10 January 2022

Submitted in Electronic Form
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For the kind attention of:
Shri Syed Tausif Abbas
Advisor (Networks, Spectrum and Licensing)
Telecom Regulatory Authority of India (TRAI)

Re: Consultation Paper on Auction of Spectrum in frequency bands identified for IMT/5G

This joint submission is being made on behalf of the Global Satellite Operators Association (GSOA)[1], the Asian Video Industry Association (AVIA)[2], Asia-Pacific Satellite Communications Council (APSCC)[3] and the Global VSAT Forum (GVF)[4] in response to Consultation Paper No. 8/2021 (the "Consultation Paper").

GSOA, AVIA, APSCC and GVF welcome the TRAI's Consultation Paper on spectrum policy. We believe the TRAI recognizes that satellites play a key role in connecting people, expanding ICT services and supporting the socio-economic development of all regions across India. Satellites present a cost-effective solution for tackling the digital divide, by enabling the rapid expansion of terrestrial networks or providing broadband directly to remote and hard to reach areas.

[1] **GSOA** is the global platform for collaboration between satellite operators. As the world's only CEO-driven satellite association, GSOA leads the sector's response to global challenges and opportunities. It offers a unified voice for the world's largest operators, important regional operators and other companies that engage in satellite-related activities. GSOA is recognised as the representative body for satellite operators by international, regional, and national bodies including regulators, policymakers, standards-setting organisations such as 3GPP, and international organisations such as the International Telecommunications Union (ITU) and the World Economic Forum (WEF).

[2] **AVIA** is the trade association for the video industry and ecosystem in Asia Pacific. AVIA's aim is to support a vibrant video industry for the benefit of all stakeholders. AVIA's members include many of the satellite operators providing the broadcasting and networking technology needed to conduct business both within and outside of India.

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

[4] **GVF** is the only global non-profit association of the satellite industry with members from the entire ecosystem. Founded in 1997 and headquartered in London, it brings together organizations from around the world representing operators, manufacturers, service providers and other parts of the satellite ecosystem that are engaged in the development and delivery of satellite technologies and services for consumers, commercial and government organizations worldwide. GVF's aim is to facilitate expanded access to satellite-based connectivity solutions, which is achieved through regulatory, policy and spectrum advocacy; training and certification; product quality assurance; and collaboration with user groups and other satellite stakeholders.

In many instances, satellites are being used to help expand the coverage of existing 3G and 4G networks to places that would not otherwise be covered. Furthermore, the integration of satellites into the 5G ecosystem will bring high throughput 5G and cloud computing services to all users, everywhere.[5]

However, to play their role in the communications ecosystem, satellites need continued access to adequate spectrum. For this reason, GSOA, AVIA, APSCC and GVF support a balanced approach to spectrum allocations that takes into account the spectrum needs of all relevant services (mobile, satellite, and others).

The Consultation Paper discusses a number of different frequency bands. GSOA, AVIA, APSCC and GVF would like to submit comments to the TRAI on two frequency bands which are essential to the provision of robust satellite services to Indian consumers and companies. This document will first present comments on questions raised in the Consultation Paper with regards to the 3300-3670 MHz band (see section 1) before moving on to comments specific to the 24.25-28.5 GHz band (see section 2). The comments of GSOA, AVIA, APSCC and GVF also express the satellite industry's strong opposition to auctions of spectrum for space-based communications (see section 3).

[5] *See*, K. Liolis, J. Cahill, E. Higgins, M. Corici, E. Troudt and P. Sutton, *Over-the-Air Demonstration of Satellite Integration with 5G Core Network and Multi-Access Edge Computing Use Case*, 2019 IEEE 2nd 5G World Forum (5GWF), 2019, pp. 1-5, doi: 10.1109/5GWF.2019.8911717; *see also*, https://www.ses.com/blog/ses-leads-satellite-enabled-5g-tests.

1 Comments Regarding the 3300-3670 MHz Band

The C-band frequencies have been used for more than 25 years in India to deliver TV Channels to the nation's population. Today, there are 900+ TV channels being beamed out to approximately 200 million households in India, serving more than 50,000 businesses in the form of Last mile Cable Operators (LCOs) and Multi-System Operators (MSOs), which generates substantial employment in the country. Both the Indian Space Research Organization (ISRO) and international satellite operators have invested billions of dollars in deploying multiple C-band satellite systems to keep pace with market requirements over the last two decades. The specific benefits of the use of C-band in India are:

- <u>A contribution to India's economic growth</u>: satellite-based television distribution has been the core of the media and entertainment industry in India over the last 20+ years. This had a net positive effect of INR 790 Bn (~$11Bn) in FY 2020, as estimated by the FICCI-EY M&E report[6], through all the Pay-TV subscriptions and ad revenues in the industry.

- <u>Foreign direct investment (FDI) in nation-building</u>: the share of the information and broadcasting sector in total FDI inflows into India peaked at 3.5% in 2016-2017. Over the last 10 years, this segment has brought in $5.4Bn worth of FDI to India, propelling growth as well as stimulating the Indian economy.

The 3300–3670 MHz band has been reallocated and identified for IMT/5G services in India, and this decision could cause detrimental effects on the Indian economy as a whole if these valuable C-band satellite services are not well protected as IMT/5G deployment proceeds in the country. These C-band satellite services will require measures – *e.g.*, in the form of power limits, guard bands and/or separation distances – to ensure that they are protected from terrestrial 5G services that may be deployed in an adjacent frequency band because C-band earth station receivers are susceptible to interference from the out-of-band emissions (OOBE) of 5G emitters.

1.1 Issues for Comment

In the Consultation Paper, the TRAI itemised a list of specific questions for comment. We address these issues below.

Q8. Whether entire available spectrum referred by DoT in each band should be put to auction in the forthcoming auction? Kindly justify your response.

India should re-consider whether the entire 3300-3670 MHz "mid-band" spectrum is truly needed for 5G/IMT. The terrestrial mobile industry commonly estimates that 80 to 100 MHz per mobile network operator (MNO) would be required for such services. In the response to claims by some MNOs that they need access to at least 80 MHz of contiguous spectrum, Ofcom -- the communications regulator in the United Kingdom[7] -- researched the ability of terrestrial mobile operators to launch 5G services with 40 MHz of spectrum. This research found that *"(…) there was no evidence that 5G could not be delivered*

[6] https://ficci.in/pressrelease-page.asp?nid=4137.

[7] *See,* Ofcom, *§A7.39, Award of the 700 MHz and 3.6-3.8 GHz spectrum bands: Annexes* (13 March 2020), available online at https://www.ofcom.org.uk/data/assets/pdf_file/0017/192410/annexes-award-700mhz-3.6-3.8ghz-spectrum.pdf.

with smaller [e.g. 40 MHz blocks] or non-contiguous carriers in other frequency bands [i.e. spectrum other than C-band]." To support its finding that 40 MHz of C-band spectrum was sufficient to provide 5G services, Ofcom developed a theoretical cell site throughput model to estimate network performance based on various assumptions on the type of antenna used, bandwidth of C-band carrier, and signal strength received by the user. The results clearly demonstrate that terrestrial mobile operators will be able to deliver all the main services anticipated under 5G – including, but not limited to, connected cars, virtual reality cloud broadband, and live 4K streaming – with 40 MHz of spectrum.

Figures 1 and 2, below, show the results of Ofcom's studies and clearly demonstrate that mobile operators will be able to provide all the main services provided by 5G with 40 MHz of spectrum. Mobile operators may want 80 to 100 MHz of spectrum from the C-band for optimal performance, but they do not need it to offer high quality services to remain competitive. In other words, most benefits arising from the implementation of 5G services, both for the economy and for consumers, will be obtained through the deployment by each MNO of the first 40 MHz of spectrum, with the deployment of any additional spectrum up to 100 MHz that they can acquire only bringing incremental benefits.

Based on this analysis, the 300 MHz of spectrum in the 3300-3600 MHz band should be more than enough to support India's mid-band 5G spectrum requirements, while preserving the 3600–4200 MHz band for productive and valuable satellite services. The 300 MHz of spectrum in the 3300-3600 MHz band can provide India's four MNOs with up to 75 MHz each, or the three private MNOs (with 90% of the mobile subscribers) with 80 MHz each and BSNL/MTNL (with 10% of subscribers) with 60 MHz – more than enough, by Ofcom's analysis, to support mid-band 5G services. There is also unassigned spectrum in the 2300 MHz and 2500 MHz bands that could be used to meet 5G spectrum demand for MNOs – all without having to disturb satellite services in the 3600-4200 MHz band.

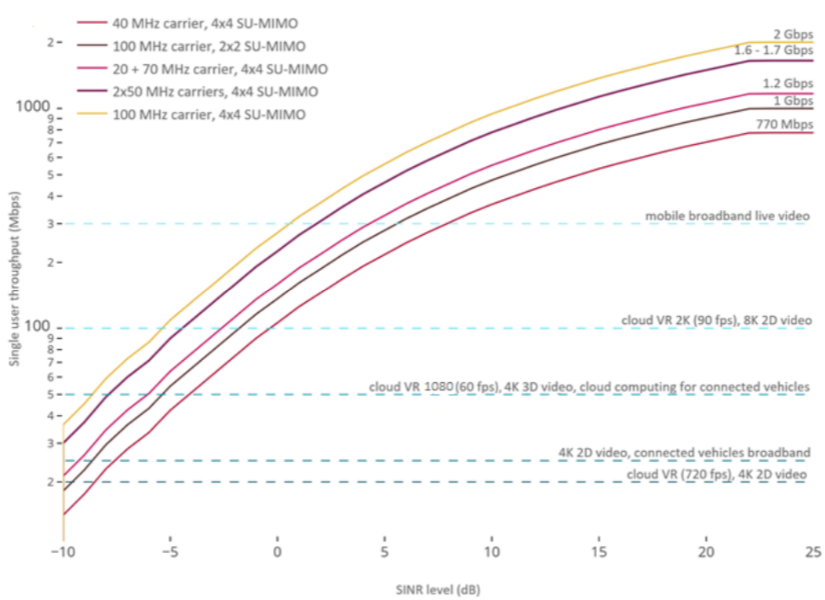

Figure 1. Downlink throughput for a single user (SUT) across different signal levels in a cell compared to the minimum rate required for some 5G services.[8]

[8] *See, Id, Figure A7.26*.

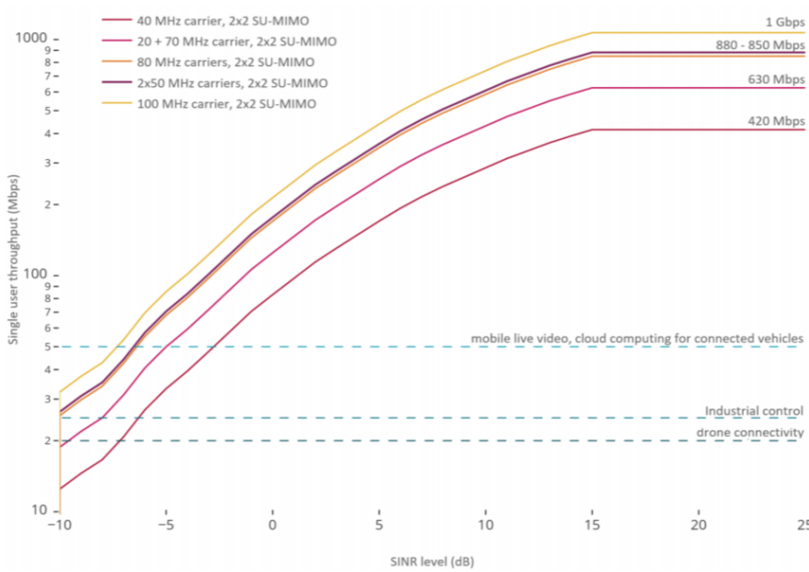

Figure 2. Downlink throughput for a single user (SUT) across different signal levels in a cell compared to the minimum rate required for some 5G services.[9]

The terrestrial mobile industry is arguing for 100 MHz of contiguous spectrum for the delivery of Ultra-reliable Low Latency Communications (URLLC). URLLC is a specialist application more suited to specific instances and not for general (public) use and, as such, is unlikely to generate the revenues needed to fund widespread 5G roll-outs. ITU-R Report M.2410-2017[10] "Minimum requirements related to technical performance for IMT-2020 radio interface(s)" recommends 100 MHz as the minimum bandwidth required for URLLC (and Enhanced Mobile Broadband, or eMBB). However, this ITU-R Report also states that the required 100 MHz can be achieved through multiple carriers: there is no requirement to achieve the 100 MHz through a single carrier using a single contiguous block. URLLC is also not considered a high bandwidth or data-hungry service.

5G standards set by 3GPP allow for the resource block sizes needed for URLLC in a 50 MHz bandwidth, which has additional advantages regarding the required signal strength and therefore the service range of the site.[11] It is important to emphasize that this specialist application would be deployed at specific locations such as campus and industrial sites, but not on a general network. URLLC would be better suited to unencumbered bands, free from neighboring operators, making certain millimetre wave spectrum in the 26 GHz band already identified for IMT far better suited for this application than C-band frequencies.

Q12. What should be optimal block size and minimum quantity for bidding in 3300-3670 MHz band? Kindly justify your response.

Based on Ofcom's findings and the analysis in the response to Q8, above, GSOA, AVIA, APSCC and GVF believe that the minimum quantity for bidding would be 40 MHz of spectrum to be able to launch 5G services.

[9] *See, Id, Figure A7.27.*
[10] Available online at: https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2410-2017-PDF-E.pdf.
[11] *ShareTechNote.com. 5G Frame Structure*, available online at: https://www.sharetechnote.com/html/5G/5G_FrameStructure.html.

Q16. Is there a need to prescribe any measure to mitigate possible interference issues in 3300-3670 MHz and 24.25-28.5 GHz TDD bands or it should be left to the TSPs to manage the interference by mutual coordination and provisioning of guard bands? Kindly provide justification to your response.

As submitted above, India's mid-band 5G spectrum requirements can be met using the 3300-3600 MHz band, supplemented by the 2300 MHz and 2500 MHz bands, without having to encroach on satellite services above in the 3600-4200 MHz band.

But whether the boundary between 5G/IMT and fixed-satellite service (FSS) is drawn at 3600 MHz or 3670 MHz, GSOA, AVIA, APSCC and GVF are concerned about the adjacent band compatibility between FSS stations and 5G/IMT stations, which needs to be carefully considered in order to protect C-band FSS operations. FSS earth stations are very sensitive to interference from 5G/IMT systems. While the separation distances related to adjacent band compatibility issues are smaller than those for co-frequency operations, it may not be feasible to ensure separation, in particular if FSS earth stations are deployed in large numbers or without the knowledge of their locations. Hence, careful consideration should be given to adjacent band compatibility issues as indicated in Figure 3, below, where interference to satellite receive earth stations could happen in the following ways:

- IMT emissions in the 5G/IMT band can saturate the Low Noise Block (LNB) downconverter of the FSS earth station, which traditionally operates in the 3400-4200 MHz band, even if the mobile 5G signal is adjacent to the satellite signal; and
- Unwanted (out of band and spurious) emissions of the mobile 5G/IMT signal falling within the FSS operating band can cause in-band interference to FSS signals.

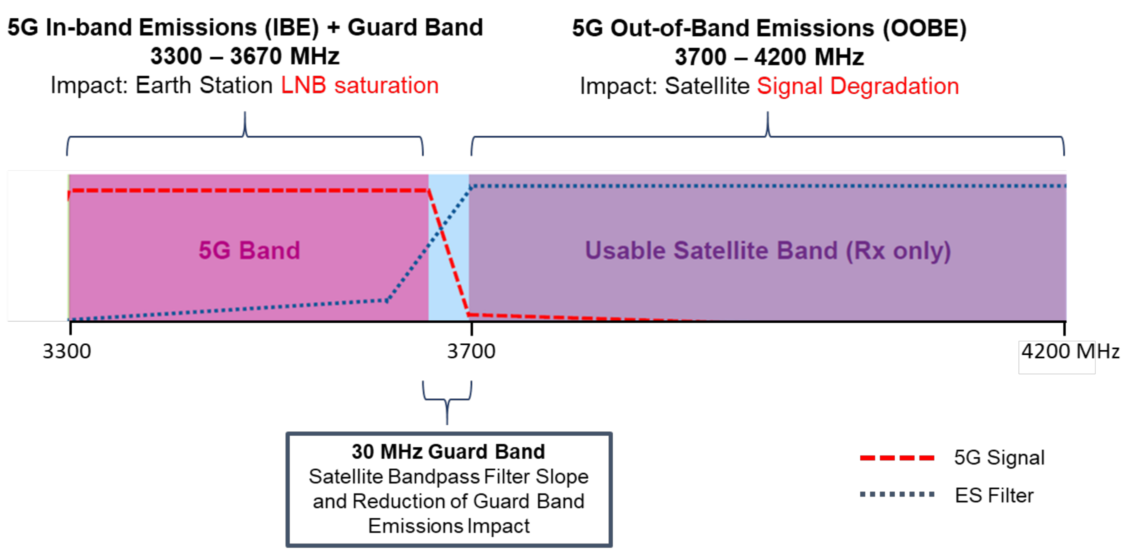

Figure 3. Adjacent band compatibility between FSS and IMT
(showing a nominal upper boundary of 3670 MHz for IMT; the boundary could be at 3600 MHz).

Typically, earth station LNBs are designed to receive the entire 3400-4200 MHz band. The 5G/IMT signals in the IMT band therefore can saturate the amplifier stage in the LNB or bring it into non-linear operation, thus blocking reception of signals. Moreover, emissions from 5G/IMT systems will cause the LNBs in the FSS earth stations to produce unwanted signals in the form of intermodulation products. These products will act as additional interfering signals and further degrade the performance of the satellite service.

As described above, the IMT systems' signal power at the input of an FSS earth station LNB can easily saturate the LNB and wipe out the satellite signal. The best solution to mitigate the IMT systems' interference is to insert a RF waveguide filter between the output of the antenna and the input of the LNB. This will filter out to a great extent the unwanted IMT signal from saturating the LNB.

Narrowing the frequency response of FSS earth stations could be an effective mitigation technique for those earth stations that do not need to receive the same frequencies used by IMT systems, to lower the magnitude of the interfering IMT signal received. This can be achieved by adding a filtering function before the LNB.

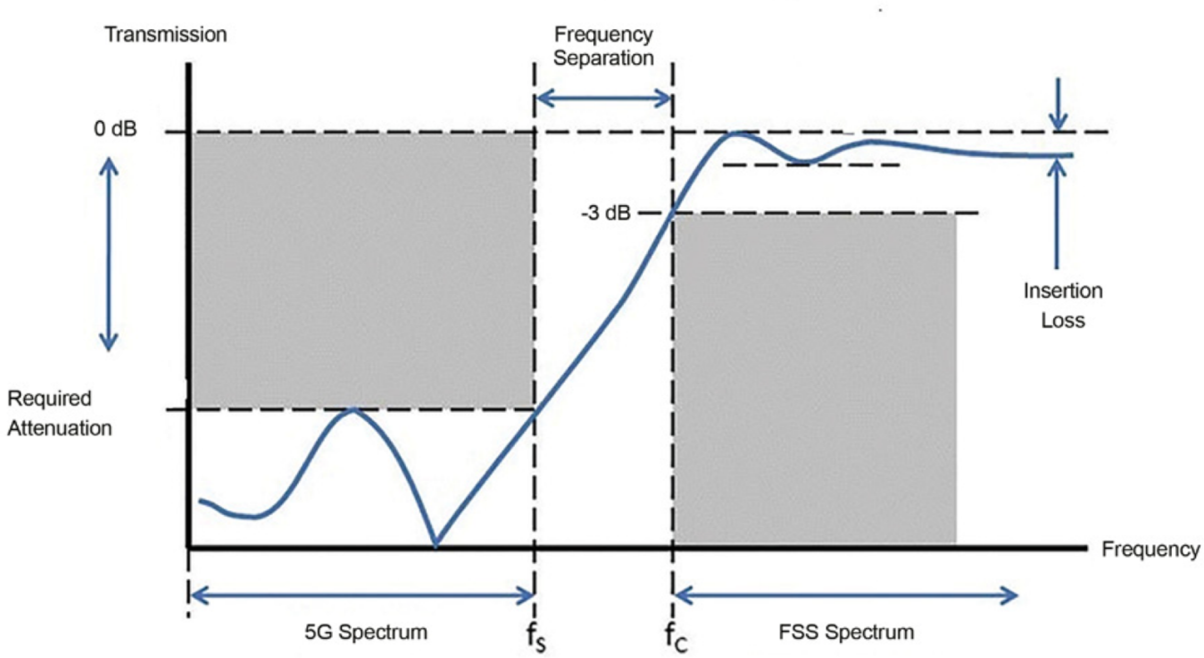

Figure 4. Filter and guard band.

As shown in Figure 4, above, the filter could only be operated properly if there is frequency separation (*i.e.*, a guard band) between the edge of the 5G/IMT transmission and the FSS transmission to provide the waveguide filter the necessary bandwidth to reject the 5G/IMT interference at the earth station. However, it is still important to note that the implementation of such filters on the FSS earth station receivers presents a certain number of drawbacks:

- Cost of filter and implementation rollout.

- Impact on the receiver performances (*e.g.*, filter insertion loss, increase of the system noise temperature, phase and group delay).
    - Special enhanced filters for a response with rapid attenuation increase within lower guard bands will imply elevated insertion losses that may generate the need to change the antenna to maintain the original G/T (and station operation) and avoid service interruption. In addition, according to previous calculations made by satellite operators, we notice that for systems employing adaptive coding and modulation, the introduction of the enhanced filter will result in a reduction in throughput of over 30% in some cases. <u>We are happy to share this analysis, if necessary</u>.

In addition, this frequency separation would guarantee some level of attenuation of the unwanted signals from the 5G/IMT operations falling in the FSS earth station receiving frequency band. As opposed to the 5G emissions in the IMT band that can be mitigated by the implementation of a filter at the FSS earth station, the 5G/IMT unwanted emissions falling within the satellite operational receive band cannot be filtered. Regulation on specific 5G/IMT unwanted emissions limits versus frequency separation is key in this context to limit the impact of these unwanted emissions on adjacent band operating services.

To conclude, it will be essential for the TRAI to establish adjacent band protection criteria for FSS earth stations vis a vis 5G/IMT (*e.g.*, a guard band in the IMT portion of the band) and an out-of-band power-flux density (PFD) limit for IMT transmitters to protect FSS earth stations in the adjacent band.

There are several countries that have done some field test experiment on how to deploy IMT, including 5G, while preserving satellite services in the 3400–4200 MHz band. Below are examples of several Asia Pacific countries that have performed field tests to study the coexistence between IMT and FSS and implemented the conclusions of those field test outcomes into their 5G spectrum roadmap in their respective countries.

1) Hong Kong

IMT allocation: 3400–3600 MHz.
Guard band: 100 MHz (3600–3700 MHz).
FSS allocation: 3700–4200 MHz.
Filter retrofitted @ FSS earth stations with the following specifications:

- At least 55 dB rejection for the band below the 3600 MHz band.
- Adoption of restriction zones to protect Telemetry, Tracking and Command (TT&C) stations.

The details on the Office of the Communications Authority (OFCA) decision on the reallocation of the 3.5 GHz band for IMT deployment, including its applicable mitigation measures, can be found at: https://www.coms-auth.hk/filemanager/statement/en/upload/441/ca_statements20180328_en.pdf.

2) Singapore

IMT allocation: 3450–3650 MHz, with 3600–3650 MHz and 3450–3500 MHz limited for indoor and underground use.
Guard band: 50 MHz (3650–3700 MHz).
FSS allocation: 3700–4200 MHz.

Filter retrofitted @ FSS earth stations with the following specifications:

- At least 45 dB rejection for the band below 3650 MHz.
- Adoption of 2 exclusion zones to protect critical FSS operations (*e.g.*, TT&C stations) and 5 precautionary zones for high density areas of C-band FSS operations.

The details on the Infocomm Media Development Authority (IMDA) decision on the reallocation of the 3.5 GHz band for IMT deployment, including its applicable mitigation measures, can be found at: https://www.imda.gov.sg/-/media/Imda/Files/Regulation-Licensing-and-Consultations/Consultations/Consultation-Papers/Second-Public-Consultation-on-5G-Mobile-Services-and-Networks/5G-Second-Consultation-Decision.pdf.

3) China

IMT allocation: 3300–3600 MHz, with 3300–3400 MHz limited for indoor use.
Guard band: 100 MHz (3600–3700 MHz).
FSS allocation: 3700–4200 MHz.
Filter retrofitted @ FSS earth stations with the following specifications:

- At least 55 dB rejection for the band below 3600 MHz.
- Adoption of interference coordination areas with a specific separation distance between IMT and FSS.

The details on the Ministry of Industry and Information Technology (MIIT) decision on the reallocation of the 3.5 GHz band for IMT deployment, including its applicable mitigation measures, can be found at (in Chinese language): http://www.srrc.org.cn/article22361.aspx.

Beside the 3 countries mentioned above, the Ministry of Communications and Informatics (MCI) in Indonesia has recently performed field test experiments to study the coexistence between IMT and FSS in the 3400–4200 MHz band. Based on field test experiments, the conclusions of this coexistence study between IMT and FSS are as follows:

- IMT allocation: 3400–3600 MHz.
- FSS allocation: 3700–4200 MHz.
- Guard band: 100 MHz (*i.e.*, 3600–3700 MHz).
- Additional band pass filter with specifications 60 dB rejection for the band below 3600 MHz.

The above conclusion can be found in the document submitted by Indonesia to the AWG-27 meeting, which we attached as Annex 1 to these comments.

Since Myanmar is one of India's neighboring countries, it is also worth mentioning the 5G spectrum roadmap in C-band of the Ministry of Transport and Communications, with the intention of preserving satellite services with the following conditions:

- IMT allocation: 3400–3520 MHz.
- FSS allocation: 3625–4200 MHz.
- Guard band: 105 MHz (i.e., 3520–3625 MHz).

The above conditions can be found at: https://www.ptd.gov.mm/Uploads/Reports/Attach/122020/200471330122020_Spectrum%20Roadmap%20(2020)'%20Facilitate%20the%20sustainable%20growth%20of%20Industry%20(Draft).pdf.

In addition, GSOA, AVIA, APSCC and GVF believe that India needs to protect other existing C-band primary services (*e.g.*, FSS) in its neighboring countries, such as Bhutan, Nepal, Bangladesh, Pakistan, Sri Lanka, China, and Myanmar from harmful interference due to 5G deployment in India.

Q20. What should be associated roll-out obligations for the allocation of spectrum in the 3300-3670 MHz frequency band? Kindly justify your response.

GSOA, AVIA, APSCC and GVF believe it is important for the MNOs who have won a bid to present their business plans with certain timelines on how they will utilize the spectrum. The Government would need to review whether such business plans are feasible or not, and also to monitor the implementation of such business plans regularly. This would include verification of the correct implementation of the 5G systems with respect to compliance with the regulatory provisions set out to protect other services in the C-band and in adjacent frequencies. For the specific case of FSS protection in the 3600-4200 MHz band, it is key that a process is put into place to ensure that defined adjacent band protection levels are respected, *e.g.*:

- Ensuring that there is ample frequency separation for the FSS filters to efficiently mitigate any interference from emissions in the 5G/IMT band.
- Ensuring that the 5G/IMT emissions comply with in-band and unwanted emissions limits.
- Ensuring that key FSS earth station sites are protected through the implementation of exclusion zones.
- Ensuring funding to cover implementation of protection for FSS earth stations through the implementation of filters when other interference coordination techniques are not feasible, and/or compensation of the costs associated with the necessary measures to compensate any degradation in the reception of the signal (due to filter installations), in order to restore the same quality of the service of the received signals, ensuring that the quality of the transmissions that are currently being made will be maintained without imposing additional costs to satellite or earth station operators.

Q24. Keeping in mind the importance of 3300-3670 MHz and 24.25-28.5 GHz bands for 5G, whether a spectrum cap per operator specific to each of these bands should be prescribed? If yes, what should be the cap? Kindly justify your response.

As per the Ofcom findings discussed in these comments, MNOs will be able to deliver all the main services anticipated under 5G – including, but not limited to, connected cars, virtual reality cloud broadband, and live 4K streaming – with 40 MHz of spectrum (see response to Questions 8 and 12, above). In addition, it is important to establish a spectrum cap per operator in order to avoid a monopoly and create conditions for fair and good competition among available MNOs in India. GSOA, AVIA, APSCC and GVF believe that 80 MHz of spectrum should be the spectrum cap for the band 3300–3600 MHz to accommodate the different terrestrial mobile operators.

Q27. For computation of overall spectrum cap of 35%, should the spectrum in 3300-3670 MHz and 24.25-28.5 GHz bands be included? Kindly justify your response.

In addition to an overall spectrum cap across multiple bands, GSOA, AVIA, APSCC and GVF favour in-band spectrum caps to avoid a monopoly and create conditions for fair and good competition. As per the above answers, a spectrum cap of 80 MHz prescribed for the 3300–3600 MHz band would correlate to an in-band spectrum cap of 26.7%.

Q69. To meet the demand for spectrum in globally harmonized IMT bands for private captive networks, whether the TSPs should be permitted to give access spectrum on lease to an enterprise (for localized captive use), for a specific duration and geographic location? Kindly justify your response.

GSOA, AVIA, APSCC and GVF do not have specific comments in response to this question. However, if the Government will allow TSPs to give spectrum on lease to an enterprise for localized captive use for a specific duration and geographic location, then it should not be in the 3670-4200 MHz band currently being used for satellite services, as suggested in ¶ 4.40 of the Consultation Paper. It will be very difficult to ensure protection of satellite services in the 3670-4200 MHz band from co-frequency private networks (especially if deployed outdoors) due to the sensitivity of the earth station receivers. Moreover, the deployment of such private networks will likely preclude any future deployment of FSS earth stations nearby due to interference.

Q71. Whether some spectrum should be earmarked for localized private captive networks in India? Kindly justify your response.

Reserving specific parts of the spectrum for specialised local applications is not an efficient method for maximising spectrum use. GSOA, AVIA, APSCC and GVF believe that localized private captive networks in India do not need dedicated spectrum since the frequency bands that have been identified for 5G/IMT could be reused by MNOs or through spectrum leasing for localized private captive networks in specific geographic locations.

If considered, spectrum for specialised local applications should be identified in bands internationally identified for 5G/IMT uses by the ITU. One of the principal technical features of 5G/IMT highlighted by mobile operators is the possibility to implement services to private networks through 'Network Slicing'[12]. Technical risks exist from allowing private local use of spectrum for non-IMT and IMT uses outside bands identified for IMT. To minimise the risks of spectrum being hoarded, underutilised, or traded by private local users back to 5G/IMT operators (resulting in losses to the Government and windfall gains to private network licensees), the TRAI will benefit from first assessing the level of long-term demand, roll-out success, and spectrum efficiency of licensed spectrum by 5G/IMT operators, before committing any exclusive long-term use of spectrum to private networks.

12 *See*, GSMA, *An Introduction to Network Slicing*, at 14 (2017) (describing network slicing for enterprise networks so that a "private network is no longer needed").

Q72. In case it is decided to earmark some spectrum for localized private captive networks, whether some quantum of spectrum be earmarked (dedicatedly) from the spectrum frequencies earmarked for IMT services and/or spectrum frequencies earmarked for non-IMT services on location-specific basis (which can coexist with cellular-based private captive networks on shared basis)? Kindly justify your response with reasons.

Please see above responses.

Q73. In case it is decided to earmark some quantum of spectrum for private captive networks, either on exclusive or shared basis, then

a) Spectrum under which band(s) (or frequency range) and quantum of spectrum be earmarked for Private Network in each band? Inputs may be provided considering both dedicated and shared spectrum (between geographically distinct users) scenarios.
b) What should be the eligibility conditions for assignment of such spectrum to private entities?
c) What should be the assignment methodology, tenure of assignment and its renewal, roll-out obligations?
d) What should be the pricing mechanism for assignment of spectrum in the band(s) suggested for private entities for localized captive use and what factors should be considered for arriving at valuation of such spectrum?
e) What should be the block size and spectrum cap for different spectrum band(s) suggested in response to point (a) above.
f) What should be the broad framework for the process of (i) filing application(s) by enterprise at single location, enterprise at multiple locations, Group of companies. (ii) payment of spectrum charges, (iii) assignment of frequencies, (iv) monitoring of spectrum utilization, (v) timeline for approvals, (vi) Any other
g) Any other suggestion on the related issues may also be made with details. (Kindly justify your response with reasons)

Should the Government decide to use exclusive spectrum for the deployment of private captive networks, then please refer to Figure 5, below. A study conducted by LS Telcom[13] indicates that there are around 400 MHz of spectrum identified for IMT in Region 3 that have not yet been licensed and utilized in India. Should there be a need to identify spectrum for private captive networks, the 400 MHz of spectrum that have not yet been licensed and utilized for IMT should be the primary candidate band for the deployment of private captive networks in the country – all without having to encroach upon spectrum being used for satellite communications.

GSOA, AVIA, APSCC and GVF note that private captive networks using 5G technology support bandwidths of 10, 15, 20, 30, 40, 50, 60, 70, 80, 90, and 100 MHz, and carrier aggregation can be used for combining spectrum in different frequency bands. Thus, we believe there is no imminent need for wide contiguous spectrum blocks for 5G spectrum.

[13] *See*, Analysis of the world-wide licensing and usage of IMT spectrum (lstelcom.com).

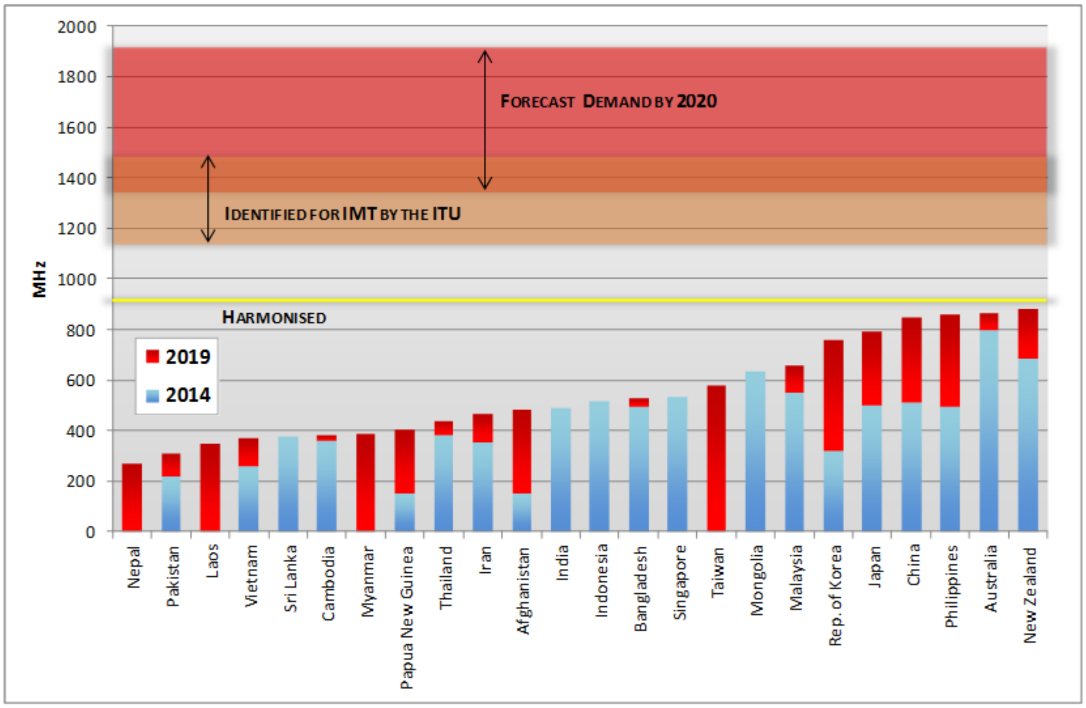

Figure 5. Harmonized IMT Spectrum in Region 3, Source: LS Telcom.

As an additional reference, the information in the Table in Figure 6, below, shows the harmonized spectrum for terrestrial mobile services that is available in Region 3. A total of approximately 915 MHz could be used for the private captive network deployments in India in a harmonized manner. The TRAI could review and identify which harmonized IMT spectrum has not yet been licensed and utilized in the country, and then could make available that spectrum for private captive network deployments.

3GPP Band		Uplink (MHz)	Downlink (MHz)	Region 3
FDD Bands				
31	450 MHz	452.5 - 457.5	462.5 - 467.5	10
28	700 MHz	703 - 748	758 - 803	90
5	850 MHz	824 - 849	869 - 894	Up to 130
8	900 MHz	880 - 925	935 - 960	
3	1800 MHz	1710 - 1785	1805 - 1880	150
1	2100 MHz	1920 - 1980	2110 - 2170	120
7	2600 MHz	2500 - 2570	2620 - 2690	140
Sub-Total				640
TDD Bands				
75/76	1400 MHz	1427 - 1517		90
33	1900 MHz	1900 - 1920		20
34	2000 MHz	2010 - 2025		15
40	2300 MHz	2300 -2400		100
38	2600 MHz	2570 - 2620		50
Sub-Total				275
TOTAL				915

Figure 6. List of Harmonized IMT Spectrum in Region 3.

Q74. What steps need to be taken to facilitate identification, development and proliferation of India specific 5G use cases for different verticals for the benefit of the economy and citizens of the Country? Kindly provide detailed response with rationale.

GSOA, AVIA, APSCC and GVF do not have specific comments on the above question. However, the TRAI should also note that the viability of 5G use cases remains uncertain. In China, for example, many 5G use cases previously touted by the terrestrial mobile industry – including remote surgery and 5G Virtual Reality – are being abandoned as too niche or expensive.[14] Indeed, one executive has admitted that the "showroom" applications "were ultimately just a promotion for 5G."[15]

1.2 Summary of Comments on C-band

Based on the above explanations, below is a summary of our comments on the Auction of Spectrum in the C-band, as identified in the Consultation Paper:

- There is no need to add more C-band spectrum for 5G services in the 3.5 GHz band in India, since the 300 MHz of C-band spectrum in the 3300-3600 MHz band is more than enough to deploy terrestrial 5G services in India.

[14] *See*, https://www.lightreading.com/asia/china-culls-unprofitable-5g-use-cases-as-it-narrows-focus/d/d-id/772855.
[15] *Id.*

- It is important for the Government to protect C-band FSS operations in India from harmful interference due to 5G deployments due to the importance of FSS contributing to the Indian economy. Any disruptions to C-band FSS in India would disrupt the Indian economy.

- It is important for the Government to establish technical frameworks to protect C-band FSS operations from harmful interference due to 5G deployments, such as an adequate guard band between FSS and 5G/IMT as well as clear unwanted emission limits for 5G/IMT. It is important to have clear rules and milestones associated to the process of reporting a harmful interference situation and facilitating the start of service of new earth station installations. This will avoid lengthy coordination and interference resolution processes that may harm the existing ecosystem of C-band solutions and could negatively impact the development of new satellite services in this frequency band.

- This approach can be seen in some Asia Pacific countries that have successfully deployed 5G services while protecting C-band FSS operations in the adjacent band.

- The Government should include proper financial coverage for the costs of protection of C-band users during and after 5G rollouts. This would cover the installation of filters, the replacement of antennas and the associated logistics.

- In addition to overall spectrum caps, it will be important to prescribe an in-band spectrum cap of 80 MHz to establish conditions for fair and good competition among MNOs to deploy 5G in India. Fair and good competition among MNOs will benefit 5G end users in the country. This document also notes that 40 MHz of spectrum would already allow terrestrial mobile operators to deliver all the main services anticipated under 5G.

- Localized captive networks in India do not need a dedicated spectrum band since the spectrum assigned for IMT/5G could be reused by the MNOs or via spectrum leasing to serve localized captive networks.

- Should the Government decide to use dedicated spectrum for localized captive networks, then there are around 400 MHz of harmonized IMT spectrum in Region 3 that have not yet been utilized and licensed in India. That spectrum would be the primary candidate bands for the localized captive networks use, and not spectrum that is currently being used for satellite communications.

2 Comments Regarding the 24.25-28.5 GHz Band

<u>2.1 Issues for Comment</u>

Following are the responses from GSOA, AVIA, APSCC and GVF with respect to the questions for comment on the 24.25-28.5 frequency band.

Q8: Whether entire available spectrum referred by DoT in each band should be put to auction in the forthcoming auction? Kindly justify your response.

GSOA, AVIA, APSCC and GVF object to the inclusion of the 27.5-28.5 GHz band in India's 5G auction plans, and instead support the continued prioritization of the FSS, including Earth Stations in Motion (ESIM), in the 27.5-31.0 GHz bands (Ka-band) so that existing and planned satellite systems in this frequency band can deploy and provide broadband services ubiquitously.

Ka-band frequencies are essential for the operation of modern broadband satellite systems. Hundreds of GEO satellites and thousands of non-GEO satellites using Ka-band frequencies have been and are being launched to deliver broadband services everywhere. Satellite-based services in the Ka-band support a wide variety of applications, including aeronautical and maritime broadband, mobile backhaul connectivity, fixed broadband services, and government universal service programs, among others. These satellite systems can help provide internet connectivity to schools, hospitals, government offices and businesses of all sizes, and also provide disaster relief operations. By offering backhaul services that complement terrestrial networks where optical fiber is hard to lay or terrestrial infrastructure does not exist, satellites can help terrestrial mobile operators connect local industries and customers in hard-to-reach, underserved and unserved areas.

For the frequency range 27.5-28.5 GHz, GSOA, AVIA, APSCC and GVF propose that the TRAI recommend the following:

- The spectrum from 27.5-28.5 GHz should be excluded from the auction for 5G/IMT.
- Access to the 27.5-28.5 GHz band should be maintained for FSS, both for gateway feeder links, ESIM uses and customer terminals.
- The frequency bands identified for 5G/IMT in India should be aligned with the internationally harmonized 3GPP n258 (26 GHz) band (24.25-27.5 GHz).

We present the following justification for this recommendation:

- The frequency range 27.5-28.5 GHz is already used in many of the satellites that are either launched or in the build stage and will deploy to offer broadband services around the world, including to customers in India. The Department of Space (DoS) recognizes the critical space operations that take place in the 28 GHz band, and previously objected to the band being allocated to the mobile industry.16 The allocation of the 27.5-28.5 GHz frequency range to IMT/5G will severely impair the deployment and operation of these satellites and curtail the capacity available to offer broadband services.
    - Any requirement for FSS and IMT (mobile 5G) to share any portion of the 27.5-28.5 GHz band will constrain and, at the same time, prevent both services from reaching their full potential due to the geographical separation distances required to ensure compatibility.

- Considering the propagation characteristics of the 27.5-28.5 GHz frequency range for 5G/IMT, these frequencies would be best suited for 5G capacity enhancement in urban areas. However, satellite broadband systems use the 27.5-28.5 GHz for service coverage all across the country and around the

[16] *See*, https://economictimes.indiatimes.com/industry/telecom/telecom-news/dept-of-space-isro-refuse-to-free-up-28-ghz-band-for-5g-rollout/articleshow/68714554.cms.

world. Additionally, the 27.5-28.5 GHz band is used by satellite systems to provide coverage to subscribers who live in unserved and underserved areas, where options for access to broadband solutions are lacking. Given a choice between using this band to provide more 5G in areas that already have 5G or using this band for high-speed satellite services to connect all parts of the country, the Government should choose the latter.

- According to data published by the TRAI, as of June 2021 less than 38% of the rural population in the country subscribes to the internet. There are still over 25,000 villages in India that have no internet or terrestrial mobile services available. Despite efforts by the Government to lay optical fiber, less than 65% of the gram panchayats in the country are connected. Satellite systems can bridge the digital divide in India and bring internet connectivity to rural, far-flung and hard to reach regions of the country, as noted in the TRAI's recent consultation paper on the ease of doing business in the telecommunications sector.[17] The TRAI Chairman, PD Vaghela, has acknowledged the potential of satellite communications to connect underserved areas in India.[18] Satellites are vital to achieving the country's goal of 'broadband for all' outlined in the National Digital Communications Policy, 2018, a fact that has been recognized by officials in the Department of Telecommunications (DoT) as well.[19]

- Countries which have allocated the Ka-band from 27.5-28.5 GHz to the FSS have a much smaller geographical area that has been adequately covered by fiber network. This is not the case with India. More than 70% of the population lives outside urban areas and do not have access to broadband services.

- The recent pandemic has demonstrated that while the urban population switched to an on-line mode of learning and supporting work requirements, the population living outside urban areas struggled to receive education and access to economic opportunities. The single biggest factor was lack of quality broadband in the areas that have been poorly served by terrestrial communication networks. Surveys suggest that only 20% of students in India have access to reliable online education, with reliable internet connectivity being a significant reason for the lack of access.[20]

- ISRO has already manufactured satellites that use the 27.5-28.5 GHz band for rural connectivity projects of the Government. If the 27.5-28.5 GHz band is allocated for 5G/IMT, some of these programs will be set back by several years severely impacting the rural connectivity initiatives of the Government.

- In 2018, the Government announced the Flight & Maritime Connectivity rules based on recommendations put forth by the TRAI. These rules designate the frequency band from 27.5-28.5 GHz for use by these services. Service providers have made investments to launch Flight & Maritime Connectivity services using the 27.5-28.5 GHz band, and a sudden change in the regulations will severely impact investor confidence and set a wrong precedent for the development of broadband technologies in India.

[17] *See*, *Consultation Paper On Ease of Doing Business in Telecom and Broadcasting Sector*, 8th December 2021, available at: https://trai.gov.in/sites/default/files/CP_08122021.pdf.
[18] *See*, https://telecom.economictimes.indiatimes.com/news/satcom-can-boost-connectivity-in-remote-areas-trai-chairman/87874106.
[19] *See*, https://telecomtalk.info/new-spacecom-policy-satellite-broadband-boom-india/461071/.
[20] *See*, https://www.thehindu.com/news/national/remote-education-was-inaccessible-to-most-children-says-survey/article37461115.ece.

- 4G/5G services need backhaul services to reach the remote areas of the country. These backhaul services are provided by satellites very effectively. The TRAI recognized this need and further recommended allowing VSAT operators to provide backhaul services via satellite.[21] However, without access to the 27.5-28.5 GHz band, the satellite capacity available to provide these backhaul services will be severely reduced.

- There is plenty of other spectrum that could be used for 5G in the millimetre wave bands without disturbing the extensive satellite use of the 27.5-28.5 GHz band. For example, the 24.25-27.5 GHz band has been identified by the ITU for 5G/IMT use on a global basis (while the 27.5-28.5 GHz has not). The 24.25-27.5 GHz band provides 3.25 GHz of total spectrum for 5G/IMT services. Considering that there are four terrestrial mobile operators in India, an assignment of 800 MHz to each is possible for immediate deployments in the 24.25-27.5 GHz band.

- There is ample evidence to indicate that the 24.25-27.5 GHz band is more than enough to satisfy 5G requirements in millimetre wave bands. For example, in 2018 South Korea licensed each of their 3 MNOs with 800 MHz of 5G spectrum in the 26/28 GHz bands, with an obligation to build out more than 45,000 5G base stations by the end of 2021. However, by the end of August 2021, these 3 MNOs had only built out a total of 161 base stations across the country due to a lack of demand and applications to justify the investment.[22] Similarly, the European Commission has found a lack of demand for 26 GHz spectrum for 5G, noting that while millimetre wave bands were once popular, "their popularity had now waned."[23] Accordingly, there is no justification for taking the 27.5-28.5 GHz away from productive satellite uses in order to satisfy uncertain 5G demand, especially when there is plenty of other unencumbered millimetre wave spectrum available for terrestrial mobile applications.

- If demand for spectrum for 5G in millimetre wave bands eventually emerges, the 2019 ITU World Radiocommunication Conference (WRC-19) identified an additional 14 GHz of spectrum for 5G/IMT in several frequency bands (37-43.5 GHz, 45.5-47 GHz, 47.2-48.2 GHz, and 66-71 GHz). These spectrum identifications in millimetre wave bands provide more than adequate spectrum for any future growth of 5G/IMT services that might emerge. Existing and growing satellite services in the 27.5-28.5 GHz band need not be sacrificed for possible future 5G millimetre wave services.

- In the 3GPP's plenary meeting that took place between 6-17 December 2021, various enhancements were agreed for NTN[24] work for Release 18. Specifically, an NTN-NR Work Item was approved with one objective being to look at NR-NTN deployment in bands above 10 GHz -- this will start with a study using harmonized Ka-band frequencies[25] (17.7-20.2 GHz and 27.5-30.0 GHz) as the reference, providing important recognition of satellite services in the Ka-band.

- By allocating the 24.25-27.5 GHz band to 5G/IMT and keeping the 27.5-29.5 GHz band for FSS, the Government would ensure that both 5G and satellites can reach their full potential, while avoiding the need for complex co-existence rules. Satellite operators have demonstrated and continue to

[21] *See*, *Recommendations on 'Provision of Cellular Backhaul Connectivity via Satellite Through VSAT Under Commercial VSAT CUG Service Authorization'*, 28th July 2020, available at: https://trai.gov.in/sites/default/files/Recommendations_28072020_0.pdf.

[22] *See*, http://www.koreaherald.com/view.php?ud=20210910000417.

[23] *See*, https://5gobservatory.eu/26-ghz-holds-back-achievement-of-eu-5g-goals/.

[24] Non-terrestrial networks (satellite, etc.).

[25] 3GPP TSG RAN Meeting #94e RP-213690.

demonstrate a requirement to access to the full spectrum range between 27.5-31.0 GHz, with the steady of launch of satellites in this band over the last two decades and with the introduction of new GEO and non-GEO broadband satellite systems.

- Whilst admitting both types of allocation (FSS/IMT) follow one type of public interest and its adequacy to each country's specific needs should be assessed, there is currently no valid evidence that actual usage of the 26 GHz band for IMT services will not be sufficient to meet such public interest needs.

- Auction success depends on adequate spectrum prioritisation aligned with demand. global research[26] demonstrates that the highest demand for 5G spectrum is in the mid-bands, while there is little demand for 5G in millimetre wave spectrum in the 26 and 28 GHz bands.

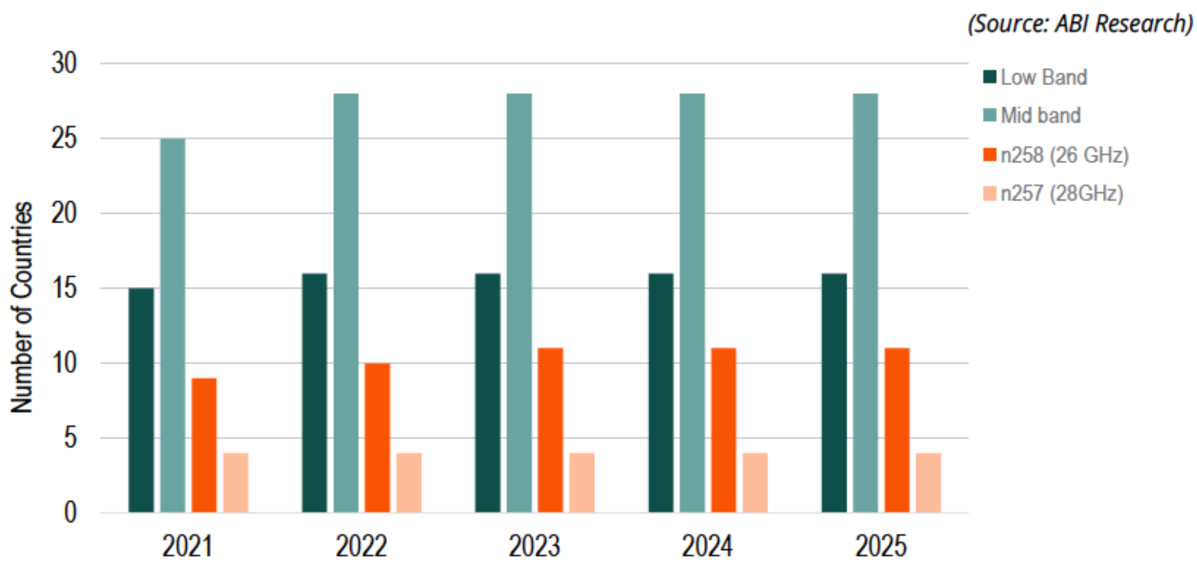

Figure 7. Current and expected spectrum allocation for terrestrial 5G in emerging markets, 2021-2025

The same studies show that 5G in millimetre wave spectrum in the 26 GHz and 28 GHz bands has not had significant use. Offering bands with low demand poses the risks of spectrum being unsold or, even worse, being diverted from productive satellite services but then underutilised by terrestrial players. Both of these outcomes will result in a costly regulatory failure for India, through the loss of substantial economic opportunities. These losses will result from a failure to allocate the 27.5-28.5 GHz spectrum for higher economic value uses and, from denying Indian citizens, business and public entities the opportunity to enjoy ubiquitous, cost-effective satellite broadband. It is noted that Brazil, another large economy, recently attempted to auction millimetre wave spectrum for 5G, which resulted in unsold spectrum[27]. As noted above, one of the major countries promoting 5G in the 28 GHz band, Korea, has not seen any

[26] ABI Research: *Emerging Markets Broadband Objectives: Spectrum Requirements* (2021), available at: https://go.abiresearch.com/lp-emerging-markets-broadband-objectives-spectrum-requirements.

[27] Reuters, *Brazil to reschedule auction for unsold 5G spectrum, minister says* (Nov. 5, 2021), available at: https://www.reuters.com/business/media-telecom/brazil-reschedule-auction-unsold-5g-spectrum-minister-says-2021-11-05/.

significant demand for 5G services in the 26/28 GHz band with just 161 millimetre wave 5G base stations deployed after several years instead of the government-required 45,000 by the end of 2021[28].

Offering the 27.5-28.5 GHz band in the upcoming 5G auction for low-demand and costly 5G broadband uses in millimetre wave spectrum will result in Indian citizens being denied the benefits of high-demand, advanced satellite broadband services. Plum Consulting has shown that using the full 27.5-29.5 GHz band for satellite broadband in India would result in an estimated increase in GDP of up to USD 184.6 billion (see Figure 8, below).[29] This potential uplift in GDP would be substantially impaired if half of that spectrum were to be auctioned unnecessarily for 5G instead. As explained above, 5G demand for millimetre wave spectrum (if and when it eventuates) can be met with the 26 GHz band without taking any 28 GHz spectrum away from productive satellite services.

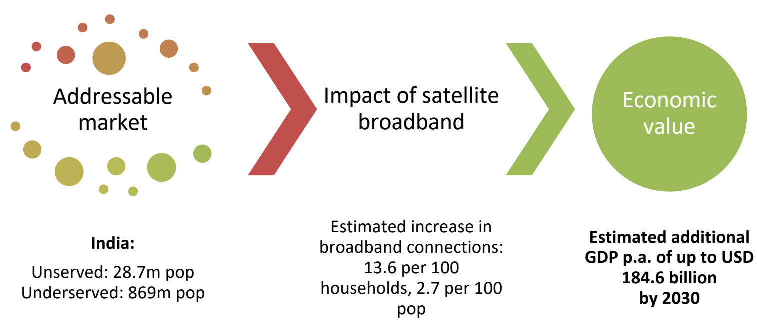

Figure 8. Estimated economic benefits of allocating the full 28 GHz band (27.5 – 29.5 GHz) for satellite broadband in India (Source: Plum Consulting, 2021)

If, despite the above arguments, the Government were to auction the 27.5-28.5 GHz band for 5G, it should allow future FSS fixed earth stations to be deployed in the band by agreement with the 5G licensees. Because 5G in millimetre wave bands will generally only be deployed as a "capacity band" in dense areas, it is likely that the 27.5-28.5 GHz band will not be used by MNOs for 5G in all places. In such circumstances, there should be a mechanism whereby an FSS earth station licensee seeking to use the band can coordinate the use of such spectrum with 5G licensees.

[28] The Korea Herald, *Telecos lag in mmWave 5G equipment installation: lawmaker* (Sept. 10, 2021), available at: http://www.koreaherald.com/view.php?ud=20210910000417.

[29] Plum: *Expanding digital connectivity through satellite broadband in the 28 GHz band* (Oct. 2021), available at: https://plumconsulting.co.uk/expanding-digital-connectivity-through-satellite-broadband-in-the-28-ghz-band/. Compare GSMA, *The Impacts of mmWave 5G in India*, at 2, 13 (Oct. 2020) (estimating USD150m increase in GDP from 2025-2040 due to millimetre wave 5G in India), available at: https://www.gsma.com/spectrum/wp-content/uploads/2020/11/mmWave-5G-in-India.pdf.

Q16. Is there a need to prescribe any measure to mitigate possible interference issues in 3300-3670 MHz and 24.25-28.5 GHz TDD bands or it should be left to the TSPs to manage the interference by mutual coordination and provisioning of guard bands? Kindly provide justification to your response.

The following comments address the 24.25-28.5 GHz bands.

GSOA, AVIA, APSCC and GVF urge the TRAI to only consider interference mitigation after a high-level plan has been devised and agreed for the use of each of the separate 26 GHz and 28 GHz bands. GSOA, AVIA, APSCC and GVF note that 5G/IMT systems have been designed to be incompatible with satellite services, including ESIM, on a co-frequency basis. Hence, at a minimum, the TRAI should decouple the 26 GHz and the 28 GHz bands for separate analysis and public consultation because the interference contexts for services in each band are very different.

In terms of in-band interference, IMT/5G systems are not being designed to be compatible with the existing and widespread satellite use of the same spectrum. As technical studies by both the terrestrial IMT/5G and the satellite industries have shown, introducing terrestrial IMT/5G services in the same bands as satellite services could constrain the continued evolution of satellite services, in violation of the principles of Resolution 238 (WRC-15)[30]. Notably, these studies may understate the incompatibility of terrestrial IMT/5G with satellite use of the 28 GHz band, because in its separate 3GPP standards process, the terrestrial IMT/5G industry is defining terrestrial IMT/5G technologies that operate at very different parameters (such as power levels and antenna pointing) than those they otherwise have identified as relevant to the ITU studies[31].

Separate and apart from incompatibility issues is the risk of aggregate IMT/5G interference from any terrestrial transmissions in the 28 GHz band into satellite receivers in space (which are designed to receive 28 GHz uplink signals from satellite user terminals and gateways). This issue has not been studied at the ITU in the context of today's broadband satellite systems, because, again, the ITU did not even consider designating the 28 GHz band for terrestrial IMT/5G services.

GSOA, AVIA, APSCC and GVF have supported the study and the development of reasonable operating parameters for terrestrial IMT/5G in the 26 GHz band through the ITU WRC-19 process. To this end, GSOA, AVIA, APSCC and GVF urge the DOT and the TRAI to conform domestic deployment of terrestrial IMT/5G in the 26 GHz band to the operating parameters decided in Resolution 242 (WRC-19).[32] GSOA, AVIA, APSCC and GVF emphasize the importance of the portion of this Resolution that requires IMT/5G base stations within the 26 GHz band with higher power operations (e.i.r.p per beam exceeding 30 dB (W/200 MHz)) to not point their antenna beams upward and maintain a minimum separation angle of ≥± 7.5 degrees.

[30] *See* ITU-R, Resolution 238 (WRC-15), available online at: https://www.itu.int/dms_pub/itu-r/oth/0c/0a/R0C0A00000C0014PDFE.pdf.
[31] *See, e.g.*, 3GPP TS 38.104 V15.2.0 (2018-06).
[32] See, ITU-R, Resolution 242 (WRC-19), available online at: https://www.itu.int/dms_pub/itu-r/oth/0C/0A/R0C0A00000F0080PDFE.pdf.

Q.21 What should be associated roll-out conditions for the allocation of spectrum in 24.25 to 28.5 GHz frequency range? Kindly justify your response

The text in the Consultation Paper states in Sec. 2.67 that "*24.25–28.5 GHz (mmWave) spectrum is likely to be used for provision of 5G use cases/applications requiring very high data rates and ultra-low latency. Therefore, the TSPs would be deploying it selectively in the areas where the demand for such use cases/applications exists. Further, the technical characteristics of high band are such that it cannot be used for meeting coverage requirement.*"

It is clear that, given the contention in the 24.25-28.5 GHz band and its high value for satellite services, nationwide allocation to 5G of the 27.5-28.5 GHz band is not the best way forward in India, as it would unnecessarily sterilize valuable spectrum in areas where 5G will never be deployed in the country using these frequencies.

In the most unfortunate case that the 27.5-28.5 GHz frequencies were auctioned nationwide for 5G on an exclusive basis, the spectrum denial to other services would also be nationwide. Any such 5G spectrum allocation should therefore be associated with strict nationwide roll-out conditions. Spectrum unused within a certain timeframe, according to the rollout conditions, should be promptly recovered and its use reconsidered.

Q.71 Whether some spectrum should be earmarked for localized private captive networks in India? Kindly justify your response

GSOA, AVIA, APSCC and GVF oppose the suggestion that the 28.5-29.5 GHz band be earmarked for private 5G networks. There is no clear need for India to earmark spectrum for localized private captive networks. Demand for such private networks can be more efficiently met by MNOs using "network slicing" capabilities commonly found in 5G to create such networks using the MNO's own infrastructure, spectrum and know-how. In the alternative, MNOs could lease unused spectrum for such purpose. Moreover, a wide range of other frequency bands already identified for IMT could be used to accommodate these private systems without having to encroach on bands used and planned to be used for critical satellite services. In any event, any use of the 28 GHz band for private networks should be on a non-protected, non-interference basis to ensure that satellite services in this band can continue to be deployed without constraints.

3 Spectrum for Space-based Communications

The satellite community opposes the suggestion (in sections *1.51-1.53* of the Consultation Paper) of a possible auction mechanism for satellite spectrum in any satellite band for GEO or non-GEO systems.

The parallel between "access spectrum" for satellite and terrestrial networks does not stand, as the spectrum sharing mechanism is completely different. Spectrum assignment for satellite services should be based on an administrative process, which is standard procedure elsewhere. In fact, spectrum assignment by auction is not suitable for spectrum that can be shared between multiple satellite operators and systems (such as in the C-, Ku- and Ka-bands), whether in GEO or non-GEO orbits. Such efficient sharing of spectrum by satellite systems is made possible also thanks to the directivity of antennas. Spectrum assignment by auction to satellite services in these bands would lead to unnecessary spectrum segmentation and, therefore, a terribly inefficient use of spectrum. This is a very different situation from spectrum assignment to terrestrial mobile operators, where spectrum cannot be shared amongst MNOs and has to be managed by a single operator.

In summary, a spectrum auction for satellite spectrum would artificially limit the number of satellite operators sharing the spectrum and exclude them from the market, while satellite operators can (differently from terrestrial mobile operators) coexist in the same frequency range.

4 Conclusion

GSOA, AVIA, APSCC and GVF appreciate this opportunity to share our views with the TRAI. In addition, GSOA, AVIA, APSCC and GVF stand ready to provide additional information on any of the topics discussed in this contribution, if the TRAI would find that useful.