



TELSTRA CORPORATION LIMITED

Optimising Arrangements for the 3400-3575 MHz band

Public submission

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EXECUTIVE SUMMARY

We welcome the opportunity to comment on the ACMA's options paper *Optimising the 3400-3575 MHz band* (IFC 12/2019). Optimising the 3400-3575 MHz band is a significant opportunity to improve the efficiency and utility of the wider 3400-3700 MHz band. This proposal should be the ACMA's second highest priority following the reallocation of the 26 GHz band because, without optimisation, the mixture of different technology generations in the 3400-3575 MHz band has potential to limit the capability of all fifth generation mobile broadband (5G) networks deployed in the wider 3400-3700 MHz band.

The development of 5G is a step function change in technology and represents a critical input to the next wave of innovation and productivity improvement in Australia. Much of the foreshadowed improvement is predicated on new technical capabilities delivered by the 5G New Radio (5G NR) standards, including the introduction of a range of new frame structures to deliver higher bitrates and lower latency.

Synchronisation challenges

While the 3400-3575 MHz band was originally designed and optimised for Frequency Division Duplex (FDD) operation, current and future networks in this band will be using Time Division Duplex (TDD) technology. Synchronisation of TDD networks, so that no base stations are transmitting while adjacent base stations are receiving, is essential for making efficient use of this spectrum. Without synchronisation, wasteful geographic corridors or frequency guard-bands would have to be established to manage the risk of interference between networks. However, for synchronisation to work at all, every adjacent network must use compatible uplink/downlink timing and frame structure. Network operators using technology generations prior to 5G NR (for example, 4G TD-LTE) do not have access to the new frame structures created in 5G NR. If one operator uses a 4G-LTE frame structure, then all operators have to use frame structures that are compatible with 4G-LTE. This will prevent 5G deployments reaching full potential.

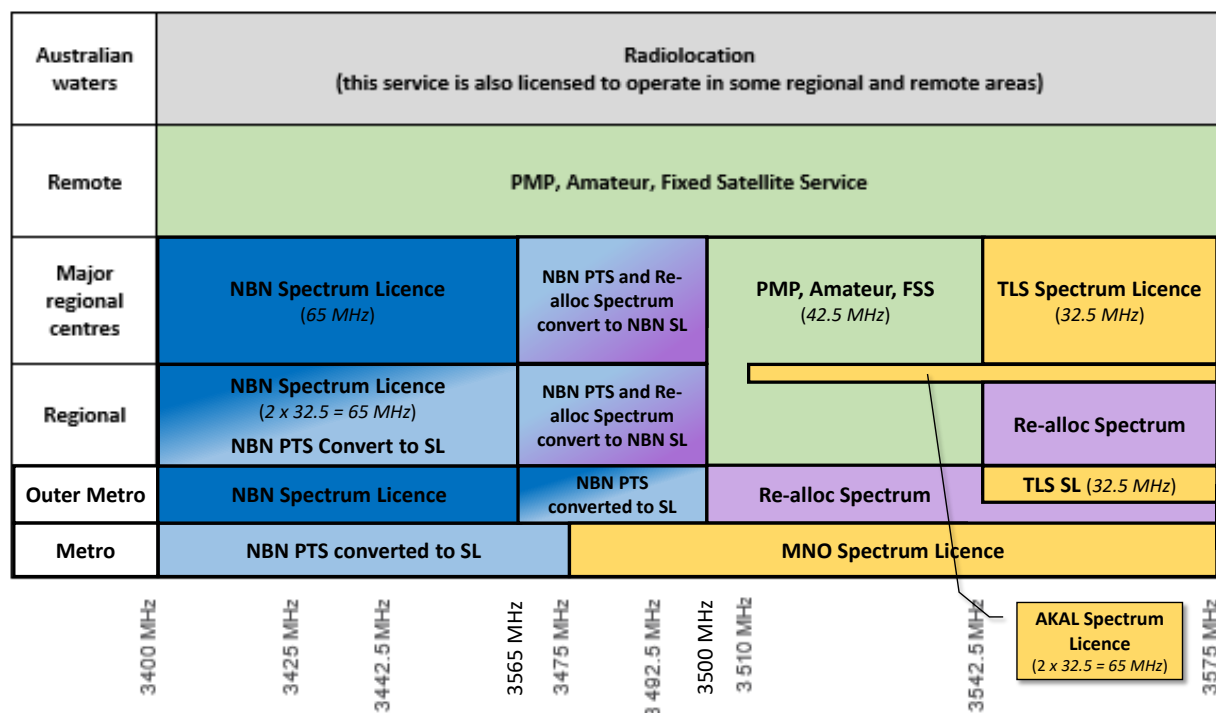
A better option

To simplify the challenges associated with designing a network synchronisation arrangement to encompass multiple technology generations and use cases over time, we believe none of the ACMA's proposed options are optimal, and an alternative option should be considered. This alternative option is an expansion of the ACMA Option 3b. It requires the ACMA and industry to reconfigure the use of the 3.4 GHz band in a collaborative manner so that:

- all legacy (pre 5G NR) technology is accommodated at the lower end of the band;
- all 5G NR technology is accommodated at the upper end of the band; and
- a sufficiently wide guard band is maintained in the middle of the band to manage the risk of interference between the two types of technology, noting that there is also potential to reduce the size of this guard band over time as legacy technology is upgraded to 5G NR compatible technology.

The following diagram illustrates the optimal outcome for the configuration of the band that is delivered by this alternative option.

Optimal configuration of the 3400-3575 GHz band



As well as resolving the synchronisation challenges, this option also has the additional benefit of freeing a larger block of contiguous spectrum (42.5 MHz) that can be used by point-to-multipoint (PMP) operators (e.g. Wireless ISPs), Amateur and Fixed Satellite Services (FSS) in most regional areas.

In our submission we demonstrate how this alternative option meets the ACMA's principles for spectrum management and optimisation goals identified for the band. We also show how the benefits are shared across all users, thus creating a strong incentive for all users to support the proposed restacking of the band.



01 Introduction

We welcome the opportunity to comment on the ACMA's options paper *Optimising the 3400-3575 MHz band* (IFC 12/2019). Optimising the 3400-3575 MHz is a significant opportunity to improve the efficiency and utility of the overall 3400-3700 MHz band, and we maintain that this proposal should be the ACMA's second highest priority following the reallocation of the 26 GHz band because the interleaved configuration of technology generations in 3400-3575 MHz has the potential to limit capabilities and benefits of early deployments of all fifth generation mobile broadband (5G) networks in the 3400-3700 MHz band. This would occur if 5G networks are required to synchronise with earlier technology generation(s) operating on adjacent frequencies.

Our submission is structured as follows:

- Section 2 makes the case for a better option;
- Section 3 describes our proposed option in detail;
- Section 4 explains how our proposed option benefits all incumbent users of the band; and
- Appendix 1 contains answers to the fourteen specific issues the ACMA raises for comment.

02 The case for a fourth optimisation option

The ACMA's consultation paper identifies three primary options, and in this submission we propose an additional option which offers a better overall outcome. Before presenting this option, we discuss the rationale for our proposed option by outlining inherent issues with Time Division Duplex (TDD) networks, and the limits of network synchronisation in resolving them. Failing to take the limits of synchronisation into account will force 5G network operators to implement suboptimal frame structures, which in turn will limit the full extent of new 5G capabilities such as higher bitrates and lower latency.

2.1. Use of guard bands to avoid 5G NR / LTE synchronisation requirements

A consequence of TDD is that base stations in close geographic and/or frequency proximity need to be synchronised with each other to prevent one base station transmitting when an adjacent base is receiving. Base stations often have line of sight or low obstruction visibility of many other base stations, hence can easily interfere with each other, whereas a mobile device will typically only see a very small number of base stations as it is low to the ground and radio paths are typically obstructed. So, if one base station is transmitting at the same time as a neighbouring base station is attempting to receive, the emissions from the transmitting station will interfere with the weaker handset emissions being received by the second base station.

In order to avoid geographic corridors and/or frequency guard bands, which are an inefficient use of spectrum, network synchronisation can be used. This ensures base stations operate harmoniously in the same area and on the same frequency such that they always transmit at the same time and always receive at the same time. The challenge for an operator with overlapping base station coverage is that it must manage uplink/downlink timing control and use the same TDD frame structure to avoid severe interference. Even in a country as large as Australia, all operators must agree on, and implement the same uplink/downlink timing and the same TDD frame structure, including adjacent frequency operators that have overlapping base station coverage.



TDD technology has a “ripple” effect when it comes to synchronisation and frame structures. Different base stations on the same frequency in the same area have to use identical frame structures and timing. This impacts all the surrounding co-channel areas, which also need to fall into line. And then, due to imperfect out-of-band emissions and interference rejection, the frequency adjacent services also need to align, and the services next to them need to align. And so on, across all networks and sites.

This challenge is then compounded when different operators have different needs, leading to preferences for different frame structures. Different network operators, especially where one operator is serving fixed-wireless customers and the other is serving mobile customers, may prefer different frame structures that support different uplink/downlink ratios to manage varying end-user applications with different levels of asymmetry. This makes reaching agreement on a single frame structure challenging.

The challenge is further compounded where different generations of TDD technology (e.g. 4G TD-LTE and 5G NR) are attempting to coexist. The 5G New Radio (5G NR) standard introduces new frame structures and shorter transmit/receive turn-around times required to support increases in overall bitrate and new low-latency capabilities that simply do not exist in earlier technology generations. The consequence for adjacent networks on different generations is that the newer generation network must be configured with a backward-compatible legacy frame structures to avoid interfering with the legacy technology. This will limit the new 5G capabilities and benefits.

Overcoming these compounding challenges is difficult. A better alternative is to implement a sufficiently wide frequency guard band and out-of-band receiver rejection such that synchronisation between older and newer generation technologies is not required at all. Guard bands are costly to the utility of the band, as they are not used to deliver communication, and it is important to reduce the number of them as much as possible. But enabling the greater spectral efficiency of the newer technology while avoiding unplanned infrastructure replacement in the older technology outweighs the loss of utility in the band resulting from use of a guard band. It may also be possible to reduce the size of the guard band over time as legacy technologies upgrade to 5G NR.

Consequently, we are proposing that the best way to maximise the utility of the 3.4 GHz band is to move different technology generations (4G TD-LTE and 5G NR) to opposite ends of the band, and implement a single sufficiently wide frequency guard band between them such that no synchronisation is required between the different generations of equipment. This will maximise the utility of the band by allowing 5G NR network operators to realise the full potential of the new generation technology and also giving 4G TD-LTE operator(s) flexibility, as explained below. A 4G TD-LTE operator would have discretion to:

- adopt whatever frame structure they want, at the cost of using some of their spectrum as a guard band to prevent interference to frequency adjacent services in the same area; or
- invest in new infrastructure using the same frame structure as the 5G NR frequency adjacent services in the same area, along with the benefits of being able to access more spectrum and achieve greater spectral efficiency.

2.2. A new spectrum ‘reserve’ for PMP operators in 3400-3700 MHz

We appreciate this consultation only focuses on 3400-3575 MHz. However, 3400-3575 MHz is a segment of the 3400-3700 MHz band, and when optimising the 3400-3575 MHz segment, it is important to consider the entire band holistically.



To this point, the 2018 Ministerial direction on 3.4 and 3.6 GHz Bands Interference Management¹ required the ACMA to place conditions on all spectrum licences and nbn's PTS licences in the 3400–3575 MHz band such that where no other interference management resolution can be agreed to, parties are required to adopt a common 'frame structure' to synchronise the operation of affected services. The important point here is that while the condition was only imposed on 3400-3575 MHz licensees, it was done with harmonisation across the entire 3400-3700 MHz in mind, as the lower segment cannot operate in isolation of the upper segment.

While nbn is the most obvious 4G TD-LTE operator in the band, we observe that a number of PMP operators across the band are also using 4G TD-LTE technology, or other older generation technology such as Wi-MAX. PMP operators are dotted across the entire 3400-3700 MHz band, and we note the ACMA's interest in considering the needs of these operators in the consultation paper.

We propose that older generation technology licensees from anywhere in the 3400-3700 MHz range be offered the opportunity to move toward the bottom of the band, with nbn at the very bottom, and with miscellaneous operators (e.g. PMP, FSS and Amateur) being located in a spectrum 'reservation' that is created immediately above the nbn holding.

2.3. Optimisation approach

We propose three guiding principles to deliver the outcomes outlined above.

1. 5G NR network operators should be grouped at the top of the 3400-3575 MHz band and 4G TD-LTE network operators (including older technology operators) should be grouped at the bottom of the band.
2. A minimum guard band of 15 MHz will be required for compatibility between 5G NR and 4G TD-LTE services. This is based on advice from our equipment vendors, noting that Active Antenna Systems AAS equipment typically used for 5G NR is more difficult to filter than conventional radio equipment.
3. A guard band is required for compatibility between 5G NR operators and frequency adjacent PMP services. This requirement is similar to principle 2 for 4G TD-LTE operators but recognises the fact that in general PMP operators have lower transmit powers than TD-LTE base stations. PMP services can have external filtering fitted to avoid blocking issues from adjacent blocks. The actual magnitude of the required guard band between 5G NR and PMP operators will have to be determined during the design of the technical framework for this band.

The guard band in principle 2 could be achieved by replanning the existing NBN channels and self-imposed guard bands in such a way that the existing guard bands are aggregated together and located immediately above the NBN active spectrum. This approach gives the mobile network operators maximum flexibility to agree on a common 5G frame structure that is unshackled from legacy LTE constraints.

We do not deny guard bands impose a cost on the utility of the band, as they are not used to directly deliver communication. However, the cost of maintaining a single guard band here is outweighed by the benefit of allowing 5G NR network operators to realise the full potential of the next generation networks, free of NBN related performance constraints. Further, this affords nbn the opportunity to upgrade its

¹ Australian Communications and Media Authority (Radiocommunications Licence Conditions—3.4 and 3.6 GHz Bands Interference Management) Direction 2018. <https://www.legislation.gov.au/Details/F2018L01045>



network to 5G NR technology in the future, which will then provide it with the dual benefits of being able to access more spectrum and achieve greater spectral efficiency.



03 A new and better option

In this section, we outline our proposed option, which is based on the ACMA's Option 3b. Like the ACMA's Option 3b, our option contains two phases, the first to establish arrangements to facilitate defragmentation and the second to conduct the defragmentation. However, our option goes further to achieve the optimal post-defragmentation configuration, including creating a reservation for PMP, FSS and Amateur licensees in major regional centres and most of the remaining regional centres.

Given the significant potential for 3400-3575 MHz optimisation to improve the utility of the overall 3400-3700 MHz band, we believe the optimisation of 3.4 GHz and consideration of this proposal should be the ACMA's second highest priority following the reallocation of the 26 GHz band. This is because the 3400-3700 MHz band is the pioneer band for 5G networks in Australia, and it is vital that conditions are established to allow 5G networks to realise their full potential.

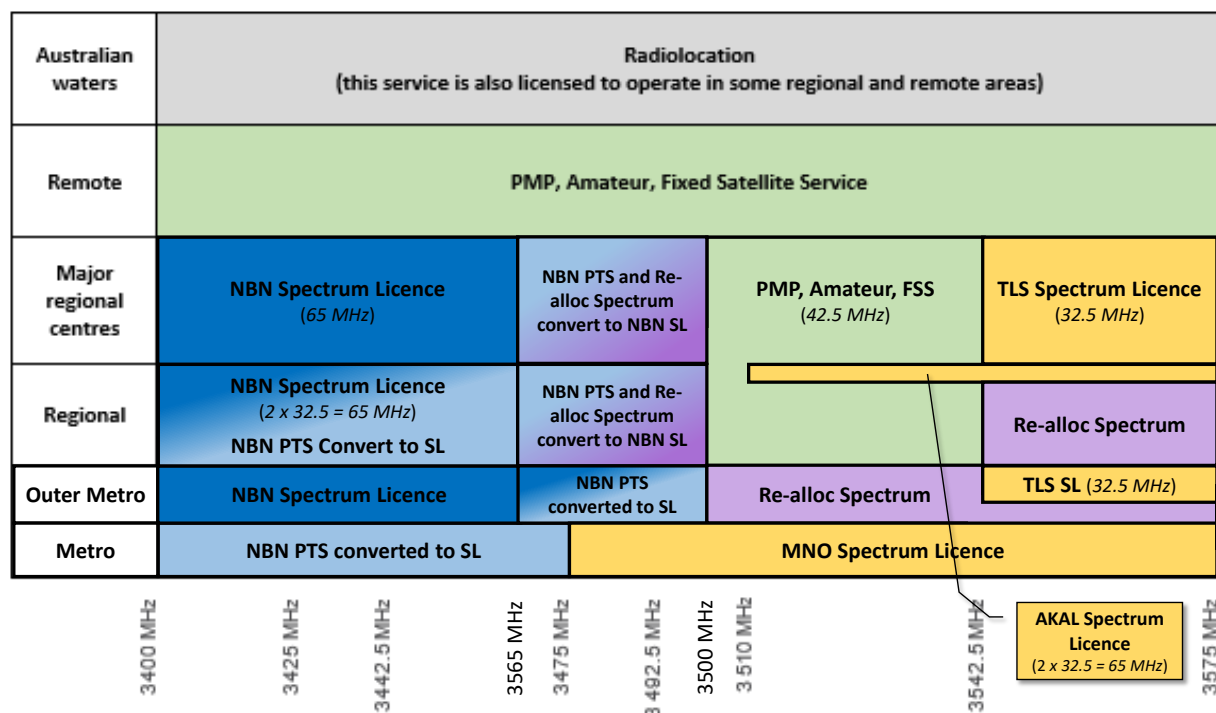
We consider ACMA guidance is required to facilitate the optimisation of the 3400-3575 MHz band by encouraging network operators on older generation technology to move toward the bottom of the band, while MNOs operating 5G NR are encouraged to the top of the band in a timely manner. While we continue to believe market forces and commercial arrangements are generally the best way to move spectrum to its highest value use, in this specific case, given the complexity involving many users of both apparatus and spectrum licences, we believe some additional guidance is deemed necessary to coordinate an outcome in a timely manner.

3.1. The new option

In line with Option 3b, our alternative option is a two-phase process that firstly requires the conversion of some of nbn's PTS apparatus licences to spectrum licences, followed by a second restacking phase. A further similarity between Option 3b and our proposal is the creation of a spectrum reservation for PMP, FSS and Amateur licensees in regional areas. However, we extend the creation of the spectrum reservation to all major regional centres, whereas there is currently no allocation for PMP, FSS or Amateur in major regional centres under Option 3b.

Our proposed option then goes further to identify the optimal arrangement within the band for different technology operators such that guard bands are created to avoid the need for synchronisation between networks of different technology generations. While actual trading of spectrum between spectrum licensees is ultimately voluntary, we are of the view this configuration delivers incremental benefit to all current and potential future users of the band, providing a strong incentive for voluntary participation in restacking the band.

Figure 1 below illustrates how the 3400-3575 MHz band will be structured at the completion of the second phase of our proposed option. The structure facilitates guard bands to avoid the need to use network synchronisation between 5G NR and 4G TD-LTE technologies. In the metropolitan areas, the 15 MHz guard band is implemented within nbn's spectrum licence (3460-3475 MHz) as the aggregate of the 3 x 5 MHz existing guard bands. In outer metropolitan areas, major regional centres and remaining regional areas, the >20 MHz guard band resides in the reallocated spectrum or in the spectrum reservation created for miscellaneous operators (PMP, Amateur and FSS).

Figure 1: Optimal arrangement of the 3400-3575 GHz band to facilitate guard bands

The key features of the new structure are as follows:

- nbn is encouraged to move to the bottom 100 MHz of the band in all five outer metropolitan areas, the major regional centres and the remaining regional areas of the 3.4 GHz band (3400-3500 MHz). nbn should also be encouraged to move to the bottom 75 MHz of the band in the six metropolitan areas (3400-3475 MHz). This is the minimum of either nbn's spectrum licence holding in a given geographic area, or nbn's current apparatus licence registrations in the ACMA's Register of Radiocommunications Licences (RRL).
- Establish a 42.5 MHz reservation of spectrum for miscellaneous services (P2MP, FSS and amateur services) between 3500-3542.5 MHz in all major regional centres and remaining regional areas, except for the regional area in WA, and the areas surrounding Canberra and Melbourne where the AKAL spectrum licences exist in the old 3442.5-347 MHz and 3542.5-3575 MHz FDD pair. Miscellaneous services are not allocated a spectrum reservation in metropolitan or outer metropolitan areas under our proposal. A technical framework will have to be designed that minimises interference to adjacent channel operators at either end of the spectrum reservation.
- In metropolitan areas, establish a 15 MHz guard band between nbn's 4G TD-LTE deployment and MNOs operating 5G NR. This is achieved within nbn's 75 MHz spectrum, as the three existing 5 MHz guard bands are aggregated to 3460-3475 MHz, and the three existing 20 MHz channels are stacked contiguously in 3400-3460 MHz. This configuration is maintained as long as nbn operates 4G TD-LTE technology, and has no net effect (either increase or decrease) on nbn's current quantum of usable spectrum. The metropolitan guard band can be reduced



if/when nbn convert to 5G NR technology, so long as a frame structure compatible with existing MNO deployment is used.

- In outer metropolitan areas, a guard band is achieved by virtue of the reallocated spectrum in 3500-3542.5 MHz. nbn will be spectrum licensed in 3400-3500 MHz and will be first in time, and any future owner(s) of 3500-3542.5 MHz will need to coordinate with nbn's existing spectrum licensed space.
- In major regional centres and the remaining regional areas, a guard band is achieved by using the 3500-3542.5 MHz spectrum 'reservation' for PMP, FSS and Amateur services. Spectrum on either side of the reservation will be spectrum licensed, and apparatus licensed services within the reservation will need to coordinate with spectrum licensees. We also observe that only a 10 MHz guard band is possible in regional Western Australia and the regional zones around Canberra and Melbourne where the AKAL spectrum licences already exist.
- Continued support for FSS operation in the band is provided at defined Earth Station Protection Zones (ESPZs) in regional Australia.
- Introduce a PTS apparatus licensing option in remote areas, alongside PMP, FSS and Amateur. This requires RALIs FX-14 and FX-19 to be updated and aligned.
- Amateur services to retain secondary status services in areas designated for their operation.
- The owners of new spectrum licences that have been converted from PTS apparatus licences are to pay a market rate for the term of the licences.

Implementation considerations

In developing options for restacking a band, consideration must be given to choreographing the actual restack. It is often very difficult to schedule a direct frequency swap between two services in different bands. Bandwidth mismatches may result in interference to a third operator where a wider channel service seeks to swap with a narrower channel service, or geographic locations and transmission footprints may not line up, again potentially causing interference to a third operator. Direct one-to-one frequency swaps will be a scarcity, requiring complex coordination across multiple sites and operators if occupants of two segments of a band attempt to directly swap. The solution is for one segment of the band to be completely vacated, allowing another segment to restack into the vacated spectrum.

This is the crux of the problem with Option 3b, where regional PMP operators in the lower segment of the FDD pair (3425-3442.5 MHz) are first relocated into the upper segment of the FDD pair (3475-3492.5 MHz). This clears the lower segment of the pair to make way for nbn's PTS licensed services to be moved out of 3492.5-3542.5 MHz. Option 3b stops at this point, leaving the ACMA to note that one of the disadvantages of Option 3b is that "*Optus and nbn licences are not able to be completely defragmented*"².

Our proposed option goes one step further, requiring PMP operators to then move slightly further up the band to 3500-3542.5 MHz. While we are aware that this may result in some PMP operators having to shift twice, we are of the view that any location within 3400-3575 MHz would be within the tuning range of this equipment, such that new equipment would not be required for each transition. Further, it may be

² Consultation paper, p.27, second last chevron.



possible to achieve the restack in a single move for the PMP operators if the spectrum in 3500-3542.5 MHz (i.e. nbn's PTS apparatus licence range) is sparsely populated.

Further work is required to fully understand the nuances of choreographing the restack, but to the extent that some PMP operators may be inconvenienced with two frequency moves, we believe it is worth the extra effort to achieve a more optimal final outcome.

Our proposed option requires nbn to forego future access to some of the spectrum notionally available to it for PTS apparatus licences. However, by more efficiently stacking nbn's FWA services in the bottom 100 MHz of outer metro, major regional centres and regional locations, and the bottom 75 MHz of metropolitan locations, our proposal will not require nbn to reduce their aggregate 'in-use' spectrum at any site, nor does it require them to return any spectrum held under spectrum licences.

nbn's current registered spectrum (i.e. registrations in the ACMA's Register of Radiocommunications Licences – RRL) does exceed the 100 MHz allocation we propose for outer metropolitan, major regional centres and the remaining regional areas in a few instances. We believe this to occur in less than 2% of cases, and propose that, in order to avoid reducing nbn's current registered spectrum holdings, nbn would be able to acquire PTS apparatus licences immediately above 3500 MHz.

By adopting our proposal, nbn will have the flexibility to make its own decisions on how it uses its spectrum, as it is now 'separated' in frequency as much as possible from the MNOs. nbn could, for example, decide to retain the 1:1 DL:UL ratio in its fixed wireless network, because the 15-20 MHz of 'guard band' from the MNOs gives it the capability to do so. Alternatively, nbn could decide in the future that it will adopt 5G NR and align its frame structure with that of the MNOs so it no longer needs a guard band and can use all of its spectrum.

Miscellaneous services (PMP, FSS and Amateur) operators would then be invited to move to the new reservation at 3500-3542.5 MHz in regional areas and major regional centres. One of the bonuses for miscellaneous service operators arising from our proposal is that a reservation is created in major regional centres, which does not appear in any of the ACMA's options. A further benefit is that PMP operators in 3575-3700 MHz, with apparatus licences that expire when the new spectrum licences come into force, would also be invited to move to the new spectrum reservation if that suits their needs, potentially providing an alternative long term home for them to move to. Embargo 52 will need to be updated to allow new applications for PMP, FSS earth station or Amateur apparatus licences within the 3500-3542.5 MHz reservation. A technical framework will also have to be designed to minimise interference to adjacent channel operators at either end of the spectrum reservation and with co-channel operators within the reservation. This requires RALI FX-14 to be updated, which also requires FX-19 to be updated to align with FX-14.

The spectrum reservation in major regional centres and regional areas also serves as a guard band between nbn's 4G TD-LTE deployment and MNOs using 5G NR. We anticipate that contention between users of the 42.5 MHz reservation and spectrum licensees on either side will be considerably less than the contention between nbn and MNOs, as operators of miscellaneous services are generally using substantially lower power equipment, along with shorter propagation distances, and less likelihood of interference to spectrum neighbours.

Finally, where spectrum previously made available for nbn's PTS apparatus licences is converted to spectrum licences for nbn, a market rate should be paid for the term of the licences. This rate will recognise the opportunity cost of this spectrum. Like any other spectrum licensee, we are of the view the fee should be payable at the commencement date for the spectrum licence; not before, and not after.



3.2. How our option meets the ACMA's principles for spectrum management

The ACMA's five principles for spectrum management are:

1. Allocate spectrum to the highest value use (HVV) or uses.
2. Enable and encourage spectrum to move to its HVV.
3. Use the least cost and least restrictive approach to achieving policy objectives.
4. To the extent possible, promote both certainty and flexibility.
5. Balance the cost of interference and the benefits of greater spectrum utilisation.

In the previous section, we outlined how our proposed option is an extension to Option 3b. Given the ACMA's options are designed to achieve its principles, we will not presume to explain how our proposed option meets the ACMA's principles where there is commonality between our proposal and Option 3b. We will, however, explain how additional elements in our proposal align with, and improve on Option 3b for the third and fifth principles.

Our proposed option extends Option 3b by defining the optimal outcome after the restack of the band is completed. Superficially, this may appear restrictive (i.e. contrary to the third principle), if the ACMA is trying to create a specific outcome, rather than removing barriers to allow trading to run its own course. However, it is important to recognise that guidance is not restriction, and that the parties are still completely at liberty to choose their own restacking arrangements once the licence types are converted. Further, there is a risk that insufficient guidance on the optimal arrangement will continue to deny the band from reaching its HVV, which will occur if a global solution to the network synchronisation problem is not found.

With regard to the fifth principle, we submit that our proposed option also delivers greater utility from the spectrum. While we recognise that guard bands superficially come at a cost to spectrum *utilisation*, utilisation is not the only measure of the *utility* of spectrum. We also observe that we are not proposing to increase the total amount of guard band spread across the band, but rather, are aggregating the individual small 5 MHz guard bands into a single guard band of 15 MHz in metropolitan areas, and around 20 MHz elsewhere. nbn has the opportunity to upgrade its network to 5G NR technology in the future, facilitating a reduction in the size of the guard band. This provides nbn the dual benefits of being able to access more spectrum freed by the removal of the guard band and the opportunity to achieve greater spectral efficiency from 5G NR technology.

Our proposal does, however, improve the utility of the band by allowing MNOs to implement the advanced capabilities of 5G NR, as well as providing nbn the flexibility to retain its existing 4G TD-LTE frame structure, thereby avoiding a significant cost imposition in transitioning to frame structure 2, as required under the 2018 Ministerial Direction. Overall, our proposed use of guard bands maximises spectral efficiency of the band as a whole, while minimising the industry level cost of unplanned infrastructure upgrades.

3.3. Our option meets the ACMA's planning goals for optimisation

In addition to the ACMA's five principles for spectrum management, the ACMA also outlines six planning goals for optimisation of the 3400–3575 MHz band proposal:

1. barriers to change are removed (for example, to facilitate trading);



2. arrangements for wireless broadband use are put in place across the entire 3400–3575 MHz band Australia-wide;
3. area-based Public Telecommunications Service (PTS) and spectrum licensees achieve contiguous spectrum holdings in all areas they hold licences
4. area-based PTS and spectrum licensee's total spectrum holdings are maintained in all areas they hold licences
5. spectrum arrangements for point-to-multipoint (PMP) licensing are consolidated into a single frequency range to facilitate the adoption of time division duplex (TDD) wireless broadband technologies and provide access to larger channel sizes
6. the amount of spectrum available for PMP licensing remains the same or increases in all areas. This provides an option for incumbent PMP licensees to continue operating in the band if they wish.

Our proposed option is an extension to the ACMA's Option 3b, and the ACMA's consultation³ contains an assessment of Option 3b against these six planning goals. We fully agree with the ACMA's assessment in regard to Option 3b, and as such, won't repeat that assessment here in relation to the components of our proposed option that mirror the ACMA's Option 3b.

The ACMA's assessment of its own Option 3b identified three disadvantages (in common with, and listed under Option 3a) with that option. Our proposed option improves the outcome against each of these three disadvantages:

Addressing disadvantage 1

Miscellaneous operators (PMP, FSS and Amateur) will have to relocate to a new portion of the band, which is likely to be of some disruption to those operators. While this statement remains true, our proposed option improves the scope for these operators by provisioning a larger reserve (42.5 MHz compared to only 35 MHz) in regional areas for them to relocate to.

Addressing disadvantage 2

Optus and nbn are unable to completely defragment their licences in some regional areas. The reason this occurs is because the 35 MHz allocated to PMP, FSS and Amateur is located in the 3475-3510 MHz range, which prevents nbn from realising a contiguous 100 MHz block across regional NSW, Victoria, Queensland, South Australia and Tasmania. Under our proposal to create a reserve for PMP, FSS and Amateur in the 3500-3542.5 MHz range - in both regional locations and major regional centres (rather than 3475-3510 MHz) - it is possible to fully defragment both nbn and Optus holdings. We believe that our proposed option fully resolves the second disadvantage of Option 3a/b.

Addressing disadvantage 3

Agreement is required from all affected spectrum licensees for the defragmentation to occur. We agree with this observation and note that our proposal does not change this; voluntary agreement by spectrum licensees is still required. However, we believe the opportunity to avoid using network synchronisation between different technology generations is a strong incentive for spectrum licensees to voluntarily and willingly participate in a restack. For all MNOs (including Optus), it avoids forgoing access to the 5G NR frame structures that support higher bitrate and lower latency, which is a strong incentive to engage in

³ p.27 and p.28



the restack. Similarly, for nbn there is a strong incentive to participate, as it alleviates the need to migrate its network to LTE frame structure 2, as required in the 2018 Ministerial Direction⁴ on 3.4 and 3.6 GHz band interference, providing nbn with the flexibility to use the frame structure that best meets its needs.

Finally, it is important to test our proposed option directly against each of the six planning goals. Our proposed option meets the first three and the fifth goals, as barriers to trading are removed, arrangements for wireless broadband access are established, and consolidated, contiguous spectrum is achieved for both PTS and PMP licensees.

The fourth goal states area-based PTS and spectrum licensee's total spectrum holdings are to be maintained, and a cursory examination of our proposal would suggest the new spectrum available to nbn under our proposed option is less than the sum of the spectrum licences and the spectrum available for area-based PTS licences. However, the goal of simply maintaining headline accessible spectrum space (inclusive of space accessible for PTS apparatus licences) provides no incentive for efficient use. A better goal is to ensure there is no reduction in spectrum available to meet the needs of that network, with an assumption that the spectrum is used efficiently.

On this basis, our proposal accommodates all of the spectrum currently registered in the ACMA's Register of Radiocommunications Licences (RRL) in the range 3400-3575 MHz. As outlined above in section 3.1, there are some sites where nbn's registered spectrum licences currently exceed 100 MHz, and we recommend the additional spectrum requirement can be accommodated through PTS apparatus licences located immediately above 3500 MHz.

⁴ Australian Communications and Media Authority (*Radiocommunications Licence Conditions—3.4 and 3.6 GHz Bands Interference Management*) Direction 2018. <https://www.legislation.gov.au/Details/F2018L01045>



04 Our proposed option benefits all users of 3.4-3.575 GHz

In this section, we explain how our proposed new option benefits all users of the 3.4-3.575 GHz band, and the 3400-3700 MHz range more broadly.

4.1. Benefit to nbn

The option we propose separates different technology generations to opposite ends of the 3400-3575 MHz band through the use of guard bands. The 2018 Ministerial direction on 3.4 and 3.6 GHz Bands Interference Management requires the ACMA to direct parties experiencing interference to implement a frame structure that uses both uplink-downlink configuration 2 and special sub-frame configuration 6. The direction is only required where the *“level of interference ... exceeds the compatibility requirement”*⁵. We are of the view that implementing the guard bands as outlined in our proposed option will ensure that interference is not experienced, and as such, the direction to implement the frame structure described in the ministerial direction will not be required.

So, in our proposal, nbn now has the flexibility to make its own decisions about how to use its spectrum, as this is now ‘separated’ in frequency as much as possible from the MNOs. nbn could, for example, decide to retain the 1:1 DL:UL ratio in its fixed wireless network, because the 15-20 MHz of ‘guard band’ from the MNOs gives them the capability to do so.

nbn could also decide in the future that it will adopt 5G NR and align its frame structure with that of the MNOs so it no longer requires a guard band. This would allow it to use all of its spectrum. Either way, nbn has the freedom to choose its own frame structure without imposing restrictions on 5G NR operators, or, it can convert its network to 5G NR and use more of the 75 MHz spectrum it holds under its existing spectrum licence.

4.2. Benefit to MNOs

The main benefit to MNOs arising from our proposed option to move different technology generations to opposite ends of the band is that it allows MNOs to establish synchronisation parameters (frame, sub-frame, etc) optimised for 5G NR, rather than having to select parameters that align with older technology generations. This avoids the risk that alignment with older generations will limit some of the new 5G capabilities associated with higher bit rates and lower latency.

4.3. Benefit to PMP operators

Our proposed option includes a 42.5 MHz spectrum reservation for miscellaneous services (PMP, FSS and Amateur) operators, in major regional centres and regional areas, except regional Western Australia and the small geographic locations around Canberra and Melbourne where AKAL spectrum licences exist. This spectrum reservation is not currently available to PMP operators at all in the major regional centres, as spectrum outside of spectrum licensed allocations and the nbn PTS allocation is only available for Amateur services and FSS. So, its introduction is likely to be of interest and benefit to PMP

⁵ Part 5, section 1(i) of Australian Communications and Media Authority (Radiocommunications Licence Conditions—3.4 and 3.6 GHz Bands Interference Management) Direction 2018. <https://www.legislation.gov.au/Details/F2018L01045>



operators, including operators in the 3575-3700 MHz band. The spectrum reservation is also a 7.5 MHz increase over the 35 MHz already available to WISPs in regional areas (except WA and the locations around Canberra and Melbourne).

The spectrum reservation in major regional centres and regional areas serves the dual purpose of creating a new or increased reservation for miscellaneous services (PMP, FSS and Amateur) operators as well as a guard band between nbn's 4G TD-LTE deployment and MNOs using 5G NR. This is likely to be able to be achieved with little interference to miscellaneous services operators in the spectrum reservation. Nevertheless, a technical framework will have to be designed to minimise the risk of interference to operators in the spectrum reservation, and this would be delivered through an update to RALIs FX-14 and FX-19.



Appendix 1: Response to the ACMA's issues for comment

This appendix contains our responses to the fourteen specific issues posed in the options paper.

1. Do stakeholders have any comments on the case for action in the 3400–3575 MHz band?

The case for action is very compelling. The historic evolution of this band from its original FDD configuration to the more recent international harmonisation of the entire 3400-3700 MHz band for 5G IMT has resulted in a fragmented allocation that risks limiting the new 5G capabilities associated with higher bit rates and lower latency.

We agree with the ACMA's observation the longer defragmentation is delayed, the higher the cost of achieving defragmentation, as deployment will only increase over time, creating a greater volume of network equipment to retune. We consider ACMA guidance is required to facilitate the optimisation of the 3400-3575 MHz band, and in the body of our submission, we have proposed a new option that requires increased guidance to drive the optimal outcome by encouraging network operators on older generation technology to move toward the bottom of the band, while MNOs operating 5G NR are encouraged to the top of the band.

While we continue to believe market forces and commercial arrangements are generally the best way to move spectrum to its highest value use, in this specific case, given the complexity involving many users of both apparatus and spectrum licences, we believe some additional guidance is deemed necessary to coordinate an outcome in a timely manner.

Also, we recommend the 3400-3575 MHz optimisation proposal should be the ACMA's second highest priority, with only the 26 GHz band reallocation as a higher priority because the configuration of the 3400-3575 MHz band has the potential to limit capabilities and benefits of early deployments of all fifth generation mobile broadband (5G) networks in the 3400-3700 MHz band.

2. Do stakeholders have any comments on the planning options identified? Are there any other planning options that should be considered? (Please provide reasoning.)

The body of our submission outlines a new and improved option based on the ACMA's Option 3b, along with detailed justification for proposing the option based on the impact forced network synchronisation between 5G NR networks and networks operating older technology generations would have on the 5G offering.

In addition to the justification we have provided, we have also outlined how our proposal will benefit all incumbent users of the band, especially nbn and PMP operators.

Full details are in the body of our submission.

3. Do stakeholders have any comments on the planning goals for the 3400–3575 MHz band? Are there any other planning goals that should be considered?

We support the planning goals the ACMA has identified for the optimisation of the 3400-3575 MHz band, and do not have any additional goals to suggest.



We have taken the opportunity to assess our proposed option against the ACMA's planning goals in section 3.3 of our submission.

4. If Option 2a or 2b are adopted, do stakeholders have views on how long the re-allocation period should be?

We recommend the ACMA should proceed with our proposed option, rather than Option 2a or 2b, as our proposed option will enable greater utility from the band as a result of separating and avoiding conflict between different technology generations.

Our proposal includes a restacking phase, which will require some incumbents to retune to other parts of the band. We recommend the minimum two-year reallocation period permissible under section 153B of the Radiocommunications Act should suffice.

5. If Option 3a or 3b are adopted, do stakeholders have views on the period of time incumbent apparatus licensees should be given to implement restack? (Noting effected licences would not be reissued on existing frequencies beyond this point.)

Our proposed option is an extension to the ACMA's Option 3b, and so this question is directly relevant to our proposal. The largest single owner of apparatus licensed services is nbn with 12,586 assignments under 10 PTS apparatus licences. We will not presume to speak for nbn on the length of time required to implement a restack across these services, however as a starting point for an industry agreed timeframe to complete the restack, we recommend the minimum two-year reallocation period permissible under section 153B of the Radiocommunications Act is a good guide.

However, as outlined in section 4.3 of our submission, we believe it is prudent for PMP service operators moving into the spectrum reservation (3500-3542.5 MHz) to adopt a 5G NR frame structure to facilitate synchronisation with frequency adjacent neighbours. This necessarily requires the operator to update their equipment, both at the base station, and at each of the end users. While the process of managing all relevant activities to minimise disruption to customers requires a reasonable degree of coordination, the exercise itself is unlikely to be very time consuming. In fact, to minimise disruption to customers, the actual cutover exercise needs to be as brief as possible.

We believe that the planning and coordination activities for relocation of PMP services could be achieved within the minimum two-year reallocation period for services currently residing in 3400-3575 MHz, given there are only 108 licences across the 18 licensees. As we noted in section 3.1 of our submission, to fully defragment nbn and Optus' spectrum, it is possible that some PMP operators may have to move twice and choreographing the restack can be challenging across multiple sites, frequencies and operators.

Under our proposed option, PMP services operating in 3575-3700 MHz are invited to re-tune into the spectrum reservation created in 3500-3542.5 MHz (if it meets their needs), as an option to continue service after the end of the reallocation period currently in place on the 3575-3700 MHz band. Of course, PMP operators in the 3575-3700 MHz band are under no obligation to relocate within the same re-allocation period prescribed for operators in the 3400-3575 MHz band.

There is only one FSS earth station licence in the 3400-3575 MHz band (Lockheed Martin, licence 1913278/1) which is located at the Uralla earth station facility, which is an Earth Station Protection Zone (ESPZ). As such, there is no need for Lockheed Martin to retune or relocate this service.



6. If Option 3a or 3b are adopted, do stakeholders have views on how long the re-allocation period should be?

We recommend the ACMA should proceed with our proposed option, rather than Option 3a or 3b, as our proposed option will enable greater utility from the band as a result of separating different technology generations.

Our proposal includes a restacking phase, which will require some incumbents to retune to other parts of the band. We recommend the minimum reallocation period permissible under section 153B of the Radiocommunications Act.

7. Do stakeholders have any comments on the assessment of planning options against the principles?

We have made comments in relation to the ACMA's assessment of Option 3b against the spectrum management principles in section 3.2 of our submission.

8. Is there any relevant evidence that provides an indication of the value wireless broadband operators place on how additional spectrum is made available (i.e. under spectrum or apparatus licensing arrangements)?

We place a high value on additional spectrum in the 3400-3700 MHz band, as evidenced by our recent participation in the 3.6 GHz auction in November 2018. Given the large capital investment required to roll out mobile wireless broadband networks, our strong preference is that additional spectrum is made available under spectrum licensing.

We do not plan to use this band for a fixed wireless broadband network, so we do not offer any comment on the value fixed wireless broadband operators may place on additional spectrum, nor do we offer any comment on whether a spectrum or apparatus licence type is preferred.

9. Do stakeholders have any comments on the preferred planning option for remote areas?

We recommend the ACMA should introduce the option for PTS apparatus licences in remote areas, alongside PMP, FSS and Amateur. This would facilitate either MNO coverage in locations outside the regional areas, or private network deployments at locations such as remote mining sites. This will require RALIs FX-14 and FX-19 to be updated and aligned.

10. Should the broader 3400–3700 MHz band be considered when expanding arrangements for PMP in remote areas?

Whenever possible, we recommend the ACMA should consider the broader 3400-3700 MHz range holistically, and consideration for PMP services in remote areas is no exception to this rule. We are aware of government requirements that limit the ability to deploy PMP services in some parts of the Northern Territory 3575-3700 MHz, and this may well extend to PMP services in 3400-3575 MHz.



11. Do stakeholders have any comments on the preferred planning option for metropolitan areas, regional areas and major regional centres?

We note the ACMA's preference for Option 3b⁶. We have outlined a new proposed option in our submission that extends the ACMA's Option 3b to fully defragment Optus and nbn's spectrum. Our proposed option overcomes one of the ACMA's stated limitation of Option 3b, and we recommend the ACMA give serious consideration to our proposed option.

12. Would an earlier conversion of NBN Co's PTS licences in metropolitan areas provide greater certainty for negotiations on defrag to occur?

This question is relevant to nbn and Optus, so we do not offer any comment.

13. Are the existing third-party authorisation arrangements (Approach 1) sufficient to facilitate access to urban areas of NBN Co's PTS licences by other operators? If not, should the ACMA investigate what, if any, urban areas might be available under Approach 2?

The ACMA canvasses two possible approaches for wireless broadband operators to access urban areas currently covered by nbn's PTS licence. Approach 1 uses existing third-party arrangements for both apparatus and spectrum licences under the current Radiocommunications Act. Approach 2 seeks to excise some defined urban areas from nbn's PTS licence and allocate them via market based mechanisms such as an auction.

The ACMA notes Approach 2 has the consequence that formal coordination arrangements to manage interference need to be established, and that this will involve a formal consultation as the ACMA investigates the trade-off between a Device Boundary Condition (DBC) on nbn's spectrum licence versus a site-based coordination approach. This will undoubtedly delay the defragmentation process.

In accordance with our view that the 3.4 GHz optimisation project should currently be the ACMA's second highest priority, we support Approach 1 for individual third-party authorisation arrangements under nbn's PTS licences, as this avoids any possible delay in completing the restack that would arise as a result of the consultation required under Approach 2.

14. Do stakeholders have any views on what co-channel interference management technique should be applied under Approach 2?

In our answer to question 13, we support Approach 1 for the use of third-party arrangements under nbn's existing PTS licences. As such, co-channel interference arrangements will be managed on a site-by-site basis for each individual application for third-party access.

⁶ Consultation paper, p.30