Joint Response

of APSCC, CASBAA, ESOA and GVF

to the

Preparing for 5G in New Zealand
Discussion Document

issued by Radio Spectrum Management

1. Introduction

The Asia-Pacific Satellite Communications Council (APSCC), CASBAA Ltd. (formerly the Cable and Satellite Broadcasting Association of Asia), the Global VSAT Forum (GVF), and the EMEA Satellite Operators' Association (ESOA) welcome the opportunity to provide responses to the **Preparing for 5G in New Zealand** Discussion document issued by the Radio Spectrum Management (RSM) unit of the Ministry of Business, Innovation and Employment of the New Zealand Government.[1]

APSCC is a non-profit international association representing all sectors of satellite and/or space-related industries, including private and public companies, government ministries and agencies, and academic and research entities. The overall objective of APSCC is to promote communications and broadcasting via satellite as well as outer space activities in the Asia-Pacific for the socioeconomic and cultural welfare of the region.[2]

CASBAA is the leading non-profit trade organization in the Asia-Pacific region seeking to promote multi-channel television via cable, satellite, broadband and wireless networks. CASBAA Ltd. represents around 100 Asia-focused corporations, which in turn serve more than 3 billion people and provide connections and content to more than 500 million households.[3]

GVF serves as the unified voice of the global satellite communications industry. It brings together organizations engaged in the delivery of advanced broadband and narrowband satellite services to consumers, and commercial and government enterprises worldwide.[4]

ESOA is a non-profit organization established with the objective of serving and promoting the common interests of EMEA satellite operators. The Association is the reference point for the European, Middle Eastern and African satellite industry and today represents the interests of 34

[1] https://www.rsm.govt.nz/projects-auctions/current-projects/preparing-for-5g-in-new-zealand-technical-consultation/5g-spectrum-road-map-discussion-document.pdf, 29th March 2018.

[2] More information on APSCC can be found at www.apscc.or.kr.

[3] More information on CASBAA can be found at www.casbaa.com.

[4] More information on GVF can be found at www.gvf.org.

members, including satellite operators who deliver information communication services across the globe as well as EMEA space industry stakeholders and space insurance brokers.[5]

APSCC, CASBAA, GVF and ESOA and specifically their satellite operator members support the introduction of 5G services. Indeed, many of the Satellite Associations' satellite operator members are actively involved in providing infrastructure that will be critical to the success of 5G.

The following are the main points raised in the response, discussed in more detail later in the document:

- Satellite will be an important part of the future 5G ecosystem, just as it forms an important part of today's 2G/3G/4G ecosystems. A number of applications of satellite in providing essential 5G infrastructure are highlighted, some of which satellite is uniquely well placed to deliver. Thus, as part of its spectrum planning for 5G, RSM will need to consider not just the terrestrial mobile aspects of the 5G ecosystem, but also the satellite aspects, of which the Ka-band is a key band that is already being deployed for High Throughput Satellites (HTS) designs.

- Many satellite operators either have satellites in orbit or scheduled to launch in the next two to three years with Ka-band transponders covering New Zealand as part of the wider Oceania and Asia Pacific regions. Some of these are already using frequencies that overlap with those that RSM is considering for terrestrial 5G mobile services, and many more are scheduled to launch.

- The Satellite Associations and their satellite industry members are concerned at the suggestion of possible allocation of the 1400 MHz, 3.5 GHz and 26 GHz[6] bands to mobile services. The suggestion of possible allocation of the band 27.5-29.5 GHz to IMT is also a major concern, given both its existing and rapidly growing use for satellite applications and no potential for its global 5G harmonization, since it was specifically excluded from the WRC-19 agenda for discussion.

- There is plenty of other spectrum for consideration under WRC-19 AI 1.13 that is not already in use by, or actively planned for use by satellites, some of which is also much better suited to 5G high bitrate requirements. Terrestrial mobile 5G spectrum requirements can be met without straying from the WRC-19 candidate bands for 5G/IMT-2020, into spectrum that is already being used by other services. In the case of the band 27.5-29.5 GHz, this band is already being used by satellite services including for complementary 5G applications, gateways, portable VSATs and novel applications in very rapid expansion, such as ESIMs (Earth Stations in Motion).

[5] More information on ESOA can be found at www.esoa.net.

[6] Comparison with the situation in other countries and the ITU is made more complex with the definition used in the consultation document for the 26 GHz band: 24.25-28.35 GHz. For most administrations the "26 GHz band" refers to 24.25-27.5 GHz and the "28 GHz" band typically refers to the band 27.5-29.5 GHz. This response has adopted the RSM definition for the 26 GHz band.

- In general, for services such as 5G and satellite, global harmonization of spectrum is not only good practice, but an essential requirement for volume production of terminals at low cost and global inter-compatibility. The Satellite Associations strongly urge RSM to adhere to these basic principles.

- Satellites, in particular, tend to have regional or global coverage. Assignment of spectrum to other services in parts of the coverage areas, without first ensuring compatibility, will create unforeseen and unfillable gaps in the coverage area.

- While data consumption is expected to grow substantially in the coming years, and the satellite industry is investing to meet such growth, it remains to be seen whether it will grow at the rates envisaged in mobile industry forecast models, some of which are extreme. It is important for RSM **not** to over-allocate spectrum for a future mobile service at the expense of other current productive users of spectrum based on unrealistic over-estimations of future demand.

- RSM should take a more holistic approach towards spectrum planning that considers the spectrum requirements of **all** parts of the 5G ecosystem, including the potential spectrum efficiencies obtained by, for example, appropriate use of satellites for broadcast mode delivery of popular content – including live video and forward and store video and software updates.

2. The Role of Satellite in 5G Communications Systems

We would like to make it clear from the outset that our organizations, and the satellite industry as a whole, support the introduction of 5G/IMT services. Indeed, many of our members are actively involved in providing infrastructure and services that will be critical to the success of 5G, and satellites already form a ubiquitous and critical part of the existing global communications infrastructure, as detailed in **Figure 1**.

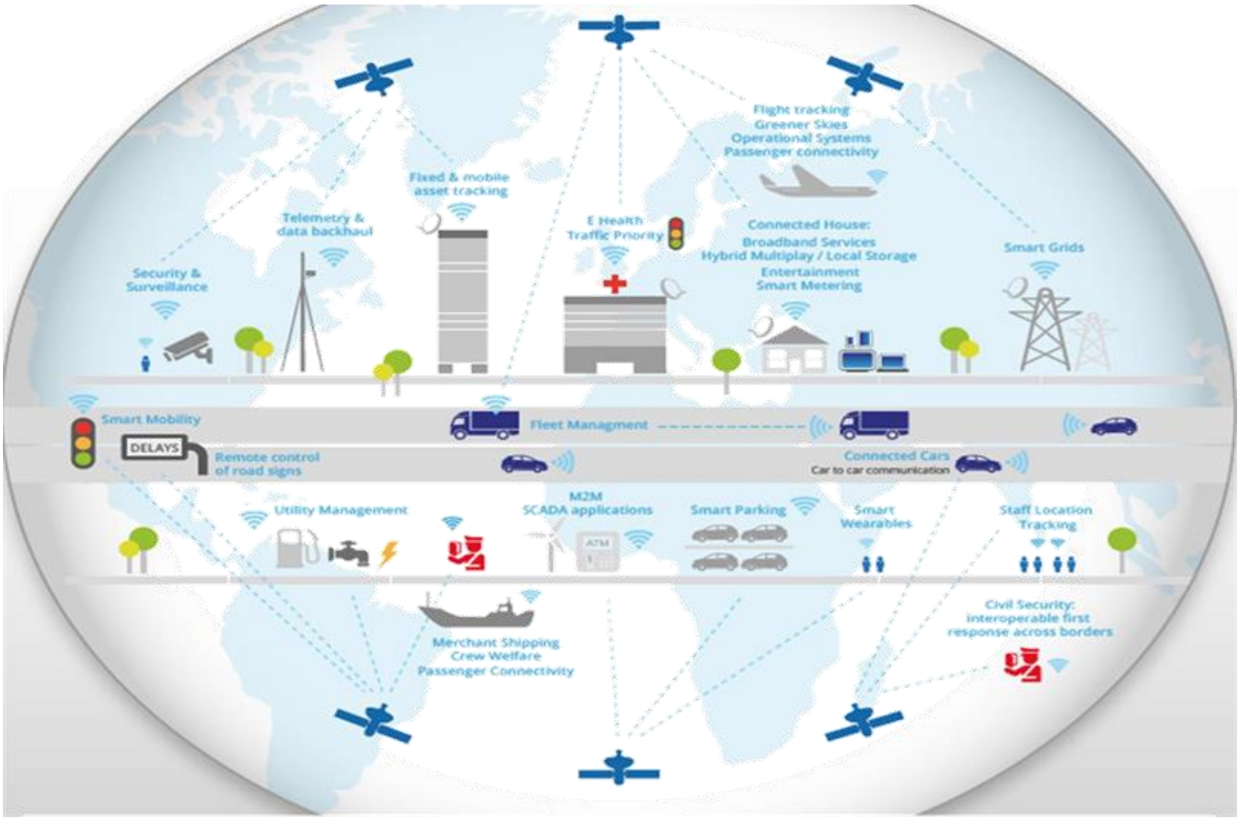

Figure 1 Satellites' roles in 5G and other twenty first century communications

The visions of the potential applications that will be part of the emerging 5G ecosystem generally include three key usage scenarios:

a) enhanced mobile broadband;
b) massive machine-type communications; and
c) ultra-reliable and low-latency communications.

These 5G usage scenarios are quite diverse in their technical characteristics. Notably, most 5G use cases do not have extreme bandwidth and/or extremely low latency requirements. As a result, satellites – in both geostationary (GEO) and non-geostationary (non-GEO) orbits – can and will play important roles in supporting the key 5G usage scenarios, including emerging 5G applications (as explained below), just as satellites support 2G, 3G and 4G/LTE networks today.

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

a. By extending terrestrial 5G connectivity from places with great connectivity (e.g. Auckland) to places that are not so well-connected or that terrestrial networks would not otherwise reach (e.g. remote areas, aircraft, ships, and trains).

b. 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).

c. By helping terrestrial 5G networks meet the extremely low latency (<1ms) requirements of some of the new 5G applications through efficient multicasting of commonly accessed content to storage caches at multiple 5G base stations.

While most 5G applications (e.g. Internet of Things) will not have extremely low (<1ms) latency requirements, it is projected that a few, still-emerging applications might have such requirements (e.g. virtual reality/augmented reality and autonomous vehicles).

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"[7] as depicted in Figure 2. Satellite systems can efficiently provide the same content to thousands of 5G base stations.

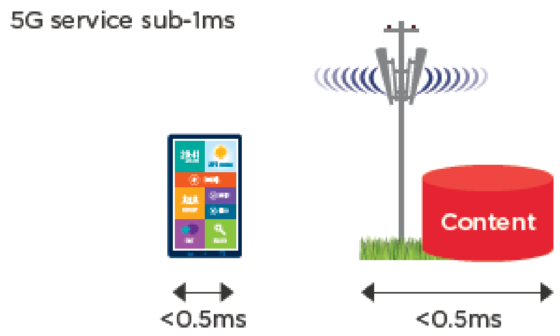

Figure 2 Achieving <1ms latency requires content to be cached at or very close to 5G base stations

d. By restoring connectivity when existing terrestrial networks have been disabled (e.g. after a natural disaster).

Other 5G applications we can identify include:

I. Backhaul for terrestrial mobile networks (e.g., 3G, 4G and 5G in the future)
II. Governmental / institutional closed-user groups
III. Oil & gas services at fixed locations
IV. Distance learning, telemedicine
V. Voice over IP (VoIP).

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[7] GSMA Intelligence, *Analysis: Understanding 5G: Perspectives on future technological advancements in mobile*, at 12-13 (December 2014), https://www.gsmaintelligence.com/research/2014/12/understanding-5g/451/

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 earth station terminal 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 can be expected to simply be "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[8], up from 60% at the end of 2016. While only 13% of all mobile data may be live video including broadcast video[9], potentially as much as a quarter of all data delivered to mobile devices could more efficiently be delivered by broadcast push forward and store[10], 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. The same Cisco VNI paper linked above forecasts: "Seventy-one percent of all Internet traffic will cross CDNs by 2021 globally, up from 52 percent in 2016."[10]

This is acknowledged by the IMT industry, for example the GSMA in its report *4G Broadcasting, the Network Opportunity*[11]. None of the arguments are specific to 4G – in fact 5G should better be able to support broadcast. There are several consortia working to ensure broadcast efficiencies are either incorporated into 5G networks, or integrated with 5G networks with dedicated broadcast networks to enable multiple delivery methods to mobile devices, including: 5G Media Initiative, Sat5G, SATis5 and 5G-Xcast.[12]

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[8] Cisco *Visual Networking Index – Mobile*, Period 2016-2021, February 2017 https://www.cisco.com/c/en/us/solutions/service-provider/visual-networking-index-vni/index.html

[9] Cisco *The Zettabyte Era: Trends and Analysis – Visual Networking Index – IP*, Period 2016-2021, at 3, June 2017 "Live Internet video will account for 13 percent of Internet video traffic by 2021." https://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/vni-hyperconnectivity-wp.pdf

[10] See, for example, *The Economic Benefit of Broadcast Offload in Mobile Data Delivery, A White Paper proposed by Rise Conseil & TDF*, April 2015, which shows how mobile media data network traffic could be reduced by 22% and total national mobile data network traffic reduced by 14% with "broadcast offload" to just 30% of the French population. http://docplayer.net/41704135-The-economic-benefit-of-broadcast-offload-in-mobile-data-delivery.html

[11] Published 27 February 2017, at https://www.gsma.com/futurenetworks/digest/new-report-4g-broadcasting-opportunity/

[12] See https://www.broadbandtvnews.com/2017/09/01/tv-broadcast-delivery-improved-on-4g-and-5g-networks/, https://www.ses.com/press-release/ses-and-sat5g-spearhead-development-ubiquitous-5g-network-capabilities, http://sat5g-project.eu/, https://artes.esa.int/projects/satis5 and http://5g-xcast.eu.

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 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.

3. The Need to Provide and Protect Satellite Spectrum

For satellites to play their role in the 5G ecosystem, they will need continued, sustainable access to satellite spectrum. This should be taken into account in RSM's spectrum planning processes for 5G.

In this regard, the Satellite Associations note that:

I. Many HTS satellites have already been deployed, or are being planned to be deployed, in multiple frequency bands, including in the band 27.5-29.5 GHz on which RSM sought comment.

II. ITU WRC-19 Agenda Item 1.13, following WRC-15 Resolution 238, will be considering 33 GHz of spectrum – a very large amount – as 5G candidate bands, including part of the 26 GHz band but not, as also acknowledged in the discussion document, the band 27.5-29.5 GHz.

III. 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.

4. Amount of 5G Spectrum Needed by 2022 Not Clear from Consultation

Mobile network operators will continue to focus on generating a return on investment from 4G (and 3G) networks, whilst expansion of WiFi and integration with cellular will be key in supporting greater data rates of the 5G ecosystem. Furthermore, exponential growth cannot continue indefinitely as the result would be that whatever is growing will eventually reach an infinite size. In most cases, the growth of something follows an 'S-Curve' where growth is pseudo-exponential to begin with, but where it slows down and eventually reaches equilibrium in the long term when no further growth takes place.

It seems from the Discussion Document that RSM may not be fully convinced of the near-term need for all of the 5G mobile spectrum that has been requested by the mobile industry. It remains to be seen whether data consumption will grow to the extent projected under various models to support 5G mobile spectrum requests, many of which are rather extreme.

For example, a recent paper by LS Telcom[13] 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, a rather extreme case in itself.) It determined that under this scenario "the amount of global mobile data traffic would be around 3150 Exabytes per month by 2035." However, "[t]his 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)."

Thus, 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 its 5G mobile spectrum requirements to be less than 3.5 GHz[14], rather than the up to 20 GHz estimated under various models, based on (among other things) an assessment of actual traffic growth, local density of cell site deployments and expected rates of off-load on to Wi-Fi and future WiGig networks.

It is also worth noting from the LS Telcom paper, citing a Tefficient paper[15], that Finland – which has comparable population (+17%), population density (+13%) and GDP per capita (+9%) to New Zealand – is by far the world leader in mobile data usage per subscriber. The latest version of the Tefficient paper states: "The average Finnish SIM card [including all SIMs in the market such as M2M] carried 11.3 GB of data per month in 1H 2017." The LS Telcom paper calculated the average efficiency of the Finnish mobile networks. The total amount of spectrum assigned to mobile operators in Finland is 655 MHz comprising spectrum in the 450, 700, 800, 900, 1800, 2100 and 2600 MHz bands.[16] It is thus possible to deliver an average of over 17 Mbytes per month per MHz of spectrum using 4G and prior technologies. As LS Telcom concludes: "This represents achievable spectrum efficiency based on today's technologies and networks and is therefore a useful benchmark in comparing efficiency in other countries."

This does beg the question to RSM whether significantly more spectrum is required for 5G services, depending on how close the current utilisation of the mobile network's existing spectrum comes to the Finnish "gold standard", in terms of Mbytes data delivered per month per MHz.

[13] *When will Exponential Mobile Growth Stop?*, 9 October 2017 https://www.lstelcom.com/fileadmin/content/marketing/news/2017_LStelcom_Report_WhenWillExponentialMobileGrowthStop.pdf

[14] See *CONSULTATION PAPER ISSUED BY THE INFO-COMMUNICATIONS MEDIA DEVELOPMENT AUTHORITY OF SINGAPORE*, at 17, 22-25 (23 May 2017), https://www.imda.gov.sg/-/media/imda/files/inner/pcdg/consultations/consultation-paper/public-consultation-on-5g-mobile-services-and-networks/5g-public-consultation.pdf?la=en

[15] The latest version of the paper that LS Telcom cites is at: http://media.tefficient.com/2017/12/tefficient-industry-analysis-3-2017-mobile-data-usage-and-revenue-1H-2017-per-country-24-January.pdf

[16] http://www.spectrummonitoring.com/frequencies/#Finland

5. Specific Issues with Proposed Allocation of 3.5 GHz Band to Mobile Services

The C-band frequencies between 3400–4200 MHz have been a cornerstone of many satellite services for decades. In addition to its key function in providing connectivity within and to areas with high rain fall rates, where its low susceptibility to rain fade make it the most reliable commercial fixed satellite service (FSS) band, C-band is used for a number of other critical functions.

Next-generation modulation standards for satellite communications have been tested with speeds ranging from 300 Mbit/s and up to 700 Mbit/s for professional video applications on standard C-band transponders.

New high-performance satellite platforms will combine C-, Ku- and Ka-bands wide beams, spot beams, and frequency reuse technology to support broadband, media and mobility solutions, with the following benefits:

- High performance and lower cost per bit delivered
- Wide beams and spot beams in the same band for broadcast and high-throughput applications
- Frequencies can be aligned to region and application-specific requirements
- High throughput, efficiency and reliability enabling smaller mobility-friendly terminals and benefiting data-centric services like cellular backhaul
- As of 2015, over the whole world, more than 180 geostationary satellites route services via more than 2,000 C-band transponders. These satellites undergo regular replacement cycles.

The 3400-4200 MHz band is currently used by several services, including the Fixed Satellite Service (FSS). FSS earth stations (FSS-ES) are bringing significant economic benefit to Asia-Pacific. In a world powered by demand for information and advances in access technology, accessing data communication over satellite services is becoming a very cost effective reality, resulting in further growth in data traffic especially in the 3600-4200 MHz spectrum due to the coverage attributes that C-band provides.

Most of the world's coverage via C-band is anchored through FSS earth stations that heavily use the 3600-4200 MHz band. C-band frequencies are used for intercontinental links and links with high reliability requirements, including safety and security services, broadcast distribution and satellite telemetry tracking and control. Satellite operators rely heavily on this band because it has a number of advantages over other frequency bands. These advantages include:

- Reach. The large geographic coverage area of C-band satellite beams allows for whole regions or continents to be connected – resulting in a very cost-effective communications network.

- Resilience. C-band is resistant to rain fade. As a result, services provided in C-band offer extremely high reliability, even during heavy rain at or near the uplink and/or downlink stations.

RSM states in Section 3.5, paragraph 1 of the Discussion Document:

"The 3.5 GHz band extends from 3.4 to 3.7 GHz. The band is expected to be the main band for initial 5G deployment around the world. Equipment manufacturers have announced trials of 5G services using this band beginning in February 2018. Given the international trends, we consider the 3.5 GHz band is the top priority band for allocation for 5G"

Later, in Section 3.5, paragraph 5 RSM states:

"The upper part of the 3.5 GHz band (3589 to 3700 MHz) is allocated to fixed satellite services (in the space-to-earth direction) and is largely unused. The only use is for a satellite gateway earth station in north Auckland. These licences will expire in October 2022. The satellite operator has been given five years to quit the band."

WRC-15 identified 200 MHz (3400-3600 MHz) for IMT in the mid-range band. This spectrum is therefore available, internationally harmonized under the ITU for deployment of 5G. It should be noted that currently not all of the spectrum licensed to mobile operators is actually used to provide services to users. IMT can still grow and serve in the existing spectrum. Large investments required for the research and roll-out of 5G networks are likely to pay off only in densely populated urban hot spots, which are more efficiently served by regional rather than nationwide 5G network deployments.

Some current and future IMT services requirements can be met by more efficient use of 4G/3G, WiFi/RLAN or other terrestrial networks as well as satellite networks, as indicated in Figure 3.

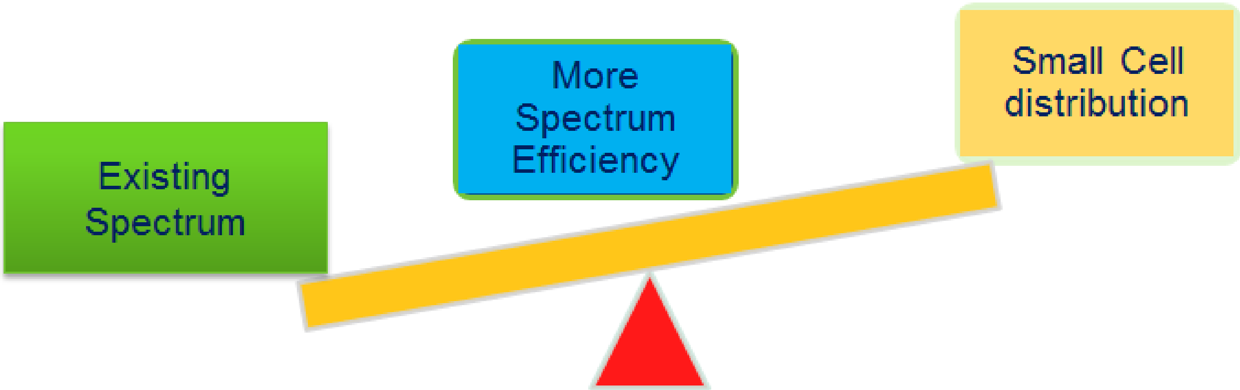

Figure 3 Levering existing spectrum with greater spectrum efficiency and small cell distribution

It is also important to stress the fact that decisions at the 2015 World Radiocommunication Conference (WRC-15) with respect to the identification of spectrum for IMT in the 3400-4200 MHz band[17] were as follows:

- The 3400-3600 MHz band has a nearly global identification for IMT in all ITU Regions, including in New Zealand, which has been included in ITU Radio Regulations Nos. 5.432B and 5.433A.
- The 3600-3700 MHz band has been identified for IMT in **only four** countries in ITU Region 2 (Americas), with no such identification in any other part of the world including New Zealand.
- **The 3700-4200 MHz band was preserved for FSS globally in all ITU Regions**.

[17] See Resolution 223 (WRC-15).

Figure 4 below summarizes the decisions at WRC-15 with respect to the C-band.

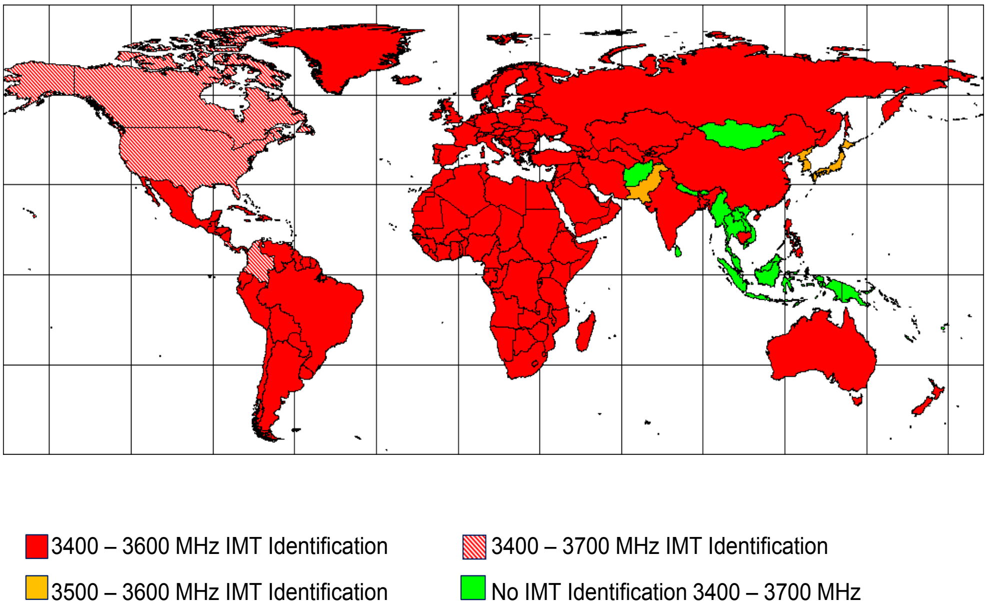

Figure 4 WRC-15 C-band identifications for IMT

WRC-15 further decided not to include frequency bands in the 3600-4200 MHz range on the agenda of WRC-19 for possible identification for 5G.

Regarding RSM's consideration to allocate the 3400-3700 MHz frequency range for IMT, RSM appears already to have considered to what extent there are already licensed FSS earth stations in that segment of C-band and what will happen to them.

An alternative would be to grandfather the existing licensed earth stations and allow them to continue to operate, with appropriate mechanisms to protect them from IMT interference (e.g., a minimum separation distance or coordination zone around the earth station). The methodology for calculating the necessary separation distances can be found in ITU Report ITU-R S.2368, produced by Joint Task Group 4-5-6-7.[18]

It is important to note the fact that the Discussion Document does not address the need for protection of current and future satellite stations operating in the band 3700-4200 MHz from possible undue interference from IMT deployments in the 3400-3700 MHz bands. The Discussion Document is silent on the issue of interference from IMT stations into FSS, FS and services other than 5G and broadband wireless access and the need to adopt protection measures, despite the fact that high-power terrestrial IMT/5G transmissions below 3700 MHz could prevent the use of the C-band above 3700 MHz as a result of out-of-band emissions from IMT systems, overload of the satellite receiver's Low Noise Block Converter (LNB) or intermodulation effects.

[18] Report ITU-R S.2368-0, Sharing studies between International Mobile Telecommunication-Advanced systems and geostationary satellite networks in the fixed-satellite service in the 3 400-4 200 MHz and 4 500-4 800 MHz frequency bands in the WRC study cycle leading to WRC-15 (06/2015), http://www.itu.int/pub/R-REP-S.2368-2015.

RSM should note that the impact of terrestrial stations on satellite stations should be addressed through interference mitigation measures, such as filtering, RF screening, and the imposition of power limits on base stations around receive earth station sites. Most importantly, in order not to impact any incumbent services it would be necessary to set up a sharing framework.

A spectrum sharing framework can be understood as a set of sharing rules and conditions and its development will require the involvement of all relevant stakeholders, including the incumbents. Such rules would be incorporated in the relevant national license conditions, and may include procedures to be followed during the roll-out of the IMT - 5G services. In setting up a sharing framework, RSM should take into account:

1. Continued FS/FSS operation and possible introduction of new FS/FSS users;
2. Possible changes to existing FS/FSS operations (e.g. a change in frequency, change in antenna pointing direction, addition of radio frequency shielding around FSS earth stations), subject to the national decisions, and proper compensation mechanisms;
3. Improvement of the performance of mobile networks concerning its mitigation techniques;
4. Need for transparent and non-discriminatory sharing regulation, ensuring efficient use of the available spectrum resource; and
5. National constraints, as well as international obligations.

All the above will impact the setup of a national sharing framework providing the base for the further considerations on the appropriate sharing measure.

Regarding RF screening, even if such measures could be implemented, there are actual implementation costs (e.g., costs of upgraded equipment, labour and downtime, among others) and ongoing performance impacts (e.g., installation of a filter to shield a satellite station operating above 3700 MHz band would reduce performance across the entire C-band receive spectrum) that must first be addressed before considering how IMT stations will be allowed to operate in the C-band.

Protection of satellite stations from undue interference is essential in order for satellite services to continue to provide critical communications services and connectivity to New Zealand businesses, consumers and government users.

6. Specific Issues with Proposed Allocation of 26 GHz (24.25-28.35 GHz) Band to Mobile Services

As noted above, WRC-19 Agenda Item 1.13 will consider the band 24.25-27.5 GHz for terrestrial mobile 5G services. In most countries this is referred to as the “26 GHz” band, but we note that RSM uses a different definition for “26 GHz”: 24.25-28.35 GHz. Quite a number of countries are seriously considering the band 24.25-27.5 GHz as a “pioneer” candidate band for 5G – including Australia, the European Union and Mainland China – and it is thus appropriate for RSM to examine that band, taking into account these international developments.

It should be noted, however, that there are satellite allocations in portions of the band 24.25-27.5 GHz that were only recently affirmed. For example, the FSS allocation in the 24.65-25.25 GHz portion of the 26 GHz band was only recently expanded at WRC-12 to support a new BSS allocation at 21.4-22 GHz. The satellite industry has only recently begun to deploy capacity using that uplink band – for example DIRECTV-14 and DIRECTV-15 in the US.

As noted above, BSS spectrum can be used to distribute commonly accessed content and software to 5G base stations in order to make future 5G networks more efficient. The fact that the 24.65-25.25 GHz band is not yet in use for satellites in the region today, given the recent WRC allocations, should not count against the band's potential to be used by FSS networks in the future, which could include applications used to augment 5G networks. It should also be noted that some recently launched HTS systems are also using another part of the 26 GHz band – the 27.0-27.5 GHz band – including Australia's Sky Muster / NBNCo-1 and -2, launched in just the last two years – and this band may feature in the design of future HTS systems.

Regarding the band 27.5-28.35 GHz, the Satellite Associations are opposed to consideration of the use of this band for 5G, for the reasons explained below.

The Satellite Associations recommend that the focus for terrestrial 5G spectrum should be on those portions of the 26 GHz not already allocated for satellite, i.e. 24.25-24.65 GHz (400 MHz) and 25.25-24.65 GHz (400 MHz). To the extent that RSM considers the portions of the band that are already allocated to satellite, 24.65-25.25 GHz, 27.0-27.5 GHz and 27.5-28.35 GHz, it will have to take into account sharing studies that are underway at the ITU to consider shared use of the FSS uplink bands. Previous sharing studies have shown the need for interference alleviation measures, which increase cost and time to service and reduce flexibility and efficiency.

7. Specific Issues with Proposed Allocation of 27.5-29.5 GHz Band to Mobile Services

The Satellite Associations urge RSM not to open any part of the 27.5-29.5 GHz band for mobile services in New Zealand.

Opening up the 27.5-29.5 GHz band for mobile services would either preclude or severely hamper these plans, leading to investment being reallocated to other satellite hubs in the region.

Unlike the band 24.25-27.5 GHz, the band 27.5-29.5 GHz is not included in WRC-19 AI 1.13 and thus has low potential for international harmonization. In fact, only a small number of countries (the U.S., Korea and Japan) are working outside the WRC-19 framework to consider any parts of the 27.5-29.5 GHz band for 5G mobile services. Most countries are focused instead on the AI 1.13 bands, including the 27 countries of the European Union, Australia, and Mainland China, which is focusing on the 26 GHz (24.25-27.5GHz as internationally defined) and 37-42.5 GHz bands rather than the 27.5-29.5 GHz band.

Furthermore, satellite operators around the world and in the Asia Pacific region itself have been deploying or are planning to deploy geostationary and non-geostationary high throughput satellite (HTS) systems in the 27.5-29.5 GHz band, including many with coverage of New Zealand: see Table 1.

This is in part why the 27.5-29.5 GHz band was specifically excluded from the list of candidate 5G bands in WRC-19 Agenda Item 1.13. Use of the 27.5-29.5 GHz band for 5G mobile services on a national basis would undermine the international harmonisation of the band for satellite services.

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) Inmarsat Global Xpress (I5 F1 & I5 F3) Intelsat IS-33e	GEO GEO GEO	Ka-band Ka-band HTS Ku-band / Ka-band
2017	Inmarsat Global Xpress (I5 F4) Chinasat-16	GEO GEO	Ka-band Ka-band
2018	O3b (Batch 4 & 5) SES-12 Intelsat IS-H3e	MEO GEO GEO	Ka-band Ku-band / Ka-band HTS Ku-band / Ka-band
2019	Kacific-1 / JCSat-18 OneWeb APStar-6D Chinasat-18	GEO LEO GEO GEO	Ka-band Ku-band / Ka-band Ku-band/Ka-band Ku-band/Ka-band
2020	SpaceX Inmarsat-6	LEO GEO	Ku-band / Ka-band L-band/C-band/Ka-band
2021	Telesat LEO O3b mPower Viasat-3 MEASAT-3R	LEO MEO GEO GEO	Ka-band Ka-band Ka-band Ka-band
2022/2023	MEASAT-2a	GEO	Ka-band

Table 1 High Throughput Satellites covering Asia Pacific using Ka-band (not exhaustive)

Ka-band spectrum in the 27.5-29.5 GHz band is already in use in New Zealand for multiple applications. Existing and planned HTS capacity is expected to support 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.

It should also be noted that the WRC-19 is considering establishing earth stations in motion (ESIM) regulations in the 27.5-29.5 GHz band (AI 1.5), which means likely use of the 27.5-29.5 GHz band by satellite antennas on vessels and aircraft with global circulation. The satellite operators respectfully suggest that the RSM considers this aspect, given New Zealand's position as a maritime and aeronautical hub in the Oceania region. In addition to large numbers of foreign vessels/aircraft, ESIMs operating in the 29.5-30GHz spectrum (return link) are already installed on New Zealand vessels and airlines, while their data traffic is typically delivered via gateways operating in the 27.5-29.5 GHz (forward link). The same ESIM terminals can also operate in portions of the 27.5-29.5 GHz band according also to the outcome of studies under WRC-19 AI 1.5.

For all of these reasons, RSM should strive to avoid designating any part of the 27.5-29.5 GHz band – which is already actively being used, or is planned to be used, for current and next-generation GEO and MEO satellites – for terrestrial 5G mobile services, as there is ample other spectrum under consideration at the ITU for this purpose.

8. Specific Issues with Proposed Allocation of 1400 MHz Band to Mobile Services

RSM states that it "do[es] not consider there is demand for the . . . 1400 MHz band[] to be allocated to IMT," and accordingly, it sees this as "a low to medium priority for reallocation." The Satellite Associations agree that the 1400 MHz should not be a priority for reallocation at this time. Moreover, should RSM turn its focus to this band in the future, IMT deployment in the 1400 MHz band will have to be considered carefully and done in a way that provides sufficient protection to critical Mobile Satellite Service (MSS) operations in the adjacent frequency band.

The 1400 MHz band (1427-1518 MHz) is adjacent to the MSS band 1518-1559 MHz, which is used for MSS downlinks, i.e. for land terminals, ships and aircraft to receive emissions from GSO satellites. L-Band MSS is used for safety of life communications and mission-critical voice and data services – including Global Maritime Distress and Safety System (GMDSS) and Aeronautical Mobile Satellite Radiocommunication Service (AMS(R)S) – around the globe.

Currently the band 1525-1559 MHz is used in New Zealand for MSS downlinks. The band 1518-1525 MHz is also expected to be used for MSS downlinks in the Asia-Pacific region in the near future, from around 2020 when the first Inmarsat-6 satellites are planned to be launched. RSM should therefore start to consider making the band 1518-1525 MHz available for MSS operations in New Zealand. There is a demonstrated need and market for MSS in New Zealand. MSS in 1518-1525 MHz is already available in other regions and could be put to use by some ships, planes and terminals in New Zealand as soon as it is deployed. Therefore, considerations for making this MSS band available should take a higher priority than any review of the 1400 MHz band for 5G services.

In Europe, where it is being considered for terrestrial use, the 1400 MHz band is planned for use by “supplemental downlink systems”. Such systems are intended to provide additional capacity in specific areas where existing 4G networks are deployed and are experiencing congestion. It is not seen as a priority band for 5G rollout. Although parts of the 1400 MHz band have been made available for several years in Europe, there are currently no operational mobile broadband systems in this band. We are aware that some countries are considering this band for FDD and TDD mobile networks, but there is no equipment available for such use today.

L-Band MSS is of high importance to the aviation industry, to the maritime industry, and to users of land mobile terminals.

- Regarding aviation use, L-band satellite communications supports the AMS(R)S and is important for ensuring flight safety. A satellite communications terminal is required to fly in many preferred flight tracks and if the terminal is not able to be successfully tested at the airport prior to takeoff, a plane will have to adjust its route, resulting in travel delays and unforetold economic impacts. Airlines are also expecting to make greater use of L-band MSS in the future to support the International Civil Aviation Organisation (ICAO) Global Aeronautical Distress and Safety System (GADSS).
- MSS is similarly essential to maritime operations. L-Band MSS terminals are a means of complying with International Maritime Organisation (IMO) Safety-of-Life At Sea (SOLAS) communications equipment requirements in all sea areas, and in some areas they are the only permissible equipment. As such, many ships rely upon Inmarsat terminals to meet this obligations, and if the terminal is unable to pass a systems test, the ship cannot legally sail.
- Land terminals are used by first responders for essential coordination and communications after natural and man-made disasters, by military users, and by diverse industries including the transportation, energy and agriculture for mission-critical voice and data applications. While terrestrial infrastructure is overloaded or unreliable, these terminals ensure that life-saving services are delivered when and where they are needed. Additionally, energy production and distribution, transportation, construction, and other industries use MSS terminals to provide mobile communications with a level of reliability and ubiquity not delivered over terrestrial networks. Going forward, lightweight L-Band MSS terminals with low power consumption will be key to driving innovation in areas such as intelligent transportation systems and the Internet of Things.

L-Band MSS terminals - aeronautical, maritime and land - are vulnerable to interference from mobile service base stations transmitting in the adjacent 1400 MHz band. An MSS terminal operating within a certain range of a base station could be prevented from operation by receiver overload or by base station out-of-band emissions. The interference range varies depending on mobile and MSS characteristics, but can be as much a 20 km. Protection measures are required irrespective of whether the band 1518-1525 MHz is used for MSS operations in New Zealand.

If the 1400 MHz band were to be used for TDD system, the MSS terminals would also be vulnerable to interference from the mobile terminals and this might also require constraints on mobile system characteristics.

As stated above, RSM places this band on a low to medium priority for reallocation to IMT and is questioning whether demand for this band exists (section 7.3). Given this demand question, the many other bands being considered for 5G systems, and given the existing use of the 1400 MHz band in New Zealand, RSM might reasonably decide not to proceed with this band any further. Should RSM decide to proceed with this band for 4G or 5G mobile systems, however, it will be necessary to carefully evaluate the technical conditions for mobile operations in the 1400 MHz band and to define adequate protection measures for compatibility with MSS operations in the adjacent band. Naturally, such measures should be clearly defined before an award can take place.

Technical studies related to compatibility between mobile systems and MSS systems are currently being considered in the ITU and in the AWG. The studies are ongoing but it is apparent that some constraints will be required on mobile systems to ensure compatibility with current and future MSS operations. The constraints required include a guard band and power limits on mobile stations (in-band and out-of-band). The satellite associations remain ready to discuss the matter in more detail if necessary.

9. More than Enough Other Spectrum to Meet Realistic 5G Mobile Spectrum Demand

As noted above, WRC-19 Agenda Item 1.13 will consider about 33 GHz of spectrum in aggregate as potential candidate bands for 5G/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 and MEO satellite systems. There is certainly no need to look at the 27.5 to 29.5 GHz band, which is not even included among the candidate bands in the Agenda Item.

The satellite industry expects data consumption to grow substantially in the near to medium term, and it is investing in HTS systems – both GEO and MEO – to meet that growth, including in Ka-band HTS systems – see **Table 1** above.

If the amount of spectrum required for 5G is closer to 3.5 GHz rather than to 20 GHz, then it is very likely that 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.

Portions of the Q/V-bands (37-52 GHz) included in WRC-19 Agenda Item 1.13 may be available to meet 5G mobile requirements. However, portions of these bands 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 not only consider allocating Q-/V-band spectrum for 5G (AI 1.13), but also additional V-band spectrum for VHTS systems (AI 9.1.9) and Q/V-band spectrum for High Altitude Platforms (AI 1.14). Although there is a significant amount Q/V-band spectrum under study, a careful evaluation of the various spectrum requirements will need to be undertaken to determine if there is enough spectrum to accommodate all future requirements. In addition, sharing studies are underway to assess compatibility.

Other mmWave bands will be considered for 5G / IMT-2020 terrestrial mobile services under WRC-19 Agenda Item 1.13, including the 31.8-33.4 GHz (32 GHz), 37-52 GHz (Q/V band), 66-76 GHz (66 GHz) and the 81-86 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, for example, the Ka-band.

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 bands 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 MIMO antenna systems are already being manufactured.

10. Responses to Specific Discussion Document Questions

The Satellite Associations offer responses to questions 1, 3, 6, 8, 11, 12, 13, 28, 29, 34, 36 and 37.

Q1. What are the likely uses for 5G in New Zealand initially and in the longer term?

Satellite operators expect to be providing capacity to meet many 5G use cases, including but not limited to all those set out in Section 2 of this response.

In addition, in supporting the development of 5G, broadband connectivity on aircraft and ships, for example, is only practically deliverable using satellites. Satellite capacity can also be expected to support 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.

Finally, ESIMs applications currently studied under WRC-19 AI 1.5 are planned to use the 28GHz spectrum for mobile broadband provision to vessels, aircraft, trains and other mobile platforms. These services will be international and global by nature.

Q2. Do you consider competition should be encouraged at the infrastructure level or purely at the retail level for 5G? Why?

Q3. What regulatory issues need to be considered from a 5G perspective in New Zealand?

In addition to the regulatory issues described by RSM, bands to be make available for 5G terrestrial technologies in New Zealand will require conditions to ensure compatibility with users of other services in the same and adjacent frequency bands. Furthermore, the need for wide geographic availability of 5G services will require the availability of satellite systems in New Zealand and it is therefore important to ensure regulations allow for the ongoing development of satellite systems in a wide range or frequency bands.

Q4. What aspects of these regulatory issues are most significant for 5G?

Q5. Do you agree that the 3.5 GHz band is the top priority for allocation for 5G?

Q6. Do you have any comments on reallocating 3587 to 3690 MHz for 5G?

The Satellite Associations acknowledge that this band *may* currently not be widely used in New Zealand for reception of Fixed Satellite Services but are concerned that the Consultation paper does not mention how many antennas may currently be receiving FSS services in the band 3600 to 3700 MHz in New Zealand, nor in adjacent band which is also vulnerable to interference from 5G systems in the band 3587-3690 MHz.

The RSM highlights that Inmarsat current operates in the band 3589-3639 MHz and it is disappointing to see that RSM has given Inmarsat five years notice to quit the band. It seems incongruous that 5G systems in New Zealand are apparently unable to co-exist with a single earth station using a portion of the 3.5 GHz band.

The Satellite Associations would like to highlight two additional concerns about the potential reallocation and its impact on neighbouring FSS users:

- in Oceania – particularly the tropical Pacific Island Nations including Papua New Guinea, Fiji, Solomon Islands, Vanuatu, Samoa and Tonga
- in the near-adjacent band 3700 to 4200 MHz – particularly at the lower end.

While most of New Zealand enjoys temperate oceanic or subtropical climates (Köppen Cfb; ITU-R rain climatic zone K) most of its neighbouring Pacific Island Nations experience a tropical rainforest climate (Köppen Af; ITU-R rain climatic zone P).

New Zealand also has fibre cable access to the rest of the world via multiple routes; whereas not all of the Pacific Island Nations have fibre access at all, and even those that do have access, have it to a limited number of their constituent islands and excepting Fiji, via single routes.

While New Zealand thus has the luxury of using C-band for other purposes, C-band satellite delivery is essential for primary intra- and inter-island communications in many other Pacific Island Nations, given C-band's superior availability and reliability under heavy rainfall conditions, and for backup and disaster recovery, or when the limited fibre connections are disrupted.[19]

The consultation paper does not mention TV channels currently received in New Zealand via TVRO antennas, whether in the 3589 to 3600 MHz band, or the 3600 to 3700 MHz band, both currently designated in Table of Radio Spectrum Usage in New Zealand (PIB 21) Issue 9.1 as being used for Fixed satellite "Extended C" band – downlink.

A recent consultation response shows that at least one operator of 10 metre C-band earth stations at three Auckland suburbs, has suffered interference on at least two occasions, one requiring installation of band pass filters (to block out of band emissions from unspecified source(s)) and another requiring the Wi-Max interferer to cease transmission of its own internal intranet.[20] An unofficial list of the channels that were potentially interfered with in the latter case is provided for reference.[21]

Less visible to RSM, and almost certainly not licensed, are TVRO antennas sold privately for reception of foreign (mostly East and South Asian) content that might be of particular interest to ethnically Chinese, Indian, Filipino and Korean residents, plus anyone wanting to learn Chinese, any Indian languages, Tagalog or Korean. For example, one Auckland based supplier installer offers

[19] A recent example: http://www.dailymail.co.uk/news/article-5529877/Australian-tradesman-leaves-New-Zealand-residents-without-internet.html

[20] https://www.rsm.govt.nz/projects-auctions/completed/draft-outlook-2017-2021/folder-submissions-received/SKY%20draft%20Spectrum%20Outlook%20Submission see last two paragraphs on page 8.

[21] https://www.lyngsat.com/AsiaSat-7.html

reception solutions[22] for free-to-air services on Chinasat-6B[23] and Palapa-D.[24] Given that New Zealand located earth stations can potentially receive from geostationary satellites from about 103° East to 246° East with at least 5° elevation, there are many other possible satellites that could be of interest to various residents.

However, even if no satellite TV channels are currently being received below 3700 MHz, without suitable mitigation measures, the presence of 5G IMT signals in the 3587 to 3690 MHz band would have great potential to disrupt any such TV channels received in the adjacent standard C-band 3700 to 4200 MHz, particularly at the lower end of the band, as a result of out-of-band emissions from IMT systems, overload of the satellite receiver's Low Noise Block Converter (LNB), or intermodulation effects.

The wide-band LNBs used to receive such services cost effectively are unable to discriminate sufficiently by accepting a very low power satellite signal centred at (say) 3705 MHz and rejecting a comparatively very high power 5G base station signal centred at (say) 3695 MHz. In practice, the orders of magnitude higher power signal will cause the LNB to overdrive or saturate, rendering it useless for reception of wanted TV signals.

In the UK, OFCOM took this factor and many others into consideration in its recently concluded 3.4 GHz spectrum auction covering the frequencies 3400 to 3600 MHz[25] (actually 3410 to 3480 and 3500 to 3580 MHz). In particular, OFCOM commissioned a very detailed study into the impact of 5G in this frequency band on existing services in this and adjacent bands,[26] summarised in its Information Memorandum on The award of 2.3 and 3.4 GHz spectrum bands of 11 July 2017.[27]

The Satellite Associations urge RSM to undertake a similarly comprehensive study for New Zealand.

Q7. Do you agree that the 26 GHz band is a high priority for allocation to 5G in New Zealand?

Q8. Would this band be of interest to your organization for trials for 5G services in New Zealand?

As explained more fully in Section 6 above, parts of the 26 GHz band, including 24.65-25.25 GHz, 27.0-27.5 GHz and 27.5-28.35 GHz, are currently assigned by ITU-R for fixed satellite services and used by many of the Satellite Associations' member companies.

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[22] https://www.kiwiantennas.co.nz/waitoki-chinasat6b-c-band-satellite-dish-installation.html

[23] https://www.lyngsat.com/ChinaSat-6B.html

[24] https://www.lyngsat.com/Palapa-D.html

[25] https://www.ofcom.org.uk/spectrum/spectrum-management/spectrum-awards/awards-in-progress/2-3-and-3-4-ghz-auction

[26] http://stakeholders.ofcom.org.uk/binaries/consultations/pssr-2014/summary/pssr.pdf

[27] https://www.ofcom.org.uk/__data/assets/pdf_file/0030/81579/info-memorandum.pdf

These frequency bands are of continued and growing interest to the Satellite Associations' member satellite companies, including for providing 5G services in New Zealand and elsewhere.

New Zealand is a regional telecommunications hub, seeing multiple networks serving the entire Pacific and interconnecting the Pacific with other regions. For this purpose, New Zealand has several teleports within its territory.

Transmitting earth stations can create interference into 5G receivers in the vicinity, user terminals and base stations. Requiring transmitting earth stations to protect co-frequency 5G mobile devices in either band would likely impede deployment of such earth stations within New Zealand and thus diminish the attractiveness of New Zealand as a regional telecommunications hub.

International studies are currently taking place to determine the required distance to avoid undue interference into 5G receivers in the band 24.25-27.5 GHz. While the required separation distances are yet to be determined, the Satellite Associations note that within New Zealand, significant portions of the territory may be affected by possible interference from transmitting earth stations.

Further to this, and as already mentioned, New Zealand is also an aeronautical and maritime hub. It is most likely, in the near future, that, in addition to main hub antennas and portable VSATs, earth station terminals installed on vessels and aircraft will also operate in the 27.5-29.5 GHz band. In this respect, it is important to reiterate that the 27.5-28.35 GHz portion of the New Zealand "26 GHz" band is not considered under WRC-19 AI 1.13 for possible IMT identification.

Q9. Do you agree that the 31.8 to 33.4 GHz, 40.5 to 42.5 GHz and 42.5 to 43.5 GHz bands are a low priority for allocation to 5G in New Zealand?

Q10. When do you think equipment is likely to become available in the bands identified in Q9?

Q11. Do you have any comment on the possible allocation of 27.5 to 29.5 GHz to IMT?

As explained comprehensively in Section 7 above, the Satellite Associations oppose the opening of the 27.5-29.5 GHz band for mobile terrestrial 5G services in New Zealand.

The entire 27.5-29.5 GHz band is currently assigned by ITU-R for fixed satellite services. It is not on the WRC-19 AI 1.13 and thus has low potential for international harmonization. As set out in Table 1 and further explained thereafter, the Satellite Associations' member companies have invested and are continuing to invest heavily in Ka-band satellites and related infrastructure, including particularly High Throughput Satellites which open up new possibilities for communications to remote areas.

Applications include already deployed gateway earth stations, aeronautical and maritime connectivity, plus direct connection or backhauling of aggregated machine-to-machine / internet-of-things data from multiple locations, such as sensor networks and other Smart City applications, and enabling connected cars.

The Satellite Associations are not aware of any co-existence studies taking place related to terrestrial 5G services in the 27.5-29.5 GHz band and this will need to be studied in detail if RSM were to consider 5G services in the 27.5-29.5 GHz band. The potential for interference from FSS earth stations to terrestrial 5G systems is similar to the 26 GHz band except that many more earth stations are expected in the 27.5-29.5 GHz band, including earth stations on ships and aircraft (ESIM). It is difficult to envisage that 5G services could be introduced in this band without significantly constraining FSS deployment in New Zealand.

Q12. Is there demand for alternative uses other than IMT of the 1400 MHz band? If so, what uses?

As noted above, there is demand for use of the band 1518-1525 MHz for MSS applications, in addition to the current MSS band of 1525-1559 MHz. The availability of this band for MSS services will support the availability of mobile services for users throughout New Zealand, including some of the 5G use cases such as IoT.

Q13. When is the demand likely to require consideration of reallocation of the 1400 MHz band for IMT, if at all?

Demand for MSS services in the band 1518-1525 MHz will likely require consideration for reallocation of this band in the near future.

Q14. Is there a need for more sub 1 GHz spectrum for IMT/5G?

Q15. If so, how should we deal with radio microphones in the 600 MHz band?

Q16. When is the demand likely to require reallocation of the 600 MHz band to IMT, if at all?

Q17. Which allocation methodology should be used for allocating spectrum bands identified for use with 5G? Why?

Q18. Should different allocation mechanisms be used for rights for regional providers and national providers? Why?

Q19. Should deployment of 5G technology be specified for some or all bands? If not, why not?

Q20. What implementation requirements should be specified and how should these be expressed? – time, extent, etc –

Q21. What should be the consequence of non-implementation – lose spectrum, additional payment, other

Q22. Should the implementation requirements be different for regional and national providers? What should these be and why?

Q23. Should acquisition limits be imposed on 5G bands? If so, what should these be and why?

Q24. Should acquisition limits be imposed for regional providers? If so, what should these be and why?

Q25. What term should be used for management rights suitable for 5G? Why?

Q26. Should the 5G bands be replanned as TDD bands or some bands or parts of bands be retained as FDD? Why?

Q27. What bandwidth should be used as the basis for allocation? Why?

Q28. What out of band emission limits should apply to management rights when first created for allocation? Why?

Satellite earth station receivers are designed to receive signals from satellites located far away in space – 36,000 kilometers above the equator – which are many orders of magnitude, e.g. a million times, weaker than terrestrially based signals. That fact makes them extremely sensitive to interference. Protection of FSS earth stations is vital for the continued provision of critical satellite services.

Stringent 5G IMT out-of-band emission limits will be necessary as part of the measures to protect satellite operations in adjacent satellite frequency bands, including the 1400 MHz band and 3.5 GHz band. Given the comparative weakness of received satellite signals compared to terrestrial, the Satellite Associations would expect the out-of-band emission limits into adjacent or nearby satellite bands to be at least as stringent as the out-of-band limits that the 5G IMT services require between each other.

Regarding the 3.5 GHz band, we note that 3GPP[28] and FCC[29] have defined spectrum emission masks (SEM), while OFCOM has defined a block edge mask (BEM)[30] and CEPT is in the process of finalising an appropriate BEM[31] through public consultation.

These are in addition to limits on spurious emissions, which 3GPP defines as all emissions beyond 10 MHz below and 10 MHz above the band allocated to the 5G service. 3GPP itself specifies a spurious emission limit of -40dBm/MHz for the frequency range 3720 to 4200 MHz in Table 6.6.4.3.1-8: Additional E-UTRA BS Spurious emissions limits for Band 48 and Band 49, in the latest Base Station Specification 3GPP TS 36.104 V15.2.0 (2018-03).

The Satellite Associations would recommend Telecom Spectrum Management to undertake detailed studies of potential interference into adjacent band services – including but not limited to FSS – as for example OFCOM has over the past several years, and to provide open consultation on any

[28] For latest version of 3GPP Base Station specification see the following page and select "Versions" tab: https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=2412
For latest version of 3GPP User Equipment specification see the following page and select "Versions" tab: https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=2411

[29] Electronic Code of Federal Regulations Title 47 → Chapter I → Subchapter B → Part 22 → Subpart H → §22.917 https://www.ecfr.gov/cgi-bin/text-idx?SID=4c03b8f51405c8a9f340acf508d95462&mc=true&node=se47.2.22_1917&rgn=div8

[30] See question and answer 8 at: https://www.ofcom.org.uk/spectrum/spectrum-management/spectrum-awards/awards-in-progress/2-3-and-3-4-ghz-auction/q-and-a

[31] See Draft CEPT Report 67 at: https://cept.org/ecc/tools-and-services/ecc-consultation direct download at: https://www.cept.org/files/9522/Draft CEPT Report 67 PF_1.docx

proposed out-of-band and spurious emission limits before finalising any specifications, or references to existing specifications.

Regarding the 1400 MHz band, members of the Satellite Associations are working in the ITU and AWG on the studies to define the necessary out-of-band emission limits. While this work is still in progress base station out-of-band EIRP emission limits of around -45 dBm/MHz should be anticipated.

Q29. Should out of band emission limits be different if the band is technology neutral? If so, what out of band emission limits should be applied?

The 3.5 GHz SEM specifications and BEM specifications above and the spurious emission limit specifications include or reference detailed explanations of the assumptions made about the technology used, and whether or technically to what extent they are really "technology neutral".

Ultimately, the detailed studies of potential interference into adjacent band services are required before finalising specifications and specific operating conditions of base stations in the vicinity of licensed FSS earth stations.

Q30. How should interference between adjacent frequency 5G TDD networks be managed? Should this be the same for all frequency bands?

Q31. How should interference between different technologies within the same band be managed, if bands are technology neutral?

Q32. Should regional uses be provided for in the 3.5 GHz band plan? Why?

Q33. If allowed in the 3.5 GHz band, how could this be managed or facilitated?

Q34. Which alternative bands may be suitable for regional allocation? Why?

The Satellite Associations note that the band 1980 – 2010 MHz and 2170 – 2200 MHz are suggested as potential bands to accommodate regional wireless broadband providers. RSM should note that these bands are allocated to the MSS, and are used by several Regional systems. While there may be little use in New Zealand today, there could be a requirement to make these bands available for MSS operations in the future. Any use of these bands by terrestrial systems should subject to compatibility with MSS operations in New Zealand and elsewhere.

Q35. Is early access to the 3.5 GHz band required for roll out of 5G networks prior to the expiry of existing rights in 2022? If so, why?

Q36. How could early access to the 3.5 GHz band be achieved?

The RSM lays out four options for possible early access to the 3.5 GHz band. It is emphasized that the existing satellite use of part of the 3.5 GHz band is protected until October 2022, which will naturally inhibit the options for making this part of the band available early. The second option put forward by RSM - to allocate rights commencing in 2020 in the upper portion of the 3.5 GHz band -

appears to be wholly incompatible with the current and recently agreed conditions on satellite use of the band and should therefore be dismissed.

Q37. Should the government be involved in early access arrangements for the 3.5 GHz band?

The Satellite Associations urge RSM NOT to require early vacation of any band compared to its management rights expiry.

The design and deployment cycles for satellites approach or exceed 20 years. From 30 months before launch there is a design freeze, and a typical geostationary satellite has a design lifetime of 15 years, which with careful management may comfortably be exceeded by 1-3 years.

The break-even point obviously varies from satellite to satellite, but is often during the latter half of the lifetime of the satellite.

Just for the Ka-band frequencies – 24.25-28.35 GHz and 27.5-29.5 GHz – the investments in the (non-definitive and non-exhaustive) list of in-orbit and near-future High Throughput Satellites in Table 1 alone, along with associated ground infrastructure, all combined amount to billions of USD.[32]

Satellite companies expect to generate sufficient revenues from these assets to recover and earn a reasonable rate of return on such investments for the lifetimes of the satellites.

Q38. Is early access to the 26 GHz band required for roll out of 5G networks prior to the expiry of existing rights in 2022? If so, why?

Q39. How could early access to the 26 GHz band be achieved?

Q40. When is demand for the bands above 30 GHz likely to eventuate?

Q41. When is demand for the 600 and 1400 MHz band likely to eventuate, if at all?

[32] *See*, *e.g.*, Peter B. de Selding, *ViaSat details $1.4-billion global Ka-band satellite broadband strategy to oust incumbent players*, http://spacenews.com/viasat-details-1-4-billion-global-ka-band-satellite-broadband-strategy-to-oust-incumbent-players/ (10 Feb. 2016); Peter B. de Selding, *SES bets more than $1 billion that Boeing satellites can lure Amazon Web Services et al*, https://www.spaceintelreport.com/ses-bets-1-billion-boeing-satellites-can-lure-amazon-web-services-et-al/ (19 Sep. 2017).