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Introduction

Boeing Australia Holdings (Boeing Australia) welcomes the opportunity to comment on the ACMA's discussion paper 'Planning of the 3700–4200 MHz band.'[1] This consultation is timely and appropriate given the interest in the frequency band of long-established services and new technologies that might be able to share his valuable radio frequency spectrum space. Such interest includes new and innovative satellite applications, 5G IMT identification and wireless broadband (WBB) as referenced in the discussion paper.

The 3 700-4 200 MHz frequency band spectrum is critically important to many established Australian C-Band satellite services and is immediately adjacent to frequencies necessary for aeronautical safety services.

Aeronautical issues

Boeing Australia appreciates the ACMA's recognition of the importance of radio altimeters and wireless avionics intra-communications (WAIC) that utilise the frequency band 4 200-4 400 MHz and the implications of any reassignment within the 3 700-4 200 MHz frequency band (standard C-Band) that may impact these essential aviation applications. The frequency band 4 200-4 400 MHz is allocated exclusively to aviation safety applications operating in the aeronautical radionavigation and aeronautical mobile (route) services. Boeing Australia is involved in the global manufacture of commercial and government aircraft, which require use of the adjacent 4 200-4 400 MHz frequency band by radio altimeters and WAIC.

Radio altimeters monitor an aircraft's altitude and are a critical component of an aircraft's ability to fly and land safely, especially in bad weather. The WAIC systems being developed also utilise the 4 200-4 400 MHz frequency band. WAIC systems provide wireless safety related communications for operational and monitoring systems on a single aircraft. As a result, Boeing Australia is of the view that a minimum of the top 200 MHz of the standard C-Band is required to protect the aviation safety applications utilising the frequency band 4 200-4 400 MHz from terrestrial mobile applications.

The ACMA should not entertain any action that might risk interference to these highly sensitive aeronautical safety services in the adjacent 4 200-4 400 MHz frequency band. This is further covered later in the submission in response to 'issues for comment.'

[1] Boeing Australia Holding's portfolio includes advanced manufacturing of commercial aircraft composite components, defence systems design and development, modeling and simulation, research and development, support and training, and unmanned systems.

Satellite issues

Boeing Australia is active in manufacture and support of satellite communications systems for licenced operators in Australia, including C-Band satellites used extensively throughout Australia and the immediate Asia-Pacific region. Numerous important industries depend on C-Band satellite services to provide uninterrupted and highly-reliable communications to less accessible locations, including for air traffic control and monitoring and distribution of detailed weather information used to support the safe and efficient operation of Australian airspace. Therefore, consideration of additional or alternative uses of any portion of the 3 700-4 200 MHz frequency band must not impair the ability of C-Band satellite users in Australia and the region to continue to access and benefit from these services.

While the ACMA has noted in the discussion paper the important use of the band for the fixed satellite services (FSS), it is not agreed that the FSS is a 'legacy' use of the band in so much that C-Band satellite services encompass new and innovative public, commercial and government communication applications.[2] In Australia the 3 700-4 200 MHz frequency band, and especially up to 4 000 MHz, is heavily licenced to significant commercial, government and defence interests. Any decision for a whole or substantial refarming of the frequency band will be fraught with significant operator cost and dislocation, inevitably being passed on to the user clients.

The regulation of C-Band in Australia has been developed over a very long period of time and provides essential rigour underpinning the efficient operation of incumbent allocations. Whereas, a substantive replanning and/or refarming of the frequency band would be a formidable regulatory undertaking. The end result may inadvertently see incumbent services either reallocated, or sharing with new applications or services and not being adequately protected from interference.

Given Boeing Australia's significant interest in aeronautical and satellite industries across Australia and in the Asia-Pacific region we also raise the point that a reduction of C-Band satellite capacity in Australia represents a concern for many of Australia's Asia-Pacific neighbours that rely on C-Band for fundamental communications. It is well understood by ACMA that domestic decisions that may reduce the viability of satellite services in C-Band, even if they have no or minimal impact on our neighbours, can be viewed negatively and carry geopolitical implications. Given recent sensitivities in the region, Boeing Australia is sympathetic to the concerns of our neighbours but notes any decision affecting Australia's use of satellite standard C-Band will necessarily be that of the broader Australian Government. Our point is simply to highlight and retain awareness of this important consideration.

[2] Executive summary of the discussion paper 'These investigations have all carefully considered legacy uses of the band, especially by the FSS for 'C-band' satellite services …'.

Response to issues for comment

The following response to issues for comment in the discussion paper are on issues only relevant to Boeing Australia.

> *Are there any other international developments in the 3700–4200 MHz band that the ACMA should be aware of?*

The discussion paper shows ACMA is well across international developments in the frequency band. However, the challenge for ACMA in taking into account determinations or considerations of other administrations is to ascertain the suitability of these approaches to Australia's needs. One example is a potential extension of IMT identifications beyond 3 700 MHz that would need to take into consideration neighbouring Asia-Pacific sensitivities about reduced regional C-Band capacity as described earlier.

Additionally, the upper 200 MHz of the standard C-Band requires essential guard band protection to radio altimeters and WAIC applications in 4 200-4 400 MHz. Any application or service with the potential to create interference to these applications should not be seriously entertained unless there is a, yet to be determined, means of mitigation that protects radio altimeters and WAIC.

The discussion paper notes the US is considering a proposal from the C-Band Alliance to free up 200 MHz of C-Band satellite spectrum for terrestrial wireless use. In this approach incumbent users would be repacked in the remaining 300 MHz of the 500 MHz of available spectrum in the band.[3] This proposal, while having interesting technical merits, represents a deeper challenge for Australia. Mostly due to a wider array of existing important commercial, government and defence licenses and assignments in Australia, whereas standard C-Band in the US is predominantly for broadcasting services.

> *What are the future requirements of point-to-point links and FSS earth stations in the 3700–4200 MHz band? Does this differ by geographical area and/or segment of the band*?

Point-to-point links

The discussion paper notes the significant decline in licenced point-to-point links in the frequency band. As two embargoes prohibiting new point-to-point links apply in parts of the standard C-Band ACMA would be well placed to interpret the impact on potential and existing operators to continue the effect of the embargoes.

FSS earth stations

As for FSS earth stations the requirements are considerable and have often been addressed elsewhere. In terms of the minor decline in Australian earth station receive licences (and applications) this is insignificant and may arguably be that more efficient and newer technically advanced FSS operations are

[3] The C-Band Alliance a US industry group made up of satellite providers Intelsat, SES, Eutelsat and Telesat, although it is has been reported Eutelsat has recently left the group.

possible with less infrastructure needing to be licenced. However, while the number has decreased demand for FSS is likely to only increase in the near to longer term.

Earth station protection zones

Boeing Australia in general supports the concept of Earth Station Protection Zones (ESPZ) and agrees there are mutual benefits in freeing up spectrum in populated areas for other uses while providing greater protection for operating earth stations. However, this is necessarily a long-term ambition that should not commercially disadvantage operators. Additionally, the discussion paper states 'the ACMA is still investigating the viability of the ESPZ's in eastern Australia, with a view to identifying one or two of these as long term ESPZ's.' Further discussion on ESPZs should be separate to this current consultation on 3 700-4 200 MHz noting there is currently an ACMA Technical Liaison Group for 3.4 GHz / 3.6 GHz considering ESPZs.[4]

Television Receive Only

Boeing Australia has no comment on the unlicenced Television Receive Only (TVRO) systems operating in the 3 400–4 200 MHz frequency band apart from noting the established 'policy' that unlicenced earth stations are unprotected in Australia.

> *What are the future requirements for WBB services in the 3700–4200 MHz band and what arrangements should be considered? Does this differ by geographical area and/or segment of the band?*

Boeing Australia does not support expansion of terrestrial mobile transmissions in 3 700-4 200 MHz as use of such an application would adversely interfere with signals from individual satellite transponders and reception and transmission of earth stations. In the upper part of the frequency band interference would affect the adjacent aeronautical allocation use of radio altimeters and WAIC.

Antennas that receive satellite downlink signals in the C-Band frequency range are, by necessity, extremely sensitive. They are designed to receive a low-power signal emitted by small transmitters located thousands of kilometres in orbit. While C-Band, satellite services co-exist with terrestrial fixed point-to-point services using tightly focused beams from fixed points, terrestrial wireless applications are generally ubiquitous and mobile. These applications emit signals from many locations, in all directions, simultaneously. The signals disrupt the sensitive C-Band satellite receiving systems, causing a potential for total loss of service in the C-Band. This is supported by the study contained at Appendix 4 of the *Future approach to the 3.6 GHz band options paper*. ACMA states

> 'This study investigated the compatibility of FSS earth stations with macro and small cell WBB deployments, both fixed and mobile, in Sydney and Perth. The results of this study are considered to also apply to the 3700–4200 MHz band. In short, the study showed it is

[4] https://www.acma.gov.au/Industry/Spectrum/Radiocomms-licensing/Spectrum-licences/spectrum-licence-technical-liaison-groups-1

impractical for fixed or mobile WBB macro cell deployments to share the same spectrum with licensed FSS earth stations within a large population centre.'

Noting also that the study concluded 'it could be possible for WBB small cell deployments to coexist with FSS earth stations in the same or nearby geographical area,' it remains unclear what the parameters of such a deployment might be in the case of specific and individual earth stations. Should this be eluding to an application of ESPZ which is a long-term proposition, then as described above this is not the time or forum to consider such an approach where ongoing consultation elsewhere should be played out.

Operation of fixed WBB (not mobile) geographically removed from FSS earth stations and restricted to frequencies below 4 000 MHz (to protect radio altimeters and WAIC applications) may be a consideration but may have potential limitations too restrictive for WBB. A consideration for WBB interests.

What services/applications should be accommodated in the 3700–4200 MHz band? and *Which frequencies ranges should be made available for these services/applications?*

The 'spectrum scenarios' presented in the discussion paper are obvious and unfortunately too general to be of value. Given ACMA is requesting further information from stakeholders on all the scenarios, Boeing Australia briefly responds to the points the ACMA has referenced to inform its (ACMA's) decision making in respect of the suggested spectrum scenarios as follows:

- the impact any changes may have on incumbent services

Clearly significant incumbent services being FSS should not be adversely affected or disadvantaged.

- future requirements of incumbent services

For FSS these are many and evolving. The satellite industry has always been at the forefront of communications innovations and continues to do so.

'Small satellites, high-throughput satellites, satellites with all-electric propulsion and low-Earth orbiting (LEO) satellites are among the game-changing innovations enabling a range of solutions from digital financial services to better health care to smarter cities.'[5]

Notably high-throughput, high-capacity broadband geostationary satellites will be suited to C-Band transmission due to the low rain fade radio wave propagation characteristics of the frequency band. This evolving technology has benefits for high-speed connectivity to communities in remote locations across Australia, the Pacific and Southeast Asia.

The FSS is expected to introduce innovations consistent with the regulatory environment in standard C-Band that it operates in.

[5] Houlin Zhao, ITU Secretary-General, ITU News No 2 2019
https://www.itu.int/en/itunews/Documents/2019/2019-02/2019_ITUNews02-en.pdf

- the compatibility of new services with adjacent band services.

Any new services or applications will need to provide guard band protection, in the range 4 000-4 200 MHz, to essential radio altimeter and WAIC operations in the adjacent frequency band. Additionally, the established and future FSS operations will need to have long term surety of operation and protection from any increased interference to their operations.

On what basis should access be provided? Should access be granted on an exclusive or shared basis, on a coordinated or uncoordinated basis, et cetera?

Regarding 'shared access' to the frequency band the 'ACMA acknowledges there could be continued interest and demand from numerous incumbent services to continue operating in the 3700–4200 MHz band into the future.' This is true of FSS as it is also correct that 'it may also not be practical for some incumbent services to relocate to new spectrum, areas or alternative means of delivery.' FSS has spectrum allocations across various other frequency bands that suit specific operations. Standard C-Band is long established as the best option for wide area clear coverage and limited rain fade impact on transmissions.

The 'sharing arrangements' noted in the discussion paper are valid for FSS excepting the generalist multi-tiered approach and dynamic shared access options. Boeing Australia considers that the 'FCC decision in relation to CBRS (Citizen Broadband Radio Service) use of the 3.5 GHz band was based on a dynamic spectrum access model,' is a creative initiative more suited to the US 3.5 GHz frequency band than the vastly different allocated standard C-Band in Australia.

Given the ubiquity of standard C-Band and especially FSS operations in the band in Australia and most parts of the globe, with the notable exception of the US, dynamic spectrum access is not a viable option for the frequency band. Dynamic spectrum access is recognised to be more suited to television white space and 2 GHz frequency ranges. The ACMA is currently seeking input on dynamic spectrum access and associated regulatory options in the consultation 'New approaches to spectrum sharing.'[6] Boeing Australia supports the consultation on new spectrum sharing and recommends dynamic spectrum access, given the current occupancy of standard C-Band in Australia, is not a consideration for the frequency band.

Is there any additional information available that would assist the ACMA in assessing compatibly of potential new WBB services in the 3700–4200 MHz band with WAIC and radio altimeter systems in the 4200–4400 MHz band?

Boeing Australia acknowledges the ACMA's understanding of the importance of the aeronautical allocations in the 4 200-4 400 MHz frequency band. As mentioned in the discussion paper, WRC-15, via the addition of Radio Regulations Article **5** Table of Frequency Allocations footnote No. **5.436**, added WAIC to the aeronautical mobile allocation 4 200-4 400 MHz. Similarly, WRC-15 added Radio Regulations footnote No. **5.438** reserved exclusively for radio altimeters installed on board aircraft and for the associated transponders on the ground.

[6] https://www.acma.gov.au/theACMA/new-approaches-to-spectrum-sharing-1

Radio altimeters operate by transmitting radio signals toward the ground and then determining the aircraft's altitude based on the time it takes the signal to reflect off the ground and back to the aircraft receiver. Radio altimeters are highly susceptible to interference both within their operational swept bandwidth as well as from outside this bandwidth. The sensitivity of radio altimeters to interference is largely due to the fact that radio altimeters operate at a low power level, and thus there is a risk that ground-based radio transmitters operating near the upper edge of the 3 700-4 200 MHz frequency band could direct sufficient power in an upwards direction to overpower the relatively weak radio altimeter signals that have been reflected off the ground.

For example, if mobile wireless or point-to-multipoint fixed services are introduced near the upper edge of the 3 700-4 200 MHz frequency band, out-of-band emissions from those services could mix with the radio altimeter signal and cause an aircraft's radio altimeter to mistake the mixed signal as terrain, potentially resulting in the radio altimeter reporting a false altitude to the pilot. Most radio altimeters on large aircraft today use Frequency Modulated Carrier Wave digital technology, which transmits a very wide bandwidth signal, sometimes as large as 196 MHz, hence the need for a 200 MHz guard band protection.

WAIC systems involve the use of wireless communications systems within an aircraft to replace a potentially substantial portion of aircraft wiring. Because the safe and effective operation and monitoring of aircraft systems entails a significant amount of communications, WAIC systems require access to the entire 4 200-4 400 MHz frequency band for monitoring and data transfer requirements of modern aircraft. WAIC systems and radio altimeters are capable of sharing the 4 200-4 400 MHz frequency band as WAIC systems send and receive transmissions exclusively inside an aircraft, and thus they receive the benefit of fuselage attenuation, which protects radio altimeters from the relatively low-power WAIC transmissions inside the aircraft. Mobile wireless and fixed point-to-multipoint (P2MP) systems, however, transmit relatively powerful signals that could cause substantial interference to WAIC and radio altimeter systems if they transmit adjacent to the 4 200-4 400 MHz frequency band.

In summary, it would not be possible to permit P2MP transmitters or terrestrial mobile applications or base stations to operate in the 4 000-4 200 MHz frequency band because of the interference that would result to radio altimeter receivers and WAIC communications, potentially compromising control of the aircraft.

While the ACMA notes that it has 'not yet conducted sharing and compatibility studies between possible WBB use in the 3700–4200 MHz band with WAIC and radio altimeter systems in the 4200-4400 MHz band,' Boeing Australia considers the International Telecommunication Union Radiocommunication Sector (ITU-R) studies leading to the footnotes approved at WRC-15 and the numerous ITU-R Reports and Recommendations (cited in the discussion paper) constitute sufficient knowledge of the importance of protection of the 4 200-4 400 MHz aeronautical allocations. Nonetheless, Boeing Australia would be willing to assist with additional studies should ACMA deem necessary.

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