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TRAI Consultation Paper on Assignment of Spectrum for Space-based Communication Services

Intelsat would like to thank the Telecom Regulatory Authority of India (TRAI) for the opportunity to provide comments on their Consultation Paper on Assignment of Spectrum for Space-based Communication Services (the "Consultation").

Intelsat is the world's leading satellite operator with more than 50 satellites covering 99% of the globe. For over five decades, our innovations have paved the way for a communications revolution in space. Today, we operate the world's largest hyperconnected satellite and terrestrial network, which we are expanding to a multi-orbit, multi-band, multi-frequency global unified network that will enable us to provide faster and better services to a range of new customers. Intelsat has a long history of working collaboratively with the space sector in India, notably the launch in 1999 of INSAT - 2E, also known as Intelsat APR-2, a multi -purpose satellite for telecommunication, television broadcasting and meteorological services. Our current business interests in India are substantial and growing. This includes distributing content to 400+ TV channels on our satellites, investing $5 million in two teleports to offer inflight connectivity and maritime services, and building a 125-seater facility in Chennai that serves as our global NOC 24x7 Support Service. We have ambitious plans to sell inflight connectivity to domestic Indian airlines, expand maritime operations, and provide land-mobile services to large Indian and global enterprises.

Therefore, we greatly appreciate the detailed, well-researched description provided within the Consultation of how the space sector uses spectrum in India and elsewhere to provide important commercial services. In particular, the TRAI's own description illustrates two critical points:

- **There is a rich ecosystem of satellites serving India** providing many different types of data service, such as mobile, broadcast and backhaul, to a wide variety of users. These services deliver critical economic and social benefits to India and to other countries worldwide. Accordingly, the space sector is worthy of significant attention from every regulator that is concerned with the allocation of valuable satellite spectrum.
- **The way that satellite operators use spectrum is very different from how mobile operators use spectrum.** Whereas mobile operators require access to broad blocks of spectrum on an exclusive basis, satellite spectrum use is de facto non-rivalrous, allowing

several operators to re-use the same frequencies at the same time. Consequently, a fundamentally different allocation regime is required for the assignment of space-based communication services, for the reasons stated in our response.

Before we proceed with our in-line responses to the queries presented within the Consultation, we note that the Consultation identifies auctions as a viable method of allocation, based on economic efficiency principles and judicial decisions in India. Auctions have historically proven to be an effective mechanism for allocating mobile spectrum in India and other countries, due to exclusive allocation requirements and the significant demand for exclusive bandwidths for delivery of services.

Auctions invite a pool of bidders with similar high-value business cases, allowing them to compete head-on for value and spectrum, subject to preserving sufficient competition in the downstream market. In other spectrum use sectors, where similar conditions apply, auctions are likely to be viewed as a good allocation mechanism. However, these conditions do not apply for use of spectrum for satellite-based communication services. We submit that auctions are not the appropriate mode, where there are bands whose satellite use is primarily non-rivalrous, such as the Ka and Ku bands.

As a company committed to serving Indian customers and bridging the digital divide, we express deep concern over the potential negative impact of spectrum auctions for satellite services on the Indian population, particularly those who remain unconnected. Connecting the unconnected is a significant challenge as it often involves high costs, and we firmly believe that auctioning satellite spectrum could further hinder Indian consumers ability to access essential services and opportunities. By auctioning spectrum, there is a risk of impeding the progress towards digital inclusion for these citizens, who already face numerous barriers. It is crucial for Indian policy makers to consider the broader implications of auctioning satellite spectrum and proceed to a careful evaluation of the spectrum allocation methods that ensure affordable and widespread connectivity for all.

We have sought to provide our rationale for the inapplicability of auction-based allocation processes for spectrum assignment for satellite services herein. We will further elaborate on the suitability of administrative assignment over auction allocation processes, based on technical considerations and global precedents and provide our views on the same.

Section 1. Auction of Satellite Spectrum above 3 GHz would result in market failure.

It is vital to note that the high frequency spectrum bands are capable of concurrent use by multiple satellite operators, provided that the satellite operators follow international best practices in coordinating their operations, when sharing frequencies. In the event that we seek to move ahead with auction of such frequency bands, it would be akin to introducing artificial scarcity, potentially pitting satellite operators against each other and reducing the amount of spectrum that would otherwise be available when sharing the spectrum. Furthermore, in the event that terrestrial mobile operators and satellite operators are required to compete within the

same auction, it is likely that terrestrial mobile operators would seize a disproportionate share of spectrum, to the detriment of satellite operators.

Any plausible design for an auction for satellite spectrum above 3 GHz would result in market failure, meaning an inefficient allocation, reduced service availability, less competition, and higher prices for consumers, hindering the ability to offer affordable services to consumers and exacerbating the digital divide.

In the following sections, In Section 2, we elaborate on why auctions are the correct assignment tool for mobile but the wrong tool for shared spectrum used by satellite. In Section 3, we explain why administrative decisions, not auctions, are required to decide the frequencies allocated to satellite use. In Section 4, we point out that other countries generally do not use auctions for satellite spectrum, for the reasons that we explained in sections 2 and 3. Finally, in Section 5, we address the individual questions in the consultation document, referring back to prior sections of our response for supporting evidence where appropriate.

Section 2. Auctions are the appropriate assignment tool for mobile terrestrial services, but the wrong allocation process for satellite services.

At times auctions are an effective mechanism for allocation of scarce resources, including radio spectrum, to maximize revenue collection. However, at other times, when the market conditions are not conducive, auctions can lead to inefficient outcomes that may compromise social welfare. For most satellite spectrum, where the spectrum use is non-rivalrous and there is no market scarcity, leveraging auctions for allocation would likely result in inefficient and anti-competitive outcomes, and further eliminate the advantages of non-rivalrous spectrum utilization.

In order to determine the viability of any allocation procedure, we must first move towards identifying the primary objectives for the allocation, and whether such allocation processes are the appropriate route to meet the identified objectives given the circumstances and constraints in the market.

In a broad sense, the objectives for spectrum allocation are usually the same.

First, there is a primary objective of economic efficiency. Prioritizing economic efficiency means the spectrum should be allocated to the users in a way that maximizes economic and social benefits. There are competing commercial and public services uses for spectrum and regulators must devise procedures to ration current and future supply for spectrum. The impact on economic efficiency is oftentimes the highest consideration governing allocation decisions. Without an economically efficient spectrum management, countries may not be able to service the end users, at reasonable rates, and may lead to insufficient spectrum for uses that generate high social value or are intended towards social welfare.

Another key objective for spectrum allocation should be maintenance of downstream competition in the industry. Spectrum allocation decisions can generate increased downstream competition by ensuring there is a critical mass of competing firms, lowering barriers to entry and expansion, and enabling new or existing operators to realize cost reductions that can be

passed on to consumers. Increased competition is beneficial because it creates incentives for further cost reduction and for lower prices, which will normally feed through into higher end-user demand. Furthermore, without appropriate controls in place, spectrum could be acquired for anti-competitive purposes. For instance, if downstream markets are uncompetitive or if market power has been gained by acquiring spectrum, the party with the greatest monetary ability will usurp a significant market share and may not be keen to dedicate such usage for the greatest social benefits. Bidders with anti-competitive motives may further seek to buy additional spectrum to create barriers to entry of new players into the market. Competition can be protected through the right design of primary allocation processes along with a policy that enables spectrum trading and liberalization so that competing suppliers can respond to changing circumstances over time if new high value uses and users emerge. Furthermore, it is essential that the space and satellite industry are participating in a competitive market, to ensure they meet the objectives of the New Space Policy, 2023.

While spectrum has substantial economic value for the exchequer of the Government of India, it is best practice to ensure that spectrum allocation is done with the intention to maximize the overall benefit to society and its citizens from spectrum derived services. Any decision to boost revenue by selling access to market power, without any consideration to the societal benefits of allocation, would end up being welfare destructive as the revenue would come at the expense of consumers and, ultimately, a lower tax base. Nevertheless, revenue maximization and efficient allocations are not mutually exclusive, and may be a secondary effect from allocations that prioritize efficiency and competition.

While auctions and other market mechanisms are robust spectrum allocation solutions, they are only applicable in certain specific cases. Leveraging an auction in situations with no scarcity of resources would not necessarily be harmful but would be an inefficient use of time and resources.

Creating artificial scarcity in order to run an auction is also not a feasible solution and would have counterproductive consequences. This approach may lead to higher revenues at the expense of welfare and competition. Exclusive licenses, by breaking up spectrum blocks, would be akin to buying a monopoly right over a shared resource. Any revenue raising benefits would be entirely illusionary; this approach would destroy economic value as customers would be deprived of valuable services, which could have been offered by the shared use of such spectrum, and the available services would necessarily have to be priced at exorbitant rates for the licensee to derive complete value of their allocated resource. Additionally, there would be a loss of tax revenue owing to less economic activity.

A second consideration is whether the auction is allocating shared or exclusive access to spectrum. Typically, auctions are most effective when the regulator is looking to allocate exclusive access to spectrum. However, it only makes sense to allocate exclusive access to spectrum if spectrum use is rivalrous. With rivalrous spectrum use, if one party uses it, another cannot. On the other hand, if spectrum use is non-rivalrous, the spectrum can be shared by multiple users without causing signal interference. Mobile spectrum is rivalrous as it must be

managed by a single mobile operator in a specified area and (with limited exceptions) cannot be shared.

The lower frequency (S and L) satellite bands have some similarities to mobile in this respect, as, because of the nature of use, the users need exclusive access. However, in the higher (Ku/Ka) bands, the use of spectrum by satellite operators is non-exclusive, non-rivalrous in nature, as the same frequencies can be re-used by multiple operators in the same geographic area. In these bands, the use of satellite spectrum is not a zero-sum game where one party's use of the spectrum reduces the availability of the spectrum for others.

To auction non-rivalrous satellite spectrum, a regulator would need to arbitrarily segment the bands and force exclusivity and fragmentation in the market. This would unnecessarily limit the number of satellite operators sharing the spectrum and reduce the spectrum available to each user. As a result, the benefits of non-rivalrous spectrum use would be lost, as the sharing of frequencies between operators is what allows large capacities of satellite spectrum to be available over a given area. Finally, auctioning non-rivalrous spectrum would create gatekeepers or frequency band managers who would control the industry and need to decide how to manage or potentially resell the spectrum. This may block new entrants and harm competition, undermining a primary objective of spectrum management.

Participating in an auction for non-rivalrous spectrum use would also prove difficult for bidders. Owing to the lack of scarcity, the value of the spectrum would be difficult to measure. This uncertainty would make it challenging for bidders to determine their willingness to pay and formulate a bid strategy. If the bidders were unable to accurately predict the value of the spectrum or if the auction failed to attract enough bidders owing to this uncertainty, the auction could fail. Situations like these are further likely to result in a ‘free rider’ problem, in which individual users can benefit from a shared resource without paying for its use. In other words, they can ‘free ride’ on the efforts of others without paying their fair share. This can lead to an inefficient auction outcome where the spectrum is not sold for its true value, or it may not be sold at all.

As the TRAI recognizes in the Consultation, the commercial space sector is booming, with many new satellites being launched and new services, such as mobile to cellular handsets and software-designed satellite access being rolled out. Moreover, to further develop India’s telecommunication infrastructure by enabling high-speed internet and mobile connections to unconnected villages users, satellite links will offer the only realistic and economic solution. While the current spectrum allocation for space can absorb significant growth, it is likely that the coordination of services will become more challenging, with increased usage of satellite spectrum. It may be that this is addressed by technology advances, such as smart databases to coordinate frequency use.

Section 3: Administrative decisions are required to decide the frequencies allocated to satellite use

Auctions work on the assumption that the willingness to pay of bidders is a good proxy for the economic and social value that they will generate from deploying the spectrum. Absent competition concerns, this assumption is recognized as being reliable when bidders are competing to offer similar services using related technologies (e.g., mobile using 4G/5G). However, this may not be the case if the competing use cases differ significantly. In such cases, auctions cannot be a substitute for regulatory intervention to ensure an adequate allocation of spectrum for all socially valuable services. An analogy here may be drawn to land, where, for example, local governments intervene to ensure a healthy distribution of land between residential, commercial and industrial uses, while also preserving some land for public uses, such as roads and parks.

Section 4: Other countries do not use auctions for satellite spectrum

International benchmarks show that leveraging auctions to allocate satellite spectrum is not common practice. Very few countries have ever attempted to allocate satellite spectrum via auctions and the few who have mostly discovered difficulties and ultimately abandoned such practice, as TRAI notes in the Consultation.

In 2000, the U.S., the government enacted the Orbit Act, which prohibits auctioning spectrum for satellite services. Since 2004, the US has replaced its auction rules with a streamlined administrative process. In 2020, Brazil amended its regulatory framework to replace satellite auctions with administrative licensing, referencing the need to align Brazilian procedures to those adopted by relevant satellite markets. Most recently Thailand tried to auction satellite spectrum in 2021 for the first time. Eventually the auction was cancelled as there was only one bidder, and now Thailand has decided to assign the bands administratively.

The countries that have recently successfully conducted auctions of satellite spectrum have done so for lower frequency bands. For instance, Saudi Arabia ran an auction to determine the S-band allocation. The nature of use in the S-band made it more suitable for auction as the use case required exclusive access. Additionally, while Mexico still utilizes auctions for some satellite spectrum allocation, this is limited to low and mid-frequency bands.

When used, auctions for high frequency satellite bands have not been successful. They do not yield signification participation from bidders. As a result, all leading countries have opted for globally adopted administrative processes.

Assigning portions of satellite spectrum on an exclusive basis would be contrary to current international use and the need of India to further develop its telecommunications infrastructure.

Section 5: Responses to specific questions

In this section, we provide our response to the specific questions raised by TRAI. We refer back to our main response where relevant.

Question #	Response and Comments
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 .	Intelsat recommends that TRAI follows the ITU frequency allocations to satellite services. It is essential for the Indian National Frequency Allocation Plan to be in harmony and incorporate the ITU frequency allocations and ITU Radio Regulations encompassing all frequencies allocated by the Indian administration for different satellite communication services. An example of the partial satellite allocations is provided in the Annex.
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?	Gateways are meant to aggregate traffic from all users into a few key locations. These gateways are typically comprised of several large earth stations and require a substantial investment (i.e., millions of US$) because they act as a conduit between all satellite users and the public telecommunications network. Gateways are also meant to be few. A typical GSO high throughput satellite requires on average 3 to 7 gateways. The number of gateways is directly related to the amount of spectrum available to be used by each gateway. In Ka-band, it is ideal for gateways to have access to the entire 27.5-30 GHz (uplink) and 17.8-20.2 GHz (downlink). As an example, if this spectrum is slashed by half, the number of required gateways will then have to double, and that will clearly worsen the economics for the satellite operator, and ultimately for the end user.
Q4: For space-based communication services, whether frequency spectrum in higher bands such as C band, Ku band and Ka band,	Frequency spectrum in higher bands such as C band, Ku band, and Ka band should not be assigned to licensees on an exclusive basis for space-based communication services. Instead, they should be assigned on a shared basis under administrative

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?	assignment, as satellite spectrum is shared among multiple satellite networks, enabling efficient transmission of signals from satellites at different orbit locations. More specifically, multiple satellite operators use the same frequencies across multiple satellites without interfering with each other and coordinate in sharing the same frequencies across their services. As a result, the sharing of frequencies between operators results in large amounts of capacity being available over a given geography. Geostationary (GEO) operators can use separations to operate in the same frequency band in the same geographic area, while non-geostationary (NGSO) operators are required by ITU Regulations not to cause interference to GEOs. Allowing satellite spectrum, and especially fixed satellite spectrum, to be assigned on a non-exclusive basis will lead to efficient and cost-effective use of the scarce resources. Moreover, assigning satellite spectrum on an exclusive basis will lead to the following challenges - First satellite spectrum is coordinated at the ITU level. through various coordination and interference mitigation techniques. Satellite systems have a predefined range of frequencies, filed at ITU, and follow a long and rigorous process of notification and registration into the MIFR. Once a satellite system's frequencies have been registered at an ITU level, they cannot subsequently be amended depending on the outcome of the spectrum assignment of a market. Exclusive assignment is more appropriate for telecommunications networks whose designs depend on the network and market requirements, than for satellite networks which are designed to meet the above-mentioned process at an ITU level. - Assigning spectrum on an exclusive basis will restrict the use of the spectrum to a few operators, dividing the satellite spectrum and significantly reducing its value. This value reduction will not respond to a specific need, since as abovementioned, sharing of satellite spectrum is technically feasible. - Assignment of satellite spectrum to a single licensee in India would have a negative impact on the country's satellite communication infrastructure. Allocating exclusive rights to one user or one satellite network for a given frequency band in an area would restrict the services provided and may prevent

	access to unserved or underserved areas of India if the one licensee cannot commit to the coverage. This could further result in a situation wherein gatekeepers with deep pockets could effectively use the allocated satellite spectrum to drive up the price, and block new entrants and fair competition in the industry, significantly impeding efforts to connect the unconnected in India - Auction concepts such as block size, spectrum cap, and intra-band share cannot be applied to satellite spectrum management. The whole band needs to be assigned as systems design may require the full band to provide uninterrupted service. Therefore, it would be unrealistic and counterproductive to apply the auction mechanism for satellite services. - Exclusive satellite spectrum use conditions may lead to negative consequences, such as operators deciding not to share or buying small amounts and pooling their frequencies, which could undercut the market's ability to set prices.
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?**	We submit that satellite spectrum should not be allocated on an exclusive basis, and therefore an auction model should not be considered. As described in Sections 2 and 3, satellite operators differ from terrestrial operators. The latter have access to various spectrum bands and can enable or disable their base stations based on demand and network requirements. Satellite systems are designed to operate consistently on the same frequency range across the globe, as per their ITU filings and the sizes of the satellite beam sizes which include wide beams covering entire continents and across borders. To auction a satellite spectrum band, we would have to divide it into portions or blocks (as is done for terrestrial) and then auction the various blocks. Therefore, auctioning of satellite spectrum would result in the fragmentation of satellite spectrum which in turn will decrease throughput and data speeds in proportion to the fragmentation. In effect, this means a great reduction in the efficiency of spectrum usage which goes against the most basic objective of any spectrum policy (i.e., enhanced efficiency of usage). As the international examples we provided in Section 4 demonstrate, the difficulty of auctioning satellite spectrum has not proven to be feasible in any other country.

(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.** **Kindly justify your response.**	
6. What provisions should be made applicable on any new entrant or any entity who could not acquire spectrum in the auction process/assignment cycle? **a.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?** **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**	We do not believe any additional measures are needed to ensure that new entrants have access to spectrum, as long as shared use of satellite spectrum is permitted. The benefit of a shared access system is that it will accommodate new entrants as they enter the market. Allocating exclusive satellite spectrum licenses by means of an auction would erect artificial barriers to entry by creating a one-off entry opportunity at an arbitrary point in time. Any entity that failed to secure a license in an auction for exclusive licenses will find it much harder to establish itself in the Indian market in future (even if it has the relevant international rights and capacity), likely to the detriment of competition and economic welfare. This effect is seen in the mobile market, where exclusive licensing means that successful entry often depends on securing a critical mass of spectrum at a large multiband auction. Maintaining a coordinated shared access regime is key to encouraging market entry, fostering downstream competition, and promoting the efficient use of spectrum.

ensure rationale of spectrum auction and to avoid adverse impact on the dynamics of the spectrum auction? **c. 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?**	
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	For mobile satellite service spectrum in the lower (MSS) bands, which share similarities with terrestrial mobile spectrum in terms of their usage, trading and leasing should be allowed. The rivalrous nature of this spectrum use means that these licenses can be traded in a conventional secondary market, similar to mobile licences. Allowing the trade or lease of this spectrum can promote its efficient use by enabling it to be transferred to entities that can derive the greatest value from it. There may also be scope to allow users to change technology and services.

ensure rationale of spectrum auction and to avoid adverse impact on the dynamics of the spectrum auction? Kindly justify your response.	In the higher (FSS) spectrum bands used by satellite services, where frequencies can be shared by multiple satellites, we support granting trading rights but the property rights must be defined in a way that respect the shared use nature of the band. Because these bands are used in a de facto non-rivalrous manner, they can accommodate multiple users without causing interference, reducing the scarcity that typically drives the trading value of spectrum. For the foreseeable future therefore, the tradable value of any spectrum rights will likely be very low (given that a new user could simply approach the TRA for a new licence and coordinate with existing users). Nevertheless, making the licences tradable would still be helpful, as it will make it easier to move around licences within corporate structures. To the extent that legacy licences enjoy seniority in coordination processes, they may also offer some premium value over new licences, and trading can help ensure such rights reside with the most efficient user. It is also worth considering the potential for future trading of collective property rights in these shared bands. If the usage characteristics or market dynamics change over time, it may become beneficial to allow a group of users to trade their collective rights to use part of the satellite spectrum. Defining tradable property rights could provide a basis for satellite operators to coordinate amongst themselves how they collectively use the spectrum. This may facilitate dynamic efficiency in the use of shared use satellite spectrum over time.
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,	It is imperative that the envisaged regulatory scheme creates provisions to protect incumbent licensees providing space-based communication services to ensure the continuity of their operations. Any service disruption could have wide-ranging impacts on consumers, businesses, and potentially critical services. Ensuring continuity of services is not only important for the service providers themselves, but also for the stability and reliability of communication networks on which many sectors and consumers depend.

its services are not disrupted? If yes, what mechanism should be prescribed? Kindly justify your response.	One commonly used mechanism to protect incumbent use is to adopt 'grandfathering' provisions. This provision could guarantee that existing licensees retain their rights to operate within their currently held spectrum frequency range for a defined period, even if the band is re-allocated or re-assigned through an auction or assignment process.
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 (nonexclusive) 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.** **56** **(b) Any other suggestions may kindly be made with detailed justification.** **Kindly justify your response.**	The sharing of satellite spectrum should be aligned with the ITU coordination framework that ensures the compatibility between satellite networks. It should also be noted that satellite spectrum rights are closely intertwined with orbital rights, so auctioning spectrum rights within one jurisdiction and without associating the auctioned spectrum rights with orbital rights may lead to the impossibility of efficiently using the spectrum or orbital rights would be somewhat meaningless. If the auctioned spectrum rights are not associated with orbital rights, these auctioned rights would be practically unusable. In respect of technical compatibility between satellite networks, ITU has frequency coordination procedures and criteria to ensure compatibility between satellite networks of different countries. For foreign satellites to be granted landing rights to offer services in India, one requirement could be that all required frequency coordination in the frequency band in question is completed with Indian satellite networks.
Q10 :In the frequency range 27.5-28.5 GHz, whether the spectrum assignee should be permitted to utilize the	Allowing flexible use of the 27.5-28.5 GHz spectrum for both IMT and space-based communication services has been done in number of countries, including the United States and the United Kingdom.

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.	However, the potential interference between these services presents a challenge. Absent regulatory measures, existing earth stations may experience interference from IMT services. To mitigate this, it is often sufficient to establish exclusion zones around earth stations, as has been done in the US and the UK. These exclusion zones generally do not impose significant constraints on mobile network operator deployment plans, since as TRAI notes, earth stations are often located in sparsely populated areas where mmWave spectrum is unlikely to be deployed.
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:**	In C-, Ku- and Ka-band, the bands 11.7-12.2 and 21.4-22 GHz are allocated by ITU for broadcasting services (downlink) and the 14.5-14.8, 17.3-18.1 and 24.65-25.25 GHz are allocated for feeder links (uplink) for broadcasting services. Other than that, all other satellite allocated bands in these frequency ranges are generally allocated by ITU for general satellite use and satellites are seen to be built with transponders that can provide a multitude of applications in any of the frequency bands of its transponders. For this reason, it is not desirable to subdivide the frequency bands and assign different applications to different frequency bands.

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:	
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?**	The lower frequency (S and L) satellite bands have some similarities to mobile spectrum in that their use is rivalrous and therefore, users may require exclusive access to the spectrum. Where spectrum use is rivalrous and scarce, either an auction or a beauty contest should be used to ensure a degree of competition and the efficient allocation of resources. With appropriate auction design, a competitive bidding process can ensure the highest value users obtain the spectrum rights and extract the most value from their licenses. However, a beauty contest, where licenses are awarded based on a set of criteria rather than solely based on the bid price could be suitable, depending on TRAI's objectives. A beauty contest would allow TRAI to consider a broader range of factors beyond the bid price, such as an applicant's technical capabilities, quality of service commitments, and plans for coverage or innovation.
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**	Satellite spectrum, included in the C, Ku and Ka band, should be assigned administratively on an application basis and should not be auctioned. Our reasoning is set out in Sections 1-4 of our response and answers to prior questions.

(c) Any other? **Please provide your response in respect of different types of services (as mentioned in Table 1.3 of this consultation paper). Please support your response with detailed justification**	
Q17: Whether spectrum for user links should be assigned at the national level, or telecom circle/ metro-wise? Kindly justify your response.	If there is a need to differentiate frequency assignments in different parts of the country, e.g. as a result of international commitments or compatibility with other services, this could be included in the national legislation and licensing conditions. User links should be assigned on a national level to ensure consistent and seamless satellite connectivity for the following reasons: - Satellite coverage is extensive, and one beam may cover the whole country or in general vast geographical areas within one country. - Satellite services applications like, Earth-stations-in-Motion (ESIMs) are transportable by nature, meaning that they allow connectivity in different locations. - National licensing will be a streamlined process and will reduce the administrative burden on the licensing applications for both the regulators and the applicants. - There is no technical reason to restrict licensing in specific areas for user links, as the modern satellite applications like ESIMs and VSATs operate under low interference risk, and there is no need for coordination or interference analysis per specific area of operation.
Q18: In case it is decided to auction user link frequency spectrum for different types of services, should separate auctions be conducted for	In general, the decision to conduct auctions to award spectrum licenses should be based on the nature of the expected spectrum use – specifically, its rivalrous or non-rivalrous characteristics.

each type of services? Kindly justify your response with detailed methodology.	For mobile satellite service spectrum in bands like L-band, where frequency sharing may not be feasible owing to technical constraints, auctions could be an effective way to allocate spectrum licenses. The competitive bidding process inherent in auctions can help ensure that these scarce resources are awarded to entities are likely to put them to the most effective use, and who therefore value them most, thereby promoting optimal use of the spectrum and a competitive downstream market. However, for spectrum used in a non-rivalrous manner, which includes all satellite bands spectrum above 3 GHz, auctions are not an appropriate allocation mechanism. The ability of satellites to reuse frequencies across non-interfering spatial zones means the same spectrum can be used simultaneously by multiple satellites without causing interference. Instead, TRAI should consider alternative allocation mechanisms that take into account the unique characteristics of non-rivalrous satellite spectrum use rather than blindly apply the use of auctions. Alternative mechanisms include administrative assignment based on technical and operational criteria, or a market-based approach that allows for secondary trading and leasing of spectrum rights.

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.	For the reasons set out in Sections 1-4 and prior answers to questions,, satellite spectrum for both user and gateway links should only be assigned administratively. Specifically, for gateway links, in addition to the above-mentioned, it should be noted that gateway frequencies are used only in specific locations, and the regulator can ensure that all interference mitigation techniques and coordination is completed before issuing the license. By allocating gateway spectrum administratively, regulators can facilitate the sharing of these resources, ensuring that each operator can establish and maintain their gateway infrastructure at the designated locations.
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.	For the reasons set out in Sections 1-4 and prior answers to questions, satellite spectrum for both user and gateway links should only be assigned administratively and not through auction. An auction would likely lead to inefficiency and market failure. In a hypothetical case where auctions were conducted, having different services compete with each other would raise yet further concerns about market failure.
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?**	For the reasons set out in Sections 1-4 and prior answers to questions, satellite spectrum for both user and gateway links should only be assigned administratively and not through auction.

(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 Kaband, 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? Kindly justify your response.	
Q22: Should gateway links and user links be auctioned separately?	For the reasons set out in Sections 1-4 and prior answers to questions, satellite spectrum for both user and gateway links should only be assigned administratively and not through auction. Moreover, gateway and user links should be assigned separately, as the gateway operator may be a different entity from the service provider operating the end-user frequencies. Moreover, the spectrum needs from user links may evolve differently and separately from the spectrum needs of the gateway links.
Q23: What protection distance is needed to avoid interference?	In gateway earth station, it is customary that several earth stations simultaneously use the same frequency band at the same location, in respect of satellites at different orbit locations.

	However, if the question relates to protection of earth stations from terrestrial mobile deployment, there is no one-size-fits-all answer. Some of the key factors that affect the protection distance are: - Power levels of terrestrial signals - Height of terrestrial transmitters - Pointing angles for terrestrial transmitters (down tilt) - Terrain/topography between the terrestrial transmitter and the victim earth station(s). - Look angle of victim earth stations in relation to interfering terrestrial transmitter. Without knowing these parameters, among others, it is impossible to determine the required protection distance.
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.**	We do not believe there should be a minimum net worth requirement for a service provider to be licensed. Instead for some services that are provided to the wider public (e.g., Access, Internet) the government can request a business and market plan for the operator seeking to obtain a Unified License. Such requirements are not appropriate for less commercial services, as the Captive VSAT services.

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.	For the reasons set out in Sections 1-4 and prior answers to questions, satellite spectrum for both user and gateway links should only be assigned administratively and not through auction. "Roll-out" obligations is a regulatory term more appropriate for terrestrial service providers, that depend their network deployment in revenue-generating areas. Satellite services are usually present to cover areas that terrestrial networks cannot reach or are not cost-effective to cover (e.g. rural areas), or to even supplement terrestrial networks (e.g. through CBH). Consequently, imposing roll-out obligations on satellite service providers may create an unnecessary burden and potentially obstruct the efficient deployment of satellite networks. Instead of roll-out obligations, satellite spectrum licenses should include terms and conditions for non-exclusive (shared) assignment, that include coordination and shared use requirements and compliance with the ITU rules and procedures.
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.	Restrictions on crossholding of equity should not be applicable for satellite based service licenses, as long as there are no anti-competitive actions involved.
Q27. Keeping in view the provisions of ITU's Radio Regulations on	We foresee major challenges in ensuring co-frequency, co-geography coexistence. Time and again, ITU studies[1] have shown that terrestrial mobile and FSS/BSS are

[1] Report ITU-R M.2109 and S.2368

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.	inherently incompatible. This is also evident by actual spectrum repurposing efforts taken by other administrations where satellite services have to be moved out in order to make room for terrestrial mobile services. This was the case in C-band clearing efforts and also in millimeter wave cases (28 GHz) where extremely stringent rules were placed on deployment of satellite earth stations in order to ensure unfettered access for terrestrial mobile services. Furthermore, when the ITU Radio Regulations allocate a frequency band for multiple services, this does not mean that these services are technically compatible with each other, but provisions and criteria are contained in the Regulations to obtain international compatibility. Domestically, countries are sovereign to adopt whatever provisions and criteria they see fit and ITU and the Radio Regulations do not provide any provisions.
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.	To obtain compatibility between space-based communication links using the same spacecraft or spacecraft with moderate orbital separation, at C-, Ku- and Ka-band, it is normally possible to re-use the same frequency on two orthogonal polarizations. For compatibility with terrestrial services, it may be more difficult to make use of polarization discrimination since different propagation paths and reflections from buildings etc. may change the polarization orientation or disrupt the polarization purity.
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	Intelsat opposes both models. Model #1 is impractical for higher bands as exclusive use rights are not consistent with how satellite operators share the frequencies. Model #2 is notionally feasible but any limit on the number of winning bidders would be inherently arbitrary, introducing artificial scarcity and limiting economic activity, therefore impairing growth in the Indian economy.

in higher bands (such as C band, Ku band and Ka band)?	Model #1 would result in several issues as it only makes sense to allocate exclusive access to spectrum if spectrum use is rivalrous. With rivalrous spectrum use, if one party uses it, another cannot. To run an exclusive auction for non-rivalrous satellite spectrum, such as the higher (Ku/Ka) satellite bands, a regulator would need to arbitrarily segment the bands and force exclusivity and fragmentation in the market. This would unnecessarily limit the number of satellite operators sharing the spectrum and reduce the spectrum available to each user. As a result, the benefits of non-rivalrous spectrum use would be lost, as the sharing of frequencies between operators is what enables satellite operators to provide high bandwidth capacity in a given area. Even if access to the spectrum could then be leased to multiple providers, auctioning non-rivalrous spectrum would create gatekeepers or frequency band managers who would control the industry and could be expected to artificially restrict capacity so as to realize windfall gains. This may block new entrants and harm competition, undermining a primary objective of spectrum management and restricting services affordability. Model #2 is notionally feasible but not a good idea, for three reasons: 1. Any restriction on the number of winning bidders would be inherently arbitrary. If the TRAI set this at a low number, then there would be artificial scarcity, with some satellite operators squeezed out of the market. This would be value destructive given that all satellite operators can be accommodated with coordination. If the TRAI set this at a high number, then everyone would win a licence and unsold licences would remain for new players to buy later. In this case, an auction is redundant. The current process of licensing on demand, subject to coordination rules, is more flexible and can deliver a better outcome. 2. If winning bidders were allowed to sub-lease shared access to licensed spectrum, this might address the concern about there being artificial scarcity, however, owing to the lack of exclusivity, the value of the spectrum in the auction would be difficult to measure. Bidders might try to form consortiums,

	but how should they share costs when their use cases are non-rivalrous? Bidders might try to form consortiums and would present bidders with the challenge to determine their willingness to pay and formulate a bid strategy. If the bidders were unable to accurately predict the value of the spectrum or if the auction failed to attract enough bidders owing to this uncertainty, the auction could fail. 3. Inviting coordinated bids to win shared access also introduces what is known in economics as the 'free rider' problem, in which individual users may aim to benefit from a shared resource without paying for its use. This can lead to an inefficient auction outcome where the spectrum is not sold for its true value, or it may not be sold at all. In summary, auctions are simply not a tractable model for the C band, Ku band and Ka bands for the foreseeable future. However, if TRAI's intent is to empower satellite users to more effectively manage their spectrum resources over time, then the alternative mechanism of associating clearer property rights with satellite licences and allowing trading may be a way forward. We refer you to our answer to question 7.
Q30. In your opinion, which of the two models mentioned in Question 29 above, should be used? Kindly justify your response.	Consistent with reasons listed above, any competitive bidding (auction) model will be inferior to an allocation on an administrative basis where decisions are made about who is most suited to use the spectrum based on the broader analysis of economic and social benefits. Therefore, neither model should be used.
Q31:In case it is decided to assign spectrum for user links using model # 2 i.e., non-exclusive spectrum	We refer you back to our answer to question 29. Any limit on the number of winning bidders would be inherently arbitrary, introducing artificial scarcity and limiting economic activity, therefore depriving the Indian economy. Given the de facto non-

assignment to limited bidders (n+ Δ), then what should be **a. (a) the value of Δ, in case it is decided to conduct a combined auction for all services** **b. (b) the values of Δ, in case it is decided to conduct separate auction for each type of service.**	rivalrous nature of satellite spectrum use in the C, Ka and Ku bands, there is no sensible way to calculate a specific number for Δ. Accordingly, such an approach to auction design is not appropriate.
Q33. What could be the likely issues, that may arise, if Option # 1: (Area specific/exclusive 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?	For the reasons set out in Sections 1-4 and prior answers to questions, satellite spectrum for both user and gateway links should only be assigned administratively and not through auction. We refer to specific Questions 4,6, 16 and 19 regarding the issues that may arise if satellite spectrum is auctioned.
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	For the reasons set out in Sections 1-4 and prior answers to questions, satellite spectrum for both user and gateway links should only be assigned administratively and not through auction. We refer to specific Questions 4,6, 16 and 19 regarding the issues that may arise if satellite spectrum is auctioned.

links? What changes could be made in the proposed option to mitigate any possible issues? In what manner, areas/ regions/ districts should be identified?	
Q35. In your view, which spectrum assignment option for gateway links should be implemented?	As per the Question 19, spectrum for gateway links should be assigned on an non-exclusive administrative basis, subject to the relevant interference mitigation techniques and frequency coordination methods.
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?	For the reasons set out in Sections 1-4 and prior answers to questions, satellite spectrum for both user and gateway links should only be assigned administratively and not through auction. As discussed in Section 2, while the current spectrum allocation for space can absorb significant growth, it is possible that in the future, the coordination of services will become more challenging. It may be that this is addressed by technology advances, such as smart databases to coordinate frequency use. It is also possible that, one day in the future, there may be a role for a market mechanism in addressing points of conflict in the satellite coordination process in some bands. However, even at that point, an exclusive licensing model (similar to that of mobile) would not be the answer as it does not fit with the nature of the satellite spectrum use. Rather, any 'auction element' would need to be integrated into the coordination process, with users perhaps paying for priority rights either in advance or on a dynamic basis. To be clear such mechanisms are not needed now and may never be needed, but we describe them here for the purposes of demonstrating how different they would look from a 'conventional' mobile spectrum auction.
Q37. Any other issues/suggestions relevant to the subject, may be submitted with proper explanation and justification.	It is advised strongly against granting access to spectrum for satellite links at C-, Ku and/or Ka-band through auctioning as this would be detrimental for India's current telecommunications infrastructure and its ability to further develop it.

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.**	Intelsat believes that a cost-based approach is the most efficient pricing system to ensure affordable satellite services. The cost of the authorization should focus on the recovery of the regulator's administrative costs to process the application and maintain the license. Internationally, in most of the administrations, spectrum for user and gateway links is charged as an administrative fee generally to cover the administrative costs. Licensing fees should not be used as a source of revenue or be excessive, as licensing fees are generally passed on to the customer. As example, the UK, US, as Australia, Canada, Germany, New Zealand also follow cost-recovery or administrative-based spectrum pricing models, ensuring affordability for satellite operators and the public. Additionally, regulatory spectrum fees should not be based solely on the amount of MHz overally used, A pricing policy that considers situations when satellite service providers must use broad bandwidth because of the configuration of satellite systems, requiring use of a substantial part of bandwidth. For instance, Intelsat's network may employ multiple different access schemes, which include dynamic return link channel sizing and transmit frequency selection. Based on traffic conditions and resource availability, earth stations may be able to transmit in the whole Ku band but by transmitting at a variable bandwidth, the earth stations will only utilize a small portion of the band at a time. However, if the service provider only has a few earth stations throughout the country, this may become economically unfeasible due to high regulatory fees. Lastly, TRAI should give incentives for services provided in remote areas, where revenue generating is low and where satellite connectivity is the only option.
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	The valuation of space-based communication spectrum bands should not be based on the prices determined through the auction of spectrum bands for IMT services. This stance stems from the fundamental differences between these services and their use of spectrum resources.

i. **For user link** ii. **For gateway link**	IMT/5G services are designed to deliver high-speed data and voice services within a limited geographical area. Mobile operators use their spectrum licenses for one very specific application: public communications. Satellite services, meanwhile, are designed to provide connectivity over vast areas and support many different applications including fixed/mobile satellite services, broadcasting, emergency management, maritime and aviation communications. It is unclear how the value of a spectrum license used to enable a terrestrial public communication network could be used to infer the value of spectrum license used to enable emergency satellite communications for example. Adding to the complexity, the investment and costs associated with infrastructure deployment, operation, and maintenance for terrestrial and space-based systems are significantly different. The nature of spectrum use also varies considerably between IMT and satellite services. Terrestrial public communications operate within a limited geographical area and require exclusive use of spectrum resources to ensure interference-free operations. The (sometimes high) prices paid by mobile operators for IMT spectrum licenses are the result of competition generated by the rivalrous nature of spectrum use for terrestrial networks. Spectrum use by satellite services, meanwhile, is non-rivalrous in nature. The broad coverage footprint and the ability to reuse frequencies means the same spectrum can be used simultaneously by multiple satellites without causing interference, provided they operate in different geographies or at different polarizations. A spectrum license for IMT services is, fundamentally, a different asset to a spectrum license for satellite services. On top of this, the demand and supply dynamics for terrestrial and satellite spectrum are inherently different. The user base, usage patterns, and growth potential vary widely between the two, which can significantly impact the valuation of the spectrum.
Q40:If response to the above question is yes, please specify the detailed	Intelsat has no further comments.

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.**	Attempting to derive the value of space-based communication spectrum bands by relating them to the value of other bands using a spectral efficiency factor makes little sense. First, it is unclear how one would determine the appropriate spectral efficiency of a band, as this depends on a number of other factors, such as the modulation technique used. Second, it is unclear how spectral efficiency relates to value. For instance, emergency communication services might have low spectral efficiency because they require robust, fail-safe communication channels, often with redundancy and lower data rates. However, the value of these services is high owing to their critical nature in emergency situations. Spectral efficiency is an inappropriate proxy for value as it fails to capture other critical aspects that determine value, such as scarcity, the band's physical characteristics (e.g., resistance to rain fade), and the particular use case. In bands that are not congested, like the C, Ka and Ku bands used for satellite communications, there is no scarcity to create a competitive market price. Therefore, pricing should be based on cost recovery, reflecting the costs associated with managing and regulating the band.
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**	This is not applicable for satellite use, as auctions not appropriate.

If yes, please specify in detail what methodology may be used in this regard.	
Q43. Should revenue surplus model be used for the valuation of space-based spectrum bands **i. For user link** **ii. For gateway link**	This is not applicable for satellite use, as auctions not appropriate.
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.**	For the reasons set out in Sections 1-4 and prior answers to questions, satellite spectrum for both user and gateway links should only be assigned administratively and not through auction.International benchmarking has demonstrated that auctions are not a viable solution for satellite spectrum. More specifically, in the case of satellite spectrum, the international best practice is to use administrative processes to assign spectrum for satellite services. There is no precedent for auctions of satellite spectrum in the C, Ku and Ka frequency bands and other frequency bands that can be shared between among multiple satellite operators. As TRAI acknowledges in Section 4.17 of the Consultation, the very few jurisdictions that have auctioned domestic orbital slots have either abandoned the practice (e.g., US, and Brazil) or have encountered difficulties with failed auctions (e.g., Thailand, Mexico). Moreover, administrative process for satellite spectrum is used in the jurisdictions with the most developed satellite sectors (e.g. U.S., the U.K., Brazil, Canada, China, and France). A recent example of satellite spectrum auction is the S-band auction in Saudi Arabia. However, this auction refers to the MSS spectrum in the 2GHz band that, similarly to spectrum allocated to mobile terrestrial operators, cannot be shared amongst satellite operators in the same location. In summary it can be inferred that internationally, there is no design model available for auction of the frequency spectrum in higher frequency bands such as C-band, Ku band, and Ka band, which are sharable among multiple service providers. India will be the first

	jurisdiction to try to establish and enforce such process and this may lead to high risk for operators and market failure.

Annex

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.

Intelsat recommends that TRAI is following the ITU frequency allocations to satellite services. An example of the partial satellite allocations is found below:

Frequency Range (GHz)	Region 1 Current Use	Region 2 Current Use	Region 3 Current Use	Future Trends
7.25-7.75	Government / military satellite networks as well as commercial use. Weather monitoring. Space Research. Radar applications. Maritime satellite terminals.		Military satellite networks.	Militaries around the world continue to rely on and operate in this band.
7.9-8.025	Government / military and commercial use.			Militaries around the world continue to rely on and operate in this band.
8.025-8.400	Government / military and commercial use. Gateway downlinks for NGSO Earth Exploration satellites. Small sats, including nano and pico sats.			Militaries around the world continue to rely on and operate in this band. In Region 3, current use is increasing.
8.4-10.0	Weather monitoring, air traffic control, maritime vessel traffic control,			

	defense tracking and vehicle speed detection for law enforcement. Space Research and active radars on board NGSO in the Earth Exploration Satellite Service.			
10-10.5	Weather monitoring, air traffic control, maritime vessel traffic control and active radars on board NGSO in the Earth Exploration Satellite Service.			
10.7-10.95	Globally harmonized for FSS. Heavy usage by government and commercial operators by GSO networks and non-GSO systems. All ITU Member States given guaranteed access to their own orbital slots through ITU Appendix 30B Plan. These are permanently reserved for these member states to be used at any time they desire. Domestic satellite networks (VSAT, SNG, CBH, HEST, LEST, DTH, DTT, TVRO).		Globally harmonized for FSS All ITU Member States given guaranteed access to their own orbital slots through ITU Appendix 30B Plan. These are permanently reserved for these member states to be used at any time they desire. Government and commercial use. Domestic GSO satellite networks (VSAT, SNG, CBH).	Use of this band is intensifying with more Video via FSS to remain strong in many regions. Land, aero and maritime ESIMs to deploy. Expansion into High Throughput Satellites, incl. Software Defined Satellites (SDS). LEO systems to deploy.

10.95-11.2	Globally harmonized for FSS. This band is heavily used by GSO and NGSO satellites for all type of satellite services. Domestic and international satellite networks, including High Throughput Satellites (VSAT, SNG, video distribution (incl. cable TV feeds and direct to home reception), mobile terminals (incl. aeronautical and maritime), CBH, emergency communications/ disaster relief).		The current use is expected to continue and grow and more focus on High Throughput Satellites, with increasing throughput, are expected. Video via FSS to remain strong, VSAT and other data networks important. Use of aeronautical and maritime mobile terminals well established over many years and use increasing with ESIMs. LEO systems to deploy (NGSO satellite networks to co-exist with GSO through epfd limits)
11.2-11.45	Globally harmonized for FSS. All ITU Member States given guaranteed access to its own satellite capacity through ITU Appendix 30B Plan to be available to be used at any time they so desire. Government and commercial use by GSO networks and non-GSO systems. Domestic satellite networks (VSAT, HEST, LEST, SNG, CBH, DTH, DTT, TVRO).	Globally harmonized for FSS All ITU Member States given guaranteed access to its own GSO satellite capacity through ITU Appendix 30B Plan to be available to be used at any time they so desire. Government and commercial use. Domestic GSO satellite networks (VSAT, SNG, CBH).	Video via FSS to remain strong in many regions. Land, maritime, aero ESIMs to deploy. LEO systems to further deploy. Expansion into High Throughput Satellites, incl. Software Defined Satellites (SDS). Market for current applications expected to grow.

			NGSO satellite networks co-existing with GSO through epfd limits.	
11.45-11.7	Globally harmonized FSS. This band is heavily used by GSO and NGSO satellites for all type of satellite services. Domestic and international satellite networks, including High Throughput Satellites for VSAT, HEST, LEST, SNG, video distribution (incl. cable TV feeds and direct to home reception), mobile terminals (incl. aeronautical and maritime terminals), CBH, emergency communications/ disaster relief).			The current use is expected to continue and grow and more focus on High Throughput Satellites, with increasing throughput, are expected. Video via FSS to remain strong in many regions, VSAT and other data networks important in some regions, Use of aeronautical and maritime mobile terminals well established over many years and use increasing with ESIMs. LEO systems to deploy (NGSO satellite networks to co-exist with GSO through epfd limits).
11.7-12.2	Globally harmonized for satellites use. Heavily used for DTT, DTH, NGSO FSS and FSS-like services, including aero mobility, maritime, network services, broadband, enterprise, trunking, VSAT and CBH.	Globally harmonized for satellites use. Heavily used as primary FSS band for GSO and NGSO in the Americas including DTT, DTH, blanket licensing for aero mobility, maritime connectivity,	Globally harmonized for satellites use. All ITU Member States given guaranteed access to its own satellite capacity through ITU Appendix 30 Plan to be available to be used at any time they so desire. Predominantly	BSS Video to remain strong in many regions. Land, aero, maritime ESIMs to deploy using LEO systems. Software Defined Satellites (SDS). Market for current applications expected to grow.

	AP30/30A downlink – equitable access planned band (BSS).	broadband, enterprise, trunking, VSAT, CBH.	domestic government and commercial use (depending on country). TV and radio broadcast (cable TV feeds and direct to hope reception) and associated feederlinks. Heavily NGOS FSS and FSS-like services, including aero mobility, maritime, network services, broadband, enterprise, trunking, VSAT and Backhaul.	Further expansion of HTS in Region 2.
12.2-12.5		Used for DTH, GSO and NGSO FSS and FSS-like services, including blanket licensing for aero mobility, maritime, network services and CBH. AP30/30A downlink – equitable access planned band (BSS).	Heavily used by GSO and NGSO satellites for all type of satellite services. NGSO satellite networks co-existing with GSO through epfd limits.	BSS Video to remain strong in many regions, Aero ESIMs to deploy, LEO systems to deploy. Use of High Throughput Satellites, incl. Software Defined Satellites (SDS).
12.5-12.75	Globally harmonized for satellites use. Primary Ku downlink band heavily used by GSO and NGSO satellites for all type of			For FSS, current use is expected to continue and grow and more focus on High Throughput Satellites, with increasing throughput, are expected.

	satellite services, incl. for VSAT, HEST, LEST, SNG, video distribution (cable TV feeds and direct to home reception), mobile terminals (incl. aeronautical and maritime terminals), CBH, emergency comms/ disaster relief).			Video via FSS to remain strong in many regions, VSAT and other data networks important in some regions, Use of aeronautical and maritime mobile terminals well established over many years and use increasing. Use of High Throughput Satellites, incl. Software Defined Satellites (SDS).
12.75-13.25	Globally harmonized for FSS. All ITU Member States given guaranteed access to its own satellite capacity through ITU Appendix 30B Plan to be available to be used at any time they so desire. Government and commercial use by GSO networks and non-GSO systems. Domestic satellite networks (VSAT, HEST, LEST, SNG, CBH).		Globally harmonized for FSS. All ITU Member States given guaranteed access to its own GSO satellite capacity through ITU Appendix 30B Plan to be available to be used at any time they so desire. Government and commercial use. Domestic GSO satellite networks (VSAT, SNG, CBH).	Planned use for IFC and maritime. Video via FSS to remain strong in many regions, Land, aero and maritime ESIM to deploy. Expansion into High Throughput Satellites, mobile terminals (incl. aeronautical and maritime). Software Defined Satellites (SDS) and LEO systems to further deploy – noting that NGSO satellite networks to co-exist with GSO through epfd limits.
13.25-13.4				
13.4-13.65	FSS downlink only.			New FSS band since 2015 – new satellites designed with this band.

13.75-14.0	Globally harmonized for FSS. Military/NATO use in the 13.75-14 GHz band for radar applications. Global uplink band for GSO/NGSO use. FSS government and commercial use for feeder links, Gateways, backhaul, VSATS.			Revise current ITU radio regulation to alleviate operational limitations. Extend mobility applications.
14.0-14.5	Globally harmonized for FSS. Primary Ku uplink band globally – used heavily by thousands of GSO and NGSO satellites for all types of services.			Heavy use by all FSS/MSS applications. Use of mobile terminals, including aeronautical and maritime mobile terminals, well established over many years and use is increasing. Increased use of High Throughput Satellites, incl. Software Defined Satellites (SDS).
14.5-14.8	Feeder links for BSS AP30/30A uplink – equitable access planned band (feeder link BSS).	FSS use with limitation on antenna size in a number of countries.	Some countries including in high rain-rate areas are given guaranteed access to BSS feederlinks through ITU Appendix 30A Plan. In other countries, ITU Radio Regulations also open up for FSS uplinks other than BSS feeder links.	Opened up for new FSS applications since 2015 – new satellites designed with this band .

			Predominantly domestic government and commercial use (depending on country) for BSS feederlinks.	
17.3-17.7	BSS feederlinks & FSS downlinks. AP30/30A uplink – equitable access planned band (BSS).	BSS feederlinks & DTH downlinks. AP30/30A uplink – equitable access planned band.	BSS feederlinks (ITU Appendix 30A Plan) in 17.3-18.1 GHz range.	New FSS downlink allocation in Region 2 to be decided at WRC-23. Use increasing and more NGSO systems using the band. Expected heavy use for HTS and broadband. BSS video and associated feederlinks to remain strong.
17.7-17.8	High Throughput Satellites, GSO and NGSO co-existing through coordination procedures (broadband connections, VSATs, land, maritime and aeronautical ESIMs. Feeder (Gateway) downlinks. Government and commercial use. AP30/30A uplink – equitable access planned band (BSS).		BSS feederlinks (ITU Appendix 30A Plan) in 17.3-18.1 GHz range. High Throughput Satellites, GSO and NGSO co-existing through epfd limits. (broadband connections, VSATs, land, maritime and aeronautical ESIMs). Government and commercial use.	Further development of current use, including GSO High Throughput Satellites with increasing capacity, ESIMs (land, maritime and aeronautical), and more NGSO systems using the band with increasing number of satellites in constellations. BSS video and associated feederlinks also to remain strong.
17.8-18.1	High Throughput Satellites, GSO and NGSO co-existing	High Throughput Satellites, GSO and NGSO co-existing	BSS feederlinks (ITU Appendix 30A Plan) in 17.3-18.1 GHz range.	Further development of current use, incl. GSO High Throughput Satellites with increasing

	through coordination procedures (broadband connections, VSATs, land, maritime and aeronautical ESIMs). Government and commercial use. AP30/30A uplink – equitable access planned band.	through epfd limits (broadband connections, VSATs, land, maritime and aeronautical ESIMs). Government and commercial use.	High Throughput Satellites, GSO and NGSO co-existing through epfd limits. (broadband connections, VSATs, land, maritime and aeronautical ESIMs). Government and commercial use.	capacity, ESIMs (land, maritime and aeronautical), and more NGSO systems using the band with increasing number of satellites in constellations. BSS video and associated feederlinks also to remain strong.
18.1-18.8	High Throughput Satellites, GSO and NGSO co-existing through epfd limits (broadband connections, VSATs, land, maritime and aeronautical ESIMs. Feeder (Gateway) downlinks. Government and commercial use.			Further development of current use, incl. GSO High Throughput Satellites with increasing capacity, ESIMs (land, maritime and aeronautical), and more NGSO systems using the band with increasing number of satellites in constellations.
18.8-19.3	High Throughput Satellites, GSO and NGSO co-existing through coordination procedures (broadband connections, VSATs, land, maritime and aeronautical ESIMs. Feeder (Gateway) downlinks. Government and commercial use.			Further development of current use, incl. GSO High Throughput Satellites with increasing capacity, ESIMs (land, maritime and aeronautical), and more NGSO systems using the band with increasing number of satellites in constellations.
19.3-19.7	High Throughput Satellites, GSO and NGSO co-existing through coordination procedures (broadband connections, VSATs, land, maritime and aeronautical ESIMs. Feeder (Gateway) downlinks. Government and commercial use.			Further development of current use, incl. GSO High Throughput Satellites with increasing capacity, ESIMs (land, maritime and aeronautical), and more

				NGSO systems using the band with increasing number of satellites in constellations.
19.7-20.2	High Throughput Satellites, GSO and NGSO co-existing through epfd limits (broadband connections, VSATs, land, maritime and aeronautical ESIM. Feeder (Gateway) downlinks. Government and commercial use.			Further development of current use, incl. GSO High Throughput Satellites with increasing capacity, ESIMs (land, maritime and aeronautical), and more NGSO systems using the band with increasing number of satellites in constellations.
20.2-21.2	Government/military satellite networks. Fixed and mobile terminals: in all 3 regions.			
21.4-22	BSS downlinks.		BSS downlinks.	Definitive regulatory provisions for BSS in this band was not established until at WRC-12. Few satellites still to use this band.
22.55-23.55	Allocation for Inter-satellite links.			Links between LEO satellites and between LEO satellites and GSO satellites.
37.5 to 42	High Throughput Satellites, GSO			Further development of current use, incl. GSO High Throughput Satellites with increasing capacity
47.2 to 52.4	High Throughput Satellites, GSO			Further development of current use, incl. GSO High Throughput Satellites with increasing capacity