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GSOA is the global non-profit association of the entire satellite ecosystem that brings members together and serves as the premier platform for worldwide collaboration. As the world's only CEO-driven satellite association, GSOA takes the lead in addressing global challenges, seizing opportunities, and providing a unified voice for the satellite industry. GSOA is widely recognized as the representative body for satellite operators by international, regional, and national entities, including regulators, policymakers, standard-setting organizations like 3GPP, and international organizations such as the International Telecommunications Union (ITU) and the World Economic Forum (WEF).

Q1. Which frequency band(s)/ range(s) should be considered for the assignment to NGSO based Fixed Satellite Services for providing data communication and Internet service? Please provide a detailed response separately for the user link and feeder link.

User links:

	Space-to-Earth	**Earth-to-space**
Ku band	10.7-12.75 GHz	13.75-14.5 GHz
Ka-band	17.7-18.6/18.8-GHz	27.5-29.1/29.5-30.0 GHz

Feeder link:

	Space-to-Earth	**Earth-to-space**
Ka-band	17.7-18.6/18.8-20.2 GHz	27.5-29.1/29.5-30.0 GHz
Q/V band	37.5-40.5	47.2-52.4 GHz

Unless stated otherwise in the ITU Radio Regulations, the frequency ranges for assignment to NGSO based Fixed Satellite Services in India should largely be consistent to those assigned to the GSO Fixed Satellite Services.

Q2 Which frequency band(s)/ range(s) should be considered for the assignment to GSO/ NGSO based Mobile Satellite Services for providing voice, text, data, and Internet service. Please provide a detailed response separately for the user link and feeder link.

User links:

3GPP Band Class	**Space-to-Earth**	**Earth-to-space**
n256	2170 MHz – 2200 MHz	1980 MHz – 2010 MHz
n255	1525 MHz – 1559 MHz	1626.5 MHz – 1660.5 MHz
n254	2483.5 MHz – 2500 MHz	1610 MHz – 1626.5 MHz

These bands are globally harmonized for use by MSS on a primary basis, enabling standardized 3GPP based solutions with global economies of scale and capability for full integration with mobile networks to achieve ubiquitous connectivity.

Gateway links

	Space-to-Earth	**Earth-to-space**
C band	3700-4200 MHz	5925-6425 MHz
	6925-7075 MHz	5100-5250 MHz
Ka band	17.3-20.2 GHz	27.5-30.0 GHz:
Q/V band	37.5-40.5	47.2-52.4 GHz

Q3. What should be the maximum period of assignment of spectrum for -

(c) NGSO based Fixed Satellite Services for providing data communication and Internet services, and

(d) GSO/ NGSO based Mobile Satellite Services for providing voice, text, data, and Internet services?

Please provide a detailed response alongwith international practice in this regard.

In the context of administrative assignment for satellite spectrum allocation, it is essential to ensure that the duration of the license provides stability and confidence for operators to invest and maintain their services. A minimum license period of 10-15 years, with presumption of annual renewal, can offer the necessary long-term assurance for operators to plan and implement their services effectively.

Q4. 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 alongwith international practice in this regard.

A new satellite filing may be submitted when additional satellites are launched to augment the existing capacity of the existing NGSO filings. This is an example where NGSO satellites could be supported by several ITU satellite filings.

Therefore, every ITU filing should not be treated as a separate satellite system.

Q5. 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 –

(c) NGSO based Fixed Satellite Services for providing data communication and Internet services; and

(d) GSO/ NGSO based Mobile Satellite Services for providing voice, text, data, and Internet services?

Please provide a detailed response alongwith international practice in this regard.

As highlighted also by the Consultation Paper, there is already a comprehensive ITU framework in place, setting the principles for coordination and collaboration between the satellite operators. As such, it is sufficient for India to just adopt the provisions of ITU-RR. By adhering to the current ITU Radio Regulation and Coordination framework, 99.95% of the spectrum assigned to satellite networks has been free from reported harmful interference. This impressive statistic demonstrates the robustness of the existing international framework. The principle that the right to use orbital and spectrum resources for a satellite network or system is acquired through negotiations has proven to be the most effective means of achieving rational, cost-effective, and efficient spectrum and orbital management.

Q6. For satellite earth station gateways of different satellite systems operating in the same frequency range, whether there is a need to prescribe a protection distance or any other measures to avoid interference from each other–

(c) Between the gateways of GSO and NGSO systems; and (d) Between the gateways of NGSO systems?

If yes, please provide a detailed response alongwith international practice in this regard.

Gateways on NGSO systems consist of arrays of antennas tracking several satellites at the same time. The complexity of gateway operation and lower elevation angle may lead to interference scenarios between NGSO systems. Therefore, coordination is needed to ensure that gateways of different systems do not interfere with each other. Various mitigation techniques can be used to facilitate co-existence, including separation distances, power limitations, use of high gain antennas with high off-axis discrimination.

Coordination between satellite systems is conducted among operators under the well-established and internationally recognised ITU Coordination Procedures. Furthermore, making the locations of licensed Earth stations known and exchanging ephemeris data are solutions that may practically be implemented. Other ideas such as providing general operational characteristics can help other non-GSO operators with interference avoidance techniques. Information sharing of licensed Earth Station gateways and terrestrial services available can help initiate the coordination process and reduce the risk of interference by potentially providing operators the ability to implement preventive techniques to minimize in-line events with other systems. Regulator should encourage the completion of good faith coordination and implementation of interference avoidance techniques to manage interference situations and share spectrum efficiently at a given location.

Q7. In case the spectrum assigned for satellite gateway links is also assigned to terrestrial networks such as Fixed Service, IMT etc., what protection distance or criterion should be included in the terms and conditions of the assignment of spectrum for satellite gateway links to avoid any interference to/ from terrestrial networks? Please provide a detailed response alongwith international practice in this regard.

To avoid interference between satellite gateway links and terrestrial networks such as Fixed Service (FS) and International Mobile Telecommunications (IMT), several protection criteria and separation distances need to be established in the terms and conditions of spectrum assignment.

Coexistence of IMT with other radiocommunications systems in general has been a long and fiercely debated problem that has raised, and is still raising, a lot of concerns. This is not specific to the satellite sector, as several other valuable spectrum users (e.g. broadcasters, WIFI, fixed links operators, radars, scientific community) are suffering from the increasing spectrum demand from the mobile

operators and vendors and the potential for harmful interference. GSOA expects TRAI to be fully aware of the exponential spectrum demand for mobile terrestrial 5G systems which high-power emissions in ubiquitous deployments implies very spurious effects, not only within the frequency bands which the 5G equipment is using, but also in adjacent bands used for other services, including satellite. Numerous ITU and CEPT reports have established the strict conditions under which IMT and FSS can coexist. For example, ITU-R Report M.2109 (WRC-15) and S.2368 (WRC-19) have concluded on separation distances in the order of 100km between the services.

In the case of the 28 GHz, IMT was not identified in this band. However, similar terrestrial sharing studies were conducted by Task Group 5/1 for the 26 GHz band[1]. The results of the studies showed possible separation distances of up to 10km between FSS earth station and IMT station.

For the 28 GHz band, it is expected for this separation distance to be even lower due to the higher attenuation along the propagation path.

In Section 3.21 TRAI outlined that the frequency band 12.75-13.25 GHz is shared with microwave access services MWA using IMT technology, however this is not correct since the FS allocation in this band is restricted to point-to-point FS links and not point-to-multipoint links which is where IMT technology is normally adopted. In fact, there has been extensive studies which showed using ptmp links in this band would impact not only other FS ptp links but also FSS services.

GSOA is concerned about potential out-of-band emissions from the adjacent 26 GHz band by terrestrial IMT/5G systems into the 28 GHz band. Increases in power by terrestrial IMT/5G systems in the 26 GHz band could increase terrestrial IMT/5G out-of-band emissions into the 28 GHz band. Increased out-of-band emissions in the 26 GHz band could adversely affect the interference environment in the 28 GHz band by interfering with the ability of satellite receivers in space to receive signals from earth stations. Therefore, GSOA respectfully requests that TRAI limit out-of-band emissions from terrestrial IMT/5G operations in the 26 GHz band into the 28 GHz band to protect satellite broadband service in the adjacent 28 GHz band. GSOA also requests that TRAI ensure that the aggregate level of terrestrial IMT/5G out-of-band emissions from the 26 GHz band into the adjacent 28 GHz band does not cause harmful interference to satellite receivers in the 28 GHz band.

Coexistence between Fixed Service links (FS) and Earth Station gateways has long been managed through appropriate onsite coordination ensured by national regulators, conditioned to the need for Earth Station gateways to have a license subject to appropriate coordination conditions. The situation is now evolving differently with the introduction of FWA using 5G technology, especially if it is used for point-to-multipoint links. GSOA believes that the implementation of 5G technology in FS applications such as FWA presents important risks of interference to incumbent services, including into FSS Earth station receivers. These new FWA

[1] Please refer to CPM19-2 report page 172 Section 2/1.13/3.2.1.3

application need to be scrutinized and specific frameworks would need to be developed to ensure that other incumbent services are duly protected. GSOA notes that TRAI specifically refers to the 17.7-19.7 GHz band which an increasing number of Ka-band satellite systems in GEO, MEO or LEO are using to deliver services in all regions. GSOA therefore asks TRAI to exercise an extreme vigilance on the type of Fixed Radio Links that are licensed in the 17.7-19.7 GHz band to avoid a situation where coexistence with FSS may be seriously challenged.

Q8. In case the spectrum assigned to the satellite user link is also assigned to terrestrial networks such as Fixed Service, what criterion should be included in the terms and conditions of the assignment of spectrum for satellite user links to avoid any interference to/ from terrestrial networks? Please provide a detailed response along with international practice in this regard.

1. Geographical Separation Requirements: Clear geographical separation should be stipulated to mitigate interference. The distances between terrestrial base stations and satellite user terminals should be defined based on the frequency band used and the operational characteristics of the systems involved. This aligns with practices recommended in ITU-R documents that provide guidelines on minimum separation distances to avoid harmful interference.
2. Power Limits and Effective Isotropic Radiated Power (EIRP) Restrictions: Assignments should include specific power limit restrictions that dictate the maximum EIRP for terrestrial devices operating in the same spectrum band to ensure that they do not interfere with satellite operations. For example, the response document for Colombia suggests implementing EIRP limits similar to established standards in Europe .
3. Coordination Mechanisms: A robust coordination framework should be established, wherein terrestrial and satellite service providers are required to engage in prior coordination before deploying new services. This practice is supported by the ITU Radio Regulations, which facilitate the coexistence of different services through mutual agreement and operational adjustments
4. In the case of Earth Stations in Motion (ESIM), sharing conditions can be adopted from relevant resolutions such as Res 123 (WRC-23) and Res 169 (WRC-19) for protection of terrestrial services in the Ka-band for NGSO and GSO ESIMs.

Q9. Whether there is a need to prescribe any conditions to mitigate the risk of scarcity of satellite gateway sites? If yes, please provide a detailed response alongwith international practice in this regard.

As opposed to terrestrial networks, satellite operators require only a limited number of gateways to serve a large geographical area, such as India. In such cases, spectrum scarcity is not a pressing concern, and alternative allocation methods, such as administrative assignment, are more appropriate.

Moreover, the flexibility of gateway infrastructure allows for the coexistence of multiple satellite systems in the same location as part of the coordination process. GSO can share gateway locations without causing interference or affecting the performance of their respective networks. Additionally, these GSO gateways can even be collocated with NGSO antenna farms, further demonstrating the efficient use of available resources.

Hence, there is no need to prescribe any conditions to mitigate the risk of scarcity of satellite gateway sites.

Q10. In addition to the roll-out conditions recommended by TRAI for satellite-based Telecommunication Service Authorisation through its recommendations on the Framework for Service Authorisations to be Granted Under the Telecommunications Act, 2023 dated 18.09.2024, whether there is a need to impose certain additional roll-out obligations for the assignment of frequency spectrum for –

(c) NGSO based Fixed Satellite Services for providing data communication and Internet services;

(d) GSO/ NGSO based Mobile Satellite Services for providing voice, text, data, and Internet services?

Please provide a detailed response alongwith international practice in this regard.

"Roll-out" obligations are a regulatory measure typically used to address the shortcomings of terrestrial operators, who tend to focus their network deployment in revenue-generating areas. In contrast, satellite services aim to fill the gaps left by terrestrial networks and provide coverage in areas where traditional terrestrial networks cannot reach or are not cost-effective. Consequently, imposing roll-out obligations on satellite service providers may create unnecessary burdens and obstruct the efficient deployment of satellite networks.

Instead, a more flexible and supportive regulatory framework should be established for satellite services, focusing on facilitating deployment to address coverage gaps and enhance connectivity for unserved or underserved areas. This approach will enable satellite operators to contribute to bridging the digital divide effectively and ensure that their services are available to those who need them most.

Q11. Whether there is a need to introduce a provision for surrender of frequency spectrum prior to the expiry of the period of validity of spectrum assigned for -

(c) NGSO based Fixed Satellite Services for providing data communication and Internet services;

(d) GSO/ NGSO based Mobile Satellite Services for providing voice, text, data, and Internet services?

If yes, what should be the process, and associated terms and conditions such as minimum period of spectrum holding, notice period, surrender fee, etc.? Please provide a detailed response with justifications.

Introducing a provision for premature surrender can help ensure that spectrum is utilized efficiently. It enables operators who no longer require their spectrum to relinquish it, thus making it available for others in need. This can especially be relevant in a fast-evolving sector like satellite communications, where technological advancements may alter the needs of operators.

The process should be transparent and straightforward. A standardized application should be submitted by the operator wishing to surrender their spectrum, detailing the reasons for surrender and evidence supporting the timing of this move. There shall be a possibility to receive reimbursement of any usage fees already paid, proportionate to the remaining period.

Q12. Whether there is a need to prescribe timelines for processing the applications for the assignment of frequency spectrum for-

(c) NGSO based Fixed Satellite Services for providing data communication and Internet services;

(d) GSO/ NGSO based Mobile Satellite Services for providing voice, text, data, and Internet services?

Please provide a detailed response with justifications.

The importance of efficient and timely processing of such applications promotes the growth and accessibility of satellite services. Timely processing of applications, which in most cases ranges between a 30 and 60 days timeframe, can foster a competitive environment by enabling operators to obtain necessary licenses and begin services more quickly. Delays in application processing could hinder the deployment of new technologies and services that are crucial for digital inclusion and connectivity, particularly in underserved areas.

Rapid processing of applications is also essential for ensuring that consumers have access to a variety of satellite services. Delays could restrict service options for consumers and lead to decreased competition, which could negatively impact pricing and service quality.

It is also important that the regulator allows an operator to be called for a meeting to discuss and/or clarify details of the licence application, and thus allow for minor modifications before the expiry of the said regulatory deadline.

Q13. Whether there are any other suggestions related to assignment of spectrum for-

(a) NGSO based Fixed Satellite Services for providing data communication and Internet services;

(b) GSO/ NGSO based Mobile Satellite Services for providing voice, text, data, and Internet services?

Please provide a detailed response with justifications.

GSOA would like to highlight that the satellite industry requires a long investment horizon, and the certainty and predictability of regulatory regime is key to its future. Therefore, it is critical that the spectrum allocated to the industry today remains available in the long term in order not to jeopardize its investment.

Additionally, provisions relating to the assignment of spectrum for NGSO FSS should be consistent and similar to that of GSO FSS, to the extent possible, to prevent any discrimination.

In relation to the NGSO MSS, as a result of continuously moving satellites and user equipment with omni-directional antennas, frequency reuse in the same geographic area is not possible in the L-band and S-band. This necessitates the assignment of exclusive spectrum for use by each MSS provider in these bands.

The more bandwidth assigned to the MSS operator for NTN, the greater the capacity that can be offered to Indian consumers, governments, and businesses. Within the S band, two blocks of 2x15 MHz each are ideal for interested operators to implement the 5G NTN service. This block size provides equal spectrum resources for two MSS operators to co-exist and will allow the deployment of the most advanced 5G NTN services. While a scenario such as three operators with 2x10 MHz would provide a competitive environment, too small an allocation could yield a severely limited technical system that will not have the capabilities to create a viable competitor.

The spectrum needs of competing MSS providers serving the same region – in this case, the whole of India – is analogous to long-recognized arrangements for terrestrial mobile operators, in which licensees offering service in the same geographic area are assigned discrete, dedicated spectrum to avoid interference and degradation of service quality for users. Implementing a spectrum-sharing arrangement between MSS providers would create conditions in which the services provided by any licensee would not meet the desired quality of service levels.

A recommended channelization of the spectrum into blocks of multiples of 5 MHz and using out-of-band emissions and frequency tolerance limitations consistent with 3GPP NTN standards. While operators primarily rely on their dedicated frequencies, operators may be allowed to access other's spectrum through spectrum leases or other mutually agreeable arrangements.

Q14. Should spectrum charges for NGSO-based FSS providing data communication and Internet services, be levied: i. On a per MHz basis, ii. On a percentage of Adjusted Gross Revenue (AGR) basis, or iii. Through some other methodology?

Please provide a detailed justification for your answer.

GSOA recommend a cost based administrative fees or a percentage of Adjusted Gross Revenue (AGR) basis. FSS spectrum is a shared spectrum. As a result new entrants find it easy to get spectrum access and pay a % of the revenue they earn and use the spectrum. Considering that India is encouraging many new space startups, having a minimum charge will dissuade such players and it is detrimental to India's interest.

Q15. In case it is decided that spectrum charges for NGSO-based FSS providing data communication and Internet services should be levied on a per MHz basis, should these charges be calculated based on:

i. The Department of Telecommunications (DoT) order dated December 11, 2023, or ii. An alternative approach (please specify)?

Please provide a detailed justification to support your answer.

No. the per MHz basis is dated, FSS require large bandwidth of often several GHz in both uplink and downlink. In this light, applying a per MHz approach could result in exorbitant amounts.

• High spectrum prices ultimately affect end-users, particularly those in remote areas where satellite connectivity is the only viable option. By keeping spectrum charges reasonable, regulators can encourage satellite service providers to offer competitive pricing, making connectivity more accessible for consumers in underserved regions.

• Governments and regulatory bodies should prioritize the allocation of spectrum to services that benefit society, such as disaster recovery and universal connectivity, . This approach emphasizes the importance of public interest over revenue generation. By focusing on the societal benefits of satellite services, regulators can ensure that policies support the nation's overall well-being rather than solely aiming for financial gains.

As advised by ITU[2] , It is proposed that the fundamental rationale for licensing fees should compensate only for administrative costs to the Regulator, not be used as a source of real profit for the government and/or the regulator.

Q16. If it is decided that spectrum charges for NGSO-based FSS providing data communication and Internet services should be levied on a percentage of AGR basis:

i. What should be the appropriate percentage of AGR?

[2] Report on satellite regulation in developing countries, section 2.4.2.4 Licensing Fees, https://www.itu.int/itudoc/itu-d/question/studygr1/q17-1-ii.pdf

ii. Should a minimum spectrum charge be specified to address the issue of inefficient utilization of spectrum? If yes, what methodology may be used to determine the amount of the minimum spectrum charge?

iii. Is there an alternative approach that could be followed to address the issue of inefficient spectrum utilization?

Please provide a detailed justification for your answers.

The proposed spectrum charges should not be more than the already proposed 1% of the AGR, or waive it, since this spectrum is used primarily for connecting the Unconnected. This is a good reflection of the actual value of spectrum, as directly and uniquely linked to the actual spectrum use in the country.

Q17. Considering the Adjusted Gross Revenue (AGR) based charging methodology currently followed for Commercial VSAT and in view of the enhanced scope of the Satellite service authorisation, what should be the spectrum charge, as a percentage of AGR, that should be levied on GSO-based FSS? Or,

Should some alternative spectrum charging methodology be used for determining spectrum charges for GSO-based FSS? Please provide a detailed justification for your answer.

For user links, considering that the main concern seems to be the discovery of the "true value of spectrum", it is reasonable to use the already proposed 1% of the AGR or waive it since this spectrum is used primarily for connecting the Unconnected. This is a good reflection of the actual value of spectrum, as directly and uniquely linked to the actual spectrum use in the country.

Q18. Should spectrum charges for GSO and NGSO-based MSS that provide voice, text, data, and Internet services be levied: i. On a per MHz basis, ii. On a percentage of AGR basis, or iii. Through some other methodology?

Please provide a detailed justification for your answer.

An administrative assignment and pricing approach for L-band and S-band spectrum should be used for MSS services. This is clearly aligned with the provisions of Section 4(4) and the First Schedule of the Telecommunications Act, 2023 (the Act). As required by the Act, assignment shall be by administrative process for MSS in the L and S bands, as well as for in-flight and maritime connectivity and Global Mobile Personal Communication by Satellites, both of which are services that may be offered by MSS providers.

An administrative assignment and pricing approach can and should be configured to enable recovery of spectrum management costs by TRAI while enabling satellite service providers to direct appropriate resources to the deployment, operation, and maintenance of networks and satellite infrastructure.

Q19. If it is determined that spectrum charges for GSO/NGSO-based MSS providing voice, text, data, and Internet services should be levied on a per MHz basis, should these charges be calculated based on:

i. The Department of Telecommunications (DoT) order dated December 11, 2023, or
ii. An alternative approach (please specify)?

Please provide a detailed justification to support your answer.

N/A

Q20. If it is decided that spectrum charges for GSO/NGSO-based MSS providing voice, text, data, and Internet services should be levied on a percentage of AGR basis:

i. What should be the appropriate percentage?

ii. Should a minimum spectrum charge be specified to address the issue of inefficient utilization of spectrum? If yes, what methodology may be used to determine the amount of the minimum spectrum charge?

iii. Is there an alternative approach that could be followed to address the issue of inefficient spectrum utilization?

Please provide a detailed justification for your answers.

N/A

Q21. Whether there are any other issues/suggestions relevant to the spectrum charging for:

i. NGSO/GSO based FSS providing data communication and Internet services.

ii. NGSO/GSO based MSS providing voice, text, data, and Internet services.

The response may be submitted with proper explanation and justification.

Spectrum costs should be reasonable and aimed primarily at covering the administrative costs associated with managing, monitoring, and regulating satellite spectrum. This approach encourages more efficient and equitable spectrum use, fostering innovation and ensuring the sustainability of the satellite industry. It can also promote a healthy satellite industry that can continue providing essential services, such as disaster recovery, encouraging innovation, and fostering competition.

Several countries adopt an administrative fee-only approach for satellite spectrum allocation, which primarily covers the costs of managing, monitoring, and regulating the spectrum.