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COMMUNICATIONS ALLIANCE

SATELLITE SERVICES WORKING GROUP

SUBMISSION

to the

Australian Communications and Media Authority's (ACMA)

Uncoordinated ubiquitous FSS earth station coexistence with FWA in the 28 GHz band discussion paper

15 March 2021

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EXECUTIVE SUMMARY

The Communications Alliance Satellite Services Working Group (SSWG) welcomes the opportunity to provide comments to the ACMA *Uncoordinated ubiquitous FSS earth station coexistence with FWA in the 28 GHz band* Discussion Paper.

The SSWG acknowledges the complexity of the issues involved in creating a fair and efficient coexistence framework, and offers the content of this submission in a constructive spirit, for the ACMA's consideration.

In summary, the SSWG does not support the parameters used in the coexistence paper and suggests the values derived in the more comprehensive TLG be used at the AWL outer boundaries and presented in RALI MS-46.

The SSWG proposal would result, we believe in only a small or no stand-off from AWL boundaries based on well-studied and generally accepted parameters from RALI MS-46, and therefore would generate a more effective and efficient outcome, overall, for users of all services operating within the band.

This submission comments on and makes suggestions in relation to a range of related issues, including FWA antenna heights, protections levels, system deployment, 'dead zones', guard bands and ESIMs.

The SSWG notes that many of its members will be submitting independent responses to this consultation.

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 provide a unified voice for the telecommunications industry and to lead it into the next generation of converging networks, technologies and services. The prime mission of Communications Alliance is to promote the growth of the Australian communications industry and the protection of consumer interests by fostering the highest standards of business ethics and behaviour through industry self-governance. For more details about Communications Alliance, see http://www.commsalliance.com.au.

1. Introduction

The '*Uncoordinated ubiquitous FSS earth station coexistence with FWA in the 28 GHz band'* Discussion Paper presents studies and proposals from the ACMA for 'exclusion zones' and 'guard bands' to ensure that ubiquitous Fixed Satellite Service ('FSS') outside of designated population areas and adjacent Fixed Wireless Access ('FWA') (in AWLs) can coexist.

In the Australian Radiofrequency Spectrum Plan both Fixed Service (in this case point-to-multipoint FWA) and Fixed Satellite Service (Earth-to-space) in this band are co-primary, despite the different geographic areas in which each can claim protection from the other. However, the discussion paper appears to take a 'worst-of-the-worst' case deterministic analysis using extreme ranges of FWA protection and system parameters, resulting in disproportionate burden being placed on the FSS to protect the FWA. This contrasts with the approach taken during the recently completed TLG process, which dealt with the reverse situation, i.e. interference from terrestrial services to satellite services. During the TLG the satellite community was regularly reminded of its obligation to 'share the pain' - a concept that should also feature in the solution-design in this latest process.

The discussion paper takes a more stringent approach to protection of the FWA than the ACMA took in RALI MS-46 for the coordination of FSS earth stations and FWA, including at the boundary between the areas in which each is primary. In the lead up to 26/28 GHz and resulting in RALI MS-46, the ACMA conducted an exhaustive Technical Liaison Group (TLG) process which, while not meeting fully the demands of either sector, was generally accepted by both. The parameters and outcomes derived from the TLG process were well supported and strongly evidence-based. In the view of the SSWG, there is no basis for departing from the parameters developed at the TLG to require uncoordinated FSS earth stations to provide more protection to FWA.

The Discussion Paper uses different values for a number of parameters than those in RALI MS-46, resulting in large areas where neither FSS nor FWA can use the spectrum (assuming FWA services are treated the same as FSS), or (worse) only allows the FWA to deploy; relying on the mandatory separation of uncoordinated FSS deployments to provide the FWA with *de facto* protection. The SSWG believes this is not an efficient use of the spectrum resource. Nor is it fair to effectively place the entire burden of compatible co-existence on uncoordinated FSS earth stations. Instead, by re-examining many of the assumptions in the paper and using parameters adopted in RALI MS-46 and developed in the TLG, the SSWG believes that these dead zones can be reduced or removed and people and industry close to the populated areas can receive equivalent services to those elsewhere.

The updated principles of the ACMA for spectrum management require it to 'balance the cost of interference and the benefits of greater spectrum use.' In the SSWG's view, this means that a service should not be designed, nor be protected to, the extremes of equipment performance, deployment or link budget.

The SSWG believes it is quite possible, if designed and deployed properly, for a 'smart' FWA system using adaptive active arrays to operate compatibly with FSS uplinks noting particularly that the critical criteria for assessing the interference impact of FSS on FWA is short and long term FWA network capacity degradation. Indeed, primary FWA deployments inside an AWL will already be operating in an environment vis a vis primary FWA deployments in the same AWLs and in adjacent AWLs, and will need to use adaptive strategies to extract maximum performance in that environment. The same strategies can and should be used vis a vis primary FSS deployments (whether coordinated or uncoordinated) in areas adjacent to AWLs. This means that, at a minimum, primary FWA should not require any more protection from primary FSS in adjacent areas than from primary FWA in adjacent areas.

The 28 GHz TLG and RALI MS-46 defined a power flux density (PFD) of –91 dBW/m^2/MHz for 95% of the time measured at a 5 m height above the boundary of an FWA AWL to protect against non-AAS FWA and FSS deployments in the adjacent AWL. Within the outer boundaries of population centres FWA will need to design their systems to be compatible with other services operating in the frequency range 27.5-28.1 GHz accordingly. Thus the SSWG believes that adding the FWA base station gain to develop another more stringent protection level does not make sense. AWL boundaries should be the same whether between AWLs where FWA is primary or between AWLs where FWA is primary and where FSS is primary.

These conservative assumptions also serve to deny other very valuable services, such as aeronautical, maritime and land-mobile ESIM, full access to the major markets where there are the most customers. The value of being able to plan a ship unload and refuel is high, just as is the ability to transfer aircraft data, refuelling requirements etc prior to landing (and also without increasing pilot workload while landing). These activities require gate-to-gate and pier-to-pier spectrum access for ESIM. We seek to determine whether, with some reasonable operating technical parameters, FWA can be designed and deployed to be compatible with satellite broadband services in the band.

Therefore the SSWG does not support the parameters used in the coexistence paper and suggests the values derived in the more comprehensive TLG be used at the AWL outer boundaries and presented in RALI MS-46.

RALI MS 46 presents a system of parameters which, while still conservative in our view, are a much better dataset from which to undertake these studies and could result in a lot less spectrum wastage and dead zones. The SSWG suggests in this response that the ACMA redo the studies using these parameters combined with a realistic value for clutter and using probabilistic methodologies. The SSWG further suggests that guard bands to protect from out of band interference (OOB), while possibly necessary for TDD FWA with horizontally pointing antennas, are not necessary for FSS given realistic antenna patterns and high elevation pointing angles. Such guard bands were not required of coordinated FSS earth stations, and there is no basis for imposing them on uncoordinated FSS earth stations. In any case, the 26 GHz band is similar in geographic distribution to the 28 GHz band, so the 'in band' protections afforded in 28 GHz (unless removed entirely) will be more than sufficient (by up to 12 dB) to protect 26 GHz from OOB emissions.

2. The 28 GHz Band

The ACMA released its plans for the 28 GHz band in September 2019 and the satellite industry was generally satisfied with the outcome, despite the 600 MHz in the frequency range 27.5-28.1 GHz being excised for co-primary Fixed Wireless Access (FWA) and satellite for Area Wide Licences (AWLs). While not an ideal outcome, the FSS industry decided it was acceptable, provided the band was still available for fixed satellite and ESIM services to customers.

AWLs were subsequently suggested as a method of licensing FSS transmitters in the band using a power flux density (PFD) of –91 dBW/m2/MHz for 95% of the time at a height of 5 m above ground level at the AWL boundary. While conservative, this has been prescribed and also gives a defined boundary condition to which the FWA designers must work. This boundary condition applies both to primary FWA transmitters in adjacent areas and to primary coordinated FSS transmitters in adjacent areas. The SSWG is unable to see why a different PFD is needed at the outer boundary to protect primary FWA inside the boundary from equally primary, uncoordinated FSS earth stations in the adjacent areas.

3. The balance of pain

In line with the ACMA's principle of 'balance the cost of interference and the benefits of greater spectrum use', the SSWG believes the ACMA should retain the simple –91 dBW/m^2/MHz for 95% of the time PFD and apply it to these studies as a first step towards defining the 'at boundary' protection for FWA inside AWLs.

However the SSWG continues to believe that with appropriate mitigation techniques and a modest degree of burden sharing FSS can work within the AWLs with minimal disruption to FWA and in this way extract the maximum benefit from the use of the spectrum.

The SSWG understands that the changes we have proposed represent a significant change from the conservative, deterministic study used in the paper and suggests the simple and accepted –91 dBW/m^2/MHz for 95% of the time be used to reduce the 'dead zone' immediately and a further study supported by a TLG be commenced as soon as practical using all FSS and FWA parameters and including input from SSWG members.

4. FWA antenna heights

While recognising that there could be a range of antenna heights used for an FWA system, the coexistence paper proposes that 30 m should be used for all base stations. This actually contradicts many vendor system designs, where lower base stations are used to reticulate to nearby dwellings etc over short distances.

In any case, 30 m is an extreme height and should not be used to determine coexistence at the boundary. The SSWG notes that if the simple TLG PFD is used, antenna height becomes irrelevant.

The SSWG notes that RALI MS 46 stipulates the power at an AWL edge should be calculated at 5 m above ground level (AGL) for 95% on the area/time which, at the population centre boundaries where housing would be within sparse sub-urban/rural in most cases is more realistic and was evidence-based via the TLG.

The SSWG notes that any such pfd would (should) also be applied to secondary FWA beyond the boundaries of the designated populated centres, otherwise the entire premise of the 'coexistence' paper becomes invalid. Using the conservative values chosen for the paper would result in wide 'service free zones' at the edges of major population centres, exactly where FSS and FWA are needed most! The SSWG believes the ACMA should avoid these service free zones, just as the SSWG does.

5. Protection levels

The ACMA has proposed an 'AWL edge' protection level of –116.6 dBW/m^2/MHz at the abovementioned 30 m height for uncoordinated FSS earth stations. This is based on the –91 dBW/m^2/MHz PFD limit with an antenna gain added. The SSWG cannot see justification for adding an antenna gain to the –91 figure, when it is not used for inter-AWL coexistence or for co-existence between primary coordinated FSS earth stations and primary FWA at the same AWL boundary. The SSWG does not support the –116.6 dBW/m^2/MHz level, as it appears arbitrarily chosen to widen the 'dead zone' and is not applied via RALI MS-46.

RALI MS 46 on the other hand stipulates –91 dBW/m^2/MHz for 95% of the time measured at a height of 5 m above the ground. While –91 dBW/m^2/MHz is still in the SSWG's view somewhat conservative at least this requirement presents some probabilistic opportunities to reduce dead zones, is measured at a far more realistic height of 5 m AGL and is based on the outcome of an exhaustive evidence-based process.

6. System deployment

The coexistence paper does not mention deployment densities, nor appear to consider them at all. Deployment densities of any particular system are vital when trying to determine the interference potential or spectrum denial of that system.

Starting inside the population centres/AWLs there are a large number of substitutes for FSS services such as fibre, cable, cellular broadband and FWA in numerous bands. While the price point is also a major consideration, technically with a large number of substitutes the number of competing systems deployed will be much lower. This should be taken into account when determining whether FSS can deploy inside the band/populated areas and SSWG does not believe it has been fully investigated.

The FSS 'footprint' is very small and is pointing angle dependent. Simple radio system engineering dictates that through judicious use of antenna pointing and through sacrificing a small amount of the available link budget, FWA systems can be designed and deployed to be compatible with FSS transmitters, as shown in the attached analysis. To allocate the entire available dynamic range to FWA, and to impose long-term protection requirements for 100% of the time without consideration of the fact that FWA will always have much less than100% service availability, and expect FSS to meet that most certainly does not balance the cost of interference and the benefits of greater spectrum use. In fact it achieves the opposite, i.e. by 'steel plating' one service, another is denied access and spectrum utility is decreased to the detriment of end users.

The SSWG proposes that the ACMA redo its engineering studies based on the levels and heights in RALI MS 46 and determine a more realistic set of requirements that does not deny large areas of population both FSS and FWA services and that subsequently makes best use of the spectrum.

7. Antennas

For the FSS antenna the coexistence paper proposes using the antenna pattern model in Recommendation ITU–R S.580. It is important to note that in practice, actual antenna models performance could be much better. For example, using S.580 would result in an off-axis gain of 4 dBi at 10° elevation and –8 dBi at 30° elevation, whereas one antenna used by an Australian operator has an off-axis gain of between –8 dBi and –15 dBi over the same elevation angles, and that these angles would be visible to the angle of arrival towards the receiver of an FWA station. This is of course statistically distributed. The SSWG suggests the ACMA develop a 'typical' pattern based on actual antennas. In our view this will reduce gain towards the horizon by 6 to 12 dB and likewise reduce the impact on the community caused by wasted spectrum and dead zones.

For FWA the paper proposes a 23 dBi and a 33 dBi base station antenna. It is noted that 23 dBi is based on an 8 x 8 array with active antenna system, whereas 33 dBi is a solid parabolic and is probably being used to 'stretch a cell' which we do not support, as it would be difficult for an IMT-type phased array antenna to reach this level of gain. We also fail to understand how such a system could meet the AWL boundary pfd requirements. A more realistic gain for an active array serving three or more user terminals is 15 to 23 dBi. However the SSWG is prepared to accept 23 dBi as a maximum (as was used in the TLG studies). There is no basis, so far as we can see, for using a higher base station antenna gain to derive a lower PFD limit at the AWL boundary to protect FWA from uncoordinated FSS earth stations vs.

coordinated FSS earth stations. Instead, the same PFD limit of –91 dBW/m^2/MHz for 95% of the time at 5 m above ground level should be used in both cases. The SSWG further rejects the notion that lower antenna gain would somehow require larger separation distances.

Finally the document states 'with beamforming technology, a VSAT could fall within the main beam of the antenna at any time (i.e. the FWA BS antenna beam is pointing towards the VSAT).' The SSWG has concerns about this approach, as the interference path in this case assumes that the VSAT's peak antenna gain is pointing towards the FWA BS antenna also with peak antenna gain. This assumption does not take into account the angle of arrival of the interference signal that would be subject to off-axis discrimination of the VSAT antenna pattern despite the document assuming the reference antenna pattern of Recommendation ITU–R S.580. The SSWG fails to see how this could happen in real life unless an FWA BS was right at the southern edge of the boundary pointing out with an FSS transmitter a few meters away. The SSWG suggests this is an absolute end of 'extreme' installation practice, which should not be protected and even if adopted the probabilities are so low they can be effectively ignored.

8. Other Parameters

The ACMA may also wish to consider FSS duty cycle. Duty cycle may reduce the level of protection required for FWA or even bring any exceedance of the –91 dBW/m^2/MHz within the 95% requirement obviating the need to apply any measures to FSS inside the populated areas.

Information on duty cycle for different applications is not currently available, however SSWG members would be able to source this information if ACMA commits to a more thorough coexistence study.

9. Dead zones at the edge of populated areas

The 'coexistence' paper proposes that no FSS terminal be operated closer than 15 km from an AWL boundary. This is based upon the overly conservative protection levels for FWA and 'Table 1' which quotes between 3.1 and 9.8 km (for cases that assume additional attenuation related to clutter) depending on the FWA base station antenna gain of either 23 dBi or 33 dBi at a height of 30 m as we have discussed.

The SSWG contends the ACMA should be consistent with RALI MS 46 and the general principles of sound spectrum engineering and seek to reduce these dead zones as much as possible. To this end the ACMA should apply a pfd of –91 dBW/m^2/MHz measured at a height of 5 m AGL. The ACMA should also use clutter of at least 12 dB (depending on distance) and an additional allowance for building shielding based on advice to installers discussed previously. The SSWG understands that building shielding will not be uniform or available in all cases, however MS 46 allows for this by requiring the pfd be maintained for 95% of the time.

Given all of the boundary AWLs are at the edges of population centres where building heights are low and the 'normal' reticulation model would be a small cell one, the SSWG believes the 30 m base station antenna case represents the extreme case where a carrier is trying to stretch the capabilities of 28 GHz, perhaps to cover users beyond their licensed AWL into areas where they do not enjoy protection from the FSS. While the SSWG would not preclude the possibility of such deployments, this should not be permitted at the expense of high value FSS services where they could otherwise be deployed, and should be required to accept the interference risk of stretching their deployments into areas where the FWA is not supposed to be protected from the FSS.

With the more reasonable 5 m measurement height the increase in smooth Earth propagation and increase in clutter would mean the 'dead zone' could be reduced to as low as 1 km or less in order to meet a PFD level of –91 dBW/m^2/MHz. The SSWG believes that 18 dB of clutter loss would be the norm and that a simple installation instruction to 'install the FSS terminal on the side of the building opposite to the nearest AWL boundary' would ensure a much greater clutter loss than 18 dB. In addition most if not all FSS user terminals are installed below the roof ridge-line or at ground level. Again 24 dB clutter loss is probably a more realistic figure for these systems.

There is also a probabilistic element that has been ignored. To cause interference, the FWA would have to be able to see an FSS terminal and, as we have previously pointed out, to date nbn have deployed Skymuster receivers in a band shared with fixed services without a reported case of interference (in a lower band where antenna performance is reduced).

The SSWG understands that full consideration of the probabilistic elements in such a study would take time, but offers a preliminary analysis in the attached which attempts to take account of the dynamic nature of the interference environment. As such we suggest recalculating the boundary at –91 dBW/m^2/MHz for 95% of the time at 5 m using the figures below and then investigating whether any stand-off is required, or indeed if FSS can operate inside AWL, using statistical analysis. We note that close operation or operation inside AWL may require a RALI or similar and the SSWG would be pleased to assist in developing this.

10. Adjacent channel and guard bands

Guard bands deny services to end users and are a waste of valuable spectrum. The SSWG notes that there are no guard bands proposed between FWA in AWLs even though some of their reported out of band emissions exceed those of FSS transmitters and their antennas point, generally, horizontally. While not addressed in the 'coexistence' paper, the SSWG contends that OOB performance of TDD systems are worse than FDD and that FWA antennas point (effectively) horizontally while FSS point upwards. Will any proposed guard bands be applied to FWA?

That said, guard bands for either system are not needed. Using more realistic antenna patterns for both systems, introducing realistic clutter and using a stochastic model to determine the probability of interference these dead zones would be reduced to 1 km or less. Given that 1st adjacent channel is at least 8 dB below the wanted channel for FSS (it would be worse for TDD FWA) the required physical separation would be more than halved. With a realistic dead zone calculated using MS 46 requirements this would be a matter of metres and would in any case be inside any required stand off from the boundary. As a result, the ACMA found no basis to require a guard band in MS 46 to protect primary FWA AWLs from primary coordinated FSS earth stations in adjacent areas, and there is basis for concluding that uncoordinated FSS earth stations would have such worse out-of-band performance as to require a guard band.

As previously mentioned, the 26 GHz licence areas are similar to the AWL areas so this logic dictates 26 GHz will also be protected.

Thus no guard band is required to protect FWA operating within the AWL parameters and outside of the AWL FWA are secondary.

11. FSS parameters

The ACMA has used ITU data for antenna patterns and OOB power levels. In both cases these are overly conservative. Noting the argument above showing guard bands are simply not necessary, we will focus on the antenna patterns at a horizontal axis around 40° from main beam.

The ITU pattern underestimates directivity significantly, particularly to the rear of the antenna. Depending on installation it underestimates directivity at and around the 40° off axis by 3 to 9 dB. We suggest using a figure of –12 dBi dB given other losses such as shielding and vegetation are not taken into account and that at least 50% of FSS antenna would present the much deeper 'back lobe' to the AWL. So again, a statistical analysis would achieve a much better outcome for all.

12. Alternative calculations

The SSWG believes that while the parameters used in the paper are flawed and result in a loss of spectrum utility and service provision, the calculations made were sound. Thus if these calculations are adjusted for the more realistic RALI MS-46 (TLG) parameters the outcome would be agreeable for SSWG members.

TABLE 1

Required separation distance between VSAT and FWA using –91 dB(W/(m^2*MHz)) and an addition -6dBi on the antenna

	FWA BS**		**FWA UE**	
VSAT Tx Power density (dBW/MHz)	–5.8	–22	–5.8	–22
FWA Rx Antenna gain (dBi)	23	23	14 / 20	14 / 20
Additional losses (dB)*	18 dB (Clutter)			
Minimum separation distance (m) (with additional losses)	~500 m	~10 m	~170 m	~40 m

* The measurement height of 30 m has not been changed thus additional clutter is likely.

** A FWA BS at an AWL boundary would be unable to meet RALI MS-46 requirements and is therefore unlikely.

The SSWG notes that the requirement to meet –91 dBW/m^2/MHz is at 5 m for 95% of the time under RALI MS-46. Thus the figures of between 10 m and 500 m meet these requirements, noting that an FWA BS at an AWL boundary could not meet the RALI MS-46 conditions and so 500 m is an extreme limit.

Terrain makes a deterministic calculation difficult at –91 dBW/m^2/MHz for 95% of the time at 5 m, however using common FSS parameters.

The SSWG also notes the FSS antenna gains at 40° only occur when the FSS user terminal is directly south of an AWL. In all other cases the actual off axis angle is greater than 40° and to the north of the AWLs is actually the 'back beam' of the antenna which is significantly lower.

Installation of the FSS user terminal is also a consideration. They are usually installed at ground level (pole mounted) or on the roof (at about 5 m), but when roof mounted are below the ridge line in most cases (where a ridge exists) so again the actual distribution of shielding is higher than 18 dB in most cases.

Using a basic probabilistic analysis is difficult without knowing exactly where a ubiquitous FSS user terminal will be, however the figures above represent only a small sample of FSS user terminal installations and given the '95% of area' requirement in RALI MS-46 the maximum separation distances are not needed. Thus the SSWG suggests the 'stand-off' from AWL boundaries be set at 100 m to the south and 0 meters to the north where significant roof shielding would be present.

Finally these very small but more realistic distances reopen the question 'Why can FSS User terminals not be permitted inside AWLs?' Given evidence from the 18 GHz NBN deployment (FS -> FSS) suggests interference is statistically very unlikely.

13. ESIM – protection of primary FWA

The ACMA (in this study but not the TLG) used very conservative values to suggest all forms of ESIM are, to some extent, incompatible with AWLs. The SSWG urges the ACMA to consider this issue more deeply.

In the SSWG's view, the ACMA should not use ITU WRC-19 Resolution 169 domestically, as the basis for the protecting terrestrial FWA services from ESIMs in the 27.5 – 28.1 GHz band. As the ACMA is aware, Res 169 was a compromise at WRC-19 and was not based on science or studies. By its terms, Res 169 is also only intended to protect an adjacent country's terrestrial services from ESIM operations (which is a non-issue for Australia, which has no near neighbours) when within line-of-sight and in overlapping frequencies, and Res. 169 clearly states that member states are free to adopt a different measure, including higher pfd value, for the protection of domestic terrestrial services. As a result, the SSWG recommends that the ACMA adopt its own criteria based on the outcome of the studies being undertaken here with the new characteristics discussed above, but in any case, should not adopt any criteria more constraining than that established by the European Communications Committee (ECC) for Earth Stations on Moving Platforms (ESOMPs) for the protection terrestrial Fixed Service in this band, where they are within line-of-sight and co-frequency. The ECC studies are the most comprehensive for terrestrial fixed service and, since they based on high gain FS, adjusting the ECC values using –91 dBW/m^2/MHz at 5 m as a starting point for Aero ESIM should be considered. Moreover, the ECC have been in force for quite several years and have proven to be sufficient to protect terrestrial services.

Using the parameters from RALI MS-46 and extending the 95% to time, the SSWG believes that A-ESIM will not cause an issue at all, especially given the down-tilt requirements on FWA base stations and the transient nature of overflying aircraft. Likewise, the antennas on M-ESIM are equal to or better in performance than fixed earth station user terminal antennas. Thus (unless floating FWA is proposed) M-ESIM could be permitted up to the dock. Therefore, the ACMA should follow the analysis and determine what the correct values are rather than adopt overly conversative values that waste the use of spectrum.

Land ESIM may require different criteria, however geo-fencing is very feasible based on studies that provide for line of sight and co-frequency requirements and the distances from the AWL roughly the same (depending on antenna type) and so the same small co-existence distances should be adopted.

14. ESIMs – operations at airports and major maritime ports

In its 28 GHz Decision, when considering the operation of ESIMs, the ACMA 'also identified restricting the deployment of FWA services (or make them secondary) in and around airports and major maritime ports as another technique to manage interference.'[1] The SSWG and many of its members have raised this matter for further consideration by the ACMA numerous times during the TLG and the subsequent public consultations leading up to the establishment of the AWL regime.

The ACMA's principles of spectrum management require it to 'balance the costs of interference and the benefits of greater spectrum use.' In the SSWG's view, the balance clearly favours greater use of the 27.5 – 28.1 GHz for A-ESIMs and M-ESIMs around airports and major maritime ports in defined populated areas than preclusion of such operations in order to protect the primary FWA.

For A-ESIMs, the benefits of gate-to-gate service in 27.5 – 28.1 GHz for the millions of passengers that ordinarily enter or depart Australia at its airports outweigh any FWA service at or near the airport where other frequencies can be used. The population that might be served by FWA within the AWL cells that encompass an airport can be expected to be zero (or very small), rendering any loss of FWA service in such areas insignificant. Moreover, any indoor operations at airports can expect to be protected by the large building attenuation losses at these high frequencies. Any significant population in nearby cells can be protected using the same PFD boundary condition, which A-ESIMs should be able to meet, given the typical A-ESIM power levels and the distance from active gates, taxiways and runways.

Similarly, for M-ESIMs, the benefits of continuous satellite services in 27.5 – 28.1 GHz all the way into major maritime ports for the millions of passengers and crew on cruise ships and other vessels visiting Australia outweigh the relatively limited FWA service in those areas. The location of M-ESIM terminals high above sea level (e.g. when mounted on cruise ships and other large vessels) and their upward orientation is likely to create fairly incompatibility zones. At the very least, a closer look by the ACMA at the population, likely FWA deployments, and likely interference scenarios around major maritime ports is warranted.

15. Summary

The SSWG has proposed a small or no stand-off from AWL boundaries based on well-studied and generally accepted parameters from RALI MS-46.

The SSWG also proposes A-ESIM be permitted overflight and operation at airports based on the –91 dBW/m^2/MHz at 5 m from RALI MS-46 and M-ESIM be permitted 'port to port' based on the same parameters. Operation at airports and major maritime ports, even within populated areas, is warranted as the benefits of gate-to-gate and port-to-port services to millions of passengers and crews visiting Australia by aircraft or vessel would outweigh the relatively small population that could be denied FWA service by A-ESIM or M-ESIM operations at such airports and maritime ports. L-ESIM are able to be geo-fenced, to the extent necessary based on study results, and depending on antenna performance should be permitted similar flexibility of operations.

Finally, given the very small incompatibility of FSS User terminals, as shown here and in the TLG, if a true statistical analysis was conducted it should be possible to allow FSS user terminal inside AWLs that support FWA within designated population areas.

[1] ACMA, Future use of the 28 GHz band: planning decisions and preliminary views, at 13 (Sep. 2019).

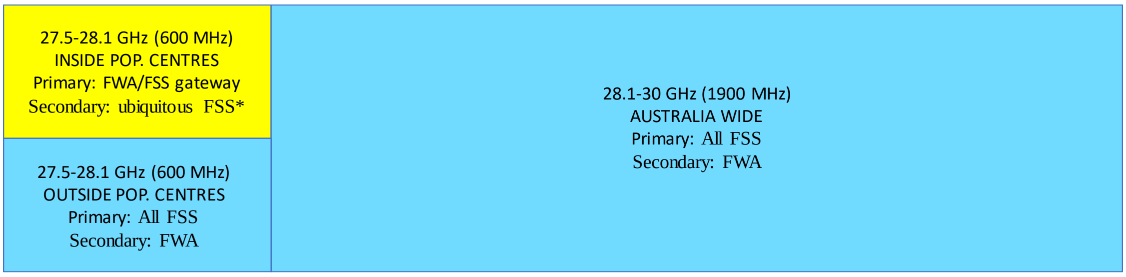
The SSWG suggests the boundary be adjusted ASAP to minimise the ‘dead zone’ using all available evidence and the TLG PFD of –91 dBW/m^2/MHz for 95% of the time followed by a more rigorous probabilistic study to determine if FSS can indeed be operated inside AWLs using guidance in the form of a simple RALI.

Attachment A

Impact assessment of nbn's SkyMuster satellite service on planned FWA networks[2]

Introduction

Recent spectrum planning decisions by the Australian Communications and Media Authority (ACMA) have introduced new arrangements in the 27.5-29.5 GHz band, *inter alia*. The new arrangements are summarised in the image below.



As indicated in this diagram, the most prominent feature of ACMA's spectrum planning decision is the shared nature of the band, i.e. fixed-satellite services (FSS) and fixed wireless access (FWA) are expected to share throughout the 27.5-29.5 GHz band. Although the nature of the sharing changes with geography, e.g. whether a service is inside or outside a metropolitan area, there is a clear expectation for sharing to occur cooperatively, with no part of the spectrum denied to either service anywhere in Australia.

nbn is Australia's largest satellite incumbent with large investment in the 27.5-29.5 GHz band (among others), known in the satellite industry as the Ka-Band, and all satellite upgrade paths are critically dependent on this band. **nbn** is also Australia's largest provider of terrestrial wireless broadband services and, although not currently operating in any band >3.6 GHz, is very interested in parts of the 27.5-29.5 GHz band to support an upgrade path. As such, **nbn** is heavily interested in a sharing outcome which is suitable for both services.

This document presents an impact assessment of **nbn**'s SkyMuster satellite service on planned FWA networks operating in the same frequency and geography.

System characteristics

The system characteristics of both the satellite and terrestrial services is shown in Tables 1 and 2 respectively. The Earth station characteristics shown in Table 1 are representative of the user segment of the **nbn** SkyMuster satellite service. They are derived from real world data and are a true-to-life representation of Australia's most extensive – and in 27.5-29.5 GHz, the only – deployment of very small aperture terminals (VSAT).

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[2] This study only addresses one sample system. Other systems may have different characteristics and no conclusions can be drawn about operational and technical criteria of those other systems from this example study.

Parameter	Value	Units
Frequency	28	GHz
Earth station transmit power – clear sky	-73.5	dBW/Hz
Earth station emission bandwidth	12	MHz
Earth station elevation	40	degrees
Earth station antenna gain to horizon	-20	dBi
Earth station transmit duty cycle	1	%
Cross-polar discrimination (circular-to-linear)	3	dB

Table 1. Earth station emission characteristics

The terrestrial system characteristics are shown in Table 2 and are assumed to be an FWA implementation of IMT-2020-like applications.

Parameter	Base (BS)	User (UE)	Units
Frequency	28		GHz
Noise temperature	290		K
Noise figure	12		dB
Margin	7	10	dB
Activity factor	80	25	%
TDD ratio	20	80	%
Bandwidth	200	67	MHz
Probability of bandwidth overlap with Earth station	100	33	%
Antenna gain	23	17	dBi
Antenna pattern	Recommendation ITU-R M.2101		

Table 2. FWA characteristics

Interference calculation methodologies

To determine the interference potential from Earth stations into FWA employing IMT-2020-type characteristics, two approaches are presented. Both use statistical methods which randomise variables such as location and antenna pointing. The first method is time-invariant and calculates interference margin as a function of distance separating transmitter and receiver. The other calculates a time percentage probability of excess interference as a function of distance between transmitter and receiver.

Margin vs distance

As indicated above, the first calculation of interference potential aims to determine the interference margin as a function of distance between the transmitting Earth station and receiving FWA station. This is done according to the following:

- VSATs are uniformly randomly distributed across a 200 m x 200 m grid
- FWA station is assumed to be at the centre of this grid
- Azimuth angle to each VSAT is determined, along with distance and free space loss at 28 GHz
- For each simulation point, a uniformly randomly distributed value for azimuth pointing of the FWA station is determined and compared with azimuth to VSAT to determine an offset angle
- Gain at calculated offset is calculated according to Recommendation ITU-R M.2101
    - using 4x16 elements for BS
    - using 4x4 elements for UE
- Off-axis emission level from a VSAT is calculated as $I_{offaxis} = P_d + G_{offaxis} + 10\log BW_{VSAT} - XPD$ where:
    - P_d is power spectral density
    - $G_{offaxis}$ is the off-axis gain towards the horizon
    - BW_{VSAT} is emission bandwidth
    - XPD is cross-polar discrimination
- Interference threshold for the FWA station is $I_{thr} = -228.6 + 10 * \log T + NF + \frac{I}{N} + 10\log BW_{FWA}$ where:
    - *T* is noise temperature
    - *NF* is noise figure
    - I/N is $10\log(10^{0.1*M} - 1)$ where M is margin
    - BW_{FWA} is receiver bandwidth
- Free space loss and FWA antenna gain in the direction of the VSAT is applied to $I_{offaxis}$ to determine received power at the FWA station
- Received power at the FWA station is compared with I_{thr} and a margin calculated
- Margin is plotted as a function of distance for each simulation point
- This approach is similar to that used in Section 4 of Report ITU-R S.2463, which concerns a different band but which otherwise studies a very similar sharing scenario

This method is a relatively straightforward application of the system characteristics given in Tables 1 and 2. Apart from randomly varying the position of the Earth station, the only other variable is the pointing angle, and therefore off-axis gain, of the FWA station.

Also worth noting is the method for calculating the I/N ratio, which necessarily differs from that used in fixed-fixed sharing studies. Particularly, since a FWA base station receives on only a 20% duty cycle, and Earth station transmit duty cycles are 1%, interference can only ever be a short-term phenomenon, if it occurs at all. As such, the long-term I/N threshold[3] used for static sharing between terrestrial services is an inappropriate measure to apply to short-term inter-service sharing scenarios. Rather, this study uses the same method applied in every other assessment of short-term interference, namely, to allow system margins to be temporarily consumed by a short-term interferer. This approach, and the equation given above (using margin to determine I/N) is taken directly from Appendix 7 of the ITU Radio Regulations.

Time percentage as a function of distance

The second calculation methodology considers the time variations inherent in each of the transmitting and receiving stations, according to the following:

- VSAT is placed sequentially at each point in a 150m x 150 m grid with a 10 m spacing
- FWA station is assumed to be at the centre of the grid
- Distance, free space loss at 28 GHz, and the azimuth angle from FWA station to VSAT are determined for each grid location
- A time series analysis is performed at each grid point
- FWA receive and Earth station transmit times are uniformly randomly distributed across 100,000 time samples, using the duty cycle for each service
- For each time sample, if VSAT is transmitting when FWA station is receiving
    - A uniform random azimuth pointing angle is calculated for the FWA station
    - This pointing angle is compared to the azimuth to the VSAT and an offset is determined
    - The FWA station receive antenna gain at that offset is determined in the same way as the "margin vs distance" analysis above
    - FWA receive gain and free space loss are applied to $I_{offaxis}$ to determine received power at the FWA station
    - Received power at the FWA station is compared with a threshold
    - If received power is above the threshold an interference event is recorded
- For each grid point, the percentage of time points, at which an interference event is recorded, is determined, and scaled by the probability of bandwidth overlap.
- Time percentage of interference events for each grid point is plotted on the 150m x 150m grid

[3] The I/N ratio assumed in the development of the apparatus licensing framework for terrestrial services in 27.5-29.5 GHz is aimed at helping to determine device boundaries, effectively demarcating adjacent property claims. As such, the application of the I/N threshold in this situation primarily serves a legal, not technical purpose, and should have no bearing on sharing between satellite and terrestrial services.

Results

The results of this sharing study are presented in Figures 1 and 2 below, which display a graph using both interference calculation methodologies, for FWA base and user stations respectively.

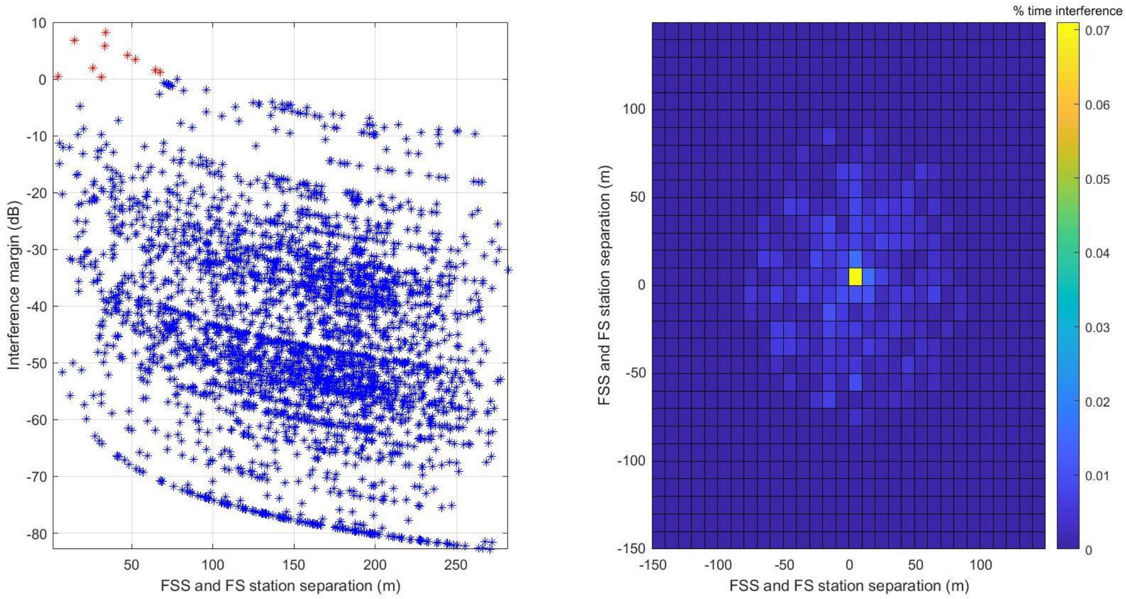

Figure 1. Interference assessment FSS-FWA BS

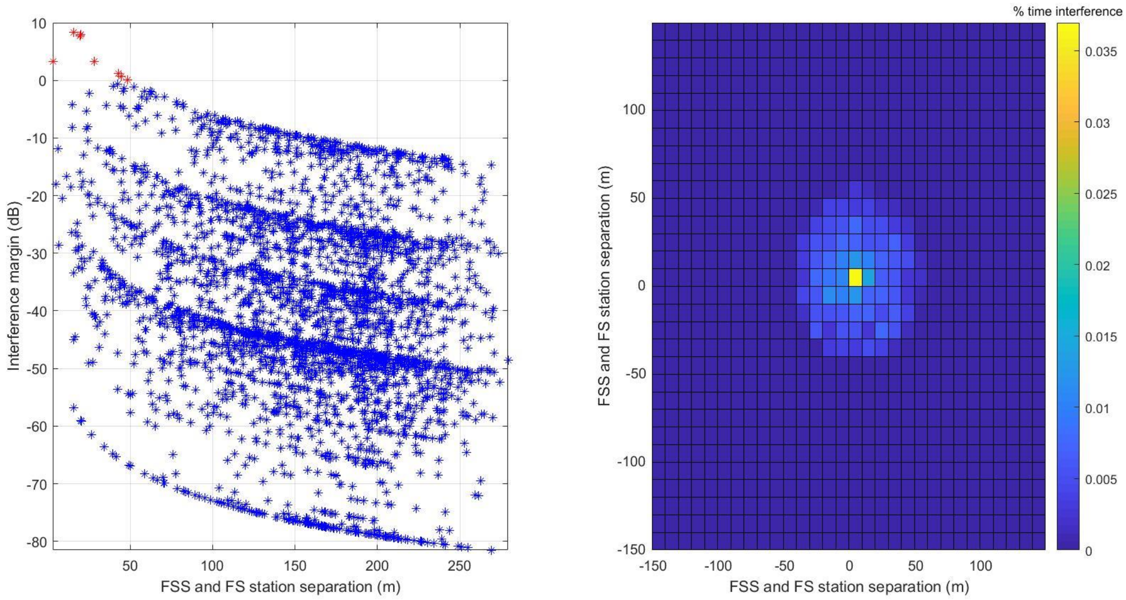

Figure 2. Interference assessment FSS-FWA UE

As shown in Figures 1 and 2, interference is not expected for any separation distance greater than about 100m (BS) and 50m (UE). Within these distances, the right panel of each figure shows an interference probability not exceeding 0.1% (BS) or 0.05% (UE) of time. Significantly, there does not appear to be a minimum separation distance within which the two systems are necessarily incompatible.

Not considered in this analysis are several factors which would reduce the interference potential even further, such as clutter, terrain, various fading mechanisms, site management, or atmospheric absorption. A full consideration of all these factors would certainly show an insignificant residual risk of interference but is left out of this analysis for simplicity, given the already extremely low likelihood of interference, even when the potential for interference is not being actively managed.

Conclusions

This document presents the results of a sharing study between transmitting Earth stations with real-world characteristics relevant to the current Australian operating environment, and the environment and receiving FWA stations with IMT-2020 characteristics. Results show that, without applying any active mitigation techniques, there is a negligible potential for interference. These results support the conclusion that successful sharing between satellite and terrestrial services can be expected, without any requirement for frequency or geographic separation.

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Published by:
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