OneWeb India Communications Private Limited
Tower-B, Knowledge Boulevard, Sector-62
NOIDA Gautam Buddha Nagar UP
201301 IN

TRAI/FY23-24/OW/22
Dated: 01.06.2023

To,
Shri Akhilesh Kumar Trivedi,
Advisor (Network, Spectrum and Licensing)
Telecom Regulatory Authority of India,
Mahanagar Door Sanchar Bhawan,
JawaharLal Nehru Marg,
New Delhi – 110 002.

Subject: Response to Consultation Paper on "Assignment of Spectrum for Space-based Communication Services"

Dear Sir,

This is in reference to TRAI's Consultation Paper on "Assignment of Spectrum for Space-based Communication Services" dated 06.04.2023 (CP No. 6/2023).

In this regard, please find enclosed our response for your kind consideration.

Thanking you,

Yours sincerely,
For **OneWeb India Communications Private Limited**

Rahul Vatts
Director

OneWeb India Communications Pvt. Ltd.
Assignment of Spectrum for Space-based Communication Services

At the onset, OneWeb would like to thank the Telecom Regulatory Authority of India for the opportunity to provide comments on their Consultation Paper on Assignment of Spectrum for Space-based Communication Services.

OneWeb has finished deploying all its gen-1 satellites to ensure the global coverage, and is busy deploying the ground infrastructure, including 2 gateway earth stations in India. The primary goal of OneWeb satellite network is to bridge the digital divide by catering to populations that are currently underserved by traditional terrestrial broadband solutions, including rural and remote areas with limited or no access to high-speed internet. OneWeb is able to deliver low-latency, high-speed broadband services to these communities, fostering economic growth, enhancing educational opportunities, and improving access to healthcare services through telemedicine.

The success of our mission depends on the efficient and interference-free use of the entire Ku band for our User terminals and entire Ka band spectrum for our gateways, albeit on a shared basis with other satellite operators.

OneWeb is pleased to provide our views on this important consultation, key points of our input include:

- Satellite spectrum is used differently than terrestrial mobile spectrum. While mobile operators require exclusive access to a portion of a frequency range, **several satellite operators can share the entire range of the spectrum**. Therefore, mobile spectrum management and assignment, including auction mechanism, cannot be adopted for satellite.

- **The International Telecommunication Union (ITU) plays an essential role in managing the use of satellite spectrum globally**, facilitate the implementation of various coordination and interference mitigation techniques that help maintain a harmonious and well-regulated satellite communications environment. Satellite systems operate within a predefined range of frequencies, which are filed with the ITU and undergo a lengthy and rigorous process of notification and registration into the Master International Frequency Register (MIFR), adhering to strict ITU Radio Regulations.
- **Satellite spectrum can only be assigned administratively**, on a shared basis with other satellite operators, considering the complexity and coordination required for satellite services. This approach is the recommended approach for satellite spectrum by ITU, and widely adopted internationally. It ensures stability and confidence for satellite operators and for the satellite industry to thrive.
- **Auctioning of satellite spectrum is not a feasible solution**, as it introduces artificial scarcity and limits competition. Satellite spectrum assignments must consider the global nature of satellite operations, which serve multiple countries from a single satellite or satellite constellation. As such, spectrum assignment processes need to be harmonized and coordinated on an international level, rather than exclusively addressing national market considerations.
- Implementing artificial scarcity for the sake of auction will result in inefficient use of the satellite spectrum resource and is against the fundamental principle of spectrum management. India will throttle needlessly its own space ecosystem as this not only limits the number of satellite operators to provide comprehensive services across multiple regions, but it also reduces

competition and prevent its citizen and business from accessing the full readily available satellite capacity over India.

- **Satellite services genuinely provide connectivity to populations that are currently underserved** to fostering economic growth of those communities, enhancing educational opportunities, and improving access to healthcare services through telemedicine, ensuring no one is left behind through the digital society. Auctioning satellite spectrum could lead to a prioritization of revenue generation over these public interest considerations, ultimately undermining the essential services that satellite communications can offer.
- **Access to user and gateway links spectrum are both critical** for our service and our network, although the spectrum band required, and timing may differ between different generations of our constellation. However, it is crucial to maintain a coordinated approach to ensure seamless operation of satellite services.
- **The 27.5-28.5 GHz band is critical for satellite services**, particularly for NGSO systems. Recent cancellation of 5G licenses in this band after 5 years in Korea demonstrated that mobile operators do not require this band. The TRAI should recommend the DoT to refrain from licensing this band for 5G, at least until further assessments of the mobile ecosystem's needs and developments are carried out.

In summary, **OneWeb respectively submit that administrative assignment of spectrum, on a non-exclusive basis, is the only mechanism for space-based communication services**, and any auction mechanism is detrimental to both the satellite industry and Indian citizens.

Please find our responses to specific questions in the subsequent pages. Please do not hesitate to contact us if you would like to discuss the content further.

OneWeb responses to selected questions of the TRAI Consultation on Assignment of Spectrum for Space-based Communication Services

Q1. For space-based communication services, what are the appropriate frequency bands for (a) gateway links and (b) user links, that should be considered under this consultation process for different types of licensed telecommunications and broadcasting services? Kindly justify your response with relevant details.

In general, all spectrum assigned for space based communications services as per the ITU Radio Regulation and the India NFAP should be considered in the scope.

More specifically, **OneWeb User Terminals and Gateway Earth Stations will utilise the following Ku and Ka-band Fixed Satellite Service (FSS) for service links and feeder links:**

Type of Link and Direction	**Frequencies**
UT to satellite (Earth-to-space)	14.0 - 14.50 GHz
Satellite to UT (Space-to-earth)	10.7 - 12.7 GHz
Gateway to Satellite (Earth-to-space)	27.5 - 29.1 GHz 29.5 - 30.0 GHz
Satellite to Gateway (Space-to-earth)	17.8 - 18.6 GHz 18.8 - 19.3 GHz

Table 1. OneWeb GEN-1 frequencies

In addition, OneWeb has also ITU Filing in the Q/V band (37.5-52.4 GHz) for its future GEN-2 feeder links.

Q2. What quantum of spectrum for (a) gateway links and (b) user links in the appropriate frequency bands is required to meet the demand of space-based communication services?

Information on present demand and likely demand after about five years may kindly be provided in two separate tables as per the proforma given below:

OneWeb's GEN-1 satellite design **necessitates access to the entire Ku-band and Ka-band spectrum** as specified in the Table 1 above. In addition, the full Q/V band would be necessary for our gateway links when the GEN-2 come into service in about 5 years.

Importantly, providing access to only a portion of the spectrum would have serious consequences for our network's overall performance and could lead to inefficiencies and coverage gaps. In particular, gateway links play a critical role in maintaining the network's connectivity, without accessing to the entire range, seamless coverage over India and South Asia would be compromised, negatively impacting the end-users who depend on these satellite services.

To ensure that OneWeb's satellite network can deliver optimal performance and uninterrupted coverage, it is crucial that the full Ku-band and Ka-band spectrum, and Q/V band at a later stage, to be made available for use, albeit on a shared basis with other satellite operators. This will enable OneWeb to continue providing vital satellite services and play a pivotal role in bridging the digital divide in India and beyond.

Q3. Whether there is any practical limit on the number of Non-Geo Stationary Orbit (NGSO) satellite systems in Low Earth Orbit (LEO) and Medium Earth Orbit (MEO), which can work in a coordinated manner on an equitable basis using the same frequency range? Kindly justify your response.

NGSO constellations varies greatly in design, orbital altitudes, and frequency usage, etc. OneWeb is confident **several LEO and MEO constellations can co-exist and share the spectrum resources**, if the ITU coordination rules are respected. Furthermore, the ITU Radio Regulation Article 22 has adopted equivalent power flux-density ("EPFD") limits to

protect GSO satellites against unacceptable interference from NGSO satellite systems, ensuring the GSO and NGSO can coexist interference free.

At OneWeb we are currently proactively engaging in coordination with all satellites systems that have an earlier ITU date of protection, and we expect other operators with systems that have a later protection date, to proactively coordinate with us. This is key to guarantee that satellite services can be provided free of interference.

Q4. For space-based communication services, whether frequency spectrum in higher bands such as C band, Ku band and Ka band, should be assigned to licensees on an exclusive basis? Kindly justify your response. Do you foresee any challenges due to exclusive assignment? If yes, in what manner can the challenges be overcome? Kindly elaborate the challenges and the ways to overcome them.

There are fundamental differences between terrestrial mobile operator spectrum and satellite spectrum. Terrestrial operators require exclusive spectrum rights due to the nature of their operations and the infrastructure they employ, exclusive access to spectrum eliminates the meticulous process of coordinating each base station individually.

In contrast, the **modus operandi of satellite spectrum allocation is fundamentally non-exclusive**. This approach necessitates satellite operators to meticulously coordinate their use of the spectrum to prevent interference. As a result, it enables an array of satellites to utilize the same frequency concurrently. This simultaneous usage, in turn, can potentially generate a magnitude of capacity far beyond what a single operator could achieve on its own. This efficient use of spectrum is at the heart of satellite operations, fostering a system that optimizes the shared resource for maximum benefit. Consequently, satellite spectrum is never exclusively assigned, as opposed to mobile access spectrum.

It is well known that satellite spectrum is not restricted by national territorial boundaries. More importantly, the satellite spectrum is shared among various operators within the Fixed

Satellite Service (FSS) and Broadcasting Satellite Service (BSS) sectors, and through the deployment of satellites in both geostationary (GEO) and non-geostationary (non-GSO) orbits.

The coordination of satellite spectrum usage takes place at a global level, adhering to strict ITU Radio Regulations. The ITU plays an essential role in promoting the efficient use of satellite spectrum, facilitate the implementation of various coordination and interference mitigation techniques that help maintain a harmonious and well-regulated satellite communications environment.

Satellite systems operate within a predefined range of frequencies, which are filed with the ITU and undergo a lengthy and rigorous process of notification and registration into the Master International Frequency Register (MIFR). Once a satellite system's frequencies have been registered, they cannot be altered based on the outcome of spectrum assignment decisions in a specific market. This highlights the importance of long-term planning and international coordination in the satellite industry, as operators must carefully plan their spectrum resources to ensure continued, reliable service to their customers.

Q5. In case it is decided to assign spectrum in higher frequency bands such as C band, Ku band and Ka band for space-based communication services to licensees on an exclusive basis,

(a) What should be the block size, minimum number of blocks for bidding and spectrum cap per bidder? Response may be provided separately for each spectrum band.

(b) Whether intra-band sharing of frequency spectrum with other satellite communication service providers holding spectrum upto the prescribed spectrum cap, needs to be mandated?

(c) Whether a framework for mandatory spectrum sharing needs to be prescribed?

If yes, kindly suggest a broad framework and the elements to be included in the guidelines.

(d) Any other suggestions to ensure that that the satellite communication ecosystem is not adversely impacted due to exclusive spectrum assignment, may kindly be made with detailed justification.

As explained in the previous answer, **satellite spectrum, specifically for FSS and BSS, cannot be allocated on an exclusive basis**, and therefore an auction model cannot be considered. Additionally, concepts such as block size, spectrum cap, and intra-band share, originate from terrestrial mobile spectrum management, the principles governing satellite spectrum management differ significantly from those applied to terrestrial mobile spectrum.

The entire frequency band must be allocated on a non-exclusive basis as emphasized earlier. FSS satellite spectrum is shared among multiple operators and coordinated at the ITU level. Segmenting the frequency band into portions or blocks, akin to terrestrial spectrum management practices, would lead to the fragmentation of satellite spectrum, subsequently diminishing throughput and data speeds in proportion to the fragmentation. Consequently, this fragmentation would result in a considerable reduction in spectrum usage efficiency, which contravenes the fundamental objective of efficient usage of spectrum.

Furthermore, certain system designs, such as the one utilized by **OneWeb, necessitate access to the entire band to ensure the delivery of seamless, uninterrupted service**. **This level of access is achievable within a shared basis**, as it harnesses the potential of spectrum coordination. However, such wide-ranging usage would be unattainable under an exclusive spectrum allocation model, where each operator is limited to a specific portion of the spectrum. This underscores the inherent flexibility and capability that shared spectrum usage offers for diverse system requirements.

Q6. What provisions should be made applicable on any new entrant or any entity who could not acquire spectrum in the auction process/assignment cycle?

i. **Whether such entity should take part in the next auction/ assignment cycle after expiry of the validity period of the assigned spectrum? If yes, what should be the validity period of the auctioned/assigned spectrum?**

ii. **Whether spectrum acquired through auction be permitted to be shared with any entity which does not hold spectrum/ or has not been successful in auction in the said band? If yes, what measures should be taken to ensure rationale of spectrum auction and to avoid adverse impact on the dynamics of the spectrum auction?**

iii. **In case an auction based on exclusive assignment is held in a spectrum band, whether the same spectrum may again be put to auction after certain number of years to any new entrant including the entities which could not acquire spectrum in the previous auction? If yes,**

(i) After how many years the same spectrum band should be put to auction for the potential bidders?

(ii) What should be the validity of spectrum for the first conducted auction in a band? Whether the validity period for the subsequent auctions in that band should be co-terminus with the validity period of the first held auction?

Unlike terrestrial operators, who have access to various spectrum bands and can enable or disable their base stations based on demand and network requirements, satellite systems such as OneWeb are designed to operate consistently on the same frequency range across the globe, as per their ITU filings. OneWeb satellites cannot swap to different frequencies depending on the territory it flies over; this necessitates a coordinated approach at the ITU

to allow the full spectrum band to be used by OneWeb, alongside other operators. This harmonized approach ensures that all satellite operators coordinated through ITU process can deliver seamless, reliable services to users worldwide, regardless of the specific country or region in which they operate.

Therefore, **limited or partial access to the required spectrum, through various assignment cycles, as done for terrestrial spectrum auction, makes it impossible for a satellite operator such as OneWeb to provide service**. This lack of access not only reduces competition but also eliminates the presence of a global player capable of addressing the digital divide and expanding connectivity to underserved regions. In such a scenario, consumers are adversely affected, as they lose out on the potential benefits that increased competition and greater choice among service providers could bring. Ensuring fair and comprehensive access to satellite spectrum is essential for fostering a competitive and innovative satellite communications ecosystem.

The US Orbit Act 2000 exemplifies the importance of safeguarding the public interest in satellite spectrum allocation. The legislation specifically aims to prevent the assignment of international orbital locations or spectrum used for the provision of vital services through competitive bidding. By doing so, the Orbit Act underscores the need to prioritize the public interest and maintain the unique characteristics of satellite spectrum allocation that enable the delivery of essential services to communities around the world.

The unique nature of satellite spectrum allocation, its harmonized approach at the ITU Regional level, and its potential to provide critical services with societal benefits all highlight the importance of ensuring fair and comprehensive access to satellite spectrum. By taking these factors into account and prioritizing the public interest, a competitive assignment model cannot be used for satellite spectrum.

Q7. Whether any entity which acquired the satellite spectrum through auction/assignment should be permitted to trade and/or lease their partial or entire satellite spectrum holding to other eligible service licensees, including the licensees which do not hold any spectrum in the concerned spectrum band? If yes, what measures should be taken to ensure rationale of spectrum auction and to avoid adverse impact on the dynamics of the spectrum auction?

Again, Spectrum trading is a concept from terrestrial mobile spectrum management, suitable for exclusive spectrum. As explained in previous answers, satellite spectrum is sharable in nature and therefore this concept cannot apply.

Q8. For the existing service licensees providing space-based communication services, whether there is a need to create enabling provisions for assignment of the currently held spectrum frequency range by them, such that if the service licensee is successful in acquiring required quantum of spectrum through auction/ assignment cycle in the relevant band, its services are not disrupted? If yes, what mechanism should be prescribed?

Given the unique nature of the satellite industry and its distinctive use of spectrum, as discussed above. Introducing an exclusivity-based spectrum assignment model, such as through auctions, could have far-reaching implications for the satellite industry, its consumers, and the broader economy. **An auction-based approach for the assignment of currently held spectrum frequency ranges for existing service licensees is not feasible.**

This approach would disrupt established satellite services. The existing operators have designed their networks based on the principle of shared spectrum usage, and forcing them into an exclusive spectrum model could render their investments unviable, causing significant service disruptions. Such disruptions would adversely affect a wide range of consumers and industries that rely on these services, from remote communities to critical sectors like defense, disaster management.

Additionally, such a change could lead to serious legal implications. Existing operators could potentially challenge the change on grounds of fairness and the protection of their investments and vested rights. This could result in protracted legal battles, creating uncertainty in the industry and potentially deterring future investment.

Q9. In case you are of the opinion that the frequency spectrum in higher frequency bands such as C band, Ku band and Ka band for space- based communication services should be assigned on shared (non- exclusive) basis, -

(a) Whether a broad framework for sharing of frequency spectrum among satellite communication service providers needs to be prescribed or it should be left to mutual coordination? In case you are of the opinion that broad framework should be prescribed, kindly suggest the framework and elements to be included in such a framework.

(b) Any other suggestions may kindly be made with detailed justification.

For **Fixed satellite service spectrum, shared basis is the only viable approach to ensure the efficient utilization of this resource**. This principle allows multiple satellite operators to access and coordinate spectrum usage, promoting optimal use of the available frequencies.

The framework for coordination already exists at the ITU level and should not be determined at the national level. By adhering to the current ITU framework and Coordination Procedures, 99.95% of spectrum assigned to satellite networks has been free from reported harmful interference. This impressive statistic demonstrates the robustness of the existing framework. The principle that the right to use orbital and spectrum resources for a satellite network or system is acquired through negotiations concerned with the actual

usage has proven to be the most effective means of achieving rational, cost-effective, and efficient spectrum and orbital management.

Q10. In the frequency range 27.5-28.5 GHz, whether the spectrum assignee should be permitted to utilize the frequency spectrum for IMT services as well as space-based communication services, in a flexible manner? Do you foresee any challenges arising out of such flexible use? If yes, in what manner can the challenges be overcome? Kindly elaborate the challenges and the ways to overcome them.

OneWeb is using the full 27.5-29.1 and 29.5-30.0GHz for its gateways in India, any presence of IMT or other services including Satellite user terminals, Fixed or in Motion, within vicinity of the gateway locations could create potential interference, and impact the OneWeb service in India and whole South Asian region. OneWeb request TRAI to implement rules that determine a coordination distance threshold, requiring new services (mobile or satellite) to seek coordination with existing gateway licensees. The distance needed to ensure an interference-free operation depends on the technical characteristics of the Gateway, this distance being very different depending on these characteristics and terrain. It is therefore advisable that instead of a coordination threshold distance, a power flux-density (PFD) threshold or another technical threshold for such coordination be adopted.

Several countries that initially deviated from ITU recommendations by allocating the 28GHz band for terrestrial mobile services are now re-evaluating their decisions and taking corrective actions. Korea for example were the first country to assign the 28GHz to 5G, however after 4 years, the ministry has decided to cancel the 28GHz license of all 3 MNOs because of lack of usage. Consequently, TRAI should advise the DoT to refrain from licensing the 27.5-28.5 GHz band for 5G at this stage and instead conduct a thorough assessment of the genuine requirements and development of the mobile ecosystem within this frequency range.

Q11. In case it is decided to permit flexible use in the frequency range of 27.5 - 28.5 GHz for space-based communication services and IMT services, what should be the associated terms and conditions including eligibility conditions for such assignment of spectrum?

In the case DoT still decide to go with assignment to IMT against ITU Radio Regulation, we must note that 5G deployment utilizing mmWave bands is primarily effective in highly populated urban centers due to its limited range and high-capacity capabilities. As a result, it would be more appropriate to consider issuing location-specific licenses for IMT rather than nationwide licenses, on a non-interference, non-protection basis. This will offer more potential for coexistence with satellite gateways.

Q12. Whether there is a requirement for permitting flexible use between CNPN and space-based communication services in the frequency range 28.5-29.5 GHz?

The goal of a private networks using IMT technology is to access the economies of scale of IMT ecosystem and make best use of the lower cost equipment to implement private network. Implementing such network outside of globally harmonised IMT spectrum band is defeating the purpose. The ecosystem in the 29GHz is non existing, it is therefore better to find alternative internationally harmonised IMT band instead of 29GHz for CNPN.

Q13. Do you foresee any challenges in case the spectrum assignee is permitted to utilize the frequency spectrum in the range 28.5-29.5 GHz for cellular based CNPN as well as space-based communication services, in a flexible manner? What could be the measures to mitigate such challenges? Suggestions may kindly be made with justification.

Same as above, there is no rational to introduce CNPN within a non IMT band. If DoT, despite the risk jeopardizing the whole satellite industry, decide to go ahead and assign this band for CNPN, it should be on a localised license on non-interference, non-protection basis.

Q14. Whether space-based communication services should be categorized into different classes of services requiring different treatment for spectrum assignment? If yes, what

should be the classification of services and which type of services should fall under each class of service? Kindly justify your response. Please provide the following details:

a) Service provider-wise details regarding financial and market parameters such as total revenue, total subscriber base, total capital expenditure etc. for each type of service (as mentioned in the Table 1.3 of this consultation paper) for the financial year 2018-19, 2019-20, 2020-21, 2021-22, and 2022-23 in the format given below:

Type of service:				
Financial Year	**Revenue (Rs. lakh)**	**Subscriber base**	**CAPEX for the year (Rs. lakh)**	**Depreciation for the year (Rs. lakh)**
2018-19				
2019-20				
2020-21				
2021-22				
2022-23				

b) Projections on revenue, subscriber base and capital expenditure for each type of service (as mentioned in the Table 1.3 of this consultation paper) for the whole industry for the next five years starting from financial year 2023-24, in the format given below:

Type of service:			
Financial Year	**Revenue (Rs. lakh)**	**Subscriber base**	**CAPEX for the year (Rs. lakh)**
2023-24			
2024-25			
2025-26			
2026-27			
2027-28			

There is no need for space-based communication services to be categorised into different classes of services requiring different treatment for spectrum assignment since multiple services share (and are already being provided to use) the same frequency bands, which are currently being assigned on an administrative basis.

Thus, **there is no need to bring in additional complexity by categorising space-based communication services into different service classes requiring different treatments for spectrum assignment.**

Q15. What should be the methodology for assignment of spectrum for user links for space-based communication services in L-band and S-band, such as-

(a) Auction-based

(b) Administrative

(c) Any other?

These bands are usually for Mobile Satellite Service, which generally requires exclusive access to spectrum and therefore different than FSS. Depending on demand and supply, a market-based approach may be appropriate.

Q16. What should be the methodology for assignment of spectrum for user links for space-based communication services in higher spectrum bands like C-band, Ku-band and Ka-band, such as

(a) Auction-based

(b) Administrative

(c) Any other?

These bands are for BSS and FSS. Considering the various factors discussed in the previous responses, it is clear that **administrative allocation is the only suitable approach for assigning fixed satellite spectrum.**

Satellite services operate on a non-exclusive basis, coordinating with other operators to enable multiple satellites to use the same frequency band simultaneously. This shared use, which allows for maximized capacity and efficient use of the spectrum, would not be achievable with an exclusive, auction-based assignment.

Auctions could potentially create a scenario where deep-pocketed entities monopolize the spectrum, thus stifling competition and innovation in the industry. The single or few operators are only able to provide a fraction of the total capacity available over India. By adopting an administrative allocation approach, regulators can ensure that satellite spectrum is assigned efficiently and effectively, supporting the ongoing growth and development of the satellite communications industry while safeguarding the essential services that satellite networks provide.

Please provide your response in respect of different types of services (as mentioned in Table 1.3 of this consultation paper).

Q17. Whether spectrum for user links should be assigned at the national level, or telecom circle/ metro-wise?

Assigning user links on a national level is indeed a logical approach for licensing satellite services, as it offers several advantages that cater to the unique nature of satellite communications:

- Satellite services inherently provide extensive coverage, making them ideal for serving vast geographical areas within a country. National-level licensing ensures that satellite user devices can be used consistently and seamlessly across the entire nation.

- Satellite services are characterized by their transportable nature, allowing users to maintain connectivity even when moving between different locations. By assigning user links on a national level, regulators can ensure that users can fully leverage the benefits of transportable satellite services without encountering licensing restrictions or limitations based on regional boundaries.

- National-level licensing streamlines the administrative process for both regulators and satellite service providers, as it avoids the need for managing multiple regional licenses. This simplified approach reduces bureaucratic hurdles, making it easier for providers to deploy their services across the country.

- Satellite services play a critical role in disaster recovery and emergency response efforts. By assigning user links on a national level, regulators can facilitate the rapid deployment of satellite communications during emergencies, ensuring that vital services remain accessible even in remote or affected areas.

- Satellite services have the potential to bridge the digital divide by providing connectivity to underserved and rural areas. National-level licensing enables satellite operators to offer their services to a broader user base, promoting digital inclusion and ensuring that all citizens have access to essential communications services.

Q18. In case it is decided to auction user link frequency spectrum for different types of services, should separate auctions be conducted for each type of services? Kindly justify your response with detailed methodology.

Considering the various factors discussed in the previous responses, it is clear that auction is not feasible for satellite spectrum.

Q19. What should be the methodology for assignment of spectrum for gateway links for space-based communication services, such as

(a) Auction-based

(b) Administrative

(c) Any other?

Please provide your response in respect of different types of services. Please support your response with detailed justification.

Assigning satellite spectrum for gateway operations administratively is the only appropriate approach, given the considerations presented in the previous answers.

Gateway frequencies are used at specific locations only, which makes them even more suitable for sharing among different satellite operators compared to user link spectrum. This localized usage of frequencies allows for greater coordination and sharing of spectrum resources, promoting more efficient utilization of the available frequencies.

Furthermore, a **competitive bidding process for gateway spectrum may create contradictions with existing regulatory requirements in India to establish a gateway in the country**. Failure to obtain the necessary gateway spectrum through an auction might result in satellite operators being unable to meet their regulatory obligations, leading to an artificial barrier to compliance.

Gateway operations are critical to maintaining the reliability and resilience of satellite networks. By assigning gateway spectrum administratively, regulators can ensure that satellite operators have the necessary resources to establish robust and reliable communications links between satellites and terrestrial networks, ultimately contributing to the overall stability of the satellite communications ecosystem.

Q20. In case it is decided to auction gateway link frequency spectrum for different types of services, should separate auctions be conducted for each type of services? Kindly justify your response with detailed methodology.

Considering the various factors discussed in the previous responses, it is clear that auction is not feasible for satellite spectrum.

Q21. In case it is decided to assign frequency spectrum for space-based communication services through auction,

(a) What should be the validity period of the auctioned spectrum?

(b) What should be the periodicity of the auction for any unsold/ available spectrum?

(c) Whether some mechanism needs to be put in place to permit the service licensee to shift to another satellite system and to change the frequency spectrum within a frequency band (such as Ka- band, Ku-band, etc.) or across frequency bands for the remaining validity period of the spectrum held by it? If yes, what process should be adopted and whether some fee should be

charged for this purpose?

Considering the various factors discussed in the previous responses, it is clear that auction is not feasible for satellite spectrum.

Q22. Considering that (a) space-based communication services require spectrum in both user link as well as gateway link, (b) use of frequency spectrum for different types of links may be different for different satellite systems, and (c) requirement of frequency spectrum may also vary depending on the services being envisaged to be provided, which of the following would be appropriate:

(i) to assign spectrum for gateway links and user links separately to give flexibility to the stakeholders? In case your response is in the affirmative, what mechanism should be adopted such that the successful bidder gets spectrum for user links as well as gateway links.

or

(ii) to assign spectrum for gateway links and user links in a bundled manner, such that the successful bidder gets spectrum for user link as well as gateway link? In case your response is in the affirmative, kindly suggest appropriate assignment methodology, including auction so that the successful bidder gets spectrum for user links as well as gateway links.

It is clear that for any satellite system, the assignment of both user links and gateway links is vital. A satellite service provider would be unable to operate effectively if they have only partial or no gateway link spectrum assigned, even when granted to their required user link spectrum. Consequently, a coordinated and bundled approach to assigning spectrum for user links and gateway links is necessary to ensure the seamless operation of satellite services.

However, separate assignments for user and gateway links could be considered. The service provider could initially apply for the gateway spectrum, and once it becomes operational, proceed with the application for the user link spectrum. It is important for satellite service providers to have the flexibility to obtain authorizations as their needs evolve after obtaining their license.

Adopting this approach allows satellite operators to effectively respond to changing demands and requirements, ensuring efficient use of spectrum resources and the continued delivery of quality satellite services. For example, in the case of OneWeb, we are planning to use additional spectrum in the Q/V band for our Gen-2 gateways. Therefore, we could apply for those additional band just for the gateway in the future.

Q23. Whether any protection distance would be required around the satellite earth station gateway to avoid interference from other satellite earth station gateways for GSO/ NGSO satellites using the same frequency band? If yes, what would be the protection distance (radius) for the protection zone for GSO/ NGSO satellites?

GSO and NGSO gateways can generally coexist, due to various implementation of GSO arc avoidance by NGSO systems to comply with EPFD limit.

Coordination is required between NGSO gateways and generally some separation distances are necessary. This can also be ensured by taking into account the agreed interference criterion and the technical characteristics of the systems involved, as part of the overall system coordination. The matter is better left to satellite operators in the context of the coordination process, as this is entirely dependent on the specific characteristics of the different gateways/systems/networks.

OneWeb is using the full 27.5-29.1 and 29.5-30.0GHz for its gateways in India. OneWeb request TRAI to implement rules that determine a coordination distance threshold in the

order of 100 km, requiring new NGSO gateway to seek coordination with existing gateway licensees.

Q24. What should be the eligibility conditions for assignment of spectrum for each type of space-based communication service (as mentioned in the Table 1.3 of this Consultation Paper)? Among other things, please provide your inputs with respect to the following eligibility conditions:

(a) Minimum Net Worth

(b) Requirement of existing agreement with satellite operator(s)

(c) Requirement of holding license/ authorization under Unified License prior to taking part in the auction process

Considering the various factors discussed in the previous responses, it is clear that auction is not feasible for satellite spectrum.

Eligibility conditions for the spectrum assignment on the administrative basis should be applied flexibly, taking into account the specific nature of each type of space-based communication service. Those should have the ultimate policy goal to ensure that the spectrum is utilized efficiently, services are provided reliably, and public interest is served.

Typically, the applicant should possess the necessary technical expertise and resources to provide the proposed service. They should also demonstrate compliance with technical standards and regulations. Ability to comply the ITU Radio Regulation and has the ability to coordinate frequency use to avoid harmful interference with other services. The applicant should demonstrate it has the necessary ITU filings and has the local authorisation under the Unified License.

Q25. What should be the terms and conditions for assignment of frequency spectrum for both user links as well as gateway links for each type of space-based communication service? Among other things, please provide your detailed inputs with respect to roll-out obligations

on space-based communication service providers. Kindly provide response for both scenarios viz. exclusive assignment and non- exclusive (shared) assignment with justification.

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

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

Instead, a more flexible and supportive regulatory framework should be established for satellite services, focusing on facilitating their deployment to address coverage gaps and enhance connectivity for unserved or underserved areas.

Q26. Whether the provisions contained in the Chapter-VII (Spectrum Allotment and Use) of Unified License relating to restriction on crossholding of equity should also be made applicable for satellite- based service licensees? If yes, whether these provisions should be made applicable for each type of service separately? Kindly justify your response.

The restriction of crossholding of equity is applicable only on exclusive spectrum usage and is not be made applicable for satellite-based spectrum.

The provisions contained in the Chapter-VII (Spectrum Allotment and Use) of Unified License relating to restriction on crossholding of equity should not be made applicable for satellite- based service licensees.

The restriction on crossholding of equity was introduced to discourage monopoly or the hoarding of spectrum for mobile services (**which is exclusively assigned LSA wise**) in order to ensure adequate competition in the market. *On the contrary, for the provision of satellite-based services, this is not a concern since there is no exclusive spectrum assignment and several satellite operators share the entire spectrum range non-exclusively.*

Cross-holding restrictions should be kept separate for access spectrum in terrestrial networks and access spectrum in cases of satellite communication. This means, an operator holding access spectrum for terrestrial networks should not be allowed to hold any beneficial interests in another operator holding access spectrum for terrestrial networks. However, there should not be any restriction on cross-holding between an operator holding access spectrum for terrestrial networks and an operator holding spectrum for any kind of satellite communication.

In the event, TRAI decides to frame the cross-holding norms for satellite communication services then , within satellite communication, cross-holding restrictions should apply i.e. one operator providing satellite based communication services should not be allowed to hold equity in another legal entity providing satellite based communication services.

Q27. Keeping in view the provisions of ITU's Radio Regulations on coexistence of terrestrial services and space-based communication services for sharing of same frequency range, do you foresee any challenges in ensuring interference-free operation of space-based communication network and terrestrial networks (i.e., microwave access (MWA) and microwave backbone (MWB) point to point links) using the same frequency range in the same geographical area? What could be the measures to mitigate such challenges? Suggestions may kindly be made with justification.

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.

Q28. In what manner should the practice of assignment of a frequency range in two polarizations should be taken into account in the present exercise for assignment and valuation of spectrum? Kindly justify your response.

Polarization should be left to the spectrum assignee to optimise the efficient usage.

Q29. What could be the likely issues, that may arise, if the following auction design models (described in para 3.127 to 3.139) are implemented for assignment of spectrum for user links in higher bands (such as C band, Ku band and Ka band)?

a. **Model #1: Exclusive spectrum assignment**

b. **Model#2: Auction design model based on non-exclusive spectrum assignment to only a limited number of bidders**

What changes should be made in the above models to mitigate any possible issues, including ways and means to ensure competitive bidding? Response on each model may kindly be made with justification.

Issue of Model #1

As mentioned in previous responses, **the exclusive spectrum assignment model is not suitable for satellite operators.**

Concepts such as spectrum blocks and spectrum caps are specific to terrestrial mobile spectrum management and do not apply to satellite services. Satellite systems operate within a predefined range of frequencies, which have undergone a lengthy and rigorous process of notification and registration with the ITU, ultimately leading to inclusion in the Master International Frequency Register (MIFR). As a result, satellite operators cannot selectively choose frequencies based on market spectrum assignments.

Issues of Model #2:

This model **creates an artificial scarcity by limiting the number of licenses available** for satellite operators.

The satellite spectrum is inherently sharable among satellite operators and coordinated at a global level. By restricting the number of operators in a particular market, the full potential of the spectrum is not being utilized, which goes against the fundamental principle of efficient spectrum management.

Moreover, if the Indian authorities decide to limit the number of operators in their market for the purpose of increasing government revenue, it will not only negatively impact the satellite operators who do not obtain a license, but also the consumers in India. As a result of limited licenses, Indian consumers will have fewer choices compared to other markets. Reduced competition often leads to higher consumer prices and lower adoption rates, further exacerbating the digital divide.

Implementing Model #2 may inadvertently hinder the development of satellite services within India, stifling innovation and potentially delaying the deployment of advanced satellite communication technologies. By creating an environment with limited competition, it could discourage new entrants and reduce the incentives for existing operators to invest in network improvements, which ultimately diminishes the quality of service provided to the end-users.

Q30. In your opinion, which of the two models mentioned in Question 29 above, should be used? Kindly justify your response.

As explained in the previous answers, no auction model is an appropriate spectrum assignment method for fixed Satellite spectrum.

Q31. In case it is decided to assign spectrum for user links using model # 2 i.e., non-exclusive spectrum assignment to limited bidders (n+ Δ), then what should be

(a) the value of Δ, in case it is decided to conduct a combined auction for all services

(b) the values of Δ, in case it is decided to conduct separate auction for each type of service

Please provide detailed justification.

Considering the various factors discussed in the previous responses, it is clear that auction is not feasible for satellite spectrum.

Q32. Kindly suggest any other auction design model(s) for user links including the terms and conditions? Kindly provide a detailed response with justification as to how it will satisfy the requirement of fair auction i.e., market discovery of price.

Considering the various factors discussed in the previous responses, it is clear that auction is not feasible for satellite spectrum.

Q33. What could be the likely issues, that may arise, if Option # 1: (Area specific assignment of gateway spectrum on administrative basis) is implemented for assignment of spectrum for gateway links? What changes could be made in the proposed option to mitigate any possible issues?

Administrative assignment for gateway links is indeed the most appropriate approach for managing satellite spectrum. This method has been successfully implemented in numerous countries around the world, ensuring efficient coordination and allocation of spectrum resources for satellite operators.

Globally, it is the only approach to managing satellite gateway spectrum. It ensures efficient spectrum utilization, fosters competition, and enables satellite operators to provide essential services that benefit society as a whole.

The proposal to use auction-determined prices for user links as a basis for charging for spectrum for gateway links is not an appropriate approach for managing satellite spectrum. This method could have negative consequences for the satellite industry and the end-users it serves.

Considering the various factors discussed in the previous responses, it is clear that auction is not feasible for satellite spectrum.

In addition, the pricing mechanisms for user links and gateway links should be kept separate as they serve different purposes and are subject to different regulatory and technical requirements. User links provide connectivity directly to end-users and uses spectrum on a nationwide basis, while gateway links are essential for managing and controlling satellite networks, but only in a single location. Equating the pricing of these two types of spectrum links could result in distorted market signals, leading to inefficient allocation and usage of spectrum resources.

Q34. What could be the likely issues, that may arise, if Option # 2: Assignment of gateway spectrum through auction for identified areas/ regions/ districts is implemented for assignment of spectrum for gateway links? What changes could be made in the proposed option to mitigate any possible issues? In what manner, areas/ regions/ districts should be identified?

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

Moreover, the flexibility of gateway infrastructure allows for the coexistence of multiple satellite systems in the same location. GSO can share gateway locations without causing

interference or affecting the performance of their respective networks. Additionally, these GSO gateways can also be collocated with NGSO antenna gateways, further demonstrating the efficient use of available resources.

Q35. In your view, which spectrum assignment option for gateway links should be implemented?

Administrative assignment is the best and only approach instead of auctions for gateway links, regulators can better ensure the efficient use of spectrum resources, and reduce potential conflicts among operators

Q36. Kindly suggest any other auction design model(s) for gateway links including the terms and conditions? Kindly provide a detailed response with justification as to how it will satisfy the requirement of fair auction i.e., market discovery of price?

As explained in the previous answers, no auction model is an appropriate spectrum assignment method for fixed satellite spectrum.

Q37. Any other issues/suggestions relevant to the subject, may be submitted with proper explanation and justification.

Q38. In case it is decided for assignment of spectrum on administrative basis, what should be the spectrum charging mechanism for assignment of spectrum for space-based communications services

i. **For User Link**

ii. **For Gateway Link**

Please support your answer with detailed justification.

When setting spectrum charges for administrative assignment, regulators should consider the following factors:

- Spectrum pricing should be based on the cost of managing and regulating the spectrum.
- High spectrum prices ultimately affect end-users, particularly those in remote areas where satellite connectivity is the only viable option. By keeping spectrum charges reasonable, regulators can encourage satellite service providers to offer competitive pricing, making connectivity more accessible for consumers in underserved regions.
- Governments and regulatory bodies should prioritize the allocation of spectrum to services that benefit the wider society, such as disaster recovery. This approach emphasizes the importance of public interest over revenue generation. By focusing on the societal benefits of satellite services, regulators can ensure that policies support the overall well-being of the nation, rather than solely aiming for financial gains.

Q39. Should the auction determined prices of spectrum bands for IMT /5G services be used as a basis for valuation of space-based communication spectrum bands

i. For user link

ii. For gateway link

Please support your answer with detailed justification.

Satellite spectrum pricing cannot be based on 5G spectrum prices for several reasons, including but not limited to the following arguments:

- Mobile and satellite services are fundamentally different target markets. While mobile operators primarily focus on densely populated urban areas, satellite services address the connectivity needs of rural and remote populations. These distinct target markets require

different pricing models and policies.

- Mobile and satellite services have distinct operational and deployment cost structures. Satellite operators face significant upfront costs for satellite manufacturing, launch, and operations, while mobile operators have ongoing costs related to infrastructure deployment and maintenance. Pricing satellite spectrum based on the mobile economic model could impose an undue financial burden on satellite operators and hinder the growth and development of satellite services.

- Basing satellite spectrum pricing on the mobile economic model does not account for the specific requirements of universal connectivity. Satellite services play a vital role in providing essential communication services in areas where terrestrial networks are unavailable or not cost-effective. Applying the same pricing model as mobile operators could make satellite services unaffordable for the very communities they are meant to serve, further exacerbating the digital divide.

Q40. If response to the above question is yes, please specify the detailed methodology to be used in this regard?

Q41. Whether the value of space-based communication spectrum bands

i. For user link

ii. For gateway link

be derived by relating it to the value of other bands by using a spectral efficiency factor? If yes, with which spectrum bands should these bands be related to and what efficiency factor or formula should be used? Please support your response with detailed justification.

No, spectral efficiency is not band specific but technology specific.

Q42. In case of an auction, should the current method of levying spectrum fees/charges for satellite spectrum bands on formula basis/ AGR basis as followed by DoT, serve as a basis for the purpose of valuation of satellite spectrum

i. **For user link**

ii. **For gateway link**

If yes, please specify in detail what methodology may be used in this regard.

Considering the various factors discussed in the previous responses, it is clear that auction is not feasible for satellite spectrum.

Q43. Should revenue surplus model be used for the valuation of space- based spectrum bands

i. **For user link**

ii. **For gateway link**

Please support your answer with detailed justification.

Considering the various factors discussed in the previous responses, it is clear that auction is not feasible for satellite spectrum.

Q44. Whether international benchmarking by comparing the auction determined prices of countries where auctions have been concluded for space-based communication services, if any, be used for arriving at the value of space-based communication spectrum bands:

i. **For user link**

ii. **For gateway link**

If yes, what methodology should be followed in this regard? Please give country-wise details of auctions including the spectrum band /quantity put to auction, quantity bid, reserve price, auction determined price etc. Please support your response with detailed justification.

As noted in the consultation paper "US, Mexico, and Brazil had attempted to sell frequencies for satellite usage but eventually did not succeed and at last resorted to administrative licensing."

Only example of auction is for Saudi for MSS Spectrum. However, MSS is notably different than FSS in several aspects. MSS terminals are deployed ubiquitously and use omnidirectional antennas which make it difficult to share spectrum among the MSS operators or with other services, therefore an MSS operator usually needs exclusive access to their spectrum in order to ensure there is no interference to their operation. This is similar to the way terrestrial mobile operators use spectrum. Therefore, the auction could be justified in the particular case of MSS bands, but this is very different scenario than FSS where sharing is much easier due to coordination between satellite operators, especially for gateways.

It must be noted that in another much wider consultation, CITC made it very clear that satellite bands were out of the discussion for auction and are protected. "Continued guaranteed and protected access to all existing satellite bands for current and future uses, which include L, C, Ku and Ka bands..."

Q45. Should the international administrative spectrum charges/fees serve as a basis/technique for the purpose of valuation in the case of satellite spectrum bands

i. For user link

ii. For gateway link

Please give country-wise details of administrative price being charged for each spectrum band. Please specify in detail terms and conditions in this regard.

In setting spectrum pricing, it's crucial for India to consider the broader socio-economic impacts, rather than focusing solely on short-term financial gains from inflated spectrum prices. Satellite connectivity, especially in remote and underserved areas, plays a vital role in promoting digital inclusion, fostering economic development, and enabling access to essential services such as education, healthcare, and emergency communications.

An international benchmark could be considered for spectrum pricing, but it is essential to carefully select the data points, taking into account markets with similar policy goals. Comparing India's spectrum pricing to markets with comparable demand and progress will provide a more accurate and relevant benchmark for spectrum pricing. In addition, the pricing model need to factor in policy goals, as satellite communication can ensure that the connectivity needs of these underserved areas are better addressed.

Q46. If the answer to above question is yes, should the administrative spectrum charges/fees be normalized for cross country differences? If yes, please specify in detail the methodology to be used in this regard?

To ensure a fair and meaningful comparison, it is important to consider socio-economic factors, such as income distribution and the digital divide, as they can influence the demand for connectivity and spectrum pricing decisions. The unit price should be adjusted by factors such as Gross Domestic Product per capita (GDPPC) or Purchasing Power Parity (PPP). This adjustment will account for differences in economic conditions and purchasing power across the selected markets, providing a more accurate and meaningful benchmark for India's spectrum pricing decisions. In addition, the pricing should reflect the wider policy goals, as satellite communication can ensure that the connectivity needs of these underserved areas are better addressed.

Q47. Apart from the approaches highlighted above which other valuation approaches can be adopted for the valuation of space-based communication spectrum bands? Please support your suggestions with detailed methodology, related assumptions and other relevant factors.

Spectrum pricing for satellite services should ideally be set on a cost recovery basis. This means that the fees charged to satellite operators would only cover the administrative costs incurred by the regulatory authorities in managing the spectrum, including the costs associated with frequency assignment, monitoring, and enforcement.

Satellite services play a crucial role in providing public interest services such as disaster recovery, weather forecasting, and defense communications. Cost recovery pricing ensures that these important services can be provided affordably.

By adopting a cost recovery approach to spectrum pricing, India can create an environment that encourages innovation and investment in the satellite sector. This, in turn, can accelerate the adoption of broadband technology across the country, bridging the digital divide and creating substantial socio-economic benefits.

Moreover, by fostering a thriving satellite sector and wider broadband adoption, India can also generate significant indirect revenues over the long term. These revenues can come in the form of increased economic activity, job creation, and indirect taxes, and can greatly surpass any short-term revenue from high spectrum price. This approach aligns with the country's policy objectives of promoting digital inclusion, economic development, and public interest services.

Q48. Should the valuation arrived for spectrum for user link be used for valuation for spectrum for gateway links as well? Please justify.

Between user link spectrum and gateway link spectrum, the nature of spectrum usage and the associated impacts are significantly different between the two:

While user link spectrum is utilized on a nationwide basis, gateway link spectrum is employed in specific locations only. This means that the value assigned to nationwide spectrum usage should not be applied to location-specific usage, as the context and scale are different.

Since the use of gateway link spectrum is location-specific and limited in scope, the potential for spectrum denial to other users is minimal. Thus, a cost recovery administrative approach would be more suitable for valuing gateway link spectrum, as it takes into account the limited impact on other users.

Q49. If the answer to the above is no, what should be the basis for distinction as well as the methodology that may be used for arriving at the valuation of satellite spectrum for gateway links? Please provide detailed justification.

As for question 47, spectrum pricing for satellite services should ideally be set on a cost recovery basis and prioritize the policy goal of connecting the unconnected. This is the case in several other jurisdiction where OneWeb has deployed gateways. Those regulators adopt an administrative fee-only approach for satellite gateway spectrum allocation, which primarily covers the costs of managing, monitoring, and regulating the spectrum, and incentivised companies such as OneWeb to pick their country to establish gateway serving the region.

Q50. Whether the value arrived at by using any single valuation approach for a particular spectrum band should be taken as the appropriate value of that band? If yes, please suggest which single approach/ method should be used. Please support your answer with detailed justification.

Considering the various factors discussed in the previous responses, it is clear that auction is not feasible for satellite spectrum.

Q51. In case your response to the above question is negative, will it be appropriate to take the average valuation (simple mean) of the valuations obtained through the different approaches attempted for valuation of a particular spectrum band, or some other approach like taking weighted mean, median etc. should be followed? Please support your answer with detailed justification.

Considering the various factors discussed in the previous responses, it is clear that auction is not feasible for satellite spectrum.

Q52. Should the reserve price for spectrum for user link and gateway link be taken as 70% of the valuation of spectrum for shared as well as for exclusive assignment? If not, then what ratio should be adopted between the reserve price for the auction and the valuation of the spectrum in different spectrum bands in case of (i) exclusive (ii) shared assignment and why? Please support your answer with detailed justification.

Considering the various factors discussed in the previous responses, it is clear that auction is not feasible for satellite spectrum.

Q53. If it is decided to conduct separate auctions for different class of services, should reserve price for the auction of spectrum for each service class be distinct? If yes, on what parameter basis such as revenue, subscriber base etc. this distinction be made? Please support your answer with detailed justification for each class of service.

Considering the various factors discussed in the previous responses, it is clear that auction is not feasible for satellite spectrum.

Q54. In case of auction based and/or administrative assignment of spectrum, what should the payment terms and associated conditions for the assignment of spectrum for space-based communication services relating to:

i. Upfront payment

ii. Moratorium period

iii. Total number of installments to recover deferred payments

iv. Rate of discount in respect of deferred payment and prepayment

Considering the various factors discussed in the previous responses, it is clear that auction is not feasible for satellite spectrum. For administrative assignment, a one off payment should cover the administrative cost, and yearly fee payment for the license duration.