COMMUNICATIONS ALLIANCE LTD

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SATELLITE SERVICES WORKING GROUP

SUBMISSION

to the

Australian Communications and Media Authority's (ACMA)

Area-wide apparatus licences in the 3.8 GHz band in metropolitan and regional Australia

Licensing, allocation process, technical framework and pricing arrangements Consultation Paper

1 August 2023

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EXECUTIVE SUMMARY

The Communications Alliance Satellite Services Working Group (SSWG) welcomes the opportunity to provide comments to the ACMA's *Area-wide apparatus licences in the 3.8 GHz band in metropolitan and regional Australia, Licensing, allocation process, technical framework and pricing arrangements* Consultation Paper.

If Area-wide apparatus licences are adopted for FSS earth receive stations - AWL rx (AWL receive), the ACMA technical framework proposes that FSS will need to include significant AWL geographic areas and frequency ranges to protect FSS receivers. If the proposed ACMA AWL pricing model is adopted, this will result in FSS operators and service providers being unable to operate from their existing metropolitan earth stations because of the economic burden. This would make AWL rx unworkable for SSWG members presently providing C-band satellite services in this band. The SSWG therefore strongly opposes current and future FSS licences for Earth Stations in the 3.75 – 3.95 GHz band being cancelled or being required to be issued as AWL rx unless the licensing and pricing arrangements significantly improve.

The ACMA was advised very early in the consultation process by members of the SSWG that continuing to license FSS ES receivers using the current site-based Apparatus licences (AL) methodology will produce a more spectrum efficient arrangement and allow FSS ES receivers to continue to operate.

Since there is no benefit to FSS operators or service providers in adopting the proposed AWL rx methodologies, current and future Fixed Satellite Services (FSS) should continue to be licensed via apparatus licence (AL) arrangements.

The SSWG requests that Earth receiver apparatus licences authorised before 31 December 2023 be grandfathered for five years. This will still enable WBB services to identify what impact these existing licences will have on their new AWLs before acquisition, while Earth receiver apparatus licensees will have time to manage their clients' requirements through changes to their teleport operations.

To protect earth station receivers from WBB transmitters in adjacent channels, RF filters need to be fitted to the ES receiver LNBs. In the draft RALI MS47 a new minimum frequency response for earth receive station's RF filter is proposed by the ACMA. The SSWG requests that a modified frequency response based on a practical RF filter be used to specify the minimum frequency response of the earth receive station's RF filter at small frequency separations as is currently specified for earth receive stations site-based licences. The SSWG would also propose that the unwanted (out of band and spurious) emissions be the mechanism used in determining the adjacent channel separation distance.

The SSWG requests additional time to allow current and future earth station receiver licenses (authorised after 16 July 2022) to source and fit custom filters. For the spectrum and remote licence areas, it is proposed that the date of 16 July 2025 be assumed for fitment of custom filters and for all other metro and regional areas it be set at two years after the results of the public consultation for the present 3.8 GHz AWL consultancy has been released.

Due to the proposed significant number of changes to Earth station receiver licensing, carrier and filtering changes that affect clients, the SSWG proposes that LA WBB AWL licences are not introduced any earlier than two years after the outcome of the public consultation is known for satellite operators to prepare for these changes. However, this does not mean that SSWG supports and agrees to the maximum total radiated power for a WBB in the band 3.8 GHz nor the implementation of AWL rx Licensing for FSS.

The SSWG opposes the introduction of WA WBB with the high power transmitters (EIRP 37.2 dBW/MHz) in any of this 3.8 GHz AWL band and request that FSS be given initial priority over LA WBB by allowing earth station receiver apparatus licences that were granted before 31 December 2023 to continue through renewal of their licences.

The SSWG also highlights that only low/medium power Wireless Broadband (WBB) for local area networks should be considered for the 3.8 – 3.95 GHz band. This document proposes to consider the following levels for low/medium power local area WBB:

- Low power: Max EIRP of 18 dBm / 5 MHz which is 31 dBm/100 MHz, similar to the ACMA limit for the restricted cell area, and
- Medium power: Max EIRP of 36 dBm/5 MHz which is 49 dBm/100 MHz.

This submission does not necessarily represent the views of nbn, which is lodging its own submission.

About Communications Alliance

Communications Alliance is the primary telecommunications industry body in Australia. Its membership is drawn from a wide cross-section of the communications industry, including carriers, carriage and internet service providers, content providers, equipment vendors, IT companies, consultants and business groups.

Its vision is to be the most influential association in Australian communications, co-operatively initiating programs that promote sustainable industry development, innovation and growth, while generating positive outcomes for customers and society. The prime mission of Communications Alliance is to create a co-operative stakeholder environment that allows the industry to take the lead on initiatives which grow the Australian communications industry, enhance the connectivity of all Australians and foster the highest standards of business behaviour. For more details about Communications Alliance, see http://www.commsalliance.com.au.

1 Introduction

The technical framework, allocation process and pricing for the 3.8 GHz AWL band was not discussed in the ACMA *3.4 – 4.0 GHz Technical Liaison Group* (TLG) as originally proposed before ACMA submitted the pack of documents for public consultation. Therefore, the SSWG raises significant issues in this response to the ACMA's plans which may need further discussions before these activities are implemented.

2 Technical framework

2.1 Proposed changes to RALI MS47

2.1.1 Assumed date and other implementation considerations of custom C-band earth station receiver filters

The ACMA is proposing that for earth receive stations licences after 16 July 2022 (Spectrum declaration date) in the 3.7 – 4.0 GHz band, that custom filters (with lower and upper frequency limits) are assumed to be fitted. The SSWG has identified a number of issues that will limit implementation and timing of deployment of these custom filters:

- Physical space in antenna hub: Some SSWG members will need to add this extra custom filter on top of existing 3.8 GHz standard 5G filter. This will not always be possible due to the limited space in the antenna hubs. The LNA/LNBs have to be protected from the weather and as it's the last component after the filters, they still need to be fitted inside the antenna hub. Adding a new filter which can be around 200 mm long is therefore not always possible. SSWG members may have to invest time and money in developing a custom waveguide solution to fit the custom filters inside the antenna hubs.
- Capital costs: Some SSWG members have already invested in standard 5G filters to filter mobile operator signals below 3.7 GHz. Now SSWG members are being asked to invest in custom filters. If satellite carriers change operating frequencies, then replacement custom filters will need to be purchased due to the lower and upper filter limits.
- Delivery and installation times: custom filters are affected by global supply issues and delivery times are pushed to around 10 to 12 weeks from receipt of order. Installation of the filters must be planned with clients and require shutdown of the service causing outages to clients.

The use of custom filters is both impractical and uneconomical. Some SSWG members operate multiple carriers on the one antenna so will be forced to license large bandwidths (at significant cost) as only one custom filter can be applied to each antenna.

If custom filters are needed, affected SSWG members are planning to engage the Department (DITRDCA) to recover costs to implement these changes on an ongoing basis.

Proposal: The SSWG requests additional time to allow current and future earth station receiver licenses (authorised after 16 July 2022) to source and fit custom filters. For the spectrum and remote licence areas, it is proposed that the date of 16 July 2025 be assumed for fitment of custom filters and for all other metro and regional areas it be set at two years after the results of the public consultation for the present 3.8 GHz AWL consultancy has been released.

2.1.2 Adjacent-channel co-existence between FSS and LA WBB

To protect earth station receivers from WBB transmitters in adjacent channels, RF filters need to be fitted to the ES receiver LNBs. In the draft RALI MS47 section 4.10.2 (May 2023) a minimum frequency response of earth receive station's RF filter is specified as seen in Table 1 below.

Frequency offset from each edge of Earth receive station receiver licensed frequency (MHz)	Rejection (dB)
< 80	60
≥ 80	70

Table 1 Minimum frequency response of earth receive station's RF filter

This filter requirement for the AWL rx licence only specifies one frequency offset: 80 MHz. For any frequency offset less than 80 MHz, the requirement indicates that 60 dB filter rejection is to be achieved. To date, the sharpest filters available in the market require 20 MHz frequency separation to reach 60 dB rejection and therefore, the above rejection requirement is not achievable for small frequency offsets less than 20 MHz. Thus a minimum 'guard-band' must be assumed (20 MHz at the very minimum) which should not be part of the AWL rx fee.

There are two ways to achieve this 60 dB rejection:

- Modify the filter rejection for frequency offsets less than 80 MHz, or
- Assume there is a 'guard-band' in the AWL rx sufficient for a practical filter to provide 60 dB at 0 – 80 MHz offset.

Proposals:

- The SSWG requests that a modified frequency response based on a practical RF filter be used to specify the minimum frequency response of the earth receive station's RF filter at small frequency separations as is currently specified for earth receive stations site-based licences.
- To meet the ACMA assumed filter rejection of 60 dB at frequency offsets less than 80 MHz, a minimum *guard band* of 20 MHz added to the lower and upper edge of the earth station receiver carrier needs to be assumed when a practical RF filter is used which should not be part of the AWL rx fee.

To protect the earth station receiver from WBB transmitters in adjacent channels, RF filters as previously discussed needs to be fitted and an additional 'guard-band' (i.e., frequency separation) included in the AWL rx licence to avoid LNB saturation (see Annex B) and OOB emissions (Annex A).

Table 2 on the following page, taken from the results of Annex A and B, shows the minimum separation distances between the adjacent channel WBB transmitter (assumed maximum TRP of 48 dBm/5MHz[1]) and FSS ES receiver to protect from ES LNB saturation and OOB emissions.

[1] Refer Radiocommunications Licence Condition (Area-Wide Licence) Amendment Determination 2022 (No. 1)

FSS ES elevation	Separation distance to protect FSS from ES LNB saturation 5G Max gain (26 dBi) (km) – Annex B	Separation distance to protect FSS from OOB emissions 5G Max gain (26 dBi) (km) – Annex A
10	0.13	34
15	< 0.1	30
30	< 0.1	24
45	< 0.1	21
60	< 0.1	21

Table 2 Minimum separation distances to protect FSS

For the case of LNB saturation, the separation distance is relatively low. The reason is that a rejection of 60 dB is always assumed due to the issue raised above regarding the lack of minimum *guard-band*. A refinement of this frequency response is required as no filter would be able to achieve 60 dB rejection for any frequency separation especially for very small frequency offset (< 20 MHz).

Proposal: The SSWG proposes that the unwanted (out of band and spurious) emissions be the mechanism used in determining the adjacent channel separation distances as detailed in Annex B.

2.2 Proposed changes to AWL LCD: EIRP limits applicable to LA WBB in the 3.8 GHz band

The SSWG's understanding is that the band 3.8 GHz in metro and regional area is planned for local area WBB networks that are supposed to be lower in power as compared to commercial 5G deployment. In the ACMA's '*Radiocommunications Licence Condition (Area-Wide Licence) Amendment Determination 2022 (No. 1)'* it is proposed that the maximum total radiated power for a WBB in the band 3.8 GHz in metro and regional area be 48 dBm/5 MHz (which translates to an eirp of 74 dBm/5 MHz and 87 dBm/100 MHz with an AAS antenna). While the SSWG believes that the ACMA did not engage the Technical Liaison Group (TLG) to discuss this technical detail for metro and regional areas, European countries/CEPT are considering low and medium power WBB base stations in the 3.8 GHz band with the following limits:

- Low power: Max EIRP of 18 dBm / 5 MHz which is 31 dBm/100 MHz, similar to the ACMA limit for the restricted cell area, and
- Medium power: Max EIRP of 36 dBm/5 MHz which is 49 dBm/100MHz.

Annex C compares the co-channel separation distances of the ACMA proposed high power WBB transmitters with the medium and lower power transmitters being considered in Europe.

A summary of the study results is presented in Table 3 on the following page.

WBB eirp power level	Separation distance to protect FSS (km)	Separation distance to meet DBC (km)	Minimum FSS AWL radius (km)
High power (37.2 dBW/MHz)	163	41	**122**
Medium power (– 1dBW/MHz)	46.9	6.1	**31.8**
Low power (–19dBW/MHz)	31.8	0.8	**31**

Table 3 In band coexistence study results for FSS ES at 10° elevation

Based on Table 3 above, the WBB low power level realistically represents the Local Area Wireless Broadband (LA WBB) characteristics and supports the ACMA's initial C-band replanning proposal in the 3.8 GHz allowing LA WBB to share with existing services. Otherwise, the proposed high power levels for WBB would indicate that there is no intention to use the 3.8 GHz band for LA WBB and FSS pragmatically will no longer be able to use the 3.8 GHz band in metropolitan and regional areas. The benefits of using medium and low power LA WBB limits (instead of the high power limits) in the 3.8 GHz band are:

- The AWL tx (AWL transmit) cell sizes can be reduced for coexistence with other LA WBB AWLs ('intra-service sharing') and with FSS AWL rx ('inter-service' sharing'). This has a positive impact on LA WBB AWL prices, and
- The efficiency of spectrum sharing of the 3.8 GHz band with incumbent services is significantly improved.

Proposal: The SSWG therefore proposes that ACMA review and adopt the European low/medium power levels (Max EIRP of 18 dBm / 5 MHz, 36 dBm/5 MHz respectively) for local area WBB to improve sharing with incumbent services and enable a technology neutral approach.

A summary of the co-channel and adjacent channel cases and the AWL rx protection radii is provided in Figure 1 on the following page.

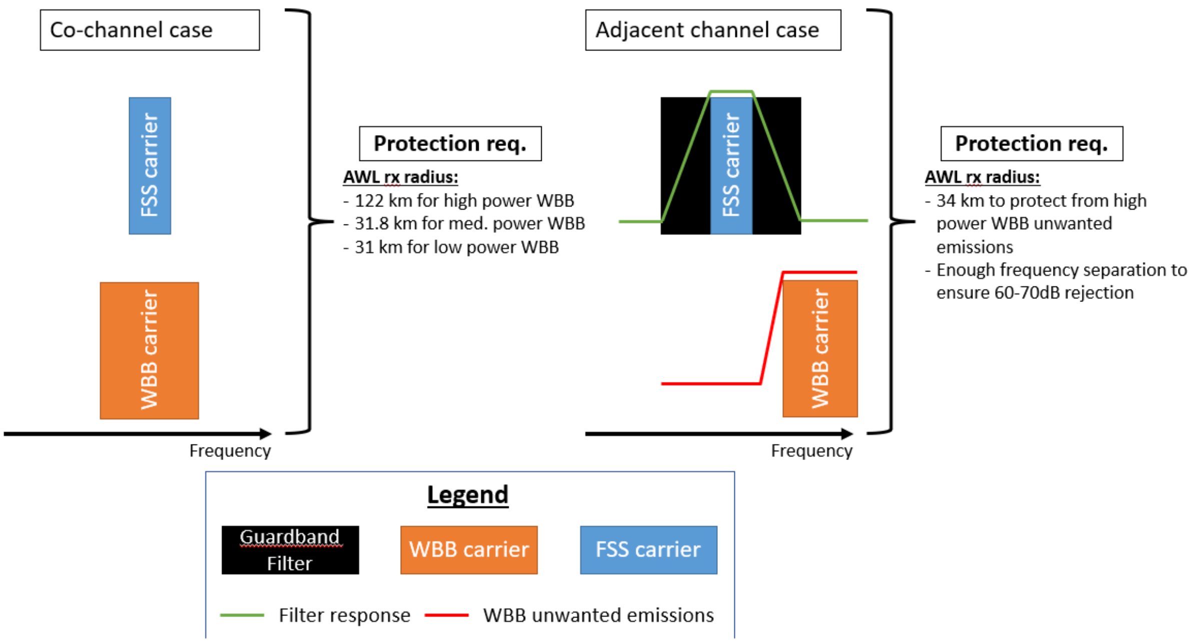

Figure 1 Protection radii for FSS AWL rx from AWL in the 3.8 – 3.95 GHz band

3 Allocation process

3.1 Considerations of incumbent Earth receiver licences

It is understood that the ACMA considers 'incumbent' earth station receiver licences as licences that were authorised before Embargo 78 took effect (i.e. 22 July 2020). The SSWG does not support such an early incumbency date especially as there had been no direct consultation with incumbent licensees to apply such an embargo before that date.

The ACMA has conceded that the authorisation date is not accurate for some of these Earth station receiver apparatus licences. It would be requested that the ACMA provide the correct authorisation dates for all Earth station receiver apparatus licences registered in the 3.7 – 4.0 GHz band before 22 July 2020.

Currently there are 130 Earth station receiver apparatus licences in the 3.8 GHz band listed on the ACMA Register of Radiocommunications Licences (RRL). According to the RRL, approximately 40 licences were authorised before 22 July 2020, and 90 after 22 July 2020. A reason for this large number of licences being authorised after the 22 July 2020 is that satellite service providers often have contracts with clients for one year or less due to the changing environment in which these clients operate (e.g., cruise ships, oil, gas and mining exploration). Thus, new or varied licences need to be applied for to meet the client requirements while maintaining licences as per the Radiocommunications Act. New and varied licences lose their 'incumbency' status under the ACMA's interpretation after 22 July 2020.

The ACMA's interpretation of what are 'incumbent' licences is not explained in any of the documentation related to the C-band replanning for the 3.7 – 4.2 GHz band. Without a definition some have resorted to a standard dictionary definition which refers to 'current licences'.

The SSWG requests that Earth receiver apparatus licences currently granted (without or without conditions of renewal) be allowed to continue through renewal of their licences. The licensees have been operating these 'incumbent' FSS services in the band at these locations for long periods of time, and the changes to individual licence frequencies does not detract from the well-established long tenure of certain C-band earth stations in metro and regional areas.

Proposal: The SSWG requests that Earth receiver apparatus licences authorised before 31 December 2023 be grandfathered for five years. This will still enable WBB services to identify what impact these existing licences will have on their new AWLs before acquisition, while Earth receiver apparatus licensees will have time to manage their clients' requirements through changes to their teleport operations.

3.2 Commencement of AWL allocation

It is understood from this consultancy document that the ACMA is proposing that the commencement of AWL (including AWL rx) licensing be Q1 2024.

Proposal: Due to the proposed significant number of changes to Earth station receiver licensing, carrier and filtering changes that affect clients, the SSWG proposes that LA WBB AWL licences are not introduced any earlier than two years after the outcome of the public consultation is known for satellite operators to prepare for these changes. However, this does not mean that the SSWG supports and agrees to the maximum total radiated power for a WBB in the band 3.8 GHz nor the implementation of AWL rx Licensing for FSS.

3.3 Allocation Option 1: 6-month LA WBB priority period

In section 3.2, the SSWG is proposing that LA WBB AWL licences are not introduced any earlier than two years after the outcome of the public consultation is known. Having said that, the SSWG opposes the introduction of WA WBB in any of this 3.8 GHz AWL band. If WA WBB services are allowed, these spectrum licensees are likely to take up significant areas of metro and regional spectrum space making the continued use of this band for FSS and other incumbent services impossible. The benefits of using the LA WBB medium and low power limits being considered in Europe is discussed further in Section 2.2.

As indicated in Section 3.1, FSS licensees are often dictated by short period client contracts to make changes to their earth station receive licences and this flexibility would not be possible if spectrum licensees were allowed to take up WA AWLs in the band. The SSWG does not believe that the 3.4 – 3.7 GHz spectrum licensees have any supportable reason to take out licences in this band noting that they will shortly have access to over 100 MHz of additional spectrum as part of the new spectrum licences being issued.

Also as noted in Section 3.1, the SSWG requests that FSS be given initial priority over LA WBB by allowing earth station receiver apparatus licences that were granted before 31 December 2023 to continue through renewal of their licences. A similar provision is being proposed for PTP licensees by the ACMA.

Proposal: The SSWG opposes the introduction of WA WBB with the high power transmitters (EIRP 37.2 dBW/MHz) in any of this 3.8 GHz AWL band and request that FSS be given initial priority over LA WBB by allowing earth station receiver apparatus licences that were granted before 31 December 2023 to continue its operations through renewal of their licences.

3.4 Allocation limits

It is noted and supported that any statutory or quantum allocation limit will not apply to AWL rxs.

Proposal: As indicated in section 3.3, the SSWG opposes any licences being issued for WA WBB with the high power transmitters (EIRP 37.2 dBW/MHz) in any of the 3.8 GHz AWL band.

3.5 Allocation Option 2: general allocation approach

Proposal: The SSWG supports a second allocation process that would preclude the 3.4 – 3.7 GHz spectrum licensees from taking up any spectrum in any of the 3.8 GHz metro and regional AWL band.

4 Pricing

The proposed new licensing method for satellite earth station receivers in the band is Area Wide Licensing (AWL rx). In introducing this method of licensing, the ACMA is intending that prospective AWL rx licensees will acquire AWL spectrum space (both in area and frequency) that is needed to ensure their operations are provided suitable co-channel and adjacent channel protection from existing and future AWLs used by wireless broadband (WBB) transmitters. This is the opposite to the current first-in-time method used in site-based apparatus licences and which has been relied on for many years, where the first-in-time licensee has priority and new licensees must find a way to minimise interference to the existing licence (including existing receive licence).

Section 5.4 provides a comparison of the costs of the current and proposed licensing arrangements for satellite earth station receivers.

Adopting the proposed AWL rx licence methodology for satellite earth station receivers will massively and unnecessarily increase the annual tax for satellite earth station receiver licences. Therefore, a financial business case could not support this increase in licence fees for FSS to deploy its services in metropolitan and regional areas in the 3.8 GHz band. It is uneconomical and will lead to FSS being systematically disadvantaged vis-à-vis other services in the same region and band, resulting in FSS being driven out through the new pricing and licensing methodology.

Proposal: The SSWG therefore strongly opposes the proposed AWL rx licence methodology and pricing for satellite earth station receivers. The ACMA had been advised earlier in the consultation process[2] by members of the SSWG that continuing to license FSS ES receivers using current AL methodology will produce a more spectrum efficient arrangement and allow FSS ES receivers to continue to operate.

5 Questions from the ACCC

5.1 Use cases

5.1.1 What are the likely intended uses of 3.8 – 3.95 GHz band spectrum?

Several SSWG members presently provide satellite services in the 3.8 – 3.95 GHz band for back-hauling internet connectivity and data applications from remote and oceanic

[2] Submission to the ACMA 'Comments on FSS and WBB coexistence framework in 3.7 – 4.2 GHz' by Intelsat, Inmarsat, SES and Speedcast (Feb 2022)

areas to teleport hubs in metro and regional areas. The end-users (clients) are in fixed locations, or mobile in ships. These uses are expected to increase as the dependency on remote, mobile connectivity and dependency on cloud-based applications continue to grow and develop.

5.1.2 In which geographic areas is the spectrum intended to be used?

C-band satellite services are often used by clients in remote areas (land and sea) with their teleport hubs in metro and regional areas. To underline the importance of the teleport hubs in metro and regional areas in Australia, a number have been serving clients for 20 to 30 years.

5.1.3 How much spectrum is needed to support the intended use case?

Until recently, C-band satellite operators in Australia had access to the band 3.4 – 3.6 GHz (200 MHz) on a secondary basis[3] and 3.6 – 4.2 GHz (600 MHz) on a primary basis[4]. With the current and imminent re-allocations of 3.6 – 3.8 GHz (200 MHz) spectrum for exclusive use by 5G mobile, this has reduced C-band satellite downlink bandwidth availability to 400 MHz. With ACMA's proposed methods of spectrum allocation and licensing of AWL to 3.8 – 3.95 GHz for WBB applications, which the SSWG does not support, the use of this band for C-band satellite purposes in metro and regional areas will be very limited. Pragmatically, the result is that C-band satellite operators in Australia will be left with only 250 MHz out of an initial 800 MHz.

Speedcast Australia, one of Australia's C-band service providers (and member of the SSWG) presented a paper to the ACMA (16 September 2020)[5] where they advised that they use 450 MHz of spectrum in the 3.7 – 4.2 GHz band using ten C-band satellites connected to three teleports in metropolitan areas. Speedcast and other satellite service providers use of C-band has continued to increase since that time. With the reduction in the availability of C-band spectrum bandwidth for satellite services, Speedcast and other Australian C-band satellite service providers might need to migrate their clients services to the higher C-band spectrum and consequently there will be once-off and ongoing cost for such migration.

With the loss of spectrum for C-band satellites services in Australia, the cost of the remaining bandwidth is increasing (due to supply and demand) and it will impact the end user retail price for providing C-band services in Australia. Also, due to insufficient spectrum on some satellites there is a possibility that new earth stations (antennas) may be needed to be deployed to connect to alternative satellites to support demand. Referring to the 2020 Speedcast paper[6], new earth stations were estimated to cost in the order of $300,000 per antenna.

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[3] Cannot claim interference protection from primary services which makes it unsuitable for critical applications.

[4] Can claim interference protection from secondary services and primary services assigned after the satellite service is assigned.

[5] Submission by Speedcast to the ACMA 'Planning options for the 3700–4200 MHz band - consultation 22/2020'

[6] Submission by Speedcast to the ACMA 'Planning options for the 3700–4200 MHz band - consultation 22/2020'

5.2 Downstream markets

5.2.1 What is the good or service that the 3.8 – 3.95 GHz spectrum can support the production of?

The Australian C-band satellite service providers supply back-haul and internet services to mining, offshore oil and gas, government, NGOs, maritime and disaster response applications to teleport hubs in metro and regional areas. Metro C-band Earth Stations are also used to receive the feeder downlinks of mobile satellite service (MSS) satellites, used by commercial aircraft in remote areas of Australia through the Aeronautical Mobile Satellite (Route) Service (AMS(R)S), and by shipping in and around Australia for GMDSS and other maritime communications. These uses are expected to increase as these industries continue to grow and develop.

Australia is widely used as a gateway for the Asia-Pacific region in the use of the 3.8 – 3.95 GHz band by Australian satellite service providers to provide reliable communication including internet connectivity in areas where terrestrial services are impractical due to being cost prohibitive. Therefore, restrictions to the 3.8 – 3.95 GHz band in Australia to support gateways will also impact satellite users in other countries, and consequently satellite operators and the space industry in general.

5.2.2 Where is the good or service intended to be supplied to?

As indicated in Section 4.1.2, the C-band satellite service is supplied to clients in remote areas (land and sea) of Australia and to the Asia-Pacific region (land and sea) within the wide coverage of the C-band satellite beams. Satellite service providers use gateways in metro and regional areas to provide services to clients and feeder downlinks for MSS satellites.

5.2.3 Are there substitutes available to the good or service?

Due to the remote and inaccessibility of certain parts of Australia and sea areas, satellite services are the only form of cost-effective broadband communication available for end users. For Pacific islands where there are islands with low populations significantly distant from capital city satellite services it is the only form of broadband communication available.

5.2.4 How could the spectrum allocation impact the state of competition and/or incentives to invest in downstream markets

Pacific Island countries relying on gateways in Australia already have difficulty in paying for satellite spectrum. With the loss of spectrum for C-band satellites services, the cost of the remaining bandwidth will increase (supply and demand) leading to these countries being further disadvantaged and unable to provide adequate telecommunications services to their communities.

In general, C-band spectrum prices may increase to a point that downstream markets can no longer afford to use the spectrum.

5.3 Alternative spectrum

5.3.1 Do you consider that substitutable spectrum exists for the 3.8 – 3.95 GHz bands that can similarly enable the production of the goods or services in downstream markets? If so, what spectrum bands do you consider to be substitutable?

The unique propagation characteristics of C-band satellite systems (due mainly to their lower operating frequency range compared to Ku and Ka band systems) enables reliable backhaul telecommunications services in high rainfall and oceanic areas of

Australia, its territories and in tropical regions of Asia-Pacific. Therefore, C-band cannot be simply replaced with Ku or Ka band systems.

5.4 Pricing

5.4.1 Do you have any comments on the suite of pricing arrangements proposed?

Currently satellite earth station receivers in this band are licensed via site-based apparatus licences. For metro and regional areas, the annual per MHz charge (x 1000 kHz charge) for:

- High density (Sydney/Wollongong, Melbourne/Geelong and Brisbane/Gold Coast) is $522.70/MHz, and
- Medium density (Perth, Adelaide, Newcastle) is $211.90/MHz,

as detailed in Table 23 of the ACMA [Apparatus licence fee schedule (July 2023)] reproduced below.

Table 23: Annual licence tax ($ per kHz)

Spectrum location	Geographic location				
	Australia-wide	High density	Medium density	Low density	Remote density
0 to 30 MHz	1.2172	1.2172	1.2172	1.2172	1.2172
>30 to 403 MHz	2.7496	1.0739	0.5298	0.1188	0.0592
>403 to 520 MHz	2.8210	2.0907	0.7227	0.1233	0.0000
>520 to 960 MHz	2.8210	1.5797	0.7227	0.1233	0.0615
>960 to 2,690 MHz	2.8167	0.6322	0.2923	0.1470	0.0733
>2.69 to 5.0 GHz	2.8136	0.5227	0.2119	0.1755	0.0877
>5.0 to 8.5 GHz	1.1878	0.2196	0.1023	0.0465	0.0226
>8.5–17.3 GHz	0.1047	0.0377	0.0089	0.0006	0.0003
>17.3–31.3 GHz	0.0733	0.0195	0.0031	0.0003	0.0000
>31.3 to 51.4 GHz	0.0200	0.0106	0.0017	0.0001	0.0000
>51.4 to 100 GHz	0.0028	0.0003	0.0003	0.0000	0.0000
>100 GHz	0.0000	0.0000	0.0000	0.0000	0.0000

Taking a geographical location in a medium density area as an example, a typical satellite earth station receiver licence has a spectrum bandwidth of 0.25 – 15 MHz equating to an annual charge of between $53 and $3,178.

The ACMA's proposed new licensing method for satellite earth station receivers in the metro and regional areas in the 3800 MHz band is Area Wide Licensing (AWL rx). The ACMA is proposing that prospective AWL rx licensees will acquire AWL spectrum space (both in area and frequency) that is needed to ensure their operations are provided suitable co-channel and adjacent channel protection from existing and future AWLs used by wireless broadband (WBB) transmitters. This approach is opposite to the current first-in-time method used in site-based apparatus licences and which has been relied on for many years, where the first-in-time licensee has priority and new licensees must find a way to minimise interference to the existing licence (including existing receive licence).

Co-channel Interference protection

Taking the results of technical studies previously submitted by the SSWG to the ACMA[7] (and relevant sections provided in Annex A of this document), for co-channel operation and assuming the proposed high power WBB level, an AWL rx radius of 122 kms may need to be assumed for satellite earth station receivers (AWL rx) licence. The annual AWL rx tax is calculated using the formula:

Annual AWL rx tax = $/MHz/pop price × bandwidth (MHz) × population of geographic area

where:

$/MHz/pop price is the tax rate for one MHz of spectrum per head of population (in this case, the proposed $/MHz/pop price is $0.0041).

Bandwidth is the total amount of spectrum in MHz authorised by the licence.

Population (based on the 2021 Census) is the population of the geographic area authorised by the licence.[8]

Taking as an example Mawson Lakes, South Australia (a suburb of Adelaide), which is in a medium density geographical location, and assuming an AWL rx radius of 122 kms with the proposed high power WBB level, for co-channel operation, the annual charge per MHz would be between $4,457 and $6,142[9] using the minimum and maximum range of Hierarchical Cell Identification Scheme (HCIS) cell sizes required.

Adjacent-channel Interference protection

As indicated in Section 2.1.2, the ACMA is assuming that a 'guard-band' be included in the AWL rx to provide 60 dB rejection at 0 MHz offset from the licence boundaries. This means that an additional 'guard-band' of 20 MHz, above and below the earth station receiver carrier, needs to be included in the AWL rx licence. Assuming the 'guard-band' is used, for a single WBB transmitter carrier interferer, a minimum of 34 kms separation distance is required as indicated in Section 2.1.2. What this means is that in addition to the AWL rx co-channel protection area there needs to be acquired, an AWL rx adjacent-channel protection area of additional 40 MHz is required for each carrier bandwidth (of 0.25 and 15 MHz).

Figure 2 on the following page illustrates the requirement to acquire suitably sized HCIS cells to protect the earth station receiver against co-channel and adj-channel interference.

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[7] The SSWG submission to the ACMA '[Proposed spectrum re-allocation declaration for the 3.4 GHz and 3.7 GHz bands]' (4 May 2022)

[8] The geographic area is defined in terms of the Hierarchical Cell Identification Scheme (HCIS). The population is based on the aggregate population of all the geographic cells to be authorised by the licence.

[9] For co-channel operation, the mid-value between $4,457 and $6,142 is $5,300 which is used to calculate the approx. licensing cost. This is based on using the IW3 HCIS 3 cell (approx. 111 x 111 kms) and IW HCIS 4 cell (approx. 333 x 333 kms) respectively. A mid-value between the two HCIS is used rather than the area as the average population density is likely to be less for the minimum AWL rx size compared to the smaller HCIS cell.

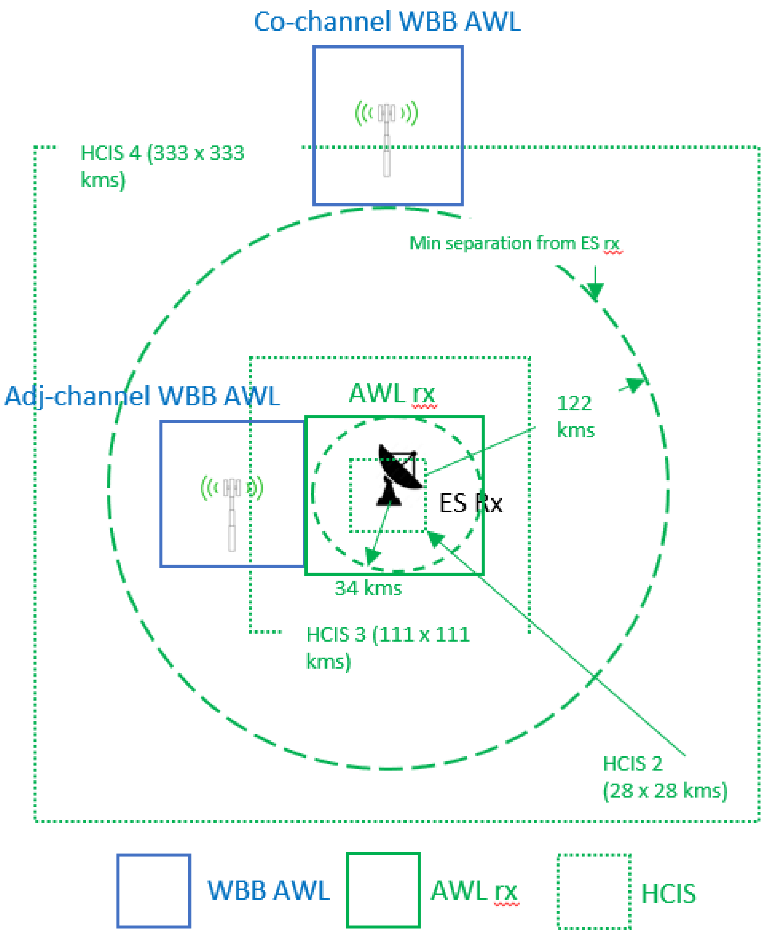


Figure 1 HCIS cells for co-channel & adjacent channel protection (not to scale)

Taking the Mawson Lakes example, for the adjacent-channel case and assuming an AWL rx radius of 34 kms, the annual charge per MHz would be approx. $5,100[10] (scaling up from the HCIS 2 cell).

Table 4 below compares the annual tax of the current site-specific apparatus licences with the proposed annual tax of the AWL rx for the two example carrier bandwidths assuming a FS ES antenna elevation of 10° and the proposed high power WBB. It should be noted that the fees for AWL rx presented in these two tables are indicative but provide an order of magnitude. The AWL rx fees will depend on the actual HCIS cells licensed and the population within these cells. Note that the ACMA Site Location Map does not have the granularity below HCIS 2, which limits the accuracy of using this tool to calculate the AWL rx licence fee.

[10] For adjacent-channel operation, the mid-value between $3,400 and $4,457 which is $3,928 is used to calculate the approx. licensing cost. This is based on using the IW3O HCIS 2 cell (approx. 27.75 x 27.75 kms) and IW3 HCIS 3 cell (approx. 111 x 111 kms) respectively. A mid-value between the two HCIS is used rather than the area as the average population density is likely to be less for the minimum AWL rx size compared to the smaller HCIS cell.

Carrier bandwidth (MHz)	Site-based apparatus licence (AL)	AWL rx co-channel BW fee	AWL rx adj-channel BW fee	Total AWL rx fee
0.25	$53	$1,325[11]	$158,102[12]	$158,445[13]
15	$3,178	$79,500[14]	$216,040[15]	$236,620[16]

Table 4: Annual tax comparison - FS ES antenna elevation of 10°.

If an FSS ES antenna with an elevation angle of 15° and proposed high power level WBB were assumed, the annual taxes for the AWL rx would reduce as indicated in Table 5 below (as per Annex A: minimum co-channel FSS AWL rx radius of 85 kms, minimum co-channel FSS AWL rx radius of 30 kms).

Carrier bandwidth (MHz)	Site-based apparatus licence (AL)	AWL rx co-channel BW fee	AWL rx adj-channel BW fee	Total AWL rx fee
0.25	$53	$1,114[17]	$158,102[18]	$158,234[19]
15	$3,178	$66,855[20]	$216,040[21]	$223,975[22]

Table 5: Annual tax comparison - FS ES antenna elevation of 15°.

The proposed massive increase in annual tax for satellite earth station receiver licences (AWL rx) from site-based AL is uneconomical and will lead to FSS being systematically disadvantaged vis-à-vis other services in the same region and band, resulting in FSS being driven out through the new pricing and licensing methodology.

[11] 0.25 (MHz) x $5,300 (/MHz for co-channel) = $1,325 (10 degrees El)

[12] 40.25 (MHz) x $3,928 (/MHz for adj-channel) = $158,102 (10 degrees El)

[13] Total AWL fee = AWL rx co-channel BW fee + AWL rx adj-channel BW fee – AWL rx co-channel BW x AWL rx adj-channel fee

[14] 15 (MHz) x $5,300 (/MHz for co-channel) = $79,500 (10 degrees El)

[15] 55 (MHz) x $3,928 (/MHz for adj-channel) = $216,040 (10 degrees El)

[16] Total AWL fee = AWL rx co-channel BW fee + AWL rx adj-channel BW fee – AWL rx co-channel BW x AWL rx adj-channel fee

[17] 0.25 (MHz) x $4,457 (/MHz for co-channel) = $1,114 (15 degrees El) – used HCIS 3 (111 x 111 km) as min AWL rx cell similar in size

[18] 40.25 (MHz) x $3,928 (/MHz for adj-channel) = $158,102 (15 degrees El) – used the same as for 10 degrees El as separation distance almost same

[19] Total AWL fee = AWL rx co-channel BW fee + AWL rx adj-channel BW fee – AWL rx co-channel BW x AWL rx adj-channel fee

[20] 15 (MHz) x $4,457 (/MHz for co-channel) = $66,855 (15 degrees El) – used HCIS 3 (111 x 111 km) as min AWL rx cell similar in size

[21] 55 (MHz) x $3,928 (/MHz for adj-channel) = $216,040 (15 degrees El) – used the same as for 10 degrees El as separation distance almost same

[22] Total AWL fee = AWL rx co-channel BW fee + AWL rx adj-channel BW fee – AWL rx co-channel BW x AWL rx adj-channel fee

The ACMA was advised earlier in the consultation process by members of the SSWG[23] that licensing FSS ES receivers using current AL methodology will produce a more spectrum efficient arrangement and allow FSS ES receivers to continue to operate. The ACMA points out in their list of apparatus licence types on their web site that the reason Area-Wide Licences (AWLs) are used is 'to operate multiple radiocommunications devices for any service in a specific geographic area and frequency band.' AWL might be suitable as a licensing scheme for terrestrial transmitting stations to provide clear guidance on their emission limits supporting mobile terminals, but it is not applicable for FSS since in one AWL rx area they may be only one FSS receive earth station.

Proposal: The current site-based apparatus licence methodology is still suitable for satellite earth station receivers in this band especially as earth station operators often only have one or a small number of antennas in a fixed defined location. The SSWG absolutely opposes the proposed AWL rx licence methodology and pricing for satellite earth station receivers.

[23] Submission to the ACMA 'Comments on FSS and WBB coexistence framework in 3.7 – 4.2 GHz' by Intelsat, Inmarsat, SES and Speedcast (Feb 2022)

Annex A
Technical study to determine separation distances between FSS and WBB

This study by Intelsat, Inmarsat, SES and Speedcast[24] was submitted to the ACMA as part of the 3.4 – 4.0 GHz TLG process and is reproduced below for ease of reference. Terminology has been updated to match current ACMA consultation papers but the assessment results are the same.

This study aims at determining the required separation distances between FSS ES and WBB deployments in order to meet the FSS ES protection levels defined by the ACMA, both for co-channel and adjacent channel sharing scenarios. In addition, this section provides an estimation of the required size of the AWL for the FSS to protect FSS ES deployment from an adjacent WBB AWL. For this study, the impact of WBB deployment into FSS is assessed by considering the emissions of 5G BS deployments.

It is important to note that adjacent channel infers that the WBB transmitter does not overlap in frequency with the FSS ES receiver. Co-channel infers that the WBB transmitter is in the 3.8 – 4.0 GHz band and FSS ES Rx in the 3.8 – 4.2 GHz band.

1 FSS assumptions

1. Protection level given by maximum interference level for both co-channel and out of band emission cases: I_{max} = –128.6 dBm/MHz not to be exceeded for more than 20% time. This is equivalent to –58.6 dBW/MHz.

   Different elevations of the FSS ES were considered: 10, 15, 30, 45 and 60°.

   These different elevation angles of the receive earth stations are based on the below table which provides an example of elevation angles for some Intelsat's operational satellites for services in metropolitan areas:

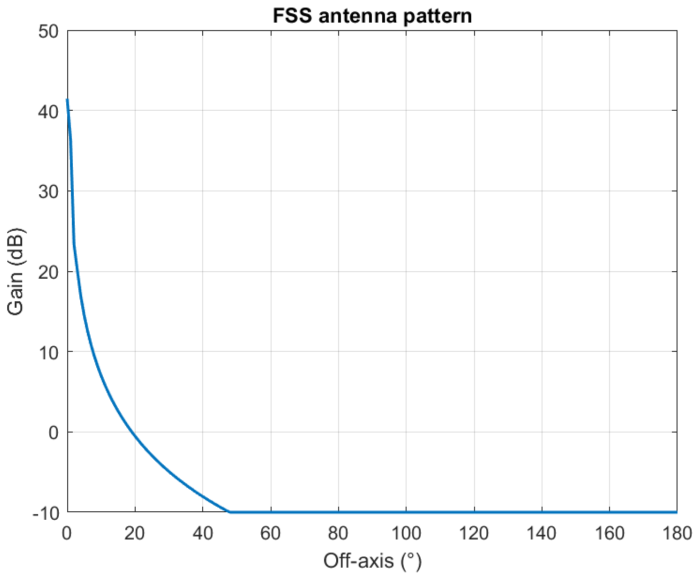
Elevation Assessments (Metropolitan Areas)								
No.	**Intelsat satellite name**	**Orbital Location**	**Elevation @ Adelaide**	**Elevation @ Brisbane**	**Elevation @ Canberra**	**Elevation @ Melbourne**	**Elevation @ Sydney**	**Elevation @ Perth**
1	Intelsat 18	180E	30.5	46.2	37.6	33	40	13.3
2	Intelsat 19	166E	40.1	54.8	45.2	40.9	47.5	25.1
3	Horizons 3e	169E	38.2	53.3	43.9	39.5	46.2	22.6

Table A1 Examples of elevation angles

[24] Submission to the ACMA 'Comments on FSS and WBB coexistence framework in 3.7 – 4.2 GHz' by Intelsat, Inmarsat, SES and Speedcast (Feb 2022)

2. Antenna diameter: 3.8 m
3. Resulting FSS antenna gain towards 5G interferer following S.465:

Elevation (deg)	10	15	30	45	60
Antenna gain (dBi)	7	2.6	– 4.9	-9.3	–10



Note: For elevations greater than 48° the antenna gain is –10 dBi and does not change as per ITU-R S.465

4. Antenna height considered: 10 m

2 5G assumptions

1. Power considerations:
    a. The ACMA Spectrum license[25] maximum allowable TRP for in band case (cf. Condition 14 of Schedule 2): 48 dBm/5 MHz

       Note: This is actually higher than what is currently agreed at WP5D (46 dBm for bandwidths of **40 or 80 or 100 MHz**). This means that the ACMA TRP is 11 to 15 dB higher.
    b. The ACMA Spectrum license maximum allowable TRP (unwanted emission limits) for AAS when considering 10 MHz frequency separation (cf. Condition 7 of Schedule 2): –6 dBm/MHz.
2. The study considers an IMT macro/wide-area urban/suburban AAS antenna pointing towards the FSS receiver. The AAS antenna gain was modelled following the characteristics described in Annex 4.4 to the WP5D/716 chairman's report. The relevant characteristics for the 5G systems operating in the 3.4 – 4.0 GHz spectrum can also be found in Annex 4.4 to the WP5D/716 chairman's report. The maximum

[25] Based on a typical ACMA Spectrum licence for the 3.4 GHz band available in ACMA's RRL.

gain is calculated by multiplying the antenna elemental gain. In the logarithmic domain this yields: 6.4 + 10 log(8 x 4 x 3) = 26.2 dBi.

3. Antenna height considered (based on the WP5D characteristics provided in the Annex 4.4 to the ITU-R WP5D/716 chairman's report): 20 m.

3 Propagation model

The ITU-R recommendation P.452 was used for this case with an associated time percentage of 20% (linked to ACMA's protection level for FSS ES). No clutter was considered in this first evaluation as the aim is to determine the coordination distance that would be needed to protect the FSS ES. The coordination distance needs to consider all possible deployment configurations, including the case where there is no clutter loss on the path.

4 Estimation of the FSS AWL size to protect FSS ES

In addition to the protection level of –128.6 dBm/MHz to be met at the FSS ES receiver, the ACMA also defines a device boundary limit for the WBB AWL of – 90 dBm/MHz for AAS transmitters in Schedule 2 of the S.145 determination:

$$RP - MP \leq 0$$

where:

$$MP = PL + LOP - Gr$$

and:

RP is the horizontally radiated power, measured in dBm per MHz.

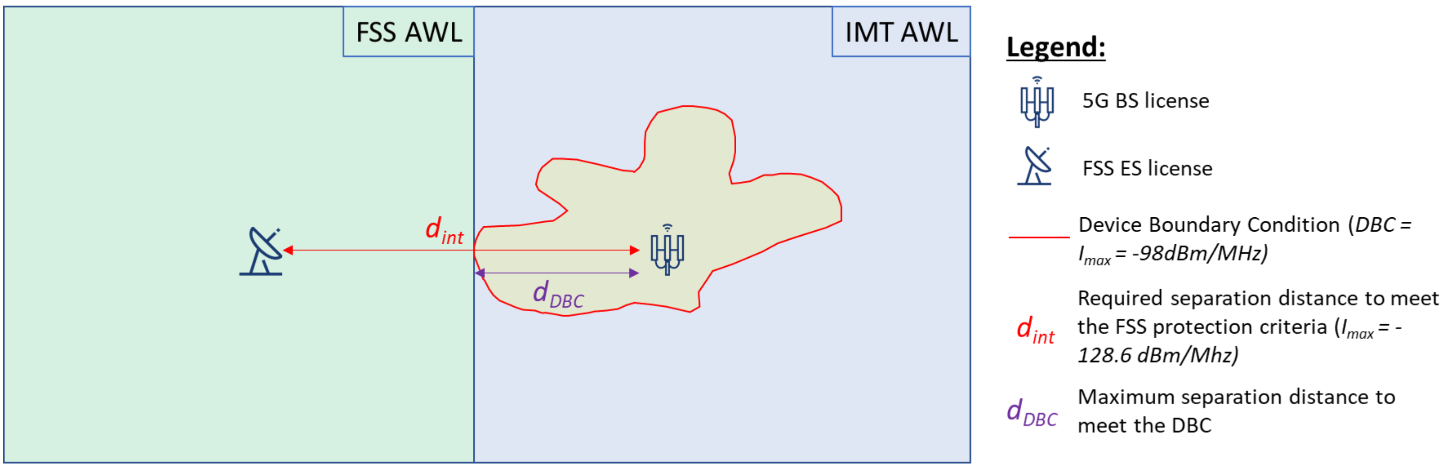
PL is the propagation loss (dB).

G_r is the nominal radiocommunications receiver antenna gain including feeder loss set to 0 dBi.

LOP is the protection level set to –90 dBm/MHz for transmitters with AAS, and – 98dBm/MHz for transmitters without AAS.

The above Device Boundary Condition (DBC) equates to having a maximum interference level of $I_{max} = LOP = -90\ dBm/MHz$ at the device boundary.

The following figure illustrates the situation.



Based on the DBC, one can determine the maximum required separation distance for a 5G BS boundary limit (i.e. d_{DBC}). In addition, the required separation distance to ensure that the FSS ES protection criteria is met (i.e. d_{int}) can also be calculated.

An estimation of the minimum FSS AWL distance can then be determined with the following formula:

$$d_{FSS\ AWL_{min}} = d_{int} - d_{DBC}$$

The following sub-sections calculate in turn d_{int} and d_{DBC}.

4.1 Calculation of d_{int}

The following formula was used for the calculation of the interference with the above assumptions:

$$I_{FSS} = EIRP_{BS} + G_{FSS} - P_{loss}$$

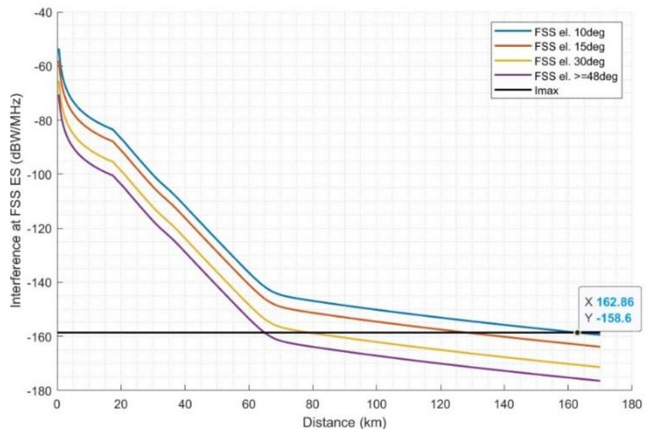
where:

I_{FSS}	is the interference received at the FSS receiver (dBW/MHz)
$EIRP_{BS}$	is the BS e.i.r.p. (TRP + gain) towards the FSS receiver (dBW/MHz)
P_{loss}	is the propagation loss based on P.452 propagation model (dB)

Using this formula and the list of parameters presented in sections 1 and 2, the separation distance can be calculated for both the co-channel and the adjacent channel cases. As explained in section 2, for the adjacent channel case the 5G out-of-band emission limit for a 10 MHz frequency separation was taken as an assumption. It is important to note that this scenario only addresses the unwanted emissions of 5G falling within the FSS ES operating band.

Additional consideration should be made on the impact of 5G BS emissions within 3.4 – 3.8 GHz that could drive the LNB of the FSS ES receivers into saturation if proper filtering is not implemented (this is considered in Annex B). FSS ES receivers in the C-band generally use LNB devices that operate from 3400 to 4200 MHz. In order to avoid driving the FSS ES LNB into saturation and effectively blocking the FSS ES receiving capabilities, filters need to be implemented to zone out potential 5G emissions in the 3400 – 3800 MHz. For such filters to effectively mitigate the interference, enough frequency separation needs to be implemented between the end of the 5G emission range and the start of the receiving range of the FSS ES at 3800 MHz. Filters to be fitted on the FSS ES side would require larger frequency separation than 10 MHz (assumed for modelling the WBB unwanted emissions) to efficiently filter out WBB emissions below 3.8 GHz. The minimum frequency separation required to effectively filter out 5G emissions in the 3.4 – 3.8 GHz depends on a number of assumptions (e.g. LNB sensitivity, required attenuation, filter specification). Further discussion on the right amount of guard-band for the effective implementation of filters at the FSS ES is contained in Annex B.

Curves below represent the interference level versus distance for both the co-channel and adjacent channel cases. The black line represents the protection level for FSS ES as defined by the ACMA:

<table>
<tr>
<th>Co-channel case
(e.g. 5G in 3.8 – 4.0 GHz and FSS ES in 3.8 – 4.2 GHz)</th>
<th>Adjacent channel case
(e.g. 5G in 3.4 – 3.8 GHz and FSS ES in 3.8 – 4.2 GHz)</th>
</tr>
<tr>
<td>
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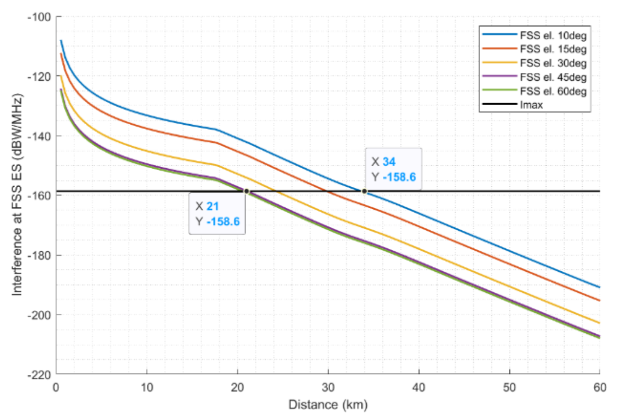
<td>
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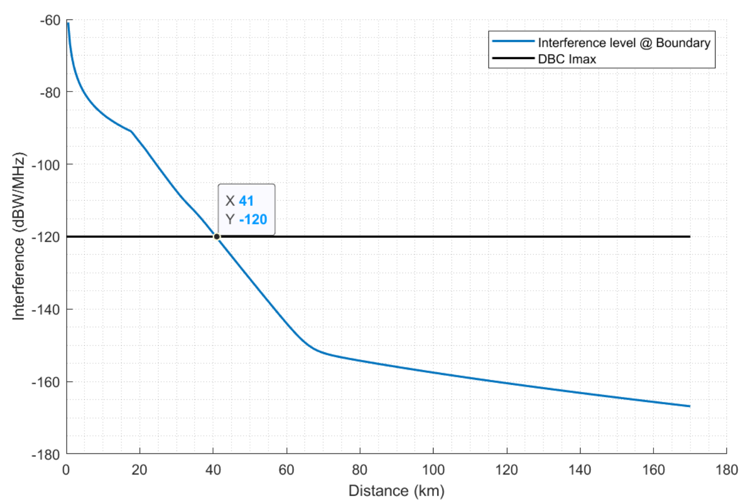
</tr>
</table>

4.2 Calculation of dDBC

In order to obtain d_{DBC} the exact same process was performed as in the previous section by calculating the interference versus distance for the co-channel case except for the fact that the receiver gain was set to 0 dBi as specified in Schedule 2 of the s145 determination.



5 Summary of the study and preliminary assessment

5.1 Co-channel case (3.75 – 3.95 GHz in regional areas and 3.8 – 3.95 GHz in metro areas)

Table A2 provides the co-channel separation distances required for a 5G BS (WBB) to meet both the DBC and the FSS ES protection criteria. The difference between distances provides an idea on the minimum separation distance required for the AWL rx.

Assuming 5G BS maximum gain (26 dBi)			
FSS ES elevation (deg)	**Separation distance to protect FSS (km)**	**Separation distance to meet DBC (km)**	**Minimum FSS AWL radius (km)**
10	163	41	122
15	126		85
30	77		36
45	64		23
60	64		23

Table A2 Co-channel coexistence study results

Based on the results in the above table, in order to consider all possible deployment of FSS in a given AWL license framework, then a minimum radius of **122 kms** should be considered for the FSS AWL rx. If the radius is smaller than 122 kms, this means that 5G BS (WBB) in a neighbouring AWL cell could cause harmful interference to FSS receivers depending on their actual deployment characteristics. In other words, in order to accommodate all types of FSS ES deployment within the AWL framework, the radius of the AWL would need to be much larger than 122 kms. This would equate to very large areas where both FSS and 5G would not be able to deploy and lead to inefficient use of spectrum.

5.2 Adjacent-channel case (3.75 – 3.95 GHz in regional areas and 3.8 – 3.95 GHz in metro areas)

For adjacent channel cases, the ACMA is proposing that separation distances between WBB and FSS receivers be determined by using new RF filter rejection levels specified in the draft RALI MS47 section 4.10.2 (May 2023).

As partly highlighted in section 4.1, there needs to be a differentiation between the two following adjacent band interference mechanisms:

1. Typically, earth station LNBs are designed to receive the entire 3.4 – 4.2 GHz band. The WBB signals in adjacent channels of the 3.75/3.8 – 4.0 GHz band or the adjacent 3.4 – 3.75/3.8 GHz band therefore can saturate the amplifier stage in the LNB or bring it into non-linear operation thus blocking reception of intended signals.

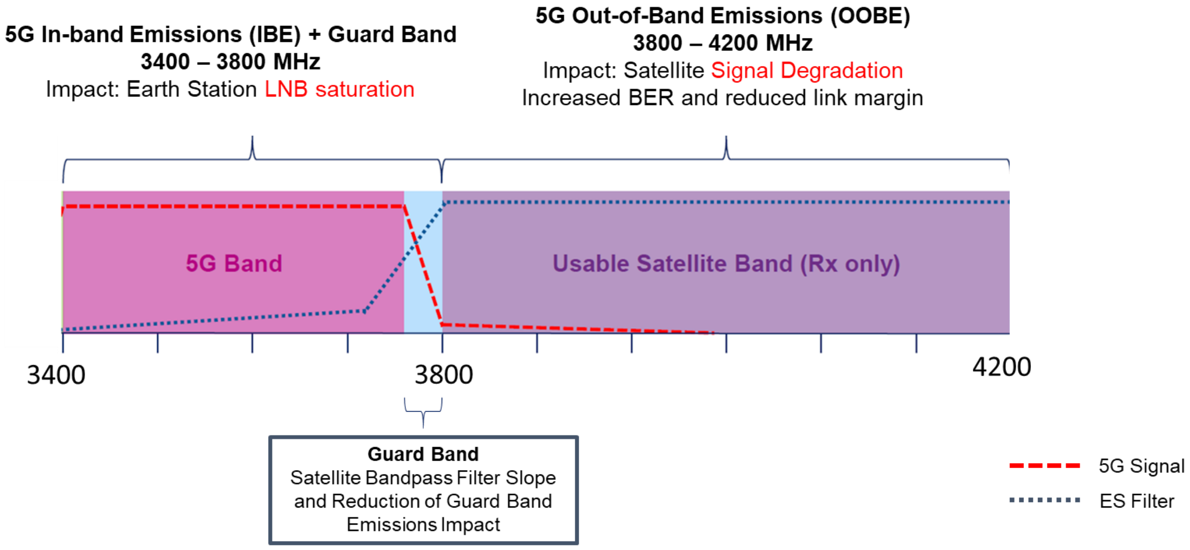
   The best solution to mitigate the IMT systems' interference is to insert a RF waveguide filter between the output of the antenna and the input of the LNB. The filter could only be operated properly if there is frequency separation (i.e. guard band) between the edge of the IMT/5G transmission and the FSS transmission to provide the waveguide filter the necessary bandwidth to reject the 5G interference at the earth station.

   However, it is still important to note that the implementation of such filters on the FSS earth station receivers presents a certain number of drawbacks (degradation of existing services with a reduction in margin and throughput, filter cost, implementation rollout).

2. Unwanted (out of band and spurious) emissions of the WBB signal falling within the operating FSS operating band 3.8 – 4.2 GHz can cause in-band interference to FSS signals. As opposed to the emissions in the 3.4 – 3.7 GHz that can be mitigated by

the implementation of a filter at the FSS earth station, the WBB unwanted emissions falling within the 3.8 – 4.2 GHz band cannot be filtered. Regulation on specific WBB unwanted emissions limits versus frequency separation is key in this context to limit the impact of these unwanted emissions on adjacent band operating services.

The following diagram highlights the two different scenarios.



The sharing results due to FSS ES LNB saturation as described in point 1 is considered in the technical study in Annex B.

The sharing results in this section cover only the interference mechanism described in point 2 above, i.e., the OOB emissions of WBB falling within the FSS operating band. The ACMA is not presently considering this mechanism for interference from WBB transmitters to FSS ES receivers although this is the predominant factor in determining the separation distances.

Table A3 below presents the results of the required separation distances in order to avoid unwanted interference falling within the FSS ES operating band 3.8 – 4.2 GHz. It is important to note that a 10 MHz frequency separation was already assumed for the 5G BS unwanted emissions to obtain the following results.

FSS ES elevation	Separation distance to protect FSS 5G Max gain (26 dBi) (km)
10	34
15	30
30	24
45	21
60	21

Table A3 Adjacent channel coexistence study results

Annex B
Technical study - Required separation distance between WBB and FSS rx to avoid LNB saturation taking into account AWL rx filtering requirements (draft RALI MS47 section 4.10.2)

This analysis considers the impact of In-Band Emissions (IBE) from WBB operations in adjacent channels into FSS operations taking into account the draft RALI MS47 (May 2023) minimum filtering specification (section 4.10.2).

This annex considers the FSS ES LNB saturation that could be caused from 5G emissions in adjacent channels. For filters to effectively mitigate the interference, enough frequency separation needs to be implemented between the end of the 5G carrier emission and the start of the receiving carrier of the FSS ES. The minimum frequency separation required to effectively filter out 5G emissions in adjacent channels depends on a number of assumptions (e.g. LNB sensitivity, required attenuation, maximum insertion loss specification, among others).

The analysis will calculate the required separation distance between the two services assuming various frequency separation and associated filter rejection following the minimum filtering requirement defined in the draft RALI MS47 section 4.10.2 (May 2023).

1 Overview of the analysis

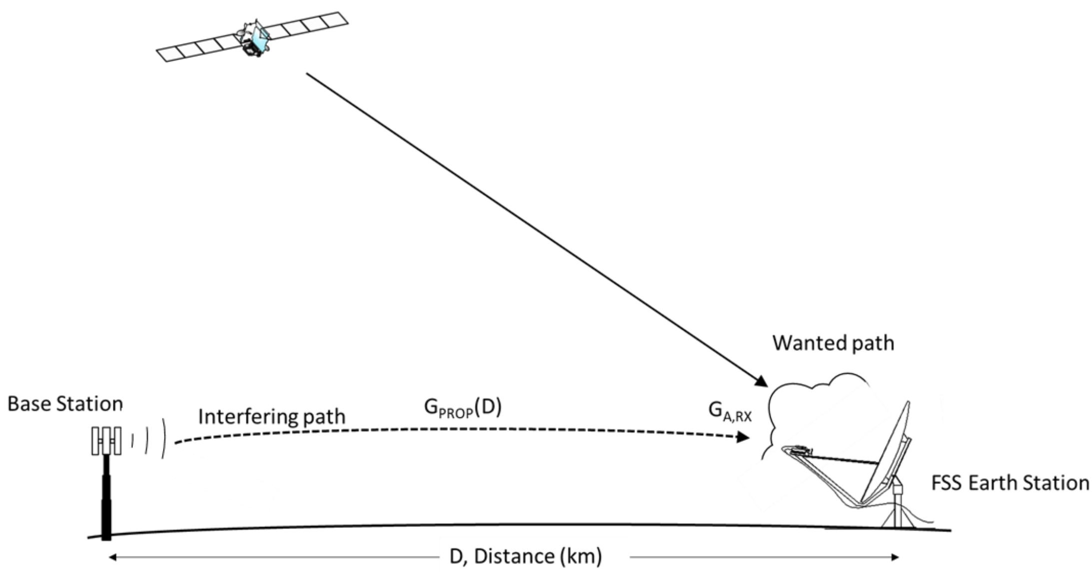


Figure B1 Diagram of the interference scenario

The interference analysis is performed for a number of separation distances between the 5G BS interferer and the FSS ES receiver. For each separation distance, the interference power perceived by the FSS ES is calculated and stored.

2 WBB characteristics

- Power considerations:

ACMA Spectrum licence maximum allowable TRP for in band case (cf. Condition 14 of Schedule 2): 48 dBm/5 MHz.

- WBB base station gain:

The study considers an IMT macro urban/suburban AAS antenna pointing towards the FSS receiver. The AAS antenna gain was modelled following the characteristics described in Annex 4.4 to the ITU WP5D/716 chairman's report. The relevant characteristics for the 5G systems operating in the 3.4 – 3.8 GHz spectrum were extracted and are presented in the annex to this document. The maximum gain is calculated by multiplying the antenna elemental gain. In the logarithmic domain this yields: 6.4 + 10 log(8 x 4 x 3) = 26.2 dBi. The maximum e.i.r.p. density is therefore 48 + 26.2 = 74.2 dBm/5MHz.

- Antenna height considered (based on the WP5D characteristics presented in the Annex): 20 m.
- The assumption is that the 5G BS is pointing towards the FSS ES. Two cases are considered:
    - **Case 1 – Worst Case**: The maximum eirp density (74.2 dBm/5 MHz) is considered in the entire 400 MHz overlap (3.4 – 3.8 GHz).

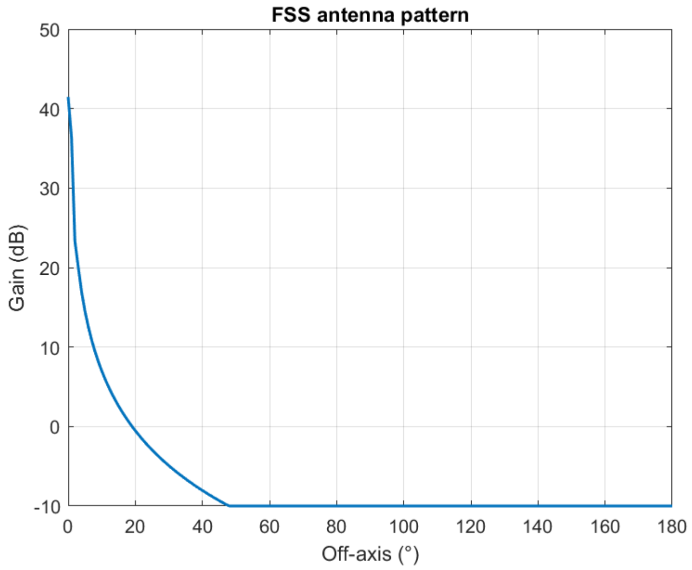
      ►Total 5G in-band eirp considered falling in the LNB passband: 63.23 dBW
    - **Case 2 – Single Carrier**: As suggested by its name, the first case is a worst case and as it is unlikely that multiple BSs with different carriers spread out in 3.4 – 3.8 GHz would all point with the maximum eirp towards the FSS receiver. Therefore, this second case considers the maximum eirp interference from a single 5G BS carrier.
    - ►Total 5G in-band eirp considered falling in the LNB passband: 44.2 dBW.

3 FSS characteristics

- Protection criteria of the LNB:

  LNB linear operating point threshold level: – 65 dBm. This level defines a target for the total input power received by the LNB, which in this case is composed of the wanted signal (C for carrier) and the 5G interference (I for interference).
- Antenna diameter: 3.8 m
- FSS ES system noise temperature: 100 K
- FSS antenna gain towards 5G interferer following S.465 for different antenna elevations:

Elevation (deg)	10	15	30	45	60
Antenna gain (dBi)	7	2.6	– 4.9	– 9.3	–10



Note: For elevations greater than 48° the antenna gain is –10 dBi and does not change as per ITU-R S.465

- Antenna height considered: 10 m
- Estimation of potential wanted signal level in the portion of spectrum 3.8 – 4.2 GHz:
  - Total bandwidth: 400 MHz
  - 11 carriers of 36 MHz assumed with a transponder eirp of 44 dBW

$$C = EIRP_{satCarrier} + 10\log_{10}(N_{carrier}) - \mathrm{FSL}(GSO\ to\ ES) + Grx$$

$$C = 44 + 10\log_{10}(11) - 194.5 + 32 \approx -108\ dBW = -78\ dBm$$

- FSS filtering specification follows the RALI MS47 minimum requirements
  - For earth station under AWL rx licence (section 4.10.2 of the draft RALI MS47 section 4.10.2 (May 2023)):

Frequency offset from each edge of Earth receive station receiver licensed frequency (MHz)	Rejection (dB)
< 80	60
≥ 80	70

Table B1 Minimum frequency response of earth receive station's RF filter

The filter requirement for the AWL rx licence only specifies one frequency offset: 80 MHz.

For any frequency offset less than 80 MHz, the requirement indicates that 60 dB filter rejection is to be achieved. This rejection is not achievable for small frequency offsets, e.g. less than 20 MHz, and so a minimum of 20 MHz 'guard-band' is assumed.

For this case, only two frequency separations will be considered in the study:

Frequency separation (MHz)	< 80	≥ 80
Filter rejection (dB)	60	70

4 Propagation model

- Propagation model ITU-R P.452 to model terrestrial path
- Smooth earth considered to have results that are generic
- Percentage of time linked to the propagation model: 20% time (based on FSS long term protection criteria time percentage)
- The propagation environment is assumed to be suburban. It is important to note that the nominal clutter height specified in ITU-R recommendation P.452 for the suburban environment is 9 m. Both antennas being above this level, no clutter loss is taken into account.

Figure B2 below provides the attenuation of the propagation model versus distance for the FSS ES and 5G BS heights, 10 m and 20 m, respectively. The free space path loss (FSPL) model is also represented for comparison.

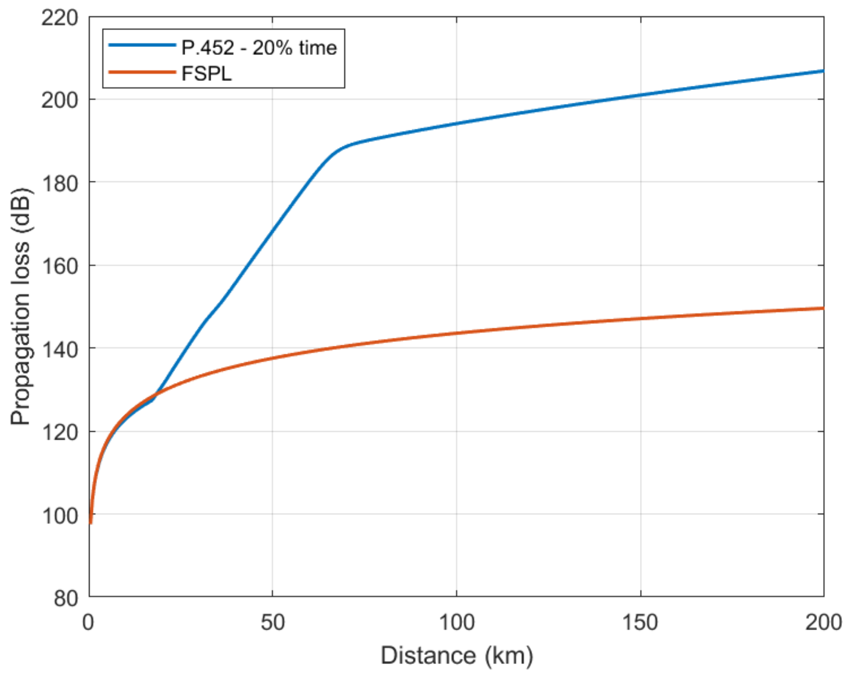
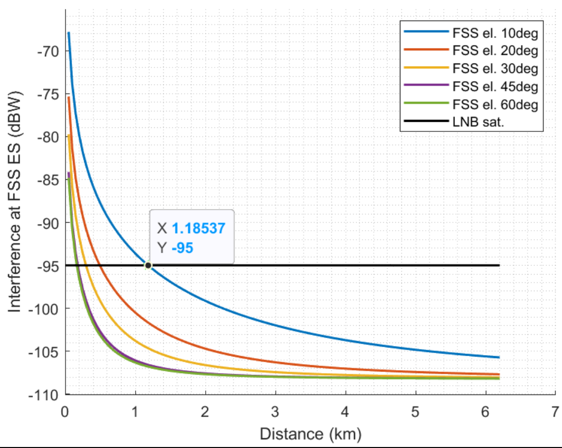
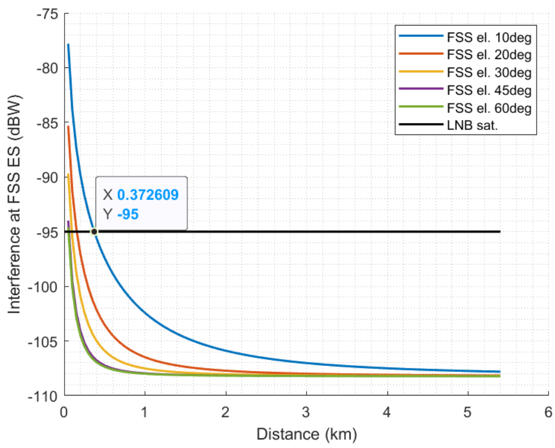


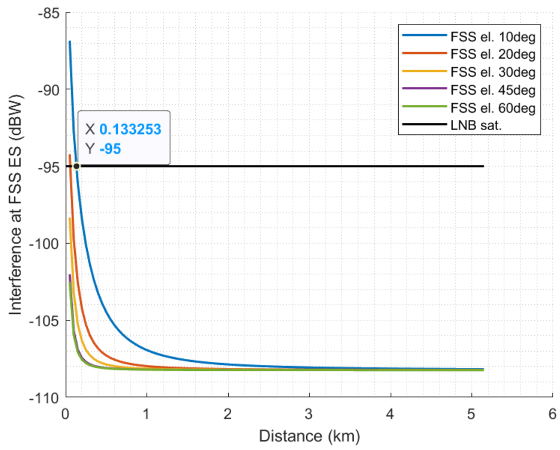
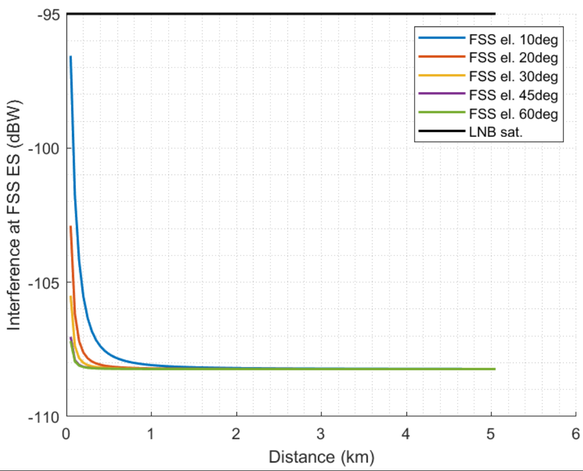
Figure B2 Propagation loss as a function of distance

5 Results

5.1 Case 1: Worst case analysis

Freq. separation: < 80 MHz Filter rejection: 60 dB **Resulting separation distance: 1.2 km**	Freq. separation: ≥ 80 MHz Filter rejection: 70 dB **Resulting separation distance: 0.37 km**
	

5.2 Case 2: Single carrier analysis

Freq. separation: < 80 MHz Filter rejection: 60 dB **Resulting separation distance: 0.13 km**	Freq. separation: ≥ 80 MHz Filter rejection: 70 dB **Resulting separation distance: < 0.05 km**
	

6 Discussion on the results

Freq. Sep. (MHz)	Filter Rejection (dB)	Worst case analysis separation distance (km) (El = 10°)	Single carrier analysis separation distance (km) (El = 10°)
< 80	60	1.2	0.13
> 80	70	0.37	< 0.05

- The low separation distances shows that 70 dB of filter rejection is the right amount to avoid WBB IBE to drive the FSS ES into saturation.
- The reason for the low separation distances is that only two rejection levels are defined, 60 and 70 dB, for below and above 80 MHz frequency separation. These are high levels of filter rejection, however the frequency response provided by RALI MS47 section 4.10.2 fails to provide more information for lower frequency separations.

No practical filter would be able to achieve 60 dB rejection for any frequency separation especially for very small frequency offsets (< 20 MHz).

There are two ways to achieve the 60dB rejection:

- Modify the frequency response required for frequency offsets less than 80 MHz, or
- Assume there is a ‘guard-band’ sufficient for a practical filter to provide 60 dB at 80 MHz offset.

The SSWG requests that a modified frequency response based on a practical RF filter be used to specify the minimum frequency response of the earth receive station’s RF filter at small frequency separations as is currently specified for earth receive stations site-based licences.

The ACMA by providing only two rejection levels is assuming that a ‘guard-band’ be used in the AWL rx to meet the rejection levels at the edges of the AWL rx and enable the low separation distances to be assumed.

To meet the ACMA rejection of 60 dB at frequency offsets less than 80 MHz a minimum ‘guard band’ of 20 MHz added to the lower and upper edge of the earth station receiver carrier needs to be assumed when a practical RF filter is used.

The short separation distances required to mitigate the impact of In-Band Emissions (IBE) from WBB operations in adjacent channels causing FSS ES LNB saturation identifies that it is a minor mechanism compared to unwanted (out of band and spurious) emissions studied in Annex A. Therefore, the SSWG proposes that the unwanted (out of band and spurious) emissions be the mechanism used in determining the adjacent channel separation distances.

Annex C
Study of separation distances between FSS AWL rx and WBB AWL tx for different WBB power levels

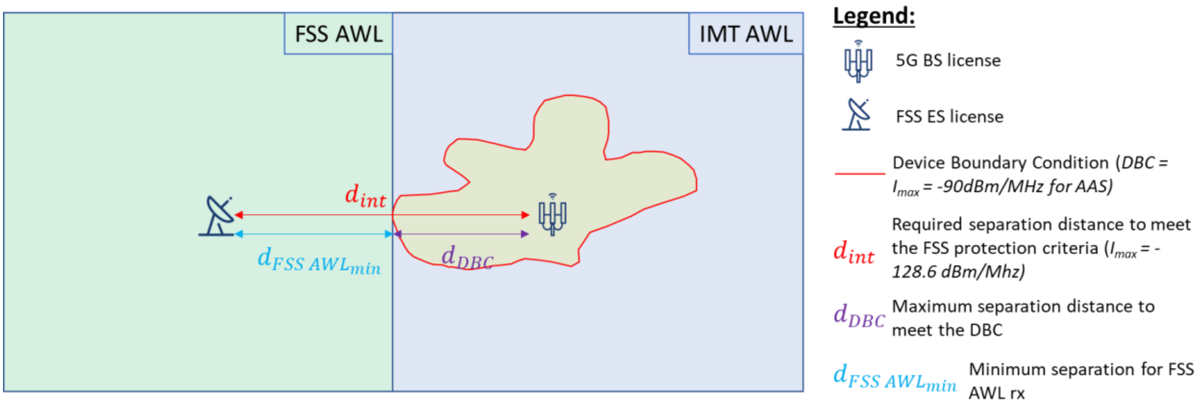
1 Introduction

This document calculates the separation distances required for the FSS AWL rx and WBB AWL tx in order to ensure that the limits presented in the draft RALI MS47 (May 2023) and ULOI are respected.

Two conditions are analysed:

1. The AWL tx device boundary condition: I_{dBC} = –90 dBm/MHz (for AAS as per Part 2 of Schedule 2 of ULOI)
2. The FSS protection limit: I_{maxFSS} = –128.6 dBm/MHz (Appendix F for RALI MS47)

The following figure presents the different separation distances that are calculated to meet the different boundary conditions.



Based on the DBC, one can determine the maximum required separation distance for a 5G BS boundary limit (i.e. d_{DBC}). In addition, the required separation distance to ensure that the FSS ES protection criteria is met (i.e. d_{int}) can also be calculated.

An estimation of the minimum FSS AWL distance can then be determined with the following formula:

$$d_{FSS\ AWL_{min}} = d_{int} - d_{DBC}$$

The following sub-sections calculate in turn d_{int} and d_{DBC}.

2 Calculation of d_{int}

The following formula was used for the calculation of the interference with the above assumptions:

$$I_{FSS} = EIRP_{BS} + G_{FSS} - P_{loss}$$

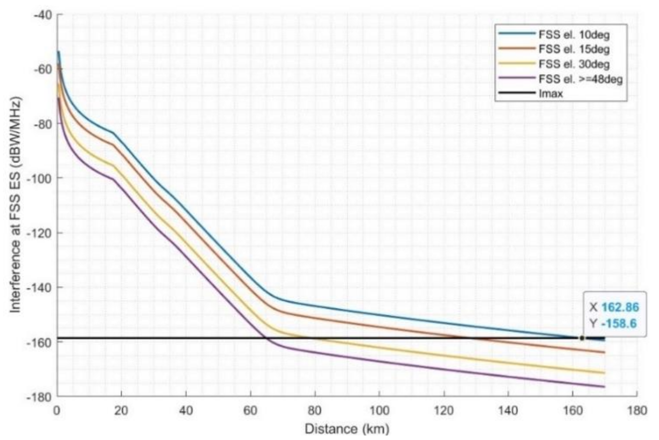
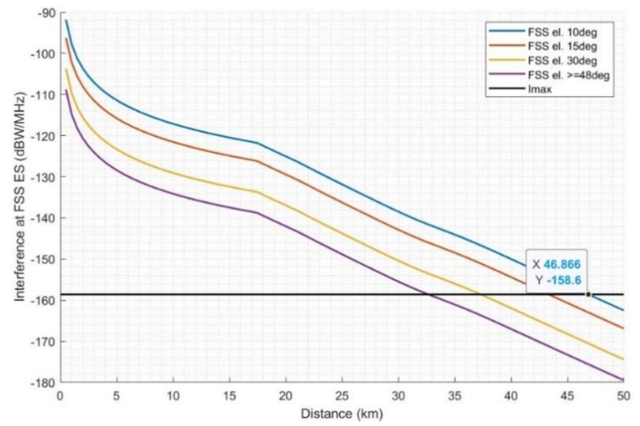
where:

I_{FSS}	is the interference received at the FSS receiver (dBW/MHz)
$EIRP_{BS}$	is the BS e.i.r.p. (TRP+gain) towards the FSS receiver (dBW/MHz)
P_{loss}	is the propagation loss based on P.452 propagation model (dB)

Regarding the BS power, three cases are considered:

- Case 1 – High power: TRP = 48 dBm/5MHz. Considering a classic 26.2 dBi AAS antenna gain (6.4 dBi elemental gain + 10 log(8*4*3) number of elements with sub array), this equates to a max EIRP = 74.2 dBm/5 MHz = 37.2 dBW/1 MHz
- Case 2 – Medium power: This case is based on the medium power BS considered for local area networks studied in CEPT, i.e. max EIRP = 49 dBm/100 MHz = – 1 dBW/1MHz
- Case 3 – Low power: This case is based on the low power BS considered for local area networks studied in CEPT, i.e. max EIRP = 31 dBm/100 MHz = – 19 dBW/1 MHz

The base station is considered to be at 20m height and the receiver at 10 m. The figures also show the result for different FSS ES pointing elevation (10, 20, 30, >48 °)

<table>
<tr><th>High power BS (EIRP = 37.2 dBW/MHz)</th><th>Medium power BS (EIRP = –1 dBW/MHz)</th></tr>
<tr><td>
</td><td>
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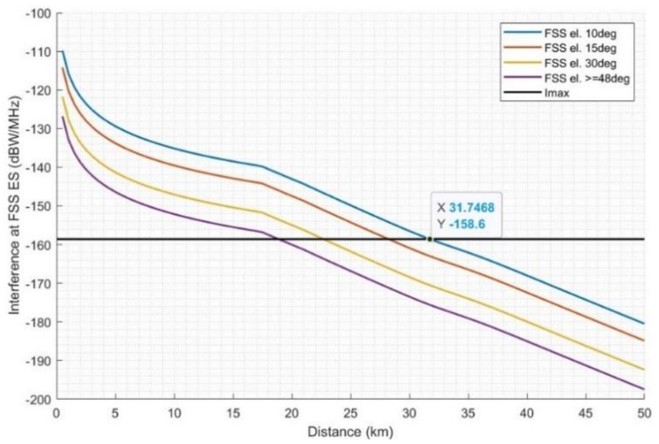
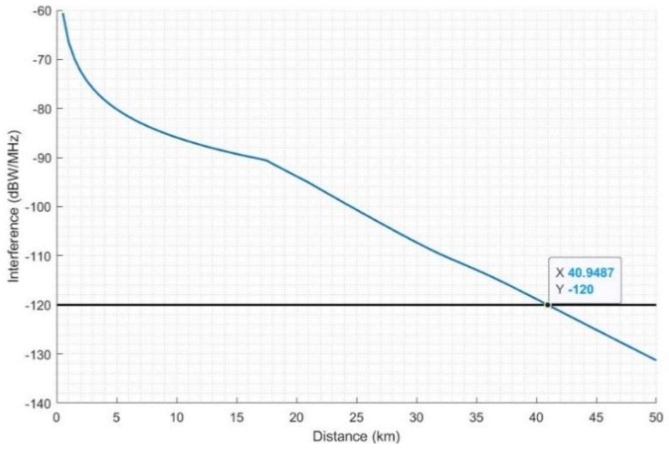
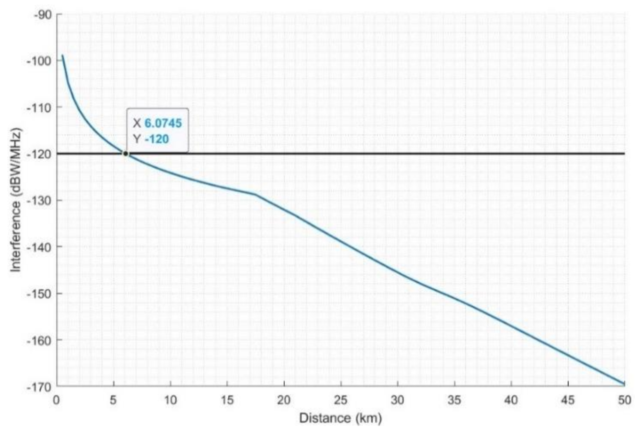
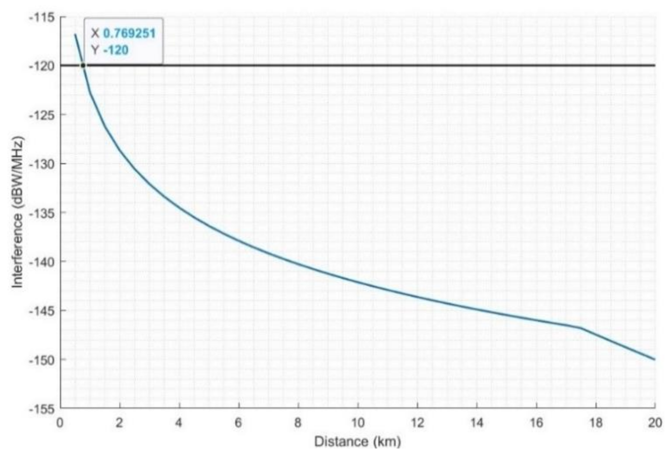
<tr><th>Low power BS (EIRP = –19 dBW/MHz)</th><th></th></tr>
<tr><td>
</td><td></td></tr>
</table>

3 Calculation of d_{DBC}

In order to obtain d_{DBC} the exact same process was performed as in the previous section by calculating the interference versus distance for the in-band case except for the fact that the receiver gain was set to 0 dBi as specified in Schedule 2 of the ULOI.

High power BS (EIRP = 37.2 dBW/MHz)	Medium power BS (EIRP = –1 dBW/MHz)
	
Low power BS (EIRP = –19 dBW/MHz)	
	

4 Summary of the study and preliminary assessment

The following table provide the in-band separation distances required for a 5G BS (WBB) to meet both the DBC and the FSS ES protection criteria. The difference between distances provides an idea on the minimum separation distance required for the FSS AWL.

WBB eirp power level	Separation distance to protect FSS (km)	Separation distance to meet DBC (km)	Minimum FSS AWL radius (km)
High power (37.2 dBW/MHz)	163	41	**122**
Medium power (–1dBW/MHz)	46.9	6.1	**31.8**
Low power (– 19dBW/MHz)	31.8	0.8	**31**

Table C1 In band coexistence study results for FSS ES at 10° elevation

Communications Alliance Satellite Services Working Group membership

Amazon Web Services
EchoStar Global Australia
Foxtel
FreeTV
Globalstar
Global VSAT Forum (GVF)
Inmarsat
Intelsat
Ipstar
Iridium
King & Wood Mallesons
Lockheed Martin
nbn
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OneWeb
Optus
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Pivotel Satellite
SES
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