COMMUNICATIONS ALLIANCE LTD

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Wireless broadband in the 26 GHz band

COMMUNICATIONS ALLIANCE SATELLITE SERVICES WORKING GROUP SUBMISSION

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INTRODUCTION

The Communications Alliance Satellite Services Working Group (SSWG) welcomes the opportunity to provide this submission in response to the *Wireless broadband in the 26 GHz band* Options Paper by the Australian Communications and Media Authority (ACMA).

The submission provides comments with a particular focus on the 26 GHz band in response to the Options Paper but also provides comment on the 28 GHz band and the mm Wave bands more generally, as consideration of these bands cannot be carried out in isolation.

The SSWG is planning to also make a response to the ACMA *28 GHz spectrum planning* Discussion paper.

Executive Summary

The SSWG supports further consideration for moving towards the refarming stage for the 26 GHz, providing that agreement can be reached on defining what the upper and lower boundary of the 26 GHz band should be.

The analysis of the Highest Value Use of a spectrum band requires a holistic approach, and certainly broader that, consideration of the details of just two bands at 26 and 28 GHz. The Highest Value Use would be achieved by correct apportionment of sufficient IMT spectrum spread across the range of frequencies up to 88 GHz. Without this analysis, the identification and allocation of IMT/5G would be inefficient and of limited value, particularly if other services are denied in the process.

The concept of 'tuning ranges' as an argument for identifying mmWave bands for mobile 5G is of no relevance. The decisions of mobile equipment manufacturers as to which frequencies to mount on a device is no substitute for proper spectrum policy decision-making.

Frequency sharing strategies must recognise that it is very challenging for one ubiquitous service (consisting of IMT base stations and devices) to share the same frequency range as another ubiquitous service (consisting of gateways, VSATs and ESIMs).

The SSWG supports further consideration for moving towards the refarming stage for the 26 GHz providing agreement can be reached on defining what the upper and lower boundary of the 26 GHz band should be. The SSWG have developed two options for segmentation across both the 26 GHz and 28 GHz bands (24.25 to 29.5 GHz) for the ACMA's consideration. SSWG prefers the first segmentation model, where the band is segmented at 27.0 GHz, but SSWG also acknowledges that the 27.0 to 27.5 GHz portion is currently used only for satellite gateway uplinks, and that the 27.0 to 27.5 GHz band is not allocated to the FSS in Region 1.

Communications Alliance is aware that individual some members, including Telstra and Optus, do not agree with some aspects of this submission, and will also be making their position clear in separate submissions.

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.

General comments

The Communications Alliance Satellite Service Working Group (SSWG) welcomes the opportunity to respond to the ACMA *Wireless broadband in the 26 GHz band* Options Paper.

At the centre of the ACMA considerations is a general drive for spectrum identification for IMT in the future. The justifications of regulatory decision making will be related to the *Highest Value Use* of spectrum. However, this needs to be qualified amidst the alleged bourgeoning demand for IMT spectrum, alongside innovative uses of competing and in some cases complementary satellite technology and applications as well as other existing terrestrial service demands and developments.

Some broader considerations

When is *Highest Value Use* satisfied – or will the outcome of considerations of this question always lead to the answer of IMT when applied to discrete bands in a progressive fashion? Consideration of this question requires a holistic approach which is greater than the details of just two bands at 26 and 28 GHz. *Highest Value Use* would be achieved by correct apportionment of sufficient IMT spectrum spread across the range of frequencies up to 88 GHz. Beyond that apportionment, identification/allocation for IMT/5G would be inefficient and of limited value, particularly if other services are denied in the process.

A holistic approach is also very relevant to the Earth Exploration-Satellite Service (EESS). Missions that utilise the 23.6 to 24 GHz band do so to sense contributions to the received signal mainly by atmospheric water vapour but also cloud liquid water components. The spectral lines in this band and most EESS passive bands are not typically used in isolation but rather combined with other passive bands in order to remove contributions from certain atmospheric gaseous components or surface radiation components to yield the desired information. So for example it may be used to remove the water vapour signal from measurements in a different band in order to extract the desired signal produced by some other atmospheric or surface component. Five frequencies (around 6 GHz, 10 GHz, 18 GHz, 24 GHz and 36 GHz) are necessary for determining the dominant surface and atmospheric parameters. Thus, a single EESS band is seldom used in isolation, and contamination of any single band affects the accuracy of all dependent physical parameters being measured.

These broader considerations indicate that efficient spectrum usage should not be approached on a piecemeal, band by band basis. A comprehensive strategy involving all potential bands is needed.

More than enough other spectrum to meet realistic 5G mobile spectrum demand

WRC-19 Agenda Item 1.13 will consider more than 33 GHz of spectrum in aggregate as potential candidate bands for IMT-2020. It should be possible to find more than enough spectrum within this 33 GHz to meet any realistic projection of data consumption growth, without impinging upon bands already actively being used or planned to be used for current and next-generation GEO, LEO and MEO satellite systems. Great care is needed in addressing the 28 GHz band, which is not even included among the candidate bands in the Agenda Item. WRC-15, which set the Agenda for WRC-19, excluded those frequencies from consideration for 5G/IMT-2020. In particular, WRC-15 decided overwhelmingly that, due to the existing and planned satellite use of the band, including for gateways and user terminals, it would not be appropriate to study any part of the band for designation for terrestrial IMT/5G. This exclusion was therefore done purposely for the benefit of service developments other than terrestrial IMT/5G. Some countries are breaking away from this set of bands under

ITU-R study, within one pretext of 'tuneable ranges' as proposed by vendors who put this forward as justification for a regulatory right to spectrum beyond the bands in Agenda Item 1.13.

On the 37 to 52 GHz Q/V band range we are seeing reliance on the tuning range argument is fuelling interest for the Q/V band where some Administrations argue this range can be segmented for different regions.

To provide some background, Intelsat Next Generation Satellites *Epic 2.0* are designed to include the use of Q/V for gateway links. Intelsat is assuming frequencies within the range of 37.5 to 40.5 GHz dual polarization for the downlink and within the range of 47.2 to 50.2 GHz dual polarization for the uplink.

With the tuning range argument, there is an ongoing debate within the wireless industry and regulators regarding the implementation of wide tuning ranges for newly developed 5G equipment for frequencies in the mmWave bands. This issue has arisen from the proposed mmWave bands identified under Agenda Item 1.13. For example, the mobile community is advocating to regulators to support the ranges of frequencies beyond those proposed under Agenda Item 1.13, (i.e. 28 GHz as above) rather than be selective of individual bands considering protection to their existing incumbent systems. The range 24.25 to 29.5 GHz and 37.0 to 43.5 GHz are examples in which equipment vendors could support a wide tuning range and in turn regulators are supporting the same idea.

The ability of mobile equipment manufacturers to build devices with wide tuning ranges, however, does not justify identifying all bands for 5G/IMT-2020. Wide tuning ranges are not a spectrum policy tool. It is no substitute for proper policy decision making about which spectrum bands should be for which services based on an assessment of public need and public good. To let wide tuning ranges to drive Australia's spectrum policy would be a complete abdication of the government's responsibility for spectrum allocation.

Turning to demand, the satellite industry expects data consumption to grow substantially in the near to medium term, and it is investing in HTS systems (in GEO, LEO and MEO) to meet that growth, including in Ka-band HTS systems – see Table 1 below.

In the broadband mobile world, it remains to be seen, however, whether data consumption will grow to the extent projected under various models to support 5G mobile spectrum requests, which are rather extreme. For example, a recent paper by LS Telcom shows that mobile data consumption growth predictions under the ITU forecast model are unrealistic. LS Telcom's approach was to consider how much data would be consumed 'in the limit, based on every mobile subscriber on the planet streaming 4K video for 16 hours per day' - in other words, itself a rather extreme, if at least plausible case. It determined that under this scenario 'the amount of global mobile data traffic would be around 3150 exabytes per month by 2035.' However, 'this is around 315 times higher than today and represents a CAGR of just 38% per annum (i.e. lower than the current estimates of 50% per annum).'

It is not surprising that even regulators in small, densely populated countries have come up with much lower estimates of mobile data consumption growth and, thus, much lower estimates of 5G mobile spectrum requirements. Singapore's IMDA, for example, recently estimated 5G mobile spectrum requirements to be closer to 2 GHz rather than the 20 GHz estimated under various models, based on (among other things) an assessment of local density of cell site deployments and expected rates of off-load on to Wi-Fi and future WiGig networks.

The table below illustrates the quantum of spectrum already allocated or planned for allocation for IMT-2020/5G in a number of countries. The table also shows how the amount allocated should be adjusted to take account of the lower population density for Sydney.

Country	26/28 spectrum available for eMBB (GHz)	Highest population density city	Population density per km²	Connection density increase versus Sydney %	Quantum for Sydney based on population density adjustment
China	2.75	Shanghai	15,000	300	910
Japan	2.50	Tokyo	11,500	230	1,087
Korea	2.40	Seoul	23,500	470	510
Singapore	2.0	Singapore	28,600	572	350
Canada	1.85	Vancouver	5,500	10	1,682
Australia	??	Sydney	5,000	0	??

If the amount of spectrum required for 5G is closer to 2 GHz (or less) than to 20 GHz (or more), then the ITU under WRC-19 Agenda Item 1.13 will be able to identify more than enough globally harmonized spectrum to support 5G mobile spectrum requirements. This should be achievable without cannibalizing or sharing satellite spectrum that is already in use or planned to be used for current and next-generation GEO and non-GEO HTS systems that will support and augment future 5G networks.

The 26 GHz band is a likely 'pioneer' 5G band. Within this band, attention should focus first on those portions not already allocated to satellite, given the recent Broadcasting Satellite Service (BSS) feeder link allocation in the 24.65 to 25.25 GHz at WRC-12 and the recent launch of HTS satellites using the 27.0 to 27.5 GHz FSS uplink band.

As for the portions of the Q/V-bands (37 to 52 GHz) included in WRC-19 Agenda Item 1.13, they are likely to be contended, since they are already being incorporated into next-generation Very High Throughput Satellite systems (including 6 global non-GEO systems proposed by Boeing, SpaceX, Telesat, O3b, OneWeb, and Theia). Indeed, WRC-19 will consider allocating more V-band spectrum for VHTS systems (Agenda Item 9.1.9), as well as for High Altitude Platforms (Agenda Item 1.14), and 5G (Agenda Item 1.13). Though it remains to be seen whether there is enough spectrum to accommodate all future requirements, and sharing studies are continuing to assess compatibility, core spectrum needs to be reserved for satellite end user terminals and access for individually-licensed earth stations should be preserved in the entire band. This should be harmonized at least at the regional level.

A number of other mmWave opportunities in higher frequency bands will be considered for 5G/IMT-2020 terrestrial mobile services under WRC-19 Agenda Item 1.13, including the 31.8 to 33.4 GHz (32 GHz), 66 to 76 GHz (66 GHz) and the 81 to 86 GHz (81 GHz) bands. It should be possible to find adequate spectrum in these bands to meet terrestrial 5G requirements without the contention with existing and planned use of satellite spectrum that is foreseeable in the Ka, Q and V-bands. The 66 GHz and 81 GHz bands, in particular, are considered very good prospects for international harmonization given their limited existing and planned use by other radio services. The 66 and 81 GHz band in the 'high' mmWave bands should yield about 15 GHz of spectrum in contiguous blocks of at least 5 GHz, which could support very wide-band 5G/IMT-2020 carriers. These high mmWave bands should therefore be able to support the development of 5G mobile networks in high density indoor and outdoor scenarios, such as stadiums, campuses or shopping malls located in urban and suburban areas. The use of these bands would also benefit from synergies with WiGig – currently being deployed at 61 GHz – for which chipsets and Multiple-Input Multiple-Output (MIMO) antenna systems are already being manufactured.

Examples of innovation and spectrum need in the satellite industry – with emphasis on Ka-band

The need to provide and protect satellite spectrum includes the recognition that for satellites to play their role in the 5G ecosystem, they will need continued, sustainable access to appropriate spectrum. This should be taken into account in planning processes for 5G.

In this regard, it is noted that:

- many HTS satellites have already been deployed, or are being planned to be deployed, in multiple frequency bands, including in the portions of the Ka-band spectrum being considered for 5G mobile spectrum (See Table 1).
- ITU WRC-19 Agenda Item 1.13, following WRC-15 Resolution 238, will be considering over 33 GHz – a colossal amount of spectrum – as 5G candidate bands, including the 26 GHz band but not the 28 GHz band.
- there is more than enough spectrum under consideration by the ITU for 5G/IMT-2020 to meet realistic demand projections, and there is simply no need to re-allocate satellite spectrum already in use or planned to be used for current and next-generation GEO and non-GEO satellite systems to meet 5G mobile spectrum requirements.

TABLE 1
High Throughput Satellite deployment

In service	High Throughput Satellite	Orbit	Frequency bands
2005	Thaicom-4 / IPStar-1	GEO	Ku-band / **Ka-band**
2013, 2014	O3b (Batch 1, 2 & 3)	MEO	**Ka-band**
2015, 2016	Sky Muster I & II (NBN-Co)	GEO	**Ka-band**
2017	Inmarsat Global Xpress (I5 F4) Chinasat-16	GEO GEO	**Ka-band** **Ka-band**
2018	O3b (Batch 4 & 5)	MEO	**Ka-band**
	SES-12	GEO	Ku-band / **Ka-band**
2019	Kacific-1 / JCSat-18	GEO	**Ka-band**
	OneWeb APStar-6D	LEO GEO	Ku-band / **Ka-band** **Ka-band**
2020	SpaceX	LEO	Ku-band / **Ka-band**
2021	Telesat LEO	LEO	**Ka-band**
	O3b mPower	MEO	**Ka-band**

Intense satellite use of the 28 GHz band and low probability of international harmonization of this band for terrestrial 5G

The 28 GHz spectrum band plays a key role in current satellite operations, in respect of which138 GSO and NGSO satellite systems, including *High Throughput Satellites,* are already using the band (see Table 2). The number has been growing steadily in the past few years and will continue to grow. As the 28 GHz band is key to satellite system development and innovation on a global basis, the international satellite community has significant interests in this band. Based on latest reports available from ITU, it can furthermore be seen that 1500+ satellite network filings have been submitted which have included the said 28 GHz band). Internationally this band is being used heavily by companies that provide satellite broadband services to masses, including those in unserved and underserved areas.

Gateways The 28 GHz band has a primary allocation for FSS (Fixed Satellite Service) and is used in its entirety, due to capacity requirements, for gateways of satellite systems with user payloads in Ka-band and other bands (e.g. Ku or S-band).

It is essential that FSS gateway operation in the 28 GHz band will not be constrained by 5G deployment, also considering that a domestic gateway is often a regulatory requirement or benefit to the local economy.

VSATs VSAT use allows remote areas of the country to be connected. Part of the 28 GHz band is also identified, via ITU RR No. 5.516B, for use by high-density applications in the FSS, i.e. ubiquitous VSATs, in the Earth-to-space direction. In Region 3, the relevant portions of the band are 28.45 to 29.1 GHz, 29.46 to 30 GHz. Importantly it is anticipated that access to the whole Ka band will be required for VSAT uplinks in the future and to facilitate this use it is planned to re-locate some gateways to the higher Q and V bands.

ESIMs In addition to the traditional fixed use, the 28 GHz band is also being considered for ESIM (Earth Stations In Motion) under WRC-19 Agenda Item 1.5, to provide broadband connectivity to users on the move and/or in areas not reachable by terrestrial networks (aircraft/vessels) in addition use on land.

Whilst the gateways could be few in numbers with larger antennae and known locations, the ESIMs would be ubiquitous, numerous in number and be spread across wide areas. Moreover, it is important that future earth stations and user terminals (which are of unknown location) be allowed to deploy. This would not be possible if similarly, ubiquitous IMT/5G terminals are allowed to deploy in the same band.

TABLE 2
Satellites operating in Ka-band

1	SES 15	31	SGDC 1	61	Astra 4A	91	GSAT 19 B67	121	QZSS 3
2	Galaxy 23	32	Viasat 2	62	Eutelsat 7A	92	Turksat 4B	122	Cosmos 2526
3	Anik F3	33	Astra 1H	63	Eutelsat 7B	93	Yahlive	123	COMS 1
4	Spaceway 1	34	Eutelsat 65 West A	64	Eutelsat KA-SAT 9A	94	Express AM6	124	Chinasat 1A
5	ViaSat 1	35	Telstar 19V	65	Inmarsat 5F4	95	Intelsat 33e	125	APSTAR 6C
6	Anik F2	36	Amazonas 3	66	Sicral 1B	96	Inmarsat-5F1	126	QZSS 1
7	Wildblue 1	37	Amazonas 5	67	Eutelsat 16A	97	Amos 4	127	Express AM5
8	Echostar 17	38	Inmarsat-5F2	68	Sicral 1A	98	Intelsat 20	128	NBN-Co 1A
9	ACTS	39	Intelsat 29E	69	Astra 1L	99	UHF 10	129	Kizuna
10	AMC 15	40	Intelsat 32e	70	Arabsat 5C	100	GSAT 14	130	NBN-Co 1B
11	Spaceway 1	41	Hispasat 36W-1	71	GovSat-1	101	ABS-2	131	Mtsat 2
12	Directv 15	42	Skynet 4F	72	SES 16	102	DFH 76	132	Jcsat 16
13	Directv 12	43	Hylas 1	73	Astra 3B	103	Cosmos 2520	133	DFH 139
14	Directv 10	44	Hylas 4	74	Eutelsat 25B B50	104	Chinasat 1C	134	Optus C1
15	SDO	45	Hispasat 1F	75	Badr 5	105	TDRS 8	135	Superbird B2+B111
16	Directv 9S	46	Hispasat 1E	76	Badr 7	106	NSS 6	136	Superbird B3
17	Directv 8	47	XTAR-LANT	77	Astra 2F	107	SES 8	137	JCSat 16
18	Directv 14	48	Nimiq 2	78	Astra 2E	108	Luch 5V	138	Inmarsat-5F3
19	Directv 11	49	AlComSat 1	79	Astra 2G	109	Chinasat 2A		
20	Spaceway 2	50	Al Yah 3	80	Hylas 2	110	Chinasat 2C		
21	Echostar 19	51	Intelsat 37e	81	Astra 5B	111	Asiasat 7		
22	Spaceway 3	52	Telstar 12V	82	Skynet 4C	112	Gaofen 4		
23	Echostar G1	53	Cosmos 2473	83	Express AMU1	113	DFH 165		
24	Galaxy 28	54	Nilesat 201	84	Athena Fidus	114	Chinasat 16		
25	Tupac Katari 1	55	Syracuse 3B	85	HellasSat 3	115	Koreasat 5A		
26	SES 2	56	Amos 3	86	Turksat 4A	116	Koreasat 5		
27	AMC 16	57	Amos 7	87	Nigcomsat 1R	117	Koreasat 7		
28	Star One D1	58	Skynet 4E	88	Cosmos 2520	118	ABS-7		
29	Nimiq 4	59	Thor 7	89	Syracuse 3A	119	Thaicom 4		
30	Venesat 1	60	Eutelsat 3B	90	Yahsat 1B	120	Asiasat 9		

Current and future satellite deployment in the 28 GHz band make this band unsuitable for terrestrial 5G and underscores the reason why the 28 GHz band was not included in WRC-19 Agenda Item 1.13 for possible IMT identification.

Every effort should be made to avoid disrupting the major and long-term investments related to satellite network deployments, especially when there is ample other spectrum under consideration at WRC-19 that is more likely to be globally harmonized.

It is clear that the 28 GHz band will not be internationally harmonized for terrestrial 5G and is therefore a poor candidate for suitable economies of scale for 5G equipment. Further to this, use by 5G on a national basis will disrupt the global harmonisation for satellite use, which is of the upmost importance due to the international nature of satellite service.

The role of satellite in 5G communications systems

In addition to their prominent role in international broadcasting, satellite technologies are also expected to play an important role in the future 5G ecosystem, including:

- by extending terrestrial 5G connectivity from places with excellent connectivity to places that are not so well-connected or that terrestrial networks would not otherwise reach (e.g. lower population-density areas, aircraft, ships and trains).
- by efficiently supporting Machine-to-Machine (M2M) / Internet-of-Things (IoT) networks through direct connection or backhauling of aggregated M2M/IoT data from multiple locations (e.g. to support sensor networks and other Smart City applications, or to enable connected cars, planes and ships).
- to help terrestrial 5G networks meet the low latency requirements (< 1 ms) of some of the new 5G applications through efficient multicasting of commonly accessed content to storage caches at multiple 5G base stations. In this regard, while most 5G applications (e.g. Internet of Things) will not have low latency requirements (< 1 ms), it is projected that a few, still-emerging applications might have such requirements (e.g. VR and autonomous driving). According to the GSMA, 'any

service requiring such a low latency will have to be served using content located very close to the customer, possibly at the base of every cell, including the many small cells that are predicted to be fundamental to meeting densification requirements.'

- to restore connectivity when existing terrestrial networks have been disabled (e.g. after a natural disaster).

Satellites already play comparable roles in today's 2G, 3G and 4G/LTE networks, and are well placed to continue playing such roles for 5G networks, as more High Throughput Satellites (HTS) in both geostationary (GEO) and non-geostationary (non-GEO) orbits are deployed, and as smaller, more advanced, and lower-cost ground antennas are developed.

While ubiquity of service, support for M2M and IoT and low latency are recognized as requirements that differentiate 5G networks from previous generation networks, most data traffic will be substantially 'more; faster' content, as conveyed today over 4G LTE and 3G networks.

Video content is forecast to account for up to 78% of all Asia Pacific mobile data consumption by 2021. While only 13% of all mobile data may be live video including broadcast video, potentially as much as a quarter of all data delivered to mobile devices could more efficiently be delivered by broadcast push forward and store, including popular, frequently requested content for time shifted viewing, and mobile software – especially operating system updates.

While unicast serves 'long tail' content well, multicast and broadcast are much better ways to deliver this 'head' content, both directly to reception devices for live consumption (or time-shifted consumption, subject to storage in the reception device), and to edge caches in the network. Cisco forecasts '71% of all Internet traffic will cross Content Delivery Networks (CDNs) by 2021 globally, up from 52% in 2016.'

This is acknowledged by the IMT industry, for example the GSMA in its report *4G Broadcasting, the Network Opportunity.* None of the arguments are specific to 4G – in fact 5G should better be able to support broadcast, and there are several consortia working to ensure broadcast efficiencies are either incorporated into 5G networks, or integration of 5G networks with dedicated broadcast networks to enable multiple delivery methods to mobile devices, including 5G Media Initiative, Sat5G, SATis5 and 5G-Xcast.

While this efficiency gain can be realised at various levels in the network using various technologies, satellites have proven to be a particularly efficient platform for the 'broadcast' or point-to-multipoint distribution of live and/or commonly accessed content, as evidenced by its enduring role as a DTH and video distribution platform for live events.

As a result, the appropriate integration of satellites and terrestrial 5G networks should be actively encouraged and not precluded by 5G spectrum and policy decisions.

26 GHz ACMA Discussion Paper

A fundamental consideration of this paper is to identify the boundaries of what is regarded as the '26 GHz band'. For this purpose, the ACMA set up a *pro tem* Working Group which was to finalise its work in advance of the submission deadline.

The Working Group has been provided with two documents. The first one relating to the lower boundary of the 26 GHz band and this particularly focusses on coexistence issues with IMT and the EESS. The second one particularly relates to the higher boundary and coexistence issues between IMT and the FSS.

A working paper on IMT/FSS provided by the ACMA has set out their observations and takes into account the work of ITU-R TG 5/1 which is set the task of sharing consideration under

Agenda Item 1.13. The paper advances the idea that there is a large safety margin of protection. However, within the Working Group this was challenged by the satellite sector – in particular by nbn Co – which has provided calculations showing the oversimplicity when related to real systems in Australia and consequent dramatic reductions in the ACMA's calculated protection margins. There are also diametrically opposite opinions on whether the situation is summarised as ergodic in nature.

These issues will feed into the outcomes and should be useful. Either way, the SSWG has been supportive of the ACMA taking into account these studies and of moving to the next stage of progression toward the *refarming stage*, based on an agreed output from the Working Group. Unfortunately, it appears that the Working Group as a whole was not convinced of the assumptions and methodology proposed by the ACMA and the future risks to satellite services. This is dealt with in more detail in the following sections.

28 GHz ACMA Discussion Paper

Some of the outcomes of the 26 GHz studies will have an influence on the 28 GHz paper[1] considerations. Likewise, the holistic consideration of all mmWave bands has an influence on whether 28 GHz should be included at all for potential IMT or 5G identification.

The difference and the most significant consideration relates to Agenda Item 1.5. Here the satellite tuneable range under study for ESIM (Earth Stations in Motion within the 'FSS Envelope') is 27.5 to 29.5 GHz. User terminals in maritime, aeronautical and land segments are being studied. ESIM comprise ubiquitous terminals in each of these three segments and these are not the subject of TG 5/1 (Agenda Item 1.13) studies. ITU-R WP 4A has carriage on these satellite matters.

It is highly challenging for ubiquitous IMT/5G terminals and base stations to be able to coexist with ubiquitous VSATs, ESIMs and gateways at the same frequencies in a manner that allows both services to grow to their full potential.

The ACMA has put forward five Scenarios for consideration – with differing band usages. Given that Ka-band is critical to existing and future satellite ubiquitous service developments, the SSWG recommends that the existing class licence approach in Ka band be extended to include the ranges 18.2 to 18.8 GHz, 19.3 to 19.7 GHz, 27.5 to 28.5 GHz, and 29.1 to 29.5 GHz, to the exclusion of IMT/5G terminals. It is neither necessary, nor appropriate, to consider the 28 GHz band for future 5G mobile terrestrial networks.

In addition, the SSWG notes that the existing coordinated FSS arrangements are contained in all five Scenarios put forward by the ACMA. The SSWG's consolidated views of the 26 GHz and 28 GHz planning issues are presented in the form of a band segmentation proposal below.

Preferred Approach in the 26 GHz Band

The SSWG is of the view that viable planning options can be devised to meet the needs of all prospective 26 and 28 GHz stakeholders including MBB (eMBB and FWA), fixed point-to-point links, satellite gateway and VSAT links as well as ESIM via a sensible band segmentation approach. For example, the band could be segmented at 27.0 GHz with terrestrial below and satellite above if the eMBB element of MBB spectrum demand was limited to around 1800 MHz and provided the potential use of 24.65 to 25.25 GHz for BSS feeder links (which will be limited in number) is preserved (e.g. in areas in which ubiquitous 5G is unlikely to be deployed). Alternatively, if a requirement of around 2400 MHz of MBB spectrum could be

[1] ACMA 28 GHz spectrum planning Discussion paper - September 2018

justified – and it must be stressed that much additional work on the part of mobile network operators would be necessary to establish such a requirement – the only option may be to segment the band at 27.5 GHz on the assumption that a significant guard band may be required to protect the passive service below 24.0 GHz. Again, the potential use of 24.65 to 25.25 GHz for BSS feeder links (which will be limited in number) should be preserved (e.g. in areas in which ubiquitous 5G is unlikely to be deployed).

The preference of the SSWG is for segmentation at 27.0 GHz based on the lack of any justification of excess demand which would necessitate releasing bands above 27.0 GHz for MBB. However SSWG also acknowledges that the 27.0 to 27.5 GHz portion is currently used only for satellite gateway uplinks, and that in the longer term many satellite operators plan to use higher bands for gateway links to free up Ka band spectrum for VSATs and ESIM, both of which may be able to share with the FWA component of MBB if appropriate conditions can be agreed which ensure compatibility. It is also recognised the 27.0 to 27.5 GHz band is not allocated to the FSS in Region 1 and therefore the needs of satellite services in this band were not considered under European ECC decisions.

In reaching the above conclusion, the following factors are pertinent:

- unless emissions from MBB networks towards satellite orbits are power-limited in an appropriate manner, satellite receivers will be at risk of unacceptable interference. While the magnitude of the risk may be argued, it is undeniable that as the density of MBB networks increases, so will aggregate interference and hence the risk of satellite receiver performance degradation.
- experience in other bands indicates that under conditions where aggregate interference to satellite receivers can arise, it is only a matter of time before this is realised, and by then it is too late to address the problem because practical, acceptable mitigation techniques are not readily available once spectrum licences are issued in a band.
- initial proposals from satellite stakeholders for the imposition of regulatory limits have been vigorously opposed by mobile network operators on the basis that they are not needed and/or are impractical, leading to the dilemma that a) on the one hand any restriction acceptable to MBB operators will cause unacceptable interference to satellite services and b) on the other, any restriction sufficient for the protection of satellite services will be considered unacceptable by MBB operators.
- in this situation SSWG is of the view that the onus is on the aspirants to prove that the risk of interference to satellite receivers is negligible using reliable information about the nature of MBB networks that may emerge over a long period of time.
- given the rapid developments of MBB technologies, yet to be determined business cases and deployment types, it is obvious that it is not possible to prove that interference will be negligible and therefore the risk cannot be ignored.
- the deployment of advanced HTS has reduced the cost per bit for satellite services and significantly increased the bitrates offered to customers. This has allowed satellite operators to offer services at par for cost and quality with terrestrial service providers, which in turn has resulted in an increased number of broadband terminals deployed in sub-urban and even urban locations. Likewise, there is a clear preference on the part of the mobile network operators for wide area spectrum licenses and therefore segregation based on geographic separation would not necessarily be feasible given typical satellite beam areas, which require national coverage to address their markets.

- mobile operators are unwilling to accept any interference impact from satellite earth stations into the receivers of their mobile networks and satellite operators are not amenable to the imposition of additional constraints on their emissions to protect mobile terminals or base stations. Requiring FSS earth stations to protect mobile networks in the 27.0 to 29.5 GHz, for example, will curtail (or even freeze) future deployment of earth stations (whether gateways, VSATs or ESIMs) in the band and make it very difficult for operators to recover the recent and massive investments they have made in the satellites already launched and under construction. The risk of stranding billions of dollars of satellite investments in the band can be avoided by accommodating mobile operations in a different band altogether.
- with notional 20-year spectrum licenses it is not realistic to make confident predictions about the types of MBB deployment scenarios, associated emission parameters or the numbers of terminals that may be active in satellite beam areas, however it can be predicted with confidence that interference will increase over time in shared bands and could quickly reach unacceptable levels.

While it is noted that the ACMA's conclusions regarding the feasibility of satellite MBB co-existence are very positive, the SSWG considers this conclusion is questionable for the following reasons:

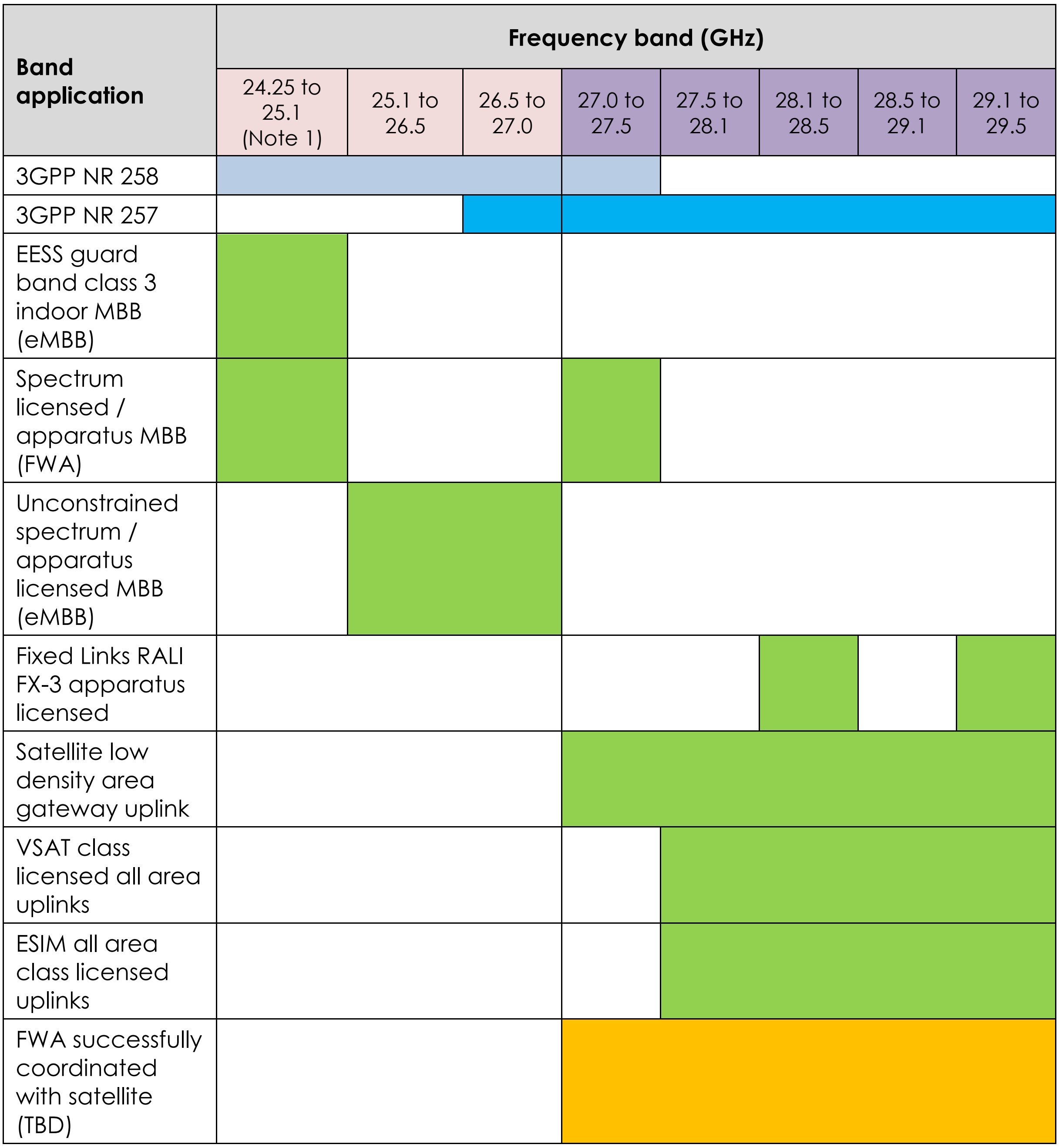
- the MBB emission parameters assumed for the ACMA's study are unrealistic and do not align with what is being proposed by the mobile industry via 3GPP.
- the methodology used by the ACMA excludes deployment scenarios that are likely to be far more interfering to satellite orbits. For example, links to vehicles and other non-handheld devices that are anticipated to become prevalent in the future were not studied and may dominate aggregate interference.
- while the ACMA study concluded that the interference from terminal devices will dominate aggregate interference, the full range of terminal antenna configurations were not studied and their off-axis performance remains largely uncharacterised.
- it is not clear that it is possible to suppress off-axis emissions above the horizon and to control the elevation angles of MBB stations, both of which measures would be necessary to ensure successful coexistence with satellite services.

The satellite community has consistently made the case that the feasibility studies undertaken in the ITU-R lack the rigour needed to consider them sufficient for the purpose of facilitating unconstrained MBB deployments, and evidence now emerging via 3GPP and mobile equipment manufacturers has reinforced this contrary view. The SSWG is firmly of the view that satellite and MBB band sharing will become increasingly risky for satellite stakeholders. It is highly likely to be unacceptable in the case of the mobile element of MBB (eMBB) which is expected to be unconstrained. In the case of the fixed element of MBB (FWA) the situation may be less problematic because it appears practical to constrain FWA in terms of antenna performance, antenna pointing, and station deployment densities via license conditions designed to ensure compatibility with satellite services. In certain cases, it may also be practical to coordinate the use of satellite and FWA between the respective operators as a way of managing mutual interference, although the latter needs further investigation.

The SSWG is also very concerned about any planning decisions that would deny long term security for satellite in a significant portion of the 26 and 28 GHz bands as this could jeopardise existing and ongoing investments in satellites and on network and system upgrades vital for the ongoing commercial viability of the satellite industry. This is an issue of utmost concern for the satellite community. Based on past experience, when mobile services are introduced into a band they typically become ubiquitous over time and acquire a dominant position in the band at the expense of other services.

The SSWG urges the ACMA to seriously consider the band segmentation proposals outlined in this submission noting, however, that any decision to segment at 27.5 GHz would have to take account of the impact on the incumbent satellite use of the 27.0 to 27.5 GHz portion. The latter option effectively removes a 500 MHz allocation to the fixed-satellite service, given the potential for unacceptable interference to or from satellite services. Due to the potential impact on the ability of satellite services to access sufficient spectrum to meet demand, it would be necessary to facilitate VSAT access to Ka-Band above 27.5 GHz and gateway links in Q/V bands.

Practical spectrum arrangements to accommodate the full range of anticipated services and applications in the 26 and 28 GHz bands based on band segmentation of terrestrial and satellite services at 27.0 GHz and 27.5 GHz are illustrated in Figures 1 and 2 below.



Note 1: Guard band still under study and this may impact on the 25.1 GHz boundary

Figure 1
27.0 GHz band segmentation and allocation example

Note 1: Guard band still under study and this may impact on the 25.1 GHz boundary.

Figure 2
27.5 GHz band segmentation and allocation example

Other matters specific to 26 GHz

Prior to addressing the specific questions in the ACMA Options Paper, the SSWG offers the following comments of significance to the satellite industry in the current market place:

- if 27.5 GHz became the delineation point, then consideration will need to be given to coordination and licensing on a case-by-case basis for Gateway Earth Stations/Teleports in the 27.0 to 27.5 GHz band.
- a number of existing Teleports operated by SSWG members are located within the area which the ACMA is considering for designating in the 26 GHz band for IMT (Fig 4 of Options paper). Any licensing arrangement should allow the possibility of these teleports to be authorised for use of 27.0 to 27.5 GHz services.
- the SSWG believes that further study is needed both internationally and domestically to determine the optimum sharing arrangements between IMT and satellite Earth Stations in the 27.0 to 27.5 GHz band.
- any sharing arrangements between Satellite Earth stations and terrestrial services in the 27.0 to 27.5 GHz band may need also to consider the possibility of operation with non-geo-stationary satellites.

Responses to specific ACMA questions

The following table provides responses from our members on some of the specific questions posed in the Options Paper.

1	Does the three-type model constitute an appropriate high-level representation of potential usage of the 26 GHz band? If not, are there any use cases that should be included, excluded or omitted?	No comment.
2	What are the implications for 26 GHz wireless broadband in Australia of the Electronic Communication Committee of CEPT (ECC) decision on emission limits to protect passive EESS ?	More generally, the implications of the lack of clarity on the practical lower boundary of the 26 GHz are significant for the satellite industry in bands above 27.0 GHz. Specifically, a lower setting of the lower boundary, if acceptable from the EESS perspective, could lead to all IMT-2020 spectrum requirements being satisfied using only bands below 27.0 GHz. These considerations call into question whether there is a need to release spectrum for IMT-2020 in satellite bands above 27.0 GHz.
3	Are the proposed defined geographic areas for wide-area licensing appropriate?	No. The outer regions of the proposed areas include large areas which are currently beyond the reach of fixed line and fixed wireless networks, so include many premises which can reasonably expect not to be served by IMT-2020.
4	What is the expected proliferation of—or demand for—services deployed under type 2 (apparatus-licensed)	No comment other than an indication of the future proliferation can be gauged by the current filings with the ITU which show a 10x increase in the

	and/or 3 (class-licensed) models?	immediate future. The breakdown into type 2 and type 3 licensing is expected to reflect this.
5	Comment is sought on preferred option(s) for configuring and licensing the 26 GHz band.	The preferred options need further consideration and refinement because they rely on an incorrect assumption that satellite services are compatible with IMT-2020, which they are not. The SSWG's preferred options are presented above.
6	If options 3 or 5 (all variants) are preferred, how much of the band should be available for spectrum licensing and apparatus licensing?	No comment except to refer to the band segmentation which is proposed in this submission by the SSWG. This represents a more practical and achievable proposition.
7	If options 4 or 5 (all variants) are preferred, how much of the band should be available for class licensing?	No comment on the variants proposed except to refer the ACMA to the band segmentation proposals in this submission.
8	If options 4 or 5 (all variants) are preferred, what conditions should be applied to a class licence to protect co-frequency spectrum-licensed operations (in defined areas)? Would it be appropriate to define a means of making class-licensed use visible (for example, through a form of voluntary device registration)?	No comment. The further development anticipated will depend on an agreed segmentation model as proposed by the SSWG.
9	Are there any other replanning options that should be considered?	Consideration should be given to the fact that, of all administrations that have moved to allocate spectrum for IMT-2020 ahead of WRC-19, none have relied on the assumption that unconstrained mobile services can share with satellite services. The issue of compatibility between terrestrial and space services has been handled in one of two ways: 1. complete frequency avoidance through band segmentation; or 2. conditions on IMT to ensure compatibility There is no reason to accept that neither of these measures will be necessary to ensure to ensure successful sharing in Australia.
10	Is there likely to be sufficient demand for type 1 services in regional centres outside metropolitan areas, and if so, what centres (either explicitly listed or by population threshold) should be included in the expanded licence areas?	No comment but should not be ruled out. The answers will come from the economic and commercial considerations of services, some of which are still on the development path. Hence it may be premature close off at this point in time as this would be an example of regulation trying to outguess and control market developments. Flexibility to respond should be a guideline to regulatory pre-conditioning.

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