. If they have not (now close to 20 years later), then there is a compelling case to give them a "hurry-up". Given that the 5G future of this band has been known internationally for so long, it would be inexcusable if that gap was still allowed by the national spectrum manager to remain unavailable for 5G evolution.

ASH takes the view that the arrangements for the renewed spectrum licences that inherit from the old configuration of this band are wasteful and inefficient to the vision of 5G. This is especially the case in LTE Band 42, which is the current international priority band for handset radio availability and will be the first band to launch in this part of the spectrum. It is also important for Australia, because LTE Band 43 operations may need to be curtailed in Region 3 due to the existence of the C-Band satellite service.

The most technically efficient approach is to have a homogenous technical plan for the entire band, predicated on forward technical plans for 5G-NR deployment (i.e. up to 100 MHz channels) using TDD and including separate support for small-cell architecture.

Against that background, it is highly desirable in spectrum management and policy terms that the LTE Band 42 be rationalised and re-packed to avoid technical waste of what is otherwise likely to be valuable spectrum. Offering the whole band as a coherent block with a new rational technical framework predicated on 5G-NR will be far more valuable for all operators, and thus to the public interest and economic interest of Australia. It will resolve the currently inefficient allocations and their inability to support 20 MHz channels efficiently. It will resolve the inherently inefficient mid-band gap and open it to use.

The mechanism ASH described below will perform this fairly (to everyone), and it will advance the public interest in accordance with the law. It also links neatly with the "overlay" model which we propose is far more effective and efficient than spectrum reallocation in providing for incumbent rights.

The *Radiocommunications Act 1992* provides at Division 6, Part A (ss.91-95) a process for the *compulsory acquisition* (on just terms) of spectrum licences. These provisions provide a simple reliable lawful mechanism to rationalise the whole band from past planning constraints.

Once resumed, the bands can be replanned for technical homogeneity, the current inefficiencies can be corrected and "clean spectrum" can be reoffered to the market on equivalent terms to <u>all</u> interested parties.

We propose special arrangements below for services that are provided as part of the NBN that are consistent with our submission.

ASH recommends that the Minister initiate a process, as he is empowered to do under s.91 of the Act, to resume <u>all</u> previously awarded existing spectrum licences in the 3.4 GHz Bands as a prelude to the replanning of the band for new spectrum licences to support 5G. A new technical plan should replace the non-standard FDD duplex arrangements and provide for a standard technical framework supportive of LTE 5G-NR using TDD predicated on 20 MHz channels.

Nothing prevents the spectrum licence incumbents bidding in a future allocation, and we suggest they well may welcome the opportunity to rationalise their holdings at what might be a lower price to support the technology of the future, and that their holdings do not currently support efficiently.

This would open the way for more spectrum in the valuable LTE Band 42 being offered than is currently envisaged.

ASH argues that this would be in the national economic interest as it enables a more technically efficient vision of LTE and 5G-NR in the 3.4-3.8 GHz bands and especially in LTE Band 42. Allocation of the whole of this band would in our estimation raise more than sufficient revenue to offset the cost of "compensation on just terms" for a part of the administratively set renewal price being refunded.

If all 400 MHz were to be offered and won at auction with a coverage of (say around) 12 million people at a realistic minimum price of $0.03/MHz/pop the result would contribute $144 million to the Australian Treasury and generate many multiples of that in downstream economic product each year.

NBN Wireless Broadband Using 3.6 GHz Licences

At ASH, we acknowledge the importance of the Australian national broadband initiative and the place of the NBN in advancing national policy.

ASH notes that while some existing spectrum licences remain fallow, other licences are used today to support apparatus associated with the NBN, by NBN Co. Since NBN uses parts of the 3.4-3.6 GHz bands spectrum licences to advance policy, we offer a simple, clear and lawful mechanism to protect those national policy interests, while at the same time allowing the rationalisation of planning for LTE Band 42 for 5G-NR.

5G-NR radio systems, when they are available, are likely to outperform existing NBN radio broadband links and will, in time, substitute for them. In many areas, by 2020 we can expect 5G radio systems to be offering ubiquitous services with higher capacity than NBN Co can offer with current technology, even in metropolitan areas where the competition is with optical fibre.

If ACMA follows our recommended path regarding resumption of spectrum licences in LTE Band 42, so they might be reissued, there will be a public policy imperative to preserve continuity of broadband access for existing NBN customers using radio links.

The issue of continuity extends to all incumbent spectrum licences.

The solution is the same for all and it is simple.

On our reading of the law, once the spectrum licences have been resumed, there would be little to prevent the immediate administrative issue of *apparatus licences* for all currently registered devices under each spectrum licence resumed. This could be done administratively with no disruption to the legal authority to operate devices. It may be necessary to do this prior to any spectrum reallocation declaration issued (if one is issued at all), but the process could be set up and triggered automatically at the necessary points of the process.

Those apparatus licences could then be subject to the same clear-or-stay model as proposed for other WISPs and fixed links.

The overarching public interest is to configure these bands now for the long-term evolution of 5G.

ASH invites the ACMA to consider how much more difficult it will be to rationalise this band in a few years, after it has been allocated and deployed in a piecemeal way, rather than now when there is an opportunity to get it right.

This is a band for strategic planning and arrangement today, rather than marginal fiddling at the edges.

Europe has taken a sensible, defensible and strategic approach to 5G in these bands that is the envy of the world. It will reap dividends.

We hope Australia will join that vision.

Summary

In this submission, we have raised several opportunities for Australia related to 5G evolution and deployment. It promises to be much more than just another "G" in the series, but a profoundly important technical leap enabling a new and innovative economic opportunities. The new radio architecture of 5G-NR is prime among these, as is small-cell infill and network densification that is a part of the ASH core business.

The offer proposed by ACMA is timid.

Now is a time to be forward thinking and strategic for the benefit of the nation rather than seeking the path of least resistance with incumbent interests.

ASH believes that the real value of the opportunity will be realised by fixing the current spectrum planning quagmire that LTE Band 42 has become. It should be replanned in its entirety to support 4G-LTE and evolving 5G services.

Let's have a level open playing field for all; not one dominated by sectional interests and industry capture.

The case for LTE Band 43 is in our opinion less urgent, but it forms part of the 5G strategic planning framework internationally. We believe it is largely inevitable that the whole band to 3.8 GHz will be realised to support LTE 5G [as is the case in Europe], but this is more likely over the medium term.

We argue that a national coherent strategic plan, consistent with the international framework and technology roadmap is a national imperative.

We support the establishment of a satellite receiver quiet zone outside of the valuable markets and have offered pointers on what we believe are appropriate criteria for selecting candidate sites. We believe that in the longer term, all operators including satellite operators will come to enjoy the benefits of such an arrangement.

We do not support statutory intervention for clearance and safe zones for apparatus licences as raised in the ACMA options paper. We believe that these are unnecessarily blunt instruments that could lead to the mandatory clearance of services (or protection of legacy services) that pose no threat of technical interference to 4G-LTE/5G. For those that might inhibit roll-out, we believe that the evidence instead shows that a negotiated clearance regime between the affected parties will lead to more efficient outcomes.

ASH strongly advocates the use by the Minister of the resumption powers in the *Radiocommunications Act 1992* to rationalise the recently renewed spectrum licences LTE Band 42. The licences can be resumed, compensation paid and former licensees will then have an equal opportunity to bid for licences in a subsequent auction on a level playing field with all other interests. Rationalisation of the planning of these bands is critical to the deployment of 5G concepts, and especially the 5G-NR radio architecture.

In the meantime, we advocate the automatic issue of apparatus licences for all registered active transmitters operating under the licences that are resumed. This will preserve access by customers to services currently in place.

We support the auction of new spectrum licences in the bands using a coherent technical framework as soon as practicable, but taking care to differentiate the offer between the prospects of LTE Band 42 and Band 43. These are different bands in terms of their underlying economic prospects. Overwhelmingly, for the next 3 to 5 years, the economics strongly favour LTE Band 42.

We do not object to a 7-year spectrum reallocation period for incumbent apparatus licence, so that their operations are protected from interference by incoming spectrum licensees, and we note that this opens the opportunity for private negotiations over clearance that are likely to out-perform in efficiency the mandatory clearance model. To us, seven years might as well be the entire licence term.

Conclusion

ACMA has a rare opportunity with this strategically important band to the future development of wireless telecommunications. The band is currently in such a mess that it compromises the enablement of the 5G vision.

ASH has a small but very experienced team across Europe, Asia, the Americas and Australia with experience in the product vision, technology, spectrum planning and management and market theory.

We will be at your service to provide any further technical briefing or explanation that you may require.

My team and I are available to join you by Skype if you desire, or to come to Australia to present to a select group on the 5G opportunity. We also have some of our expertise located in Sydney and Canberra in Australia.

Given that this submission raises issues of public policy and industry development and the exercise of Ministerial powers I am copying it to Senator the Hon Mitch Fifield, Minister for Communications.

Thank you for considering our views.

Yours sincerely,

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