भारतीय दूरसंचार विनियामक प्राधिकरण

Telecom Regulatory Authority of India

Recommendations on
Terms and Conditions for the Assignment of Spectrum for Certain Satellite-Based Commercial Communication Services

New Delhi, India

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Chapter I: Introduction

A. Background

1.1 Through a letter dated 13.09.2021 (**Annexure 1.1**) on the subject-"Seeking TRAI recommendations for the auction of spectrum in the frequency bands identified for International Mobile Telecommunications (IMT)/ 5G", the Department of Telecommunications (DoT), Ministry of Communications, Government of India sent a reference under the terms of the clause 11(1)(a) of the TRAI Act 1997 to Telecom Regulatory Authority of India (hereinafter, also referred to as "TRAI" or "the Authority"). Through the said reference, DoT requested TRAI to provide recommendations, *inter-alia*, on the auction of spectrum for space-based communication services. The relevant extract of the reference is reproduced below:

"6. Department of Space (DoS) had invited comments on Draft Spacecom Policy liberalizing space segment for private sector participation to provide commercial communication services in India. This includes the Low Earth Orbit (LEO) and Medium Earth Orbit (MEO) satellite constellations operational over India. In case of satellite communication, the subscriber is accessed from the satellite through "Access Spectrum" similar to "Access Spectrum" in terrestrial network and the demand for such spectrum will potentially increase in the future.

7. In view of the above, under the terms of clause 11(1)(a) of TRAI Act, 1997 as amended by TRAI Amendment Act 2000, TRAI is requested to:

…

(c) provide recommendation on appropriate frequency bands, band plan, block size, applicable reserve price, quantum of spectrum to be auctioned and associated conditions for auction of spectrum for space-based communication services, in view of para 6 above."

1.2 In this regard, TRAI, through its letters dated 27.09.2021 and 23.11.2021, sought, *inter-alia*, the following information/ clarifications in respect of space-based communication services from DoT:

(a) Details of the frequency bands and quantum of spectrum available in each band required to be put to auction and associated information in respect of space-based communication;

(b) Whether spectrum for space-based communication is being envisaged to be assigned on exclusive basis or will the same be shared among multiple service licensees?

(c) Details of spectrum assignment mechanism and methodology of charging currently being followed by DoT for space-based communication services.

1.3 In response, DoT, through a letter dated 27.11.2021, informed, *inter-alia*, that information in respect of space-based communication services sought by TRAI would take some time, therefore, to avoid delay in 5G roll-out, TRAI may go ahead with consultations/ recommendations on issues excluding space-based communication services referred in the DoT's reference dated 13.09.2021 and the letter dated 23.09.2021. Through the said letter, DoT also mentioned that the issues related to space-based communication services may be taken up separately on the receipt of information from DoT.

1.4 Thereafter, through a letter dated 16.08.2022 **(Annexure 1.2)**, DoT provided information with respect to space-based communication services as sought by TRAI through the letters dated 27.09.2021 and 23.11.2021. While providing the information, DoT requested TRAI to provide recommendations on certain additional issues. The relevant extract of the DoT's letter dated 16.08.2022 is given below:

(a) TRAI, through consultations, may assess the demand for space-based communication services and accordingly provide recommendations on the quantum of spectrum in each band required to be put to auction.

(b) It is envisaged to auction the space spectrum on exclusive basis. TRAI may explore feasibility and procedure of sharing auctioned spectrum among multiple service licensees. TRAI may provide recommendations on sharing of auctioned frequency bands between satellite networks and terrestrial networks also, the criteria for sharing and appropriate interference mitigation techniques for sharing and coexistence.

(c) In frequency bands 27.5-28.5 GHz (identified for IMT) and 28.5-29.5 GHz (being studied for Captive Non-Public Networks), TRAI may recommend a mechanism for sharing of auctioned frequency bands in which both IMT/ CNPN and satellite-based services (both user terminal and gateways) can be provided in a flexible manner.

(d) Since the service providers may require spectrum both in user link as well as in feeder link, TRAI may take inputs from stakeholders and recommend an appropriate auction methodology so that the successful bidder gets spectrum for user link (shared with IMT in flexible) as well as feeder link.

(e) In addition, TRAI is requested to provide any other recommendations as deemed fit for the purpose of spectrum auction in these frequency bands, including the regulatory/ technical requirements as enunciated in the relevant provisions of the latest ITU-R Radio Regulations.

1.5 Through the afore-mentioned letter dated 16.08.2022, DoT provided a list of frequency bands to be considered by TRAI for providing recommendations with respect to space-based communication services, as given below:

S. No.	Frequency Band	Link	Remarks
1	10.7 – 12.75 GHz	Space to Earth	
2	12.75 – 13.25 GHz	Earth to Space	
3	13.75 – 14.5 GHz	Earth to Space	
4	17.7 – 18.6 GHz	Space to Earth	17.7 – 18.4 GHz is used for Earth to Space also.
5	18.8 – 19.3 GHz	Space to Earth	

6	19.3 – 19.7 GHz	Space to Earth	
7	19.7 – 21.2 GHz	Space to Earth	
8	27.5 – 29.5 GHz	Earth to Space	27.5 – 28.5 GHz has been identified for implementation of IMT in India.
9	29.5 – 31 GHz	Earth to Space	

1.6 While providing the above list of frequency bands, DoT also mentioned that *"TRAI can however provide recommendations for other frequency bands also"*.

1.7 Thereafter, TRAI, through its letter dated 19.10.2022 to DoT, sought further information/ clarifications, wherein DoT was requested, *inter-alia*, to clarify that for which kind of licensed services, spectrum for space-based communication has been envisaged to be granted through auction. DoT was requested to provide information as per the table given below:

S. No.	Type of service	Whether spectrum is envisaged to be assigned through auction (Yes/ No)?	Reasons, if any
1	Access		
2	Internet		
3	NLD		
4	ILD		
5	GMPCS		
6	VSAT CUG (Commercial)		
7	Captive VSAT CUG		
8	Machine to Machine (M2M)		
9	DTH		
10	Teleport		
11	DSNG		
12	HITS		
13	Any other relevant service (please specify)		

1.8 In response, DoT, through a letter dated 16.12.2022, conveyed that TRAI may provide suitable recommendations for each of the space-based communication services after a detailed examination.

1.9 In this regard, TRAI released a consultation paper on 'Assignment of Spectrum for Space-based Communication Services' dated 06.04.2023 for soliciting comments of stakeholders on the issues related to the assignment of spectrum for space-based communication services. As part of the consultation process, an Open House Discussion (OHD) was conducted on 14.07.2023 through online mode.

1.10 Meanwhile, in December 2023, the Parliament enacted a new statute namely, 'the Telecommunication Act, 2023'[1]. The Act amends and consolidates the law relating to development, expansion and operation of telecommunication services and telecommunication networks, assignment of spectrum, and for matters connected therewith or incidental thereto.

1.11 Sub-section 4 of Section 4 of the Telecommunications Act, 2023 is reproduced below:

"The Central Government shall assign spectrum for telecommunication through auction except for entries listed in the First Schedule for which assignment shall be done by administrative process.

Explanation. - For the purposes of this sub-section, -

(a) *"administrative process" means assignment of spectrum without holding an auction;*

(b) *"auction" means a bid process for assignment of spectrum."*

1.12 The First Schedule of the Telecommunications Act, 2023 lists 19 items for assignment of spectrum through the administrative process. The relevant items of the First Schedule are reproduced below:

"...

[1] https://egazette.gov.in/WriteReadData/2023/250880.pdf

14. In-flight and maritime connectivity.

15. Space research and application, launch vehicle operations and ground station for satellite control.

16. Certain satellite-based services such as: Teleports, Television channels, Direct To Home, Headend In The Sky, Digital Satellite News Gathering, Very Small Aperture Terminal, Global Mobile Personal Communication by Satellites, National Long Distance, International Long Distance, Mobile Satellite Service in L and S bands.

…"

1.13 In view of the above, TRAI, through a letter dated 08.02.2024, conveyed DoT that its "*[r]eference requesting TRAI to provide its recommendations for auction of spectrum for space-based communication services, may require a review by DoT. Therefore, DoT is requested to provide the specific issues on which TRAI's recommendations are required on the subject.*"

B. DoT's Reference dated 11.07.2024

1.14 Through a dated 11.07.2024 (**Annexure-1.3**), DoT sent a fresh reference to TRAI in terms of Section 11(1)(a) of the TRAI Act, 1997, on the subject- 'Seeking TRAI recommendations on terms and conditions of spectrum assignment including spectrum pricing for certain satellite-based commercial communication services'. The DoT's reference dated 11.07.2024 is reproduced below:

"TRAI in its letter No. C-15/2/(2)/2022-NSL-II dated 08 February 2024 requested DoT to review its earlier reference No. L-14006/01/2021-NTG dated 13/09/2021 to TRAI seeking their recommendations for auction of spectrum for space-based communication services in view of the provisions of the Section 4 & First Schedule of the Telecommunications Act 2023.

2. It is to inform that a reference dated 21/06/2024 has already been sent to TRAI for seeking recommendations on terms and conditions, including fees

or charges, for authorization to provide telecommunication services (including satellite-based communication services) as per the provisions of the Telecommunications Act, 2023.

3. Since the last reference dated 13/09/2021 to TRAI on spectrum for space-based communication services, a few Unified Licenses with VSAT CUG, Global Mobile Personal Communication by Satellite (GMPCS), NLD and ISP Category 'A' authorizations have been issued by DoT for providing satellite-based communication services through Non-Geostationary Orbit (NGSO) satellites. For assignment of spectrum to such licensees, terms and conditions of spectrum assignment including spectrum pricing need to be finalized.

4. Keeping in view the provisions of Section 4 and the First Schedule of the Telecommunications Act-2023, in terms of Section 11(1)(a) of TRAI Act 1997, TRAI is requested to provide its recommendations on terms and conditions of spectrum assignment including spectrum pricing while accounting for level playing field with terrestrial access services for the following satellite-based communication services:

i. NGSO based Fixed Satellite Services providing data communication and Internet services. In its recommendations, TRAI may take into account services provided by GSO-based satellite communication service providers.

ii. GSO/ NGSO based Mobile Satellite Services providing voice, text, data, and internet services."

1.15 Subsequently, DoT, through a letter dated 24.07.2024 (**Annexure-1.4**), informed that the recommendations made by the Authority for a reduction in Spectrum Usage Charges (SUC) from 4% to 1% of AGR and levy of 1% across all data-rates for Commercial VSAT CUG Service Licensees in the Recommendations on "Licensing Framework for Satellite-based connectivity for Low Bit Rate Applications" dated 26.08.2021 are not yet implemented. The DoT also informed that it continues to levy SUC between 3% to 4% of AGR depending on data rates for Commercial VSAT CUG Service Licensees. Further,

DoT requested TRAI to take this also into consideration while providing recommendations to the DoT's reference dated 11.07.2024 on the subject.

1.16 Through a subsequent reminder letter dated 21.08.2024 (**Annexure-1.5**), DoT mentioned that *"[i]t is pertinent to mention that the NGSO satellite based communication services would play a significant role in bridging the digital divide and providing telecommunication services including broadband services, in rural and remote areas of the country. As already intimated earlier, the Department has issued authorisations for providing satellite-based communication service using NGSO constellations to a couple of entities. However, for providing the services the assignment of spectrum to these entities is necessary. Accordingly, the TRAI is requested to provide its recommendations on the above-mentioned issues as soon as possible …"*

C. TRAI's Consultation Paper dated 27.09.2024

1.17 In this background, the Authority issued a consultation paper on 'terms and conditions for assignment of spectrum for certain satellite-based commercial communication services' dated 27.09.2024 (hereinafter, also referred to as, "the Consultation Paper dated 27.09.2024")[2] to solicit comments of stakeholders on specific issues related to terms and conditions for the assignment of spectrum for certain satellite-based commercial communication services. Initially, the last dates for furnishing comments and counter-comments were kept as 18.10.2024 and 25.10.2024, respectively. However, upon requests from some stakeholders, the last dates for furnishing comments and counter-comments were extended up to 25.10.2024 and 01.11.2024, respectively.

[2] The Consultation Paper dated 27.09.2024 is available at the following URL: https://trai.gov.in/sites/default/files/CP_27092024.pdf

1.18 In response to the Consultation Paper dated 27.09.2024, the Authority received comments from 30 stakeholders and counter-comments from 12 stakeholders. The comments and counter-comments received from stakeholders were placed on the TRAI's website[3]. An Open House Discussion (OHD) on the Consultation Paper dated 27.09.2024 was held on 08.11.2024 with stakeholders, through online mode.

D. The Present Recommendations

1.19 Based on the comments and counter-comments received from stakeholders during the consultation process, and further analysis, the Authority has arrived at the present recommendations. The recommendations comprise four chapters. This chapter provides an introduction and background to the subject. Chapter II provides a brief description of the issues related to the terms and conditions for the assignment of spectrum for certain satellite-based commercial communication services, a summary of stakeholders' comments, and the Authority's analysis and recommendations thereupon. Chapter III provides analysis and recommendations on the issues related to spectrum charging mechanism for satellite-based commercial communication services. Chapter IV provides a summary of the recommendations.

[3] The counter and counter-comments on the Consultation Paper dated 27.09.2024 may be accessed at the following URL: https://trai.gov.in/consultation-paper-terms-and-conditions-assignment-spectrum-certain-satellite-based-commercial

Chapter II: Examination of the Issues Related to the Assignment of Spectrum for Certain Satellite-based Commercial Telecommunication Services

2.1 As mentioned in the previous chapter, DoT, through a reference letter dated 11.07.2024 stated that *"[k]eeping in view the provisions of Section 4[4] and the First Schedule[5] of the Telecommunications Act-2023, in terms of Section 11(1)(a) of TRAI Act 1997, TRAI is requested to provide its recommendations on terms and conditions of spectrum assignment including spectrum pricing while accounting for level playing field with terrestrial access services for the following satellite-based communication services:*

(i) NGSO based Fixed Satellite Services providing data communication and Internet services. In its recommendations, TRAI may take into account

[4] Section 4 of the Telecommunications Act, 2023 deals with 'assignment of spectrum'. Section 4 is reproduced below:
"4. (1) The Central Government, being the owner of the spectrum on behalf of the people, shall assign the spectrum in accordance with this Act, and may notify a National Frequency Allocation Plan from time to time.
(2) Any person intending to use spectrum shall require an assignment from the Central Government.
(3) The Central Government may prescribe such terms and conditions as may be applicable, for such assignment of spectrum, including the frequency range, methodology for pricing, price, fees and charges, payment mechanism, duration and procedure for the same.
(4) The Central Government shall assign spectrum for telecommunication through auction except for entries listed in the First Schedule for which assignment shall be done by administrative process.
Explanation.— For the purposes of this sub-section,—
(a) "administrative process" means assignment of spectrum without holding an auction;
(b) "auction" means a bid process for assignment of spectrum.
(5) (a) The Central Government may, by notification, amend the First Schedule for assignment of spectrum—
(i) in order to serve public interest; or
(ii) in order to perform government function; or
(iii) in cases where auction of spectrum is not the preferred mode of assignment due to technical or economic reasons.
(b) The notification referred to in clause (a) shall be laid before each House of Parliament.
(6) The Central Government, if it determines that it is necessary in the public interest so to do, may exempt,—
(a) from the requirement of assignment under sub-section (2), in such manner as may be prescribed; and
(b) by notification, specific usages within specified frequencies and parameters, from the requirements of sub-section (2).
(7) Any exemption with respect to use of spectrum granted under the Indian Telegraph Act, 1885 and the Indian Wireless Telegraphy Act, 1933 prior to the appointed day, shall continue under this Act, unless otherwise notified by the Central Government.
(8) Any spectrum assigned through the administrative process prior to the appointed day, shall continue to be valid on the terms and conditions on which it had been assigned, for a period of five years from the appointed day, or the date of expiry of such assignment, whichever is earlier.
(9) Any spectrum assigned through auction prior to the appointed day, shall continue to be valid on the terms and conditions on which it had been assigned.

[5] The First Schedule of the Telecommunications Act, 2023 lists 19 items for 'assignment of spectrum through administrative process'. The relevant items of the First Schedule are reproduced below:
"14. In-flight and maritime connectivity.
15. Space research and application, launch vehicle operations and ground station for satellite control.
16. Certain satellite-based services such as: Teleports, Television channels, Direct To Home, Headend In The Sky, Digital Satellite News Gathering, Very Small Aperture Terminal, Global Mobile Personal Communication by Satellites, National Long Distance, International Long Distance, Mobile Satellite Service in L and S bands."

services provided by GSO-based satellite communication service providers.

(ii) GSO/ NGSO based Mobile Satellite Services providing voice, text, data, and internet services."

2.2 In this regard, the Authority released the Consultation Paper dated 27.09.2024 to solicit comments from stakeholders on the subject. Through the Consultation Paper dated 27.09.2024, a total of 21 broad questions were raised on a range of issues.

A. Issues related to spectrum assignment methodology and level playing field

2.3 After the release of the Consultation Paper dated 27.09.2024, a stakeholder raised issues related to (a) spectrum assignment methodology and (b) level playing field with terrestrial access services, through its representations to the Authority. It also brought out, *inter-alia*, the same issues through its written comments in response to the Consultation Paper dated 27.09.2024. A few other stakeholders also raised similar issues in their written submissions to the Authority. Notably, certain other stakeholders submitted contrary views to the Authority. A gist of the issues raised by various stakeholders in respect of (a) spectrum assignment methodology and (b) level playing field with terrestrial access services are given below.

(1) Spectrum assignment methodology

2.4 A gist of the issues raised by a stakeholder on the spectrum assignment methodology is given below:

(a) In its reference dated 11.07.2024, the DoT did not prescribe a specific methodology for spectrum assignment and instead, it left this matter open for discussion, in line with reference to the provisions of Section 4 read with the First Schedule of the Telecommunications Act, 2023. This

decision to keep the methodology open rather than restricting it to the administrative assignment, was made despite the fact that certain satellite-based communication services are already included in the First Schedule of the Act.

(b) In its current consultation paper, TRAI has omitted the consultation on methodologies, thereby foreclosing an issue that the DoT had explicitly left open for further consultation and recommendations by TRAI. Not a single question has been included in the consultation paper regarding the methodology of assignment.

(c) As per Section 4(4) of the Telecommunications Act, 2023, the default method for spectrum assignment is through auction. Exceptions can be made to auction, for administrative assignments only for use cases listed in the First Schedule. Section 4(5)(a) of the Act grants the Government the authority to assign spectrum administratively in two specific instances i.e. for government use, and in cases where an auction is not economically or technically feasible. The condition specified in section 4(5)(a)(i) of the Act is redundant as both auction and administrative assignment are done in the public interest. Each entry in the First Schedule must meet these criteria not only at the time of inclusion but should continue to meet the criteria prescribed in Section 4(5)(a) of the Act at all relevant points of time. Under the Telecommunications Act, 2023, both DoT and TRAI are required to test each type of spectrum usage in accordance with Section 4(5)(a)(i), (ii), and (iii) of the Act.

(d) Section 57(1)(a) grants the Central Government the authority to amend the First Schedule, allowing it to add or delete entries as necessary.

(e) As technology evolves, the usage of various spectrum bands will change. Further, various types of networks get the capability to provide new services which are same as the services provided through any other network technology or topology, thereby, requiring not only the addition of new entries but also the removal of outdated ones.

(f) Therefore, it would be legally inappropriate to base spectrum assignment methodology decisions solely on the basis of current entries in First

Schedule without considering the broader legislative intent expressed in Section 4(4) and 4(5) of the Act, particularly when the Hon'ble Supreme Court has, in repeated judicial pronouncements, held that the alienation of spectrum must be through auction.

(g) TRAI would be failing in its statutory duty, as established by the TRAI Act, 1997, if it did not thoroughly analyze the technical and economic feasibility of spectrum auctions for satellite services under the provisions of the Telecommunications Act, 2023. TRAI's failure to invite comments on the mode of assignment of spectrum for satellite-based communication services violates the requirement for transparency under Section 11(4) of the TRAI Act.

(h) The consultation paper does not even discuss the methodology for assignment of spectrum through administrative means. In the event, if TRAI after due consultation reaches to a conclusion that the Auction is not technically and economically feasible, it would still be required to recommend the methodology for administrative assignment including the eligibility criteria, a limit on the number of operators (as any resource cannot be assigned to infinite number of operators) and their selection criteria, in addition to recommendations on pricing, quantum and other terms and conditions.

(i) Any administrative assignment, generally, rely on the First come First Serve, which has been junked by Hon'ble Supreme Court in its 2G judgment and Presidential Reference, a position that has not been revised till date. The Telecom Act does not overrule or fundamentally alter the basis of these judgments. Any assignment of spectrum by a means other than auction is susceptible to challenge under Article 14 of the Constitution (right to equality), which mandates that the State must follow transparent, fair, and non-arbitrary procedures in alienating natural resources. Therefore, the Authority will have to develop a methodology for administrative assignment that is different from "First come, First Serve" model.

(j) The stakeholder while submitting written comments also shared a copy of a legal opinion, wherein it was, *inter-alia*, concluded that:

"i. The decisions of the Supreme Court in the 2G Judgement and the Reference Judgement continue to hold the field and the enactment of the Telecom Act has not altered the position that assignment of spectrum by the State to private parties by means other than auction is liable to be set aside for arbitrariness under Article 14 of the Constitution.

ii. Section 4(4) read with Entry 16 of First Schedule and Section 4(5) of the Telecom Act must be read as requiring each instance of assignment of spectrum to be preceded by an analysis of whether or not a deviation from the mandated rule of auction is merited. Such an analysis must be conducted with reference to the parameters laid down in Section 4(5)(a) of the Telecom Act."

(k) Further, after the last date for the submission of comments and counter-comments, the stakeholder submitted a copy of another legal opinion to the Authority covering issues including spectrum assignment methodology.

2.5 A few other stakeholders, who raised issues related to spectrum assignment methodology, made the following submissions:

(a) As per the guidelines of Hon'ble Supreme Court, the natural resources, including spectrum, are to be allocated only via auction process. Accordingly, the spectrum for satellite-based services shall be discovered through a widely accepted mechanism of auctions if it is to be used by the spectrum holder for offering voice and data services to end customers. For determining the reserve price, TRAI should recommend the prices for satellite spectrum considering the factors like spectral efficiency over the last auction prices of closest spectrum bands.

(b) The First Schedule clearly indicates that the administrative allocation of spectrum is restricted to 'certain satellite-based services' and not all satellite-based services.

(c) GMPCS authorisation is related to mobile services and same was the scope of GMPCS authorisation when the legislation was laid before the Parliament. Therefore, the administrative assignment of spectrum to be given under GMPCS authorisation is only for MSS and it cannot be for FSS. Changing the scope of GMPCS authorisation to cover FSS for the purpose of administrative allocation of the spectrum, would be against the provisions and intent of the Telecommunications Act, 2023.

(d) The methodology of administrative allocation to MSS is restricted only with respect to L and S bands. All other bands to be used for MSS are not part of this Schedule and hence, outside the ambit of administrative assignments. In all other spectrum bands for MSS, auction is the only option. In case of FSS bands, if the Government decides to assign this spectrum on exclusive basis, the possibility of auction may be explored.

(e) There should be suitable conditions and restrictions on the spectrum utilization if spectrum is assigned administratively (only where objective is to serve areas where terrestrial coverage is not available and spectrum is allocated at nominal cost), so as to fulfil the policy objectives and not to gain competitive advantages over other commercial services.

(f) Any shared spectrum assignment will be detrimental to new operator interests as it will be left at the mercy of closed club of incumbent operators for interference management and coordination. Effectively, the approved set of NGSO operators utilize the same frequencies through self-coordination, which is another way of dividing the entire spectrum in that band for exclusive use between the approved operators. Further, a global example of administrative exclusive use is in the FCC rules for NGSO-FSS system, wherein exclusivity is provided through priority in processing rounds and any subsequently approved NGSO FSS systems are required to coordinate with the earlier round of assignment. To add to this, the FCC also provides for a default spectrum split process in case of failure to coordinate.

2.6 On the other hand, stakeholders, with opinions contrary to the views mentioned above, made the following submissions:

(a) The comments relating to the review of the First Schedule of the Act to provide for auctioning of spectrum are incorrect and misleading and driven only by commercial interests through wrong interpretations. Section 4(4) read along with Entry 16 of the First Schedule clearly lays down unambiguously, the methodology for the assignment of satellite spectrum and that is through administrative method. The items mentioned in the First Schedule have been specifically put there since administrative assignment is the only mode of assignment for those entries. For all other cases, spectrum can be assigned through auction.

(b) The Government, through the Telecommunications Act, 2023, has already concluded that spectrum for satellite services will be assigned administratively. This needs to be accepted by all stakeholders rather than trying to raise the issue again. The method for the spectrum assignment is already concluded and rightly is not the scope of this consultation paper.

(c) The auction methodology leads to exclusive usage, and would lead to market access being limited to a few deep pocketed players. As a result, competition shall also get limited. In the case of satellite communications, spectrum is shared, facilitates multiple players and thus higher competition. This results in maximum efficiency of spectrum. Sharing of precious spectrum is the ultimate hallmark/ goal of any spectrum usage.

(d) The use of orbits is internationally regulated by ITU and coordinated at an international level. Hence, national administrations do not have complete control/ ownership of this orbit-spectrum resource. Therefore, the auction of any resource, on which the administration does not have complete control, does not stand to logic. Hence, the spectrum for satellite services is not amenable to auction practices.

(e) There are multiple users of satellite spectrum, viz., VSAT, DTH, broadcasters and teleport. Any plan to auction the spectrum only for satellite communications would seriously impact various industry segments which are using satellite spectrum as well.

(f) Satellite spectrum and mobile spectrum are unequal by virtue of circumstances in which they are placed. As per Article 14 of the Constitution of India, the two have to be treated differently on a mandatory basis because case law has established that unequal are not permitted to be treated as equals.

(g) 'Same service, same rules' is a facade created to prevent any meaningful room to diverse technologies. There is no basis for applying such a rule in the sphere of economic regulations. There can be no one size fit all formula when the nature and ecosystem of technologies is so diverse and more particularly when satellite-based service industry is at a very nascent stage and does not possess economies of scale. The argument of 'same service, same rule' will stifle competition by preventing newer players from entering the market.

(h) Satellite and terrestrial spectrum are inherently different. Satellite Spectrum is a shared resource. Satellite operators use the same frequencies across multiple satellites without interfering with each other. They also coordinate with each other in sharing the same frequencies across their services. In the case of shared spectrum, any number of operators are possible. Satellite spectrum being a shared resource gets used by multiple operators. As a result, the satellite spectrum is never exclusively assigned as opposed to the mobile access spectrum and hence is never auctioned.

(i) Administrative assignment of shared spectrum like NGSO-based FSS systems is not exclusive and, therefore, does not preclude the same spectrum for administrative assignment to other satellite-based communication services/ systems. As such, the stated concerns that spectrum is "kept" or "hoarded" would not materialize in shared spectrum that is administratively assigned.

(j) The Section 4(4) read along with Entry 16 of the First Schedule clearly lays down unambiguously, the methodology for the assignment of satellite spectrum and that is through administrative method. The method of

spectrum assignment is already concluded and rightly is not the scope of this consultation paper.

(k) One of the stakeholders also quoted a legal opinion, wherein it mentioned, *inter-alia*, that:

(i) State actions, whether it relates to the distribution of natural resources or grant of contracts, must be tested against the touchstone of Article 14 of the Constitution, and may not be struck down for being arbitrary without consideration to the actual constitutional infirmities associated with such action.

(ii) Auction cannot be considered a "constitutional mandate", as it would stand in complete contravention to the scheme of Article 14.

(iii) Allocation of natural resources to the highest bidder may not necessarily be the only way to subserve the common good and, at times, may run counter to the public good. "Distribution", as envisaged under Article 39(b) has broad contours, and cannot be limited to meaning only a singular method of resource disposal i.e., auction. The overarching and underlying principle governing distribution is the 'furtherance of common good.' As the allocation of resources is primarily intended towards serving public interest and the "common good", it cannot ipso facto be interpreted that auction represents the best method for allocation. (para. 119, Reference (Supra)

(iv) Lastly, the potential for abuse in other resource allocation methods could not be the basis for considering auctions as a legal/ constitutional mandate, as there was an equal potential for abuse in an auction.

(v) The 2G Case, was solely examining the issue of allocation in respect of mobile/terrestrial spectrum without deliberating on the allocation of satellite spectrum. Telecom / mobile license holders have access to 'back haul' networks, which were not disturbed/cancelled. This is indicative of the fact that the sole consideration in the 2G matter was

the method and manner of grant of licenses for operation of mobile/cellular networks, which is distinct from satellite spectrum.

(vi) In light of the above decisions, the issue of satellite spectrum allocation, should be guided by the overarching principles of: (a) maximizing the greater good/ furtherance of the common good; and (b) adopting a fair, reasonable and transparent method of allocation which is in consonance with principles of Article 14 of the Constitution.

…

(vii) Due to the distinctive features of satellite spectrum, the considered opinion is that auctioning satellite spectrum may not be the most appropriate and efficient method of resource allocation. In light of the Hon'ble Supreme Court's decision of auction not being a mandatory process for resource allocation and that the principle underlying the distribution of natural resources should be in furtherance of the common good, administrative allocation of satellite spectrum is a more efficient form of allotment of spectrum.

…

(2) Level playing field between satellite-based commercial communication services and terrestrial access services

2.7 A gist of the issues raised by one of the stakeholders is given below:

(a) The questions, their tonality and phrasing in the consultation paper, is at complete variance with the DoT's express mandate to account for level playing field with terrestrial access services, while recommending spectrum assignment regime for certain satellite-based communication services.

(b) DoT correctly recognized the need for a level playing field in its reference to TRAI; however, the consultation paper issued by TRAI appears to overlook this critical issue. It seems TRAI has pre-emptively closed the matter without soliciting the views of stakeholders. Not a single question

has been included in the consultation paper regarding the methodology of assignment, pricing or other terms and conditions to ensure a level playing field between satellite and terrestrial services. By failing to ask pertinent questions on this issue, stakeholders are deprived of the opportunity to voice their opinions. Such a consultation exercise could result in recommendations that disregard this vital issue of level playing field.

(c) Several global satellite constellations (e.g., Starlink/ Space X, Kuiper-Amazon, OneWeb-Eutelsat, SES-Jio, and Telesat etc.) have expressed interest in obtaining spectrum and market access rights in India. These constellations will primarily provide Access Services, directly competing with terrestrial networks both in Mobile and Fixed Wireless Access (FWA). Given that terrestrial networks acquire spectrum, both for Mobile and Fixed Wireless Access through auctions, a fair and transparent auction system for satellite services is essential to ensure level playing field between these similar service providers

(d) It is critical that the spectrum assignment framework promotes fair competition, transparency, and innovation and brings more and more investments in the sector. This remains the most critical ingredient of level playing field and its absence can lead to utter chaos causing favouritism, regulatory arbitrage and a pathway to legal entangles, which is enormously detrimental to the sector as well as national economy.

(e) Spectrum assignment for both terrestrial and satellite-based access services follow the principle of "Same Service, Same Rules". Therefore, ensuring parity in regulatory levies, including spectrum charges, is essential to prevent regulatory arbitrage and to ensure level playing field.

(f) The requirements of level playing field is not limited to NGSO and IMT/ terrestrial access services but is equally relevant for GSO-based Fixed Satellite Services (FSS) that provide data communication and internet services. The Section 4(i) of the DoT reference dated 11.07.2024, specifically mentions TRAI to take into account the services provided by GSO based satellite communication services. However, the consultation

paper focuses exclusively on NGSO-based Fixed Satellite Services and fails to address spectrum assignment and level playing field between the GSO based Fixed Satellite Services and IMT/terrestrial services altogether. The level playing field should be applicable all across in access communications.

(g) The emergence of unified networks that will deliver the same service over both media to the same consumers. Technological advancements are enabling converged networks have blurred the distinctions between satellite and terrestrial networks, and satellite-based services are no longer confined to areas unserved by terrestrial networks but are at par in provisioning access services in a competitive manner.

(h) Some of the technological advancements in the satellite based communication sector such as Non-Geostationary Satellite Orbit (NGSO) systems, Direct-to-Device (D2D) services, the convergence of satellite-based access services in IMT Advanced with the inclusion of satellite as a network node in 3GPP standards that requires flexible deployment and integration of both terrestrial and satellite based networks results in a unified communications network which will provide seamless services between mobile/fixed wireless and satellite based networks.

(i) The world has moved so much on the technology front that the unified communication networks are being envisaged and planned that will combine the strengths of satellite, terrestrial and with airborne networks as well in future to deliver a holistic experience to the users.

(j) Ensure level playing field between satellite and terrestrial networks, by keeping the spectrum assignment methodology, terms and conditions, and applicable charges always same and uniformly applicable to both the networks.

(k) Keeping the technological developments in mind, new Telecommunications Act has incorporated Section 6 that says that "*The Central Government may enable the utilisation of the spectrum in a flexible, liberalised and technologically neutral manner, subject to such*

terms and conditions, including applicable fees and charges, as may be prescribed."

(l) TRAI has not included any questions on how the spectrum will be used in a flexible manner between terrestrial network and satellite network to allow a fully integrated network as envisaged in 3GPP R17 onwards, in case the spectrum is assigned through two different methodologies i.e. through auction and administrative.

(m) All Communication access services are competing services:

i. A majority of the NGSO satellite operators are targeting to offer high-throughput broadband connectivity directly to users (direct broadband-to-home). It is like fixed wireless access (FWA) services by terrestrial network. Further, both GSO and NGSO satellite operators are also targeting to provide voice, text, low-rate data, and IoT service directly to users using existing/ modified mobile phones using satellite and/ or IMT spectrum. Thus, there is no difference between customers of terrestrial and satellite networks, be it a mobile device or FWA.

ii. Amazon's Project Kuiper plans to launch 3,236 satellites to provide global broadband coverage, investing over $10 billion to achieve this. SpaceX's Starlink has already launched over 4,000 satellites, generating $1 billion in revenue in 2022, and is targeting a $1 trillion market. OneWeb aims for global coverage by the end of the year, targeting enterprise clients and merged with Eutelsat for broader market reach. NGSO satellite business plans will create competition with terrestrial networks, and spectrum auctions will ensure fair competition between these players.

iii. The satellite capacities generated by the massive foreign satellite constellations, aimed at providing FSS and MSS, will far surpass the capacities of most domestic terrestrial telecom operators.

(n) Satellite spectrum is not necessarily used in a shared mode and exclusive assignment is possible through auction-

i. Even for the NGSO constellation, it is not possible to use the same frequencies between geographically spread fixed, nomadic, or mobile user terminals and satellites moving at high speeds on low/medium earth orbits. Sharing frequencies to avoid frequent inline interference events between thousands of satellites and millions of user terminals would pose an administrative nightmare for the government if a large number of NGSO operators (let's say 10 operators) were assigned the same frequencies. While some operators may argue that interference mitigation can be achieved with the help of technology, such mitigation would limit the number of operators in the NGSO space.

ii. Even Federal Communications Commission (FCC) in the USA has achieved spectrum sharing between NGSO operators for their user links by limiting the number of operators to utilize the same frequencies on a non-exclusive/ shared basis. Thus, the exclusivity is not based on frequency or geography, but rather on the number of operators who can be part of such club who share the frequencies through technical interconnections to avoid interference. Such an arrangement also entails exclusivity through the membership in this club of four operators.

(o) Without prejudice to the submissions, in case it is decided to assign the spectrum administratively at a spectrum charge, then in the application of this spectrum charge, complete level playing field should be ensured by keeping it equal to the auction payout of the nearest spectrum band as per its auction determined price. This charge should be exclusive of spectrum usage charge and license fee applicable under the relevant license authorization. Further, in order to ensure an efficient utilization of spectrum, the minimum spectrum charge should be equivalent to the total payment payout of the benchmarked auctioned spectrum and there should be a lock in period of 10 years.

(p) The legal opinion submitted by the stakeholder alongwith the written submission also included an opinion on the issue relating to level playing field, wherein, it was *inter-alia* concluded that:

"v. By ignoring the DoT's specific instruction to account for level playing field with terrestrial access service providers, TRAI has acted in a non-transparent and arbitrary manner, in contravention of Section 11(4), and the entire consultation process and any actions consequent thereto, are liable to be set aside."

(q) Further, the legal opinion submitted by the stakeholder after the last date of submission of comments and counter-comments, also included an opinion on the issue relating to level playing field.

2.8 A few other stakeholders, with a view that level playing field issues need to be addressed, made the following submissions:

(a) The DoT's reference has explicitly requested TRAI to provide its recommendations on the terms and conditions of spectrum assignment, including spectrum pricing, while accounting for a level playing field with terrestrial access services. The consultation paper has not addressed this critical issue, which is essential to consider while determining the terms and conditions for spectrum assignment. The absence of questions on level playing field, lacks transparency and prevents many stakeholders from considering these concerns and providing crucial inputs to TRAI.

(b) NGSO, especially LEO constellations, now offers speeds comparable to terrestrial networks, enabling some satellite communication operators to provide services to retail customers. This shift means satellite communication can now effectively compete with terrestrial access service providers for individual subscribers in the retail and urban markets. For instance, some satellite operators are positioning the satellite broadband as a viable alternative to traditional broadband access, especially in urban and suburban areas where competition among terrestrial networks is already fierce. This emerging dynamic raises urgent regulatory concerns

about maintaining a level playing field, as the lines between satellite and terrestrial access services increasingly blur for direct consumer access.

(c) The issue of creating a level playing field is crucial for the balanced growth of the entire ecosystem.

(d) Services that directly compete with terrestrial networks, such as (i) satellite-based mobile services (MSS or 3GPP-based), (ii) satellite-based Fixed Wireless Services (FSS or 3GPP-based), and (iii) Enterprise Services through NGSO constellations and any other retail services directly to customers in urban and semi-urban areas, will operate under a GMPCS license. To ensure a level playing field, the spectrum pricing for these competing services should be aligned and benchmarked with market discovered price of the spectrum for terrestrial networks.

(e) While satellite communication should be encouraged to serve traditional markets (rural and remote areas) and for traditional use cases (serving Defence, various government agencies, PSUs, cellular backhaul, disaster, etc.) to bridge the digital divide, it is essential to address the issue of level playing field. Therefore, driving the adoption of satellite communication must go hand in hand with ensuring a level playing field, fostering healthy competition that benefits consumers and the industry alike.

(f) It is important that the regulatory framework around NTN solutions should be clear and consistent with the regulatory framework of existing networks.

(g) The satellite capacities generated by the massive foreign satellite constellations, aimed at providing FSS and MSS, will far surpass the capacities of most domestic terrestrial telecom operators. Such considerable capacities position the satellite operators to compete aggressively in the Indian market, potentially disrupting the competitive balance and creating challenges for terrestrial Indian telecom providers to maintain their market share, especially in the high-capacity segments as they directly compete providing similar services such as voice, broadband internet, messaging etc. Without an appropriate regulatory intervention, this could result in an uneven competitive landscape that puts huge

investment of Indian operators at a disadvantage. Therefore, it is imperative that the level playing field issues are thoroughly examined and addressed.

(h) As satellite-based services, particularly Non-Geostationary Satellite Orbit (NGSO) constellations, evolve, they increasingly overlap with the services provided by terrestrial networks. This convergence raises important questions about spectrum assignment, pricing, and regulatory policies that need to be addressed to ensure a level playing field between satellite and terrestrial operators.

(i) Given the massive capacities that satellite constellations are bringing to the market, it is evident that they will become strong competitors to terrestrial operators especially in urban as well as semi-urban areas including retail and enterprise customer segments. The scale of data traffic they can support is comparable or even exceeds that of some terrestrial networks.

(j) The deployments of FWA by terrestrial and FSS by satellite operators providing connectivity to home/ residential and enterprise customers are similar in nature. The principle of "Same Service, Same Rules" is vital to maintaining fair competition between terrestrial and satellite operators. When satellite services compete with terrestrial networks by offering similar services to retail and enterprise customers, they must be subject to the same spectrum pricing, regulatory levies, and licensing fees as terrestrial operators.

2.9 Another set of stakeholders, with opinions contrary to the views mentioned above, made the following submissions:

(a) The issue of level playing field is fundamental to all policy discussions and TRAI as always is expected to take a balanced view while making its recommendations. Hence, there is no explicit need for it to be brought out separately.

(b) Comparison between two differently placed services being offered by different players who have different rights and obligations, cannot be

deemed as similar/ competing services. The satellite and mobile communication services differ significantly in terms of infrastructure, technology, business models, and operational needs. These differences make it impractical to treat them in an identical manner and hence the argument of level playing field between the two services is not tenable in any manner.

(c) Terrestrial mobile operators and satellite VSAT operators are on completely different footings. Satellite services operate within a finite number of orbital slots, and thus expecting satellite communication to achieve the same vast consumer base like terrestrial mobile itself is impossible.

(d) It may be incorrect to say that the GSO based VSATs compete with the terrestrial networks in India. The price per Mbps on the terrestrial network is significantly lower (to the scale of 1:100 or more) as compared to the satellite network. Thus, satellite network services is no way in competition to terrestrial network services. It is also well established that the Satcom services are used only in the areas where the terrestrial networks do not exist. This can be verified from the actual data. The annual revenue of terrestrial network service provider in India is approximately Rs. 3.5 lakh crore, whereas annual service revenue of VSAT industry is in the range of Rs. 540-600 core and total revenue is less than Rs. 2000 core. The size of VSAT antenna is way too high as compared to handheld mobile devices used for data communications. Customers deploy VSAT terminal only if terrestrial network is not feasible/ suitable.

(e) At any point in time only one satellite is able to provide service over a specific location and when that satellite moves over, the next one offers the same service. As such it is not correct to look at all satellites of the NGSO constellation as a collective set of satellites offering services to any specific location at the same time. The total capacity is very limited over India which is even less than the capacity that may be provisioned on single fiber pair (terrestrial network). Thus, there is no comparison of services planned on such NGSO constellations versus terrestrial networks.

(f) There is a fundamental difference between operations of the terrestrial wireless and satellite communication providers/systems. Unlike the spectrum for terrestrial wireless services/ systems, spectrum used by satellite communications can be shared amongst multiple operators/systems. The business model of terrestrial wireless operators/systems is distinct from satellite communication providers. Terrestrial service providers (TSP) secure their spectrum through auctions and, if successful, are awarded a license for a specific geographic area with a known population. The people and businesses in their license areas represent their customer opportunity base. The TSPs then build their base stations and supporting network infrastructure to deliver wireless communications to customers and businesses in their license area who subscribe to the TSPs' services. If demand exceeds capacity, TSPs can build more base stations and infrastructure to meet that demand. On the other hand, satellite communication providers register and coordinate their frequencies at the ITU and share these frequencies with all other satellite systems registered at the ITU. To operate in a country, satellite communication providers seek authority from the responsible national authority to offer satellite communication services in the country. If successful, satellite operators obtain approvals to operate in the country, using shared spectrum resources. The satellite operator builds and launches their satellites, builds their gateway stations and customer terminals, and begins offering services around the world. Satellite systems have a limited capacity relative to their field of view. If demand exceeds capacity in a geography, the satellite operator cannot scale a constellation in the same manner as terrestrial wireless operators can with their network. A satellite operator would need to launch more satellites and possibly build more gateway stations, and that requires a cost-benefit analysis to determine if the cost of the additional capacity would yield positive benefits.

(g) While India is an extremely important telecom market, it still only accounts for ~2.4% of the world's land area (and ~0.6% of the surface area of the

Earth) - an important factor in understanding the capacity of satellite constellations for any individual market.

B. The Authority's views w.r.t. the issues raised by stakeholders related to Spectrum assignment methodology and level playing field

(1) Spectrum assignment methodology

2.10 Earlier, DoT, through its reference letter dated 13.09.2021 to TRAI, requested, *inter-alia*, to provide recommendations on appropriate frequency bands, band plan, block size, applicable reserve price, quantum of spectrum to be auctioned and associated conditions for auction of spectrum for space-based communication services. Through its subsequent letter dated 16.08.2022, DoT provided additional information/ clarification, wherein DoT stated, *inter-alia*, that it is envisaged to auction the space spectrum on an exclusive basis. In this regard, TRAI issued a consultation paper on 'Assignment of Spectrum for Space-based Communication Services' dated 06.04.2023.

2.11 Meanwhile, in December 2023, Parliament enacted a new statute namely, the Telecommunications Act, 2023[6]. The Act amends and consolidates the law relating to development, expansion and operation of telecommunication services and telecommunication networks, assignment of spectrum, and for matters connected therewith or incidental thereto. Section 4 of the Telecommunications Act, 2023 deals with 'assignment of spectrum'. Section 4 is reproduced below:

"4. (1) The Central Government, being the owner of the spectrum on behalf of the people, shall assign the spectrum in accordance with this Act, and may notify a National Frequency Allocation Plan from time to time.

(2) Any person intending to use spectrum shall require an assignment from the Central Government.

[6] https://egazette.gov.in/WriteReadData/2023/250880.pdf

(3) The Central Government may prescribe such terms and conditions as may be applicable, for such assignment of spectrum, including the frequency range, methodology for pricing, price, fees and charges, payment mechanism, duration and procedure for the same.

(4) The Central Government shall assign spectrum for telecommunication through auction except for entries listed in the First Schedule for which assignment shall be done by administrative process.

Explanation.— For the purposes of this sub-section,—

(a) "administrative process" means assignment of spectrum without holding an auction;

(b) "auction" means a bid process for assignment of spectrum.

(5) (a) The Central Government may, by notification, amend the First Schedule for assignment of spectrum—

(i) in order to serve public interest; or

(ii) in order to perform government function; or

(iii) in cases where auction of spectrum is not the preferred mode of assignment due to technical or economic reasons.

(b) The notification referred to in clause (a) shall be laid before each House of Parliament.

(6) The Central Government, if it determines that it is necessary in the public interest so to do, may exempt,—

(a) from the requirement of assignment under sub-section (2), in such manner as may be prescribed; and

(b) by notification, specific usages within specified frequencies and parameters, from the requirements of sub-section (2).

(7) Any exemption with respect to use of spectrum granted under the Indian Telegraph Act, 1885 and the Indian Wireless Telegraphy Act, 1933 prior to the appointed day, shall continue under this Act, unless otherwise notified by the Central Government.

(8) Any spectrum assigned through the administrative process prior to the appointed day, shall continue to be valid on the terms and conditions on which

it had been assigned, for a period of five years from the appointed day, or the date of expiry of such assignment, whichever is earlier.

(9) Any spectrum assigned through auction prior to the appointed day, shall continue to be valid on the terms and conditions on which it had been assigned."

2.12 The First Schedule of the Telecommunications Act, 2023 lists 19 items for 'assignment of spectrum through administrative process'. The relevant items of the First Schedule are reproduced below:

"14. In-flight and maritime connectivity.

15. Space research and application, launch vehicle operations and ground station for satellite control.

16. Certain satellite-based services such as: Teleports, Television channels, Direct To Home, Headend In The Sky, Digital Satellite News Gathering, Very Small Aperture Terminal, Global Mobile Personal Communication by Satellites, National Long Distance, International Long Distance, Mobile Satellite Service in L and S bands."

2.13 In view of the above, TRAI, through a letter dated 08.02.2024, conveyed to DoT that *"the DoT's Reference requesting TRAI to provide its recommendations for auction of spectrum for space-based communication services, may require a review by DoT. Therefore, DoT is requested to provide the specific issues on which TRAI's recommendations are required on the subject."*

2.14 In response, DoT, through the reference dated 11.07.2024, conveyed as below to TRAI:

"TRAI in its letter No. C-15/2/(2)/2022-NSL-II dated 08 February 2024 requested DoT to review its earlier reference No. L-14006/01/2021-NTG dated 13/09/2021 to TRAI seeking their recommendations for auction of spectrum for space-based communication services in view of the provisions of the Section 4 & First Schedule of the Telecommunications Act 2023.

2. It is to inform that a reference dated 21/06/2024 has already been sent to TRAI for seeking recommendations on terms and conditions, including fees or charges, for authorization to provide telecommunication services (including satellite-based communication services) as per the provisions of the Telecommunications Act, 2023.

3. Since the last reference dated 13/09/2021 to TRAI on spectrum for space-based communication services, a few Unified Licenses with VSAT CUG, Global Mobile Personal Communication by Satellite (GMPCS), NLD and ISP Category 'A' authorizations have been issued by DoT for providing satellite-based communication services through Non-Geostationary Orbit (NGSO) satellites. For assignment of spectrum to such licensees, terms and conditions of spectrum assignment including spectrum pricing need to be finalized.

4. Keeping in view the provisions of Section 4 and the First Schedule of the Telecommunications Act-2023, in terms of Section 11(1)(a) of TRAI Act 1997, TRAI is requested to provide its recommendations on terms and conditions of spectrum assignment including spectrum pricing while accounting for level playing field with terrestrial access services for the following satellite-based communication services:

i. NGSO based Fixed Satellite Services providing data communication and Internet services. In its recommendations, TRAI may take into account services provided by GSO-based satellite communication service providers.

ii. GSO/ NGSO based Mobile Satellite Services providing voice, text, data, and internet services."

2.15 The National Frequency Allocation Plan (NFAP) 2022[7] defines the terms 'fixed satellite service' and 'mobile satellite service' as below:

"2.19. fixed-satellite service: A radiocommunication service between earth stations at given positions, when one or more satellites are used; the given position may be a specified fixed point or any fixed point within specified areas; in some cases, this service includes satellite-to-satellite links, which may also

[7] Source: https://dot.gov.in/sites/default/files/NFAP%202022%20Document%20for%20e-release.pdf?download=1

be operated in the inter-satellite service; the fixed satellite service may also include feeder links for other space radiocommunication services."

"2.23 mobile satellite service: A radiocommunication service:

- *between mobile earth stations and one or more space stations, or between space stations used by this service; or*
- *between mobile earth stations by means of one or more space stations.*

This service may also include feeder links necessary for its operation."

2.16 As per ITU[8], *an Earth station that is placed on a moving platform, such as a ship at sea, a moving train, or an aircraft in flight, is referred to as an Earth station in motion (ESIM). Earth stations in motion (ESIM) communicate, with geostationary-satellite orbit (GSO) and non-geostationary orbit (non-GSO) systems operating in the fixed-satellite service (FSS).*

2.17 The items 14 and 16 of the First Schedule of the Telecommunications Act, 2023 include the following telecommunication services:

(a) Very Small Aperture Terminal,
(b) Global Mobile Personal Communication by Satellite,
(c) National Long Distance,
(d) International Long Distance,
(e) Mobile Satellite Service in L and S bands, and
(f) In-flight and maritime connectivity.

2.18 As per ITU[9], "*GMPCS is a personal communication system providing transnational, regional or global coverage from a constellation of satellites accessible with small and easily transportable terminals. Whether the GMPCS satellite systems are geostationary or non-geostationary,* fixed *or mobile, broadband or narrowband, global or regional, they are capable of providing*

[8] Source: https://www.itu.int/en/mediacentre/backgrounders/Pages/Earth-stations-in-motion-satellite-issues.aspx

[9] https://www.itu.int/en/gmpcs/Pages/default.aspx

telecommunication services directly to end users. GMPCS services include two-way voice, fax, messaging, data and even broadband multimedia".

2.19 As per ITU[10], *"VSATs could be described as earth stations that share satellite resources among a large number of similar terminals. Individual VSAT terminals typically have small aperture sizes, transmit at relatively low equivalent isotropically radiated power (e.i.r.p.) levels, and use relatively small equipment that allows flexible installation of a satellite network earth station directly at a wide variety of user locations and platforms".*

2.20 It is noteworthy that TRAI in its recent recommendations on "Framework for Service Authorisations to be Granted Under the Telecommunications Act, 2023" dated 18.09.2024 (hereinafter, referred to as "the Recommendations dated 18.09.2024"), has recommended to the Government to grant, *inter-alia*, the following authorisations under the Telecommunications Act, 2023:

(a) Satellite-based telecommunication service authorisation; and

(b) Long distance service authorisation

2.21 Through the Recommendations dated 18.09.2024, the Authority has defined the scope of satellite-based telecommunication service authorisation as follows:

"Scope of service:

(1) Broadly, the Authorised Entity may provide Global Mobile Personal Communication by Satellite (GMPCS) Service using Mobile Satellite Services (MSS) and Fixed Satellite Services (FSS); and VSAT-based Fixed Satellite Services (FSS). Global Mobile Personal Communications by Satellite (GMPCS) system means "any satellite system (i.e. fixed or mobile, broad-band or narrow-band, global or regional, geo-stationary or non geo-stationery, existing or planned) providing telecommunication services directly to end users from a single or constellation of satellites".

[10] https://www.itu.int/dms_pub/itu-r/opb/rep/r-rep-s.2278-2013-pdf-e.pdf

Specifically, the scope of service under GMPCS and VSAT based FSS are given below:

(2) The Authorised Entity may provide GMPCS using satellite, including the following services:

(a) Transmission, emission or reception of any voice or non-voice message including video

(b) Internet access service, and Internet telephony

(c) Leased circuits and Virtual Private Networks

(d) Provide connectivity to eligible authorised entities for connecting their network elements, including backhaul connectivity

(e) Provide connectivity for M2M/ IoT devices/ aggregator devices

(f) The Authorised Entity shall either establish Land Earth Station Gateway in India or use the Satellite Earth Station Gateway (SESG) established by any authorised entity in India. GMPCS may be provided using one or more satellite systems provided that the SESG and Switch for the respective satellite systems are located in India.

(3) The Authorised Entity may provide VSAT-based Fixed Satellite Service (FSS) using satellite, including the following services:

(a) Internet Access Service

(b) Leased circuits and Virtual Private Networks; provision of data connectivity between various sites scattered within the territorial boundary of India using VSATs

(c) Provide connectivity to eligible authorised entities for connecting their network elements, including backhaul connectivity

(d) VSAT user terminal stations on moving platforms [Earth Sation in Motion (ESIM)] are also permitted for provisioning of connectivity subject to compliance with relevant TEC standard(s) and conditions mentioned therein.

(a) VSAT user terminal may also be used to aggregate the traffic from M2M/ IoT devices/ aggregator devices.

(b) For providing the VSAT-based Fixed Satellite Service (FSS), the Authorised Entity shall either establish Land Earth Station Gateway/

Hub Station in India or use the SESG established by any authorised entity in India.

…"

2.22 Through the Recommendations dated 18.09.2024, the Authority has defined the scope of long distance service authorisation as follows:

"Scope of service: The Authorised Entity may provide service as per the following scope of the authorisation:

(1) National Long Distance (NLD) Service:

(a) To carry switched bearer telecommunication traffic within India.

(b) Inter-circle switched bearer telecommunication traffic shall be handed/ taken over at the Point of Presence (PoP) of the Authorised Entity situated in originating/ terminating Telecom Circle/ Metro Area.

(c) For intra-circle switched bearer telecommunication traffic, the Authorised Entity can make arrangements under mutually agreed terms and conditions with the concerned Access Service Providers for picking up, carriage and delivery of telecommunication traffic within a designated Telecom Circle/ Metro area.

(d) To provide bandwidth to other authorised entities who are permitted to have such connectivity under their respective authorisation.

(e) The Authorised Entity can provide Leased Circuits and Virtual Private Networks (VPNs). The Authorised Entity can access the users directly for this purpose.

(f) For provision of domestic Calling Cards, the Authorised Entity can also access the users directly.

(2) International Long Distance (ILD) Service:

(a) To carry switched bearer telecommunication traffic over international long-distance network for providing international connectivity to the network operated by foreign carriers.

(b) Shall provide bearer services so that end-to-end telecommunication services can be provided by the authorised entity providing Access Services to the users.

(c) The Authorised Entity may establish an International Long Distance (ILD) Gateway Station along with requisite security monitoring equipment after obtaining security clearance/ approval from the Central Government.

(d) May offer international bandwidth on lease to other authorised entities who are permitted to have international connectivity under their respective authorisations.

(e) Can provide International Private leased Circuit (IPLC); for this purpose, the Authorised Entity can access the users directly.

(f) The Authorised Entity may also access the users directly for provision of international long distance voice service only through calling cards.

…"

2.23 Through the Recommendations dated 18.09.2024, the Authority has defined the scope of In-flight and Maritime Connectivity (IFMC) Service as follows:

"Scope of Service:

The Authorised Entity is permitted to provide voice or data or both types of messages on ships and aircrafts in the Service Area through wireless medium."

2.24 Further, DoT has recently issued an Office Memorandum[11] on the subject 'Instructions related to Security aspects in chapter XII of the UL Agreement for the provision of GMPCS service' dated 05.05.2025, wherein it has been mentioned, *inter-alia*, as follows -

"11. The Fixed Satellite Subscriber/User Terminals (which have not subscribed to any portability/mobility facility) shall suitably be bound to geo location where subscribed services are granted by the licensee. Any attempt at the subscriber

[11] https://dot.gov.in/sites/default/files/OM%20GMPCS%20Security%20instructions.pdf

level for relocation and transportation of the terminal to other locations should not be allowed. Requests for relocation or shifting be addressed to licensee and should only be granted with proper authorization."

2.25 In light of the above, both NGSO based Fixed Satellite Services providing data communication and Internet services and GSO/ NGSO based Mobile Satellite Services providing voice, text, data, and internet services are covered under the items 14 and 16 (Very Small Aperture Terminal, Global Mobile Personal Communication by Satellite, National Long Distance, International Long Distance, Mobile Satellite Service in L and S bands, and In-flight and maritime connectivity) of the First Schedule of the Telecommunications Act, 2023.

2.26 It is noted that Section 4(4) of the Telecommunications Act, 2023 provides that the assignment of spectrum for the entries listed in the First Schedule shall be done by administrative process. There was no question before the Authority to examine the methodology of assignment of spectrum for the services mentioned in DoT's reference dated 11.07.2024.

2.27 A few stakeholders have contended that Section 4(5) of the Telecommunications Act, 2023 requires that every entry in the First Schedule should comply with Section 4(5)(a)(i), (ii), and (iii); therefore, when providing recommendations on spectrum assignment, TRAI is required to assess whether the use of any given spectrum band complies with these provisions. In this regard, it is noteworthy that Section 4(5) of the Telecommunications Act, 2023 provides as below:

"(5)(a) The Central Government may, by notification, amend the First Schedule for assignment of spectrum—

(i) in order to serve public interest; or

(ii) in order to perform government function; or

(iii) in cases where auction of spectrum is not the preferred mode of assignment due to technical or economic reasons.

(b) The notification referred to in clause (a) shall be laid before each House of Parliament."

2.28 As per Section 4(5) of the Telecommunications Act, 2023, the Central Government is empowered to amend the First Schedule of the Act, and therefore, there was no question before the Authority to examine as to whether the entries of the First Schedule comply with the requirement of Section 4(5)(a)(i), (ii), and (iii) of the Act. Without an explicit reference to the Authority for testing/ review of the entries in the First Schedule of the Telecommunications Act, 2023, an action which lies in the domain of the Central Government, it would be an unreasonable extrapolation to undertake a testing/ review of entries in the First Schedule of the Telecommunications Act, 2023 by the Authority under the reference dated 11.07.2024. Hence, the Authority has rightfully not asked any specific question on testing/ review of the entries in the First Schedule of the Telecommunications Act, 2023 nor on the methodology of assignment, and proceeded with the consultation as per the extant entries of the First Schedule of the Telecommunications Act, 2023.

(2) Issue of level playing field between satellite-based commercial communication services and terrestrial access services

2.29 DoT, in para 4 of its reference letter dated 11.07.2024, has requested TRAI to provide its recommendations on terms and conditions of spectrum assignment including spectrum pricing while accounting for level playing field with terrestrial access services for certain satellite-based communication services. The issue of level playing field between terrestrial communication services and satellite communication services requires to be seen in terms of both financial and non-financial aspects. While financial aspects could include levies and charges for spectrum assignment, non-financial aspects could include period of spectrum assignment, roll-out obligations, interference management etc. The non-financial and financial aspects of spectrum assignment for satellite communication services were dealt in Chapter III and Chapter IV of the

consultation paper dated 27.09.2024, respectively, in which the facet of level playing field was duly included.

2.30 It is worth mentioning that the Authority quoted verbatim the extract of para 4 of the DoT's reference letter dated 11.07.2024 in various paragraphs of the consultation paper dated 27.09.2024 viz. para 1.13, and para 4.7. The Authority also included the relevant part of para 4 of the DoT's reference dated 11.07.2024 in para 3.1 of the consultation Paper dated 27.09.2024. The issues in Chapter III and IV of the Consultation Paper dated 27.09.2024 have been dealt in the context of para 4 of the DoT's reference duly citing the issue of "*accounting for level playing field with terrestrial access services*".

2.31 Notably, in the para 4.20 of the Consultation Paper dated 27.09.2024, the Authority mentioned as below in respect of the level playing field between terrestrial access services and satellite-based communication services:

"It is noted that in its reference dated July 11, 2024, ***the Department of Telecommunications (DoT) has requested recommendations on the terms and conditions of spectrum assignment, including spectrum pricing, with consideration for ensuring a level playing field with terrestrial access services****. In this context,* ***it is essential to examine whether such a level playing field between service providers of NGSO based Fixed Satellite Services providing data communication and Internet services and GSO/NGSO based Mobile Satellite Services providing voice, text, data, and internet services. and terrestrial access service providers actually exists.*** *Following this examination, if spectrum charges are to be levied as a percentage of AGR, the percentage previously recommended by the Authority may need to be reassessed."* [Emphasis supplied]

2.32 In short, in the present consultation process, stakeholders were adequately informed about the DoT's ask from TRAI for accounting for level playing field between terrestrial access services and satellite-based communication services.

Further, the questions raised in the Consultation Paper dated 27.09.2024 were broad and open and were drafted in a manner to solicit a full range of comments from stakeholders having varied standpoints. The questions were not tailor-made to seek narrow replies on specific issues. On the contrary, it was ensured through the language of questions that stakeholders may put forth a gamut of responses, and any stakeholder, with a divergent view, is not prevented from providing their viewpoint. Evidently, the aspect of level playing field between terrestrial communication services and satellite communication services was amply dealt with in the Consultation Paper dated 27.09.2024. As a matter of fact, in the present consultation process, many stakeholders have submitted their inputs in respect of the level playing field between terrestrial communication services and satellite-based communication services.

2.33 At this stage, it would be worthwhile to examine whether there is a case of level playing field between the providers of terrestrial communication services and the providers of satellite communication services. In the following section, the case of level playing field is being assessed for both (a) NGSO-based FSS and (b) GSO/ NGSO-based MSS, with respect to terrestrial communication services.

(a) <u>The case of level playing field between NGSO-based FSS and terrestrial access services</u>

2.34 A comparison of terrestrial access services and NGSO-based FSS has been provided in **Annexure 2.1** of these recommendations.

2.35 The network capacities of terrestrial wireless access providers and NGSO-based satellite broadband providers in terms of throughput are significantly different. As per the estimates given in Annexure 2.1 of these recommendations, the network capacity of the typical terrestrial wireless access service operator for providing broadband access to households and enterprises through FWA technology would be of the order of 168 Tbps in the near-to-medium term. On

the other hand, the network capacities of the major NGSO-based FSS providers for providing satellite broadband in India range in the order of 0.6 Tbps to 3 Tbps in the near-to-medium term. The ratio of the network capacity of the typical terrestrial wireless access service operator and the network capacity of the major NGSO-based FSS providers ranges from 56:1 to 280:1. Assuming similar data rates are offered to FWA based terrestrial broadband subscribers and satellite broadband subscribers, a typical terrestrial wireless access service provider can serve significantly higher number of broadband subscribers as compared to NGSO-based FSS operators.

2.36 It is also noteworthy that to meet the surge in demand for broadband services in a particular geographical area, a terrestrial wireless access service provider is well positioned to enhance network capacities at a much higher pace (by way of deploying base stations in the locality) as compared to the NGSO-based FSS operator, who can enhance the capacity by steering beams to only a limited extent. One could argue that the satellite operator can always increase its satellites to cater to the surge in demand. However, it may be worth noting that for satellite operators, it may not be possible to increase capacity by way of putting up more satellites on a local basis, i.e. specific to the location having a surge in demand; further, the overall capacity of the NGSO satellite constellation cannot be increased on an immediate basis. It is noteworthy that the capacity of an NGSO satellite constellation is distributed over the entire geographical area. Only a limited variation in local capabilities is presently possible by steering beams.

2.37 Based on the international scenario, the typical cost of satellite user terminal of NGSO-based FSS is higher than the cost of terrestrial FWA terminals. With technological developments, the cost of user terminals for NGSO based FSS may come down. Similarly, the cost of user terminals for terrestrial FWA services is also likely to be reduced in the near future. However, the cost of user terminals for NGSO-based FSS is likely to remain higher than the terrestrial

FWA user terminals because of the complex technological requirements of FSS terminals for satellite tracking, in the foreseeable future.

2.38 A terrestrial wireless access network can offer a full suite of services such as voice telephony, SMS, internet access to the customers and data connectivity to enterprises. Further, the advent of 5G technology has given rise to a new use case viz. internet access to households and enterprises through fixed wireless access (FWA) technology. On the other hand, NGSO-based FSS networks have two main use cases viz. (a) internet access to households and enterprises and (b) provision of data connectivity to enterprises. Thus, there is a significant difference between the range of services under terrestrial wireless access service and the range of services under NGSO-based FSS.

2.39 Keeping the above in view, it may be inferred that the substitution of terrestrial wireless access service with NGSO based FSS will remain limited in the near-to-medium term, mainly owing to the scale of their respective operations, and their limited ability to enhance capacities to meet the surge in consumer demand. The NGSO based FSS is likely to remain complementary to terrestrial FWA services in the near-to-medium term. Therefore, in the foreseeable future, the case of level-playing field between terrestrial wireless access services and NGSO-based FSS is not expected to arise.

(b) <u>The case of level playing field between GSO/ NGSO-based MSS and terrestrial access services</u>

2.40 GSO/ NGSO based mobile satellite systems make use of specific frequency bands (mainly L and S bands) allocated for MSS by ITU-RR. The total quantum of spectrum in L and S bands together is of the order 100 MHz (paired). Mobile satellite systems are coordinated at ITU level. Further, some spectrum may be earmarked by the country regulators for strategic purposes. Therefore, as per the prevailing scenario, only a small portion of the spectrum in L and S bands

[typically of the order of 10 MHz (paired) or so] is available for use by each of the mobile satellite systems for commercial purposes.

2.41 MSS is used mainly for the strategic use, establishing communication during natural disasters, in-flight and maritime connectivity, IoT connectivity in remote areas, communication between pilot and ground staff of airlines, distress communication (SoS) etc. Generally, such systems have very low traffic carrying capacity and, generally, are not used by the public. However, certain mobile satellite systems have started offering emergency SOS[12] communication on mobile handsets to the public. Such emergency SOS communication is generally text-based, at present.

2.42 A few stakeholders have raised concerns regarding the use of satellite spectrum for direct-to-mobile devices using Non-Terrestrial Networks (NTN). In this regard, it is noted that for implementing NTN in International Mobile Telecommunications (IMT) identified frequency bands, the satellite operators have recently started using the frequency spectrum held by terrestrial mobile service providers in a few countries as per their mutual agreements. In such implementations, the satellite acts as a base station for the partnering terrestrial mobile service provider. It may be worth noting that the terrestrial mobile service through Non-Terrestrial Network (NTN) is not part of DoT's reference and therefore, this aspect has not been included in the present consultation process.

2.43 The traffic carrying capacity of a wireless telecommunication network is a function of mainly two variables viz. (a) the number of wireless access nodes serving the customers, and (b) the quantum of spectrum available on such wireless access nodes. In satellite-based networks, the satellites (space stations) act as wireless access nodes. On the other hand, in terrestrial wireless access networks, the base stations act as wireless access nodes.

[12] SOS is a signal of distress and an urgent appeal for help. It is often associated with the mnemonic phrases "Save Our Souls" and "Save Our Ship".

2.44 A typical GSO-based MSS network having a global footprint consists of 3 to 4 satellites. A typical NGSO-based MSS network consists of anywhere between 10 to 100 satellites. On the other hand, the number of mobile base station sites held by major terrestrial wireless access service providers in India is of the order of 4,00,000.

2.45 The quantum of MSS spectrum available to MSS network operators in L and S bands is of the order of 10 MHz (paired). On the other hand, terrestrial wireless access network operators in India hold more than 1,000 MHz of access spectrum, of which they are already using more than 100 MHz of spectrum in their access networks.

2.46 As can be seen from the above, typically, the number of access nodes as well as amount of spectrum in MSS are much less than those for terrestrial wireless access services. Accordingly, it may be concluded that the traffic carrying capacity of GSO/ NGSO-based MSS systems is nowhere comparable to terrestrial wireless access networks.

2.47 In short, mobile satellite services, by their very nature, cater to a niche segment of the market and are not comparable with terrestrial access networks. Keeping these aspects in view, it may be inferred that there would be no real substitution of terrestrial access service by GSO/ NGSO based MSS, owing to the nature of the services in the near-to-medium term. The GSO/ NGSO based MSS is likely to remain complementary to terrestrial access services in near-to-medium term. Therefore, it may be concluded that, in the foreseeable future, the case of level playing field between terrestrial access services and GSO/ NGSO-based MSS is not expected to arise.

2.48 Further, the Authority in the Consultation Paper dated 27.09.2024 noted that: *"… Another view could be to keep a smaller period of validity of spectrum assignment for such services like five years as satellite-based broadband*

services are, at present, in a nascent stage of development, and their business potential would emerge after some years of operations; the regulatory environment might require to be reviewed and revised considering the uptake of NGSO-based FSS and GSO/ NGSO based MSS in the country, after a few years."

2.49 Some of the stakeholders, who have raised concerns over the level playing field, themselves have mentioned the technological developments that may take place in future. Some of their submissions are reproduced below:

"*As technology evolves, the usage of various spectrum bands will change, further various type of networks get capability to provide new services which are same as the services as provided through any other network technology or topology, thereby, requiring not only the addition of new entries but also the removal of outdated ones.*

…

The world has moved so much on the technology front that the Unified communication networks are being envisaged and planned that will combine the strengths of satellite, terrestrial and with airborne networks as well in future to deliver a holistic experience to the users."

2.50 While deciding the validity period for spectrum assignment, the Authority considered that technological innovations are occurring at a fast pace in the satellite communication eco-system and there may be a need to closely watch the developments and uptake of satellite-based services to assess the need for reviewing the terms and conditions of spectrum assignment including spectrum pricing for satellite-based communication services. The Authority notes that IMT-2030 [also referred to as the sixth generation (6G) technology] is expected to be developed by the year 2030, in which the integration of space (satellite) networks with terrestrial networks is envisaged for building flexible heterogeneous networks[13]. Besides, WRC' 27 will bring further clarity on the

[13] https://www.itu.int/dms_pub/itu-s/opb/itujnl/S-ITUJNL-JFETS.V1I1-9-2020-PDF-E.pdf

spectrum related aspects of space-based communications and the heterogeneous networks. Considering these factors, the Authority has recommended a shorter validity period for spectrum assignment, as discussed in the subsequent section. This will provide an opportunity for a review of the terms and conditions of spectrum assignment including spectrum pricing for satellite-based communication services based on the developments in technology and market scenario by that time.

2.51 An analysis of the issues raised in the CP dated 27.09.2024 based on the comments and counter-comments received from the stakeholders is presented below.

C. Frequency Bands for Satellite-based Communication Services

2.52 Satellite-based communication service involves two links - a user link and gateway link. The user link is a link between the satellite and user terminals, and it involves the frequency spectrum for establishing user link (uplink) and user link (downlink). While the gateway link is a link between satellite and satellite earth station gateway, and it involves the frequency spectrum for establishing gateway link (uplink) and gateway link (downlink). Thus, satellite-based communication services involve the frequency spectrum for establishing four types of links viz. user link (uplink and downlink), and gateway link (uplink and downlink).

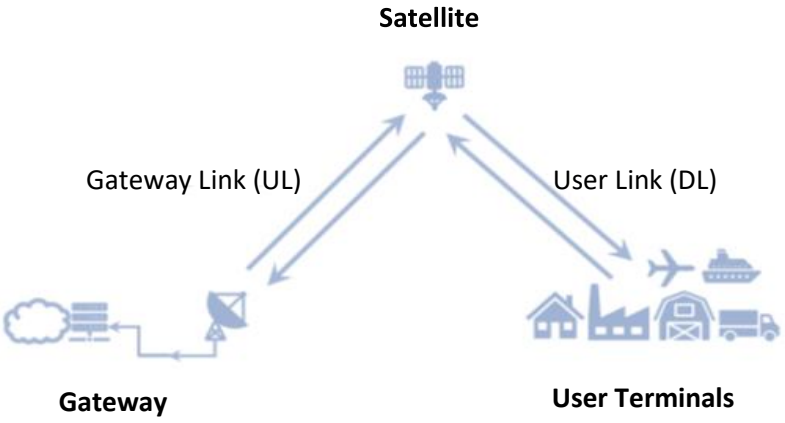

Figure 2.1: Diagram of Communication links depicting forward link and return link, and user link and gateway link

2.53 It is noted that while a variety of frequency bands can be used for providing satellite communication services, the popular frequency bands used for providing satellite communication services are L-band (1-2 GHz), S-band (2-4 GHz), C-band (4-8 GHz), Ku-band (10-15 GHz) and Ka-band (17-31 GHz).

2.54 DoT, through its letter dated 16.08.2022, had enclosed an annexure providing details of the existing/ planned deployments by various satellite operators in NGSO (enclosed as **Annexure 2.2**). From the information, it can be seen that the user links of the existing NGSO satellite systems are generally in Ku and Ka band, while the feeder links are predominantly in Ka-band. Further, the new-generation satellite communication systems have plans for deployments in higher bands such as the lower part of V-band (37.5 to 52.4 GHz) for user links as well as gateway links and E-band (71-76 GHz/ 81- 86 GHz) for gateway links.

2.55 DoT through its earlier reference letter dated 16.08.2022 also provided a list of frequency bands that may be considered by TRAI for providing recommendations with respect to space-based communication services, as given below:

Table 2.1: List of frequency bands referred by DoT through its earlier reference dated 16.08.2022

S. No.	Frequency Band	Link	Remarks
1	10.7 – 12.75 GHz	Space to Earth	
2	12.75 – 13.25 GHz	Earth to Space	
3	13.75 – 14.5 GHz	Earth to Space	
4	17.7 – 18.6 GHz	Space to Earth	17.7 – 18.4 GHz is used for Earth to Space also.
5	18.8 – 19.3 GHz	Space to Earth	
6	19.3 – 19.7 GHz	Space to Earth	
7	19.7 – 21.2 GHz	Space to Earth	

8	27.5 – 29.5 GHz	Earth to Space	27.5 – 28.5 GHz has been identified for implementation of IMT in India.
9	29.5 – 31 GHz	Earth to Space	

2.56 As regards Mobile Satellite Service (MSS), the satellite systems generally operate the user links in L-band and S-band, and the feeder links in C-band or other higher frequency bands. Frequency ranges identified for MSS in L and S bands are given below:

Table 2.2: Frequency ranges identified for MSS in L and S bands

S.No.	Frequency range	Link
1	1.525-1.559 GHz	Space to Earth
2	1.610-1.6605 GHz	Earth to Space
3	1.980-2.010 GHz	Earth to Space
4	2.170-2.200 GHz	Space to Earth
5	2.4835-2.520 GHz	Space to Earth
6	2.670-2.690 GHz	Earth to Space

2.57 Besides, there is a long list of frequency ranges which are allocated, *inter-alia*, on a primary or secondary basis for FSS and MSS in the National Frequency Allocation Plan (NFAP) 2022 released by the DoT.

2.58 In this background, the Authority solicited views of stakeholders on the following set of questions:

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.

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.

Comments received from stakeholders on Q1 and Q2

2.59 Most of the stakeholders were of the view that the frequency bands, as per ITU-RR and NFAP, can be used for providing voice, text, data, and Internet service by NGSO based FSS and GSO/ NGSO based MSS. Some stakeholders stated that frequency bands (L, S, C, Ku, Ka, Q/V bands) should be assigned for satellite services, in line with ITU Radio Regulations and India's NFAP-2022.

2.60 Some of the stakeholders submitted that for NGSO FSS, a mix of frequency bands is essential and the multi-band approach will help to achieve desired performance and reliability for end users while allowing for scalability in the future.

2.61 Some of the stakeholders further submitted that in order to meet the growing and varying demand and to ensure that spectrum is efficiently utilised, flexible usages of spectrum for user link & feeder link, should be ensured. Therefore, it is prudent that the spectrum bands identified for satellite services should be made available for both gateway links and user links.

2.62 Some of the stakeholders were of the view that entire Ku and Ka bands spectrum should be made available for use by NGSO satellite networks to deliver optimal performance and uninterrupted coverage. The 27.5-28.5 GHz band should be exclusively allocated for satellite services, as this has already been harmonized in the majority of countries for Ultra HTS systems, particularly for use by ubiquitous FSS and ESIM. On the other hand, one of the stakeholders submitted that the 28 GHz band has already been assigned for IMT/ 5G in many countries including Australia, Hong Kong, Japan, South Korea, Singapore and

US; the whole range between 24.25 GHz and 29.5 GHz is important, which will enable operators to meet the speed, latency, reliability and future capacity requirements of 5G.

2.63 A few stakeholders were of the view that the frequency bands (L, S, C, Ku, Ka, etc.) should be assigned flexibly between FSS and MSS. Technological advancements are blurring traditional distinctions between FSS and MSS satellite services, as communication networks shift towards technology-agnostic operations. This approach encourages optimal spectrum use by allowing satellite operators to innovate and efficiently meet demand.

2.64 A few stakeholders were of the view that to provide the level playing field, only fixed terminals should be allowed to be served in far-flung remote unserved regions with mobility restrictions by satellite service providers and should be governed by same set of rules as the MNOs.

Analysis of the issues raised in Q1 and Q2

2.65 DoT, through its letter dated 16.08.2022, had enclosed an annexure providing details of the existing/ planned deployments by various satellite operators in NGSO. Based on these details, the existing NGSO based FSS systems generally operate the user links in Ku and Ka band frequency spectrum, and feeder links are predominantly in Ka-band. Further, the new-generation satellite communication systems are being deployed in higher bands such as the lower part of V-band (37.5 to 52.4 GHz) for user links/ gateway links and E-band (71-76 GHz/ 81- 86 GHz) for gateway links.

2.66 The Authority noted that the immediate requirement of frequency spectrum for NGSO based FSS is in the Ku-band and Ka-band. Having said that, some satellite systems are either planning to deploy or deploying the frequency range from 37.5 GHz to 52.4 GHz. Further, the DoT through its letter dated 13.03.2024 in response to TRAI's letter dated 20.02.2024 seeking clarification

regarding a separate reference, informed that the Government has decided the following apportionment/ sharing of the spectrum in the frequency range from 37-43.5 GHz between IMT and space-based services:

Sl. No.	Application/ Service	Frequency Bands
1.	IMT	37-37.5 GHz
2.	IMT and Satellite Gateway links	37.5-40 GHz
3.	Satellite User/ Gateway links	40-42.5 GHz*
4.	IMT and Satellite Gateway links	42.5-43.5 GHz

** The frequency band 40.0-42.5 GHz (Space to Earth) is predominantly for satellite user links. However, this frequency band may also be used for Satellite Gateway links without causing any harmful interference to the satellite user links operating in these bands.*

2.67 With regard to the assignment of spectrum for feeder link in E-band, it is noteworthy that in the Resolution 775[14] of WRC-19, ITU has resolved to conduct, as a matter of urgency and in time for WRC-27, *the appropriate studies to determine power flux-density and equivalent isotropically radiated power limits in Article 21 for satellite services to protect the fixed service in the frequency bands 71-76 GHz and 81-86 GHz without* unduly *constraining satellite systems.* The same has been incorporated under Agenda item 1.10 of WRC '27. Agenda item 1.10 is *to consider developing power flux density and equivalent isotropically radiated power limits for inclusion in Article 21 of the Radio Regulations for the fixed-satellite, mobile-satellite and broadcasting-satellite services to protect the fixed and mobile services in the frequency bands 71-76 GHz and 81-86 GHz, in accordance with Resolution 775*. Taking note of Agenda Item 1.10 under WRC-27, the Authority is of the view that E-band

[14] https://www.itu.int/dms_pub/itu-r/oth/0C/0A/R0C0A00000F00171PDFE.pdf

spectrum should be considered for satellite-based communication services at a later date, in accordance with the outcome of WRC-27.

2.68 As regards GSO/ NGSO based MSS for providing voice, text, data communication and Internet service, it is observed that the services (user links) are predominantly being offered in L-band and S-band, while feeder links are being deployed in higher frequency bands including C, Ku and Ka bands.

2.69 In view of the above, the Authority is of the view that subject to alignment with the allocations in NFAP 2022, DoT should consider the assignment of frequency spectrum for user links and feeder links for NGSO based FSS for data communication and Internet service in Ku band, Ka band, and Q/V band. Further, for assigning spectrum for GSO/ NGSO based MSS for providing voice, text, data communication and Internet service, L band and S band should be considered for user links and C band, Ku band, Ka band and Q/V band should be considered for feeder links. It is noteworthy that the Government has decided that certain frequency ranges will be used only for feeder links. This aspect has been deliberated in the subsequent section of these recommendations on interference-related challenges and coordination issues.

2.70 In view of the above, **the Authority recommends that subject to alignment with the allocations in NFAP 2022,-**

(a) For assigning frequency spectrum for user links and feeder links for NGSO-based FSS for data communication and Internet service, frequency spectrum in Ku band, Ka band, and Q/V band should be considered.

(b) For assigning frequency spectrum for GSO/ NGSO-based MSS for providing voice, text, data communication and Internet service, the following frequency bands should be considered:

i. L band and S band for user links; and

ii. C band, Ku band, Ka band and Q/V band for feeder links.

D. Period of Validity of Spectrum Assignment

2.71 The Authority solicited views of stakeholders on the following set of questions:

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

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

(b) 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.

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.

Comments received from stakeholders on Q3

2.72 Many stakeholders were in favour of keeping a longer validity period. The suggested validity period ranged between 10 to 20 years. The rationale cited by such stakeholders for supporting longer validity period are given below:

(a) Aligns with international practices

(b) Provides operational certainty needed for developing and maintaining satellite services while promoting competition and innovation in satellite communications.

(c) Provides sufficient certainty for recovery of capital investments.

2.73 Some stakeholders advocated for a shorter validity period for spectrum assignment for satellite-based telecommunication services, arguing that a limited validity period would enable periodic reassessment of the sector growth

and effectiveness of current spectrum assignment policies. The suggested validity period from such stakeholders ranged from 2 to 5 years.

Comments received from stakeholders on Q4

2.74 With regard to the issue that whether for the purpose of assignment of the frequency spectrum for NGSO satellite systems, every ITU filing should be treated as a separate satellite system, the majority of the stakeholders were of the view that every ITU filing should not be treated as a separate satellite system. The stakeholders were of the view that spectrum assignment to NGSO-based communications systems should be done per IN-SPACe authorisation and not per ITU filing. The reasons cited by the stakeholders in support of their view were:

(a) NGSO satellites could be supported by several ITU satellite filings. ITU typically considers NGSO constellations as a single entity for filing purposes, but in some cases NGSO constellations are covered by more than one ITU filing.

(b) A new satellite filing may be submitted when additional satellites are launched to augment the existing capacity of the existing NGSO filings.

(c) Treating each ITU filing as a separate system disrupts the operational integrity.

2.75 On the other hand, a few stakeholders were of the view that since each satellite system requires separate frequency assignment, every ITU filing can be treated as a separate satellite system.

Analysis of the issues raised in Q3 and Q4

2.76 As per the existing practice in India, the spectrum for GSO-based satellite communication services is being assigned on an administrative basis and spectrum charges are being paid on a periodic (annual/ quarterly) basis.

2.77 As the NGSO-based satellite operators would have to make significant investment for providing satellite-based telecommunication services in the country, certain level of policy certainty may require to be provided to satellite operators. It is noteworthy that in the present consultation process, one set of stakeholders were in favour of keeping a longer validity period such as 20 years, while the other set of stakeholders were in favour of prescribing a shorter validity period ranging between two to five years.

2.78 The Authority noted that satellite-based broadband services are, at present, in a nascent stage of development, the uptake and business potential of satellite-based broadband services will emerge after some years of operations. The Authority also considered that technological innovations are occurring at a fast pace and there may be a need to closely watch the developments and uptake of satellite-based services to assess the need for a review of terms and conditions of spectrum assignment including spectrum pricing for satellite-based communication services. The Authority also noted that IMT-2030 (6G technology) is expected to be developed by the year 2030, in which the integration of space (satellite) networks with terrestrial networks is envisaged for building flexible heterogeneous networks. Besides, WRC' 27 will bring further clarity on the spectrum related aspects of space-based communications and the heterogeneous networks.

2.79 The Authority notes that in April 2023, the Government of India issued the Indian Space Policy-2023 (ISP-2023) outlining the role of all the stakeholders in the space sector in the country. The ISP-2023 has also identified the range of Space Activities that require Authorization by Indian National Space Promotion and Authorization Centre (IN-SPACe). In May 2024, IN-SPACe issued the Norms, Guidelines and Procedures for Implementation of Indian Space Policy-2023 in respect of Authorization of Space Activities (NGP)[15]. NGP provides that in respect of Authorization of Space Activities, the Authorization shall be valid till the end of the declared operational life of the satellite/

[15] https://www.inspace.gov.in/sys_attachment.do?sys_id=5d532e37877102503b0f0d060cbb35cf

constellation or 5 (five) years period, whichever is earlier. Recently, IN-SPACe has granted authorizations to two NGSO-based FSS providers for a period of five years. It is also noteworthy that the useful life of LEO satellites is, generally, of the order of five to seven years.

2.80 Considering the above aspects, the Authority is of the view that, at this stage, a shorter validity period of up to five years should be considered for spectrum assignment to an Entity holding relevant Service Authorisation granted by the DoT and also having requisite Authorization from IN-SPACe. However, after evaluating the market conditions prevalent at the end of five years, the Government may consider extending it for a further period of up to two years. The terms and conditions of spectrum assignment including spectrum pricing for satellite-based communication services recommended through these recommendations should remain valid for a period of five years from the date of notification of the policy regime in this regard by the Central Government, further extendable by a period upto two years. During this period, the market developments and uptake of satellite-based communication services will be closely monitored. Based on the assessment of market conditions, the terms and conditions of spectrum assignment including spectrum pricing for satellite-based communication services for assignment of spectrum for such services may be reviewed. Generally, in case of an administrative assignment of spectrum, any revision in the terms and conditions of spectrum assignment including spectrum pricing become applicable to all entities. Therefore, the Authority is of the view that the revision in the terms and conditions of spectrum assignment including spectrum pricing (after a period of 5 years from the date of notification of the policy regime recommended through these recommendations), notified by the Central Government, should become applicable to all authorised entities including the existing entities.

2.81 With regard to the question as to whether for the assignment of the frequency spectrum for NGSO satellite systems, every ITU filing should be treated as a separate satellite system, the majority of the stakeholders were of the view

that it is not necessary that every ITU filling is a separate satellite system. A new satellite filing may also be submitted when additional satellites are launched to augment the capacity of the existing NGSO filings. The Authority concurs with the views of these stakeholders.

2.82 In view of the above, **the Authority recommends that –**

(a) Frequency spectrum should be assigned for NGSO-based FSS and GSO/ NGSO-based MSS for a period of up to five years. However, considering the market conditions, the Government may extend it for a further period of up to two years.

(b) Terms and conditions of spectrum assignment including spectrum pricing for NGSO-based FSS and GSO/ NGSO-based MSS, recommended through these recommendations, should remain valid for a period of five years from the date of notification of the policy regime by the Central Government, further extendable by a period of upto two years.

(c) Any revision in the terms and conditions of spectrum assignment including spectrum pricing for NGSO-based FSS and GSO/ NGSO-based MSS, notified by the Central Government after a period of five years from the date of notification of the policy regime recommended through these recommendations, should become applicable to all authorised entities including the existing entities.

E. Interference-related Challenges and Coordination Issues

2.83 As per the ITU framework, NGSO systems are generally required to provide protection to GSO systems. Article 22.2 of ITU RR provides as below:

"Non-geostationary-satellite systems shall not cause unacceptable interference to and, unless otherwise specified in these Regulations, shall not claim protection from geostationary satellite networks in the fixed-satellite service

and the broadcasting-satellite service operating in accordance with these Regulations. …"

2.84 In the frequency bands for which Article 22.2 of ITU-RR does not apply, NGSO networks are required to coordinate with the existing GSO networks (Article 9.11A of ITU-RR). Further, for the coexistence of NGSO networks, as per the ITU's framework, any upcoming NGSO network is required to coordinate with the existing NGSO networks.

2.85 In the case of GSO satellites, the same frequency spectrum can be used by multiple GSO satellite systems as long as they are sufficiently apart in terms of the angular separation. In the case of NGSO satellite constellations, the same frequency spectrum is used by different satellite constellations by adopting coordination techniques. In case of in-line events where a satellite comes in the same line-of-sight path between the earth station and the satellite of another satellite constellation, the satellite operators might need to adopt additional measures to mitigate interference.

2.86 The Authority noted that there are apprehensions about interference-free operations of NGSO satellite systems. Lately, the Federal Communication Commission (FCC), USA and Ofcom, UK have examined the issue of interference between NGSO satellite systems, as mentioned below:

(a) FCC in its order released on 21.04.2023 in the matter of 'Revising Spectrum Sharing Rules for Non-Geostationary Orbit, Fixed-Satellite Service Systems' stated as below -

"*5. NGSO FSS System Spectrum Sharing Overview. The Commission has adopted rules for spectrum sharing among NGSO FSS systems. NGSO FSS space station applications granted with a condition to abide by these sharing rules are exempt from frequency band segmentation procedures that otherwise apply to applications for NGSO-like satellite operation. Instead, NGSO FSS operators must coordinate with one another in good faith the use of commonly authorized frequencies. If two or more NGSO*

FSS satellite systems fail to complete coordination, a default spectrum-splitting procedure applies.

6. Under the default spectrum-splitting procedure, whenever the percentage increase in system noise temperature of an earth station receiver, or a space station receiver for a satellite with onboard processing, of either system, ΔT/T, exceeds 6% due to interference from emissions originating in the other system in a commonly authorized frequency band, such frequency band will be divided among the affected satellite networks (i.e., individual links) in accordance with the following: (1) Each of η (number of) satellite networks involved must select 1/η of the assigned spectrum available in each of these frequency bands; (2) the affected station(s) of the respective satellite systems may operate in only the selected (1/η) spectrum associated with its satellite system while the ΔT/T of 6% threshold is exceeded; and (3) all affected station(s) may resume operations throughout the assigned frequency bands once the ΔT/T of 6% threshold is no longer exceeded. The spectrum selection order for each satellite network is determined by the date that the first space station in each satellite system is launched and capable of operating in the frequency band under consideration."

(b) Ofcom in its non-geostationary satellite systems licensing update of December 2021 noted that "*the more dynamic nature of NGSO systems, the large number of satellites involved, along with the current lack of agreements between operators, all serve to increase the risk of interference between satellite systems. These factors have prompted our consideration of the NGSO licensing process and license conditions.*". After stakeholders' consultation, Ofcom concluded that "*[w]e are not adopting spectrum splitting because of the inherent inefficiency in doing so. In addition, it may impact different systems to different degrees, and as a result may be limited in how much it incentivises cooperation between systems. There are other ways of mitigating the possibility of harmful interference without limiting operators' access to spectrum, given that*

doing so may impact the quality of service received by users and the ability to support a competitive market."

2.87 From the above description, it can be inferred that the FCC provides that NGSO FSS operators must coordinate with one another in good faith the use of commonly authorized frequencies. If two or more NGSO FSS satellite systems fail to complete coordination, they should follow a default spectrum-splitting procedure. On the other hand, Ofcom has not adopted the spectrum-splitting procedure as it considers that splitting the spectrum may impact the quality of services received by the users.

2.88 Further, as the antenna of a GSO satellite's earth station gateway (SESG) looks at a fixed angle according to the orbital slot, it is possible to establish SESGs of different GSO satellites in nearby locations without any protection zone requirement. On the other hand, NGSO satellite constellation consists of several satellites and several orbital planes. Therefore, the SESG of NGSO satellite constellation consists of an array of tracking antennas so that the satellite earth station gateway gets connected to the next arriving satellite before disconnecting from the so far connected satellite. Considering that the NGSO gateway consists of an array of tracking antennae, there may be a protection zone requirement for interference-free operation of the SESGs of different NGSO constellations using the same frequency spectrum.

2.89 In many frequency bands, spectrum is shared between satellite-based networks and terrestrial networks such as Fixed Service (backhaul) and IMT. For instance, in 13 GHz band (12.75-13.25 GHz) and 18 GHz band (17.7-19.7 GHz), the frequency spectrum is assigned for microwave access (MWA) service for cellular backhaul. Thus, MWA coexists with FSS in these frequency bands.

2.90 To control interference, ITU provides an elaborate framework including the following[16]:

(a) Allocation: Frequency separation of stations of different services (Article 5)

(b) Coordination: between Administrations to ensure interference-free operations conditions (Article 9)

(c) Power Limits: (Articles 5, 21 & 22)

(i) Power Flux Density (PFD) to protect terrestrial services

(ii) Equivalent isotropically radiated power (EIRP) to protect space services

(iii) Equivalent Power Flux Density (EPFD) to protect GSO from NGSO

(d) Regulatory Protection: Not to cause harmful interference or claim protection (Article 5 and 22)

2.91 In this regard, it is noteworthy that Article 21 of ITU-RR deals with the aspects of terrestrial and space services sharing frequency bands above 1 GHz. Section I of Article 21 deals with the choice of sites and frequencies. It provides as below:

"21.1 Sites and frequencies for terrestrial stations and earth stations, operating in frequency bands shared with equal rights between terrestrial radiocommunication and space radiocommunication services, shall be selected having regard to the relevant ITU-R Recommendations with respect to geographical separation between earth stations and terrestrial stations.

21.2 As far as practicable, sites for transmitting stations, in the fixed or mobile service, employing maximum values of equivalent isotropically radiated power (e.i.r.p.) exceeding the values given in Table 21-1 in the frequency bands indicated, should be selected so that the direction of maximum radiation of any antenna will be separated from the geostationary-satellite orbit by at least the angle in degrees shown in the Table, taking into account the effect of atmospheric refraction.

[16] Source: https://www.itu.int/en/ITU-R/space/WRS16space/PFD%20External.pdf

TABLE **21-1**

Frequency band (GHz)	**e.i.r.p. value (dBW) (see also Nos. 21.2 and 21.4)**	**Minimum separation angle with respect to geostationary-satellite orbit (degrees)**
1-10	+35	2
10-15	+45	1.5
25.25-27.5	+24 (in any 1 MHz band)	1.5
Other bands above 15 GHz	+55	No limit[3]

21.2.1 For their own protection receiving stations in the fixed or mobile service operating in frequency bands shared with space radiocommunication services (space-to-Earth) should also avoid directing their antennas towards the geostationary-satellite orbit if their sensitivity is sufficiently high that interference from space station transmissions may be significant. In particular, in the frequency bands 13.4-13.65 GHz and 21.4-22 GHz, it is recommended to maintain a minimum separation angle of 1.5 degree with respect to the direction of the geostationary-satellite orbit."

2.92 Section II of Article 21 of ITU' RR deals with power limits for terrestrial stations. It provides, *inter-alia*, as below:

"21.3 The maximum equivalent isotropically radiated power (e.i.r.p.) of a station in the fixed or mobile service shall not exceed +55 dBW."

2.93 Section-III of Article 21 of ITU's RR provides power limits for earth stations. Section-IV provides a minimum angle of elevation of earth stations. Section-V provides limits of power flux density from space stations.

2.94 In many frequency bands, the frequency spectrum earmarked for satellite earth station gateways may also be shared between satellite earth station gateways and terrestrial services like IMT. For instance, the DoT has decided to make available the frequency ranges (a) 37.5 - 40 GHz, and (b) 42.5 - 43.5 GHz, for IMT and the same will also be shared with satellite earth station gateways with a suitable protection.

2.95 In this background, the Authority solicited views of stakeholders on the following set of questions:

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 –

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

(b) 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.

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–

(a) Between the gateways of GSO and NGSO systems; and

(b) Between the gateways of NGSO systems?

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

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.

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 alongwith international practice in this regard.

Comments received from stakeholders on Q5

2.96 Most stakeholders submitted that there are sufficient provisions to resolve interference related challenges and coordination issues, and all information is well documented in ITU-RR so painstakingly after years of efforts and provide valuable guidance to all stakeholders. Some stakeholders further submitted that ITU's Radio Regulations have over the years provided interference free space operations. According to the declaration made by Director of the ITU's Radiocommunication Bureau during the `Space Sustainability Forum (Geneva, 10-11 September 2024)', 99.94% of satellite operations were free of interference during 2023.

2.97 On the other hand, a few stakeholders were of the view that the current ITU-RR provisions are inadequate for addressing the complexities of the increasing number of NGSO satellites. The following suggestions were received from the stakeholders:

(a) To reduce interference among frequency-sharing systems, exclusion zones and sufficient separation distances are essential.

(b) Some countries impose spectrum-sharing rules beyond ITU-RR and while some enforce stricter coordination and sharing requirements, especially for high-density LEO constellations.

(c) Enhance coordination procedures, implement mandatory pre-coordination meetings among operators planning to deploy NGSO constellations within overlapping frequency bands, stricter technical requirements (PFD Limits).

(d) It is critical 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 with other NGSO

systems, whenever the potential for NGSO/ NGSO interference exists at that location.

(e) It will become challenging for all NGSO constellations to use the same frequency for their user terminals within same geographical area, making it essential to assign separate frequencies to each service provider exclusively through band segmentation.

Analysis of the issues raised in Q5

2.98 Many stakeholders were of the view that the ITU framework is sufficient to take care of the interference-related challenges and coordination issues.

2.99 On the other hand, some of the stakeholders were of the view that the ITU-RR framework's provisions are inadequate for addressing the complexities of the increasing number of NGSO satellites. Such stakeholders suggested certain measures including band segmentation, lookup angle splitting, creation of sufficient separation distances, and prescribing spectrum sharing rules in line with FCC. One of these stakeholders also mentioned that the sharing of frequencies to avoid frequent inline interference events between thousands of satellites and millions of user terminals would pose an administrative nightmare for the Government if a large number of NGSO operators (let's say 10 operators) were assigned the same frequencies.

2.100 In this regard, it is noted that at present space-based communication services using NGSO satellites are not being provided in India; however, space-based communication services using NGSO satellites are already being provided in many countries including USA, Canada, UK, Germany, France, Spain, Italy, Austria, Australia, Chile, Brazil etc. It is noted that FCC, USA has granted licenses to over 10 entities for the provision of NGSO based services in Ku/ Ka bands. OFCOM, UK has already granted[17] NGSO Earth Station Network license

[17] https://www.ofcom.org.uk/manage-your-licence/radiocommunication-licences/satellite-earth/non-geo-fss

to six entities in Ku/ Ka bands and is also reviewing applications from two more entities. Therefore, there seems to be no such concern about a practical limit on the number of NGSO satellite systems that can work in a coordinated manner in the same frequency range.

2.101 It is noted that in the Norms, Guidelines and Procedures for Implementation of Indian Space Policy-2023 in respect of Authorization of Space Activities (NGP)[18] issued by the Indian National Space Promotion and Authorization Centre (IN-SPACe), Department of Space, Government of India in May 2024 incorporates, inter-alia, the provisions relating to coordination issues. The relevant extract is reproduced below:

"h) The Authorization application shall be assessed with a view to protect (i) operational services provided by the incumbent Indian and IN-SPACe authorized Non-Indian satellites/constellations, in GSO and NGSO, over India, and (ii) those existing Indian ITU Filings, in GSO and NGSO, with overlapping frequencies and coverage which are under consideration by IN-SPACe as potential candidates for the planned satellites by Indian Entities, taking into account ITU regulatory provisions and procedures. A detailed interference analysis shall be carried out by the Applicant to this effect along with outlining the additional measures and strategy to co-exist with other satellite systems for providing services over India without harmful interference, while submitting the application to IN-SPACe pertaining to the specific Orbital Resource(s). No analysis would be required to be submitted, if a coordination/coexistence agreement with the relevant satellite system(s) already exists, although reference to such agreement(s) shall be brought out in the application. In case the Authorization is being sought for a GSO satellite, the interference analysis shall be carried out by the Applicant for those satellites/ITU Filings which are within +/-5 degrees of the proposed GSO orbital slot.

i) IN-SPACe may consider granting the Authorization to the Applicant on non-protection non-interference basis, if it is satisfied that the operation of the new

[18] https://www.inspace.gov.in/sys_attachment.do?sys_id=5d532e37877102503b0f0d060cbb35cf

entrant satellite would not interfere with the incumbent services. Further, wherever applicable, desirable or advised by IN-SPACe, the Applicant (new entrant) shall, and will cause its concerned satellite operator to collaborate, negotiate and enter into frequency coordination agreement or coexistence-arrangements with the incumbent or other new entrant satellite operators (satellite systems providing services over India or those satellite system which are identified by IN-SPACe for this Authorization to provide services over India) in good faith in order to ensure that the operations of these satellites/constellations over India are without harmful interference. IN-SPACe reserves the right to make appropriate and enforceable interventions including terminating/suspending/not-granting the Authorization, if it is convinced that one party is not collaborating or negotiating in good faith or in case the reported and confirmed harmful interference to other satellite network continues to remain unresolved within the notice period provided by IN-SPACe. Notwithstanding above, IN-SPACe, in coordination with WPC, WMO and NOCC, shall reserve the right to direct an operator including the Applicant to cease the emission in case the harmful interference from its satellite/constellation to other networks is not removed or resolved after the notice period."

2.102 It is also noted that adopting measures such as band segmentation and look-up angle splitting may result in inefficient utilisation of spectrum and unnecessary reduction in the effective service capacity of the satellite systems over India. Further, it may be prudent to adopt the global practice for satellite-based services which are essentially global in nature.

2.103 In the ITU handbook on Mobile-satellite service (MSS)[19], for frequency sharing between MSS networks in MSS bands such as 1.5/1.6 GHz, it has been mentioned, *inter-alia*, that:

(a) For simultaneous use of MSS band such as 1.5/1.6 GHz by multiple networks, there needs to be consideration given to minimizing mutual

[19] https://www.itu.int/dms_pub/itu-r/opb/hdb/R-HDB-41-2002-OAS-PDF-E.pdf

interference between these networks sharing the same MSS frequency band. The ITU Radiocommunication Sector (ITU-R) has played a central role in working out standards and processes for keeping interference within tolerable limits between MSS networks sharing a common frequency band. For example, RR No. 9.11A contains the procedures for coordination and notification of frequency assignments of satellite networks in certain MSS bands.

(b) One of the key issues that makes sharing between multiple networks in the MSS more difficult than the FSS is that the antenna directivity associated with mobile earth stations (MESs) is much lower than that of traditional FSS earth stations. The MES antenna gain cannot approach that of FSS fixed earth stations simply because the antenna aperture or the size of the MES dish is very limited due to its inherent mobility – being located on a ship, aircraft, or even on a person. Consequently, the antenna beamwidth is also much greater; and this limits the ability of one MES antenna to distinguish the desired or intended satellite it is working to from the undesired or unwanted satellites in adjacent GSO orbital slots.

(c) Thus, while orbital separations needed to manage inter-system interference on the order of 3° are possible in the lower FSS bands, such as 4/6 GHz, and even down to 2° in the 11/12 GHz FSS bands, similar interference objectives in an MSS band such as 1.5/1.6 GHz typically require orbital separations of around 40° or more! Often times, this factor alone requires MSS networks to resort to frequency band segmentation techniques rather than the use of co-channel frequency sharing. However, the use of narrow-coverage spot beams on the newer generation of MSS systems can allow for a degree of frequency re-use when there is sufficient isolation between the beams of two adjacent (GSO) networks operating in the same portion of an MSS band. MSS networks not operating co-coverage are also, under the right conditions, able to re-use the same frequencies.

2.104 As mentioned above, the use of frequency spectrum in L and S bands for satellite-based communication services is generally coordinated by way of band

segmentation or geographical separation. Thus, interference issues may be minimal, which can be left to the authorised entities for mitigation as per the ITU framework.

2.105 In case of higher frequency bands, which are assigned for satellite-based communication services on a shared basis, it is noted that to control interference, ITU provides an elaborate framework including the following:

(a) Allocation: Frequency separation of stations of different services (Article 5)
(b) Coordination: between Administrations to ensure interference-free operations conditions (Article 9)
(c) Power Limits: (Articles 5, 21 & 22)
(d) Regulatory Protection: Not to cause harmful interference or claim protection (Article 5 and 22)

2.106 As per the ITU framework, coordination between different NGSO satellite systems is largely carried out through mutual coordination. However, it is noted that studies are going on in ITU towards developing a methodology for the assessment of interference between non-GSO systems.

2.107 In view of the above, the Authority is of the view that to control interference, the relevant provisions of ITU-RR should be made applicable to the authorised entities, and other entities which have been authorised by the Central Government. Further, the ITU framework for coordination among NGSO-based satellite systems, as may be laid down by ITU in the future, should also be made applicable.

2.108 The Authority is also of the view that the frequency spectrum identified by the Government for satellite-based telecommunication services in the higher frequency bands such as C, Ku, Ka, and Q/V bands that are assigned on a shared basis, should be assigned with a condition that each of the Authorised Entity and other entities which have been authorized by the Central Government to use such shared frequency spectrum, will coordinate among

themselves in good faith. Further, there could be a situation where an Authorised Entity to whom spectrum usage rights are assigned earlier, may not proactively involve in the coordination with a new Entity being the potential competitor. To mitigate such a situation, a provision for splitting of spectrum frequencies on an equitable basis may be created in line with the provision created by FCC in its 'Spectrum Sharing Rules for Non-Geostationary Orbit, Fixed-Satellite Service Systems'. It will nudge the satellite operators to coordinate among themselves in good faith at the earliest, as otherwise the performance of both the networks, i.e. the existing Entity's network and the new Entity's network, will be reduced.

2.109 Further, the Government, with the help of the Telecom Engineering Center (TEC), should examine the need for prescribing the framework for the sharing of spectrum. If found necessary, a framework for sharing of spectrum, including conditions on the maximum equivalent power flux density (EPFD), etc. may be prescribed. For this purpose, a provision should be included in the terms and conditions of the assignment of frequency spectrum that in case the need arises, the Government may prescribe a framework for the sharing of spectrum in higher frequency bands such as C, Ku, Ka, and Q/V bands, which will be binding on the authorised entities and all other entities which have been authorized by the Central Government to use such shared frequency spectrum.

2.110 In view of the above, **the Authority recommends that-**

(a) To control interference, the relevant provisions of ITU-RR should be made applicable to the authorised entities, and other entities which have been authorised by the Central Government. Further, the ITU framework for coordination among NGSO-based satellite systems, as may be laid down by ITU in the future, should also be made applicable.

(b) The frequency spectrum identified by the Government for satellite-based telecommunication services in the higher frequency bands such as C, Ku, Ka, and Q/V bands that are

assigned on a shared basis, should be assigned with a condition that each Authorised Entity and all other entities which have been authorized by the Central Government to use such shared frequency spectrum, will coordinate among themselves in good faith.

(c) A provision should be included in the terms and conditions of the assignment of frequency spectrum that in case the need arises, the Government may prescribe a framework for sharing of spectrum in higher frequency bands such as C, Ku, Ka, and Q/V bands, which will be binding on the authorised entities and all other entities which have been authorized by the Central Government to use such shared frequency spectrum.

(d) The Government, with the help of the Telecom Engineering Center (TEC), should examine the need for prescribing the framework for the sharing of spectrum. The framework may include conditions on the maximum equivalent power flux density (EPFD) etc. With a view to nudging the satellite operators to coordinate among themselves in good faith at the earliest, the Government may also consider introducing a provision for splitting of spectrum as a last resort in line with the provision created by FCC in its 'Spectrum Sharing Rules for Non-Geostationary Orbit, Fixed-Satellite Service Systems' in case two or more NGSO-based FSS satellite systems fail to complete coordination.

Comments received from stakeholders on Q6

(i) GSO-NGSO

2.111 Most stakeholders were of the view that interference is unlikely to happen due to the directional nature of GSO systems as well as strictly adhering to Article

22 of ITU-RR provisions. A few stakeholders further stated that in India, TEC/ DoT has already issued guidelines to ensure the protection of GSO systems, in line with ITU-RR, that address any potential interference.

2.112 On the other hand, a few stakeholders were of the view that for mitigating interference between satellite operators using the same frequencies for Gateway Feeder Links, the exclusion zones with proper separation or protection distance are essential to protect GSO, NGSO, and terrestrial networks from interference.

(ii) NGSO-NGSO

2.113 Some of the stakeholders were of the view that there is no need for the prescription of any additional conditions including separation distances between gateways of satellite systems. Coordination of gateways is typically left between satellite operators during site selection. The following submissions were received from the stakeholders:

(a) For NGSO-NGSO systems, the Article 9 coordination procedures provide a sufficient structure to facilitate the necessary dialogue between operators so that they can establish the technical conditions, unique to their respective systems, to ensure mutual compatibility between the satellite systems and their associated Gateway earth station. TRAI should rely on the ITU framework and international practice for any interference avoidance measures.

(b) Minimum separation distances have the perverse effect of constraining efficient sharing and reducing incentives for operators to improve their systems to better share spectrum with others. Gateways can easily be coordinated to allow them to coexist in close proximity, and the specifics of this involve a routine engineering analysis to assess potential interference issues given the technical and physical characteristics of the sites at issue, include exact location, terrain, fencing, etc. Rather than adopting an arbitrary separation distance, the TRAI should adopt a simple coordination

framework that encourages cooperation, competition, and efficient use of spectrum. For example, if coordination between two gateway operators is not able to be completed after good-faith efforts, the TRAI could consider a spectrum-splitting last resort. In such a last resort, operators would have to evenly split available spectrum (1) only in the event of in-line events, (2) only for the duration of in-line events, and (3) only if they have not completed private coordination before they both commence service. Ideally, this backstop would never be used because the prospect of non-ideal spectrum splitting will incentivize both operators to find a better solution through coordination.

(c) 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. The 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.

(d) TRAI should rely on the ITU framework and international practice for any interference avoidance measures, and not prescribe any form of protection distance or default interference avoidance measures as this would lead to inefficient spectrum use and lower quality services being available to customers and businesses in India.

2.114 Some of the stakeholders were of the view that there is a need to prescribe a coordination distance. The submissions of the stakeholders are given below:

(a) An appropriate 'coordination distance' of say 100 km, may be prescribed, requiring an operator wishing to set up a new gateway station within such distance of an existing gateway station to coordinate with such existing

gateway station based on typical ITU coordination processes, for instance, ITU-RR Appendix 7 and/or Appendix 8 procedures.

(b) Suitable protection distance may be decided based on existing interference studies carried out in different bands. If not, then the same may be required to be carried out before deciding the matter.

(c) Determining the appropriate exclusion zone between two different Non-Geostationary Orbit (NGSO) gateways is crucial for minimizing interference. While specific values for exclusion zones may not be universally defined and that can vary based on operational parameters like frequency bands, transmission power, antenna gain patterns, and the characteristics of the satellite systems involved.

Analysis of the issues raised in Q6

2.115 From the responses received from stakeholders, it can be seen that some stakeholders were of the view that there is no requirement to prescribe a protection distance or any other measures to avoid interference from each other between the gateways of GSO and NGSO systems or the gateways of different NGSO systems. On the other hand, some stakeholders were of the view that while there is no need to prescribe a protection distance, an appropriate 'coordination distance' may be prescribed, requiring an operator wishing to set up a new gateway station within such distance of an existing gateway station to coordinate with such existing gateway station.

2.116 It is noted that some stakeholders have mentioned that in the case of GSO systems, interference is unlikely to happen due to the directional nature of GSO systems as well as strictly adhering to Article 22 of ITU-RR provisions. Thus, in the case of GSO satellite systems, gateways can be deployed next to each other. On the other hand, NGSO satellite systems are complex and a gateway consists of an array of tracking antennas. The coordination distance may vary for different frequency spectrum ranges and different NGSO satellite systems. The Authority is of the view that for establishment of satellite earth station

gateway(s), the authorised entities should be mandated to coordinate among themselves in good faith.

2.117 Further, the DoT, with the help of TEC, should carry out a study to assess the requirement for prescribing coordination distance between two satellite earth station gateways (GSO-NGSO and NGSO-NSGO) operating on the same frequencies. If required, necessary guidelines may be issued. For this, a provision should be included in the terms and conditions of the assignment of frequency spectrum that in case the need arises, the Government may prescribe a coordination distance between two earth station gateways (GSO-NGSO and NGSO-NGSO) operating in the same frequencies, which will be binding on the authorised entities and all other entities which have been authorized by the Central Government to use such shared frequency spectrum.

2.118 In view of the above, **the Authority recommends that for the establishment and operation of satellite earth station gateways-**

(a) The authorised entities should be mandated to coordinate among themselves in good faith.

(b) A provision should be included in the terms and conditions for the assignment of frequency spectrum that in case the need arises, the Government may prescribe a coordination distance between two earth station gateways (GSO-NGSO and NGSO-NGSO) operating in the same frequencies, which will be binding on the authorised entities and all other entities which have been authorized by the Central Government to use such shared frequency spectrum.

(c) The DoT, with the help of TEC, should carry out a study to assess the requirement for prescribing coordination distance between two satellite earth station gateways (GSO-NGSO and NGSO-NSGO) operating on the same frequencies. If required, necessary guidelines may be issued.

Comments received from stakeholders on Q7

2.119 Many stakeholders were of the view that there are sufficient mechanisms and processes that exist under the ITU framework that should be leveraged. Instead of a coordination threshold distance, a PFD threshold or another technical threshold for such coordination be adopted as the protection distance or any other criteria would depend on the technical characteristics of the satellite earth station and the co-located IMT Base Station, keeping into account the propagation models of both the system in that specific terrain. A default protection distance can lead to inefficient spectrum use.

2.120 A few stakeholders were in favour of prescribing a protection distance. One of such stakeholders submitted that a minimum protection distance of 50 Km should be prescribed. Another stakeholder submitted that a protection distance should be established based on technical parameters such as the transmission power of terrestrial stations, antenna gain patterns, and operational frequency; for this, consider a minimum protection distance of upto 30 km (depending on band of operation and transmission power) from the satellite gateway to the nearest terrestrial station operating on the same frequency band, subject to adjustments based on local terrain and environmental factors.

2.121 One of the stakeholders mentioned that they strongly recommend against licensing satellite gateway spectrum for terrestrial IMT use cases at this time. Next-generation satellite systems depend on full access to the assigned gateway spectrum for providing high-speed, low-latency broadband service to consumers. Because IMT deployments in the satellite gateway spectrum bands typically focus on urban areas, introducing IMT into the band would make it more difficult for satellite operators to deploy gateway sites by reducing available bandwidth and reducing the ability to deploy needed ground infrastructure. The stakeholder also mentioned that mobile use of the millimeter wave bands has been slow, if not non-existent, making it untimely to consider allowing IMT services in more MWA bands. If the TRAI still adopts a shared-

use framework for including IMT in these bands, that framework must clarify that any IMT deployments must be secondary to satellite gateways in the band in order to avoid needlessly constraining the deployment of satellite gateways.

2.122 Another stakeholder submitted that-

(a) In case of uplink frequencies of feeder links, the terrestrial systems in these frequency bands are highly directional and a "protection distance" would unnecessarily result in inefficient utilization of spectrum. Rather, it is suggested that a "coordination distance" should be adopted, within which the gateway stations would be required to coordinate with the terrestrial systems, based on typical ITU coordination processes to prevent harmful interference. This coordination distance depends on the terrestrial systems concerned, and are usually around tens of kilometers.

(b) In case of downlink frequencies of feeder links, ITU Radio Regulation Art. 21 contains provision to manage spectrum sharing between satellite and terrestrial services such as Microwave Fixed links. And relevant ITU recommendations include mitigation measures that can be adopted to alleviate interference scenarios between satellite service and fixed links.

2.123 A few of the stakeholders were of the view that Gateways should be installed in pre-determined locations, creating Gateway Exclusion Zones (GEZs) where terrestrial transmissions on the same frequency bands are prohibited. These zones may vary in size depending on the frequency and should be carefully managed to prevent interference with terrestrial networks. It was further submitted that the number and location of GEZs must be carefully controlled to balance satellite services and terrestrial IMT services and should be established through a transparent auction process to avoid hoarding.

Comments received from stakeholders on Q8

2.124 Some of the stakeholders submitted that in the case of known Very Small Aperture Terminals (VSATs) location or Gateway earth stations, they can be coordinated with the Fixed Services. In the case of user terminals that are on mobile platforms such as Earth Stations in Motion (ESIM), sharing conditions could be adopted from relevant resolutions from the outcomes of past WRCs such as Res 123 (WRC23) and Res 169 (WRC-19) for protection of terrestrial services in the Ka-band for NGSO and GSO ESIMs.

2.125 One of the stakeholders submitted that a default criterion or condition for the assignment of spectrum for satellite customer terminals should not be adopted. As per footnote 5.516B in Article 5 of the ITU-RR, the operation of customer terminals –referred to as High Density Fixed Satellite Services (HDFSS) - can operate in an uncoordinated manner without causing interference to terrestrial networks and without seeking protection. In practice, the stations in the Fixed Service (FS) and FSS customer terminals will likely not overlap in frequency, time, and geography due to varying capacity needs, transmission times, deployment scenarios, and frequency selection options available to each station. As such, the overall likelihood of harmful interference occurring at the same time in the same frequencies should be relatively low.

2.126 On the other hand, some of the stakeholders raised concerns on the coexistence of satellite user links and terrestrial networks. The submissions made by the stakeholders are given below:

(a) Some stakeholders were of the view that 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.

(b) A few stakeholders were of the view that assigning spectrum to both satellite user links and terrestrial networks could lead to significant interference issues, depending on the nature and direction of the terrestrial transmissions. For example, terrestrial base stations transmitting in the shared spectrum could cause overload interference to the satellite user terminals. Such interference could degrade the quality of the satellite communication link, making it challenging to maintain reliable service. Given the potential for harmful interference, it is proposed that any spectrum allocated for satellite user links should not be shared with terrestrial networks. One of these stakeholders further submitted that it has filed extensive technical details in this regard in the United States in a proceeding before the Federal Communications Commission on exploring flexible use of the 12.2-12.7 GHz band.

(c) Another stakeholder made submissions as given below:

i. For fixed UTs, a 'protection distance' may be proposed around a terrestrial link, where no fixed UTs can be installed. Such a protection distance is usually in the order of a few/tens of kilometers. In addition, a 'coordination distance' may also be prescribed, wherein coordination would be required between the two services.

ii. For land mobility UTs, it is difficult to coordinate as the UTs are moving around. Hence, the spectrum already assigned to terrestrial networks, such as Fixed Service, should not be the same frequency bands as to be used by land mobility UTs.

iii. For aero and maritime UTs, PFD limits may be prescribed, in case the same spectrum is assigned to terrestrial networks, such as Fixed Service, as well.

(d) A few stakeholders submitted that to the extent feasible, spectrum assigned to the satellite user link should not be assigned to terrestrial networks to avoid any kind of potential interference between two services as they will come in line of communication & interference between two services may be there. The issue may be quite less when there are limited number of point-to-point fixed service (MWA) links but as the number of

satellite user links and FS services will grow, interference issue may be there, and thus is best that spectrum for satellite user link should be kept separate from terrestrial services.

Analysis of the issues raised in Q7 and Q8

2.127 Many stakeholders were of the view that the coordination with terrestrial networks operating in a co-primary status with satellite services should be handled by the operators themselves based on ITU-R Recommendations. There is no need for additional domestic regulations to resolve interference-related challenges and coordination issues. However, a few stakeholders were of the view that suitable protection distances should be prescribed.

2.128 A few stakeholders were of the view that gateways should be permitted to be installed in pre-determined locations, creating Gateway Exclusion Zones (GEZs) where terrestrial transmissions on the same frequency bands are prohibited. In this regard, it is noted that pre-determining the locations where satellite earth station gateways can be permitted to be established may potentially take away the flexibility to choose the location of the satellite earth station gateways. Further, such an approach may create another set of problems such as land prices of such locations might rise unnaturally.

2.129 As already noted, in some frequency bands, the spectrum is shared between satellite-based networks and Fixed Service (backhaul). For instance, in 13 GHz band (12.75-13.25 GHz) and 18 GHz band (17.7-19.7 GHz), the frequency spectrum is assigned for microwave access (MWA) service for cellular backhaul. Thus, MWA coexists with FSS in these frequency bands. In this regard, most of the stakeholders were of the view that since locations of microwave links are fixed and known, provisions of Article 21 of the ITU-RR and ITU recommendations are sufficient to take care of coordination issues. The Authority concurs with the view of the stakeholders.

2.130 With regard to the coexistence of satellite earth station gateways with terrestrial IMT, a few stakeholders submitted against the licensing of satellite gateway spectrum for terrestrial IMT use cases. As regards the coexistence of satellite earth station gateways with IMT, it may be noted that the issue put under consultation was not generic for all spectrum bands/ range(s) but specific to the frequency spectrum ranges(s) that have already been identified for IMT in India and at the same time it has also been decided that such frequency ranges(s) will also be permitted to be shared with satellite earth station gateways with a suitable protection, such as 37.5-40 GHz, 42.5-43.5 GHz. Similarly, for the frequency range 27.5-28.5 GHz identified for IMT, TRAI in its recommendation on 'Auction of Spectrum in frequency bands identified for IMT/5G' dated 11.04.2022, recommended that the Satellite Earth Station Gateway(s) should be permitted to be established in the frequency range 27.5-28.5 GHz at uninhabited or remote locations on case-to-case basis, where there is a less likelihood of 5G IMT services to come up. In para 2.102 of the said recommendations, the Authority had recommended that –

"a. As mmWave spectrum is going to be used for capacity requirement, its deployment is not likely to be ubiquitous rather it is more likely to be kind of hotspots or urban micro cells. Therefore, IMT Stations and Satellite Earth Stations Gateway (Earth to Space) can co-exist in 27.5-28.5 GHz frequency range. The Satellite Earth Station Gateway should be permitted to be established in frequency range 27.5-28.5 GHz at uninhabited or remote locations on case-to-case basis, where there is less likelihood of 5G IMT services to come up.

b. DoT should prescribe the exclusion zone requirement for co-existence of IMT and satellite earth stations (Earth to space) in 27.5-28.5 GHz frequency range.

c. DoT should create a software defined automated process on a portal having database of coordinates of the IMT base stations in mmWave. The geofencing coordinates of the proposed earth station in 27.5-28.5 GHz can provide the feasibility results through the portal for establishing the earth station.

d. Access to 27.5-28.5 GHz should also be allowed for Earth Stations In Motion (ESIMs) for In-flight and Maritime terminals, with appropriate sharing conditions, as in such cases, the operation would be geographically separated from terrestrial IMT.

e. Spectrum dues for 27.5-28.5 GHz frequency range can be revised on pro-rata basis for the mobile operator holding spectrum in the LSA, in which the permission for establishing earth station is given in the same frequency range, on account of creation of exclusion zone.

f. Provisions of the WRC-19 Resolution 242 to provide protection to Satellite (FSS) receiver and Resolution 750 w.r.t. power limitations to provide protection to EESS (passive), applicable for 24.25-27.5 GHz band, should also be made appropriately applicable for 27.5-28.5 GHz frequency range."

2.131 It is further noted that the WRC-19 Resolution 243 on the subject 'Terrestrial component of International Mobile Telecommunications in the frequency bands 37-43.5 GHz and 47.2-48.2 GHz' resolves as under:

"1. that administrations wishing to implement IMT consider use of the frequency band 37-43.5 GHz, or portions thereof, and the frequency band 47.2-48.2 GHz, identified for IMT in No. 5.550B and No. 5.553B, and the benefits of harmonized utilization of the spectrum for the terrestrial component of IMT taking into account the latest relevant ITU-R Recommendations;

2. that, in order to ensure coexistence between IMT in the frequency bands 37-43.5 GHz and 47.2-48.2 GHz as identified by this conference in Article 5 and other services to which the frequency band is allocated, including the protection of these other services, administrations shall apply the following condition(s):

2.1. in order to protect the Earth exploration satellite service (EESS) (passive) in the frequency band 36-37 GHz, the following unwanted emissions of IMT stations operating in the frequency band 37-40.5 GHz apply as specified in Table 1 below:

TABLE 1

Frequency band for the EESS (passive)	Frequency band for IMT stations	Unwanted emission mean power for IMT stations[1]	Recommended limits for IMT stations[1]
36-37 GHz	37-40.5 GHz	−43 dB(W/MHz) and −23 dB(W/GHz) within the frequency band 36-37 GHz	−30 dB(W/GHz)

[1] The unwanted emission power level is considered in terms of total radiated power (TRP). The TRP is to be understood here as the integral of the power transmitted from all antenna elements in different directions over the entire radiation sphere.

2.2. protection of space research service (SRS) earth stations in the frequency band 37-38 GHz and RAS stations in the frequency band 42.5-43.5 GHz from IMT stations should be facilitated through bilateral agreements for cross-border coordination as necessary;

2.3. protection of and coexistence with fixed-satellite service (FSS) earth stations within the frequency ranges 37.5-43.5 GHz and 47.2-48.2 GHz should be facilitated through bilateral agreements for cross-border coordination as necessary;

2.4. take practical measures to ensure the transmitting antennas of outdoor base stations are normally pointing below the horizon, when deploying IMT base stations within the frequency bands 42.5-43.5 GHz and 47.2-48.2 GHz; the mechanical pointing needs to be at or below the horizon;

2.5. as far as practicable, sites for IMT base stations in the frequency bands 42.5-43.5 GHz and 47.2-48.2 GHz employing values of equivalent isotropically radiated power (e.i.r.p.) per beam exceeding 30 dB(W/200 MHz) should be selected so that the direction of maximum radiation of any antenna will be separated from the geostationary-satellite orbit, within line-of-sight of the IMT base station, by ±7.5 degrees;

3. that IMT stations within the frequency ranges 37-43.5 GHz and 47.2-48.2 GHz are used for applications of the land mobile service."

2.132 As mentioned above, the Authority had earlier made recommendations for the coexistence of satellite earth station gateways with IMT in 27.5-28.5 GHz frequency range through its recommendations on 'Auction of Spectrum in frequency bands identified for IMT/5G' dated 11.04.2022. Similar provisions

can be applied for the 42.5-43.5 GHz frequency range as this range has been identified for earth to space for satellite systems. For 37.5-40 GHz frequency range, it has already been decided by the Government that IMT will coexist with the satellite earth station gateways (space to earth) with suitable protection. Considering that this frequency range i.e., 37.5-40 GHz is identified for FSS space to earth communication, provisions of Article 21 of ITU-RR already exist for terrestrial and space services sharing frequency bands. Further, provisions of WRC-19 Resolution 243 should be made applicable on IMT operations for coexistence of satellite systems and IMT.

2.133 Therefore, **the Authority recommends that-**

(a) The provisions of Article 21 of ITU-RR for terrestrial and space services sharing frequency bands above 1 GHz should be made applicable.

(b) For the coexistence of satellite systems and IMT, ITU-RR provisions and ITU recommendations, including WRC-19 Resolution 243, should be made applicable.

(c) In the frequency range(s) already identified for IMT such as 42.5-43.5 GHz, the satellite earth station gateways should be permitted to be established at uninhabited or remote locations on case-to-case basis, where there is a less likelihood of IMT services to come up. For this purpose -

(i) DoT should prescribe the exclusion zone requirement for co-existence of IMT and satellite earth station gateways.

(ii) DoT should create a software defined automated process on a portal having the database of coordinates of the IMT base stations in these frequency ranges. The geofencing coordinates of the proposed earth station in such frequency ranges can provide the feasibility results through the portal for establishing the earth station.

F. Scarcity of Satellite Gateway Sites

2.134 At present, many satellite communication systems make use of high-throughput satellites (HTSs). HTS provides significantly more throughput than a conventional satellite for the same amount of radio frequency spectrum. While a conventional satellite utilizes a broad single beam to cover wide regions or even entire continents, HTS employs - (a) frequency re-use, and (b) spot beam technology which enables frequency re-use across multiple narrowly focused spot beams (covering area in the order of hundreds of square kilometers), as in cellular networks. Together, these features help HTSs provide significantly higher throughputs as compared to conventional satellites. Initially, HTS systems used GSO satellites. However, with technological development, focus for HTS systems is increasingly shifting to NGSO satellite systems.

2.135 The satellite earth station gateway provides the interface between the space-based communication network and terrestrial communication network. In the case of GSO satellite systems, which are geostationary, the SESG requires a fixed antenna and stable communication link to maintain a constant connection with the satellite. In the case of NGSO satellites, which are non-geostationary, the gateways require precise tracking, rapid beamforming, and effective interference management.

2.136 The number of gateways required by the satellite system depends on factors such as intended application, geographic coverage, capacity, and quality of service. For conventional GSO satellites, a single gateway could provide adequate coverage for a region. On the other hand, the HTSs and NGSO satellite systems, which operate through much narrower beams, require multiple gateways to control various beams and to meet the throughput requirement.

2.137 The satellite gateway of NGSO satellite systems consists of an array of tracking antennas, and the decision of the location of the gateway may involve several

factors such as no obstructions blocking any views to the satellites, cost of land, power supply, fiber availability etc. Such gateway location deciding factors may raise a concern that one or a few service providers may take spectrum usage rights for the key locations for gateway links. A similar concern was considered by Ofcom, UK. It concluded that the risk of scarcity of gateway sites can be reduced by introducing a requirement for gateway licensees to commence and maintain transmissions within 12 months. Accordingly, the Licensing guidance for non-geostationary satellite earth stations was revised by Ofcom, UK.

2.138 While the condition prescribed by Ofcom, UK could be one of the solutions to mitigate the risk of scarcity of gateway sites, there may be a need to find other ways to address this issue. One such way could be to prescribe a certain minimum distance between two gateway sites of an entity for a given satellite system.

2.139 In this background, the Authority solicited views of stakeholders on the following question:

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.

Comments received from stakeholders on Q9

2.140 Most of the stakeholders were of the view that presently there is no need to prescribe any conditions to mitigate the risk of scarcity of satellite gateway sites. The following reasons were cited in support of their view:

(a) Flexibility of gateway infrastructure allows coexistence of multiple satellite systems in the same location as part of the coordination process.

(b) Newer NGSO satellite systems leverage on optical inter-satellite links that allow constellations to make efficient use of gateway earth stations by limiting their numbers.

(c) As long as ensuring access to sufficient spectrum, adopting coordination procedure, and providing appropriate protection from other services, there should be no scarcity of gateway sites.

(d) Practice in different countries may be based on the size, availability of various resources etc. In India, there may not be such a scarcity related to the availability of suitable satellite gateway sites.

(e) Satellite operators require only a limited number of gateways to serve a large geographical area, such as India. In such cases, scarcity is not a pressing concern.

2.141 On the other hand, a few stakeholders were of the view that strategically positioned gateway exclusion zone (GEZs) will support growing satellite demand for gateway sites, minimize interference, and protect terrestrial network coverage. Coordination between the operator and DoT's WPC wing can further refine GEZ locations to achieve minimal interference. The number and locations of GEZs must be carefully controlled to balance satellite services and terrestrial IMT services and should be established through a transparent auction process to avoid hoarding.

Analysis of the issues raised in Q9

2.142 The suggestion made by a few stakeholders that gateways should be permitted to be installed in pre-determined locations, creating Gateway Exclusion Zones (GEZs) where terrestrial transmissions on the same frequency bands are prohibited, has already been examined in para 2.128.

2.143 It is noted that the conventional satellite systems consisted of wide beams and their throughputs were not very high, one or a few satellite gateways were sufficient to meet the requirement. However, with the high throughput GSO and NGSO satellite systems, the requirement of number of gateways to be established may be much higher. Moreover, a satellite gateway of NGSO satellite systems consists of an array of tracking antennas, and the decision of

the location of the gateway may involve several factors such as no obstructions blocking any satellites, cost of land, power supply, fiber availability, geographical distribution of gateway locations, etc. Such gateway location deciding factors may raise a concern that one or a few service providers may take spectrum usage rights for the key locations for gateway links. As mentioned earlier, similar concerns were considered by Ofcom, UK and it concluded that the risk of scarcity of gateway sites can be reduced by introducing a requirement for gateway licensees to commence and maintain transmissions within 12 months. Accordingly, the Licensing guidance for non-geostationary satellite earth stations was revised by Ofcom. The Authority is of the view that similar condition should be prescribed in India while giving permission to the authorised entities for the establishment of satellite earth station gateways. The Authority is of the view that once permission to set up a gateway at a location has been granted by the Central Government, 12 months' time for commissioning of gateways is feasible. Therefore, it should be included in the terms and conditions that the Satellite Earth Station Gateway(s) should be installed and commissioned within 12 months from the date of permission granted to the authorised entities by the Central Government for the establishment of the Satellite Earth Station Gateway(s).

2.144 In view of the above, **the Authority recommends that with a view to mitigate the risk of scarcity of gateway sites, Satellite Earth Station Gateway(s) should be installed and commissioned within 12 months from the date of permission granted to the authorised entities by the Central Government for the establishment of the Satellite Earth Station Gateway(s).**

G. Roll-out Obligations for the Assigned Spectrum

2.145 As per the extant licensing regime, satellite-based commercial communication services can be provided under the following authorisations under Unified License:

(a) Commercial VSAT CUG service authorization

(b) GMPCS service authorization

2.146 According to the roll-out obligations provided in the service authorisations, for the Commercial VSAT CUG service authorization, the service licensee is required to roll out its network by installing and commissioning a Hub station for star network configuration or at least two VSAT terminals in case of mesh network configuration within 12 months from the date of frequency allotment by WPC. For the GMPCS service authorisation, the service licensee is required to commission land earth station gateway switch for the provision of GMPCS service within 12 months from the date of frequency allotment by the WPC.

2.147 It is noteworthy that in its recent recommendations on 'Framework for Service Authorisations to be Granted Under the Telecommunications Act, 2023' dated 18.09.2024, the Authority has recommended, *inter-alia*, that the scope of the extant GMPCS service authorization and Commercial VSAT CUG Service authorization should be merged into a single authorisation namely Satellite-based Telecommunication Service authorisation under the Telecommunications Act, 2023. The Authority has recommended the following roll-out obligations for Satellite-based Telecommunication Service authorisation:

"Roll Out Obligations

(5) For provision of Satellite-based Telecommunication Service, the Authorised Entity shall roll out the network within 12 months from the date of frequency assignment, unless otherwise stipulated in the terms and conditions of the assignment of spectrum.

(6) In case of GMPCS Service, the roll out of the network shall mean installation and commissioning of a Satellite Earth Station Gateway Switch. In

case of VSAT-based FSS, the roll out of the network shall mean installation and commissioning of a Hub Station for star network configuration or at least two VSAT terminals in case of mesh network configuration. For this purpose, the Authorised Entity can make use of the Satellite Earth Station Gateway Switch/ Hub Station established by other eligible authorised entities.

(7) For verification of the installation and commissioning of the applicable system, the Authorised Entity shall register with the SATCOM Monitoring Centre (SMC) of the Central Government, as per the procedure prescribed by the Central Government. Date of registration by SMC is to be treated as the date of commissioning in case of successful verification of the rollout of the network. If the verification of the roll out of the network fails, then the Authorised Entity shall re-register with the SMC after necessary corrections and in that case, the date of re-registration by SMC shall be treated as the date of meeting the roll out obligation subject to successful verification. If the network is rolled out after the expiry of the due date, such delay in rollout of network will entail recovery of Liquidated Damages (LD) under this condition:

Provided further that if the rollout of the network is effected within 30 calendar days of the expiry of the due date then the Central Government shall accept the rollout of network without levy of LD charges.

(8) In case the Authorised Entity fails to rollout the network within the period prescribed, the Central Government shall be entitled to recover LD charges @ ₹ 100,000/- (Rupees One lakh only) per month of delay subject to a maximum amount of ₹ 24 lakh. For the delay of more than 24 months, in addition to imposition of maximum amount of LD, the frequency assignment may be withdrawn. The bank guarantee (BG) shall be encashed to the extent of LD amount, if the same is not paid within the time period specified in the notice for recovery of LD. The Authorised Entity, on such occasions, shall restore the partially encashed bank guarantee to the full amount. Any failure to do so shall amount to violation of the terms and conditions of the Authorisation. For calculation of delay in compliance of roll out obligations, the month shall mean one Calendar month and any extra day shall be counted as full month for the purpose of recovery of liquidated damages."

2.148 From the above, it can be seen that the roll-out obligations are in respect of the operationalization of satellite earth station gateway i.e. feeder link frequency spectrum. In respect of the spectrum assigned for user links, no separate roll-out obligations have been prescribed. Considering that the new generation satellite systems including NGSO based satellite systems require a large quantum of frequency spectrum, one may contend that there could be a need to include certain additional roll-out obligations to ensure that the spectrum assigned for satellite-based telecommunications services is put to its efficient use.

2.149 In this background, the Authority solicited views of stakeholders on the following question:

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 –

(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 alongwith international practice in this regard.

Comments received from stakeholders on Q10

2.150 One set of stakeholders were of the view that there is no need to impose any additional roll-out obligations for the assignment of frequency spectrum. Some of these stakeholders further stated imposing additional roll-out obligations

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 un-served or underserved areas.

2.151 On the other hand, another set of stakeholders were in favour of prescribing additional roll out obligations. Suggestions by the stakeholders are given below:

(a) Gateways must be operational within one year of spectrum assignment, followed by set timelines for achieving nationwide coverage. Extensions may be granted for delays due to regulatory or environmental challenges.

(b) Certain timeline/period say 24 months could be prescribed for start of satellite-based services by satellite operator or applicant post obtaining the spectrum from authority. This is to ensure the applicants are not blocking precious resources.

(c) There should be a condition that the satellite service provider start commercial service within one-three years of the assignment of spectrum.

(d) Satellite service provider should cover, within a year of the assignment of spectrum, a certain geography comprising of areas which have no terrestrial footprint, failing which the spectrum should automatically revert to the WPC Wing. The Government may also incentivize such coverage through USOF.

Analysis of the issues raised in Q10

2.152 It is noted that while one set of stakeholders were of the view that there is no need to impose any further additional roll-out obligations for the assignment of frequency spectrum, another set of stakeholders suggested that additional obligations relating to coverage and commercial launch of services should be imposed.

2.153 In its recent recommendation on "Framework for Service Authorisations to be Granted Under the Telecommunications Act, 2023" dated 18.09.2024, the Authority has recommended, *inter-alia*, that the scope of the extant GMPCS service authorization and Commercial VSAT CUG Service authorization should be merged into a single authorisation namely Satellite-based Telecommunication Service authorisation under the Telecommunications Act, 2023. The roll-out obligations have also been recommended.

2.154 Further, considering the recommendations made by the Authority on spectrum charges in the subsequent section of this recommendation, since the minimum spectrum charges are liable to be paid from the day spectrum is assigned to an entity, it will motivate faster roll-out to begin revenue generation by an Authorised Entity. Further, considering that satellite systems for MSS services are coordinated by a due process and spectrum in higher frequency bands is assigned on a sharable basis, there is no concern w.r.t. spectrum hoarding. Therefore, the Authority is of the view that there is no need to impose any further roll-out obligations in addition to those recommended by the Authority in the recommendations on "Framework for Service Authorisations to be Granted Under the Telecommunications Act, 2023" dated 18.09.2024.

H. Surrender of the Assigned Spectrum

2.155 The Authority solicited views of stakeholders on the following questions:

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 -

(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?

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.

Comments received from stakeholders on Q11

2.156 Most of the stakeholders were of the view that a provision for surrender of assigned frequency spectrum before the completion of the validity period should be created as it would provide flexibility to the authorised entities in managing their spectrum holdings, allowing them to adapt to changing market conditions, technological advancements, or business strategies.

2.157 As regards the process and other terms and conditions, the following suggestions were made:

(a) Some stakeholders were of the view that the process should be transparent and straightforward.

(b) One of the stakeholders was of the view that the current regime for the surrender of spectrum for certain space-based communication is provided under the DoT's order dated December 11, 2023, wherein the assignees have an option to surrender the frequency assignment if no longer required or utilized by such assignee. In such an event, the assignees can apply online for the surrender of the assigned frequencies.

(c) Some of the stakeholders were of the view that there should be no surrender fee, on the other hand, some other stakeholders viewed that a minimal surrender fee to cover administrative cost, should be charged.

(d) Some stakeholders also submitted that in case an entity surrenders the frequency spectrum assigned to it before the expiry of the validity period, the fees paid proportionate to the remaining period should be refunded.

(e) One of the stakeholders suggested that the operators should be allowed to surrender the spectrum assigned for NGSO-based FSS broadband services after giving 30 days' notice, with no minimum period of spectrum

holding and no surrender fee - in line with the extant guidelines for surrender of administratively assigned spectrum.

(f) Terms and conditions similar to the existing policy for terrestrial spectrum should be implemented.

(g) It should simply be a surrender of the administrative assignment for a specific system, and should not have onerous terms, conditions, or fees associated with the return of frequency spectrum that is issued in a shared manner to many other systems.

2.158 A few stakeholders were of the view that there is no need to create specific guidelines and the same can be decided on a case-to-case basis.

Analysis of the issues raised in Q11

2.159 For the ease of doing business, in addition to reducing entry barriers, the availability of exit option is also very important. Therefore, the Authority is of the view that the option for surrender of the right to use of frequency spectrum prior to the expiry of the validity period should be available. For this, a notice period of 30 days appears to be reasonable. However, in case the surrender of the right to use of spectrum is likely to result in a disruption or closure of services for the consumers, to protect the interest of the consumers, the Authorised Entity should be required to serve an advance notice to the Central Government/ TRAI as well as each of its subscribers, 60 days prior to the proposed date of surrender of right to use of frequency spectrum. Further, the DoT may charge a reasonable processing fee to recover administrative charges, if any, for the surrender of the right to use of frequency spectrum. As regards the suggestion regarding the refund of spectrum charges already paid by the Authorised Entity desiring to surrender the spectrum, the Authority in a subsequent section of these recommendations has recommended that the spectrum charges should be levied on a quarterly basis. Therefore, the issue of refund of spectrum charges already paid by the Authorised Entity, may not be significant.

2.160 In view of the above, **the Authority recommends that entities authorised to provide satellite-based telecommunication services should be permitted to surrender the right to use of frequency spectrum assigned to them before the expiry of the validity period. For this purpose, the following should be the broad terms and conditions:**

(a) The Authorised Entity should provide a notice period to the Central Government and TRAI of at least 30 days prior to the proposed date of surrender of right to use the frequency spectrum along with the relevant details, including the precise frequency range(s) proposed to be surrendered. However, in case the surrender of right to use of spectrum by an Authorised Entity is likely to result in a disruption or closure of services for the consumers, the service provider should be required to serve an advance notice to the Central Government and TRAI as well as each of its subscribers, 60 days prior to the proposed date of surrender of the right to use of frequency spectrum.

(b) DoT may charge a reasonable processing fee to recover administrative charges, if any, for the surrender of the right to use of frequency spectrum.

I. Timelines for Processing the Applications for the Assignment of Spectrum

2.161 The Authority solicited views of stakeholders on the following set of questions:

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

Comments received from stakeholders on Q12

2.162 The stakeholders were of the unanimous view that there is a need to prescribe timelines for processing the applications for the assignment of frequency spectrum for satellite-based communication services. Many stakeholders were of the view that the spectrum assignment application be processed within 15 to 30 days from the issuance of the in-principle clearance of network by the DoT. A few stakeholders further submitted that the regulators in other countries have a 30 to 60 days' timeframe to either grant the frequency assignment or reject it.

Analysis of the issues raised in Q12

2.163 The Authority concurs with the view of the stakeholders that once in-principle clearance of satellite network has been given by the Central Government for the provision satellite-based communication services in the Country, frequency spectrum should be assigned to the Authorised Entity within a prescribed timeline, not exceeding 30 days from the date of application. In case of any objection, the same may be communicated to the concerned Authorised Entity within such window of 30 days from the date of application, for necessary action.

2.164 In view of the above, **the Authority recommends that there should be a defined timeline, not exceeding 30 days from the date of application, within which the frequency spectrum should be assigned to an Authorised Entity for provision of satellite-based communication services, provided that the in-principle clearance of satellite network has been given by the Central Government. In case of any objection,**

the same may be communicated to the concerned Authorised Entity within such window of 30 days from the date of application, for necessary action.

J. Other issues

2.165 In addition to the specific issues raised through the questions posed by the Authority, there may be certain other issues/ suggestions relevant to the subject. Therefore, the Authority solicited views of stakeholders on the following question:

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.

Comments received from stakeholders on Q13

2.166 A few stakeholders have suggested that the process for assignment of spectrum should be simplified to enhance ease of doing business. Currently, the spectrum is assigned on a carrier-by-carrier basis. Any changes in the size of the carrier or increase/decrease in the number of carriers may necessitate changes to the assignment, which is time consuming and results in additional cost and administrative burden. Spectrum should be assigned as a block, rather than on a carrier-by-carrier basis. This requirement flows from GSO-based networks, where the same satellite is shared among multiple operators, thus necessitating interference monitoring by NOCC. However, in the case of NGSO, the whole constellation serves only one entity, which is the satellite operator itself. Hence,

there is no case for interference monitoring by a third party. In case it is still felt that the submission of information regarding carrier plans, antenna parameters, etc. is necessary, NGSO operators could continue to provide the same on the Saral Sanchar portal on a self-intimation basis – rather than having to seek an approval.

Analysis of the issues raised in Q13

2.167 Some stakeholders requested that the spectrum should be assigned as a block, rather than on a carrier-by-carrier basis, as any changes in the size of the carrier or increase/ decrease in the number of carriers may necessitate changes to the assignment, which is time consuming and results in additional cost and administrative burden. *Prima facie*, it appears that there may be merit in the suggestion, as it will provide flexibility in provision of services to meet the demand of consumers. However, there may be some other concerns of the Central Government. Therefore, the Authority is of the view that the Central Government may explore the possibility of assigning spectrum as a block rather than on a carrier-by-carrier basis.

2.168 In view of the above, **the Authority recommends that the Central Government should explore the possibility of assigning frequency spectrum for satellite-based telecommunication services on a block basis rather than on a carrier-by-carrier basis.**

2.169 In addition, it is noted that a few stakeholders also submitted comments in respect to the use of inter-satellite links for feeder links. The Authority notes that the existing service authorisation regime provides that for the provision of satellite-based communication services, Land Earth Station Gateway is required to be established in India and services are required to be provided using the satellite systems provided that the satellite earth station gateway and switch for the respective satellite systems are located in India. In short, for the provision of satellite-based services in India, satellite earth station gateway for

the relevant satellite system is required to be established in India and services are required to be provided through such gateway only i.e. all the data is required to be routed through such gateway. However, with the use of inter-satellite links, there could be a possibility of bypassing the security requirement of the use of gateway established in India.

2.170 In this regard, the Authority notes that DoT has recently issued an Office Memorandum[20] on the subject 'Instructions related to Security aspects in chapter XII of the UL Agreement for the provision of GMPCS service' dated 05.05.2025, wherein the necessary provision has been included. The relevant provision is reproduced below:

"19. The licensees shall clarify on Inter Satellite Communication Links (ISCL) capability and ensure that no routing of traffic via outside gateways takes place through ISCL during Indian gateway' failure or as part of optimization. Further, the Indian user traffic shall not be mirrored to any system/server located abroad through Inter Satellite Communication Link (ISCL) or through any other means."

2.171 The following chapter examines the issues relating to spectrum charging mechanism for satellite-based commercial communication services.

[20] https://dot.gov.in/sites/default/files/OM%20GMPCS%20Security%20instructions.pdf

Chapter III: Examination of the Issues Related to the Spectrum Charging Mechanism for Satellite-Based Commercial Communication Services

A. Introduction

3.1 In chapter VII, para II of Article 44 of the constitution of the International Telecommunication Union (ITU), dealing with the 'Use of the Radio-Frequency Spectrum and of the Geostationary-Satellite and Other Satellite Orbits', it has been *inter alia* mentioned that:

"*…radio frequencies and any associated orbits, including the geostationary-satellite orbit, are limited natural resources and that they must be used rationally, efficiently and economically, in conformity with the provisions of the Radio Regulation….*"

3.2 The working paper on "Universal Coverage, Enhancing Spacecom Sector Growth, and Supporting Democratic Ethos: The Role of Satellite Spectrum Assignment" published by Indian Council for Research on International Economic Relations (ICRIER), states that:

"*Spectrum management issues related to satellite communications have become more complex as the demand for spectrum from new players, applications and systems is increasing. Spectrum being a limited resource, it is imperative that technological characteristics that enable maximal exploitation and supportive policy and regulation principles are adopted*."

3.3 The National Digital Communications Policy – 2018[21] aims at strengthening Satellite Communication Technologies in India. Section 1.3(b) of NDCP 2018 highlights various measures to optimise Satellite communications technologies in India, some of which are stated as follows:

[21] https://dot.gov.in/sites/default/files/Final%20NDCP-2018.pdf?download=1

- *Reviewing SATCOM policy for communication services, along with Department of Space, to create a flexible, technology-neutral and competitive regime, keeping in view international developments and social and economic needs of the country*
- *Rationalizing satellite transponder, spectrum charges and charges payable to WPC*

3.4 Satellite communication services are instrumental in bridging the digital divide, particularly in rural, remote, unserved, and underserved regions where terrestrial infrastructure is either limited or economically unviable. By overcoming geographical barriers, satellite technology provides connectivity, ensuring access to essential services such as education, healthcare, e-governance, and financial inclusion thereby empowering local communities and fosters sustainable socio-economic development.

3.5 During natural disasters such as earthquakes, cyclones, or floods, when terrestrial networks may become unavailable, satellite communication become a reliable mode of communication. Its resilience and independence from ground infrastructure enable rapid response and effective coordination for rescue and relief efforts, making it indispensable for emergency preparedness and disaster management.

3.6 In border and strategic areas, where establishing traditional networks is challenging due to terrain or security constraints, satellite communication ensures reliable connectivity, supporting national security operations, surveillance, and local civilian needs.

3.7 Furthermore, it facilitates communication for aircraft, ships, and vehicles operating in remote or international routes, ensuring safety, efficiency, and real-time monitoring, particularly in maritime and deep-sea environments. By addressing these diverse connectivity needs, satellite communication plays a vital role in driving economic growth and fostering inclusivity.

3.8 Satellite services play a vital role in supporting the growth of IoT and M2M applications in rural and remote areas by ensuring connectivity in locations where traditional networks are unavailable. These services enable the use of smart technologies in agriculture, healthcare, and other essential sectors, helping to improve productivity and quality of life.

3.9 Recognizing that satellite-based communication services—such as GSO/NGSO based Fixed Satellite Services and GSO/NGSO based Mobile Satellite Services —are poised to serve as enablers in delivering connectivity solutions, the Authority intends that the spectrum charging framework should encourage the prudent and efficient utilisation of spectrum. The spectrum charging regime should not only be economically sound, enable the realization of the benefits of satellite connectivity but also foster sustainable growth and investment in satellite-based communication services.

3.10 The Authority endeavours to arrive at a spectrum charging mechanism that is transparent, economically efficient, and aligned with principles of optimal spectrum management. This framework will aim to balance the interests of stakeholders, ensuring that spectrum charges for satellite-based communication services are reflective of its market value and at the same time conducive to sectoral growth.

3.11 Moreover, recognizing the important role satellite communication providers play in bridging connectivity gaps in rural and remote areas, the Authority aims to establish a spectrum pricing framework that ensures affordability for end-users.

3.12 Given the low purchasing power of consumers in rural and remote regions, it is imperative to structure spectrum charges for satellite operators in such a manner that lowers costs without compromising service quality. This approach seeks to promote the availability of reliable and affordable satellite-based

communication services, enabling inclusive digital access and fostering socio-economic development in rural, remote, underserved and unserved areas.

3.13 Considering that the satellite communication sector is at an early stage of development with limited financial and market information, the Authority has aimed to design an efficient spectrum charging regime despite constraints due to limited data. Consequently, the current spectrum charging mechanism may be regarded as specific to the satellite communication sector, at least within the present context of restricted data availability.

3.14 The business potential of satellite-based communication services would emerge after some years of operations. As the financial and market related parameters of the satellite communication sector become available after a few years, the spectrum charging mechanism might require to be reviewed/ reassessed considering the uptake of these services in the country.

3.15 The present Chapter deals with comments received by stakeholders on the issues related to Spectrum Charging Mechanism for certain satellite-based commercial communication services, the analysis of these comments, and the approach followed for determining the spectrum charges.

B. Present DoT's reference

3.16 DoT vide its letter dated 11th July, 2024 has sought TRAI's recommendations on terms and conditions of spectrum assignment including spectrum pricing for certain satellite-based commercial communication services. DoT's vide its letter has, *inter alia*, stated that:

"Keeping in view the provisions of Section 4 and the First Schedule of the Telecommunications Act-2023, in terms of Section 11(1)(a) of TRAI Act 1997, TRAI is requested to provide its recommendations on terms and conditions of spectrum assignment including spectrum pricing while accounting for level

playing field with terrestrial access services for the following satellite-based communication services:

i. NGSO based Fixed Satellite Services providing data communication and Internet services. In its recommendations, TRAI may take into account services provided by GSO-based satellite communication service providers.

ii. GSO/NGSO based Mobile Satellite Services providing voice, text, data, and internet services."

C. The per MHz charging vs. percentage of Adjusted Gross Revenue (AGR) based charging for GSO/NGSO based FSS and GSO/NGSO based MSS

3.17 Regarding the spectrum charging mechanism for NGSO-based FSS providing data communication and Internet services and GSO/NGSO-based MSS that provide voice, text, data, and Internet services, comments of the stakeholders were sought as to whether the charging should be based on per MHz basis or on percentage of AGR basis or some other methodology may be followed.

3.18 Accordingly, the following questions were raised in the Consultation Paper: -

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.

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

Comments of stakeholders

3.19 Majority of the stakeholders have favored AGR-based charging.

3.20 A broad summary of the comments of the stakeholders, who are in favour of percentage of AGR-based charging, is given below:

- AGR-based charging would facilitate expansion of services, as affordable charges to end users would increase the scale of the services, and better utilize the available satellite capacity
- Such charging would ensure that the spectrum charges are linked to the revenue generated by the service provider from such spectrum.
- It is a good reflection of the actual value of spectrum.
- Charging for spectrum as a function of revenue brings in greater transparency. Any licensee that earns more revenue pays more and vice versa.
- The AGR based charging is a good reflection of the actual value of spectrum and on the other hand applying a per MHz approach could result in exorbitant amounts.
- Spectrum charges should be sufficient to cover the administrative costs of the spectrum.
- Spectrum charges should be levied on % of AGR for simplification and as part of ease of doing business. Overall spectrum charges do not need to be any higher than the administrative costs required to cover the allocation of spectrum. It will also facilitate investment and innovation.
- AGR based charging will be beneficial for small operators, would ensure transparency and sets the stage for a healthy market structure. This method also recognizes the fact that spectrum is shared so that contributions of operators are commensurate with the success & scale of their operations.

3.21 Some of the stakeholders have favored per MHz based charging stating that per MHz charge structure is straightforward and easy to understand for service providers. It allows operators to clearly calculate their spectrum costs based on

the bandwidth they require. A per MHz charge discourages operators from holding onto unused spectrum, promoting more effective allocation and utilization of resources.

3.22 Another stakeholder has stated that in case auction-based assignment methodology is not opted for assigning the spectrum, the Authority should ensure that valuation and payouts against the use of spectrum are same for both terrestrial and satellite-based communication services and the price of spectrum for satellite-based services should not be lower than the auction determined prices (ADP) of closet spectrum band. Irrespective of the mode or formula for calculating annual spectrum charges of administrative assignment of spectrum, the outcome should be a constant i.e. equal to annual payout under deferred payment option for mmWave spectrum or C-Band spectrum with a minimum commitment period of 10 years as in case of terrestrial spectrum. Further, the charging mechanism for satellite-based communications services should ensure complete parity in spectrum payouts including upfront charges, license fees, recurring charges etc. comparable to those applied to terrestrial communications services. The stakeholder has argued that the spectrum charge should not be based on AGR, as AGR based spectrum charge is dependent on the tariff and the rollout of services by the operators without payment of any interest. Recovering cost of allocated spectrum on AGR basis will lead to different cost for different constellations/operators and penalizing an efficient operator generating more AGR with higher AGR cost. Further, it stated that such AGR based cost recovery on "Pay as You Earn" will be discriminatory vis-à-vis terrestrial media, which is required to be paid "upfront" irrespective of the revenue received by providing such services.

3.23 Further, a stakeholder has suggested to maintain level playing field and ensure that market determined price, at a LSA level, is taken for the Satellite related spectrum also, be it through auction or through administrative allocation. This stakeholder stated that prices should be determined on a per MHz basis at LSA level, linked to prices of the spectrum already auctioned and being used by the

TSPs is an appropriate mechanism for determining pricing for satellite spectrum. It further said that the auction methodology and all related modalities should remain same as is applicable for IMT spectrum auction.

3.24 One stakeholder has suggested that an appropriate spectrum methodology may be considered, revenue share or charges based on quantum of spectrum or per-user terminal charging or any other alternative approach, considering the need to encourage satellite communication in traditional markets. It stated that traditional use cases, i.e. in rural and remote areas and for Government agencies, including Defence, disaster recovery, cellular backhaul in rural and remote areas, etc., can be priced differently (say, no spectrum charge), while also ensuring a level playing field with terrestrial operators in urban areas/retail customer market. It further said that the spectrum charging methodology should be such that it addresses the concerns on level playing field with terrestrial operators qua some satellite communication operators offering services directly to customers in urban areas/retail customers.

3.25 Some stakeholders have stated that the revenue share regime can be applied for satellite communication services that do not directly compete with terrestrial network, but for services that directly compete with terrestrial networks, to ensure a level playing field, the spectrum pricing (irrespective of auction or administrative assignment) should be benchmarked with market discovered price of the spectrum for terrestrial networks.

Analysis

I. Present Spectrum Charging Mechanism

3.26 The spectrum for space-based communications services is presently being assigned through an administrative mechanism with formula-based charging for some services while charges based on percentage of AGR for other services. The administrative charges for spectrum are being paid on a quarterly or annual

basis with no upfront charge. The administrative spectrum charges, being charged currently, are detailed below: -

i. DoT's Annual Royalty Formula for Satellite-based Services

3.27 The spectrum charges for assignment of frequencies are being levied on annual basis, as per DoT's order issued vide letter no. P-11014/34/2009-PP dated 11th December 2023 (erstwhile DoT's order dated 22nd March 2012), attached at Annexure 3.1.

3.28 The Schedule-VII of the said order is applicable for Assignment of spectrum to satellite-based services including Fixed Satellite Services (FSS), Broadcasting Satellite Services (BSS), Mobile satellite Services (MSS) and Earth Exploration Satellite Services (EESS). The standard annual royalty factor is fixed as Rs. 35,000/- per frequency. The same rates are applicable for all applications under FSS, BSS, MSS and EESS, in combination with the relevant Bandwidth Factor (Bs).

3.29 The Annual Royalty charges for satellite-based services, as specified in Part-I of DOT's order dated 11th December 2023, are being calculated as given below:

$$\text{Royalty, R (in Rs.)} = 35000 \times Bs;$$

where (Bs) is the Bandwidth Factor for Satellite Communications

Table-Bandwidth Factor (Bs)

S.No.	Total Assigned Bandwidth		Bandwidth factor (Bs)			
			For uplink		For downlink	
			Broadcast	Others	Broadcast	Others
(i)	Up to and including 500 KHz, Bs is either of these three	Up to and including 100 KHz	0.25	0.20	Nil	0.20
(ii)		More than 100 KHz to up to and including 250 KHz	0.60	0.50	Nil	0.50
(iii)		More than 250 KHz to up to and including 500 KHz	1.25	1.00	Nil	1.00
(iv)	More than 500 KHz [i.e. BW > 500 KHz]		Total Bs			

Note: Bs is the Bandwidth factor

Total Bs = [Appropriate Bs from row (iii) above x bandwidth in number of multiple of 500 kHz] + [Appropriate Bs from row (i) above x number of multiple of 100KHz or part thereof in balance bandwidth]

where, Balance bandwidth = remainder of [bandwidth/ 500 kHz]

3.30 As per the above DoT's order spectrum charges for satellite services are levied in two parts i.e. Part-I: Royalty Charges and Part II : License Fee for wireless stations.

3.31 As specified in Part-II of the afore-mentioned DoT's order, the license fee for wireless stations operating under Satellite Services (FSS, BSS, MSS), including standby sets, as follows:

S.No.	Type of Wireless station License	Annual License Fee (in Rs.)
1	Fixed Earth station DTH/ Teleport/ DSNG/NLD/ILD/DCP/IP-II	1000 per station
2	Captive VSAT/Inmarsat Earth Station	500 per station
3	Vehicle Mobile/ Handheld Mobile Station	250 per station

ii. Spectrum Charges for Commercial VSAT service

3.32 For commercial VSAT service, the spectrum charges are being levied quarterly as a percentage of Adjusted Gross Revenue (AGR), based on range of data rate, as per DoT's order no. R-11014/9/2001-LR dated 16th April 2003 attached at Annexure 3.2.

3.33 The WPC spectrum charges, as per the above-mentioned order, are given below:

Range of Data rate	WPC Spectrum charges
Up to 128 Kbps	3.0% of AGR
Higher than 128 Kbps and up to 512 Kbps	3.5% of AGR
Higher than 512 Kbps and up to 2 Mbps	4.0% of AGR

iii. Spectrum Charges for satellite services under Sui Generis category

3.34 DoT has issued an office memorandum no. J-19044/03/2015-SAT dated 28th June 2021 prescribing 1% of the AGR as spectrum charge for BSNL's satellite-

based services under 'sui-generis' category. The said DoT's O.M. has been enclosed as Annexure 3.3.

3.35 Further, the scope of 'sui-generis' license granted to BSNL for provision and operation of Satellite based services using gateway installed in India has been defined under the amendment issued by DoT dated 6.5.2022, which states that:

"The licensee may provide, in its area of operation, all types of mobile satellite services such as INMARSAT service. These may include voice and non-voice messages, data services by establishing Gateway in India utilizing any type of network equipment including circuit and/or packet switches. This shall also include broadcast of distress messages in India or outside the territorial boundaries of India subject to applicable rules and laws. The licensee may also provide satellite-based data connectivity to the IoT devices/ Aggregator devices."

II. Spectrum Charging mechanism

3.36 The concept of Value-based pricing was developed by Tom Nagle in the various editions of 'The Strategy and Tactics of Pricing[22]'. The Value-based pricing is a business strategy that primarily relies on consumers' perceived value of goods or services to determine its price. That is, the price of a good is based on the consumers' willingness to pay for it. Willingness to pay (WTP) is the highest price a consumer is willing to pay for the good[23].

3.37 For valuation of terrestrial access spectrum, the Authority has been considering the revenue generated by operators as one of the variables that could potentially influence spectrum valuation. The revenue of service providers served as an important parameter in the revenue surplus model or discounted

[22] The Strategy and Tactics of Pricing
Joseph Zale, Thomas Nagle, John Hogan · 2011
[23] https://online.hbs.edu/blog/post/willingness-to-pay

cash flow model adopted by the Authority. Accordingly, it is reasonable to infer that the revenue generated from using the spectrum is an important factor that influences the valuation of spectrum for a service provider and, consequently, determines the willingness of service providers to pay for the use of that spectrum.

3.38 It is important to note that valuation models, such as revenue surplus model, also rely on data pertaining to other parameters, including costs, subscriber base, quantum of spectrum, historical data and projections. However, given the nascent stage of the satellite communication sector, there is a notable paucity of data related to its technical, financial and other market parameters. In such a scenario, spectrum prices may be assumed to be a function of revenue, which may serve as a suitable methodology. This approach seems to address the current limitations in data availability while providing a reasonable basis for spectrum valuation in the satellite communication sector.

3.39 As per the Demand Theory[24], a consumer buys a good as long as the consumer surplus (C) >=0. It must be noted that the revenue sharing model, (i.e., levying charges as a percentage of revenue/AGR) is appropriate in this scenario since it takes into account the paying capacity of the buyer as prices are linked to the revenue of the respective buyer.

3.40 Since in the AGR based charging methodology, spectrum charges are levied as a percentage of benefits from spectrum/revenue, it can be expected that the consumer surplus in this case will be greater than zero, which may positively impact the demand.

3.41 Revenue-based spectrum charges can also take into account the issue of a level-playing field among operators of different market sizes as small operators

[24] A Revision of Demand Theory, John Hicks · 1965

with lower revenues pay less, while on the other hand, larger operators who may generate more revenue, contribute more.

3.42 In the case of access/IMT spectrum, the Authority generally determines spectrum charges on a per MHz basis. These charges are derived using information related to various financial, market, and technical parameters specific to the access spectrum. Valuation and reserve prices are set through approaches and methodologies that rely on factors such as revenue, subscriber base, cost, and quantum of spectrum, utilizing both current and historical data for predictive analysis.

3.43 However, such an approach will not apply to the satellite communication sector. Given the limited number for players in GSO based satellite communications sector and nascent stage of development of NGSO based satellite communications sector, data on revenue, subscriber base, cost, and spectrum holdings is either limited or unavailable across certain satellite based communications services.

3.44 Thus, determining spectrum valuation and reserve prices on a per MHz basis with limited data may lead to charges that do not align with the paying capacity of satellite service providers, the overall market size of the GSO/NGSO based satellite communication sector and nascent stage of development of NGSO based satellite communication sector. This can also lead to potentially hindering entry, competition, investment, sustainable growth and lower uptake of the service by consumers.

3.45 Another approach of spectrum valuation could be using the Auction Discovered Price (ADP) of 2022 IMT auction of the mmWave and C-Band spectrum bands. However, it may be noted that access spectrum prices are based on technical, financial, and market parameters specific to the access service. These parameters differ significantly from those of satellite-based communication services. The following table highlights the substantial variation in the current

status of revenues across Access service, Commercial VSAT service and BSNL's GSPS service under 'sui generis' category:

Details of Revenue service-wise

			Rs. in crore
Service	**Gross Revenue**		
	F.Y. 2021-22	**F.Y. 2022-23**	**F.Y. 2023-24**
Access	2,16,933	2,69,324	2,68,273
VSAT	379.67	426.47	438.04
GSPS	70.91	104.52	87.16
VSAT GR as % of Access GR	0.18%	0.16%	0.16%
GSPS GR as % of Access GR	0.03%	0.04%	0.03%
Source: The above data is based on quarterly statements submitted by service providers to TRAI			

3.46 Currently, the total revenue from the commercial VSAT services is only 0.16% of the revenue from Access service, while the revenue from the GSPS service is merely 0.03% of the revenue from Access service.

3.47 Although the growth of the satellite sector may reduce the revenue disparity mentioned above, however, as noted in para 2.35 of Chapter-II, the network capacities of terrestrial wireless access providers and NGSO-based satellite broadband providers in terms of throughput are significantly different. Moreover, as mentioned at para 2.35, a typical terrestrial wireless access service provider can serve significantly higher number of broadband subscribers as compared to NGSO-based FSS operators. Therefore, it is reasonable to expect that the revenue-generating potential of spectrum used by satellite-based communication will be different from the revenue potential of the spectrum used in terrestrial wireless access services.

3.48 Moreover, the ADP of spectrum used for access services may be linked to a wide range of offerings, including internet, data, voice calls, SMS, and other related services. In comparison, the scope of satellite services is more

restricted. Fixed Satellite Services (FSS) are primarily used for data and internet services, while the scope of Mobile Satellite Services (MSS) is currently confined to specific applications such as emergency communications, defense, maritime operations, and other niche areas, limiting their broader adoption.

3.49 Considering the present characteristics of the satellite sector, its revenue potential, subscriber base, its present limited scope, its nascent stage of development, etc. make it distinct from the terrestrial mobile sector. Thus, using the market determined prices of access spectrum bands for valuation of satellite-based communication services such as GSO/NGSO based FSS and GSO/NGSO based MSS may not accurately reflect the economic value of spectrum for satellite-based communication services.

3.50 The per-MHz spectrum charges for satellite-based communication services cannot be appropriately determined by referencing the value of other frequency bands using a spectral or technical efficiency factor. This is primarily due to the manner in which terrestrial access services can exploit the spectrum and the manner in which satellite can utilize the spectrum are not comparable (as elaborated in para 3.47 of this chapter). Further, there is difference in scope, revenue potential, and subscriber base, among other factors, which make the economic value of spectrum for Fixed Satellite Services (FSS) and Mobile Satellite Services (MSS) incomparable to that of terrestrial access services. These differences have been explained in the preceding paragraphs.

3.51 In the light of these considerations, applying a spectral or technical efficiency factor derived from other spectrum bands to determine the value of spectrum bands for satellite-based communication services, such as GSO/NGSO-based FSS and GSO/NGSO-based MSS, would likely be inaccurate and inappropriate.

3.52 For the sake of completeness of analysis, the spectrum charges borne by terrestrial wireless access service providers have been analyzed at Annexure 3.4. However, the same has not been considered as a relevant basis for

deciding on the spectrum charges for satellite-based FSS and MSS in view of the discussion above.

3.53 Internationally, the spectrum charges for satellite services are generally applicable either on a per-MHz basis or as a fixed fee. For illustrative purposes, the spectrum fees/ charges in some of these countries are provided in Annexure 3.5. As can be observed, the per-MHz charges are generally not comparable to the auction-determined prices for terrestrial access spectrum bands. Further, the fixed fee is generally not levied based on the quantum of spectrum. This data highlights a variation in spectrum charging methodologies across different countries but nowhere these appear to be benchmarked to the auction determined prices of terrestrial access service spectrum.

3.54 Given the fact that there is limited data availability for satellite-based communication services, determining the spectrum charges based on an Adjusted Gross Revenue (AGR) model may serve as a "first-best alternative." This approach aligns the charges with the benefits or revenue generated from spectrum use and considers the user's ability to pay.

3.55 Currently also, under Commercial VSAT service authorisation and satellite communication services under 'sui generis' category, the service providers are paying charges based on a percentage of revenue. The Adjusted Gross Revenue based charging method for satellite communication sector aligns with the existing revenue-based charging framework, ensuring a consistent and stable approach and the Authority has also advocated for AGR based charging, from time to time, for satellite-based communication services. AGR based charging methodology is sector accepted, therefore, it is expected to safeguard the interests of both current and prospective service providers of satellite sector.

3.56 If such an approach is adopted for satellite communication services, there can be an argument that spectrum charges for terrestrial access services also be levied on percentage of AGR basis.

3.57 While the two services viz. satellite and terrestrial are not comparable in terms of spectrum utilization, the method of spectrum assignment are also distinct. At present, terrestrial spectrum is exclusively assigned through auctions where a quantity of spectrum (in MHz) is put to auction, and terrestrial operators are required to pay spectrum charges based on auction-determined prices, which are calculated on per-MHz basis. Accordingly, at present, spectrum charges for terrestrial access services are levied on a per MHz basis.

3.58 As per Notice Inviting Application 2022/2024, the successful bidders can make the payment with two available options. Firstly, full or part upfront payment of the bid amount and if part upfront payment has been made, which can be a multiple of complete years with a minimum of two years, the buyer have the option of availing moratorium for the corresponding number of years for which the upfront payment has been made, and the balance amount shall be payable in equal annual instalments over the remaining period. Secondly, the bidder can exercise payment option of twenty equal annual instalments of the bid amount.

3.59 If a shift in the spectrum charging methodology for terrestrial operators, say moving from per-MHz charge to an AGR-based charge, was even to be considered the same may not be feasible, as explained below:
Suppose an Adjusted Gross Revenue (AGR)-based spectrum charging regime were to be implemented for terrestrial operators, with spectrum charges applied as follows:

- Consider a spectrum charging methodology which requires operators to pay per-MHz charges on previously acquired spectrum and a percentage of AGR for newly acquired spectrum. Since AGR would then be generated from both the previously acquired and newly acquired spectrum, this approach could result in a double levy of spectrum charges on the old acquired spectrum, as operators would end up paying both a per-MHz charge and an AGR-based charge on the same spectrum.

- A more rational approach could involve operators paying per-MHz charges on previously acquired spectrum and AGR-based charges on new spectrum, considering only the specific AGR generated from the new spectrum. However, this segregation of total AGR into revenue from new and old spectrum is generally not feasible, and even if a method were devised to achieve this separation, it might create opportunities for arbitrage.

3.60 As the financial and market related parameters of the satellite communication sector become available in the future, the Authority is of the view that considering the development of satellite communication services in the country, the spectrum charging mechanism for these services may be reviewed in the near to medium term (say about 5 years).

3.61 Accordingly, **the Authority recommends that spectrum charges should be levied on a percentage of Adjusted Gross Revenue (AGR) basis 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.

(c) The spectrum charging mechanism for NGSO based FSS and GSO/ NGSO based MSS should be valid for a period of five years from the date of notification of the policy regime by the Central Government, further extendable by a period of upto two years.

3.62 It is further mentioned that the following questions were raised in the consultation paper pertaining to per-MHz charging with regard to NGSO-based FSS and GSO/NGSO-based MSS services:

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.

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.

3.63 The Authority in preceding paras has already recommended that the spectrum charges for NGSO-based FSS and GSO/NGSO based MSS services should be levied on a percentage of Adjusted Gross Revenue (AGR) basis**.** In view of the foregoing discussions, the Authority notes that the above questions 15 and 19 do not hold any further relevance, thus, no further analysis/discussion is required on the said questions.

D. Spectrum charging for GSO/NGSO-based Fixed Satellite Services

3.64 Regarding the spectrum charging for GSO and NGSO-based FSS providing data communication and Internet services, comments of the stakeholders were sought on the appropriate percentage of AGR, minimum spectrum charge etc.

3.65 Accordingly, the following questions were raised in the Consultation Paper:-

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?

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.

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.

Comments of stakeholders

3.66 In case of AGR-based charging for GSO/NGSO-based Fixed Satellite Services, a majority of the stakeholders supported less than 1% of AGR for spectrum charges for GSO/NGSO-based FSS providing data communication and Internet services. Some stakeholders even suggested that 0.1-0.2% of AGR should be taken to cover the cost of administration and regulation of spectrum.

3.67 A few stakeholders opined that the spectrum charges be based on a percentage of the AGR as previously recommended by TRAI. Another set of stakeholders strongly recommended that the charges should be only 1% of AGR to cover administrative charges.

3.68 A stakeholder has suggested that for NGSO-based FSS, an AGR percentage between 1% to 3% should be considered reasonable.

Analysis

i. Spectrum charges for GSO/NGSO-based Fixed Satellite Services

3.69 As mentioned in the preceding paras, the spectrum charges for commercial VSAT service are being levied as a percentage of Adjusted Gross Revenue (AGR), based on data rate range as per DoT's circular no. R-11014/9/2001-LR dated 16th April 2003.

3.70 Further, DoT vide its letter no. J- 19045/04/2022-SAT dated 24th July 2024 has mentioned that "…TRAI's recommendations regarding reduction in Spectrum Usage Charges from 4% to 1% of AGR and levy of 1% across all data-rates for Commercial VSAT CUG Service Licensees is not yet implemented and DoT continues to levy SUC between 3% to 4% of AGR depending on data rates for Commercial VSAT CUG Service Licensees".

3.71 It is to be noted that in its reference dated 11th July, 2024, DoT has requested recommendations on the terms and conditions of spectrum assignment, including spectrum pricing, while accounting for level playing field with terrestrial access services for the following satellite-based communication services: -

(i) NGSO based Fixed Satellite Services providing data communication and Internet services taking into account services provided by GSO-based satellite communication service providers.

(ii) GSO/ NGSO based Mobile Satellite Services providing voice, text, data, and internet services.

3.72 In this context, the Authority in para 4.20 of the Consultation paper dated 27th September 2024 has drawn attention to the fact that it is essential to examine whether such a level playing field between service providers of NGSO based Fixed Satellite Services providing data communication and Internet services and GSO/NGSO based Mobile Satellite Services providing voice, text, data, and

internet services. and terrestrial access service providers actually exists. Following this examination, if spectrum charges are to be levied as a percentage of AGR, the percentage previously recommended by the Authority (i.e. 1% of AGR) may need to be reassessed.

3.73 Before determining spectrum charges, it would be beneficial to gain insights into the different types of goods in economics. Specifically, it is important to assess how the spectrum used for fixed satellite services differs, as an economic good, from the spectrum used for terrestrial access services.

ii. Unique Characteristics of Spectrum for Fixed Satellite services

3.74 As noted by the Authority, in the Consultation Paper on 'Terms and Conditions for the Assignment of Spectrum for Certain Satellite-Based Commercial Communication Services' dated 27.09.2024, the four different types of goods defined in economics[25] are categorized based on excludability and rivalry, as given below: -

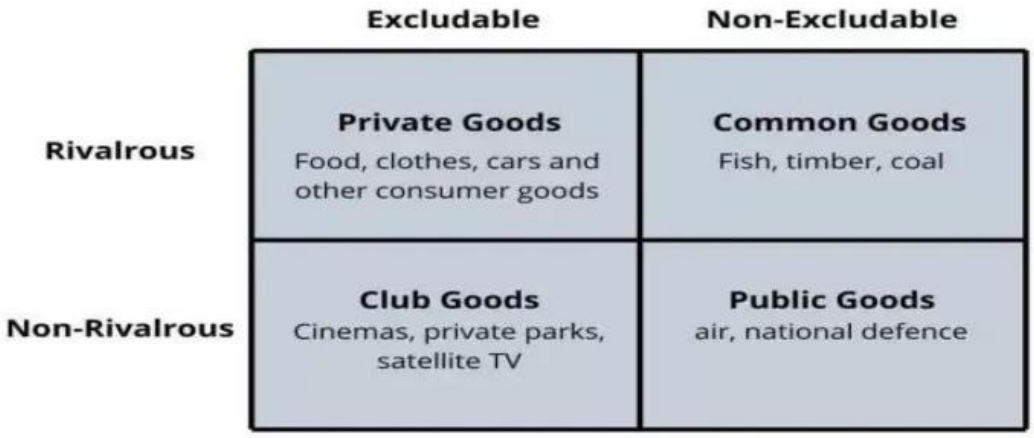

Figure : Type of goods in Economics

3.75 As per the "Economic Theory of Clubs" by James Buchanan (1965)[26] , the club goods are economic goods that are excludable and have limited rivalry, that is,

[25] The Continua of Excludability and Rivalry by Bryan Caplan
[26] Buchanan Clubs: Page 265-284 (2013), Springer

they are non-rivalrous up to the congestion limit. It follows that since terrestrial spectrum is assigned on an exclusive basis at a given price, and is thus rivalrous and excludable, has the characteristics of a private good[27]. While as, the fixed satellite-based communication systems, designed to operate on shared spectrum with low or no rivalry in consumption, acquire the characteristics of a "club good".

3.76 Fixed satellite services typically operate in the C, Ku, and Ka bands. To ensure the efficient utilization of satellite spectrum in these bands, which are designated for fixed satellite services, the spectrum is assigned on a shared basis. This approach allows the same frequency band to be allocated to multiple service providers within the same geographical area. Therefore, the shared use and "club good" characteristics of the spectrum for fixed satellite services should be taken into account when determining spectrum charges.

3.77 Private goods on the other hand are excludable and rivalrous, each unit consumed by an entity reduces the availability of that good for others. The price of private good gets determined by the competitive forces of demand and supply.

3.78 The price of private goods tends to be generally higher than club goods to reflect the scarcity and the exclusion of others from consuming it. The cost of completely excluding others in case of private goods is generally higher than the congestion costs in case of club goods.[28]

3.79 In the case of Fixed Satellite Services, since the spectrum is assigned on a shared basis with minimal impact on its usage by others, the same spectrum can be assigned to multiple users simultaneously. Thus, due to this sharing

[27] The Continua of Excludability and Rivalry by Bryan Caplan
[28] Buchanan Clubs: Page 265-284 (2013), Springer

aspect, the same spectrum band may generate revenue multiple times for the exchequer.

3.80 Thus, the assignment to multiple users on a shared basis may have an influence on the spectrum charges of spectrum for fixed satellite services. Accordingly, the unique characteristics of the spectrum for fixed satellite services need to be factored in while determining the spectrum charging mechanism.

iii. Fixed Satellite Communication Services vs. Terrestrial Communication Services

3.81 One of the distinctions between fixed satellite and terrestrial spectrum is that terrestrial spectrum is assigned on an exclusive basis, whereas spectrum for fixed satellite services is typically assigned on a shared basis, both internationally and in India. As outlined in para 3.76 of this Chapter, the spectrum for fixed satellite services exhibits the characteristics of a "club good," whereas terrestrial spectrum is regarded as a "private good." In light of this distinction, it is reasonable to expect that the cost of spectrum for fixed satellite services and terrestrial service should not be the same and in fact the spectrum cost for fixed satellite service should be lower than that of spectrum cost for terrestrial services.

3.82 It is important to recognize that the Indian satellite sector especially the NGSO based satellite communication sector is currently in its nascent stage whereas the financial and market parameters of GSO based satellite services differ significantly from those of the mobile access services.

3.83 Given the limited revenue potential and subscriber base of Geostationary Orbit (GSO)-based fixed satellite services, such as commercial VSAT, coupled with the nascent stage of Non-Geostationary Orbit (NGSO)-based fixed satellite

services, it is reasonable to set spectrum charges at a lower level compared to terrestrial spectrum charges.

3.84 The Authority is of the view that this approach will not only encourage growth of satellite services but will also support the effective proliferation of satellite broadband services. By establishing lower spectrum charges, the market can foster greater investment and increased participation in the satellite broadband sector.

3.85 Proliferation of satellite broadband is essential as Satellite internet is emerging as an effective solution for communication and broadband services in remote and rural areas where other traditional internet mediums like digital subscriber line(DSL)and cable, wireless access are hard to reach. Satellite internet can prove to be beneficial in many ways to governments, businesses, schools, and individuals[29].

3.86 As mentioned earlier, during natural disasters such as earthquakes, cyclones, or floods, when terrestrial networks may become unavailable, satellite communication becomes a reliable mode of communication. In border and strategic areas, where establishing traditional networks is challenging due to terrain or security constraints, satellite communication ensures connectivity, supporting national security operations, surveillance, and local civilian needs. It also facilitates communication for aircraft, ships, and vehicles operating in remote or international routes, ensuring safety, efficiency, and real-time monitoring, particularly in maritime and deep-sea environments

3.87 As detailed at para 2.35 of Chapter-II, the throughput of terrestrial wireless access service providers versus NGSO-based satellite broadband providers are significantly different and consequently a typical terrestrial wireless access

[29] https://www.ey.com/en_in/technology/how-satellite-internet-can-transform-digital-connectivity-in-india#:~:text=Satellite%20internet%20is%20emerging%20as,cable%20are%20hard%20to%20reach

service provider can serve significantly higher number of broadband subscribers as compared to NGSO-based FSS operators. Further, as stated at para 2.36, in order to meet the surge in demand for broadband, a terrestrial wireless access service provider can enhance network capacities at a higher pace as compared to NGSO-based FSS service provider, who can enhance capacity by steering of beams to only limited extent.

3.88 Terrestrial access service providers also offer additional benefits such as unlimited or limited calls, etc., which are currently not being provided by NGSO-based satellite broadband providers. Further, in case of satellite communication services, the subscriber presently pays a substantial price for the user terminal. The hardware cost for satellite communications services in some of the countries are given at Annexure 3.6.

3.89 Additionally, as per the comparative table given at Annexure 3.7, it can be seen that in most of the countries, the tariffs being charged by NGSO-based fixed satellite service providers are generally more than the tariffs charged by terrestrial broadband service providers vis-à-vis the speeds being offered with the plans.

3.90 Therefore, it can be expected that, in areas where both the options are available, a rational consumer may prefer terrestrial internet due to its affordability, superior speed, quality and additional benefits. Consequently, in the near to medium term, the market/subscriber base for satellite internet is likely to be patronized more needfully to rural and remote areas, where reliable terrestrial fixed internet services are not widely available. Even in the urban areas where terrestrial fixed internet services are available, international experience suggests that satellite internet services are likely to play a complementary role, at least in the near to medium term (say about 5 years).

3.91 The club good characteristics of spectrum for fixed satellite services, restricted capacity, higher terminal/hardware installation cost and a limited subscriber

base, the nascent stage of the NGSO based satellite sector, among other factors, distinguish fixed satellite services from terrestrial fixed internet services, at least during the near to medium term. It can be inferred that, at least in the near to medium term (say about 5 years), the two services should not be considered "perfect substitutes". Consequently, their spectrum charges may not be considered comparable.

3.92 The above factors further suggest that the annual spectrum charge, as a percentage of AGR, for satellite spectrum should be lower than that for terrestrial access spectrum. This is essential to promote the growth of these segments and facilitate the effective proliferation of satellite-based communication services.

3.93 In view of the discussion above, the Authority considers that the imposition of spectrum charges for GSO/NGSO-based FSS in the following manner, would be appropriate:

- A percentage of AGR applicable to both GSO-based FSS and NGSO-based FSS.
- An annual fee per subscriber, applicable only to NGSO-based FSS in urban areas, taking into account the competitive advantage of NGSO over GSO-based FSS, the higher economic value of the spectrum associated with NGSO-based FSS, and the need to incentivize NGSO-based FSS service providers to extend services to rural areas.

3.94 The rationale for determining the spectrum charges, as outlined above, is explained in the subsequent sections.

iv. Spectrum charges for GSO based FSS

3.95 DoT vide its order no. R-11014/9/2001-LR dated 16th April 2003 is levying upto 4% of AGR towards WPC charges (Royalty and License fee) for Commercial VSAT networks depending upon the range of data rates.

3.96 The Authority, in its past recommendations has recommended that spectrum usage charges in respect of commercial VSAT services should be kept at 1% of AGR. The Authority was of the view that in the interest of growth of such services, WPC spectrum charges on VSAT should be lowered.

3.97 However, it may be noted that DoT vide its letter no. J- 19045/04/2022-SAT dated 24th July 2024 has mentioned that:

"…*TRAI in its earlier recommendations on "Licensing Framework for Satellite based connectivity for Low Bit Rate Applications" dated 26-08-2021 had recommended for reduction in Spectrum Usage Charges (SUC) from 4% to 1% of AGR and levy of 1% across all data-rates for Commercial VSAT CUG Service Licensees. It is not yet implemented and DoT continues to levy SUC between 3% to 4% of AGR depending on data rates for Commercial VSAT CUG Service Licensees…"*

3.98 The DoT has further requested to take this also into consideration while providing Recommendations to its present reference on the subject.

3.99 Further, in its recommendations dated 18th September 2024 on "The Framework for Service Authorisations to be Granted Under the Telecommunications Act, 2023", the Authority has recommended for the merger of the GMPCS and the VSAT authorisation framework, whereby the scope of commercial VSAT (CUG) has been enhanced to include the provision of internet services also.

3.100 Considering the above-mentioned recommendation to broaden the scope of Commercial VSAT (CUG) services, it is reasonable to revisit and reassess the earlier recommendations regarding the applicable Spectrum Usage Charges (SUC) for such services. The expanded scope of VSAT services, by inclusion of internet service provision in the recent recommendations of the Authority dated 18th September 2024, may enhance the commercial potential of the VSAT sector. Besides, the DoT has informed TRAI that its recommendations on spectrum charging for commercial VSAT CUG have not yet been accepted. Hence, the Authority is of the view that it may be appropriate to increase the spectrum usage charge as percentage of AGR from the recommended value of 1% so as to reflect the enhanced scope and associated commercial opportunities.

3.101 Further analysis is required to determine the revised percentage, ensuring it is both equitable and conducive to the sustainable growth of the sector.

3.102 Presently, the commercial VSAT sector is a small sector in terms of market size, revenue etc. The subscriber base of this service is around 2.52 lakh for the quarter ended 30th June 2024. The trend in revenue of commercial VSAT service can be analyzed from the table below:

	2019-20	**2020-21**	**2021-22**	**2022-23**	**2023-24**
VSAT Revenue (Rs. in crore)	453.69	387.32	379.67	426.47	438.04
Y-o-Y Growth rate		-15%	-2%	12%	3%
Source: The above data is based on quarterly statements submitted by service providers to TRAI					

3.103 Presently, the Spectrum Usage Charges (SUC) of 4% of AGR are being levied on commercial VSAT operators (GSO-based Fixed Satellite Services). It is important to consider that imposing Spectrum Usage Charges (SUC) higher

than the current rate of 4% of Adjusted Gross Revenue (AGR), which is presently levied on VSAT operators (GSO-based Fixed Satellite Services) would increase their operational costs and could negatively impact their sustainability. This is especially concerning given the limited number of players in the market, their limited subscriber base, modest revenue potential, and fluctuating growth rate in their revenues. The average growth rate for the period, as outlined in the above Table was -0.5%. The Compound Annual Growth Rate (CAGR) from 2019-20 to 2023-24 stands at -0.9%.

3.104 Furthermore, the market in VSAT service is having limited competition, with approximately 90% of the revenue concentrated among two major players.

3.105 Therefore, considering the limited subscriber base, limited competition, modest revenue potential, and fluctuating growth rate in the revenues of VSAT sector, the Authority is of the view that spectrum charges should not exceed maximum of 4% of the Adjusted Gross Revenue (AGR) consistent with the spectrum charges currently being paid by commercial VSAT operators

3.106 Accordingly, **the Authority recommends that spectrum charges for GSO-based Fixed Satellite Services should be levied at 4% of Adjusted Gross Revenue (AGR).**

v. Spectrum charges for NGSO-based Fixed Satellite Services

3.107 DoT vide its reference dated 11.07.2024 has *inter alia r*equested TRAI to provide recommendations on spectrum pricing for NGSO based Fixed Satellite Services providing data communication and Internet services. The DoT reference further stated that TRAI may take into account services provided by GSO-based satellite communication service providers.

3.108 The Authority in para 3.106 above has recommended that spectrum charges for GSO based Fixed Satellite Services should be levied at 4% of Adjusted Gross Revenue. The Authority is of the view that a similar percentage of AGR i.e. 4% of AGR should be levied as spectrum charges for NGSO based FSS also, due to the following reasons:

- Both GSO and NGSO based FSS service providers are utilizing spectrum in similar bands.
- There is a need to encourage the uptake of satellite communication services in underserved areas, especially rural and remote areas. A higher AGR percentage as spectrum charge may discourage proliferation and adoption of satellite communications (NGSO based FSS).
- This will also deter any situation of arbitrage between GSO FSS and NGSO FSS if it may arise in the future.

3.109 NGSO satellite operators hold a competitive advantage over GSO satellite providers for the following reasons:

- Coverage: NGSO constellations can offer more comprehensive global coverage, including in polar and remote areas where GSO satellites may have limited or no coverage due to their equatorial orbits.
- Latency: particularly those in LEO, have a latency closer to terrestrial networks due to their closer proximity to Earth, which is advantageous for real-time applications like video conferencing, VPN or cloud services. NGSO systems are known for a number of key features such as lower propagation delay, smaller size, and lower signal losses in comparison to the conventional geostationary (GSO) satellites, which will enable latency-critical applications such as gaming to be provided through satellites[30].

[30] https://www.researchgate.net/publication/353208942_A_Survey_on_Non-Geostationary_Satellite_Systems_The_Communication_Perspective

- NGSO promises a dramatic boost in communication speed and energy efficiency, and thus, tackling the main inhibiting factors of commercializing GSO satellites for broader utilizations.[31]
- Resilience and flexibility: with multiple satellites in a constellation, NGSO systems can offer improved redundancy and resilience against system failures. NGSO satellites can also be more easily repositioned, making it possible to adapt to changing service demands or to respond to emergency situations more quickly.[32]

3.110 NGSO-based Fixed Satellite Service is yet to commence operations in India. To gain comparative insights, the subscriber base, quantum of spectrum of the largest NGSO satellite operator in the developed NGSO FSS market of the USA can be compared with one of the major VSAT operator in India based on subscriber base. The comparison is given in the table below:

Particulars	**Major VSAT operator (in India)**	**NGSO operator (in USA)**
Geographical area of the country ('000 Sq Km)	3287	9373[33]
Subscriber base (in Lakhs)	1.80[34]	14[35]
Quantum of spectrum (in MHz)	2452	6000[36] (approx.)

3.111 The data presented in the above Table indicates that in terms of subscriber base, an NGSO operator is larger than the largest VSAT operator in India. This difference in scale may provide NGSO operators with a distinct competitive

[31] A Survey on Non-Geostationary Satellite Systems: The Communication Perspective July 2021

[32] https://digitalregulation.org/regulation-of-ngso-satellite-constellations/

[33] https://www.worldometers.info/geography/largest-countries-in-the-world/

[34] As per data reported to TRAI

[35] https://circleid.com/posts/starlink-surpasses-4-million-subscribers-cementing-dominance-in-satellite-internet#:~:text=While%20Starlink%20continues%20to%20grow,1.3%20million%20in%20December%202022.

[36] As per details given at Annexure 2.2

advantage, driven by economies of scale. Larger operations may allow NGSO operators to optimize costs, improve operational efficiency, and potentially offer more competitive pricing, further strengthening their position in the market.

3.112 Considering the characteristics of NGSO services, as discussed in preceding paras viz. better coverage, lower latency, better speed and increased flexibility, NGSO operators are likely to capture a larger market share and generate higher revenue compared to GSO operators. Consequently, the economic value of spectrum for NGSO operators is expected to be higher than that for GSO operators.

3.113 Given the higher economic value that spectrum holds for NGSO operators, it is essential to ensure a balanced and equitable framework that safeguards the interests of existing Geostationary Satellite Orbit (GSO) operators. To achieve this, the Authority is of the opinion that an additional charge should be introduced for NGSO operators in the form of a per-subscriber charge, ensuring a fair contribution from NGSO operators, atleast in the near to medium term (say about 5 years).

3.114 Also, it can be anticipated that, during an initial finite period following their market entry, large NGSO operators may adopt a market penetration strategy. This strategy typically involves increasing product sales within a market segment, often by reducing prices to attract new customers[37]. Given the lower prices due to promotional offers, it is reasonable to expect reduced revenue. In such a scenario, implementing a per-subscriber charge would also ensure a fair return or revenue for the exchequer, considering the significant economic value of spectrum for NGSO operators.

[37] https://corporatefinanceinstitute.com/resources/management/ansoff-matrix/

3.115 Further, as per DoT's order dated 11th December 2023, in addition to the annual royalty, a license fee is also imposed on wireless stations operating under Satellite Services (FSS, BSS, MSS), including standby sets, as specified in Part II of the aforementioned order, as follows:

S.No.	Type of Wireless station License	Annual License Fee (in Rs.)
1	Fixed Earth station DTH/ Teleport/ DSNG/NLD/ILD/DCP/IP-II	1000 per station
2	Captive VSAT/Inmarsat Earth Station	500 per station
3	Vehicle Mobile/ Handheld Mobile Station	250 per station

3.116 As discussed earlier, given the higher economic value that spectrum holds for NSGO operators and considering the competitive advantage NGSO hold over GSO based FSS, the Authority is of the view that an additional charge should be introduced for NGSO operators in the form of a per-subscriber charge, ensuring a fair contribution from NGSO operators. The Authority is of the view that a User Fee of Rs 500 as applicable on very small aperture terminals as per DoT order dated 11th December 2023 shall be levied per subscriber of NGSO based FSS for near to medium term (say about 5 years).

3.117 It may be noted that one of the principal objectives behind the expansion of satellite services is to extend reliable connectivity to rural, remote, unserved and underserved areas. Based on the projections of population from the 'Report of the Technical Group on Population Projections for India and States 2011 – 2036'[38], the rural population comprises of 903.67 million out of a total population of 1405.84 million, as on 30th of September 2024. This implies that the rural population still comprises almost 65% of the total population of India.

[38] https://main.mohfw.gov.in/sites/default/files/Population%20Projection%20Report%202011-2036%20-%20upload_compressed_0.pdf

3.118 By reaching rural, remote, unserved and underserved areas, satellite services can play a crucial role in bridging the digital divide, enhancing economic participation, and improving access to critical information and services. Achieving this goal requires a focused strategy to attract entry and investment by NGSO based fixed satellite service providers into these regions, where connectivity gaps remain substantial.

3.119 Given the relatively higher purchasing power of subscribers in urban areas compared to rural areas and hence the high demand/consumption of data in these regions, it is possible that NGSO-based FSS providers may focus more on urban areas. This could potentially undermine the goal of bridging the digital divide in rural and remote areas. To address this, imposing a per subscriber charge of Rs 500 per annum in urban areas, while exempting rural and remote areas, may provide an incentive for operators to expand their services into rural and remote areas and if required this per subscriber charge may be reviewed in future.

3.120 Therefore, the Authority is of the view that NGSO based FSS operators shall be levied a spectrum charge at 4% of AGR and an additional per subscriber charge of Rs 500 per annum in urban areas. However, the users' in rural and remote areas shall be exempted from the per subscriber charge. Further, the classification of areas into rural, urban and remote is available with Census of India and relevant orders of Ministry of Finance. Accordingly, the Authority is of the view that DOT may suitably adopt an unambiguous definition and criteria for defining rural, urban and remote areas.

3.121 Accordingly, **the Authority recommends the following:**

i. **Spectrum charges for NGSO based Fixed Satellite Services should be levied at 4% of the Adjusted Gross Revenue (AGR).**

ii. **NGSO-based Fixed Satellite service providers should also pay an additional per subscriber charge of Rs. 500 per annum in**

urban areas while exempting the rural and remote areas from this additional charge.

3.122 Further, Non-Geostationary Satellite Orbit (NGSO) communication systems require one-time hardware cost of the User Terminals at the subscribers' end. The table at Annexure 3.6 shows the hardware cost levied by one of the largest NGSO operators across various countries. From the Annexure 3.6, it can be seen that the hardware cost for the countries ranges between US$200 and US$450. Given the relatively low purchasing power of consumers in rural and remote areas, this high cost may act as a significant barrier to adoption, potentially impeding the uptake of NGSO-based Fixed Satellite Services (FSS) in such regions. Consequently, this could pose a challenge to the effective expansion of satellite communication services in underserved and unserved areas, in the near term until terminal costs come down significantly.

3.123 To mitigate this issue, a strategy could be to reduce the financial burden on unserved and underserved subscribers in the rural and remote areas. Subsidizing the cost of NGSO-based FSS user terminals for targeted subscribers in such regions would lower entry barriers and promote the adoption of satellite-based services. Accordingly, the Authority is of the view that the Government may consider provision of suitable subsidy on each NGSO-based FSS user terminal in the unserved and underserved regions of the rural and remote areas for target segments, which may be disbursed either as a lump sum payment or in installments by devising a suitable model.

3.124 The Government may consider the options of providing subsidy through Direct Benefit Transfer (DBT) to eligible subscribers in underserved, or unserved regions of rural and remote areas for target segments OR the subsidy may be provided directly to NGSO-based FSS service providers via the Digital Bharat Nidhi Fund.

3.125 Furthermore, the Authority recommends that the Government may periodically review the subsidy amount to align with technological advancements and market developments.

3.126 Accordingly, **for the targeted subscribers in unserved/underserved regions of the rural and remote areas, the Authority recommends the following:**

(a) The Government may consider provision of a subsidy for each NGSO-based FSS user terminal in such regions at an appropriate amount. The amount of subsidy may be decided by the Government.

(b) The subsidy may be disbursed either as a lump sum payment or in installments by devising a suitable model.

(c) The subsidy may be given either through Direct Benefit Transfer (DBT) to eligible subscribers in underserved/unserved regions of rural and remote areas, for target segments OR as a direct payment to NGSO-based FSS service provider through the Digital Bharat Nidhi Fund.

(d) The amount of the subsidy may be subject to a periodic review by the Government in accordance with technological and market developments taking place.

E. Spectrum charging for GSO/NGSO-based Mobile Satellite Services

3.127 Regarding the spectrum charging for GSO and NGSO-based MSS providing voice, text, data, and Internet services, comments of the stakeholders were sought on the appropriate percentage of AGR, minimum spectrum charge etc.

3.128 Accordingly, the following question was raised in the Consultation Paper: -

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.

Comments of stakeholders

3.129 A stakeholder has stated that in case of AGR based charging the spectrum charges for MSS used for public utility purposes should, if subject to spectrum fees, be based on a nominal percentage of AGR (not more than 0.5% of AGR) for providing emergency services through satellite.

3.130 Another stakeholder has stated that in case a revenue share-based regime is adopted for SatCom spectrum charging, then nominal rates ranging between 0.1-0.2% may be levied.

3.131 Another set of stakeholders suggested that it should be 1% of AGR. Additionally in reference to L-band & S-band, as the spectrum is expected to be assigned on an exclusive basis, the pricing may be kept at a higher percentage of AGR.

3.132 A stakeholder suggested that the percentage of AGR should be kept at 0.1% of AGR for commercial Satcom services.

3.133 One stakeholder has suggested less than 1% of AGR.

3.134 Another stakeholder is of the opinion that it should be kept at a rate of 1% to 3%, striking a balance between revenue generation and promoting investment in MSS. A minimum spectrum charges equal to around 30% of the average market value per MHz should be considered.

3.135 Another stakeholder proposed 1% of AGR for NGSO systems in Ku, KA and higher bands. Additionally mentioned nominal /nil Spectrum charges (to offset administrative costs incurred by the regulator) for MSS systems used for specified applications such as traditional satellite market i.e. Government agencies, including Defence, disaster recovery, cellular backhaul in rural and remote areas, industrial and commercial users in in rural and remote areas, etc.

Analysis

i. Spectrum charges for GSO/NGSO based Mobile Satellite Services

3.136 DoT vide its letter dated 11th July, 2024 has sought TRAI's recommendations on "*terms and conditions of spectrum assignment including spectrum pricing for while accounting for level playing field with terrestrial access services for the following satellite-based communication services:*

i. NGSO based Fixed Satellite Services providing data communication and Internet services. In its recommendations, TRAI may take into account services provided by GSO-based satellite communication service providers.

ii. GSO/NGSO based Mobile Satellite Services providing voice, text, data, and internet services."

3.137 From the above, it can be inferred that the scope of Mobile Satellite Services (MSS) is broader in terms of services than Fixed Satellite Services (FSS). While FSS can provide data communication and Internet services, MSS encompasses a wider range of services, including voice-related services apart from the services being provided by FSS. Further, in the case of FSS, the same spectrum can be assigned on a shared basis to multiple operators. In this context, as

mentioned at para 2.40 of Chapter-II, GSO/NGSO-based mobile satellite systems make use of specific frequency bands (mainly L and S bands) allocated for MSS by ITU-RR. These mobile satellite systems are coordinated at ITU level. Further, as cited at para 2.40, out of the total quantum of spectrum in L and S bands, only a small portion of the spectrum [typically of the order of 10 MHz (paired)] is available for use by an MSS operator.

3.138 In view of the above, it becomes essential to analyze whether the spectrum charges for MSS should be set at a level higher than those for FSS. The broader scope of MSS, coupled with its non-shared spectrum assignment may indicate higher spectrum charges. However, determining the optimal spectrum charges for MSS requires a comprehensive evaluation of several factors. These include significantly lesser bandwidth available to MSS operator, its current use cases, the revenue-generating potential of MSS services, and the size and characteristics of its subscriber base.

3.139 As given at para 2.41 of Chapter-II, MSS is presently being used for strategic use, establishing communication during natural disasters, in-flight and maritime connectivity, IoT connectivity in remote areas, communication between pilot and ground staff of airlines, distress communication (SoS) etc. Generally, such systems have very low traffic carrying capacity and, generally, are not used by the public.

3.140 In India, the Mobile Satellite Service (MSS) currently represents a relatively small, niche market compared to the Fixed Satellite Service (FSS) in terms of prospective service providers, potential subscriber base, potential revenue and adoption levels. At present, the tariff being charged in India for GSO based MSS service are quite high, as can be seen from the Annexure 3.8.

3.141 The subscriber base for this service is generally pertaining to enterprise and niche customers with few retail subscribers. For the year 2023-24, the annual

revenue from GSPS service is about ₹87 crore, which is considerably lower compared to the revenue generated by the VSAT sector.

3.142 Therefore, considering the limited bandwidth available to MSS operator, the limited revenue, subscriber base and limited use cases of Mobile Satellite Service, the Authority is of the view that spectrum charges for MSS should not be more than the spectrum charge to be levied on GSO based FSS, i.e. 4% of AGR. In the near to medium term (say about 5 years) as per the development of use cases, adoption levels and number of subscribers in this sector, the spectrum charges for Mobile Satellite Services may be reviewed.

3.143 Accordingly, **the Authority recommends that the spectrum charges for GSO/ NGSO-based Mobile Satellite Services should be levied at 4% of Adjusted Gross Revenue (AGR).**

F. Minimum spectrum charge

3.144 Satellite services play an integral role in bridging the digital divide by providing connectivity in remote and underserved regions, supporting disaster management, and enhancing national security infrastructure. These critical functions underscore the importance of ensuring that the service providers in the satellite communication sector commence services timely and utilize the spectrum optimally in an efficient manner. Better spectrum management policies in this regard will help in better coordination and management of interference issues, if any.

3.145 As the spectrum is being charged on a percentage of AGR basis, the Authority is of the view that a minimum amount of spectrum charge may be levied on satellite service providers. This minimum spectrum charge would ensure the operators avail optimal spectrum bandwidth for providing their services. It would also ensure that certain niche service providers, who may have a

tendency to avail additional spectrum would be restricted. It would also nudge the service providers who avail spectrum use rights to expedite rolling out their services. This will also help in minimizing the coordination requirements as operators will obtain only the required spectrum for providing services.

3.146 The Authority is of the view that high minimum spectrum charges could adversely impact smaller satellite operators and those utilizing spectrum for essential services such as defence, emergency communication, public utilities, and connectivity in remote areas. Excessive charges may deter spectrum adoption by these operators, potentially hindering market entry, investment in critical sectors, and the expansion of services in underserved regions. Given the nature of satellite communication services, there is often a time lag between the assignment of spectrum and the commencement of operations. High minimum spectrum charges during this period could act as an entry barrier, disincentivizing the entry of new players into the market.

3.147 Currently, commercial VSAT service/ GSPS service are not subject to any minimum spectrum charges. The Authority recognizes that introducing high minimum charges could increase operational costs for existing operators, thereby affecting their viability. A key objective of promoting satellite communication services is to bridge the digital divide, and imposing high minimum charges would contradict this goal by limiting accessibility and affordability.

3.148 In light of the above, the Authority is of the view that the minimum spectrum charges should not be set too high at this stage, which may act as a barrier to entry for the new players in satellite segment. The minimum spectrum charges should be such that it safeguards the interests of smaller operators, VSAT operators, and satellite operators providing public utilities and connectivity in rural and remote areas.

3.149 As may be seen from Annexure 3.5, the annual fixed fees charged by regulators internationally for the provision of spectrum for satellite-based communication services are low. Accordingly, the Authority is of the view that the minimum spectrum charge should also be kept at a reasonably low level.

3.150 The Authority is of the opinion that fixing the minimum spectrum charge at 5% of the existing annual royalty charge of ₹70,000 per MHz for satellite-based services, as specified in the DoT order dated 11.12.2023[39], would be appropriate. This corresponds to a minimum spectrum charge of ₹3,500 per MHz.

3.151 In view of the above, **the Authority recommends that the Annual Minimum Spectrum Charges for GSO/NGSO-based Fixed Satellite Services and GSO/NGSO-based Mobile Satellite Services should be Rs. 3,500 per MHz.**

3.152 Further, **the Authority recommends that the annual spectrum charges should be calculated as following:**

i. **GSO-based Fixed Satellite Services and GSO/NGSO-based Mobile Satellite Services:**
   Max (4% of AGR, Annual minimum spectrum charge)

ii. **NGSO-based Fixed Satellite Services:**
   Max {(4% of AGR + 500 X N_u), Annual minimum spectrum charge}
   where N_u refers to Number of subscribers in urban areas.

[39] Refer Table-Bandwidth factor(Bs) at para 3.29 above. Relevant bandwidth factor for 500KHz equals 1. Hence, for 1MHz, bandwidth factor is 2. Accordingly, annual royalty per MHz equals 35000*2 =Rs 70,000.

G. Payment terms

3.153 Presently, as per the DoT's circular no. R-11014/9/2001-LR dated 16th April 2003, the spectrum charges on AGR basis are being paid by commercial VSAT operators on advance quarterly basis and are payable within 15 days of the commencement of the respective quarter. The annual spectrum charges for GSO/NGSO based FSS as well as GSO/NGSO based MSS as specified in paras 3.106, 3.121 and 3.143 above shall be paid in a similar manner.

3.154 However, the minimum charges as recommended in para 3.151 above shall be paid upfront at the time of assignment of spectrum and at the beginning of every year. The quarterly/annual adjustment of payment due shall be made with the minimum spectrum charge for the particular year only.

3.155 As recommended above, the NGSO operators should also pay an additional per subscriber charge of Rs 500 per annum in urban areas while the rural and remote areas should be exempted from this additional charge.

3.156 Since the spectrum charge is being paid on quarterly basis, the Authority is of the view that the additional per user charge shall also be paid by NGSO-based FSS service providers, on a quarterly basis, as follows:

Quarterly per user charge = (500 / 4) X N_u =125 X N_u

where N_u refers to total number of subscribers in urban areas at the end of the previous quarter.

3.157 Accordingly, **the Authority recommends the following payment terms:**

i. The annual spectrum charges for GSO/ NGSO-based Fixed Satellite Services, GSO/ NGSO-based Mobile Satellite Services, as specified in paras 3.106, 3.121 and 3.143 above, should be paid on advance quarterly basis and payable within 15 days of the commencement of the respective quarter.

ii. **The minimum charges should be paid in advance at the time of the assignment of spectrum and at the beginning of every year. The quarterly/annual adjustment of payment due shall be made with the minimum spectrum charge for the particular year only.**

iii. **The per subscriber charges should be paid by NGSO-based FSS service providers on a quarterly basis equal to 125 X N_u, where N_u refers to total number of subscribers in urban areas at the end of the previous quarter.**

3.158 The following chapter provides a summary of recommendations.

Chapter IV: Summary of Recommendations

4.1 The Authority recommends that subject to alignment with the allocations in NFAP 2022, -

(a) For assigning frequency spectrum for user links and feeder links for NGSO-based FSS for data communication and Internet service, frequency spectrum in Ku band, Ka band, and Q/V band should be considered.

(b) For assigning frequency spectrum for GSO/ NGSO-based MSS for providing voice, text, data communication and Internet service, the following frequency bands should be considered:

i. L band and S band for user links; and

ii. C band, Ku band, Ka band and Q/V band for feeder links.

[Para 2.70]

4.2 The Authority recommends that –

(a) Frequency spectrum should be assigned for NGSO-based FSS and GSO/ NGSO-based MSS for a period of up to five years. However, considering the market conditions, the Government may extend it for a further period of up to two years.

(b) Terms and conditions of spectrum assignment including spectrum pricing for NGSO-based FSS and GSO/ NGSO-based MSS, recommended through these recommendations, should remain valid for a period of five years from the date of notification of the policy regime by the Central Government, further extendable by a period of upto two years.

(c) Any revision in the terms and conditions of spectrum assignment including spectrum pricing for NGSO-based FSS and GSO/ NGSO-based MSS, notified by the Central Government after a period of five years from the date of notification of the policy regime recommended through these recommendations,

should become applicable to all authorised entities including the existing entities.

[Para 2.82]

4.3 The Authority recommends that-

(a) To control interference, the relevant provisions of ITU-RR should be made applicable to the authorised entities, and other entities which have been authorised by the Central Government. Further, the ITU framework for coordination among NGSO-based satellite systems, as may be laid down by ITU in the future, should also be made applicable.

(b) The frequency spectrum identified by the Government for satellite-based telecommunication services in the higher frequency bands such as C, Ku, Ka, and Q/V bands that are assigned on a shared basis, should be assigned with a condition that each Authorised Entity and all other entities which have been authorized by the Central Government to use such shared frequency spectrum, will coordinate among themselves in good faith.

(c) A provision should be included in the terms and conditions of the assignment of frequency spectrum that in case the need arises, the Government may prescribe a framework for sharing of spectrum in higher frequency bands such as C, Ku, Ka, and Q/V bands, which will be binding on the authorised entities and all other entities which have been authorized by the Central Government to use such shared frequency spectrum.

(d) The Government, with the help of the Telecom Engineering Center (TEC), should examine the need for prescribing the framework for the sharing of spectrum. The framework may include conditions on the maximum equivalent power flux density (EPFD) etc. With a view to nudging the satellite operators to coordinate among themselves in good faith at the

earliest, the Government may also consider introducing a provision for splitting of spectrum as a last resort in line with the provision created by FCC in its 'Spectrum Sharing Rules for Non-Geostationary Orbit, Fixed-Satellite Service Systems' in case two or more NGSO-based FSS satellite systems fail to complete coordination.

[Para 2.110]

4.4 The Authority recommends that for the establishment and operation of satellite earth station gateways-

(a) The authorised entities should be mandated to coordinate among themselves in good faith.

(b) A provision should be included in the terms and conditions for the assignment of frequency spectrum that in case the need arises, the Government may prescribe a coordination distance between two earth station gateways (GSO-NGSO and NGSO-NGSO) operating in the same frequencies, which will be binding on the authorised entities and all other entities which have been authorized by the Central Government to use such shared frequency spectrum.

(c) The DoT, with the help of TEC, should carry out a study to assess the requirement for prescribing coordination distance between two satellite earth station gateways (GSO-NGSO and NGSO-NSGO) operating on the same frequencies. If required, necessary guidelines may be issued.

[Para 2.118]

4.5 The Authority recommends that-

(a) The provisions of Article 21 of ITU-RR for terrestrial and space services sharing frequency bands above 1 GHz should be made applicable.

(b) For the coexistence of satellite systems and IMT, ITU-RR provisions and ITU recommendations, including WRC-19 Resolution 243, should be made applicable.

(c) In the frequency range(s) already identified for IMT such as 42.5-43.5 GHz, the satellite earth station gateways should be permitted to be established at uninhabited or remote locations on case-to-case basis, where there is a less likelihood of IMT services to come up. For this purpose -

(i) DoT should prescribe the exclusion zone requirement for co-existence of IMT and satellite earth station gateways.

(ii) DoT should create a software defined automated process on a portal having the database of coordinates of the IMT base stations in these frequency ranges. The geofencing coordinates of the proposed earth station in such frequency ranges can provide the feasibility results through the portal for establishing the earth station.

[Para 2.133]

4.6 The Authority recommends that with a view to mitigate the risk of scarcity of gateway sites, Satellite Earth Station Gateway(s) should be installed and commissioned within 12 months from the date of permission granted to the authorised entities by the Central Government for the establishment of the Satellite Earth Station Gateway(s).

[Para 2.144]

4.7 The Authority recommends that entities authorised to provide satellite-based telecommunication services should be permitted to surrender the right to use of frequency spectrum assigned to them before the expiry of the validity period. For this purpose, the following should be the broad terms and conditions:

(a) The Authorised Entity should provide a notice period to the Central Government and TRAI of at least 30 days prior to the proposed date of surrender of right to use the frequency spectrum along with the relevant details, including the precise frequency range(s) proposed to be surrendered. However, in case the surrender of right to use of spectrum by an Authorised Entity is likely to result in a disruption or closure of services for the consumers, the service provider should be required to serve an advance notice to the Central Government and TRAI as well as each of its subscribers, 60 days prior to the proposed date of surrender of the right to use of frequency spectrum.

(b) DoT may charge a reasonable processing fee to recover administrative charges, if any, for the surrender of the right to use of frequency spectrum..

[Para 2.160]

4.8 The Authority recommends that there should be a defined timeline, not exceeding 30 days from the date of application, within which the frequency spectrum should be assigned to an Authorised Entity for provision of satellite-based communication services, provided that the in-principle clearance of satellite network has been given by the Central Government. In case of any objection, the same may be communicated to the concerned Authorised Entity within such window of 30 days from the date of application, for necessary action.

[Para 2.164]

4.9 The Authority recommends that the Central Government should explore the possibility of assigning frequency spectrum for satellite-based telecommunication services on a block basis rather than on a carrier-by-carrier basis.

[Para 2.168]

4.10 The Authority recommends that spectrum charges should be levied on a percentage of Adjusted Gross Revenue (AGR) basis 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.

(c) The spectrum charging mechanism for NGSO based FSS and GSO/ NGSO based MSS should be valid for a period of five years from the date of notification of the policy regime by the Central Government, further extendable by a period of upto two years.

[Para 3.61]

4.11 The Authority recommends that spectrum charges for GSO-based Fixed Satellite Services should be levied at 4% of Adjusted Gross Revenue (AGR).

[Para 3.106]

4.12 The Authority recommends the following:

i. Spectrum charges for NGSO based Fixed Satellite Services should be levied at 4% of the Adjusted Gross Revenue (AGR).

ii. NGSO-based Fixed Satellite service providers should also pay an additional per subscriber charge of Rs. 500 per annum in urban areas while exempting the rural and remote areas from this additional charge.

[Para 3.121]

4.13 For the targeted subscribers in unserved/underserved regions of the rural and remote areas, the Authority recommends the following:

(a) The Government may consider provision of a subsidy for each NGSO-based FSS user terminal in such regions at an appropriate amount. The amount of subsidy may be decided by the Government.

(b) The subsidy may be disbursed either as a lump sum payment or in installments by devising a suitable model.

(c) The subsidy may be given either through Direct Benefit Transfer (DBT) to eligible subscribers in underserved/unserved regions of rural and remote areas, for target segments OR as a direct payment to NGSO-based FSS service provider through the Digital Bharat Nidhi Fund.

(d) The amount of the subsidy may be subject to a periodic review by the Government in accordance with technological and market developments taking place.

[Para 3.126]

4.14 The Authority recommends that the spectrum charges for GSO/ NGSO-based Mobile Satellite Services should be levied at 4% of Adjusted Gross Revenue (AGR).

[Para 3.143]

4.15 The Authority recommends that the Annual Minimum Spectrum Charges for GSO/NGSO-based Fixed Satellite Services and GSO/NGSO-based Mobile Satellite Services should be Rs. 3,500 per MHz.

[Para 3.151]

4.16 The Authority recommends that the annual spectrum charges should be calculated as following:

i. GSO-based Fixed Satellite Services and GSO/NGSO-based Mobile Satellite Services:

Max (4% of AGR, Annual minimum spectrum charge)

ii. NGSO-based Fixed Satellite Services:

Max {(4% of AGR + 500 X N_u), Annual minimum spectrum charge}

where N_u refers to Number of subscribers in urban areas.

[Para 3.152]

4.17 The Authority recommends the following payment terms:

i. The annual spectrum charges for GSO/ NGSO-based Fixed Satellite Services, GSO/ NGSO-based Mobile Satellite Services, as specified in paras 3.106, 3.121 and 3.143 above, should be paid on advance quarterly basis and payable within 15 days of the commencement of the respective quarter.

ii. The minimum charges should be paid in advance at the time of the assignment of spectrum and at the beginning of every year. The quarterly/annual adjustment of payment due shall be made with the minimum spectrum charge for the particular year only.

iii. The per subscriber charges should be paid by NGSO-based FSS service providers on a quarterly basis equal to 125 X N_u, where N_u refers to total number of subscribers in urban areas at the end of the previous quarter.

[Para 3.157]

Annexures

Annexure 1.1: DoT's reference letter dated 13.09.2021

(without annexures)

Government of India
Ministry of Communications
Department of Telecommunications
Wireless Planning & Coordination (WPC) Wing
6th floor, Sanchar Bhawan,
20, Ashoka Road, New Delhi – 110001.

No.: L-14006/01/2021-NTG Date: 13.09.2021

To,

The Secretary
Telecom Regulatory Authority of India
Mahanagar Doorsanchar Bhawan
Jawahar Lal Nehru Marg (Old Minto Road)
New Delhi-110002.

Subject: Seeking TRAI recommendations for the auction of spectrum in the frequency bands identified for International Mobile Telecommunications (IMT)/ 5G.

Sir,

In response to DoT's reference dated 17.04.2017, TRAI provided its recommendations dated 01.08.2018 on various issues involved in the auction of spectrum in 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz, 2500 MHz and 3300-3600 MHz bands. Based on the TRAI recommendations dated 01.08.2018 and response dated 08.07.2019 on DoT's back-reference, Government conducted auction of spectrum in 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz and 2500 MHz bands in March 2021. A total of 2308.80 MHz spectrum worth Rs. 400396.20 Crore at Reserve Price in different band-LSA combinations was put to auction, out of which 855.60 MHz quantum was sold in the auction resulting in total winning bids worth Rs. 77820.81 Crore. No bids were received in 700 MHz and 2500 MHz bands. Spectrum unsold in the auction held in March 2021 may be put to auction in the forthcoming auction. LSA-wise quantum available with the Government in these bands after the auction is given in ***Annexure-I***.

2. In the recommendations dated 01.08.2018, spectrum in 3300-3600 MHz band was also included. However, due to certain issues, the Government decided to initiate action to auction spectrum in this band separately after resolution of these issues and, therefore, it was not a part of the auction held in March 2021. Now, as the issues have been resolved as well as the range of available frequencies in this range has slightly gone up, it has been decided by the Government that spectrum in the frequency range 3300-3670 MHz should be made available to the Telecom Service Providers for IMT/ 5G through auction, except in few areas/locations (details of excluded areas/locations in ***Annexure-II***).

3. In addition to the above, new frequency bands (mentioned below) have also been decided to be used for IMT/5G:

(i) 526-582 MHz in all the LSAs in coordination with Ministry of Information & Broadcasting. The use will be coordinated with minimum keep out distance from MIB transmitters.

(ii) 582-617 MHz in all the LSAs. This band will be available for IMT/5G and rural point to point links.

(iii) 617-698 MHz in all the LSAs; except few areas/locations (details of excluded areas/locations in ***Annexure-II***).

(iv) 24.25 to 28.5 GHz in all the LSAs except at 5 locations (details of locations in ***Annexure-II***) with protection distance of 2.7 km.

4. DoT has also received few requests regarding spectrum requirements for captive usage of 5G applications by some industries e.g. Industry 4.0. COAI has also submitted a letter regarding Private Captive Networks, wherein they have *inter alia* requested not to reserve any spectrum which has been identified for IMT, for Private Captive Networks.

5. Parliamentary Standing Committee on Information Technology in its report on "India's preparedness for 5G" has made certain observations on pricing of spectrum. Also, DoT has received request from COAI regarding effective spectrum pricing. Copy of the relevant pages of the Standing Committee report is enclosed as ***Annexure-III***.

6. Department of Space (DoS) had invited comments on Draft Spacecom Policy liberalizing space segment for private sector participation to provide commercial communication services in India. This includes the Low Earth Orbit (LEO) and Medium Earth Orbit (MEO) satellite constellations operational over India. In case of satellite communication, the subscriber is accessed from the satellite through "Access spectrum"

similar to "Access spectrum" in terrestrial network and the demand for such spectrum will potentially increase in the future.

7. In view of the above, under the terms of clause 11 (1)(a) of TRAI Act, 1997 as amended by TRAI Amendment Act 2000, TRAI is requested to:

(a) provide recommendations on applicable reserve price, band plan, block size, quantum of spectrum to be auctioned and associated conditions for auction of spectrum in 526-698 MHz, 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz, 2500 MHz, 3300-3670 MHz and 24.25-28.5 GHz bands for IMT/ 5G.

(b) provide recommendation on quantum of spectrum/bands, if any, to be earmarked for private captive/isolated 5G networks, competitive/transparent method of allocation, and pricing, for meeting the spectrum requirements if captive 5G applications of industries for machine/plant automation purposes/M2M in premises.

(c) provide recommendation on appropriate frequency bands, band plan, block size, applicable reserve price, quantum of spectrum to be auctioned and associated conditions for auction of spectrum for space-based communication services, in view of para 6 above.

(d) provide any other recommendations deemed fit for the purpose of spectrum auction in these frequency bands, including the regulatory/ technical requirements as enunciated in the relevant provisions of the latest ITU-R Radio Regulations.

This issues with the approval of the competent authority.

13/9/2021

(Sukhpal Singh)
Joint Wireless Adviser

Enclosure:

i) ***Annexure-I***: LSA-wise quantum available with the Government in 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz and 2500 MHz bands after March' 2021 auction and after earmarking of 5 MHz (paired) to Indian Railways in 700 MHz band.

ii) ***Annexure-II***: Details of the areas/locations where certain spectrum would not be available for IMT/5G.

iii) ***Annexure-III***: Copy of the relevant pages of Parliamentary Standing Committee Report on "India's Preparedness for 5G".

Copy to:

Secretary, DoS, for kind information please.

Annexure 1.2: DoT's letter dated 16.08.2022

(with its Annexure-I)

Government of India
Ministry of Communications
Department of Telecommunications
Wireless Planning & Coordination (WPC) Wing

6th Floor, Sanchar Bhawan,
20 Ashoka Road, New Delhi-110001

No. J-19022/01/2022-SAT Date: 16 August, 2022

To

The Secretary
Telecom Regulatory Authority of India
Mahanagar Doorsanchar Bhawan
Jawahar Lal Nehru Marg (Old Minto Road)
New Delhi-110002

Subject: Seeking TRAI recommendations for the auction of spectrum in the frequency bands identified for International Mobile Telecommunications (IMT)/5G-reg.

Reference: TRAI letter No. C-15/2/(1)/2021-NSL-II dated 23rd November 2021.

Sir,

In response to DoT's reference dated 13.09.2021, Telecom Regulatory Authority of India (TRAI), vide its above referenced letter (enclosed), requested DoT to provide additional information in respect of space-based communication services.

2. In this regards, the following information is provided to TRAI with a request to provide the recommendations on 7(c) of the DoT's letter No. L-14006/01/2021-NTG dated 13.09.2021 (enclosed).

2.1 **Details of the frequency bands and quantum of spectrum available in each band required to be put to auction and associated information in respect of space-based communication:**

(a) The frequency bands and quantum of spectrum that may be considered by TRAI for providing recommendations with respect to space-based communication services are provided in **Annexure-I**.

(b) These frequency bands include "Planned bands" that when used by GSO systems in accordance with Appendices 30, 30A & 30B of Radio Regulations are reserved by ITU for use by National systems. Use of 'Planned Bands' by foreign GSO satellites is not permitted in India. TRAI may, *inter-alia*, take into account this aspect with respect to GSO systems, in the consultation process. Further, the NGSO network has to provide the protection to GSO networks as per ITU framework.

(c) While Annexure-1 includes both spectrum band and quantum of spectrum in each band, however, the demand of spectrum is not known. Therefore, TRAI, through consultations, may assess the demand for space-based communication services and accordingly provide recommendations on the quantum of spectrum in each band required to be put to auction.

2.2 **Whether spectrum for space-based communication is being envisaged to be assigned on exclusive basis or will the same be shared among multiple service licensees:**

(a) It is envisaged to auction the Space Spectrum on exclusive basis. TRAI may explore the feasibility and procedure of sharing auctioned spectrum among multiple service licensees. TRAI may provide recommendations on sharing of auctioned frequency bands between satellite networks and terrestrial networks also, the criteria for sharing and appropriate interference mitigation techniques for sharing and coexistence.

(b) In frequency bands 27.5-28.5 GHz (identified for IMT) and 28.5-29.5 GHz (being studied for Captive Non-Public Networks), TRAI may recommend mechanism for sharing of auctioned frequency bands in which both IMT/CNPN and satellite based services (both user terminal and Gateways) can be provided in a flexible manner.

2.3 **Details of spectrum assignment mechanism and methodology of charging currently being followed by DoT for space-based communication services:**

(a) Spectrum for space based communications services is currently being assigned through administrative mechanism with formula-based charging for some applications and percentage AGR based charging for others. This assignment is subject to conditions provided in the WPC Wing OM No. R-11014/15/2012-NT(Pt.) dated 05 January 2021(revised from time to time)- **Annexure-III**.

(b) Relevant spectrum charging orders are provided in **Annexure-IV**. Spectrum charges are levied as per administrative orders issued in 2012. Commercial VSAT operations are governed by an order issued in 2003 where charges were levied on a revenue sharing basis. This order is under revision, where the percentage AGR basis charging has been retained but a uniform rate of charging is proposed. Until June, 2021, the spectrum charges for Mobile Satellite Service provided by BSNL ("Sui generis") were being levied on formula basis. However, in June 2021, a separate order for this service has been issued, as per which spectrum charges are being collected from M/s BSNL on a revenue sharing basis, with retrospective effect (from the date of inception of this service). In 2021, spectrum charges for captive VSAT users were also modified.

3. Since the service providers may require spectrum both in user link as well as in feeder link, TRAI may take inputs from the stakeholder and recommend the appropriate auction methodology so that the successful bidder gets spectrum for user link (shared with IMT in flexible) as well as feeder link.

4. In addition, TRAI is requested to provide any other recommendation as deemed fit for the purpose of spectrum auction in these frequency bands, including the regulatory/technical requirements as enunciated in the relevant provisions of the latest ITU-R Radio Regulations.

This issues with the approval of the competent authority.

(Gulab Chand)
Joint Wireless Advisor

Enclosure:

1. **Annexure-I**: Frequency bands to be considered by TRAI for providing recommendations with respect to space-based communication services.
2. **Annexure-II**: Frequency assignment issued in these bands.
3. **Annexure-III**: WPC Wing OM No. R-11014/15/2012-NT(Pt.) dated 05 January 2021
4. **Annexure-IV**: Extant Spectrum charging orders.
5. TRAI letter No. C-15/2/(1)/2021-NSL-II dated 23rd November 2021.
6. DoT letter No. L-14006/01/2021-NTG dated 13.09.2021.

Annexure-I

Frequency bands to be considered by TRAI for providing recommendations with respect to space-based communication services

1. TRAI can consider the following frequency bands for providing recommendations with respect to space-based communication services.

i.	10.7- 12.75 GHz (space to Earth)	
ii.	12.75-13.25 GHz (Earth-to-space)	
iii.	13.75- 14.5 GHz (Earth-to-space)	
iv.	17.7-18.6 GHz (space to Earth)	[17.7-18.4 is used for Earth to space also]
v.	18.8-19.3 GHz (space to Earth)	
vi.	19.3-19.7 GHz (space to Earth)	
vii.	19.7-21.2 GHz (space to Earth)	
viii.	27.5-29.5 GHz (Earth-to-space)	[27.5-28.5 GHz has been identified for implementation of IMT in India]
ix.	29.5- 31 GHz (Earth-to-space)	

2. TRAI can however provide recommendations for other frequency bands also.

Note: The Planned bands are:

i. 12.75 -13.25 GHz & 6725–7025 MHz (Uplink) and 10.7-10.95 GHz, 11.2-11.45 GHz & 4500-4800 MHz (Downlink): FSS Plan (RR Appendix 30B)
ii. 11.7-12.2 GHz (Downlink) : BSS Plan (RR Appendix 30)
iii. 14.5-14.8 GHz & 17.3-18.1 GHz (Uplink): BSS feeder links Plan (RR Appendix 30A)

Annexure 1.3: DoT's reference letter dated 11.07.2024

J-19034/003/2024-SAT
Government of India
Ministry of Communications
Department of Telecommunications
WPC Wing, Sanchar Bhawan, New Delhi-110001

11 July, 2024

To

The Secretary,
Telecom Regulatory Authority of India
4th to 7th Floor, Tower-F World Trade Centre, Nauroji Nagar
New Delhi-110029

Subject: Seeking TRAI recommendations on terms and conditions of spectrum assignment including spectrum pricing for certain satellite-based commercial communication services.

Sir,

TRAI in its letter No. C-15/2/(2)/2022-NSL-II dated 08 February 2024 requested DoT to review its earlier reference No. L-14006/01/2021-NTG dated 13/09/2021 to TRAI seeking their recommendations for auction of spectrum for space-based communication services in view of the provisions of the Section 4 & First Schedule of the Telecommunications Act 2023.

2. It is to inform that a reference dated 21/06/2024 has already been sent to TRAI for seeking recommendations on terms and conditions, including fees or charges, for authorization to provide telecommunication services (including satellite-based communication services) as per the provisions of the Telecommunications Act, 2023.

3. Since the last reference dated 13/09/2021 to TRAI on spectrum for space-based communication services, a few Unified Licenses with VSAT CUG, Global Mobile Personal Communication by Satellite (GMPCS), NLD and ISP Category 'A' authorizations have been issued by DoT for providing satellite-based communication services through Non - Geostationary Orbit (NGSO) satellites. For assignment of spectrum to such licensees, terms and conditions of spectrum assignment including spectrum pricing need to be finalized.

4. Keeping in view the provisions of Section 4 and the First Schedule of the Telecommunications Act-2023, in terms of Section 11(1)(a) of TRAI Act 1997, TRAI is requested to provide its recommendations on terms and conditions of spectrum assignment including spectrum pricing while accounting for level playing field with terrestrial access services for the following satellite-based communication services:

i. NGSO based Fixed Satellite Services providing data communication and Internet services. In its recommendations, TRAI may take into account services provided by GSO-based satellite communication service providers.
ii. GSO/ NGSO based Mobile Satellite Services providing voice, text, data, and internet services.

(M Revathi)
Joint Wireless Adviser

Annexure 1.4: DoT letter dated 24.07.2024

J-19045/04/2022-SAT
Government of India
Ministry of Communications
Department of Telecommunications
WPC Wing, Sanchar Bhawan, New Delhi-110001

24 July, 2024

To

The Secretary,
Telecom Regulatory Authority of India
4th to 7th Floor, Tower-F World Trade Centre, Nauroji Nagar
New Delhi-110029

Subject: Seeking TRAI recommendations on terms and conditions of spectrum assignment including spectrum pricing for certain satellite-based commercial communication services.

Reference: DoT letter no. J-19034/003/2024-SAT dated 11-07-2024

Sir,

Your kind attention is brought to the above referred letter, wherein DoT requested TRAI to provide its recommendations on terms and conditions of spectrum assignment including spectrum pricing for certain satellite-based commercial communication services.

2. In this context, it may be noted that TRAI in its earlier recommendations on "Licensing Framework for Satellite-based connectivity for Low Bit Rate Applications" dated 26-08-2021 had recommended for reduction in Spectrum Usage Charges (SUC) from 4% to 1% of AGR and levy of 1% across all data-rates for Commercial VSAT CUG Service Licensees. It is not yet implemented and DoT continues to levy SUC between 3% to 4% of AGR depending on data rates for Commercial VSAT CUG Service Licensees (copy of SUC order dated 2003 is attached for reference).

3. You are requested to take this also into consideration while providing recommendations to the DoT reference dated 11-07-2024 on the subject.

(M Revathi)
Joint Wireless Adviser

Encl: as stated above

भारतीय दूरसंचार विनियामक प्राधिकरण
पंजीकरण सं. 30767
25 JUL 2024
ई आफिस सं.

Annexure 1.5: DoT letter dated 21.08.2024

J-19034/003/2024-SAT
Government of India
Ministry of Communications
Department of Telecommunications
WPC Wing, Sanchar Bhawan, New Delhi-110001

21 August, 2024

Subject: Seeking recommendations of TRAI on terms and conditions of spectrum assignment including spectrum pricing for certain satellite-based commercial communication services – regarding

Reference: DoT letters (i) No. J-1904/003/2024-SAT dated 11.07.2024
(ii) J-1904/003/2024-SAT dated 24.07.2024

Dear Sir,

Vide, the letter under reference No. (i), the Department has sought the recommendations of the TRAI on terms and conditions of spectrum assignment including spectrum pricing while accounting for level playing field with terrestrial access services for the following satellite-based communications services:

i. NGSO based Fixed Satellite Service providing data communication and Internet services. In its recommendations, TRAI may take into account services provided by GSO based satellite communication service providers.

ii. GSO/NGSO based mobile Satellite Services providing voice, text, data and internet services.

2. It is pertinent to mention that the NGSO Satellite based communication services would play a significant role in bridging the digital divide and providing telecommunication services including broadband services, in rural and remote areas of the country. As already intimated earlier, the Department has issued authorisations for providing satellite-based communication service using NGSO constellations to a couple of entities. However, for providing the services, the assignment of spectrum to these entities is necessary. Accordingly, the TRAI is requested to provide its recommendations on the above-mentioned issues as soon as possible, so that spectrum assignment and licensing recommendations under reference no. 20-1350/2024 AS-I (Vol. II) dated 21.06.2024 can be processed at the same time, i.e., by 22.08.2024.

3. This has the approval of the competent authority.

Encl: DoT letter dated 11.07.2024 and 24.07.2024

21.08.2024
(Gulab Chand)
Joint Wireless Adviser

To,

The Secretary
Telecom Regulatory Authority of India

भारतीय दूरसंचार विनियामक प्राधिकरण
3129
21 AUG 2024

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22/8/24.

Annexure 2.1

Comparison of terrestrial access services and NGSO-based FSS

1. A terrestrial wireless access network can offer a full suite of services to its customers such as voice telephony [they provide access to public switched telephone network (PSTN) and public land mobile network (PLMN)], SMS, internet access, and data connectivity to enterprises. The introduction of 5G technology has given rise to a new use case viz. internet access to households and enterprises through fixed wireless access (FWA) technology.

2. The NGSO-based FSS networks have two main use cases viz. (a) internet access to households and enterprises and (b) provision of enterprise data services i.e. the provision of data connectivity through leased lines and virtual private networks to enterprises.

3. As there is a significant difference between the range of services under terrestrial wireless access service and the range of services under NGSO-based FSS, one may promptly infer that there is no issue of level playing field between such services. However, if one looks for the complementary/ substitute services which are available under both services, one may draw the inference that the provision of broadband access through the FWA technology by terrestrial wireless access service providers and the provision of broadband access through the satellite user terminal by NGSO-based FSS providers offer somewhat similar services from the standpoint of consumers, and the issue of level playing field between the two services requires to be seen in the overlapping segment alone i.e. broadband access to households and enterprises.

4. For evaluating the issue of level playing field between (a) providers of terrestrial wireless access service and (b) providers of NGSO-based FSS, it would be worthwhile comparing their respective network capacities for provisioning broadband access to households and enterprises.

5. At present, the major terrestrial wireless access service providers are providing broadband access to households and enterprises using the IMT/ 5G spectrum in the mid band (3300-3670 MHz band). In future, they may provide broadband access to households and enterprises using the IMT/ 5G spectrum in the milli-meter wave band (24.25-28.5 GHz band) as well. At present, the major terrestrial wireless access service providers typically hold about 100 MHz (TDD) spectrum in the mid-band (3300-3670 MHz band) and about 1,000 MHz (TDD) spectrum in the milli-meter wave band (24.25-28.5 GHz band).

6. The network capacity throughput (in Tbps) has been estimated for a typical major terrestrial wireless access service provider holding 100 MHz of spectrum the mid-band (3300-3670 MHz band). The network capacities which would be possibly created in future through the spectrum in milli-meter wave band (24.25-28.5 GHz band) have not been considered in this exercise keeping in view that the service providers have yet to deploy the spectrum in milli-meter wave band (24.25-28.5 GHz band) at a mass scale. Essentially, our analysis focusses on a near-to-medium term only.

7. The major terrestrial wireless access service providers in India have deployed mobile base stations at unique base station sites ranging from 3.3 lakh to 4.4 lakh. For estimation purposes, it has been assumed that the typical wireless access service provider holds 3,50,000 unique mobile base station sites. As a conservative estimate, it has been assumed that, in the near-to-medium term, the typical wireless access service provider would deploy radio equipment in the mid-band (3300-3670 MHz band) in 80% of the total mobile base station sites i.e. 80% of 3,50,000 = 2,80,000 sites.

8. As per industry estimates, the average downlink 5G spectral efficiency is about 8.5 bps/ Hz. However, in the present exercise, the spectral efficiency of 5G FWA has been considered as 6 bps/ Hz as a conservative estimate. With 100 MHz of spectrum in Mid-band (3300-3670 MHz band), the typical operator could provide (100 MHz) * (6 bps/ Hz of data) = 600 Mbps of data from each base station site.

9. With 2,80,000 mobile base station sites equipped with radio equipment in the Mid-band in the near-to-medium term, the typical terrestrial wireless access service operator would be able to provide (2,80,000) * (600 Mbps) = 168 Tbps of data in the country. In other words, as per conservative estimates, the network capacity of the typical terrestrial wireless access service operator for providing broadband access to households and enterprises through FWA technology would be of the order of 168 Tbps in the near- to-medium-term[40].

10. On the other hand, the network capacities of the major NGSO-based FSS providers for providing satellite broadband in India range in the order of 0.6 Tbps to 3 Tbps in the near-to-medium term.

11. The ratio of the network capacity of the typical terrestrial wireless access service operator and the network capacity of the major NGSO-based FSS providers ranges from 56:1 to 280:1.

12. The above estimates have been captured in the following table:

S. No.	**Item**	**Terrestrial access service**	**NGSO-based fixed satellite service**
1	Range of services which may be provided by using spectrum	(a) Voice call, text messaging and internet access on handheld devices (mainly mobile phones) (b) Internet access through Fixed Wireless Access (FWA) technology (c) Data connectivity to enterprises	(a) Internet access through satellite user terminal (b) Data connectivity to enterprises (leased lines and virtual private networks)

[40] Here, it has been assumed that the entire network capacity in mid-band would be used for providing FWA based broadband connections. It is worth mentioning that the mid band (3300-3670 MHz band) is also being used for serving 5G mobile broadband (for smartphones). At present, the economic value proposition of the use of the mid band spectrum for 5G mobile broadband (for smartphones) as compared to FWA based broadband is better.

2	Complementary/ substitute services	Internet access through FWA technology	Internet access through satellite user terminal
3	The network capacity throughput of a typical major operator for providing complementary/ substitute service in India	~ 168 Tbps #	~ 0.6 Tbps to 3 Tbps @
4	Capability to increase overall capacity	Can be increased expeditiously by installing additional base stations in any area at any time to meet the demand	Can be increased only after successful filing at ITU and launch of new satellite constellations
5	Capability to increase localised capacity	Can be increased by installing more base stations at the local level	• Only limited enhancements in capacity can be done by steering nearby beams • For any major increase, the overall constellation is required to be upgraded.
6	Cost of user terminals	At present, the terrestrial mobile service providers, generally, do not charge the cost of user terminals separately. They charge a security deposit of Rs. 2,000 to 2,500.	Internationally, the cost of user terminals is high. Generally, it is in the range of Rs. 20,000 to Rs. 50,000.
7	Tariff	Internationally, the tariff of satellite broadband is significantly higher than the tariff for terrestrial broadband in most of the countries.	

This capacity can increase substantially if terrestrial wireless access providers start deploying mmWave frequency spectrum (frequency spectrum in 26 GHz

band already held by them) on a mass scale. As the present analysis has been done for near-to-medium term, the network capacity which could potentially be created through the use of mmWave spectrum has not been taken into account in this estimate.

@ The operators, generally, deploy their NGSO satellite constellations in one or more phases (also referred to as 'generation of satellites'). In successive phases, the operators may deploy additional satellites. Also, the throughput capacity per satellite may also increase in successive phases because of technological advancements. As the present analysis has been done for the near-to-medium term, the network capacity which could potentially be created in the long term has not been estimated.

Annexure 2.2: Existing/ planned deployments by various satellite operators in NGSO

[As provided by DoT through its letter dated 16.08.2022]

Existing/Planned deployments by various satellite operators in NGSO

(as per information available in Public domain)

Sl. No	Satellite Operator	Deployment (Frequency Bands)	Planned Satellite numbers	Live Satellite numbers	Frequency Bands (in GHz)			
					User Link		Feeder Link	
					Space to Earth	Earth to Space	Space to Earth	Earth to Space
1.	SpaceX (USA)	Ku/Ka* (1st Gen)	4408	**1892**	10.7-12.75	14-14.5	17.8-18.6 18.8-19.3	27.5-29.1 29.5-30.0
		Ku/Ka/E* (2nd Gen)	30000	-	10.7-12.75 17.8-18.6 18.8-19.3 19.7-20.2	12.75-13.25 13.85-14.5 28.35-29.1 29.5-30.0	17.8-18.6 18.8-19.3 71-76	27.5-29.1 29.5-30.0 81-86
		V Band*	7518	-	37.5-42.5	47.2-50.2 50.4-52.4	37.5-42.5	47.2-50.2 50.4-52.4
2.	Kuiper Systems (Amazon) (USA)	Ka Band	3236	-	17.7-18.6 18.8-20.2	28.35-29.1 29.5-30	17.7-18.6 18.8-20.2	27.5-30 37.5-42.0 42.0-42.5
		Ku/V***	7774	-	10.7-12.7 37.5-42.0 42.0-42.5	12.75-13.25 14-14.5 47.2 – 50.2 50.4 – 51.4	37.5-42.0 42.0-42.5	47.2-50.2 50.4-51.4
3	Boeing (USA)	V	5921	-	37.5-42	47.2-50.2 50.4-51.4	37.5-42	47.2-50.2 50.4-51.4
4	Astra Space (USA)	V	13620	-	37.5-42	47.2-50.2 50.4-51.4	37.5-42	47.2-50.2 50.4-51.4
5	OneWeb (UK)	Ku/Ka (Phase 1)	648	**394**	10.7-12.7	12.75-13.25 14-14.5	17.8-18.6 18.8-19.3 19.7-20.2	27.5-29.1 29.5-30.0
		Ku/Ka (Phase 2)	6372	-	10.7-12.7	12.75-13.25 14-14.5	17.8-18.6 18.8-19.3 19.3-19.7 19.7-20.2	27.5-29.1 29.1-29.5 29.5-30.0
		V Band	6372	-	40.0-42.0	48.2-50.2	37.5-42.5	42.5-43.5 47.2-50.2 50.4-51.4
6	O3B (UK)	Ka	70	**20**	17.8-18.6 18.8-20.2	27.5-30	17.8-18.6 18.8-20.2	27.5-30
		V	24	-	37.5-42	47.2-50.2 50.4-51.4	37.5-42	47.2-50.2 50.4-51.4
7	Telesat (CANADA)	Ka Band**	300	-	17.8-18.6 18.8-19.3 19.7-20.2	27.5-29.1 29.5-30	17.8-18.6 18.8-19.3 19.7-20.2	27.5-29.1 29.5-30
		V Band**	1671	-	37.5-42	47.2-50.2 50.4-51.4	37.5-42	47.2-50.2 50.4-51.4

*SpaceX not seeking authorization in USA for 12.7-12.75 GHz; 40-42.5 GHz & 51.4-52.4 GHz

**The frequency band 50.4-51.4 GHz is presently not identified in the USA for FSS.

*** 42-42.5 GHz (non-USA only)

Annexure 3.1

DoT's order dated 11.12.2023 (with Schedule VII)

Government of India
Ministry of Communications
Department of Telecommunications
Wireless Planning and Coordination Wing
20, Ashoka Road, Sanchar Bhawan, New Delhi

No. P-11014/34/2009-PP Dated: 11.12.2023

ORDER

Subject: Spectrum Charges for Assignment of Frequencies to Captive Users (being charged on formula basis) for different types of Radiocommunication Services and applications.

In pursuance of the powers conferred under section 4 of the Indian Telegraph Act, 1885 (13 of 1885) and in supersession of this Ministry's Orders Nos. P-11014/34/2009-PP (I), (II), (III) & (IV) each dated 22.03.2012, the Central Government has decided that assignment of radio frequency spectrum to all users to whom radio frequency assignment is made through administrative process and spectrum charges are calculated based on a formulae, shall be made as per the methodology defined in this order.

2. Upon successful processing of application for assignment of radio frequency, a Letter of Intent (LoI) will be issued to the applicant which include, among others, information about the license fee and royalty charge (collectively called spectrum charges) required to be paid. Spectrum charges shall be informed for the full period of the assignment requested. If the request for assignment is for a period more than one year, the applicant can opt to pay the license fee and royalty annually, in advance for each year.

3. Immediately thereafter, but in any case not later than sixty (60) days from the date of issue of the LoI, the applicant shall pay the spectrum charges for issue of Decision Letter (DL), if otherwise permissible.

3.1 If the payment is not received within 60 days from the date of LoI, the application shall be treated as cancelled and the frequency shall be freed for assignment to other applicants. The applicant will have to submit a fresh application if they still want the frequency assignment.

Page 1 of 33

4. A Construction Period of three months is permitted for the purpose of import of the equipment, site preparedness, deployment, etc. and spectrum charges be levied, after three months' period from the 1st day of the month of date of issue of LoI.

4.1 Three months' construction period shall not be applicable for temporary frequency assignment (assignment issued for the period less than one year). In such cases, spectrum charges shall be applicable from the 1st day of the month of date of issue of LoI.

5. Initially, DL shall be issued with a validity of 15 months (one year plus three months of construction period) from the 1st day of the month of date of issue of LoI that can be further extended for a period of another one year subject to payment of annual spectrum charges, in advance. For example: If date of issue of initial LoI is 20th August 2023, the spectrum charges will be levied from 1st November 2023 and the initial DL will be valid upto 31st October 2024. Further extension of one year will be expired on 31st October 2025.

5.1 In no case DL be renewed further, however, extension of another one year may be considered for Government users under certain circumstances subject to payment of annual spectrum charges, in advance.

6. The spectrum charges, comprises of Royalty and License fee, shall be calculated for following radiocommunication services as per the enclosed schedules:

6.1 All the above services have been defined in the National Frequency Allocation Plan of India (NFAP). The latest NFAP is available in DoT's website (www.dot.gov.in).

6.2 Spectrum charges, mentioned in all the schedules, are annual charges, unless otherwise specified.

6.3 Royalty charge has been made independent of numbers of equipment/set, unless otherwise specified. However, license fee will be applicable on them. Therefore, any increase/ decrease in the number of equipment (Fixed/ Mobile) in the existing frequency assignment shall require prior permission.

6.4 The spectrum charges due for different period shall be determined as follows:

License Period	**License Fee Payable**	**Royalty payable after three months period from the 1st day of the month of date of issue of LOI**	**Method of Payment**
One calendar month or less	At specified rate given in various schedules	Annual Royalty divided by 12	Full License fee and Royalty to be paid in advance at the time of issue of DL/frequency assignment.
More than one calendar month but less than 12 months	At specified rate given in various schedules	On pro-rata basis. However, part of a month shall be taken as one month.	--do--
More than one year	At specified rate given in various schedules	On pro-rata basis. However, part of a month shall be taken as one month.	Pay the License Fee plus Royalty for the entire duration in advance at the time of issue of DL/ frequency assignment or pay it in annual advance instalments.

7. Generally, there shall be no limit on number of frequency(ies) applied for any type of services. However, number of frequency(ies) shall be assigned subject to availability, technical justification, regulatory feasibility etc.

8. **Renewal of Frequency Assignment:**

8.1 The assignee shall be responsible for keeping the frequency assignment current and up to date until its surrender/ cancellation. To this effect, the assignee shall, at least 30 days before the end date of the validity of the frequency assignment, pay through Saral Sanchar Portal, the spectrum charges for the renewal of his/her existing frequency assignment.

9. **Frequency assignment/ authorization Modification Fee:**

9.1. Applicable fees for modification in the frequency authorization/ frequency assignment shall be charged at the rate of Rs. 1000/- per modification.

10. **Cancellation/ Surrender of Frequency Assignment:**

10.1 The assignee shall surrender the frequency assignment, if no longer required. To this effect the assignee shall apply for cancellation through Saral Sanchar Portal in accordance with OM No. L-14027/210/2020-WF dated 27.07.2023. Failure to surrender a frequency assignment within the stipulated time shall result in accrual of spectrum charges and late fee.

10.2 Non-purchase of equipment/ non-utilization of frequency assignment shall not be ground for exemption from payment of spectrum charges.

10.3 On surrender of frequency assignment, after adjustment of due spectrum charges, the balance amount will be either adjusted against other active frequency assignments or refunded to the applicant.

11. **Late fee for delayed payment of Spectrum Charges:**

11.1 Late fee shall be payable by the assignee on the frequency assignment for delay in payment of spectrum charges (Royalty and License fee) or any other dues payable against the frequency assignment. In this regard, any payment reflected in DoT's account after the midnight (2400 Hrs.) of the end date will be considered as a delay in payment irrespective of the date on which such transaction was initiated by the assignee of the frequency assignment.

11.2 The rate at which Late Fee is levied for a Financial Year shall be 2% added to one-year Marginal Cost of Lending Rate (MCLR) of State Bank of India, on the beginning of the Financial Year i.e. 1st April.

11.3 The Late Fee shall be compounded annually, subject to minimum annual Late Fee of Rs. 250/- per Frequency Assignment. A part of the month shall be considered as a full month for the purpose of calculation of Late Fee. A month shall be an English calendar month.

12. The applications for the frequency assignment shall continue to be processed through DoT's online portal (Saral Sanchar portal). Further, all renewals, cancellations, import permission, surrenders will also be issued through online portal (Saral Sanchar) as per prevailing instructions issued from time to time.

13. Any issue either arising due to interpretation of this Order or new uses/ applications not covered in the said Order shall be referred to the Standing Committee constituted vide WPC Wing OM of even No. dated 11.12.2023.

14. This Order issues with the approval of competent authority.

15. This Order shall come into force with effect from 01st April 2024. However, the revised spectrum charges on existing frequency assignments shall be applicable from the date of next renewal cycle.

Enclosure: As above.

11.12.2023

(P S M Tripathi)
Sr. Deputy Wireless Adviser to the Govt. of India

पी.एस.एम. त्रिपाठी/P.S.M. TRIPATHI
वरिष्ठ उप सिंहार सलाहकार
Senior Deputy Wireless Adviser
दूरसंचार विभाग, भारत सरकार
Deptt. of Telecom, Govt. of India
नई दिल्ली/New Delhi

To,

1. All concerned.
2. Wireless Finance Division
3. Wireless Monitoring Organisation
4. IT cell, DoT - for publication on DoT Website
5. ITPC, BSNL, Pune to send text messages to all licensee informing them about the new orders on frequency assignment.

Schedule-VII: Satellite based Services.

General:

(i) Satellite based Service includes Fixed Satellite Services (FSS), Broadcasting Satellite Services (BSS), Mobile satellite Services (MSS) and Earth Exploration Satellite Services (EESS)

(ii) The standard annual royalty factor shall be Rs. 35,000/- per frequency. The same rates will be applied for all applications under FSS, BSS, MSS and EESS together with the relevant Bandwidth Factor (Bs) given in Table-1 below to arrive at the amount of Annual Royalty (R) per frequency payable for an Uplink or Downlink.

(iii) Royalty charges shall not be applicable on remote terminals of Data collection platforms. Only the license fee will be paid.

(iv) Bandwidth factor for the bandwidth will be calculated in the multiple of 500 kHz and the remainder will be calculated using increments of 100 kHz.

(v) The royalty will be charged on the total bandwidth assigned i.e., including any guard bands etc.

(vi) The royalty charges for Earth-Exploration Satellite Services / Meteorological Satellite Service, will be calculated only once for every frequency carrier used by the remote users under these services.

(vii) For Space Operation Services (TTC operation), the fixed royalty charges of Rs 1,50,000/- per Earth Station per annum will be levied.

(viii) Royalty charges will be levied in respect of frequencies transmitted from or into Indian territory.

(ix) For DSNG/SNG, the royalty charges will be levied for the frequencies used on both uplinks and downlinks. In case the same frequency carrier is used by the user from different OB vans belonging to licensee, additional royalty @ 25% of the basis royalty will be charged. However, if the additional OB vans are deployed within the same venue, e.g. a stadium, additional royalty @ 25% of the basis royalty will not be charged.

(x) For temporary Up linking, a minimum royalty equivalent to that for one month will be charged.

Part-I (Royalty Charges)

1. **Annual Royalty Charges for Satellite Based Services:**

Annual Royalty (R) = Rs. 35000xBs.

Table-1: Calculation of Bandwidth Factor (Bs)

S. No.	Total Assigned Bandwidth		Bandwidth Factor (B_s)			
			For uplink		For downlink	
			Broadcast*	Others	Broadcast	Others
(i)	Up to and including 500 kHz, B_s is either of these three	Up to and including 100 kHz [i.e., BW ≤ 100 kHz]	0.25	0.20	Nil	0.20
(ii)		More than 100 kHz to up to and including 250 kHz [i.e., 100 kHz < BW ≤ 250 kHz]	0.60	0.50	Nil	0.50
(iii)		More than 250 kHz to up to and including 500 kHz [i.e., 250 kHz < BW ≤ 500 kHz]	1.25	1.00	Nil	1.00
(iv)	More than 500 kHz [i.e., BW > 500 kHz]		Total B_s			

*Broadcast in this case means those uses that are related to transmission of television content through satellite, and include, teleports, DSNG vans, DTH, HITS etc.

Total B_s = [Appropriate B_s from row (iii) above × bandwidth in number of multiple of 500 kHz] + [Appropriate B_s from row (i) above × number of multiple of 100KHz or part thereof in balance bandwidth]

where,
Balance bandwidth = remainder of [bandwidth/ 500 kHz]

Part-II (License fee)

License Fee for wireless stations operating under Satellite Services (FSS, BSS, MSS) including Standby sets

S. No.	Type of Wireless station License	Annual License Fee (in Rs.)
1	Fixed Earth station DTH/ Teleport/ DSNG/NLD/ILD/DCP/IP-II	1000 per station
2	Captive VSAT/Inmarsat Earth Station	500 per station
3	Vehicle Mobile/Handheld Mobile station	250/- per station

****

Annexure 3.2

DoT's Order no. R-11014/9/2001-LR dated 16.04.2003

Government of India
Ministry of Communications & Information Technology
Department of Telecommunications
(WPC Wing)

No.R-11014/9/2001-LR Dated: 16th April,2003

ORDER

Subject: WPC spectrum charges (Royalty and License fee) for Commercial/Captive VSAT Networks - Change over to Revenue Share.

The issue regarding the payment of WPC spectrum charges (Royalty and License fee) for commercial and captive VSAT networks has been reviewed and the following has been decided by the competent authority:

1. Commercial VSAT networks

1.1 WPC spectrum charges under the Revenue Share Regime shall come into force from the quarter beginning 1st January, 2003 and shall be as under:

Range of data rate	Revised WPC spectrum charges
Up to 128 KBPS	3.0% of AGR
Higher than 128 KBPS and up to 512 KBPS	3.5% of AGR
Higher than 512 KBPS and up to 2 MBPS	4.0% of AGR

Note: (A) The percentage of revenue share as WPC spectrum charges indicated above comprises both royalty and license fee.

(B) The highest data rate of any VSAT in the network shall be the deciding factor for the percentage revenue share towards the spectrum charges.

1.2 Adjusted Gross Revenue (AGR) for the purpose of levying WPC spectrum charges shall be same as specified under the main DOT License Agreement.

1.3 Payment of WPC spectrum charges shall be on advance quarter basis and payable within 15 days of the commencement of the respective quarter; failing otherwise the same shall invoke panel interest as per the procedure in vogue in the main DOT License.

1.4 Penal interest shall be levied as per existing norms, procedure terms and conditions in vogue for delayed/ non payments for main DOT License Agreement.

1.5 Financial settlement/accounting of spectrum charges based on Estimated/Actual/Audited AGR's(subject to physical verification) shall be undertaken on quarterly/financial year basis on the same line/procedure and term and conditions as applicable in main DOT license agreement.

1.6 Estimated/Actual AGR's duly authenticated by the authorized signatory have to be submitted at the time of making quarterly payments.

1.7 All dues up to 31st December,2002 shall be settled on the basis of the then existing formulae.

2. Captive VSAT Networks:

The issue of WPC spectrum charges for captive networks has also been reviewed and it has been decided to maintain the status quo, while allowing data rate up to 512 KPBS, as there is no concept of revenue share in captive VSAT networks.

3. These orders come into force from the quarter commencing 1st January, 2003.

4. This issues with concurrence of Wireless Finance branch of WPC Wing vide their U.O. no. 323/WPF/03 dated 10/4/2003.

(ASHOK KUMAR)
Joint Wireless Advisor
To the Government of India

Copy to:

1. All VSAT Captive/Commercial Service Providers.
2. WPC, Finance Branch.
3. VSAT Service Providers Association

Annexure 3.3

DoT's OM No. J-19044/03/2015-SAR dated 28.06.2021

Government of India
Ministry of Communications
Department of Telecommunications
Wireless Planning & Coordination (WPC) Wing
6th Floor, Sanchar Bhawan, 20 Ashoka Road, New Delhi-110 001

No. J-19044/03/2015-SAT Date: 28/06/2021

Office Memorandum

Subject: Spectrum charges for Inmarsat based Global Satellite Phone Services under 'sui-generis' category offered by M/s BSNL-reg.

Levy of spectrum charges to the users of Inmarsat Global Satellite Phone Services (GSPS) – operated by M/s BSNL under the sui generis category license granted by DOT, will be as follows:

1. M/s BSNL shall pay spectrum charges as a percentage of its Adjusted Gross Revenue (AGR). These charges would cover the entire spectrum charges for handsets and for the gateway.

2. The applicable charges shall be 1% of the AGR of BSNL's satellite based services under 'sui-generis' category. The spectrum charges shall be applicable from the date of inception of GSPS services by BSNL.

2.1 The proceeds from the sale of handsets shall be included in the AGR.

2.2 Excess payment, if any, made by BSNL with regard to this service will be adjusted against the other SUC dues payable by BSNL to DOT.

2.3 The Pr. CCA, Delhi is assigned the responsibility for the AGR based assessment and related matters.

3. M/s BSNL, being the licensee, is hereby allowed to act as a single window agency to obtain NOC/ clearance from Ministry of Home Affairs (MHA) directly and other security vetting from other security agencies, wherever applicable, as per the policy to be laid down by DoT.

(i) M/s BSNL will furnish a list of its subscribers to WPC Wing on a half-yearly basis for endorsement on its Wireless Operating License (WOL).

(ii) Also, Inmarsat satellite phone users, including those users who were issued Wireless Operating Licenses (WOL) by WPC.Wing will now be included under the provision of the service (GSPS) provided by M/s BSNL. These old users will no more be required to pay any spectrum charges separately to WPC Wing. Their existing licenses will stand terminated with effect from date of issue of this OM.

(ANIL VERMA)
उप सलाहकार (वायरलेस)
Deputy Wireless Advisor
दूरसंचार विभाग, भारत सरकार
Deptt. of Telecom, Govt. of India
नई दिल्ली/New Delhi

4. This order is applicable to the services, provided by BSNL under 'sui generis' category only.

5. This issues with the approval of the competent authority.

Yours Faithfully

28.06.2021

(Anil Verma)
Deputy Wireless Advisor (Satellite)
to the Government of India

To:

1. M/s BSNL, Bharat Sanchar Bhawan, Harish Chandra Mathur Lane, Janpath, New Delhi-01
2. Joint Secretary(IS-I), Ministry of Home Affairs, with request to inform users under MHA regarding the changed procedure.
3. Pr. Controller of Communication Accounts, Prasad Nagar, Karol Bagh, New Delhi, Delhi 110005.
4. DDG(Satellite), Satellite Division, DoT, Sanchar Bhawan/ DDG (WPF), DoT
5. Secretary, Telecom Regulatory Authority of India
6. Sr.DWA(ASMS), WPC Wing, may kindly arrange to upload this letter on DoT website.

Annexure 3.4

Analysis of spectrum charges borne by terrestrial wireless access service providers

The analysis given below covers the spectrum costs for terrestrial operators in terms of AGR and on per subscriber basis. The analysis is based on the reports periodically submitted by the service providers to TRAI and generally available in the public domain:-

- The annual amortization of spectrum auction payments and the spectrum usage charge (SUC) as a percentage of Adjusted Gross Revenue (AGR) for F.Y 2023-24 and the annual amortization of spectrum auction payments and SUC per subscriber for F.Y 2023-24, in respect of three major access service providers, is tabulated below:

Table-I: Annual amortization of spectrum auction payments along with SUC as % of AGR

TSP	**Annual amortization of spectrum auction payments + SUC as a percentage of AGR**
TSP 1	6.76%
TSP 2	11.36%
TSP 3	29.79%
Note: The above data is based on annual financial statements and periodical reports submitted by telecom service providers to TRAI for F.Y. 2023-24	

Table-II: Annual amortization of spectrum auction payments along with SUC per subscriber

TSP	Annual amortization of spectrum auction payments along with SUC per subscriber (in Rs.)
TSP 1	147
TSP 2	242
TSP 3	386
Note: The above data is based on annual financial statements and periodical reports submitted by telecom service providers to TRAI for F.Y. 2023-24	

- From the above Table, it can be observed that there is a wide variation in spectrum costs of terrestrial access service providers. While TSP-3 is an outlier, exhibiting significantly higher spectrum payments relative to its AGR, TSP-1 exhibits most efficient utilization of spectrum vis-a-vis its AGR.

- Further, it may be inferred that with utilization of mmwave band and development of 5G use cases in future, the operators' realization of revenue will increase, thereby the above spectrum cost as a percentage of AGR and on per subscriber basis may vary.

- The high percentage for TSP-3 can be attributed to legacy issues, inter alia low realization of revenue, low subscriber base, slower adoption of new technologies (e.g., 4G, 5G etc.) and underutilized spectrum investments.

- The higher ratio observed for TSP-2, compared to TSP-1, can also be attributed to certain legacy challenges such as continuing with less efficient technologies like 2G, 3G, slower increase of subscriber base for advanced technologies like 4G, etc.

- Legacy issues of TSP-2 and TSP-3 can also be attributed to the significant quantum of spectrum currently being used for 2G and 3G services.

- The lower spectrum amortization along with SUC as % of AGR of TSP-1 may also be associated with the fact that TSP1 entered the market at a relatively later stage compared to other access providers. It entered the market with the latest technology. As a result, its productivity has not been hindered by legacy issues such as high debts or old infrastructure/technologies.

- Further analysis also shows that for TSP-1, mmwave band, mid band and 700MHz spectrum bands combined cost per subscriber (5G and FWA) (with suitable assumptions) is about Rs 268.

Annexure 3.5

Spectrum fees/ charges applicable in other countries

Canada [41]

Type of Station	**Spectrum fee for fiscal year 2024-2025**
Fixed earth stations, transportable earth stations, and earth stations in motion (ESIMs)	$5.22 per MHz assigned spectrum
Mobile earth stations ≤ 3.0 GHz	$1,566.00 per MHz assigned spectrum
Mobile earth stations > 3.0 GHz	$5.22 per MHz assigned spectrum

Iceland[42]

The annual fee for the operation of an earth station is ISK 25,100

Malaysia[43]

FEES FOR APPARATUS ASSIGNMENT

Fixed Fees

Nature of Service as Per Spectrum Plan	*Type of Apparatus*	*Annual Fees (RM)*
FIXED		
	Earth Station (less than 2.4 meters)	120.00
	Earth Station (2.4 meters and above)	1,200.00
MOBILE	Mobile Station	60.00

[41] https://ised-isde.canada.ca/site/spectrum-management-telecommunications/en/spectrum-and-telecommunications-fees

[42] https://www.fjarskiptastofa.is/english/telecom-affairs/satellite-services/

[43] https://www.mcmc.gov.my/en/legal/acts/communications-and-multimedia-act-1998-reprint-200/communications-and-multimedia-spectrum-regulatio

FEES FOR APPARATUS ASSIGNMENT

Variable Fees

Bandwidth (per channel) (kHz)*	*Annual fees with respect to bands per apparatus (RM)*		
	Less than 30 MHz	*30 MHz up to 3GHz*	*More than 3 GHz*
0.000 - 5.000	42.00	90.00	60.00
5.001 - 12.000	52.00	110.00	70.00
12.001 - 25.000	62.00	130.00	90.00
25.001 - 100.000	113.00	230.00	130.00
100.001 - 200.000	186.00	380.00	200.00
200.001 - 1000.000	264.00	520.00	280.00
1000.001 - 3500.000	342.00	680.00	360.00
3500.001 - 7000.000	420.00	840.00	440.00
7000.001 - 14000.000	498.00	1000.00	510.00
14000.001 - 28000.000	576.00	1160.00	590.00
28000.001 - 36000.000	654.00	1300.00	670.00
36000.001 - 54000.000	732.00	1470.00	750.00
54000.001 or greater	810.00	1620.00	830.00

Nigeria (NCC) [44]

Nigeria charges

- The spectrum usage fee for Earth station(s) operating in L, C, Ku and Ka bands as well as VSAT terminal is USD 2,000 per annum.

[44] Condition 16 ("Fees and Charges") of the *Commercial Satellite Communications Guidelines* (Available at <https://www.ncc.gov.ng/accessible/documents/819-guidelines-on-commercial-satellite-communications-2018/file>

Singapore:[45]

Radio-communication Service	Radio Frequency Bands	Occupied Bandwidth (X)	Fee payable per frequency per annum
Satellite (GeoStationary Orbit)	All Frequency Bands	X ≤ 25 kHz	$300
		25 kHz < X ≤ 500 kHz	$400
		500 kHz < X ≤ 10 MHz	$700
		10 MHz < X ≤ 20 MHz	$1,000
		X > 20 MHz	$1,600
Satellite (Non- GeoStationary Orbit)	All Frequency Bands	X ≤ 25 kHz	$300
		25 kHz < X ≤ 500 kHz	$400
		500 kHz < X ≤ 10 MHz	$1,500
		10 MHz < X ≤ 20 MHz	$2,800
		X > 20 MHz	$4,700

U.S.A.[46]

Annual Regulatory Fees is US$ 2,610 per year per Earth Station authorisation

U.K.[47]

- GBP 200 per year for an NGSO network license.
- GBP 500 per year per NGSO gateway license.

[45] https://www.imda.gov.sg/-/media/imda/files/regulation-licensing-and-consultations/licensing/licenses/guidesatecomm.pdf

[46] https://docs.fcc.gov/public/attachments/FCC-24-93A1.pdf

[47] https://www.ofcom.org.uk/__data/assets/pdf_file/0021/229224/ngso-guidance.pdf

Annexure 3.6

Hardware cost levied by one of the largest NGSO operators across various countries

Country	Hardware cost (in US$)
Australia	223
Brazil	394
France	368
Ireland	366
Italy	368
Japan	332
Malaysia	358
Mexico	372
Peru	386
Portugal	366
Sri Lanka	407
UK	379
USA	349
Zambia	194
Source: The above information is based on data available on operator's website	

Annexure 3.7

Comparison of tariffs: Satellite vs. Terrestrial

Country	Operator	Amount in US $	Speed
Australia	Satellite operator	90	150-250 Mbps
	Terrestrial operator 1	64	220 Mbps
	Terrestrial operator 2	84	Download Speed:780 Mbps Upload speed: 40 Mbps
Brazil	Satellite operator	32	150-250 Mbps
	Terrestrial operator 1	15	500 Mbps
	Terrestrial operator 2	17	300 Mbps
Canada	Satellite operator	99	150-250 Mbps
	Terrestrial operator 1	39	Download speed: 300 Mbps Upload speed: 100 Mbps
France	Satellite operator	42	150-250 Mbps
	Terrestrial operator 1	35	400 Mbps
	Terrestrial operator 2	31	1 Gbps
Italy	Satellite operator	42	150-250 Mbps
	Terrestrial operator 1	29	2.5 Gbps
Ireland	Satellite operator	53	150-250 Mbps
	Terrestrial operator 1	37	Download speed: 500 Mbps Upload speed: 50 Mbps
Japan	Satellite operator	43	150-250 Mbps
	Terrestrial operator 1	38	1 Gbps
Kenya	Satellite operator	50	150-250 Mbps
	Terrestrial operator 1	97	500 Mbps
Malaysia	Satellite operator	49	150-250 Mbps
	Terrestrial operator 1	31	Download speed: 600 Mbps Upload speed: 500 Mbps

	Terrestrial operator 2	29	Download speed: 300 Mbps Upload speed: 50 Mbps
Mexico	Satellite operator	52	150-250 Mbps
	Terrestrial operator 1	17	300 Mbps
Nigeria	Satellite operator	23	150-250 Mbps
	Terrestrial operator 1	33	up to 150Mbps
Peru	Satellite operator	37	150-250 Mbps
	Terrestrial operator 1	17	150-300 Mbps
Portugal	Satellite operator	42	150-250 Mbps
	Terrestrial operator 1	37	500 Mbps
Singapore	Satellite operator	82	150-250 Mbps
	Terrestrial operator 1	67	2 Gbps
Sri Lanka	Satellite operator	51	150-250 Mbps
	Terrestrial operator 1	18	300 Mbps
UK	Satellite operator	94	150-250 Mbps
	Terrestrial operator 1	64	Download speed: 1.10 Gb Upload speed: 104 Mb
	Terrestrial operator 2	53	Download Speed: 900 Mb Upload speed: 90 Mb
USA	Satellite operator	120	150-250 Mbps
	Terrestrial operator 1	55	300 Mbps
	Terrestrial operator 2	35	300 Mbps
Zambia	Satellite operator	43	150-250 Mbps
	Terrestrial operator 1	89	50 Mbps
Source: The above information is based on data available on operators' website/in public domain			

Annexure 3.8

Tariff for GSO based MSS service

Prepaid Tariff Plan for Global Satellite Phone Services

		Government Users			Commercial Users	
Sl.	**Particulars**	-	**Plan G1 (monthly)**	**Plan GA (annual)**	**Plan C1 (monthly)**	**Plan CA (annual)**
1	**Initial One Time Payment/ Startup Kit with GSPS Handset**					
1.1	**Registration Amount (in Rs.)**		1,000	1,000	1,000	1,000
1.2	**GSPS Handset Cost (in Rs.)**		90,000	90,000	90,000	90,000
1.3	**Activation Charges including SIM (in Rs.)**		500	500	500	500
1.4	**Annual WPC Charges to be deposited to WPC, DoT (including license fee and spectrum Charges (in Rs.)**		14,250	14,250	14,250	14,250
2(a)	**Mandatory Minimum Monthly Recharge (in Rs.) (Plan Voucher Validity 30 days)**	-	3,000	N/A	5,000	N/A
2(b)	**Mandatory Minimum Annual Recharge (in Rs.) (Plan Voucher Validity 365 days)**	-	N/A	33,000	N/A	55,000
2.1	No. of Free Calls/SMS (National)	-	100	1200	150	1800
2.2	Top up value	200 / 500/ 1000			200/500/1000	
		During Disaster	During Normal time		-	-
3	**Call Charges National**					
3.1	Pulse rate of National Call	60 Sec.	60 Sec.	60 Sec.	60 Sec.	60 Sec.
3.2	Call Charges (National Calls)	Rs./Min.	Rs./Min.	Rs./Min.	Rs./Min.	Rs./Min.
3.2.1	GSPS originating to PSTN/PLMN (outgoing call charges to GSPS user)	12	18	18	25	25
3.2.2	GSPS Terminating from PSTN/PLMN (incoming call charges to GSPS user)	12	18	18	25	25
3.2.3	GSPS originating to GSPS Terminating (both GSPS users will be charged separately)	12	18	18	25	25
3.2.4	Per SMS Charge to GSPS Originating	12	18	18	25	25
4	**Call Charges International Calls**					
4.1	Pulse rate of International Call	N/A	60 Sec.	60 Sec.	60 Sec.	60 Sec.
4.2	Call Charges International/ Roaming Call	Rs./Min.	Rs./Min.	Rs./Min.	Rs./Min.	Rs./Min.
4.2.1	GSPS originating to PSTN/PLMN (outgoing call charges to GSPS user)	N/A	260	260	260	260
4.2.2	GSPS Terminating from PSTN/PLMN (incoming call charges to GSPS user)	N/A	260	260	260	260
4.2.3	GSPS originating to GSPS Terminating (both GSPS users will be charged separately)	N/A	260	260	260	260
4.2.4	Per SMS Charge to GSPS Originating & GSPS terminating	N/A	260	260	260	260

Post-paid Tariff Plan for Global Satellite Phone Services

		Government Users			Commercial Users
Sl.	**Particulars**	-	**Plan G1**	**Plan G3**	**Plan C1**
1	**Initial one time Payments**				
1.1	**Registration Amount (in Rs.)**		1000	1000	1000
1.2	**GSPS Handset Cost (in Rs.)**		90,000	90,000	90,000
1.3	**Activation Charges including SIM (in Rs.)**		500	500	500
1.4	**Annual WPC Charges to be deposited to WPC, DoT including license fee and spectrum Charges (in Rs.)**		14250	14250	14250
2	**Security Deposit**				
2.1	**National Calls**		5000	5000	5000
2.2	**International Calls**		10000	10000	10000
2.3	**International Roaming**		15000	15000	15000
3	**Fixed Monthly Charges/ Rental**	-	3000	5000	10000
4	**Freebies offered per month**	-	-	-	-
4.1	No. of Free Calls/SMS (National)	-	80	150	300
5	**Call Charges National**	During Disaster	During Normal time		
5.1	Pulse rate of National Call	60 Sec.	60 Sec.	60 Sec.	60 Sec.
5.2	Call Charges National	Rs./Min.	Rs./Min.	Rs./Min.	Rs./Min.
5.2.1	GSPS originating to PSTN/ PLMN (outgoing call charges to GSPS user)	12	18	18	25
5.2.2	GSPS Terminating from PSTN/ PLMN (incoming call charges to GSPS user)	12	18	18	25
5.2.3	GSPS originating to GSPS Terminating (both GSPS users will be charged separately)	12	18	18	25
5.2.4	Per SMS Charge to GSPS Originating	12	18	18	25
6	**Call Charges International**				
6.1	Pulse rate of International Call	N/A	60 Sec.	60 Sec.	60 Sec.
6.2	Call Charges International/ Roaming	Rs./Min.	Rs./Min.	Rs./Min.	Rs./Min.
6.2.1	GSPS originating to PSTN/ PLMN (outgoing call charges to GSPS user)	N/A	265	265	265
6.2.2	GSPS Terminating from PSTN/ PLMN (incoming call charges to GSPS user)	N/A	265	265	265
6.2.3	GSPS originating to GSPS Terminating (both GSPS users will be charged separately)	N/A	265	265	265
6.2.4	Per SMS Charge to GSPS Originating & GSPS terminating	N/A	265	265	265

List of Acronyms

Acronyms	Description
2G	2nd Generation
3GPP	3rd Generation Partnership Project
5G	5th Generation
6G	6th Generation
ADP	Auction Determined Prices
AGR	Adjusted Gross Revenue
BG	Bank Guarantee
Bps	bits per second
Kbps	Kilo bits per second
Bs	Bandwidth Factor
BSNL	Bharat Sanchar Nigam Limited
BSS	Broadcasting Satellite Services
CAGR	Compound Annual Growth Rate
CNPN	Captive Non Public Network
CP	Consultation Paper
CUG	Closed User Group
D2D	Direct-to-Device
DBNF	Digital Bharat Nidhi Fund
DBT	Direct Benefit Transfer
DCP	Digital Communication Provider
DoT	Department of Telecommunications
DSNG	Digital Satellite News Gathering
DTH	Direct to Home
EESS	Earth Exploration Satellite Services
EIRP	Equivalent Isotropically Radiated Power
EPFD	Equivalent Power Flux Density
ESIM	Earth Stations in Motion
FCC	Federal Communication Commission
FS	Fixed Service
FSS	Fixed Satellite Service
FWA	Fixed Wireless Access

Acronyms	Description
FY	Financial Year
GEZ	Gateway Exclusion Zones
GHz	Giga Hertz
GMPCS	Global Mobile Personal Communication by Satellite
GR	Gross revenue
GSO	Geostationary Orbit
GSPS	Global Satellite Phone Service
HDFSS	High Density Fixed Satellite Services
HITS	Headend-in-the-Sky
HTS	High Throughput Satellite
ICRIER	Indian Council for Research on International Economic
IFMC	In-Flight and Maritime Connectivity
ILD	International Long Distance
IMT	International Mobile Telephony
IN-SPACe	Indian National Space Promotion & Authorisation Centre
IoT	Internet of Things
IPLC	International Private Leased Circuit
ISP	Internet Service Provider
ITU	International Telecommunication Union
ITU-R	International Telecommunication Union Radiocommunication
ITU-RR	ITU Radio Regulations
KHz	Kilo Hertz
KM	Kilo Meter
LD	Liquidated Damages
LEO	Low Earth Orbit
LOI	Letter of Intent
LSA	Licensed Service Area
M2M	Machine to Machine
MEO	Medium Earth Orbit
MES	Mobile Earth Station
MHz	Mega Hertz
MNO	Mobile Network Operator
MSS	Mobile-satellite service
MWA	Microwave Access

Acronyms	Description
NFAP	National Frequency Allocation Plan
NGSO	Non-Geostationary Orbit
NIA	Notice Inviting Application
NLD	National Long Distance
NOCC	Network Operations and Control Centre
NTN	Non-Terrestrial Network
N_u	Number of subscribers in urban areas
OFCOM	Office of Communications
OHD	Open House Discussion
PFD	Power Flux Density
PLMN	Public Land Mobile Network
PSTN	Public Switched Telephone Network
SATCOM	Satellite Communications
SESG	Satellite Earth Station Gateway
SMC	Satcom Monitoring Centre
SOS	Save Our Souls
SRS	Space Research Service
SUC	Spectrum Usage Charge
Tbps	Tera bits per second
TEC	Telecommunication Engineering Centre
TRAI	Telcom Regulatory Authority of India
TSP	Telecom Service Provider
UASL	Unified Access Service License
UK	United Kingdom
UL	Unified License
UL (VNO)	UL (Virtual Network Operator)
USA	United States of America
USO	Universal Service Obligation
USOF	Universal Service Obligation Fund
UT	User Terminal
VPN	Virtual Private Network
VSAT	Very Small Aperture Terminal
VSAT CUG	VSAT Closed User Group
WPC	Wireless Planning and Coordination Wing

Acronyms	Description
WRC	World Radiocommunication Conference
WTP	Willingness To Pay