Viasat Australia
Level 2
6 Riverside Quay
Southbank VIC 3006
T. +61 3 9108 9000
www.viasat.com

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24 – 30 GHz Use in New Zealand
Radio Spectrum Management
Policy and Planning
Ministry of Business, Innovation and Employment
PO Box 2847
WELLINGTON 6140

Submission to the RSM consultation on the use of the 24-30 GHz range in New Zealand

Dear colleagues at RSM,

Viasat thanks RSM for providing industry with the opportunity to comment on the Ministry's views on the use of the 24-30 GHz band in New Zealand. This is an important and relevant issue since satellite broadband requires access to the entire 27.5-31 GHz band to provide the types of connectivity that Viasat proposes to bring to New Zealand.

Viasat provides affordable and reliable broadband services around the world, including the unconnected and underserved individuals, businesses in hard-to-serve locations, passengers on the move in buses, aircraft and ships, and to healthcare, education, logistics and public safety institutions, wherever they may be located.

Viasat is progressing well towards launching a new generation of Ultra-High Throughput Satellites (UHTS) that will cover all of APAC, including Australia and New Zealand: ViaSat-3 and ViaSat-4. Viasat's UHTS networks are uniquely designed and built to serve the region with unprecedented end-user speeds of up to 1 Gbp/s and throughputs of over 1 Tbp/s per satellite, providing the most cost-efficient solution available in the market. Billions have already been invested in this leading-edge satellite solution that will serve well the ubiquitous broadband needs for fixed premises as well as mobile (ESIM) users.

Spectrum access directly affects satellite capacity, and thus the ability to serve New Zealand in a cost-effective manner. For this reason, we request that New Zealand retain satellite access to the full Ka uplink band (27.5-31 GHz) for ESIM and other satellite services to and from end users—those individuals that benefit from satellite connectivity.

Viasat

Any reduction in the satellite spectrum available to serve end users would reduce the number of people/passengers that can be served by a given satellite, and also would reduce its cost-effectiveness to the detriment of end users.

Viasat is not aware of any terrestrial service provider proposing to offer this type of nationwide connectivity using this spectrum. The terrestrial services being proposed in mm-Wave bands will be specialized or limited in reach in terms of population.

Having adequate spectrum access to serve end users is the key to providing competitive and affordable satellite-powered broadband services to the people of New Zealand no matter where they live, work or travel.

We look forward to further discussions on these important issues.

Sincerely,

Cristian Gomez

Senior Director
Government & Regulatory Affairs, Asia Pacific
Viasat Inc.
www.viasat.com

Enclosed: Annex 1 – Summary of Viasat's responses to the consultation document
Annex 2 – Viasat's position paper on the use of the Ka spectrum band

ANNEX 1: Viasat responses to the questions posed by RSM

Q2. What are the likely use cases for Ka band satellite services in New Zealand in the short and long term?

The Ultra-High Throughput Satellite (UHTS) being constructed by Viasat for deployment to Australasia and rest of APAC (Viasat-3) will offer unprecedented end-user speeds of up to 1 Gbit/s and over 1 Tbit/s of total throughput. ViaSat-3 will be available to serve New Zealand after its expected launch in 2022. Moreover, the next iteration of the Viasat satellite design (Viasat-4) is already under way, yielding an unprecedented 5 to 7 Tbits/s of total throughput per satellite. Viasat-3 is designed to use the entire 17.7-21.2 GHz and 27.5-31 GHz Ka band to provide these capabilities that will transform the provision of satellite broadband.

On land, these next generation UHTS Ka satellites designed and constructed by Viasat will provide New Zealand with high-speed broadband to both fixed and mobile users/businesses in urban, suburban, and rural areas with cost effective fiber-like broadband. New Zealand's demanding land-based logistics, given sparse extensions of highways, will benefit from ubiquitous satellite-powered high-speed broadband, including ESIMs – anywhere, anytime.

New Zealand's emergency services, public safety and defense will similarly benefit from the availability of ubiquitous and secure high-speed broadband throughout New Zealand with speeds of up to 1 Gbp/s. At sea, New Zealand's vast oceanic profile will benefit from ubiquitous maritime connectivity (maritime ESIM) pier-to-pier, linking commercial shipping routes, the oil and gas industry, passenger vessels, fishing, as well as private maritime users.

New Zealand's aviation industry will also benefit from cost-effective and seamless internet connectivity onboard (aeronautical ESIM) gate-to-gate. Overall, the added value for New Zealand from UHTS services in the Ka band will result in increased aggregate economic output across industrial, enterprise, transportation, residential, private and government uses, through expanding access to national ubiquitous connectivity.

Q3. What are the spectrum requirements for ESIM use in New Zealand?

In order for New Zealand to fully realize the benefits from earth stations in motion (ESIM) across the sparse New Zealand territory (as well as at sea and air) it is important to accommodate both current and future spectrum requirements for ESIM in the entire 27.5-29.5 GHz (28 GHz) band (see Viasat position paper in Annex 2)

We have noted in Question 1 that Viasat-3 and Viasat-4 networks consist of unique designs, which provide 5G-like speeds up to 1 Gbit/s per end user. This high performance is achievable through a number of techniques, but a key ingredient is access to contiguous bandwidth in the full Ka band, including the 28 GHz band.

We note that ubiquitous ESIM operations will be affected by bandwidth constraints if the 28 GHz band is shared with terrestrial components of IMT (mobile or fixed). This can occur across two scenarios:

- Ubiquitous ESIM being constrained by technical restrictions arising from undue/ over-protection demanded by terrestrial IMT use in the same band. For example, ESIM operations will benefit maritime pier-to-pier connectivity as well as aeronautical gate-to-gate. Further, the logistics industry operates throughout the country, including deliveries to/from warehouses and manufacturing sites. These operations will take place in major economic and industrial areas, where any efforts at achieving co-existence with terrestrial IMT systems is likely to add complexity and costs, and impair service availability, to the detriment of end-users of satellite broadband services.

- Aggregate interference to ESIM space receivers from terrestrial IMT operations in the same band.

In this regard, we note that the international community, through the ITU, has accommodated the requirements of ESIM in the 28 GHz band.

The first two steps occurred in 2015 in (i) an ITU decision that validated use of the 29.5-30 GHz and 19.7-20.2 GHz segments to extend satellite broadband connectivity to ESIM, including the types of end user terminals that enable Wi-Fi connectivity on airplanes,[1] and (ii) another ITU decision that directed that the adjacent 27.5-29.5 GHz and 17.7-19.7 GHz segments also be validated for ESIM use in order to extend global broadband connectivity by satellite.[2]

The third step occurred in 2015 when, in identifying possible spectrum for 5G/IMT services, the ITU expressly rejected consideration of the 27.5-31 GHz portion of the Ka Band for those purposes,

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1 ITU Resolution 156 (WRC-15) "Use of the frequency bands 19.7-20.2 GHz and 29.5-30 GHz by earth stations in motion communicating with geostationary space stations in the fixed-satellite service."

2 ITU Resolution 158 (WRC-15), considering "d" ("there is a need for mobile communications, including global broadband satellite services, and that some of this need can be met by allowing earth stations in motion to communicate with space stations of the FSS operating in the frequency bands 17.7-19.7 GHz (space-to-Earth) and 27.5-29.5 GHz (Earth-to-space)"); considering further "a" ("a consistent approach to deployment of these earth stations in motion will support these important and growing global communication requirements").

because of the existing use of that spectrum for satellite broadband services, and the unique needs of 5G/IMT services, which are not compatible with satellite broadband services.[3]

The fourth and fifth steps occurred in 2019 when the ITU (i) decided to locate 5G/IMT services into over 17 gigahertz of separate spectrum specifically designated for that purpose, including the adjacent, but separate, 24.25-27.5 GHz band,[4] and (ii) validated ESIM use of the 27.5-29.5 GHz and 17.7-19.7 GHz segments in order to extend global broadband connectivity by satellite.[5]

As a result, satellite operators have designed, constructed, and deployed satellite broadband networks around the world based on these ITU decisions, and the longstanding global allocations for satellite services in the 27.5-31 GHz and 17.7-21.2 GHz bands.

That global consensus continues to be affirmed. More than 120 countries (a rising number) have expressed their intention to follow the ITU decisions and preserve the 27.5-31 GHz and 17.7-21.2 GHz bands for satellite broadband services. By way of example, Europe's "5G Roadmap" affirms this determination, recognizing the critical nature of this spectrum for satellite broadband, and expressing its policy: "Signal clearly that Europe has harmonised the 27.5-29.5 GHz band for broadband satellite and is supportive of the worldwide use of this band for ESIM. This band is therefore not available for 5G."[6]

As reflected in the ITU decisions and the European 5G Roadmap, this is not an issue of choosing one technology over another. A wide range of opportunities exist to accommodate 5G/IMT in other spectrum that specifically has been identified for 5G/IMT, and that would not have any of the adverse effects the ITU considered in deciding where to accommodate 5G/IMT spectrum needs: (i) changing the sharing situation regarding the satellite broadband services for which the 27.5-31 GHz and 17.7-21.2 GHz bands already are allocated; (ii) impairing the ability of satellite broadband

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3 http://interactive.satellitetoday.com/how-wrc-15-led-to-the-big-c-band-decision. At WRC-15, the 27.5-29.5 GHz band was discussed, and rejected, as a possible 5G candidate band. 29.5-31 GHz was not even considered.

4 ITU Press Release, *WRC-19 identifies additional frequency bands for 5G,* Nov. 22, 2019 ("While identifying the frequency bands 24.25-27.5 GHz, 37-43.5 GHz, 45.5-47 GHz, 47.2-48.2 and 66-71 GHz for the deployment of 5G networks, WRC-19 also took measures to ensure an appropriate protection of the Earth Exploration Satellite Services, including meteorological and other passive services in adjacent bands. In total, 17.25 GHz of spectrum has been identified for IMT by the Conference, in comparison with 1.9 GHz of bandwidth available before WRC-19. Out of this number, 14.75 GHz of spectrum has been harmonized worldwide, reaching 85% of global harmonization.") https://news.itu.int/wrc-19-agrees-to-identify-new-frequency-bands-for-5g/.

5 ITU Resolution 169 (WRC-19) "Use of the frequency bands 17.7-19.7 GHz and 27.5-29.5 GHz by earth stations in motion communicating with geostationary space stations in the fixed-satellite service."

6 *See* European Conference of Postal and Telecommunications Administrations (CEPT), *Spectrum for wireless broadband – 5G*, Section B.3 (Version 10, Revised 6 March 2020) at https://www.cept.org/Documents/ecc/57839/ecc-20-055-annex-15_cept_5g_roadmap.

services to continue to develop; (iii) constraining the evolving needs of satellite broadband services; or (iv) imposing any additional regulatory or technical constraints on satellite broadband services.[7]

Finally, we would like to highlight that New Zealand is well placed to benefit from ESIM services nationwide because the technical requirements listed in Annex 3 of Resolution 169 (WRC-19), Parts I and II are only applicable to cross-border scenarios between States and as an island nation there is no possibility of interference with neighboring countries.

Q6. Do you agree New Zealand should allocate 24.25 - 27.5 GHz primarily for IMT use?

Viasat is supportive of the implementation of IMT in the 24.25-27.5 GHz band. We note that use of the 26 GHz band for IMT should not preclude or restrict the use of the 28 GHz for the current investments and future requirements of satellite services in 28 GHz. Technical complexities have arisen due to the requirements of dissimilar services adjacent to the 26 GHz band, for example, requiring OOBE limits to protect services adjacent to 26 GHz IMT.

Given the amount of spectrum available for IMT in 26 GHz (3.25 GHz of total bandwidth) and the nascent nature of the 5G ecosystem in millimeter-wave bands, the New Zealand market size may be well placed to adopt a number of options, for example:

- accommodating access to the industry-adopted block sizes of 800 MHz per IMT licensee in 26 GHz (reaching a total of 2.4 GHz of bandwidth with three licensees)
- accommodating access to FWA/IMT private networks in the remaining 850 MHz of spectrum in the 26 GHz band, and/or
- allowing IMT licensees in 26 GHz to make use of Management Rights (MRs) in the band for IMT FWA if this is required by those MR holders, in addition to the ability to use network slicing to serve industry verticals, including IMT private networks
- taking advantage of other IMT identifications agreed under agenda item 1.13 (WRC-19) in the millimeter-wave ranges which provided over 17 GHz of additional spectrum to IMT[8]

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7 *See* ITU Resolution 238 (WRC-15) "Studies on frequency-related matters for International Mobile Telecommunications identification including possible additional allocations to the mobile services on a primary basis in portion(s) of the frequency range between 24.25 and 86 GHz for the future development of International Mobile Telecommunications for 2020 and beyond."

8 ITU Press Release, *WRC-19 identifies additional frequency bands for 5G,* Nov. 22, 2019 ("While identifying the frequency bands 24.25-27.5 GHz, 37-43.5 GHz, 45.5-47 GHz, 47.2-48.2 and 66-71 GHz for the deployment of 5G networks, WRC-19 also took measures to ensure an appropriate protection of the Earth Exploration Satellite Services, including meteorological and other passive services in adjacent bands. In total, 17.25 GHz of spectrum has been identified for IMT by the Conference, in comparison with 1.9 GHz of bandwidth available before WRC-19. Out of this number, 14.75 GHz of spectrum has been harmonized worldwide, reaching 85% of global harmonization.") https://news.itu.int/wrc-19-agrees-to-identify-new-frequency-bands-for-5g/.

Q8. How do you see our proposal of the 28 GHz band allocation?

Viasat appreciates the RSM view that it is necessary to accommodate FSS and ESIM in this band because of the tremendous demand for spectrum for satellite broadband services. In order for New Zealand to fully benefit from the availability of satellite broadband in the 28 GHz band, we note that the allocation of this band should consider:

- **Lack of substitute bands for UHTS:** the 28 GHz band is the key band for the delivery of ubiquitous UHTS services globally. Allocating the same band for services other than satellite will translate to suboptimal access to the band. Any implementation set to allow shared use of this band with terrestrial services will result in the reduction of available bandwidth to satellite users. Terrestrial IMT services are incompatible with satellite services in this band (FSS + ESIM) given the designs of the IMT systems and the ubiquitous nature of the satellite services. We note that several IMT identifications were made under agenda item 1.13, which includes the 26 GHz band and multiple other substitute bands for IMT (with over 17 GHz of bandwidth) in the higher millimeter-wave ranges.

- **Current and future requirements of UHTS services:** the 28 GHz band constitutes the one band that comprises both the necessary propagation characteristics and the required bandwidth to fully benefit from next-generation UHTS fiber-like throughputs. It is worth noting that RSM's assessment and proposal for the adjacent 26 GHz band seems appropriate in Viasat's view, as the 5G ecosystem in that band is nascent – and has an identification in the RRs. The 28 GHz band has been deployed in a large number of countries in a way that secures emerging and future access to UHTS and has been protected by the ITU in the last two WRCs.

- **Global scales favor the prioritization of satellite services in 28 GHz:** approximately 3.5 billion people represented by Europe, Indonesia, Australia, China, Russia, Bangladesh, Nigeria, Kenya, Brazil, Mexico and virtually all of Latin America, to name a few, support preserving the 27.5-31 GHz and 17.7-21.2 GHz bands for satellite and accommodating IMT/5G needs in separate spectrum. Of course, this will drive scale for use of the 27.5-31 GHz and 17.7-21.2 GHz bands by satellite systems and end users, and similarly will drive scale for 5G/IMT equipment in separate spectrum.

In consideration of the points raised, Viasat would like to offer the following arrangement for the allocation of the 28 GHz band, taking into account: i) lack of substitute bands for UHTS (and abundance of substitutes for IMT in other millimeter-wave ranges), ii) considering current and future requirements of UHTS fairly, and iii) the global stance in terms of prioritization of 28 GHz for global use by satellite services:

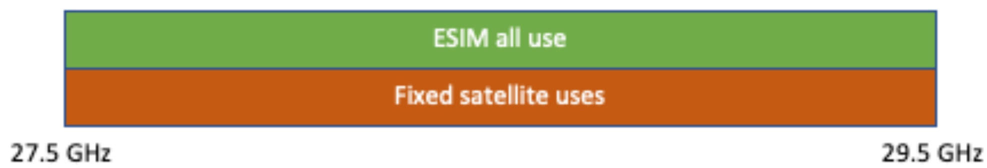

Figure 1. Possible 28 GHz band arrangement to maximise satellite uses in New Zealand

We note that RSM has considered IMT private networks, FWA and IMT indoor in its assessment of the 28 GHz allocation. Given the amount of spectrum available for IMT in 26 GHz (3.25 GHz of total bandwidth) and the development of the 5G ecosystem in millimeter-wave bands, the New Zealand market size may be well placed to adopt a number of options, for example:

- accommodating access to the industry adopted block sizes of 800 MHz per IMT licensee in 26 GHz (reaching a total of 2.4 GHz of bandwidth with three licensees). Viasat notes that mobile operators can accommodate 400 MHz channel block sizes in this band. 800 MHz block sizes are based on the implementation of multiple 400 MHz carriers per licensee, exceeding the minimum specifications set by international standards[9]. Viasat notes that in the South Korea, MNOs were provided with 800 MHz each.
- accommodating access to FWA/IMT private networks in the remaining 850 MHz of spectrum in the 26 GHz band, and/or
- allowing IMT licensees to make use of their Management Rights (MRs) in the 26 GHz band for FWA, if this is required by those MR holders, in addition to the ability to use network slicing to serve industry verticals, including IMT private networks.

[9] 5G specifications in ITU-R M.2150 require a minimum average spectral efficiency of 7.8 bps/Hz in dense urban areas for a cell capacity of 3 Gbps per cell in a 400 MHz channel

In considering the above allocation arrangements, Viasat believes that if the recommendations above are taken into account by RSM, its objectives will be met as to:

i) ensure equitable and efficient spectrum access,
ii) maximize the economic benefits from spectrum use to all New Zealanders and,
iii) ensure interference potential remains well managed.

Q.12 Are there any other issues of sharing use between satellite earth stations and ESIMs that you would like to bring to our attention?

Viasat notes that FSS fixed earth stations and ESIMs already regularly operate in the same band and are fully compatible with each other, even when the same spectrum is reused on different satellite networks (see Viasat's position paper in Annex 2).

Q14. What's your preferred licensing option in 26/28 GHz spectrum?

For the 28 GHz band, ViaSat is of the view that FSS should continue to operate under the Radio License regime. ESIMs are well placed to operate under a blanket GURL. The licensing of the 28 GHz band should avoid mixing terrestrial IMT (fixed or mobile) and satellite services (fixed + ESIM) in the same band, as these services are not compatible.

Q16. If there is a need for general use spectrum for IMT and ESIM, how much spectrum should we set aside for it? Should RSM mandate technical conditions on the general use licence?

IMT and ESIM should be placed in separate bands. This will minimize costs and ensure that the 28 GHz is available for ubiquitous UHTS satellite broadband coverage and ESIM services. A GURL for IMT uses could be considered in the remaining 850 MHz of spectrum available in the 26 GHz band next to IMT Management of Rights (3 x 800 MHz). We note that the requirement by the mobile component of IMT to achieve TDD synchronization will need to be considered across any band designated for 5G mobile IMT uses.

Q31. Do you agree that RSM should implement ITU Radio Regulations, Resolution 242, resolves 2.1 in the management rights and licenses conditions? If not please explain why or propose an alternative?

Viasat agrees with RSM. Resolution 242 should be used to protect adjacent band services, including 28 GHz band satellite operations.

Q33. Do you have any comments regarding the spectrum sharing approach proposed by RSM between FSS and IMT FWA in the 28 GHz band?

Viasat recommends RSM not to consider introducing IMT FWA into the 28 GHz band, given:

- the large amount of spectrum available in the 26 GHz band,
- the New Zealand market size,
- the undue complexities and costs arising from trying to accommodate IMT FWA in spectrum that is already a part of the global satellite ecosystem,
- the availability of other substitute millimeter-wave bands for IMT FWA, and
- the economic opportunities available to New Zealand from the possibility to fully utilize the 28 GHz band for ubiquitous FSS UHTS and ESIM type of services.

The points made in response to Questions 2 and 3 above should also be applied in relation to this question.

Q34. If RSM were to apply an EIRP limit on horizontal plane for FSS, what is the maximum EIRP value we should assume?

RSM should consider avoiding interference scenarios by licensing IMT only in the millimeter-wave bands identified under agenda item 1.13 of WRC-19, including the 26 GHz band. This would also obviate any requirement for constraining FSS operations. This will allow for innovation and growth of all broadband services for people throughout New Zealand in the future.

Q36. Do you think RSM should mandate the regulatory requirements as laid out in Resolution 169 (WRC-19) for ESIM use if a shared use between 27.5 – 28.35 GHz?

We note that Resolution 169 (WRC-19) regulatory prescriptions are applicable to cross-border situations. New Zealand is well placed to fully benefit from ESIM use given its distance from other States.

Viasat highlights the following provisions of Resolution 169 (WRC-19), which explain why that Resolution does not limit aeronautical, maritime or other ESIM operations in the 27.5-29.5 GHz band segment within an Administration's borders, but rather provides guidance for the rare cross-border case where, in a neighboring country, terrestrial services are allocated and operating in the very same frequencies as ESIM:

- *Resolves* 1.2.4 provides: "the provisions in this Resolution, including Annex 3, set the conditions for the purpose of protecting terrestrial services from unacceptable interference from aeronautical and maritime ESIMs in **neighboring countries** in the frequency band 27.5-29.5 GHz";

- Paragraph 1 of Annex 3 provides: "The parts below contain provisions to ensure that maritime and aeronautical ESIMs do not cause unacceptable interference **in neighboring countries** to terrestrial service operations **when ESIMs operate in frequencies overlapping with those used by terrestrial services at any time** to which the frequency band 27.5-29.5 GHz is allocated and operating in accordance with the Radio Regulations" (see also resolves 3 of this Resolution);

- Part II of Annex 3 provides power flux density (PFD) limits for the 27.5-29.5 GHz band segment when an aeronautical ESIM is operating "within line-of-sight of the territory of an administration";

- The further resolves provides that an administration may authorize ESIMs within its own territory and without reference to the power flux density levels contained in Res. 169, where doing so does not affect other administrations.

In summary, we understand that no terrestrial services are operating or planned for the 27.5-29.5 GHz uplink band segment in New Zealand. It is therefore possible for RSM to permit ESIM to operate without limitation in the 27.5-29.5 GHz band, and to stipulate only that licensees adhere to the provisions of Footnote 5.517A of the Radio Regulations, and Resolution 169 of WRC-19, where applicable.

Viasat urges RSM to adopt a framework for ESIM that classifies it as part of the existing FSS allocation and clarify that the 70 km limit from Resolution 169 does not apply to ubiquitous pier-to-pier maritime service within New Zealand.

In the time since WRC-19 approved the use of ESIM across the full Ka band, more and more States are adopting a free circulation policy that enables ESIMs to enter and operate within their coastal waters without the need for individual licensing.

ANNEX 2: Viasat's position paper on the use of the Ka spectrum band

Access to the 27.5-31 GHz and 17.7-21.2 GHz Bands
Enables Affordable Satellite-Powered Broadband Services

Today, satellite-powered broadband bridges the digital divide, connecting the unconnected in underserved and unserved areas across the world with affordable connectivity they would not otherwise have. These broadband services are made possible because the International Table of Frequency Allocations makes available the 27.5-31 GHz and 17.7-21.2 GHz bands for satellite services, and the vast majority of countries are following international consensus and making this spectrum available domestically for service directly to end users via small, easy to install satellite terminals. The 27.5-31 GHz band is used for communications transmissions from end users to satellites; the 17.7-21.2 GHz band is used for communications transmissions from satellites back to the end users.

As detailed below, access to these spectrum bands for user terminals is critical to enabling the *cost-effective* provision of satellite-powered broadband. Viasat is not aware of any terrestrial service provider proposing to offer this type of connectivity using this spectrum. The terrestrial services being proposed in mm-Wave bands will be specialized or limited in reach in terms of population.

As an initial matter, we emphasize that the nature of satellite networks allows many different satellite providers to use the same spectrum to serve the same geographic area without interfering with each other. Satellite systems regularly share access to the same radio spectrum by operating with angular separation from each other, so that each one operates with different lines of sight to and from a given location on Earth. This approach has worked well for half of a century and has enabled equitable access to the limited and shared spectrum resource, and intensive reuse of that resource, consistent with long-established international principles. This concept is depicted in Figures 1 and 2 below.

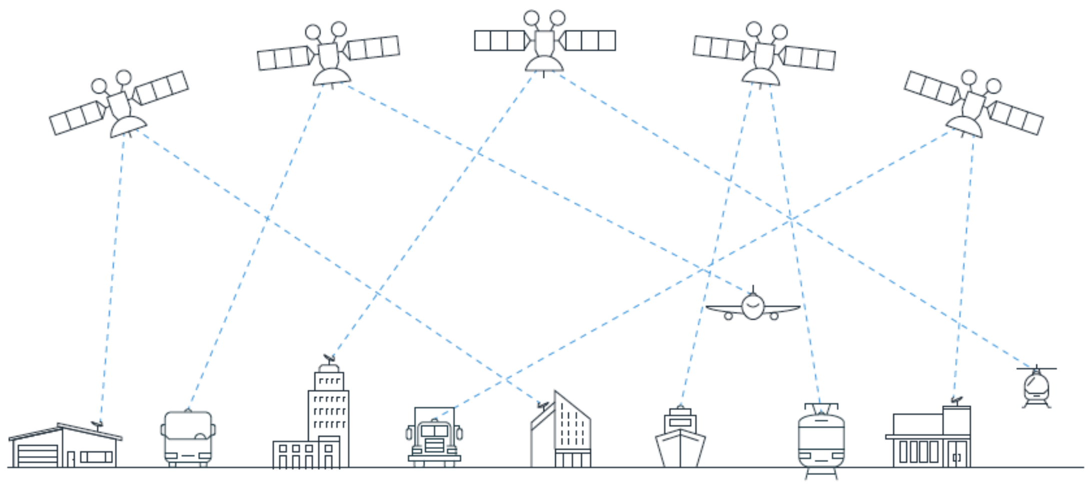

Figure 1: Angular Separation Between Satellites in the GSO Arc

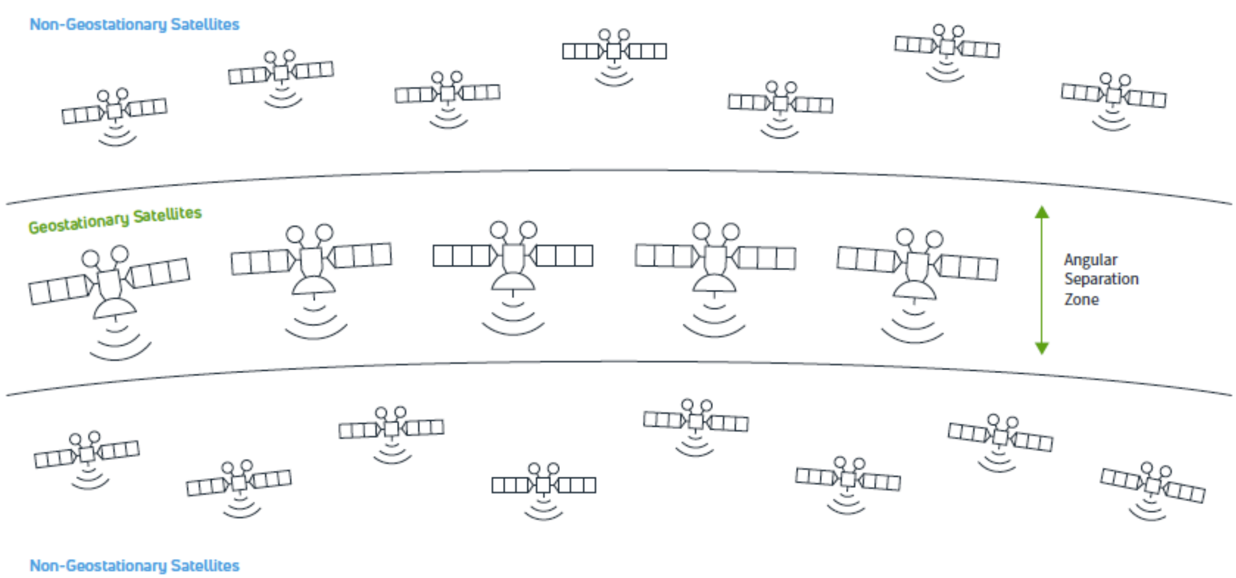

Figure 2: Angular Separation Between GSO and NGSO Satellites
(NGSO Satellites Avoid Transmitting/Receiving Co-Frequency in the GSO Zone)

Thus, it is possible to both make the 27.5-31 GHz and 17.7-21.2 GHz bands available for satellite services and facilitate many different satellite networks using this band at the same time.

Adequate Spectrum for End User Communications Enables Satellite-Powered Broadband

Satellite broadband networks provide service to end users by employing separate communications transmission paths from (i) end users to the satellite (uplinks); (ii) the satellite to gateways that interconnect to the Internet (downlinks); (iii) the gateways back to the satellite (uplinks); and (iv) the satellite back to the end users (downlinks). As noted above, the 27.5-31 GHz band is used for transmissions *to* the satellite; the 17.7-21.2 GHz band is used for communications transmissions *from* the satellite. This is depicted in Figure 3.

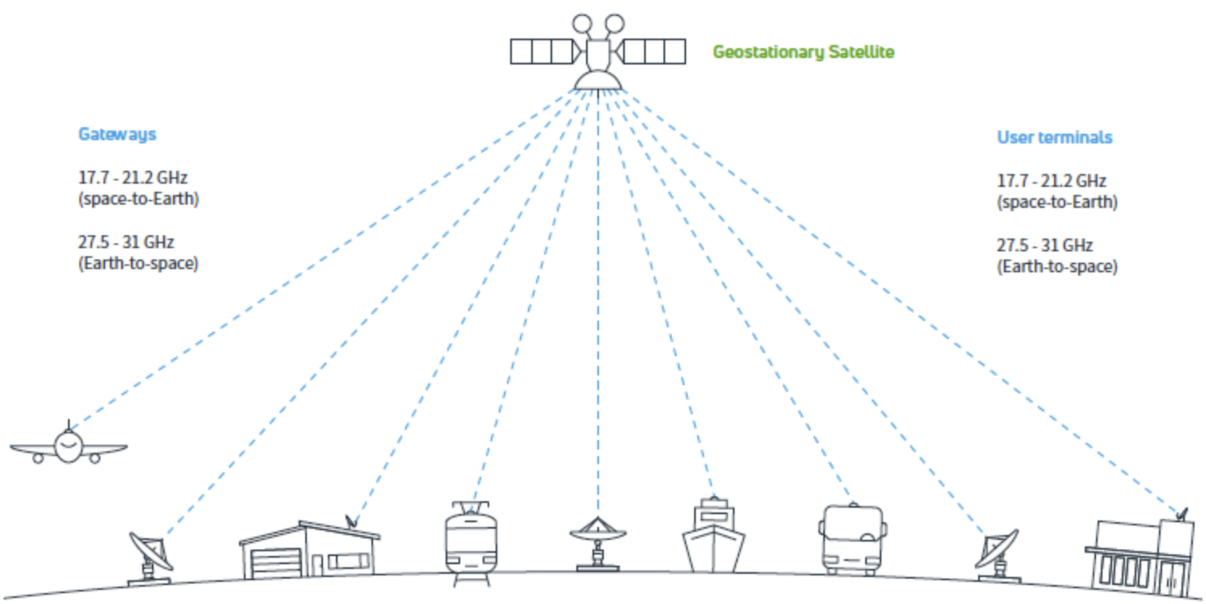

Figure 3: 27.5-31 GHz (Earth-to-space) and 17.7-21.2 (space-to-Earth) Bands Needed for Both Satellite Gateways and Their Fixed and Mobile User Terminals

As depicted in Figure 4, the amount of capacity that can be provided on a single satellite has increased by factor of ~ 500x in the recent past, and it will continue to improve in the next few years as even more advanced satellite designs are implemented. The ability to deliver more and more capacity over a single satellite results in a corresponding reduction (~ 400x) of the cost of delivering service. These exponential increases in capacity (and in cost-efficiency) are made possible by designing satellites to serve end users by utilizing the entire 27.5-31 GHz and 17.7-21.2 GHz bands designated by the international community for satellite-powered broadband, and by reusing this spectrum on a given satellite many times over.

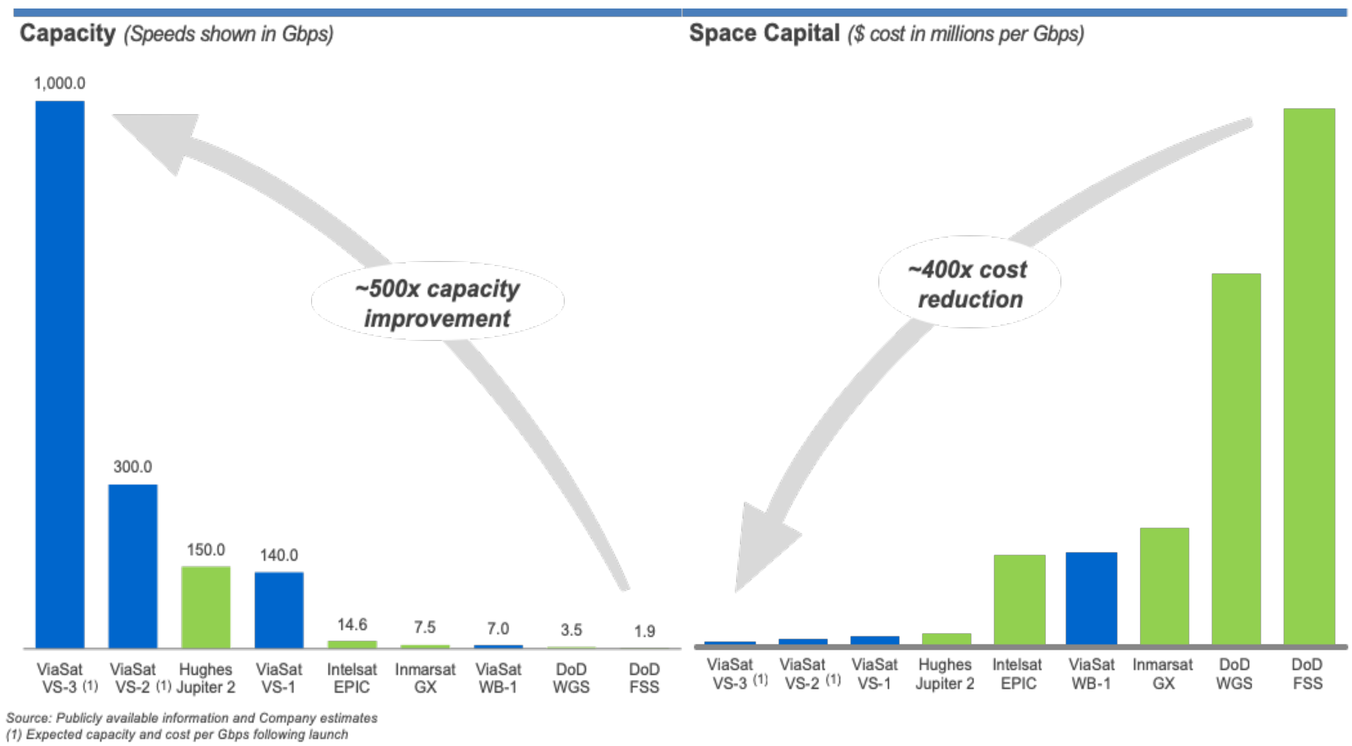

Figure 4: Exponential Increases in Satellite Broadband Capacity and Reductions in Cost

Each ViaSat-3 satellite currently under construction is designed to yield both (i) an unprecedented +1 Terabit per second of total throughput and (ii) end user speeds of up to 1 Gigabit per second. The next iteration of the Viasat satellite design (ViaSat-4) uses the same 27.5-31 GHz and 17.7-21.2 GHz spectrum and yields between 5 and 7 Terabits per second of total throughput per satellite, reducing costs even more than as depicted above.

Figure 5 provides another comparative analysis of the cost-effectiveness of the most advanced broadband satellites being deployed. As indicated below, the greatest efficiencies are delivered by geostationary satellites that utilize the full 27.5-31 GHz and 17.7-21.2 GHz spectrum bands.

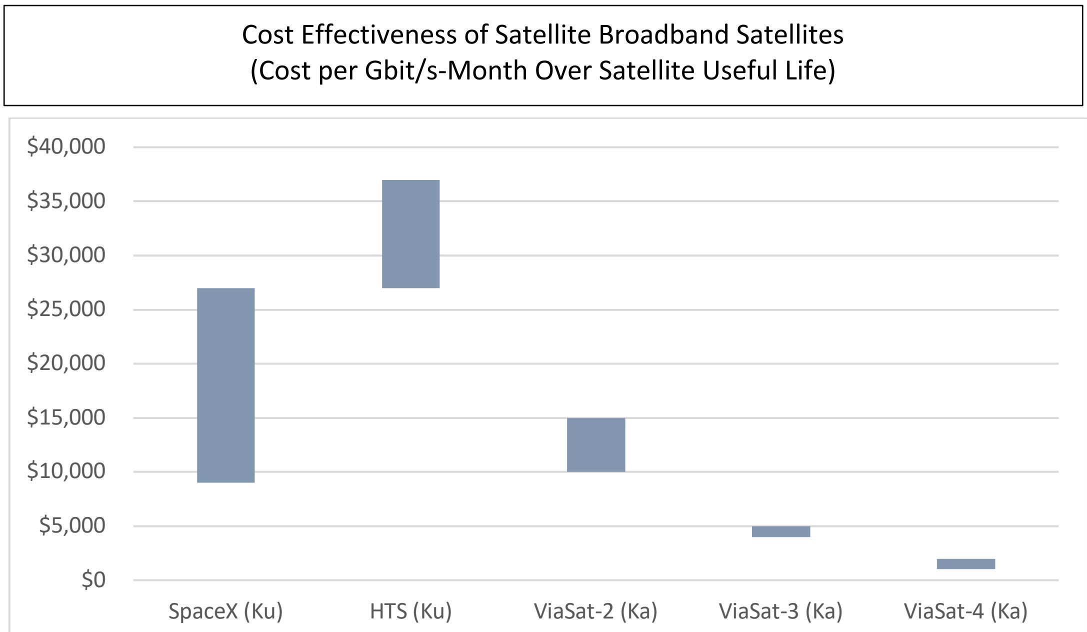

Figure 5: Ultra-High-Throughput Ka Band Satellites Change the Economics of Satellite Broadband[10]

Intensive Reuse of 27.5-31 GHz and 17.7-21.2 GHz Spectrum Provides Superior Performance and Cost-Effectiveness

The ViaSat-3 and ViaSat-4 networks are designed to eliminate all possible capacity bottlenecks in order to dramatically improve the end user connectivity experience. To provide the capacity that enables the provision of reliable and affordable satellite broadband connectivity to end users, spectrum in the 27.5-31 GHz and 17.7-21.2 GHz bands is intensively reused within these satellite

10 Source: Morgan Stanley, July 20, 2020. ViaSat-4 annotation provided by Viasat. Frequency bands specified (Ku, Ka) are those employed for end user service.

networks. *Specifically, both the end user terminals and the gateways utilize the very same parts of the spectrum to communicate with the satellite at the same time.*

One key element to achieving exceptionally high spectrum reuse within a satellite network is increasing the number of spot beams on a satellite. Within a satellite's area of coverage, there may be many thousands of beams. The spot beams look like a honeycomb pattern on the Earth's surface, similar to cell sites in terrestrial networks. Figure 6 provides a few examples of ways to reuse the same spectrum in different geographic areas of the satellite footprint on the Earth, with each color representing a different channel of the available spectrum being used in a given beam at a given time.

Figure 6: Examples of Satellite Spot Beams and Spectrum Reuse

To ensure that adjacent beams do not interfere with each other, different frequencies are employed in each adjacent beam. In non-adjacent beams, frequencies are reused because the physical separation between the beams keeps the frequency uses from overlapping and causing self-interference. This reuse of spectrum allows for many end users in the same satellite footprint to access the satellite broadband signals without service degradation. The more often frequencies are reused within a satellite footprint, the more capacity that is available and the higher the number of end users that can be cost-effectively served.

Contiguous Spectrum for Satellite Broadband Enables Cost-Effective Connectivity for End Users

Contiguous spectrum access for satellite broadband—for example, in the entire 27.5-31 GHz and 17.7-21.2 GHz bands—allows use of channel plans that maximize spectrum use by enabling efficient adjacent channel satellite operations. Doing so also minimizes interference from services in adjacent bands, including out of band emissions, that otherwise would need to be managed with respect to non-contiguous band segments. If spectrum for a satellite service is not contiguous or other services are interleaved within the satellite bands, the potential for capacity-reducing interference exists, as does the need to implement spectrum-wasting mitigation techniques, such as guard bands that no service can use. As noted above, a reduction in usable spectrum has a direct impact on satellite capacity. Having contiguous spectrum for satellite broadband service also allows for modem chips and equipment that scale in an efficient way—all critical for delivering cost-effective connectivity solutions to hundreds of millions of end users.

Access to Adequate Spectrum Is the Main Limitation in Serving End Users

Access to adequate spectrum is now the primary limiting factor in extending satellite-powered broadband connectivity to end users. Spectral efficiency determines how much information can be delivered in a unit of spectrum. Today's satellite broadband systems are approaching "Shannon's Limit" in terms of spectral efficiency[11]—that is, actual transmissions are near the maximum capacity that theoretically can be achieved over a given amount of spectrum and within the regulatory transmission power limits. This is another reason why it is critical to retain the entire 27.5-31 GHz and 17.7-21.2 GHz bands for satellite broadband, and to accommodate 5G/IMT services in separate spectrum designated for their unique purposes.

Spectrum Access Is Critical to Cost-Effectively Serve Millions of Users

A direct relationship exists between (i) the spectrum available for satellite broadband networks, (ii) the number of consumers who can be served with a given satellite, and (ii) the cost of the service to end-users.

For example, a ViaSat-3 satellite can serve millions of consumers simultaneously with speeds of up to 1 Gigabit per second as long as satellite services have access to the full 3.5 gigahertz of spectrum in both directions—27.5-31 GHz (uplinks) and 17.7-21.2 GHz (downlink). Reducing the spectrum available for service to end users, even by 500 megahertz (*e.g.*, 27.5-28.0 GHz), would reduce by ~ 15 percent the number of end users that can be supported (*i.e.*, up to ~ 800,000 fewer end users able to receive service). Correspondingly, reducing the spectrum available for service to end users by 1,000 megahertz (*e.g.*, 27.5-28.5 GHz), would reduce by ~ 30 percent the number of end users that can be supported (*i.e.*, up to ~ 1.5 million fewer end users able to receive service).

As depicted in Figures 4 and 5, the key to providing affordable service to end users is improving the cost-effectiveness of the satellite network. That occurs by maximizing the number of end users who can receive service from a given satellite, with the number of supportable end users being driven by the amount of available spectrum. Essentially the same capital investment is required to deploy any GSO broadband satellite. If the number of supportable end users is reduced (by reducing spectrum), the end users bear the impact of the loss of spectrum. While additional

11 *See* M. Viswanathan, *Channel Capacity & Shannon's theorem - demystified*, GAUSSIANWAVES (23 April 2008), https://www.gaussianwaves.com/2008/04/channel-capacity/.

satellites can be deployed to support more end users, that does nothing to alleviate the cost impact on the end user of the loss of spectrum.

Any reduction in the satellite spectrum available to serve end users would reduce the number of people that can be served by a given satellite, and also would reduce its cost-effectiveness to the detriment of end users.

International Consensus Provides for the 27.5-31 GHz and 17.7-21.2 GHz Bands to Extend Satellite Broadband Connectivity Throughout the World

In a series of actions over the past six years, the international community has affirmed the importance of retaining the 27.5-31 GHz uplink band, and the corresponding 17.7-21.2 GHz downlink band for satellite-powered connectivity to end users.

The first two steps occurred in 2015 in (i) an ITU decision that validated use of the 29.5-30 GHz and 19.7-20.2 GHz segments to extend satellite broadband connectivity to earth stations in motion (ESIM), including the types of end user terminals that enable Wi-Fi connectivity on airplanes,[12] and (ii) another ITU decision that directed that the adjacent 27.5-29.5 GHz and 17.7-19.7 GHz segments also be validated for ESIM use in order to extend global broadband connectivity by satellite.[13]

The third step occurred in 2015 when, in identifying possible spectrum for 5G/IMT services, the ITU expressly rejected consideration of the 27.5-31 GHz portion of the Ka Band for those purposes, because of the existing use of that spectrum for satellite broadband services, and the unique needs of 5G/IMT services, which are not compatible with satellite broadband services.[14]

The fourth and fifth steps occurred in 2019 when the ITU (i) decided to locate 5G/IMT services into over 17 gigahertz of separate spectrum specifically designated for that purpose, including the

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[12] ITU Resolution 156 (WRC-15) "Use of the frequency bands 19.7-20.2 GHz and 29.5-30 GHz by earth stations in motion communicating with geostationary space stations in the fixed-satellite service."

[13] ITU Resolution 158 (WRC-15), considering "d" ("there is a need for mobile communications, including global broadband satellite services, and that some of this need can be met by allowing earth stations in motion to communicate with space stations of the FSS operating in the frequency bands 17.7-19.7 GHz (space-to-Earth) and 27.5-29.5 GHz (Earth-to-space)"); considering further "a" ("a consistent approach to deployment of these earth stations in motion will support these important and growing global communication requirements").

[14] http://interactive.satellitetoday.com/how-wrc-15-led-to-the-big-c-band-decision. At WRC-15, the 27.5-29.5 GHz band was discussed, and rejected, as a possible 5G candidate band. 29.5-31 GHz was not even considered.

adjacent, but separate, 24.25-27.5 GHz band,[15] and (ii) validated ESIM use of the 27.5-29.5 GHz and 17.7-19.7 GHz segments in order to extend global broadband connectivity by satellite.[16]

As a result, satellite operators have designed, constructed, and deployed satellite broadband networks around the world based on these ITU decisions, and the longstanding global allocations for satellite services in the 27.5-31 GHz and 17.7-21.2 GHz bands.

That global consensus continues to be affirmed. Over 120 countries (a rising number) have expressed their intention to follow the ITU decisions and preserve the 27.5-31 GHz and 17.7-21.2 GHz bands for satellite broadband services. By way of example, Europe's "5G Roadmap" affirms this determination, recognizing the critical nature of this spectrum for satellite broadband, and expressing its policy: "Signal clearly that Europe has harmonised the 27.5-29.5 GHz band for broadband satellite and is supportive of the worldwide use of this band for ESIM. This band is therefore not available for 5G."[17]

Approximately 3.5 billion people represented by Europe, Indonesia, Australia, China, Russia, Bangladesh, Nigeria, Kenya, Brazil, Mexico and virtually all of Latin America, to name a few, support preserving the 27.5-31 GHz and 17.7-21.2 GHz bands for satellite and accommodating IMT/5G needs in separate spectrum. Of course, this will drive scale for use of the 27.5-31 GHz and 17.7-21.2 GHz bands by satellite systems and end users, and similarly will drive scale for 5G/IMT equipment in separate spectrum.

The decision the United States took almost a quarter of a century ago, before the Internet became what it now is, and before satellite broadband was a reality, is an artifact of history. That decision prioritized terrestrial fixed use over satellite use in the 27.5-28.35 GHz band segment in a failed attempt to develop a point-to-multipoint service called LMDS. Moreover, that decision was based on an incorrect prediction that satellite broadband would need access to only 1,000 megahertz of the Ka band to serve end users. Instead, satellite broadband service has flourished around the

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15 ITU Press Release, *WRC-19 identifies additional frequency bands for 5G,* Nov. 22, 2019 ("While identifying the frequency bands 24.25-27.5 GHz, 37-43.5 GHz, 45.5-47 GHz, 47.2-48.2 and 66-71 GHz for the deployment of 5G networks, WRC-19 also took measures to ensure an appropriate protection of the Earth Exploration Satellite Services, including meteorological and other passive services in adjacent bands. In total, 17.25 GHz of spectrum has been identified for IMT by the Conference, in comparison with 1.9 GHz of bandwidth available before WRC-19. Out of this number, 14.75 GHz of spectrum has been harmonized worldwide, reaching 85% of global harmonization.") https://news.itu.int/wrc-19-agrees-to-identify-new-frequency-bands-for-5g/.

16 ITU Resolution 169 (WRC-19) "Use of the frequency bands 17.7-19.7 GHz and 27.5-29.5 GHz by earth stations in motion communicating with geostationary space stations in the fixed-satellite service."

17 *See* European Conference of Postal and Telecommunications Administrations (CEPT), *Spectrum for wireless broadband – 5G*, Section B.3 (Version 10, Revised 6 March 2020) at https://www.cept.org/Documents/ecc/57839/ecc-20-055-annex-15_cept_5g_roadmap.

world using the entire 27.5-31 GHz uplink band, as discussed above. When the United States later allowed terrestrial mobile services into the 27.5-28.35 GHz band segment, it also recognized the substantial need for satellite use of that band segment and authorized over 9,000 protected satellite earth station gateways in the band. Of course, the Unites States has different connectivity needs than the rest of the world and its failure to accommodate *end user terminals* in the 27.5-28.35 GHz band leaves the United States unable to fully realize the capabilities of today's satellite broadband networks and enjoy the significant cost-efficiencies described above.

Finally, as reflected in the ITU decisions and the European 5G Roadmap, this is not an issue of choosing one technology over another. A wide range of opportunities exist to accommodate 5G/IMT in other spectrum that specifically has been identified for 5G/IMT, and that would not have any of the adverse effects the ITU considered in deciding where to accommodate 5G/IMT spectrum needs: (i) changing the sharing situation regarding the satellite broadband services for which the 27.5-31 GHz and 17.7-21.2 GHz bands already are allocated; (ii) impairing the ability of satellite broadband services to continue to develop; (iii) constraining the evolving needs of satellite broadband services; or (iv) imposing any additional regulatory or technical constraints on satellite broadband services.[18]

[18] *See* ITU Resolution 238 (WRC-15) "Studies on frequency-related matters for International Mobile Telecommunications identification including possible additional allocations to the mobile services on a primary basis in portion(s) of the frequency range between 24.25 and 86 GHz for the future development of International Mobile Telecommunications for 2020 and beyond."