RESPONSE TO CONSULTATION PAPER ON ASSIGNMENT OF SPECTRUM FOR SPACE-BASED COMMUNICATION SERVICES

01 June 2023, New Delhi

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Telecom Regulatory Authority of India
New Delhi

Sub: Comments on 'Assignment of Spectrum for Space-based Communication Services'

Dear Shri Trivedi,

The Esya Centre is a New Delhi-based technology policy think-tank. Our mission is to generate empirical research and inform thought leadership to catalyse new policy constructs for the future. More information on our work can be found at: www.esyacentre.org.

We are delighted to be afforded the opportunity to submit comments on the Consultation Paper (CP) on Assignment of Spectrum for Space-based Communication Services. We laud the TRAI for this open process.

Please see specific comments to the CP enclosed herewith.

In addition, we take this opportunity to share a forthcoming Esya Centre report titled '*Assigning Spectrum for Satellite Services in India*' as an annexure to our response. This report sheds light on some of the technical, regulatory, and economic issues related to satellite spectrum assignment and sharing, in the Indian context. It is based on a combination of desk research and expert consultations.

We are at your disposal for any queries and thank you for your consideration of external research and perspectives.

Sincerely,

Amjad Ali Khan
Director
Esya Centre

A) General Comments

India may become the first country to auction spectrum for satellite/space-based communication services (also commonly referred to as Satellite Spectrum). Other countries have considered satellite spectrum auctions in the past, but they did not go ahead because of discouraging results from impact assessments. Current policy efforts in India aim at ease-of-doing business and attracting investments in the satcom sector. Auctioning of satellite spectrum may negate such efforts.

Satellite spectrum is a shared global resource subject to cross-border coordination under the purview of the International Telecommunication Union (ITU). Coordination mitigates interference issues inherent in satellite services. Consequently, countries worldwide adhere to administrative allocation for shared use of satellite spectrum. India's attempt at an exceptional framework for spectrum assignment may disrupt global coordination.

We highlight issues related to satellite spectrum auctioning based on emerging trends and point towards allocational inefficiencies in the annexed report. Further, we analyse spectrum auctions in other countries such as the United States, Canada, South Korea, Brazil, etc. and find that there is no international standard for auction of satellite spectrum, especially in higher frequency bands such as C band, Ku band and the Ka band, which are sharable among multiple service providers. While there is evidence of spectrum auction for 5G/IMT services, no country has auctioned satellite spectrum for shared-use amongst different space-based communication services.

Auctioning spectrum could also lead to consequences like (a) gatekeeping and creation of artificial competition; (b) financial burden on incumbents; (c) additional business-to-business regulation and international coordination failures and (d) threat to freedom of speech.

We therefore recommend deeper analysis of: a) the impact of auctioning satellite spectrum on different services and use-cases; (b) impact on existing and future policies and laws like the Draft Telecommunications Bill, the Indian Space Policy, and the Uplinking and Downlinking Guidelines; (c) assessment of cost burden to shift incumbent services to other bands; and (d) implications on international and regional coordination mechanisms.

B) RESPONSE TO SPECIFIC CP QUESTIONS

Q1. 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.

Response: Frequency spectrum in higher bands such as C band, Ku band and Ka band, should be allotted through administrative assignment and not assigned on an exclusive basis. Unlike terrestrial mobile spectrum, frequency spectrum in the higher bands (viz. C-band, Ku-band and Ka-band), can be assigned to several service providers (For a detailed discussion on the difference between satellite and terrestrial spectrum refer to section 2.1 of the annexed report).

Thus, if satellite service providers are granted exclusive rights through auctions to use separate frequency ranges, it will result in conflicts on spectrum sharing between service providers and inefficient use of spectrum. We discuss the impact and challenges associated with the same, particularly for broadcasting services in detail in section 5 of the annexed report.

Q2. 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? Kindly justify your response.

Response: No, an entity which acquires the satellite spectrum through auction/assignment should not be granted permission to trade and/or lease their partial or entire satellite spectrum holding to other eligible service licensees. Notably, regulation of satellite spectrum and the communication of orbital "space objects"[1] comes under the purview of the ITU, which is a specialized United Nations (UN) agency responsible for allocation of radio spectrum, and satellite orbits globally, along with the development of common technical standards. Thus, an effort to auction satellite spectrum and allowing trading and/or leasing by acquiree entity will potentially involve and effect existing international coordination mechanisms. In addition, it would require designing a complicated set of rules for the coordinated operation of different satellites using the same spectrum band. Please refer to section 4 of the annexed report for a detailed discussion on the international coordination aspect and international practices on assignment of spectrum.

Q3. 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? 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.

&

Q4. 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.

Response: Spectrum should be administratively assigned for both, user link as well as the gateway links for all space-based communication services, *b*ased on international practices and an

[1] As per the International Space Laws, satellites are considered "space objects".

assessment of previously held IMT auctions,. An optimal strategy to assign satellite spectrum should prevent creation of artificial barriers, aid efficient usage, promote competition and innovation in relevant industries. Please refer to Section 3 of the annexed report which covers the issues related to auctioning satellite spectrum along with an assessment of IMT spectrum auctions held in India so far.

Annexure:

Forthcoming Report on:

'Assigning Spectrum for Satellite Services in India'

ESYA centre

ASSIGNING SPECTRUM FOR SATELLITE SERVICES IN INDIA

JUNE 2023

Assigning Spectrum for Satellite Services in India

Attribution: Tamanna Sharma and Niharika. *Assigning Spectrum for Satellite Services in India.* June 2023, Esya Centre.

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The Esya Centre is a New Delhi based technology policy think tank. The Centre's mission is to generate empirical research and inform thought leadership to catalyse new policy constructs for the future. More details can be found at www.esyacentre.org

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LIST OF ABBREVIATIONS

Abbreviation	Meaning
ACMA	Australian Communications and Media Authority
BSNL	Bharat Sanchar Nigam Limited
BSS	Broadcast Satellite Service
CDMA	Code Division Multiple Access
CP	Consultation Paper
DoT	Department of Telecommunications
DTH	Direct-to-Home
ESA	European Space Agency
FCC	Federal Communications Commission
FSS	Fixed Satellite Service
GHz	Gigahertz
GSM	Global System for Mobile Communication
GSO	Geo-Stationary Orbit
HITS	Headend-in-the-sky
IEEE	Institute of Electrical and Electronics Engineers
IMT	International Mobile Telecommunication
ISED	Industry Canada
ITU	International Telecommunication Union
KHz	Kilohertz
LTE	Long-term Evolution
MHz	Megahertz
MIFR	Master International Frequency Register
MSO	Multiple System Operator
MSS	Mobile Satellite Service
NFAP	National Frequency Allocation Plan
NGSO	Non-Geo-Stationary Orbit
RP	Reserve Price
RR	Radio Regulations
SHF	Super High Frequency
TRAI	Telecom Regulatory Authority of India
UN	United Nations
WRC	World Radiocommunication Conference

EXECUTIVE SUMMARY

India may be the first country to auction spectrum for satellite/space-based communication services (also commonly referred to as Satellite Spectrum). In April 2023, the Telecom Regulatory Authority of India (TRAI) released a consultation paper (CP) on the "Assignment of Spectrum for Space-based Communication Services" reaffirming India's plans to achieve the same. While the current policy efforts aim to foster ease-of-doing business and attract investments in the Satcom sector, auctioning satellite spectrum may have a drastic impact on incumbents, who rely on it to offer their services to consumers.

Satellite spectrum is a shared global resource and is subject to cross-border coordination under the purview of the International Telecommunication Union (ITU). This is primarily done to address interference issues, which can disrupt communication signals and impact the quality and reliability of services across different nations. Consequently, countries worldwide adhere to administrative allocation for the shared use of satellite spectrum amongst different entities. In this paper, we write about India's possible attempt at creating a parallel framework and the potential issues that may arise.

Specifically, we bring forth some of the nuanced technical, regulatory, and economic issues related to satellite spectrum assignment and sharing. First, we dive into issues related to the auction of satellite spectrum based on emerging trends and highlight allocational inefficiencies. Further, we analyse spectrum auctions in other countries such as the United States, Canada, South Korea, Brazil, etc. to understand outcomes and challenges relevant for the Indian context. We infer that internationally, there is no standardised model to auction of satellite spectrum, especially in higher frequency bands, which are sharable among multiple service providers. In addition, while there is evidence of spectrum auction for 5G/IMT services, no country has auctioned satellite spectrum to be shared amongst different space-based communication services.

Finally, we highlight some key issues that arise from spectrum auctions such as (a) gatekeeping and creation of artificial competition; (b) financial burden on incumbents; (c) business-to-business regulation and international coordination; and (d) threat to freedom of speech. Based on the issues discussed, we recommend the launch of independent studies and research to answer key questions, such as (a) impact of satellite spectrum on other services and use-cases; (b) impact on other policy efforts like the Draft Telecommunications Bill, the Indian Space Policy, and the Uplinking and Downlinking Guidelines; (c) an assessment of cost burden to shift incumbent services to another band; and (d) the implications on international and regional coordination mechanism.

1. INTRODUCTION

Wireless communication services such as telecommunications, broadcasting and air-to-ground communication for aircrafts take place via the radio frequency spectrum of the electromagnetic (EM) wave radiations, which range from 3 KHz to 3000 GHz.[i] A portion of this spectrum includes multiple frequency bands starting from 8.3 KHz to 275 GHz and is allocated to 41 different radiocommunication services as per the International Telecommunication Union (ITU) Radio Regulations. These include several different applications, depending on their use-cases and the technology involved. For instance, telecom services use technologies such as; (A) Global System for Mobile Communication (GSM or 2G) and (B) Code Division Multiple Access (CDMA or 3G) that utilize frequencies starting from 800 MHz. With technological advancements in this sector, there are now 4G Long-Term Evolution (LTE) and 5G services that require higher frequency bandwidths above 1-2 GHz, besides lower bands. On the other hand, television channel broadcasting, utilizes satellites to uplink and downlink signals, which require a higher frequency bandwidth starting from 3 GHz and occupy orbital slots in the geostationary orbit of the earth.[ii] Several other strategically important sectors such as military, aerospace and defence, disaster management, banking and agriculture also primarily rely on satellite-spectrum[1] for their functioning.

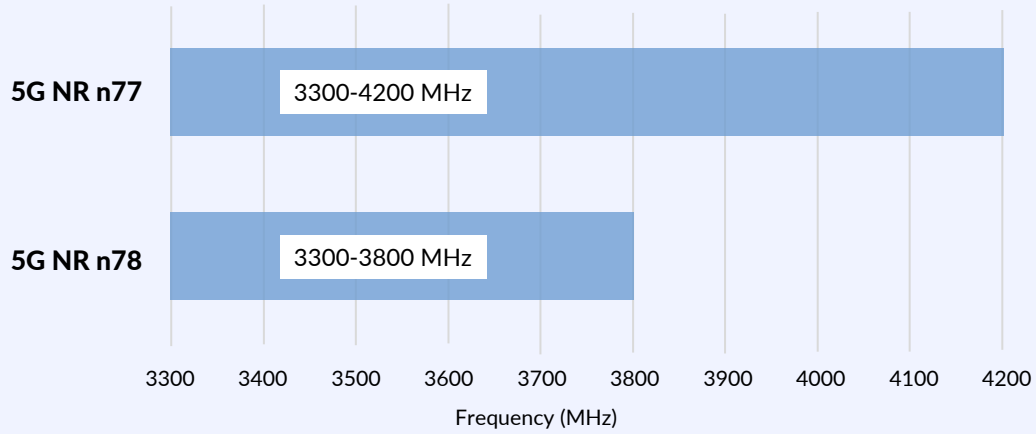
Regulation of satellite spectrum and the communication of orbital "space objects" [2]comes under the purview of the ITU, which is a specialized United Nations (UN) agency that allocates radio spectrum, and satellite orbits globally. As part of its management process, ITU has an international binding treaty adopted by its 193 member countries called the Radio Regulations (RR). The RR provide guidelines for member nations on sharing the radio frequency spectrum among different services. They also offer detailed instructions on using specific equipment to ensure successful coexistence of services. India is a signatory of the RR, which means that the country is bound by procedures and modalities contained within the guidelines. However, as per the April 2023 consultation paper (CP) on "Assignment of Spectrum for Space-based Communication Services" released by the Telecom Regulatory Authority of India (TRAI), India may inadvertently violate some of these guidelines.

The CP covers types of "access" spectrum used for communication services (terrestrial and satellite), its current use-cases, technological differences, as well as mode of spectrum assignment (i.e., administrative allocation or auction) for use by different public and private-sector entities. Most notably, the CP mentions auctioning satellite spectrum to be shared amongst entities across different satellite-based communication services, and aims to conduct a consultation on a framework that will help achieve this objective. This has sparked debate amongst stakeholders from the broadcasting, and telecom industries over the mid-band spectrum which has traditionally been used to provide TV channel services to viewers. Further, as per global standards, the mode of assignment of any service in the satellite spectrum has always been administrative allocation. Hence, the CP framework is a departure from global best practices and a cause of concern for stakeholders in the broadcasting industry, who are expected to experience severe disruption in services and may be forced to negotiate with telecom operators in case the C-band is auctioned for shared use.

2. BACKGROUND

Airwaves in the C-band spectrum can carry large amounts of data over long distances and are therefore fit for satellite transmission in industries like TV broadcasting and backhaul of telecom services. In 2018, Telecom Regulatory Authority of India (TRAI) identified multiple frequencies for 5G services in India, within the range of 3300-3600 MHz. Initially this range was excluded from the 5G auctions held in March 2021.[iii] However, TRAI later clarified "that the entire range of 3300-3670 MHz should be made available to telcos for International Mobile Telecommunications (IMT)/5G services via auction," in a consultation paper. In fact, as of 2022, parts of the C-band have been auctioned to three major telcos in the country; Vi, Bharti Airtel and Reliance Jio Infocomm.[3] Further, as per the CP, the Department of Telecommunication (DoT) is expected to allocate 40 MHz from 3630-3670 MHz to Bharat Sanchar Nigam Limited (BSNL), which will effectively reduce the 100 MHz guard band between 5G/IMT and broadcasting services to 30 MHz.

Figure 1: Band plans for 5G-New Radio (NR)



Source: TRAI recommendations on "Auction of Spectrum in frequency bands identified for IMT/5G" (2022)

The telco-led demand for satellite spectrum is also not limited to 3670 MHz, but covers the entire C-band until 4200 MHz. As per TRAI's recommendations,[iv] telcos may be given the option of opting between two 5G band plans named n77 and n78, depending on their commercial considerations (Figure 1). This may lead to interference caused by overloading of Low-Noise Block (LNBs) receivers due to high terrestrial transmissions in the 3300-3670 MHz band, leading to loss of signal in the 3700-4200 MHz frequency range, thereby disrupting broadcasting services.

2.1 Difference Between Satellite and Terrestrial Spectrum

Depending on the method of transmission, communication networks can be divided into terrestrial and satellite. Terrestrial communication consists of land-based networks in which signal transmission occurs between two land-based terminals/stations. They are prone to interference/obstruction from physical objects such as trees, hills, mountains, etc. On the other hand, satellite-based communication relies on uplinking and downlinking signals using satellites in the Geo-Stationary (GSO) and Non-Geo Stationary Orbits (NGSO). Before we discuss assignment of spectrum for these two distinct categories, it is important to recognise distinctions between the two. Below, we highlight major differences between them, based on technical requirements, business use cases as well as regulation in detail.

Technical: Satellite communication, in general uses a higher range of frequencies for signal transmission compared to terrestrial communication. Satellite communication is ubiquitous and due to its orbital range, it has higher latency, can cover a larger area on earth and reach remote corners where terrestrial communication networks are difficult to establish.

While both satellite and terrestrial networks have frequency reuse capabilities, terrestrial communication networks are economically advantageous and have an edge over their satellite counterparts. At the same time, satellite signals received at the ground terminal are much weaker than cellular signals. Hence, the receiver equipment of a satellite terminal is designed to detect low power signals in the 3300-4200 MHz range, and is extremely sensitive to any strong carrier signals which can affect the performance of receiving systems.

Business use-case: Satellite spectrum is considered a shared global resource and is non-rivalrous in nature. In other words, the same spectrum, with due coordination, can be shared by different satellites simultaneously across multiple sectors such as aviation, defence, agriculture, banking, and broadcasting without causing interference. Moreover, 'orbit-spectrum' is a shared resource which can be used by multiple users simultaneously through the process of coordination, notification and registration as stated in the RR. In the case of terrestrial spectrum, a particular frequency band can be exclusively assigned to a single operator in a geographical area through an auction process.

Regulation: Terrestrial frequency assignments close to international borders are the only ones that require 'cross-border' coordination and are notified and registered in ITU's Master International Frequency Register (MIFR). In contrast, all frequency assignments made to satellite networks have to be coordinated, notified, and registered in the MIFR, to qualify for international recognition and protection as per Article 8 of the RR.

2.2 Defining C-Band Within Satellite Spectrum

C-band is the name of the frequency range in the mid-band satellite spectrum. Its definition varies across different regions/entities, and it is important to note that the frequencies defined under C-band are approximate boundaries. Illustratively, the Federal Communications Commission (FCC) of the United States[v] define the C-band as 3.7-4.2 GHz, while the Global Satellite Coalition defines 3.4-3.7 GHz & 4.5-4.8 GHz ranges as the "Extended C-band" (Table 1). However, the Europe Space Agency (ESA) and Institute of Electrical and Electronics Engineers (IEEE)[vi] define C-band as 4.0-8.0 GHz. According to the ITU nomenclature of frequencies, this band falls in the Super High Frequency range (3-30 GHz).

TRAI's consultation paper on "Assignment of Spectrum for Space-based Communication Services," also defines that lies within the 4.0-8.0 GHz as C-Band. However, this is based on ESA's definition, and does not align with the definition laid down by the ITU, of which India is a member country

Table 1: C-Band nomenclature and its use cases

Entity/Jurisdiction	C-band Range	Use Case
Europe Space Agency (ESA)	4.0-8.0 GHz	Used for satellite communications, full-time satellite TV networks, and raw satellite feeds.
Institute of Electrical and Electronics Engineers (IEEE)	4.0-8.0 GHz	Used for satellite communications transmissions (Wi-Fi devices, cordless telephones) and weather radar systems.
International Telecommunications Union (ITU)	3.7-4.2 GHz (Standard C-band, part of the 3-30 GHz SHF band)	The band is primarily used for Fixed Satellite Services (FSS), Fixed Mobile services, and Radiolocation. ITU gives flexibility to each member state to determine the exact use case of the frequency band.

Federal Communications Commission (FCC, United States)	3.7-4.2 GHz (divided into sub-blocks)	Used for Fixed Satellite Services (FSS), in space-to-earth (downlinking) direction for communication. FSS operators in the US use the C-band to deliver programming to television and radio broadcasters and to provide telephone and data services to consumers as per the ITU Radio Regulations.
Global Satellite Coalition	3.4-3.7 GHz & 4.5-4.8 GHz (Extended C-band) 3.7-4.2 GHz (Standard C-band)	-

Source: European Space Agency, Semantics Scholar, FCC, ITU, Global Satellite Coalition

2.3 Assignment Of Services In The C-Band

Table 2 shows that frequencies in the 3.3-4.2 GHz band (C-band) range are used for Fixed, Fixed Mobile, Radiolocation, Amateur and Fixed-Satellite (space-to-earth; downlinking) services. It is important to note that the RR specify allocation of frequencies for multiple services across different regions[4] of the globe. They do not, however, cover the mode of spectrum allocation which falls under the responsibility of individual member nations. Instead, it is based on their national requirements and reflected in their National Frequency Allocation Tables/Plans (NFAP).

For instance, broadcasters in India use a large part of the C-band for uplinking TV channel signals, and the aviation industry utilizes it for air-to-ground communication in aircraft. The assignment of this satellite spectrum has been done through administrative allocation.

Table 2: Allocation to services under ITU's Radio Regulations

Frequency Band	Region 1	Region 2	Region 3
3300-3400 MHz	Radiolocation	Radiolocation, Amateur, Fixed, Mobile	Radiolocation, Amateur
3400-3600 MHz	Fixed, Fixed Satellite, Mobile except aeronautical, Radiolocation	**3400-3500 MHz** - Fixed, Fixed Satellite, Mobile except aeronautical, Radiolocation, Amateur 3500-3600 MHz - Fixed, Fixed Satellite, Mobile except aeronautical, Radiolocation	**3400-3500 MHz** - Fixed, Fixed Satellite, Mobile, Radiolocation, Amateur 3500-3600 MHz - Fixed, Fixed Satellite, Mobile except aeronautical, Radiolocation
3600-4200 MHz	Fixed, Fixed Satellite, Mobile	**3600-3700 MHz** - Fixed, Fixed Satellite, Mobile except aeronautical, Radiolocation	**3600-3700 MHz** - Fixed, Fixed Satellite, Mobile except aeronautical, Radiolocation
		3700-4200 MHz – Fixed, Fixed Satellite, Mobile except aeronautical	

Source: ITU Radio Regulations (2020) and NFAP (2022). Note: Radiolocation is the service used for radionavigation; Fixed implies radiocommunication service between two fixed points; Fixed Satellite means radiocommunication between earth stations and one or more satellites; Mobile means radiocommunication between mobile and land stations; Amateur service means radiocommunication for the purpose of self-training, technical investigations by amateurs.

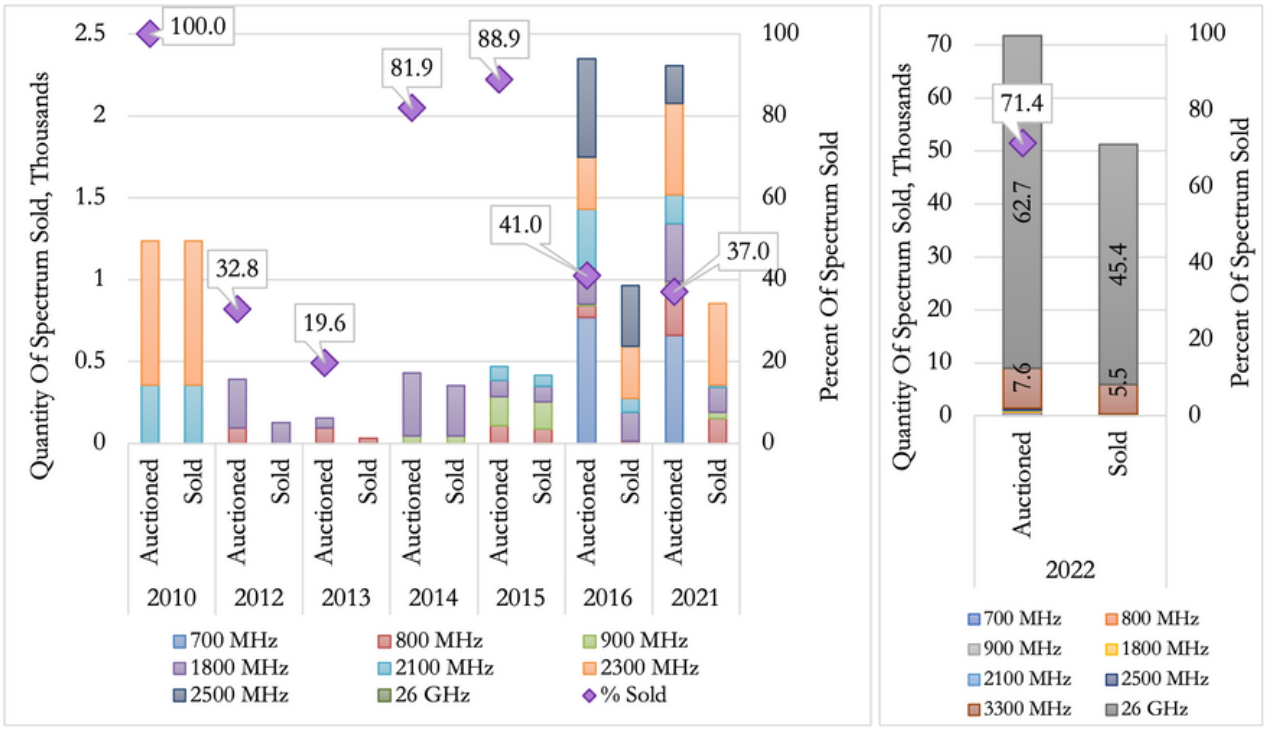
While table 2 highlights current use-cases of the C-band, over the past few years, part of this spectrum has been globally recognised as a suitable frequency band to deploy 5G/IMT services. This is because low-band frequencies support only low-bandwidth and throughput, while the high band supports higher bandwidth but can travel only short distances and even rain or wind can easily obstruct/attenuate signals in this band. The mid-band spectrum, considered the sweet spot between the two, provides the most optimal combination of high bandwidth & signal resiliency.[vii] Hence, some countries have started vacating parts of this band for 5G/IMT services (table 3 illustrates some of the key development across several jurisdictions).

3. ISSUES RELATED TO AUCTIONING SATELLITE SPECTRUM

An optimal strategy to assign satellite spectrum should prevent the creation of artificial barriers, aid efficient usage, and promote competition and innovation in relevant industries, to maximise the public welfare of this natural resource.[viii] The elementary reason for auctioning a resource is to prevent an impasse when demand is greater than supply. In addition, an auction is considered efficient when the process leads to a price discovery in the market i.e., the sale price is greater than the reserve price (RP). To assess the allocational efficiency of auctions, we analyse and discuss trends from previous spectrum auctions held for IMT services below-

a **Large portion of spectrum put to auction remains unsold –** Except for the 2010 auctions, a large part of auctioned spectrum has remained unsold (Figure 1). In 2014, 100 percent of the 900 MHz band got sold because of license extension/renewal compulsions of operators. It was artificial scarcity combined with license extension/renewal compulsions which led to spectrum sale in the early years of auction in India.[ix] In 2016, the entire 700 MHz and 60 percent of the total spectrum put up for sale remained unsold due to high prices. Only 69 percent spectrum put up for auction so far has been sold, indicating that either the reserve prices were too high or the demand for spectrum has been low.

Figure 2: Spectrum auctioned v/s spectrum sold (2010-2022)

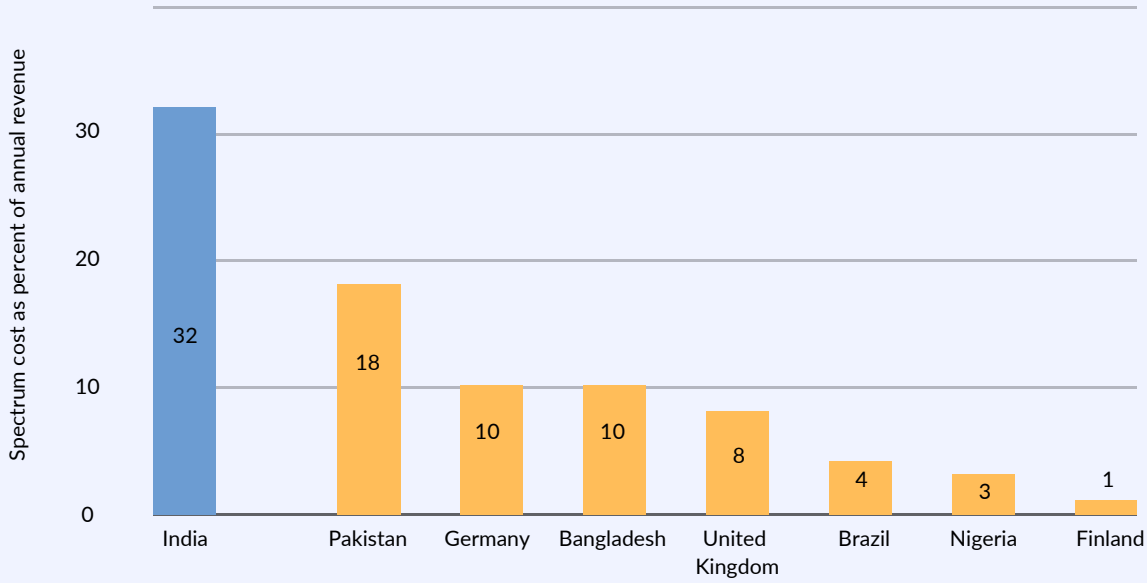


Source: TRAI documents & PIB Press Release (2022).

b **Significant portion of spectrum sold at the reserve price -** The success of an auction is determined not only by the ability to sell a large proportion of spectrum, but also by the market clearing price being significantly above the reserve price. Evidence from previous auctions indicate that a significant portion

of spectrum as sold at the RP. In 2014, 2015 and 2016 only 53 percent, 79 percent and 21 percent of the spectrum put to auction was sold above the RP respectively. Similarly, in 2022 over 99 percent of the spectrum was sold at the reserve price,[x] despite TRAI reducing the RP for many frequency bands. Figure 3 depicts that spectrum cost as a percent of the annual recurring revenues is exorbitantly high relative to other nations.

Figure 3: Spectrum costs as a proportion of annual recurring revenue, 2019



Source: Retrieved from GSMA (2021)
Note: Spectrum costs combine annual spectrum fees as well as auction payments. The latter are annualised based on the license length and the weighted average cost of capital (WACC).

Emerging trends from previous auctions suggest that the allocational efficiency of the process needs to be questioned due to three major reasons -

- If a significant portion of the auctioned spectrum goes unsold, then it is likely that demand for spectrum is less than its supply, in which case an auction serves little purpose.
- A majority of the spectrum has been sold at the reserve price which means that there has been no real price discovery. It makes the process akin to an administrative assignment but limits competition through pre-determined high reserve prices.
- Finally, while revenue maximization is important, economically efficient usage of a resource should be the primary objective of the assignment. Unsold spectrum due to auctions are left unutilized which leads to an irretrievable loss in the long haul. In addition, high spectrum costs lower the incentives to invest in network expansion and upgrades, resulting in higher consumer prices and poor quality of services.

Further, satellite spectrum, especially in higher bands such as C band, Ku band or Ka band possess a set of characteristics that are distinct from terrestrial spectrum or lower satellite spectrum bands. Consequently, the auction or exclusive assignment of satellite spectrum, may give rise to numerous concerns regarding its utilization, accessibility, and coordination. The subsequent points outline several key issues associated with this matter -

a **Satellite spectrum is a non-rivalrous resource-** As mentioned in TRAI's consultation paper,[xi] the spectrum for satellite-based communication acquires the characteristic of a "club good".[5] It means that satellite spectrum is excludable but non-rivalrous in nature, which implies that the use of the same spectrum by one does not cause any significant negative externality to other operators. Specifically, unlike terrestrial mobile spectrum, this property of satellite spectrum makes use of the same band possible by multiple satellite systems servicing the same area, without causing significant interference to other service providers. This is made possible by stringently following the provisions contained in the RR for coordination, notification and registration of frequency assignments made to various satellite systems. These provisions are a result of numerous study cycles in the ITU and are updated and revised in each World Radiocommunication Conference (WRC) held every four years.

b **Satellite network operations require significant bilateral/multilateral coordination and cooperation**- Satellite systems also must coordinate with each other to share the same frequencies across their services. ITU has not placed any limit to the number of satellite filings that can be made by member administrations for any frequency band. As a result, the satellite spectrum is never exclusively assigned (as opposed to mobile access spectrum). It is a shared commodity between satcom operators globally and is therefore not a resource appropriate for auction. Additionally, India is signatory to a specific treaty for spectrum cooperation which involves all 193 ITU member administrations. Spectrum for satcom services is authorized for 'right-to-use' by all nations across the world, and is allocated only by administrative process, at charges that essentially cover the cost of administration. This aspect is covered in more detail in the next section.

c **Exclusive access to spectrum is a fundamental basis of an auction-** Ideally, bidders in an auction for spectrum should get exclusive access, otherwise the auction mechanism fails. However, in the case of satellite spectrum, the sharing of frequencies between operators is what results in large capacities becoming available over a particular geography. Thus, any attempt to create exclusivity by dividing the satellite spectrum will create artificial scarcity, and is not a workable solution.

d **Once exclusively assigned, any change in allocation during the licence period will be difficult-** Once auctioned, assigned and the set of rules agreed upon, the allocations cannot be changed during the tenure of the licensees. Additionally, a complex set of rules would have to be put in place to coordinate operations between different satellites, both at the national and international levels. This would make the entry of new operators difficult, as existing licensees would be negatively impacted by any change in the coordination rules. Moreover, they would also be an infringement on the legal rights after winning the spectrum in an auction.

4. INTERNATIONAL COORDINATION AND SPECTRUM AUCTIONS IN OTHER COUNTRIES

International coordination of satellite systems is facilitated by ITU RR on the basis of equitable access and rational use of radio frequency spectrum and orbits.[xii] The key objective of the RR guidelines is to prevent harmful interference among radio services, protect frequencies for distress and safety purposes, and ensure the efficient operation of all radiocommunication services.[xiii] Article 9 of the ITU RR comprehensively deals with the coordination procedure. The RR also reflect international understanding of radio spectrum as they are reviewed and revised at the WRCs through consensus and approval of member states.[xiv]

The guidelines prescribed by ITU under the RR give a framework for member states to abide by. However, countries still have the freedom to choose which service utilises a particular frequency band, along with the mode of allocation. Out of the 193 ITU member countries, only a few countries have conducted auctions for domestic satellite spectrum. Table 3 highlights the most common frameworks adopted to roll out 5G services, under which, incumbent players have been allowed to transition to new frequency bands and given sufficient time to do so.

As far as international practices are concerned, the legislative history of the Orbital Sustainability (ORBITS)[xv] Act includes a Commerce Committee report.[xvi] According to the law, the Committee apprehended that concurrent auctions in other countries could place significant financial burdens on US-owned global satellites. Additionally, the Committee pointed out that the launch of a global and international satellite system requires substantial resources and a spectrum auction would disrupt availability of capital for such projects. Brazil also abandoned the auctions of satellite spectrum along with orbital slots in 2020,[xvii] and noted that no country in the world follows this approach.[xviii]

Therefore, there is no standardised design model available for the successful auction of satellite spectrum, especially in higher frequency bands that are sharable between multiple service providers. In addition, while there is evidence of spectrum auction for IMT services, no country in the world has auctioned spectrum for satellite services including BSS.

Table 3: 5G auctions in the C-band spectrum

Country	Spectrum Auction/Allocation	Industries concerned
United States	• The United States has held several 5G auctions till date. The country auctioned parts of the C-band spectrum (3.5-3.6 GHz) in 2020, and subsequently in 2021 for 3.70-3.98 GHz. • The FCC first conducted "incentive" auctions for broadcasters to free up the C-band for 5G/IMT use in 2017. The auction was aimed at aligning the use of broadcast airwaves with consumer demand of broadcast and video services, while allowing for the growth of 5G wireless services in the coming years. • Notably, the Commission conducted extensive research to align the interests of various telecom and satcom service providers and was only allowed to modify licenses of incumbent satellite operators based on the criteria that it serves public interest.	IMT services

Canada	• Industry Canada (also known as ISED) auctioned 3.5 GHz band in 2021, along with consultations on auctioning 3.8 GHz band in the coming years for 5G/IMT. • The initial consultation process for satellite spectrum auction started back in 2011. In response to this consultation for auctioning satellite spectrum, several satellite industry players had voiced their opposition to the use of auctions, stating the inherent international nature of satellite communications and regulations as a key reason. • As per ISED, broadcast licences will not be subject to spectrum auction, unless alternate uses of the spectrum are permitted. Further, ISED also clarified that license spectrum in bands designated for priority services (e.g., radiocommunications systems of national importance and defence, law enforcement, public safety and emergency services) will not be subject to auctions.	IMT services
Australia	• The Australian Communications and Media Authority (ACMA) held its first 5G auctions for the 3.6 GHz range in 2018, raising USD 637 million (AUD 853 million) in the process. • The ACMA allowed for a phased transition of incumbent players to relocate over time. Initially, incumbents were asked to transition voluntarily, and at a later stage were asked to make new arrangements or cease operations over a specified period.[xix]	IMT services
Thailand	• Thailand is conducting 5G trials in the 3.5 GHz frequency band to determine the optimal parameters for sharing with FSS providers. • This includes broadcasters who are expected to retain the 3.7-4.2 GHz band, however, Thailand's National Broadcasting and Telecommunications Commission (NBTC) will keep at least a 100 MHz guard band between the two services.[xx]	IMT services
South Korea	• South Korea held 5G auctions for the mid-band (3.5 GHz) as well as high-band (28 GHz) frequency range, raising USD 3.3 billion (KWR 3.62 trillion) in 2018. • The auctions fetched 13 percent higher than the reserve price, with a 10-year licence validity for the mid-band spectrum.	IMT services

	• Notably, a part of 28 GHz band, which was also auctioned for IMT applications, has been taken back by the Korean government, due to very low level of investment for network by operators	
Brazil	• Held 5G auctions in the mid-band 3.5 GHz frequency range in 2021. This frequency band was already being utilised by broadcasters who were later moved to the Ku-band.	IMT services
United Kingdom	• The 700 MHz and 3.6-3.8 GHz frequency bands have been awarded by auction. The frequency bands are likely to be used by mobile network operators to deliver a range of services, including 5G mobile.	IMT services

Source: FCC (2020, 2021), FCC Incentive Auctions (2017), ISED (2021), ISED (2011), ACMA (2018), GSMA (2022), Korea Herald (2022), Ministry of Science and ICT, Korea (2022), GSMA (2021), Ofcom (2021)

5. IMPACT OF AUCTIONING SATELLITE SPECTRUM ON BROADCASTERS

If satellite service providers are granted exclusive rights through auctions to use separate frequency ranges, there could be clashes on spectrum sharing between service providers which may result in its inefficient use. We discuss the impact and challenges of the same, particularly for broadcasting services in detail below-

- **Market concentration and spectrum gatekeeping:** Auctioning or exclusive access to spectrum may create barriers to entry for market players for two reasons. First, it may reinforce concentration amongst dominant players, and further diminish the possibility of new entrants to the telecom and broadcasting sectors. Second, it may limit innovation in telecom services, as smaller enterprises would not have easy access to spectrum. The same applies to broadcasters who will find it difficult to compete in spectrum auctions, given the large differences in size and scale of operations.

- **Business–to–business regulation for efficient spectrum management:** If the C-band spectrum (3300-4200 MHz) is auctioned for satellite services, TRAI and DoT may have to come up with specific regulations for shared satellite spectrum use between telcos and other entities. This includes broadcasters who require pan-India licenses for access to spectrum across different regions of the country. In its latest CP, TRAI has been asked to make recommendations on a potential framework to address the shared use of the same spectrum. This has never been done before and is likely to introduce a new set of regulatory uncertainties in these sectors. Moreover, sharing criteria between space and other services already exists in ITU's RR. It may be difficult to reconcile extant ones with a newer framework.

- **Increase cost burden on incumbents to reduce interference:** In the scenario where C-band is auctioned-off for shared use between multiple services, TRAI and DoT recommend deployment of special equipment such as high-quality bandpass filters and cavity filters to avoid interference of signals across different communication services. However, this may increase the cost burden on namely MSOs and DTH operators, will disproportionately affect smaller enterprises, and act as a disincentive for new players to enter this market.

- **Impact on live broadcasting:** Auctioning satellite spectrum would have adverse consequences for live broadcasting sports, entertainment, and religious events. Illustratively, in a scenario where a sports event takes place in one part of the country, a broadcaster would need to obtain spectrum in that geographical area for uplinking. This would involve utilizing Digital Satellite News Gathering (DSNG) equipment for downlinking at their approved teleport, and subsequently re-uplinking via another satellite in a different location. The auction of satellite spectrum would also impact the reception of live sports events uplinked from other countries to be aired in India.

- **Impact on broadband and broadcast connectivity in remote and rural regions:** Satellite spectrum is an important vehicle to ensure connectivity to remote regions in India that do not have wired connections, and areas affected by natural disasters. C-band, in particular, offers good propagation characteristics and utilizes a mature technology, making it the preferred option to serve remote areas, especially in large countries with difficult terrain and severe climate conditions.[xxi] At present, many sparsely populated areas, including areas of strategic importance, do not have mobile terrestrial coverage and other forms of connectivity. An auction to grant exclusive rights to a few players may increase costs for basic network services in these regions. This may also impact many other government programs like Digital India, Digital payments, Smart Villages, Basic Health & Education programs, etc.

- **Hinderance to distribution of content, potential violation of freedom of speech and expression of broadcasters:** Broadcasting uses airwaves to transmit and distribute content to 187 million TV households in India. For private broadcasters, it is a form of free commercial speech, protected under Article 19(1)(a) of the Indian Constitution. In case of TV broadcasting, the Supreme Court said that the regulation of airwaves should guarantee access to diversity and plurality of opinions, because it is essential to the freedom of speech and expression under Article 19(1)(a) of the Indian Constitution.[xxii] The Supreme Court recognised that the right to propagate ideas was a part of freedom of speech and expression (Sakal Newspapers v. Union of India).[xxiii] It further held that this right included the right to reach any class and number of readers. In Indian Express Newspaper v. Union of India (1985 SCR (2) 287), the Supreme Court held that there could not be any restriction on the freedom of speech and expression on the grounds of public interest. It also noted that the free speech could not be restricted on any grounds other than those mentioned in Article 19 (2) of the Indian Constitution. The state has an obligation to guarantee the right to commercial speech and to ensure plurality of opinions on television, which spectrum allocations helps fulfil.

In case of an auction, the state passes on the ability to determine spectrum use to private telecom operators/ players. As private companies have no obligation to ensure plurality, they can hoard spectrum for their own use, or act as a gatekeeper and charge broadcasters for them. In both cases, plurality of opinion, and freedom of speech and expression is impacted. Gatekeeping will prevent smaller broadcasters from paying high fees and they will lose out on the ability to access spectrum to disseminate content. Further, a citizen's right to access information is tied to the right to freedom of speech and expression. Therefore, a restriction on spectrum access by broadcasters also indirectly impacts the citizen's right to access information. The Supreme Court in 1995 had decided that Radio Frequencies are public property and should be used for public good.

Thus, due to the potential challenges that might arise because of exclusive assignment, we propose that the DoT and TRAI should resort to administrative assignment of spectrum for space-based communication services, particularly in bands such as C-band.

6. RECOMMENDATIONS

Based on the above discussions, it is apparent that the nature of auctioning a shared global resource is a complex, technical issue. Consequently, any decision on it needs a holistic assessment of its impact on consumer demand and interests, consider issues of various industry stakeholders and needs to align with the objective of maximizing public welfare. Since auctioning of satellite spectrum is under current deliberation, it is essential for the DoT and TRAI to conduct research studies in order to unveil key issues that remain unaddressed and take an informed decision. We highlight four key areas that need further clarification below -

1. The impact of satellite spectrum auctions on services other than telecommunications such as broadcasting, aviation, defence, agriculture, and banking amongst others;
2. The impact on other policy efforts like the Draft Telecommunications Bill, the Indian Space Policy, and the Uplinking and Downlinking Guidelines;
3. The cost of shifting a service like broadcasting from one spectrum band to another;
4. Implications on international and regional coordination mechanism.

In the context of these, we also recommend TRAI to consider establishing a dedicated band plan for IMT/5G services within India. This recommendation factors in the substantial customer base and extensive market opportunities available in the country, with the objective of mitigating interference potential and alleviating the burden on both new as well as incumbent players in the Satcom sector.

FOOTNOTES

1 Within the satellite frequency spectrum, there are further sub-divisions of frequency bands called the L, S, C, X, Ku, K and Ka bands, each occupying an increasing range of frequencies starting from approximately 1 GHz going up to 40 GHz. (ESA, n.d.)

2 As per the International Space Laws, satellites are considered "space objects".

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4 ITU's Radio Regulations divide the world into three regions and allocation of radio spectrum to various radio services is made for each of these regions separately. India falls under region 3.

5 Club goods are products that are excludable but non-rival. That is individuals can be prevented from consuming them, but their consumption does not reduce their availability to other individuals (at least until a point of overuse or congestion is reached).

ENDNOTES

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