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25 October 2024

Attention: Shri Akhilesh Kumar Trivedi
Telecom Regulatory Authority of India (TRAI)
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Comments to consultation paper: "Terms and Conditions for the Assignment of Spectrum for Certain Satellite-Based Commercial Communications Services"

NGSO spectrum use matters posed in questions 4 & 5 of the consultation paper:

Viasat India commends TRAI for inviting industry comments on implementing Terms and Conditions for spectrum use. Firstly, we highly commend TRAI's consideration of the need to consider issues posed by obscure practices (split filings) that some very large NGSO players have implemented in their ITU filings. Such practices are designed to obscure their systems' levels of unacceptable interference. Secondly, we also commend TRAI for recognising the need to consider the case for national level conditions to deal with interference challenges posed by very large NGSO networks aiming to bypass internationally agreed rules for the appropriate coordination of satellite systems under the ITU Radio Regulations.

Question 4: "*For assigning spectrum for NGSO-based communication services, whether every ITU filing should be treated as a separate satellite system? Please provide a detailed response along with international practice in this regard.*"

Question 5: "*Whether the provisions of ITU-RR are sufficient to resolve interference related challenges and coordination issues? If not, what additional conditions should be prescribed while assigning frequency spectrum for NGSO…"*

Viasat is of the view these two questions are highly relevant because of the emerging NGSO issues posed by the so called "LEO mega-constellations" in terms of their orbital-spectrum resource overconsumption and related production of interference into existing and planned GSO systems. We are also of the view these two questions are highly interlinked and need to be considered together. TRAI's review of these issues posed in questions 4 and 5 is very timely and need to be addressed promptly. If these two questions are left unaddressed, there will be irreversible interference impacts on India's sovereign systems, on the systems that currently serve India, as well as impacting on India's ability to secure its own use of NGSO and GSO resources in a healthy and competitive market environment.

We encourage TRAI to implement licensing conditions that will ensure spectrum use by NGSO systems will comply with ITU regulations (Article 22 epfd limits) and to develop and implement policies designed to safeguard the fair sharing of resources between NGSO systems. Very large NGSO systems (mega-constellations), through overconsumption of orbital and spectrum resources, represent a market distortion that will negatively affect India's ambitions to: a) continue to protect its critical satellite systems, and b) ensure a healthy and competitive market environment.

Some of the key impacts of orbital-spectrum overconsumption by LEO mega-constellations resulting from the misapplication of the ITU filing processes and violation of ITU interference limits (EPFD) include:

- Depriving NGSO newcomers from access to limited orbital-spectrum resources, resulting in reduced competition;
- Overconsuming the interference margins (EPFD limits) NGSO systems are supposed to share through the provisions of internationally agreed ITU rules aimed at mitigating unacceptable interference into India's sovereign GSO systems and other systems serving India;
- Increasing levels of interference into critical (sovereign and regional) GSO systems, such as those deployed, managed and operated by ISRO;
- Failing to comply with agreed rules to mitigate interference from a single NGSO system as well as from the aggregate of all NGSO systems operating over India;
- Creating asymmetrical dependencies that will affect India's national interests.

The Government of India highlighted its vision to increase the nation's share of the global space economy from 3% to 10% in coming years[1]. As India continues to leverage its satellite capabilities, it will be crucial for India to effectively navigate the challenges posed by first-to-market oriented players that prioritize market dominance through scale and speed and the monopolization of scarce and shared spectrum and orbital resources. This type of "winner takes all" approach by some players threatens the entire space economy and India's vision.

Enclosed we provide a detailed responses to Questions 4 and 5. Additionally, we are providing a response on Question 13 on the matter related to mobile satellite services. We look forward to further discussions and remain available to share more details on the matters posed.

Yours sincerely,

Cristian Gomez
Vice President
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[1] Space and G20: https://www.isro.gov.in/g20selm/assets/pdf/space_and_G20.pdf

Viasat's response to questions 4 and 5 of the consultation paper

Question 4: "*For assigning spectrum for NGSO-based communication services, whether every ITU filing should be treated as a separate satellite system? Please provide a detailed response along with international practice in this regard.*"

Every ITU filing submitted as part of a NGSO system **should not** be treated as a single and separate NGSO system. Single system epfd compliance (on the complete NGSO system), filed with the ITU, must be conducted, taking into account all its filings combined as a whole. Combining all ITU filings for that system is necessary, noting that some very large NGSO operators have implemented a deliberate practice of **"splitting filings"** into smaller parts, seeking to artificially reduce, on paper, their epfd interference levels.

Some very large NGSO operators have misapplied the ITU NGSO filing system to break their satellite system filings into multiple parts with separate filings for the same spectrum ('split filings'), and in at least one case, these same filings for a single system were also split between different administrations[2]. Each filing artificially (on paper only) appears to generate less interference than the whole system, making it easier to meet the single entry EPFD interference limits in Tables 22.1A to 22.4D and obscuring the single-entry interference evaluation which should be performed on a whole system.

In this regard, WRC-23 considered protection of GSO services from the maximum aggregate EPFD produced by multiple NGSO systems in frequency bands where EPFD limits have been adopted[3].

More inefficiencies can be seen in instances of **filings of the same NGSO constellation through different countries**. According to a recent study of filings between 2017 and 2022, three nations – Norway, Germany, and the United States – submitted filings for SpaceX.[4] The same study identified instances where a constellation had been split across multiple filings by the same or different administrations: for example, SpaceX's Starlink Gen2 constellation was submitted across 22 filings.

The BR has noted that this practice could be used to obtain favourable EPFD results that may have exceeded and hence violated the ITU interference limits if submitted as a single constellation:

… thus the only reason for misapplication of these single entry epfd limits by artificially splitting or combining non-GSO FSS systems, will be to lower the epfd levels and therefore to get a favourable finding status as a result of this regulatory examination....[5]

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2 ITU-R (2023), *Director, Radiocommunication Bureau: Report of the director on the activities of the radiocommunication sector*, Addendum 2, page 69.

3 ITU-R (2024), *World Radiocommunication Conference 2023 (WRC-23), Final Acts, December 2023.* Resolution 76 (REV.WRC-23), pages 291-294.

4 A. Falle, E Wright, A. Boley and M. Byers (2023), "One million (paper) satellites", in *Science* Vol 382 no 6667, pages 150-152. Available at https://www.science.org/doi/10.1126/science.adi4639.

5 ITU (2002), *CPM report to World Radiocommunication Conference (WRC-03)*, R00-CPM-SP-0001, section 3.1.1.

The misapplication of these ITU filing processes by very large NSGO systems, as recognised by the ITU Radiocommunication Bureau, relates to the inability of very large NGSOs (LEO mega-constellations) to comply with the internationally-agreed interference limits of the ITU that protect critical GSO systems. As such, ITU filing practices and interference compliance issues need to be considered together. In our response to Question 5 below, we explain these issues with a view to highlighting the linkages.

Question 5: "*Whether the provisions of ITU-RR are sufficient to resolve interference related challenges and coordination issues? If not, what additional conditions should be prescribed while assigning frequency spectrum for NGSO…"*

Coordination of the shared and finite satellite orbit-spectrum resource and licensing conditions to safeguard India's options in space communications infrastructure

The satellite industry is very familiar with spectrum sharing, as virtually all its spectrum is "shared" in very concrete ways. In GSO, for example, multiple satellite operators "share" the same satellite spectrum by angular separation along the geostationary arc. In NGSO, orbit sharing between systems is more complex due to the number of satellites and the variability of communication and network architecture. Although, the ITU's Radiocommunication Regulations provide a framework under which traditional frequency coordination agreements are negotiated between GSO satellite operators, this regulatory construct is proving inadequate for large constellations and vertically integrated mega-constellations that are blocking other smaller NGSOs from operating in a manner that is competitive with the large constellations.

Moreover, there is growing evidence of certain NGSO operators failing to comply with single-entry EPFD limits. This is compounded with the growing problem that the aggregate EPFD budget is being disproportionately consumed by a few NGSO operators. Recognizing India's space economy vision in NGSO as well as its existing GSO investments, we urge TRAI to consider the the impacts on India's current and future plans.

The realisation of India's vision and satellite infrastructure plans hinges on the implementation of market access procedures that effectively manage the significant risks presented by large constellation NGSO systems, which include (for example):

- Consuming an undue amount of spectrum and orbits in contravention of the International Telecommunication Union (ITU) Constitution, specifically Article 44, paragraph 2, which recognises that radio frequencies and orbits are limited natural resources and must be used "rationally, efficiently, and economically;"

- Generating undue interference that constrains the ability of other satellite systems to innovate and compete (both NGSO and GSO);

- Consuming more than their share of the interference allowance toward GSO networks and thereby hindering opportunities for other parties, including national operators, to operate their own NGSO systems

- Precluding equitable access to spectrum and orbits by other NGSO systems by using up all available "look angles" through the extremely large number of satellites within their networks and particularly when employing small user terminals with wide beamwidths; and

- Unduly raising the risks and costs associated with access to and use of space (regardless of orbit), including potential collisions and the creation of orbital debris.

Viasat proposes TRAI to require NGSO license applicants to satisfy the following requirements (A, B and C) in order to help mitigate the threats posed by large NGSO LEO satellite systems seeking to serve India:

Requirement A – Protect GSO networks from unacceptable interference generated by NGSO systems.

The potential for disruption to GSO networks by co-frequency NGSO systems is well-known and is what led to the development of various ITU Radio Regulations intended to protect GSO networks from interference generated by NGSO systems and define the terms under which both GSO and NGSO systems are to coexist. The principal provision for coexistence, No. 22.2 in the RR, requires NGSO systems to not cause *unacceptable* interference to GSO networks. Equivalent power flux density (EPFD) limits apply in certain bands that, if actually met during operation, fulfil the RR No. 22.2 obligation with respect to an NGSO system. There are two types of EPFD interference limits:

- "Aggregate" EPFD limits constrain the amount of interference that all NGSO systems may generate in total, on a cumulative basis. These aggregate limits must be shared and apportioned among all NGSO systems using overlapping frequencies.

- "Single-entry" EPFD limits constrain the amount of interference that one NGSO system itself may generate with respect to GSO networks. The single-entry limits were established based on an apportionment to a single NGSO system of a portion of the applicable "aggregate" EPFD limits.

Single-Entry EPFD limits to be met by a single NGSO system

Based on the data provided in a given ITU EPFD input filing, the ITU's Radiocommunication Bureau (BR) does a limited assessment of the EPFD levels, based on ITU-R Recommendation S.1503[6], that may be generated by a NGSO system with respect to *one particular combination of earth station location and GSO satellite location* (so called "worst-case geometry"). This limited assessment has little bearing on the interference that a NGSO system can be expected to produce at various locations within India, which may not be reflected in a worst-case-geometry assessment.

[6] ITU-R S.1503: Functional description to be used in developing software tools for determining conformity of non-geostationary-satellite orbit fixed-satellite service systems or networks with limits contained in Article 22 of the Radio Regulations.

The ITU alone cannot effectively check all of the ways an NGSO system operator may try to artificially utilize EPFD inputs in a way designed to "pass" the ITU's spot checks regarding EPFD without reflecting how the NGSO system actually would operate and affect every nation. And there are multiple and well-documented examples of this already occurring. Notably, that responsibility falls on individual administrations and regulators that consider authorizing, or granting market access to, NGSO system operations.

In a recent contribution to WP4A[7], it was demonstrated how one NGSO operator has artificially designed a single PFD mask of one of the orbital shells, to force the current algorithm to select a specific and favourable, but non-representative, 'worst-case geometry' (WCG) for the entire NGSO system. Without inclusion of that particular PFD mask of the orbital shell, which has not been authorised by the filing administration for operation, S.1503-2 software inappropriately produces higher EPFD with a lower number of satellites. Such practices conceal the interference produced by all other PFD masks of the same NGSO system filing that actually contain higher PFD levels at locations outside the WCG, leading to large exceedances of the limits at geometries other than WCG. These EPFD limit exceedances are not identified in the examination based on S.1503-2, which may result in a flawed favourable finding for an NGSO system based on an engineered PFD mask that forces the software to evaluate interference towards GSO networks in a limited and non-representative location on Earth.

As the ongoing work in ITU Working Party 4A reflects, there are significant shortcomings in the outdated Recommendation S.1503 software used by the ITU. Fortunately, alternative software is available, and more is being developed that allows a more accurate assessment of the expected interference within India.

Aggregate EPFD limits to be met by *all* NGSO systems, collectively

Radio Regulations Resolution 76 (Rev. WRC-23) defines the aggregate EPFD limits that must be met by all NGSO systems, collectively, and calls for administrations to take all possible steps, to ensure that the aggregate interference into GSO FSS and GSO BSS networks caused by NGSO systems does not exceed those limits.

In the event that the aggregate EPFD limits are exceeded, it further calls for administrations, to take all necessary measures expeditiously to reduce the aggregate EPFD levels to the limits given in Tables 1A to 1D of Res. 76.

A critical component of the aggregate EPFD assessment is to define a methodology by which multiple NGSO operators would reduce EPFD levels in case of any exceedance. Such a reduction in EPFD level must be proportional to the contribution of each NGSO system towards the aggregate EPFD. Unequitable sharing of the aggregate EPFD budget amongst NGSO systems would hinder opportunities for other parties including national NGSO systems and new entrants.

Before authorising any NGSO system to operate in India, TRAI should define a methodology for how the aggregate EPFD budget can be shared amongst all NGSO systems and how the NGSO systems will reduce the

[7] *See* WP4A document 4A/94 (18/04/2024) *Working document towards a preliminary draft revision of Recommendation ITU-R S.1503-4 - Underestimation of non-GSO interference arising from the use of worst-case geometry in S.1503 and necessity to supplement it with grid-based EPFD analysis*.

NGSO system EPFD levels, in case of exceedances. It is unreasonable to expect that NGSO licensees will adapt their operations if the aggregate EPFD exceedance is evaluated in India at a later time, especially when there is no methodology defined upfront at the time of license grant. At the very least, it will be a long process that will cause harm to GSO operations throughout the time of the aggregate EPFD exceedances by the NGSO systems. Moreover, should interference issues arise, isolating and identifying individual EPFD contributions of every NGSO system toward the aggregate EPFD will be an impossible task.

The importance of rigorously enforcing these measures is underscored by SpaceX's recent FCC filings, which include (i) a proposal to open and change the EPFD levels above those provided in Article 22 and Resolution 76 of the ITU Radio Regulations[8], (ii) a separate filing to seek authority to allow exceedances of the EPFD limits[9], and (iii) a request for authority to launch its entire constellation of over 29,000 satellites in LEO as well as a separate request for waiver of equivalent power flux density limits.[10]

Therefore, Viasat urges TRAI to conduct an independent assessment of potential for interference as entry requirement prior to obtaining a licence, from a single NGSO system and all NGSO systems collectively, within India's national territory that are not covered by the limited assessments performed by the BR regarding ITU filings for the LEO system. Such assessment should require from a NGSO operator:

- A demonstration of compliance with the single-entry and aggregate equivalent power flux density (EPFD) limits prescribed in the ITU Radio Regulations Article 22 (Art. 22) and ITU Resolution 76, respectively. This should include:
    - A demonstration for the LEO constellation as a whole;
    - A demonstration for the specific portions of the LEO constellation proposed to serve India (including the exact satellite altitudes and inclinations proposed to be used);
    - A demonstration for a suitable number of representative geographic locations within India and for all GSO satellite networks serving, or proposed to serve, India;
    - A demonstration of how the LEO system avoids interference to GSO networks created by numerous LEO earth station and satellite antenna sidelobes, and earth station antenna backlobes, particularly when phased array antennas are employed;

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8 *See In the Matter of Revision of the Commission's Rules to Establish More Efficient Spectrum Sharing Between NGSO and GSO Satellite Systems*, Petition for Rulemaking, RM-_____ (Filed 9 August, 2024), https://www.fcc.gov/ecfs/document/10809160739016/1.

9 *See Space Exploration Holdings, LLC*, Call Sign S3069, File Number SAT-MOD-20241011-00224 (Filed 11 October 2024), https://licensing.fcc.gov/cgi-bin/ws.exe/prod/ib/forms/reports/swr031b.hts?q_set=V_SITE_ANTENNA_FREQ.file_numberC/File+Number/%3D/SATMOD2024101100224&prepare=&column=V_SITE_ANTENNA_FREQ.file_numberC/File+Number.

10 *See Space Exploration Holdings, LLC*, Call Sign S3069, File Number SAT-AMD-20241017-00228 (Filed 17 October 2024), https://licensing.fcc.gov/cgi-bin/ws.exe/prod/ib/forms/reports/swr031b.hts?q_set=V_SITE_ANTENNA_FREQ.file_numberC/File+Number/%3D/SATAMD2024101700228&prepare=&column=V_SITE_ANTENNA_FREQ.file_numberC/File+Number.

- A demonstration for the operation of the LEO constellation alongside the operation of all other co-frequency NGSO constellations serving India.

- Information on the ITU filing under which the each of the NGSO systems seek to operate in India and where the NGSO system operate under multiple filings, each application should contain EPFD input files (e.g. SRS and mask database) that represent their system as a whole and that are consistent with their ITU submission.

In order to ensure that the expected interference evaluated based on above assessment is not exceeded during NGSO operation, the following licensing conditions are necessary:

1. Each individual NGSO system shall comply with the single-entry EPFD limits in Art. 22 and all NGSO systems, collectively, shall comply with aggregate EPFD limits in Resolution 76 (Rev. WRC-23);

2. The NGSO operator shall operate its system as a single constellation for purposes of the EPFD limits, no matter how many ITU filings it may seek to operate under;

3. The NGSO operator shall confirm that its deployed NGSO system is fully consistent with its ITU filings;

4. The NGSO operator shall comply with all the parameters provided in its ITU filing, specifically;
    - Maximum number of co-frequency beams serving a specific location in India, commonly known as “Nco”,
    - Minimum GSO arc avoidance angle, commonly known as “alpha angle,”
    - The downlink power flux density mask (PFD mask), taking into account the actual characteristics of NGSO system as deployed, including the radiation pattern of its satellite antenna.

As mentioned above, the aggregate EPFD limits define the interference that all NGSO systems, collectively, can generate towards GSO network and thus establish a total interference budget that must be shared by ALL NGSO systems. If, for example, one NGSO operator is allowed to operate with two NGSO systems (e.g. generation 1 and generation 2) and each one has a separate “share” of that aggregate budget, that NGSO operator can consume almost 60% of the total aggregate EPFD budget, which must be shared amongst *all* NGSO operators. To avoid disproportionate allocation to a single NGSO operator of aggregate EPFD interference budget amongst all NGSO operators, it is critical to treat all the NGSO satellites of one NGSO operator as a whole.

The need for the conditions discussed above is reinforced by the Director of the ITU's Radiocommunication Bureau recently released a report which explains that the practice of splitting a NGSO satellite system into several filed systems, "may affect the effectiveness of single-entry limits contained in Art. 22 to protect geostationary systems or have an impact in the implementation of Resolution 76 (Rev.WRC-15)."[11]

Requirement B - Ensure large NGSO constellations share frequencies and orbital resources effectively with other NGSOs, including by not relying on the requirement to coordinate, but instead requiring:

- Operating with only 1/n of the look angles in a given country, where n is the number of NGSO systems authorised to serve India in the same frequency band (whereby NGSO systems serving a country in overlapping frequencies would divide the range of satellite azimuths as seen from a location on the Earth whenever the potential for NGSO/NGSO interference exists at that location);

- Coordinating in good faith and in advance with other NGSO systems so that all n look angles may be used to serve India by different NGSO systems; and

- Maintaining an orbital tolerance of +/- 2.5 km for the apogee and perigee of each NGSO satellite, and a 0.5° tolerance for each orbital inclination the NGSO system employs, in order to ensure other NGSO systems may access the shared LEO space (or comply with such other orbital tolerance requirements as India deems appropriate to ensure the ability of other satellites and systems serving its territory to operate in the same, or overlapping, orbits occupied by the NGSO system).

Viasat recommends TRAI to review the coordination terms used to provide service within India to ensure that those agreements do not unduly constrain other NGSO systems seeking to serve India and do not result in a disproportionate distribution to one NGSO operator of the aggregate EPFD allowance to be shared by all NGSO systems serving India.

Requirement C – Take concrete steps to limit safety risks posed by NGSO operations, including by submitting a collision risk analysis of the NGSO system, as a whole, for the full orbital life of each satellite and its replacements, and as system characteristics and the orbital environment may change.

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[11] Director, ITU Radiocommunication Bureau, Preliminary Draft Report of the Director to WRC-23 on the Activities of the Radiocommunication Sector Experience in the Application of the Radio Regulatory Procedures and Other Related Matters, Addendum 2 to Document 4-3 (September 2023), at 28-29. Resolution 76 is discussed below. It addresses compliance with limits on the entirety of the aggregate EPFD↓ created by all NGSO systems of all operators.

TRAI-DoT to continue to actively participate in ITU discussions concerning EPFD

At WRC-23, India - along with a large cross-section of ITU Member States including Japan, France, Germany, Brazil, South Africa and others[12] - rightly rejected a proposal by a couple very large LEO mega-constellations to introduce a new WRC agenda item to remove, relax or replace the existing EPFD limits of the Radio Regulations. That rejected proposal was aimed at benefiting only a couple of well-funded, vertically integrated and very large LEO mega-constellations.

Viasat encourages TRAI and DoT to continue to participate in ITU discussions on EPFD. There is critical work ongoing at the ITU (ITU-R Working Party 4A) to improve the fidelity with which NGSO system(s) EPFD levels are evaluated, through update of ITU-R Recommendation S.1503, for the assessment of NGSO systems' ITU filings with respect to the Art. 22 single-entry and Resolution 76 (Res. 76) aggregate NGSO EPFD limits in the ITU Radio Regulations. **And as WRC-23 mandated, such work is to be done "without any regulatory consequences**."[13]

Tens of billions of dollars have been, and continue to be, invested in GSO infrastructure around the globe that provides critical Internet, broadcast television, and communication services to users at home, in the office, and on the move. The GSO infrastructure also supports weather forecasting (e.g., providing real-time information about weather patterns and storm systems), remote sensing (*e.g.*, collection of data and monitoring events on the Earth's surface, such as oceanic and coastal phenomena, and wildfires), defence and security, and navigation/PNT (e.*g.*, navigation systems use of GSO data to calibrate and enhance their own accuracy).

This unprecedented investment, and the resulting FSS and Broadcasting Satellite Service (BSS) services provided to countless people, are possible because of the regulatory certainty provided by the EPFD provisions found in Art. 22 (single-entry) and Resolution 76 (aggregate) of the ITU Radio Regulations. Those longstanding provisions define the communication "lanes in space" for both GSO networks and NGSO systems, controlling the level of interference that NGSO systems may generate into GSO networks, and allowing each type of technology to design its own satellite architectures, raise funding, deploy, innovate, and evolve, without unduly constraining the other.

Art. 22 and Resolution 76 are designed to ensure the efficient use of applicable C-, Ku- and Ka-band frequencies, taking into account the physics of GSO and NGSO orbits. Namely: (i) NGSO systems can and do freely operate across a wide swath of orbits around the world without adversely affecting use of the GSO orbit (when properly designed to do so); (ii) GSO networks are by definition, constrained to operating in the

[12] *See* article from the Financial Times, September 2024: https://www.ft.com/content/ac7702c8-238f-4656-bd26-a2ba445af971

[13] *See* the minutes of the eleventh Plenary of WRC-23 ("WRC-23 invites ITU-R to conduct technical studies on the epfd limits in Article 22, including the epfd limits referred to in No. **22.5K**, in order to ensure the continued protection of GSO FSS and BSS networks, and to inform WRC-27 of the results of the studies, without any regulatory consequences. This work should not be submitted under Agenda Item 9.1.").

limited orbital region above the equator; and (iii) NGSO interference into the numerous GSO networks is kept to permitted levels.

Both GSO networks and NGSO systems have coexisted for decades while sharing the same spectrum because NGSO systems have operated within the Art. 22 EPFD framework. NGSO systems can easily comply with Art. 22 by appropriately managing their emissions when passing through, or near, the line-of-sight between a GSO satellite and a GSO terminal. Ensuring that the certainty provided by the current interference framework remains in place for both existing and future GSO networks and NGSO systems is paramount for this success and innovation to continue to flourish.

Despite the decision at WRC-23 not to adopt a future agenda item with respect to the Art. 22 framework, a few large NGSO system operators once again are proposing to upset this long-settled spectrum access arrangement (see, e.g., report from Vietnam on the outcomes of WRC-23 submitted to the recent APT Wireless Group (AWG)[14]. These proposed changes would adversely affect tens of billions of dollars of satellite investments by GSO operators like ISRO and users from all nations—and the vital missions GSO satellites fulfil, including the provision of communication, broadcast, scientific, civic, and defence/security services.

Five of six regional groups and ultimately the WRC-23 rejected this proposal to study the EPFD limits for review and replacement as a couple of the NGSO operators attempted to force on the rest of the world. The WRC-23 repeatedly made it clear that the continued protection of GSO FSS and BSS networks is a priority and that any technical studies should focus on better NGSO modelling for the purposes of GSO protection under ITU-R Recommendation S. 1503, instead of wasted and fruitless efforts to open the EPFD limits themselves, contravening the directions of the WRC-23. Despite the clear need and support for S.1503 studies, a few NGSO mega- constellation operators continue to relitigate the outcome of WRC-23 in a failing effort to reopen the limits at WRC-27.

We note that, as discussed, conducting a national epfd assessment will be of critical importance to India, considering that one very large NGSO operator has already begun requesting its administration to remove epfd compliance obligations in that region of the world[15]. This operator is one of the few very large NGSO operators that are also the proponents to the ITU-R of increasing the interference levels of their NGSO system by 100 times (at least 20 dB increase), significantly shifting the interference environment in India, affecting its sovereign and other GSO systems. Since this operator is not aiming to operate under ITU-RR agreements, as per their petition to be exempted from epfd compliance obligations, India (and all other administrations) will have an increased interest in ensuring the continued protection of sovereign and other GSO systems providing services in its territory.

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[14] *See* Information Document No. AWG-33/INF-08 and the Report on "*Long-term Sustainability of the Orbital-Frequency Resources*" at https://ietvn.com/satellite-research-projects/.

[15] See details on the petition to the FCC: https://www.satellitetoday.com/connectivity/2024/10/15/spacex-requests-starlink-gen2-modification-previews-gigabit-speeds/

Viasat urges TRAI and DoT to continue to focus on the issue the entire world has recognized and identified as a matter of priority: improving how the existing EPFD protection criteria are implemented by addressing, amongst other things:

- Efforts to split a single NGSO system into multiple ITU filings to evade the EPFD protection criteria of Art. 22;[16]

- Artificially designing a single PFD mask of one of the orbital shells, to force the current algorithm to select a specific and favourable, but non-representative, 'worst-case geometry' (WCG) for the entire NGSO system.[17]

- The failure to consider geometric alignments shown to exist in which NGSO interference exceeds that permitted by Art. 22 (i.e., non-"worst-case-geometry" alignments);[18]

- The failure to consider the exceedances of EPFD protection criteria caused by the countless sidelobes from many 100s of NGSO satellites operating above and below the GSO arc;[19]

- Manipulation of EPFD inputs provided to the ITU that mask Art. 22 EPFD exceedances that otherwise would actually exist in practice;[20] and

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[16] *See* BR director's report to WRC-23, dt – 14 Aug 2023, Addendum 2 to Document 4, section 3.1.4; "*Thus, the only reason for misapplication of these single entry epfd limits by artificially splitting or combining non-GSO FSS systems, will be to lower the epfd levels and therefore to get a favourable finding status as a result of this regulatory examination*."

[17] *See* WP4A document 4A/94 (18/04/2024) *Working document towards a preliminary draft revision of Recommendation ITU-R S.1503-4 - Underestimation of non-GSO interference arising from the use of worst-case geometry in S.1503 and necessity to supplement it with grid-based EPFD analysis*.

[18] *See* ITU-R contribution, Document 4A/833-E (7 September 2022), Viasat, Inc., https://www.itu.int/md/R19-WP4A-C-0833/en, Proposal for Addressing Non-Detection of EPFD Exceedances Due to Reliance on Only a Worst-Case Geometry Evaluation, demonstrating that NGSO systems which have received favorable EPFD findings by the ITU Radiocommunication Bureau under the current process have been shown to exceed the Radio Regulations Article 22 EPFD down limits with other geometries. Peak exceedances range from 3 - 8 dB.

[19] *See* contribution WP4A/104 from France, "Working Document Towards a Preliminary Draft Revision of Recommendation ITU-R S.1503: Accounting for all sidelobe contributions of non-GSO FSS satellites in Recommendation ITU-R S.1503".

[20] *See* "Letter from Pantelis Michalopoulos, Counsel to DISH Network Corporation, to Marlene H. Dortch, FCC," IBFS File Nos. SAT-LOA-20200526-00055 and SAT-AMD-20210818-00105 (Call Sign S3069), March 6, 2023, https://www.viasat.com/content/dam/us-site/corporate/documents/2023.03.07%20DISH%20Network%20Letter%20(SAT-LOA-20200526-00055%20et%20al.pdf. This letter demonstrates that "SpaceX based its new power level calculations on an incorrect and non-compliant exclusion zone for the protection of geostationary ("GSO") satellites in an attempt to manufacture a showing of compliance with the International Telecommunication Union's ("ITU's") power limits."

- Implement Resolution 76 ("Res.76"), which addresses the protection of GSO networks from aggregate or multiple NGSO systems' interference under established aggregate protection criteria that NGSO systems collectively must not exceed[21]
    - Equitable apportionment of aggregate EPFD allowance across multiple NGSO systems

Res. 76 calls for administrations operating or planning to operate NGSO FSS systems, individually or in collaboration, to take all possible steps, including, if necessary, by means of appropriate modifications to their systems, to ensure that the aggregate interference into GSO FSS and GSO BSS networks caused by such systems does not cause the aggregate power levels given in Tables 1A to 1D of the Resolution to be exceeded.

In the event that the aggregate interference levels in Tables 1A to 1D are exceeded, it further calls for administrations, to take all necessary measures expeditiously to reduce the aggregate EPFD levels to the limits given in Tables 1A to 1D of Res. 76. In order to fulfil the requirements in resolves 1 of Res. 76, WRC-23 decided that administrations operating or planning to operate non-GSO FSS systems shall, on a regular basis (e.g. yearly), hold a consultation meeting to determine the level of aggregate interference caused to GSO FSS or GSO BSS networks from non-GSO FSS systems and determine the necessary measures to ensure compliance with the required level for protecting GSO FSS and GSO BSS networks.

Moreover, Viasat urges TRAI to take suitable actions under Radiocommunication Assembly 2023 (RA-23) Resolution 74, which calls for continued technical activities, including those on interference assessment and mitigation techniques among non-GSO systems in support of long-term sustainability with a focus on the prevention of harmful interference, and ensuring the rational, equitable, efficient and economical use of the radio-frequency spectrum and associated orbit resources, with a focus on non-GSO systems.

Large NGSO systems with thousands of satellites, particularly when they employ small user terminals, can consume significant portions of the "look angles" toward space and LEO orbits as well, preventing use of the sharing tools that have been employed successfully for decades among certain NGSO systems. This threat to NGSO spectrum sharing occurs when large LEO constellations "blanket the sky," causing many in-line interference events limiting and sometimes completely blocking other NGSO systems from sharing the same spectrum.

A large NGSO system would rarely (if ever) experience this problem itself because it has a far greater number of satellites than smaller NGSO constellations, which provides the large NGSO system with alternative communications paths in which the same spectrum remains available for its use. The upshot is that a large NGSO system would have little incentive to avoid in-line interference events; large numbers of in-line interference events would harm smaller NGSO systems without materially impacting the large NGSO system's operations. As a result, the large NGSO system can hinder other satellite operators, including new entrants, from accessing and using shared spectrum and orbital resources in the public interest.

In sum, efforts by some large NGSO operators to "blanket the sky" can have severe, direct and harmful consequences for other NGSO systems and operators – and can harm innovation, industry growth, and the

[21] *See* Resolution 76 (Rev. WRC-23); resolves 1,2, 3, and urgent call for actions for ITU-R in *the invites the ITU radiocommunication sector 1, 2.*

broader public interest. To avoid this result, it is critical for TRAI to apply at the licensing stage a condition requiring "look angle" splitting, whereby large NGSO systems serving a country in overlapping frequencies would divide the range of satellite azimuths as seen from a location on the Earth with other NGSO systems, whenever the potential for NGSO/NGSO interference exists at that location.

Question 13: "Whether there are any other suggestions related to assignment of spectrum for-
(b) GSO/ NGSO based Mobile Satellite Services for providing voice, text, data, and Internet services?"

D2D (direct-to-device) has the potential to bridge the connectivity gap by complementing the capabilities of existing terrestrial mobile networks and handsets—particularly in unserved and underserved areas —while leveraging economies of scale. BSNL has recently conducted a trial of D2D capabilities, demonstrating a service model where the satellite D2D provider partners with the mobile operator for the purpose of extending coverage where terrestrial networks currently cannot reach. We believe this partnership model is the appropriate approach to append D2D capabilities as complementary to existing terrestrial mobile coverage. We don't believe D2D capabilities are designed to serve as a competing coverage layer where mobile terrestrial coverage already exists.

Critically, though, D2D cannot and should not be viewed as monolithic in nature. To the contrary, two very different approaches to D2D are being contemplated—with very different implications for whether the existing regulatory framework is fit for purpose. Specifically:

- The first approach to D2D uses already allocated and licensed mobile satellite service (MSS) spectrum for D2D and is feasible within the existing regulatory framework that enables today's MSS services.

- The second approach to D2D relies on satellite operators transmitting in spectrum allocated to terrestrial services and licensed to mobile operators, and will require significant changes to existing regulatory frameworks in India (and globally) to allow for different uses of spectrum than existing allocations support, and careful management to avoid interference into existing uses.

Viasat urges the TRAI to keep these important distinctions in mind as it continues to examine the extent to which changes to the existing regulatory framework are necessary.

We note that operators have used satellite communication links—including links directly connecting satellites to mobile handsets—to serve mobile users *for decades*. D2D services that use MSS spectrum are simply an application of the long-existing MSS concept. This means that this type of D2D can be offered today without the need for additional national or international regulatory action.

It should also be noted that recent focus on D2D services is attributable to factors having nothing to do with the advent of LEO services. Among other things, many geographic areas still lack terrestrial connectivity, which is driving increased demand for innovative satellite-based solutions (including D2D solutions). At the

same time, advances in satellite technology, lower deployment costs, and an increased convergence between terrestrial and satellite service standardization (such as the 3GPP NTN standards) have further driven momentum for D2D.

Existing MSS networks that operate in bands already globally allocated by the ITU to MSS on a primary basis can connect and provide D2D communication seamlessly. Notably, MSS spectrum in the L- and S-bands has been widely authorised globally for MSS by regulators and, their allocations, co-existence and sharing mechanisms have been established. Therefore, MSS D2D services can be offered today in these bands without requiring additional national or international regulatory action.

In contrast, the use of terrestrial mobile spectrum (MS) to support D2D operations presents significant regulatory, technical, and operational complexities and challenges. Among other things, D2D services using terrestrial MS spectrum outside of any primary MSS allocation must be provided on a non-interference/non-protected basis under ITU Radio Regulation (RR) No. 4.4. But this can be difficult to enforce in practice. As a result, operations under RR No. 4.4 place other systems and services at a high risk of interference.

This risk is particularly pronounced in the case of LEO systems operating under RR No. 4.4. Indeed, the ITU Radio Regulations Board (RRB) has highlighted the specific issues that may arise where LEO systems seek to use RR No. 4.4.[22] As the RRB report notes:

Demonstrating conformity with the Rule of Procedure on No. 4.4 becomes very challenging when thousands of satellites could be involved. It was not clear that administrations and operators fully understood their obligations under No. 4.4 and its impact on the quality of service and capacity of their satellite system. In this context, as the risk of interference was likely increasing, more stringent regulatory provisions would be required to effectively address cases of harmful interference that originated from operations under No. 4.4 and to enforce No. 4.4 with appropriate consequences for non-compliance.[23]

Stated differently, the opportunity for satellite-to-satellite interference is increased when LEO satellite systems offering service in terrestrial MS frequency bands operate with hundreds or thousands of satellites. Reliance on RR No. 4.4 also adversely impacts the quality of service that can be supported by the LEO system itself. Under RR No. 4.4, operations must immediately cease if they interfere with other operators, which necessarily undermines the reliability of D2D service provided on this basis. This, in turn, can adversely impact the consumers that rely on that D2D service, particularly when it is being offered as an emergency communications feature.

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[22] WRC-23/Document 50 "Report by the Radio Regulations Board to WRC-23 on Resolution 80 (Rev.WRC-07)." https://www.itu.int/md/R23-WRC23-C-0050/en. Of note, in its recent Report and Order on Supplemental Coverage from Space (SCS), the Federal Communications Commission (FCC) determined that any satellite operator offering SCS services will be authorized pursuant to a secondary MSS frequency allocation in the U.S. Table, which will not conform with the International Table, therefore cross-border interference will be governed by ITU RR Article No. 4.4. (See Federal Communications Commission Report and Order on Single Network Future: Supplemental Coverage from Space; Space Innovation, released March 15, 2024, page 100 at para 224.)

[23] WRC-23/Document 50 "Report by the Radio Regulations Board to WRC-23 on Resolution 80 (Rev.WRC-07)." https://www.itu.int/md/R23-WRC23-C-0050/en.

Further, operating under a Service Level Agreement (SLA) on an RR No. 4.4 non-interference basis could be difficult as the service could be required to cease operations at any moment, thereby cutting critical services to customers with little notice. But customers might incorrectly assume that these D2D services enjoy interference protection—including because they are "hosted" on spectrum used by terrestrial mobile network operators. Under RR No. 4.4, TRAI would nevertheless need to force D2D operators to cease operations.

In short, the use of terrestrial MS spectrum for D2D implicates technical, operational, and regulatory matters that have yet to be studied or addressed fully.

Implementing assignment terms and conditions for satellite systems deployed to directly connect with mobile handsets (aka. Satellite Direct-to-Device)

- Satellite Direct-to-Device systems (D2D) designed to operate using spectrum assigned to terrestrial mobile services (IMT), as explained above, represent interference risks (as they can only operate under 4.4 of the ITU RRs on non-interference/ non-protection basis). These systems should not be allowed in India until such time when the interference risks are better understood;

- Satellite D2D systems operating in bands globally allocated to the Mobile Satellite Service (MSS) do not represent interference risks, because MSS spectrum is globally harmonised and allocated to satellite systems, and these are coordinated in accordance to the RRs. D2D services in MSS spectrum are therefore appropriate for implementation in India as follows:

    - Satellite D2D systems in MSS bands are well placed to be implemented as complementary to terrestrial coverage in areas of India which are out of reach of mobile terrestrial networks. Licensing of such D2D systems is therefore well placed to be implemented in accordance with the operational requirements of terrestrial mobile operators in India and in collaboration with terrestrial operators;

    - When D2D systems operate in MSS bands as above (complementary to mobile terrestrial licensees) as an extension of the terrestrial coverage and in direct collaboration with terrestrial operators to alleviate terrestrial coverage gaps, there is no need to deviate from the current MSS assignment mechanism that already exists in India.

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