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Infocomm Media Development Authority
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Second Consultation on 5G Mobile Services and Networks

Dear Ms Chia,

Please find following the comments of the Global Satellite Coalition ("GSC")[1] on the **Second Consultation on 5G Mobile Services and Networks** issued by the Info-communications Media Development Authority (IMDA) of Singapore.

The GSC is the voice of the global satellite industry that represents the combined membership of seven satellite associations across the globe – the Satellite Communications Brazilian National Association (ABRASAT),[2] Asia Pacific Satellite Communications Council (APSCC),[3] Asia Video Industry Association (AVIA),[4] Communications Alliance-Satellite Services Working Group (CA SSWG),[5] EMEA Satellite Operators Association (ESOA),[6] Global VSAT Forum (GVF),[7] and the Satellite Industry Association (SIA) – covering all continents and all ITU regions.

Four of GSC's member organizations – APSCC, AVIA (formerly CASBAA), GVF and ESOA – submitted comments on IMDA's first consultation on 5G Mobile Services and Networks in 2017. The GSC comments submitted today should be seen as a follow-up to those earlier comments.

Please contact GSC (info@gscoalition.org), APSCC (gregg@gapsat.com) or AVIA (john@avia.org) if you have any questions about this submission.

Sincerely yours,

Gregg Daffner	John Medeiros	David Meltzer	Aarti Holla-Maini
APSCC	AVIA	GVF	ESOA

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[1] *See* gscoalition.org.
[2] *See* www.abrasat.org.br.
[3] *See* www.apscc.or.kr.
[4] *See* www.asiavia.org.
[5] *See* www.commsalliance.com.au/Activities/committees-and-groups/SSWG.
[6] *See* www.esoa.net.
[7] *See* www.gvf.org.

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SUMMARY OF MAJOR POINTS

The IMDA's Second 5G Consultation[8] seeks input on IMDA's proposal to make available an "initial wave" of 5G spectrum by 2022 consisting of the 3.5 GHz band (3.4-3.6 GHz) band, the 26 GHz band (24.25-27.5 GHz), and the 28 GHz band (27.5-29.5 GHz).[9] In addition, IMDA would then "open up other spectrum bands a few years later, e.g. around 2025, when the global ecosystem is more ready for cost efficient deployment."[10]

In the GSC's view, the IMDA should avoid allocating too much spectrum for terrestrial 5G at the expense of satellite services, especially when 5G business cases remain unclear and when there is ample other spectrum available to satisfy any realistic 5G demand. Even though Singapore has a small territory, preserving adequate spectrum for satellite would serve Singapore's national interest by, for example, making Singapore more attractive as a satellite gateway location to enhance Singapore's position as a cloud computing and connectivity hub for the region. Singapore's existing position as a regional hub for broadcasting and media companies will also require the protection of satellite spectrum, especially in the C-band. By a similar token, Singapore's strategic position as a regional hub for shipping and air travel would only be enhanced by ensuring that satellite connectivity to ships and aircraft visiting the country can be maintained using the broadest range of frequencies. As demonstrated below, Singapore can pursue these national objectives while still providing more than enough spectrum to meet any realistic terrestrial 5G demand.

For the various bands proposed by Singapore for terrestrial 5G, the GSC submits as follows for the reasons set out herein:

- ***28 GHz.*** IMDA should remove the 28 GHz band from further consideration as a terrestrial 5G band, as it is simply not required to meet projected 5G spectrum demand based on IMDA's own estimates. The band is also unlikely to be internationally harmonized for 5G as over 120 countries around the world support preserving and expanding satellite services in the band, and it is already the subject of extensive existing and ongoing USD multi-billion investments by the satellite industry, which would be jeopardised if restrictions were imposed on location, size and uplink power of satellite earth stations operating in the band. Singapore's national interest would be better served by preserving the 28 GHz band for satellite while satisfying projected 5G spectrum demand using other spectrum.

- ***26 GHz.*** More than enough spectrum can be found in the 26 GHz band (24.25-27.5 GHz) to meet projected 5G spectrum demand in the 2022-2025 timeframe, based on IMDA's own estimates. This band is also much more likely to be internationally harmonized for 5G, as it is among those being studied by the ITU for AI 1.13 and most countries are focusing on this band as the pioneer mmWave band for 5G terrestrial services. Regulatory measures will need to be put in place to ensure protection of any BSS or FSS space stations receiving in portions of this band (24.65-25.25 GHz and 27.0-27.5 GHz). Separation distances to protect terrestrial 5G stations from FSS interference should also be investigated to assess cross-border interference scenarios, and to determine if any BSS feeder link or FSS earth stations

[8] IMDA Consultation Paper, *Second Consultation 5G Mobile Services and Networks* (May 2019), *available at* https://www2.imda.gov.sg/regulations-and-licensing/Regulations/consultations/Consultation-Papers/2019/Second-Public-Consultation-on-5G-Mobile-Services-and-Networks (hereinafter "Second 5G Consultation").
[9] Second 5G Consultation at ¶ 93.
[10] Second 5G Consultation at ¶ 93.

can be accommodated within Singapore territory. Additionally, separation distances may need to be investigated to protect any earth stations in the *space to Earth* Earth Exploration Satellite Service (EESS) in neighbouring countries in the band 25.5-27.0 GHz. Technical solutions are also readily available to protect the *passive* Earth Exploration Satellite Service in the adjacent 23.6-24.0 GHz band while still allowing the entire 24.25-27.5 GHz band to be used for 5G applications.

- ***3.5 GHz.*** While all the proposed spectrum assignments would negatively impact satellite operators and satellite service providers, the specifics of the allocation of this band are of major concern to video content providers – many of which are AVIA members, and many based in or having regional headquarters in Singapore – as Asia Pacific video content is primarily distributed by C-band satellite. IMDA's proposal for the 3.5 GHz band should be clarified, especially its proposal for a guard band in 3.6-3.7 GHz. If there is to be a guard band in that band, then it should not be allocated for the Mobile service., IMDA must also address protection of co-frequency FSS earth stations in neighbouring countries. Unlike Singapore, Malaysia and Indonesia are not among the countries in ITU Region 3 that are planning to use the 3.4-3.6 GHz band for IMT. Protection of satellite services in the adjacent band (above 3.6 or 3.7 GHz) – both in Singapore and in neighbouring countries – must also be addressed by some combination of 5G out-of-band emission masks, guard bands and/or separation distances. As the IMDA is aware, the C-band above 3.6 GHz (and especially above 3.7 GHz) is extensively used throughout the region. The practicability and logistics of migrating existing satellites services in Singapore out of the 3.5 GHz into higher bands will also require further assessment.

- ***L-band.*** GSC supports IMDA's proposal, for the time being, not to make L-band spectrum available for mobile broadband, and to instead monitor regional and international developments related to the potential use of the band 1427-1518 MHz for mobile systems. Any re-purposing of the 1427-1518 MHz band for terrestrial 5G must be accompanied by regulatory measures for the protection of L-band mobile satellite services ("MSS") in the adjacent 1518-1559 MHz band. This MSS band is installed on thousands of ships and aircraft, as well as land mobile terminals, around the world.

STATEMENT OF INTEREST

The Global Satellite Coalition ("GSC") is the voice of the global satellite industry that represents the combined membership of seven satellite associations across the globe – the Satellite Communications Brazilian National Association (ABRASAT), Asia Pacific Satellite Communications Council (APSCC), Asia Video Industry Association (AVIA), Communications Alliance (CA), EMEA Satellite Operators Association (ESOA), Global VSAT Forum (GVF), and the Satellite Industry Association (SIA) – covering all continents and all ITU regions.

The GSC includes among its members a large number of content providers and distributors, satellite operators and satellite service providers that conduct business in Singapore, in Indonesia and Malaysia, and in the wider Asia Pacific region.

A list of over 170 GSC members is attached at Annex A.

A list of GSC members' satellites using 28 GHz band is attached at Annex B.

A non-exhaustive list of AVIA members' video content channels conveyed by C-band satellite into Singapore and neighbouring countries is attached at Annex C.

The GSC wishes to protect their members' satellite service interests in Singapore, Indonesia and Malaysia, and in the Asia Pacific, including members' abilities to provide or continue to provide:

- existing services in bands designated as FSS primary or co-primary without disruption
- future services in bands designated as FSS primary or co-primary:
    - without disruption;
    - without unreasonable constraint on future deployments, rollouts or service offerings;
    - with regulatory certainty of their protection;
- infrastructure and services contributing to the 5G ecosystem.

COMMENTS OF THE GLOBAL SATELLITE COALITION

IMDA SECOND CONSULTATION ON
"5G MOBILE SERVICES AND NETWORKS"

I. INTRODUCTION

IMDA's Second 5G Consultation[11] seeks input on IMDA's proposal to make available an "initial wave" of 5G spectrum by 2022 consisting of the 3.5 GHz band (3.4-3.6 GHz) band, the 26 GHz band (24.25-27.5 GHz), and the 28 GHz band (27.5-29.5 GHz).[12] In addition, IMDA would then "open up other spectrum bands a few years later, e.g. around 2025, when the global ecosystem is more ready for cost efficient deployment."[13]

Today, satellites provide direct broadband connectivity to households and communities, both in competition with and to places where terrestrial options will likely never reach.[14] In addition, today's advanced satellites networks are expanding to provide mobile broadband connectivity on aircraft (gate-to-gate for passengers, crew and aircraft maintenance and monitoring), ships (port-to-port), and for land mobile vehicles (e.g., trains, buses, cars). In addition, and as previously demonstrated (see Annex D), the satellite industry can and will play an important role in the global 5G ecosystem, as it does today in the 2G, 3G and 4G ecosystems. Without satellites, today's 2G, 3G and 4G networks would be considerably smaller. There is every reason to believe that satellites can play a comparable role for 5G. In fact, we have successfully demonstrated that satellites are part of the 5G ecosystem providing advanced broadband networks features such as "network slicing" and mobile edge computing.[15]

All of this should be borne in mind when making spectrum policy decisions for 5G. The IMDA should balance spectrum for terrestrial 5G with the rapidly growing demand for satellite services, especially when 5G business cases remain unclear and when there is ample other spectrum available to satisfy any realistic 5G demand. Even though Singapore has a small territory, preserving adequate spectrum for satellite would be in Singapore's national interest by reaffirming Singapore's strategic position as

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[11] IMDA Consultation Paper, *Second Consultation 5G Mobile Services and Networks* (May 2019), *available at* https://www2.imda.gov.sg/regulations-and-licensing/Regulations/consultations/Consultation-Papers/2019/Second-Public-Consultation-on-5G-Mobile-Services-and-Networks (hereinafter "Second 5G Consultation").

[12] Second 5G Consultation at ¶ 93.

[13] Second 5G Consultation at ¶ 93, Fig. 4.

[14] *See*, *e.g.*, NbnCo, *nbn SkyMuster satellite explained*, https://www.nbnco.com.au/residential/learn/network-technology/sky-muster-explained ; ViaSat, https://www.viasat.com; Hughes Communications, *HughesNet*, https://www.hughesnet.com/; Eutelsat, *Konnect*, https://www.eutelsat.com/en/satellite-communication-services/satellite-internet-broadband-service.html.

[15] *See*, *e.g.*, European Space Agency, *Satellites bring multi-faceted 5G to Barcelona* (4 Mar. 2019), *at* https://artes.esa.int/news/satellites-bring-multi-faceted-5g-barcelona; European Space Agency, *Space-Enabled Internet of Things Shown in Berlin* (21 Nov. 2018), http://www.esa.int/Our_Activities/Telecommunications_Integrated_Applications/Space-enabled_Internet_of_Things_shown_in_Berlin; SES, *Satellite Networks: Enabling Ubiquitous 5G* (19 Dec. 2018), *at* https://www.ses.com/blog/satellite-networks-enabling-ubiquitous-5g; Via Satellite, *SaT5G Hit Milestone with Satellite-5G Integration Demonstration* (19 Jun. 2018), *at* https://www.satellitetoday.com/telecom/2018/06/19/sat5g-hit-milestone-with-satellite-5g-integration-demonstration/. *See also generally* https://www.sat5g-project.eu/; https://satis5.eurescom.eu/.

a regional hub for shipping and air travel by ensuring that satellite connectivity to ships and aircraft in-country can be maintained using the broadest range of frequencies to meet the growing demand for satellite broadband connectivity. As demonstrated below, Singapore can pursue these national objectives while still providing more than enough spectrum to meet any realistic terrestrial 5G demand. In addition, making Singapore more attractive as a satellite gateway location to enhance Singapore's position as a cloud computing and connectivity hub for the region will be served by ensuring the necessary frequencies are available. In this way, Singapore may even be able to export its "Smart Nation" capabilities to other nations with more limited terrestrial connectivity.

II. PROPOSED SPECTRUM ALLOCATIONS FOR 5G

A. IMDA's proposed spectrum allocations exceed 5G spectrum requirements

IMDA is proposing to allocate more spectrum for 5G than its own 5G spectrum demand estimates would justify. In its first consultation on "5G Mobile Services and Networks," IMDA carefully estimated that 5G terrestrial services would require *3360 MHz* of spectrum by 2022, based on a thorough review of various demand models and empirical data about mobile data consumption and growth in Singapore.[16] IMDA also suggested in that consultation that this spectrum requirement could be met with a mix of existing and new frequency bands.[17] Nothing in the Second 5G Consultation contradicts this estimate or suggests that it has changed.

The Second 5G Consultation, however, proposes to make available *5450 MHz* of *new* spectrum for 5G by 2022, consisting of the 3.5 GHz, 26 GHz and 28 GHz band.[18] This amount of spectrum exceeds the IMDA estimate of terrestrial 5G spectrum demand by 2090 MHz and does not take into account any existing mobile spectrum allocations that could be used to satisfy terrestrial 5G demand. There is no requirement for such a significant over-allocation of spectrum for terrestrial 5G and, indeed, the Second 5G Consultation offers no justification for it. As the IMDA is no doubt aware, allocating too much spectrum for a given service can be just as inefficient as allocating too little. In fact, the inefficiencies created by over-allocation will be particularly egregious if, as here, it would result in the displacement of important existing services and ongoing investments in a given band.[19]

Fortunately, IMDA can easily remedy this over-allocation by removing the 28 GHz band from further consideration as a terrestrial 5G band. This would reduce the amount of projected terrestrial 5G spectrum by 2000 MHz to 3450 MHz, which is much closer to, but still greater than, the 3360 MHz that IMDA originally estimated to be required for terrestrial 5G in the 2022-2025 timeframe. Equally important, removal of the 28 GHz band from 5G consideration will enable Singapore to continue enjoying being a regional leader for the many existing and planned satellite broadband services in

[16] IMDA, *5G Mobile Services and Networks*, at ¶ 64 (23 May 2017) ("First 5G Consultation") ("The results from the modelling indicated that spectrum demand is projected to increase to at least about 3360 MHz by 2022 once there is commercial deployment of 5G services and applications.").
[17] First 5G Consultation at ¶ 64 fig.5.
[18] Second 5G Consultation at ¶ 55 tbl.1 and ¶ 93.
[19] The case of Hong Kong is instructive. Even though the Office of the Communications Authority ("OFCA") made available *4100 MHz* of spectrum available for 5G in 25.25-28.35 GHz, the mobile network operators (MNOs) only applied for and were assigned *1200 MHz* of such spectrum. And even though the entire 1200 MHz of spectrum demand could have been easily accommodated in the 26 GHz band, the MNOs nevertheless, and not surprisingly as it will potentially sanitize the band for satellite services, selected spectrum in the 28 GHz that is being used for satellite services in Hong Kong. *See* OFCA, Press Release, *Offer of Spectrum Assignments in 26 GHz and 28 GHz Bands for Provision of 5G Services* (27 Mar. 2019), https://www.ofca.gov.hk/en/media_focus/press_releases/index_id_1891.html.

the 28 GHz band, including services to aircraft, at sea, or on land. Indeed, preservation of the 28 GHz for satellite broadband services would make Singapore a more attractive location for expanded gate-to-gate and port-to-port broadband communications as well as the siting of Ka-band hub earth stations to support modern High Throughput Satellite (HTS) systems serving the broader Asia-Pacific region. This in turn would enhance Singapore's position as a cloud computing and connectivity hub for the whole region.[20]

Removal of the 28 GHz band from 5G consideration will also ensure continued harmonized operations with FSS 28 GHz deployments in neighbouring Indonesia and Malaysia, both of which are poised to launch satellite services in the 28 GHz band in the near future to deliver broadband to citizens dispersed over broad and varied geographies.

B. 28 GHz band – not needed for terrestrial 5G, essential for satellite services

i. The 28 GHz band is not needed for 5G in Singapore

As demonstrated above, there is simply no need and no reason to propose the use of the 28 GHz band for terrestrial 5G services. Making available the 3.5 GHz band and the 26 GHz band will yield enough 5G mobile spectrum to exceed IMDA's own projections of 5G spectrum demand in the 2022 time frame. Any additional spectrum requirements beyond IMDA initial projections can be re-assessed at a later time, once the business case and economics of 5G become clearer[21] and the World Radio Conference 2019 (WRC-19) completes its work to identify more spectrum for IMT-2020/5G.

ii. The 28 GHz band is unlikely to be internationally harmonized for terrestrial 5G

As GSC member organizations have previously submitted, the 28 GHz band is unlikely to be internationally harmonized for terrestrial 5G use. The band is not among those being studied by the ITU for IMT-2020/5G at WRC-19 having been expressly rejected by the Member States of WRC-15. Most countries are prioritizing the 26 GHz band for 5G terrestrial services – including Australia, Brazil, China, the EU-28 countries, and the Arab League – in part because the 26 GHz band is among those most likely to be harmonized by the ITU for IMT-2020/5G.

Australia, for example, recently found that "[t]he satellite industry has made strong arguments regarding their existing and future spectrum needs in the 28 GHz [27.5-29.5 GHz] band for both gateway and ubiquitous (including earth stations in motion (ESIM) uses" and that "these arguments have merit."[22] As a result, Australia reached the preliminary conclusion that terrestrial 5G applications need not be accommodated in the 28 GHz band since "these applications are adequately catered for in the 26 GHz band."[23] Continued use of the 28 GHz band by satellite

[20] *See discussion in* Part III, Question 2, below. *See also*, *e.g.*, FutureiOT, *Inmarsat, Microsoft team up to deliver cloud services via satellite* (28 Feb. 2019), *at* https://futureiot.tech/inmarsat-microsoft-team-up-to-deliver-cloud-services-via-satellite/; Bloomberg, *SES Networks Enables Direct Connectivity to IBM Cloud via Global Satellite Network*, *at* https://www.bloomberg.com/press-releases/2018-10-04/ses-networks-enables-direct-connectivity-to-ibm-cloud-via-global-satellite-network (4 Oct. 2018). *See also* Amazon Web Services, *AWS Ground Station*, https://aws.amazon.com/ground-station/features/.

[21] Second 5G Consultation at ¶ 26.

[22] *See* ACMA, *Replanning of the 28 GHz band: Options paper* at 6 (Apr. 2019), *available at* https://www.acma.gov.au/theACMA/planning-options-for-the-28-ghz-band.

[23] *See* ACMA, *Replanning of the 28 GHz band: Options paper* at 6 (Apr. 2019), *available at* https://www.acma.gov.au/theACMA/planning-options-for-the-28-ghz-band.

services was also supported by the Australian Department of Defence,[24] with which the Singapore Ministry of Defence recently re-affirmed their close and long-standing defence relationship.[25]

Similarly, the European Commission has issued a decision directing Member States to make the 26 GHz band available for 5G by 2020. At the same time, the European Council has recently adopted a position for WRC-19 that re-affirms European support for the use of the 26 GHz and opposes any consideration of the frequency band 27.5-29.5 GHz for IMT-2020.[26] In this respect, CEPT notes that "Europe has harmonised the 27.5-29.5 GHz band for broadband satellite and is supportive of worldwide use of this band for ESIM. This band is therefore not available for 5G" in Europe (emphasis added).[27]

In fact, barely a handful of countries (*e.g.*, the U.S., South Korea, and Japan) are promoting the use of any part of the 28 GHz band for terrestrial 5G services outside of the ITU and WRC-19 process. These are the same countries that were rejected by the global community when they attempted to have the WRC-15 include the 28 GHz band in the Agenda Item 1.13 for consideration for terrestrial 5G. Instead, the WRC-15 decided to study the 28 GHz band for satellite broadband on Earth Stations in Motion (ESIMs), which is expected to be addressed at WRC-19. There is also an effort underway to expand ESIM use in the 28 GHz band to Non-Geostationary Systems (NGSO ESIMs), which will further solidify the 28 GHz band as a satellite broadband band. As a result, Singapore is unlikely to realize any greater economies of scale from identifying the 28 GHz for terrestrial 5G than from just identifying the 26 GHz band.

iii. The 28 GHz band is used extensively for satellite services around the world

The 28 GHz band is currently used extensively for satellite services globally, especially for the latest and next-generation High Throughput Satellite (HTS) systems that will provide the massive complementary bandwidth needed to make sure the benefits of 5G can be enjoyed everywhere. There are more than 100 satellites in orbit today – with several dozen launched in just the last seven years – providing services of various kinds in the 28 GHz band. These include both geostationary satellite systems (*e.g.*, IPStar, JCSAT-16, Inmarsat Global Xpress and SES-12), as well as new non-geostationary satellite constellations (*e.g.*, O3b and OneWeb). More are set to come online in the 2019-2022 timeframe, including several new and very large constellations of satellites in geostationary (e.g., Viasat-3 Asia Pacific) and non-geostationary orbits (*e.g.*, Telesat LEO and SpaceX Starlink). Annex B is a non-exhaustive list of GSC members' satellites using 28 GHz band.

As IMDA recognizes, satellite services are being provided in the 28 GHz band in Singapore today, including to aircraft and the large cruise ships that visit Singapore.[28] But there is no reason that satellite services in the 28 GHz band should be confined to ships or planes. As already noted, in the

[24] *See* Submission of Australian Department of Defence to ACMA (17 May 2019), *available at* https://www.acma.gov.au/-/media/Spectrum-Transformation-and-Government/Issue-for-comment/IFC-09-2019/DoD---28-GHz-IFC-09-2019-pdf.pdf.

[25] *See* Mindef, *Singapore and Australia Reaffirm Defence Relations at 11th Singapore-Australia Joint Ministerial Committee Meeting* (29 Mar. 2019), *at* https://www.mindef.gov.sg/web/portal/mindef/news-and-events/latest-releases/article-detail/2019/March/29mar19_nr.

[26] *See Council Decision on the position to be taken on behalf of the European Union in the International Telecommunication Union (ITU) World Radiocommunication Conference 2019 (WRC-19)* (13 Jun. 2019), *at* https://www.consilium.europa.eu/register/en/content/out?&typ=ENTRY&i=LD&DOC_ID=ST-10300-2019-INIT (contents not yet public as of 17 Jun. 2019).

[27] *See* CEPT, https://cept.org/files/18334/ECC(19)042 Annex 32_CEPT Roadmap 5G.docx

[28] Second 5G Consultation at ¶¶ 73-74.

same way that Singapore has become a media hub in the Asia-Pacific region, Singapore can take advantage of its excellent terrestrial connectivity, and the presence of major regional cloud computing data centres on the island, to encourage the establishment of Ka-band satellite gateways in the country to support the many new HTS satellite systems being launched that will serve the entire region.[29] In doing so, Singapore may even find an export market for its "Smart Nation" capabilities in countries with more limited terrestrial connectivity.

If Singapore were to allocate the 28 GHz band for 5G terrestrial services instead of satellite, it would be denying itself the benefits and opportunities that the new satellite broadband services in this band would afford, all in an effort to meet non-existent of terrestrial 5G spectrum demand. The GSC would therefore urge Singapore to adopt a more balanced spectrum policy that allows it to realize the benefits of existing and emerging satellite services in 28 GHz band while meeting projected terrestrial 5G spectrum requirements using other bands.

iv. Terrestrial 5G business cases for 28 GHz remain unclear

IMDA should strive to avoid over-allocating 5G spectrum in a way that disrupts extensive satellite broadband services and investments in the 28 GHz band, especially when the business cases for terrestrial 5G and their actual spectrum requirements remain uncertain. As the Second 5G Consultation acknowledges, "Beyond FWA [Fixed Wireless Access], the business case and economics of 5G remain unclear amongst most operators globally."[30] While recognizing FWA as a business case that is clearly being pursued in some countries such as the U.S.,[31] the IMDA also notes that FWA is not expected to be a major use case in the territory of Singapore: "the availability of a nationwide fibre broadband network with residential wired broadband household penetration rate of more than 90%, capable of delivering 1 Gbps for as low as $34 per month, reduces the need for an alternative fixed-wireless last-mile access service in Singapore."[32]

v. Co-existence of 5G terrestrial and satellite services in the 28 GHz

Conditions for the co-existence of 5G terrestrial and satellite services in the 28 GHz band would be unnecessary if IMDA were to remove the 28 GHz band from consideration as a terrestrial 5G band. As explained above, there are many good reasons for IMDA to consider doing so. But, if IMDA were to allocate the 28 GHz for terrestrial 5G mobile services into the band, notwithstanding the compelling arguments to the contrary, then the IMDA should (at the very least) investigate and implement regulatory measures to ensure (1) no harmful interference from terrestrial 5G stations into satellite receivers in space, (2) practical compatibility of 28 GHz earth stations in motion ("ESIMs") on ships and aircraft operating at Singapore ports and airports, and (3) compatibility with 28 GHz earth stations located in neighbouring countries.

The ITU has not conducted studies for the protection of 28 GHz space station receivers from 5G terrestrial stations because the 28 GHz is not among the candidate bands being considered for IMT-2020 under WRC-15 Resolution 238. . Nevertheless, enforceable protection measures (such as Total Radiated Power limits and base station down-tilts) will be need to be devised in order to protect the

[29] *See* footnote 26 above and Part III, Question 2, below.
[30] Second 5G Consultation at ¶ 26.
[31] Second 5G Consultation at ¶ 24 ("Countries seeking to deliver ultra-high-speed broadband services to homes and business premises are looking to leverage 5G to deliver last-mile fixed wireless access ("FWA") to homes, e.g., U.S. and Australia.").
[32] Second 5G Consultation at ¶ 25.

many space stations in orbit today using the 28 GHz band, and many more launching in just the next few years. It is not appropriate to have no regulatory measures, as then there can be no assurance that 28 GHz band space stations will not be impacted. Even if Singapore does not wish to use this band for satellite services, the vast majority other countries with most of the world's population have chosen to do so, and such services must be protected.

IMDA should also consider regulatory measures that would allow continued use of the 28 GHz band for earth stations in motion on ships and aircraft visiting Singapore ports and airports. While the 28 GHz band has not been retained by ITU as a candidate band to be studied for possible identification for IMT-2020/5G during WRC-19, ESIMs will likely be allowed to operate in this band as a result of a new Resolution being developed for the same conference, under WRC-19 Agenda Item 1.5. Ubiquitous terrestrial 5G stations in the 28 GHz band will preclude ubiquitous FSS earth stations in the same band. However, if IMDA decides in the end to authorise some form of terrestrial 5G in a part of the 28 GHz band, co-frequency compatibility may still be practically achievable using pfd limits for aircraft ESIMs. For ESIMs on ships, compatible operations in the 28 GHz band could be achieved by requiring a minimum distance from the shore, as is proposed through WRC-19 Agenda Item 1.5. In the specific case of Singapore, given its position just North of the Equator, compatibility could be achieved at shorter distances or no distance from certain airports and ports by maintaining a relatively high minimum elevation angle for the operation of the ESIM. While these kinds of regulatory mechanisms would allow for some degree of compatibility between terrestrial 5G and ESIMs operating in the 28 GHz band, it is clear that more extensive and more robust ESIM services require a majority of 28 GHz spectrum that is not in the same band as terrestrial 5G.

Importantly, IMDA will have to address cross-border interference from FSS earth stations located in neighbouring countries, not least because the 28 GHz is extensively used for satellite services and is unlikely to be internationally harmonized for 5G. For example, Malaysia's Measat will be launching a HTS system soon utilizing the 28 GHz band (Measat 3d).[33] Similarly, Indonesia has recently completed a government tender process for a Ka-band high-throughput satellite (Satelit Multifungsi) to expand broadband connectivity throughout Indonesia that will rely on the 28 GHz band.[34]

C. 26 GHz band – likely to be internationally harmonized for 5G

As explained above, the 26 GHz band is likely to be internationally harmonized for terrestrial 5G services. It is among the candidate bands being considered at WRC-19 and has the support of many countries. IMDA's proposed allocation of the full 3250 MHz of this band for 5G is almost enough, by itself, to meet IMDA's projected 5G spectrum demand of 3360 MHz in the 2022 timeframe (before considering the 3.4-3.6 GHz or any other bands that could be made available for 5G). Moreover, device and equipment ecosystems are already emerging in this band, which means that 5G equipment in the band is likely to be available by 2020.

Allocation of the entire 26 GHz band for terrestrial 5G services in Singapore should be subject to regulatory measures to protect the Broadcasting Satellite Service (BSS) feeder links in the 24.65-25.25 GHz and the Fixed Satellite Service in 27.0-27.5 GHz in ITU Region 3. ITU studies show that 5G terrestrial stations in these band segments can protect space station receivers based on certain parameters for the 5G stations provided by the mobile industry for those studies, such as Total

[33] *See* SpaceNews, *Measat buying single replacement for two satellites* (6 May 2019), *at* https://spacenews.com/measat-buying-single-replacement-for-two-satellites/.
[34] *See* SpaceNews, *Indonesian government chooses PSN team for 150 Gbps satellite* (3 May 2019), *at* https://spacenews.com/indonesian-government-chooses-psn-team-for-150-gbps-satellite/.

Radiated Power and base station down-tilt.[35] Terrestrial 5G operators should be required to comply with these parameters to ensure that space stations in this band are in fact protected in accordance with the ITU studies. Passive Earth Exploration Satellite Services ("EESS") in adjacent bands (23.6-24.0 GHz) will also need protection. Fortunately, technical solutions readily exist to enable commercial 5G deployments in the 26 GHz band while still protecting the passive EESS.

The IMDA should also investigate the separation distances required to protect terrestrial 5G stations from BSS feeder links in the 24.65-25.25 GHz band and FSS earth stations in 27.0-27.5 GHz, as well as the EESS receiving earth stations in 25.5 – 27 GHz in neighbouring countries.[36] This will help Singapore negotiate with neighbours that wish to use these respective bands for such services, and help determine whether any BSS feeder link or FSS earth stations can be accommodated in any location within Singapore (perhaps in one or two well-shielded locations at existing satellite teleports).

D. 3.5 GHz band – adjacent country, adjacent band and in-band TT&C satellite operations

In IMDA's Second 5G Consultation, the proposal for the 3.5 GHz is a little unclear. On the one hand, IMDA is proposing to make 200 MHz of spectrum in this band available for 5G terrestrial services, but on the other hand it is proposing to allocate the entire 3.4-3.7 GHz band for mobile services, with some sort of guard band in the 3.6-3.7 GHz. The details of IMDA's guard band proposal remains unclear, though the GSC would note that Hong Kong recently decided to adopt a 100 MHz guard band in 3.6-3.7 GHz to protect FSS above 3.7 GHz.[37] If the entire 3.6-3.7 GHz is intended to be a guard band, then it would not be appropriate to allocate the 3.6-3.7 GHz band to the Mobile service.

As previously submitted – see Annex D – a decision by Singapore to allow 5G in the 3.4-3.6 GHz band will have to take into account the use of the band for the FSS by neighbouring countries, such as Malaysia and Indonesia. Unlike Singapore, its neighbours are not among those that have indicated that they intend to use the 3.4-3.5 GHz band for IMT under ITU Radio Regulation No. 5.432B, nor are they countries listed under No. 5.433A for the 3.5-3.6 GHz band. Both Malaysia and Indonesia have satellite systems and many earth stations in operation in the 3.4-3.6 GHz band, as well as the adjacent 3.6-4.2 GHz band, which will need to be protected.[38] An informational flyer highlighting nine critical applications of C-band satellite in the region is attached at Annex E.

In addition, adjacent band interference concerns will have to be addressed, both for FSS earth stations in Singapore and in adjacent countries. The 3.6-4.2 GHz band (and especially the 3.7-4.2 GHz

[35] *See* ITU, *Task Group 5/1 Chairman's Report*, Attachment 3 to Annex 3 to Document 5-1/478-E, *Chairman's Report* (20 Sep. 2018), *available at* https://www.itu.int/md/R15-TG5.1-C-0478/en (ITU TIES account required).
[36] Singapore is among the list of countries in ITU Radio Regulation No. 5.536B in which "earth stations operating in the Earth exploration-satellite service in the frequency band 25.5-27 GHz shall not claim protection from, or constrain the use and deployment of, stations of the fixed and mobile services." However, neither Malaysia nor Indonesia are among the list of countries in that footnote.
[37] *See* OFCA, *Change in the Allocation of the 3.4-3.7 GHz Band from Fixed Satellite Service to Mobile Service* at ¶13 (28 Mar. 2018), *at* https://www.coms-auth.hk/filemanager/statement/en/upload/441/ca_statements20180328_en.pdf.
[38] *See*, *e.g.*, Gerson Damanik, SDPPI, *Satellite Regulatory and Usage in Indonesia* at 9 (30 Sep-1 Oct. 2015) (reporting 21,783 C-band earth stations in Indonesia), https://www.itu.int/en/ITU-D/Regional-Presence/AsiaPacific/Documents/Events/2015/October-IISS-2015/Presentations/S3_Gerson_Damanik.pdf. In Malaysia, the 3400-4200 MHz is the subject of a Class Assignment that allows for ubiquitous deployment of VSAT earth stations in the band. *See* https://www.mcmc.gov.my/skmmgovmy/media/General/pdf/Class-Assignment-no-1-of-2019(7-February-2019).pdf.

band) is more heavily used throughout the Asia-Pacific region, including in Singapore, for broadcasting-related and cellular backhaul purposes. This was clearly evident from the outcome of the World Radio Conference 2015, which resulted in no regional IMT identification in the C-band above 3.6 GHz in ITU Region 3.

As IMDA is aware, Singapore has established itself as a hub for broadcast and media companies in the region, and many of them rely on the C-band frequencies for video contribution and distribution, including all those listed in Annex C and more. This makes it even more important to ensure that 5G services in the 3.5 GHz band do not affect satellite services above 3.6 GHz or 3.7 GHz. The risks of adjacent band interference (in the form of out-of-band emissions or overdrive of the LNA/LNB) from terrestrial transmitters in the 3.4-3.6 GHz into satellite receivers in 3.6-4.2 GHz are significant from practical experience, and can be difficult to mitigate, especially in cross-border situations and when aggregate interference is considered. Some combination of (1) 5G out-of-band emission masks, (2) a guard band, and/or (3) separation distances, will be required for the protection of adjacent band satellite services. The better the 5G out-of-band emission mask, the smaller the guard band and/or separation distance that will be required. A paper produced by AVIA that compares and discusses the adjacent band studies and trials performed in the US, UK and Hong Kong in this band is attached at Annex F.[39]

It remains to be seen whether there is sufficient other C-band capacity for satellite users in Singapore to migrate from the 3.4-3.6 GHz band (and possibly the 3.6-3.7 GHz band) to higher bands in order to avoid interference from 5G deployments at 3.4-3.6 GHz. Migration could also be complicated by the fact that Singapore end users may not control the frequency on which video programming is being downlinked because the choice of frequencies is determined by the broadcaster and not by the recipient. But even if practicable, migration is only a solution that IMDA can enforce for Singapore users of these bands. Satellite users of these bands in neighbouring countries would still need to be protected, as discussed above.

Within Singapore, migration of C-band TT&C operations in the 3.5 GHz band for an operational satellite at the Seletar earth station will likely not be possible as the TT&C frequencies of a satellite are typically "hard-wired" during construction and may not be changeable. Given that the operational satellite in question appears to be a Singapore-licensed satellite, and IMDA's guidelines require TT&C for such satellites to be conducted within Singapore,[40] an exclusion zone of some kind will likely be necessary to ensure protection.

E. L-band – protection of adjacent band satellite operations

We note that IMDA plans to monitor regional and international developments related to the potential use of the band 1427-1518 MHz for mobile systems, and for the time being does not plan to make the band available for mobile broadband. The GSC supports this decision.[41]

[39] *See discussion in* Part III, Question 3, below.
[40] *See* IMDA, *Guidelines on the Submission of Application for the Grant of Licence for the Use of Satellite Orbital Slot*, at ¶ 2.5 (updated 27 Jul. 2017), *at* https://www2.imda.gov.sg/-/media/Imda/Files/Regulation-Licensing-and-Consultations/Licensing/licenses/GuideSatelliteOrbitalSlotLic.pdf.
[41] Second 5G Consultation at ¶ 87 ("IMDA will continue to monitor the regional and international harmonisation of the L-band channelling arrangements, and the ecosystem development within this band before allocating this band for mobile use.")

As previously submitted, if IMDA were to proceed with making the 1427-1518 MHz band available for mobile broadband, careful consideration will need to be given to potential interference into Mobile Satellite Service (MSS) operations in the adjacent band 1518-1559 MHz. This band is used by thousands of MSS terminals operating throughout the world, including on most wide-bodied airliners and on many ships and vessels. IMDA would need to address the potential interference, in particular with respect to ships operating in waters in and around Singapore, and with respect to aircraft operating in and out of Singapore's airports. Conditions for compatibility will likely require a frequency guard band to be applied to the mobile frequency arrangements below 1518 MHz, and will require deployment constraints on mobile base stations. Studies are on-going in the ITU-R on this issue to develop a new ITU-R Recommendation on compatibility measures,[42] and IMDA may at least wish to wait until those studies are complete before taking further steps on L-band.

Given the major international airport and ports in Singapore, constraints on mobile systems to adequately protect MSS terminals on ships and aircraft could be a significant deployment constraint for mobile operators in Singapore. IMDA should note that some administrations in Europe are planning to make available the L-band spectrum in a staggered fashion, with spectrum below 1492 MHz authorised initially, and a decision regarding the band 1492-1518 MHz deferred for a later date, should circumstances change in the future. This eliminates the need for significant deployment constraints on mobile base stations.

Regarding the trial use that IDMA currently authorises in the L-band spectrum,[43] this should remain in the band 1452-1492 MHz and should not be expanded into the upper part of L-band (1492-1518 MHz).

III. GSC RESPONSES TO SPECIFIC IMDA QUESTIONS

GSC would offer the following additional comments in response to the specific questions in the Second 5G Consultation.

> **Question 1: IMDA would like to seek the industry's views on skills requirements and the potential job demands in the future of networks and next generation of application/use-cases with 5G technology.**

The GSC offers no comment on this question, other than to note that Singapore also has an interest in developing skills, talent and jobs as a leader in the space industry.[44]

> **Question 2: IMDA would like to seek views on:**
> **i) The types of innovative use-cases that could capitalise and further enhance Singapore's competitive advantages, trigger new growth potential and/or strengthen Singapore's existing strategic pillars; and**
> **ii) Areas of government support that the industry require in order to enable innovation and development in 5G.**

[42] See Annex 3 of document 4C/417, https://www.itu.int/md/R15-WP4C-C-0417/en
[43] Second 5G Consultation at ¶ 87 ("In the interim, IMDA will continue to keep the L-band open for trial.").
[44] *See* Singapore Economic Development Board, *Introducing OSTIn: Office of Space Technology and Innovation*, *at* https://www.edb.gov.sg/content/dam/edbsite/news-and-resources/resources/corporate-publications/OSTIn-brochure.pdf.

Preserving adequate spectrum for satellite services, especially the 28 GHz band used by many modern High Through Satellites, including all those listed in Annex B, will help maintain and extend Singapore's competitive advantage as a central "hub" for the greater Asia-Pacific region.

Singapore's role as a major hub for shipping and air travel is already well established. As IMDA is aware, major cruise lines and airlines have been equipping their vessels and aircraft to provide their passengers, crew and airlines with high-speed satellite-enabled broadband services. Indeed, one of the major suppliers of such equipment is Singapore's own VT iDirect. Singapore's role as a hub for such cruises and airlines will be enhanced by ensuring the broadest range of frequencies is available to maintain satellite connectivity on such vessels and aircraft when they visit Singapore.

Singapore has also established itself as a media hub for the region by attracting broadcast and media companies to set up their operations on the island. Such companies rely on the C-band frequencies for video contribution and distribution, including of all the channels listed in Annex C. Singapore's continued role as a media hub in the region will depend on the success by which it protects C-band satellite services above 3.6 GHz or 3.7 GHz from terrestrial 5G services in the 3.5 GHz band.

Singapore is also becoming a major hub for cloud computing data centres. For example, Amazon Web Services, IBM Cloud, and Microsoft Azure have all established data centres in Singapore.[45] Such data centres can take advantage of Singapore's excellent terrestrial and submarine cable connectivity to reach users in other countries. However, not all countries can be reached practically via terrestrial means, which is why a number of cloud computing providers are partnering with satellite operators to offer cloud services via satellite as a means of expanding their markets.[46]

Importantly, Singapore can maintain and pursue its role as a major hub for these sectors while also providing more than enough spectrum for terrestrial 5G. As shown above, any realistic estimate of terrestrial 5G spectrum demand can be satisfied using spectrum from bands other than those already being used extensively for satellite services in the world.

Question 3: IMDA would like to seek views and comments on the suitable technical parameters, including the reasonable amount of guard band needed to reduce potential interference between IMT and FSS use in the 3.5 GHz band.

See the discussion in Part II, Section D, above. GSC has not commissioned technical studies on adjacent band protection measures. However, GSC member, AVIA, has prepared an overview of the respective technical studies performed in and technical parameters regulated in USA, UK and Hong Kong. This is attached at Annex F. GSC notes that IMDA's apparent proposal for a 100 MHz guard band in 3.6-3.7 GHz range resembles the proposal recently adopted by Hong Kong's OFCA.[47]

[45] *See*, *e.g.*, https://aws.amazon.com/about-aws/global-infrastructure/; https://www.ibm.com/cloud/data-centers/, https://azure.microsoft.com/en-us/global-infrastructure/locations/.

[46] *See*, *e.g.*, FutureiOT, *Inmarsat, Microsoft team up to deliver cloud services via satellite* (28 Feb. 2019), *at* https://futureiot.tech/inmarsat-microsoft-team-up-to-deliver-cloud-services-via-satellite/; Bloomberg, *SES Networks Enables Direct Connectivity to IBM Cloud via Global Satellite Network*, *at* https://www.bloomberg.com/press-releases/2018-10-04/ses-networks-enables-direct-connectivity-to-ibm-cloud-via-global-satellite-network (4 Oct. 2018). *See also* Amazon Web Services, *AWS Ground Station*, https://aws.amazon.com/ground-station/features/.

[47] *See* OFCA, *Change in the Allocation of the 3.4-3.7 GHz Band from Fixed Satellite Service to Mobile Service* at ¶13 (28 Mar. 2018), *at* https://www.coms-auth.hk/filemanager/statement/en/upload/441/ca_statements20180328_en.pdf.

The main concerns of GSC member companies are as follows:

1. **IMT unwanted emissions levels** – specifically out-of-band and, of most concern, spurious, since the latter extend far beyond 3 700 MHz, well into the standard C-band frequencies that are almost universally used by content providers for regional content distribution
2. **Guard band size** – if wider, disrupts more satellite services in the lower extended C-band, but may enable the remaining services in higher extended and standard C-band to operate more free of service disruptive interference, with less cost prohibitive receive filter installations
3. **IMT in-band emissions levels** – 3GPP standard TS 36.104 imposes no upper limit for wide area base stations, potentially permitting wiping out of satellite services, due to actual realisable receive filter performance, as compared to theoretical, but unrealisable "brick wall" performance
4. **Minimum separation distances** – from various types of IMT base stations to various earth stations, particularly the various teleports in and near Singapore
5. **Minimum coordination distance** – around 40km from earth stations, within which IMT power flux densities must be tightly controlled and proper coordination procedures established
6. **24/7/365 contact details for all IMT operators conducting trials and running services within minimum coordination distance** – with ability to address interference issues immediately
7. **Terrestrial 5G IMT-2020 tests in Singapore** – satellite operators and satellite service providers are unaware of the test specifications, and are concerned that they may not be representative of fully rolled out 5G services, with multiple 5G base stations surrounding earth stations, the use of multiple, beam forming antennas, and other developments.

Question 4: IMDA would like to seek views and comments on the following:
i) Whether the industry agrees with the timelines on the expected availability of the next wave of 5G spectrum; and
ii) Whether current deployments in the 2.5GHz FDD spectrum band(based on 3GPP Band 7) and in the 2.5 GHz TDD spectrum band (based on 3GPP Band 38), should be refarmed to 3GPP Band 41 for future 5G services in Singapore, and the views on the associated cost and challenges.

As IMDA has stated, terrestrial 5G rollout is expected to take several years and up to a decade or longer in the mmWave bands due to the high cost of infrastructure and length of time for equipment development. In addition, it is not expected that the 28 GHz band will see much development beyond a small number of countries who are intent on manufacturing the equipment, even though there will not be an international market. The GSC would urge IMDA to prioritise spectrum refarming from earlier mobile technologies to 5G, ahead of spectrum being used today to provide productive services in the satellite sector. In addition, the 26 GHz band is one of the most promising bands for 5G in the mmWave bands.

Question 5: IMDA would like to seek views, comments and suggestions on:
i) Whether Singapore should have two nationwide networks as a start given the considerations and trade-offs;
ii) The proposed 3.5 GHz lot sizes and spectrum packages;
iii) Whether 5G equipment would be able to support 3.5 GHz bandwidths in multiples of 50 MHz;

iv) The value, if any, in assigning the remaining 50 MHz restricted 3.5 GHz spectrum in the same assignment exercise as the unrestricted lots;
v) The proposed mmWave lot sizes and preferred band plan option; and
vi) The rank order preference of the 3.5 GHz spectrum package and mmWave lot combinations.

Please see Part II above. Specifically, GSC would urge IMDA to remove the 28 GHz from further consideration as a terrestrial 5G band for the reasons stated above. The 28 GHz band is not even needed under the IMDA plan for mmWave 5G.

Question 6: IMDA would like to seek views, comments and suggestions on:
i) The proposed network rollout and performance obligations to be imposed on the spectrum right holders;
ii) The methodology and measurement criteria for the coverage obligation;
iii) The network design and resilience challenges of 5G (in particular, enabling technologies, such as SDN, NFV and Cloud Computing that may fundamentally change how the network would be designed and deployed) and possible measures to address them, and whether there are other aspects that should be considered to enable trusted and resilient 5G network; and
iv) The framework for the provision of 5G wholesale services.

The GSC would urge IMDA to ensure that 5G licence conditions include regulatory measures and obligations to ensure protection of satellite services in the same and adjacent bands, as discussed in Part II, above, in related to various proposed bands. Without specific licence and rollout conditions to prevent such behaviour, network operators and their subcontractors may be tempted to cut corners in network deployment to hasten rollout, rather than to roll out responsibly and responsively to reported interference and disruption caused to existing critical and revenue generating services.

Question 7: IMDA would like to seek views, comments and suggestions on the spectrum assignment framework, including:
i) The proposed assignment approach;
ii) The spectrum right duration of the 3.5 GHz package and mmWave lots;
iii)The evaluation criteria, sub-criteria and weights to assess the proposals;
iv) The assessment methodology, including evidence (documentary or otherwise) to evaluate the proposals; and
v) The enforcement and/or audit mechanisms to ensure that applicants are able to deliver on their proposals.

The GSC would urge IMDA to include in the evaluation criteria a weighting in the range 5 – 10% for interference minimisation and elimination of disruptions to satellite and other established services.

Question 8: IMDA would like to seek views and comments on the trade-offs (particularly on resilience, 5G capabilities) and technical feasibility of the various levels of infrastructure sharing.

No comment, other than to note that satellite connectivity has been key to ensuring the resiliency of terrestrial networks in times of crisis or natural disasters. Submarine cables can be cut and terrestrial networks are often knocked out after typhoons, tsunamis, earthquakes and floods. In each case, satellites have been key to restoring communications quickly for disaster recovery and emergency telecommunications.

Question 9: IMDA would like to seek views and comments on the following:
i) The synchronisation approach for 5G TDD networks in a multi-operator environment for the 3.5 GHz and mmWave bands, specifically for the following:
a. Synchronised networks: the required frame alignment, compatible frame structures and BEM specifications for AAS and non-AAS base stations; and
b. Unsynchronised networks: the amount of guard band, geographical separation and BEM specifications for AAS and non-AAS base stations;
ii) The adoption of other suitable mitigation measures to mitigate interference between unsynchronised networks; and
iii)The need for IMDA to mandate a regulatory requirement for synchronisation across the 5G TDD networks or leave it to operators to co-ordinate their network deployment and parameters in order to reduce interference between networks.

The GSC commends IMDA's careful approach in ensuring 5G networks do not interfere with each other, including seeking comment on guard bands, geographic separation and BEM specifications for adjacent channel interference. We would urge the IMDA to take a similarly careful approach towards protection of satellite services operating in the same and adjacent bands, taking into account differences in relative signal levels. Please see the discussion in Part II above for satellite protection measures that are necessary and appropriate in various proposed 5G bands.

Question 10: IMDA would like to seek views and comments on the following:
i) The interest from industry players to leverage 5G spectrum or other mobile spectrum bands for fixed-wireless services that support mobile connectivity; and
ii) The policies (e.g., spectrum allocation, numbering) that should be considered to facilitate such use-cases.

The GSC would reiterate the fact that, in many countries, satellite services are already used to support 2G, 3G and 4G mobile connectivity today, and will be used to support 5G connectivity in the future.