



Reference: TC 136/66
Date: May 18th, 2023
Attention: Mr. Akhilesh Kumar Trivedi
Advisor (Networks, Spectrum and Licensing)
Telecom Regulatory Authority of India
Subject: Comments to the Consultation Paper on Assignment of Spectrum for Space-based
Communication Services
Attachment: Comments to the Consultation Paper

Dear Shri Akhilesh Kumar Trivedi,

Thaicom Public Company Limited ("THCOM") would like to thank the Telecom Regulatory of India ("TRAI") for this opportunity to provide our views and comments pertaining to the Consultation Paper on Assignment of Spectrum for Space-based Communication Services.

Please find our comments in the attachment and we are pleased to respond to any further question that TRAI may have in this matter.

Yours sincerely,

A handwritten signature in blue ink, appearing to read "E. Phakdurong".

Mr. Ekachai Phakdurong

Chief Strategy Officer

Thaicom Public Company Limited

Overall Comment**1. Spectrum Demand for Space-based Communication Services**

Satellite orbits – geostationary satellite orbit (GSO) as well as non-geostationary satellite orbit (NGSO) – and frequency bands are typically selected based on required satellite applications due to the fact that there are various aspects having to be considered such as latency, throughput, link availability, etc. Some examples of frequency bands for satellite applications are given in Table 1 below.

To some extent, conventional GSO satellites utilise global and/or regional beams in C-band and Ku-band to provide broadcast services and point-to-point telecommunications such as very small aperture terminals (VSAT), mobile backhaul, telemedicine, etc. while NGSO satellite systems provide other services such as Earth observation, global positioning systems (GPS), Internet of Things (IoT) and machine-to-machine communication (M2M) in different frequency bands. These satellite applications still continue their services nowadays and in the future.

With the increasing user demand of mobility and high-speed broadband connectivity via satellites, many satellite service providers share the same trends in building and launching a significant number of high-throughput satellites (HTS) that employ frequency-reuse, multi-spot beams to serve such demand. Thus, sufficient frequency spectrum with large bandwidth for the satellite gateways and user terminals is needed. In addition to the existing satellite applications using mostly C-band and Ku-band whose satellite networks are considered congested, HTS is now using even higher frequency bands such as Ka-band and Q/V-bands either entirely or partially.

Considering the existing spectrum demand of C-band and Ku-band as well as those of Ka-band and Q/V-bands that are now increasing for space-based communication services, THCOM is of the opinion and would like to propose the Government of India to accommodate the use of frequency bands for space-based communication services for satellite service providers as currently assigned or allocated by relevant provisions of the ITU Radio Regulations as well as the National Frequency Allocation Plan (NFAP) with no additional restriction to specific frequency bands or frequency ranges for either user or gateway link and for particular types of services in order to avoid lack of flexibility of satellite-based communication services in India.

Table 1: Common frequency spectrum of satellite applications

Frequency Band	Frequency Range	Bandwidth	Transmission Direction	Typical Satellite Application
C	3400 – 4200 MHz	800 MHz	Space to Earth	<ul style="list-style-type: none"> • Video Distribution • Direct-to-home (DTH) • Backhaul & Trunking • Enterprise Data
	4500 – 4800 MHz ¹	300 MHz	Space to Earth	
	5850 – 6725 MHz	875 MHz	Earth to Space	
	6725 – 7025 MHz ¹	300 MHz	Earth to Space	
Ku	10.7 – 10.95 GHz ¹	250 MHz	Space to Earth	<ul style="list-style-type: none"> • Broadband Access • Mobility • Direct-to-home (DTH) • Backhaul & Trunking • Enterprise Data
	10.95 – 11.2 GHz	250 MHz	Space to Earth	
	11.2 – 11.45 GHz ¹	250 MHz	Space to Earth	
	11.45 – 11.7 GHz	250 MHz	Space to Earth	
	11.7 – 12.2 GHz ²	500 MHz	Space to Earth	
	12.2 – 12.75 GHz	550 MHz	Space to Earth	
	12.75 – 13.25 GHz ¹	500 MHz	Earth to Space	
	13.75 – 14.5 GHz	750 MHz	Earth to Space	
	14.5 – 14.8 GHz ²	300 MHz	Earth to Space	
	17.3 – 18.1 GHz ²	800 MHz	Earth to Space	
Ka	17.7 – 21.2 GHz	3500 MHz	Space to Earth	<ul style="list-style-type: none"> • High-speed Broadband Access • Mobility • Backhaul & Trunking • Enterprise Data
	27.0 – 31.0 GHz	4000 MHz	Earth to Space	
Q/V	37.5 – 42.5 GHz	5000 MHz	Space to Earth	<ul style="list-style-type: none"> • Very-high-speed Broadband Access
	42.5 – 43.5 GHz	1000 MHz	Earth to Space	
	47.2 – 50.2 GHz	3000 MHz	Earth to Space	
	50.4 – 51.4 GHz	1000 MHz	Earth to Space	

Notes:

1. Use of the frequency bands is in accordance with Appendix 30B of the Radio Regulations
2. Use of the frequency bands is in accordance with Appendices 30/30A of the Radio Regulations

2. Assignment of Frequency Spectrum for Space-based Communication Services

As mentioned in the Consultation Paper (Spectrum regulation in satellite-based communication systems) for the space segment, international coordination of satellite system is crucial and satellite operators need to obtain international recognition for the frequency and orbital resources they plan to use, by way of satellite filing in ITU i.e. the global agreement is needed for use of satellite spectrum.

It is recognised that the frequency spectrum of space services are acquired through the defined frequency coordination process of the ITU except those in Appendices 30/30A/30B of the ITU Radio Regulations and those not subject to frequency coordination. Aiming at the interference-free operation of the satellite networks, an administration or a satellite operator responsible for satellite network has to internationally coordinate its frequency assignments to the affected satellite and terrestrial networks according to relevant provisions of the Radio Regulations, and it is mandatory to coordinate with those concerned networks before providing services. The Radio Regulations lay down mechanism to ensure no harmful interference occurred to/from satellite networks. For example, with respect to the interference from space services to terrestrial services, or vice versa, sharing the same frequency bands, Article 21 of the Radio Regulations contains the conditions for both services to comply with. Moreover, regarding the interference among space services sharing the same frequency bands, Article 22 of the Radio Regulations, the equivalent power flux density (EPFD) limits for NGSO and the coordination process help the co-existence between GSO satellite networks and NGSO satellite systems possible. As a result, space spectrum is utilised on a shared use approach. International practice then assigns space spectrum on a non-exclusive use basis because several satellite networks or systems with agreed technical/operational conditions are able to utilise the same frequency spectrum without harmful interference.

Taking into account the international process and practice to acquire the space spectrum and operate a satellite network or system and to avoid ones monopolizing space spectrum which could significantly impact the market, THCOM is of the opinion that the administrative assignment of frequency spectrum is most suitable for space-based communication services. The spectrum auction for exclusive use by a limited number of satellite service providers will be in contradiction to international practices and cause adverse impacts to Indian satellite industry. Reasonable fee payments regarding frequency spectrum usage may be charged as appropriate.

3. Use of Frequency Spectrum in 27.5-29.5 GHz

At international level, the World Radiocommunication Conference 2019 (WRC-19) identified the frequency bands 24.25-27.5 GHz, 37-43.5 GHz and 66-71 GHz (i.e. millimeter wave or mmWave) worldwide for

International Mobile Telecommunications (IMT) to support high-speed broadband connectivity via terrestrial mobile networks. At the same Conference, it also adopted regulatory framework and technical conditions for earth stations in motion (ESIM) communicating with GSO space stations in the fixed-satellite service (FSS) in the frequency bands 17.7-19.7 GHz (space-to-Earth) and 27.5-29.5 GHz (Earth-to-space) to support broadband connectivity and mobility services via satellite.

Further, the up-coming Conference under WRC-23 agenda item 1.16 will consider and decide appropriate regulatory framework and technical conditions of ESIM communicating with NGSO FSS in the frequency bands 17.7-18.6 GHz, 18.8-19.3 GHz and 19.7-20.2 GHz (space-to-Earth) and 27.5-29.1 GHz and 29.5-30 GHz (Earth-to-space). No ITU-R study related to IMT in mmWave (e.g. 27.5-29.5 GHz) in this study cycle has been performed.

In India, the additional frequency spectrum in mmWave for IMT in frequency bands 27.5-28.5 GHz for 5G mobile networks and 28.5-29.5 GHz for Captive Non-public Networks (CNPN) should primarily justify the spectrum demand and identify appropriate service applications. In case the frequency bands need to be shared between IMT and ESIM, one possible coexistence scenario is to deploy IMT for only indoor, and taking into account the potential, ubiquitous deployment of GSO/NGSO ESIM, no protection claim of IMT shall be made to ESIM operating in these frequency bands.

Therefore, taking account of eminent demand of space-based communication services in frequency band 27.5-29.5 GHz, THCOM is of the opinion and would like to propose the Government of India to support use of the bands by the space-based communication services specially ESIM nationwide and to not impose undue conditions that may cause unnecessary limitations to deployment of space-based communication services in frequency band 27.5-29.5 GHz.

Responses to Questions for Consultation

Response to Question 1:

Taking into account current satellite networks, the equipment availability, and relevant regulations governing use of the frequency spectrum, frequency bands for telecommunications and broadcast services should be considered as shown in Table 2.

Table 2: Frequency bands for space-based communication services

Frequency Band ¹	Telecommunications Services		Broadcasting Services	
	Gateway Link	User Link	Gateway Link/ Teleport/Hub	User Link
C	/	/	/	/
Ku	/	/ ²	/	/
Ka	/	/ ²		
Q/V	/	/		

Note:

1. Frequency bands, including detailed frequency ranges, are specified in Table 1.
2. Some portions of Ku-band and Ka-band for earth stations in motion (ESIM) may be used according to the NFAP 2022 (i.e. footnote IND 17) and relevant provisions of the Radio Regulations in addition to fixed earth stations.

Response to Question 2:

It is subject to a capacity required to cope with demand for broadband services via satellites, which is expected to grow significantly over next decades. From these global trends, having sufficient space spectrum for these satellite services is highly important for sustainable services of the satellite industry in India.

Response to Question 3:

There is a possibility that a large number of NGSO satellite systems could cumulatively generate excessive aggregate interference to other space networks/systems and terrestrial networks sharing the same frequency bands. However, there is still no conclusion in this matter, whose study shall be conducted to evaluate the interference or impacts in order to determine the limited number of NGSO satellite systems.

Response to Question 4:

Exclusivity cannot apply to assignment of the frequency spectrum of space services due to their uniqueness in nature of use, which is different from those of terrestrial services. For example, in term of frequency sharing, the same portions of frequency spectrum can be utilised among satellite operators/service providers whose networks are already coordinated.

Therefore, assigning space spectrum on an exclusive basis especially through auction process will result in inefficient use of the spectrum, e.g. disabling available space capacity of satellite service providers that could serve Indian market while creating a situation of a few number of satellite operators/service providers dominating or monopolizing use of spectrum that can cause adverse impacts to Indian satellite industry.

Response to Question 5:

Considering the C-band, Ku-band and Ka-band are commonly used by satellite service providers, it is quite obvious that to assign the spectrum on an exclusive basis is opposed to promoting effective use of satellite spectrum for extensive service applications to government and non-government entities in India. Therefore, specifying criteria (e.g. block size, number of blocks and spectrum cap, etc.) in preparation of assignment exclusivity will unavoidably cause adverse impacts to Indian satellite industry. With this, the frequency spectrum of space services should not be assigned on an exclusive basis, esp. through the auction.

Response to Question 6:

Apparently, auctioning space spectrum would not only eliminate a number of existing satellite service providers from Indian market but also block new entrants from entering the market. It would also put uncertainty for long-term services to licensees. For instant, if being unable to re-acquire frequency spectrum, their satellite capacity/services planned to continue serving India will be gone or re-allocated to somewhere else if possible, for years (i.e. validly period) and may not be re-allocated to serve India again. It is quite the case that the satellite communication ecosystem is adversely impacted.

Response to Question 7:

The auctioned winners will become the ones who are able to dominate/monopolise the market by setting preferential conditions of trading and/or leasing of their auctioned spectrum indirectly. With this, there will be only limited number of satellite service providers, resulting in that the market will lose its competitiveness in

terms of prices, services and competitors. As a consequence, end users will be adversely and unavoidably affected.

Response to Question 8:

Whenever there is a change in policies/regulations, it is in general that it ought not to retroactive nor cause negative impacts to existing licensees and service providers, including their customers. Thus, appropriate provisions should be established.

Response to Question 9:

Frequency spectrum for space-based communication services should be assigned on a shared-use basis under the framework of mutual coordination of ITU satellite filing procedures without necessity to be prescribed in detail.

Response to Question 10:

The demand of additional IMT/5G spectrum in the frequency range 27.5-28.5 GHz should be justified first. Without strong demand, assigning this frequency range to IMT/5G should be reconsidered. In addition, typical network deployment scenarios/applications of IMT in this frequency range together with proper technical conditions to co-exist with satellite earth stations should be thoroughly considered to know if the frequency band can be utilised in a flexible manner.

Response to Question 11:

Due to potential deployment of space-based communication services using ubiquitous, small user terminals and earth stations in motion (ESIM) in this frequency range, IMT serviceable areas should be indoor only if it is allowed for use in a flexible manner. This is to avoid interference and the IMT service may not claim protection from space-based communication services. Besides, site shielding for IMT networks may be necessary.

Response to Question 12:

The demand of additional IMT/CNPN spectrum in the frequency range 28.5-29.5 GHz should be justified first. Without strong demand, assigning this frequency range to IMT/CNPN should be reconsidered. In addition, ESIM may be used according to the footnote IND 17 of the NFAP 2022 and relevant provisions of the Radio

Regulations in this frequency band in addition to fixed earth stations. Therefore, IMT/CNPN should take into account the potential, ubiquitous deployment of ESIM and small user terminals operating in this frequency band and it should not claim protection from space services as well.

Response to Question 13:

Due to potential deployment of space-based communication services using ubiquitous, small user terminals and ESIM in this frequency range, IMT/CNPN serviceable areas should be indoor only if it is allowed for use in a flexible manner. This is to avoid receiving interference and the IMT service may not claim protection from space-based communication services. Besides, site shielding for IMT networks may be necessary.

Response to Question 14:

As shown in Table 1 and Table 2, frequency spectrum for space-based communication services in higher frequency bands such as C band, Ku band, Ka band and Q/V-bands can be utilised by multiple services under the required licenses, which are already in place, to provide not only telecommunications services but also broadcasting services. Hence, categorization of the different class of space-based communication services seems unnecessary.

Response to Question 15:

The frequency spectrum of space services should not be assigned on an exclusive basis due to its difference in nature of use from those of terrestrial services. For example, in term of frequency sharing, the same portions of frequency spectrum can be utilised among satellite operators/service providers whose networks are already coordinated as required by the Radio Regulations to serve India.

Therefore, assigning space spectrum on an exclusive basis especially through auction process will unnecessarily result in inefficient use of the spectrum, e.g. disabling available space capacity of satellite service providers that could serve Indian market while creating a situation of a few number of satellite service providers dominating or monopolizing use of spectrum that can cause negative impacts to the market.

Response to Question 16:

Considering the international process and practice of the ITU that satellite operators/service providers have to follow in order to acquire the space spectrum and operate a satellite network or system without harmful interference to one another, the administrative assignment of frequency spectrum is most suitable for space-based communication services.

Response to Question 17:

The frequency spectrum for user link of space-based communication services should be assigned at the national level. This is because satellite services are ubiquitous and cover wide areas. For instance, user terminals of broadcasting services are ubiquitously installed nationwide. Further, earth stations in motion (ESIM) allowed under the footnote IND 17 of the NFAP 2022 in some certain frequency bands could be operated on land, waters and in the air over Indian territory.

Response to Question 18:

No comment.

Response to Question 19:

Considering the international process and practice of the ITU that satellite service providers have to follow in order to acquire the space spectrum and operate a satellite network or system without harmful interference to one another, the administrative assignment of frequency spectrum is most suitable for space-based communication services.

Response to Question 20:

No comment.

Response to Question 21:

It is obvious that auctioning space spectrum would not only eliminate existing satellite service providers from Indian market but also block new entrants from entering the market for years (i.e. validly period). Worst, if there is some frequency spectrum left unsold, it would be inefficient use of frequency spectrum unnecessarily. With

this, the frequency spectrum of space services should not be assigned on an exclusive basis, esp. through the spectrum auction.

Response to Question 22:

Although the C-band, Ku-band and Ka-band are commonly used by satellite service providers, it is obvious that there are enormous factors to be carefully considered in detail whether to assign the spectrum on an exclusive basis. Since space stations as well as satellite network filing parameters of every satellite service provider are uniquely different, specifying criteria for space auction (e.g. separate auctions for gateway and user links, auctions in a bundled manner, etc.) will be unavoidable to adversely affect the satellite industry. With this, the frequency spectrum of space services should not be assigned on an exclusive basis.

Response to Question 23:

The protection distance shall be made available by the satellite operators/ service providers through the international frequency coordination process of the ITU, if deemed necessary. Hence, it need not be prescribed in domestic regulations as long as the space spectrum is administratively assigned.

Response to Question 24:

For non-exclusive frequency spectrum assignment, licensees who are currently holding the applicable licenses/permissions/authorisations and applicants who are in the process of applying and obtaining the applicable licenses/permissions/authorisations should have an evidence showing the existing agreement with satellite operator(s).

Response to Question 25:

For non-exclusive frequency spectrum assignment for both user links and gateway links for all types of space-based communication services, there should be no additional conditions from those already specified in the licenses/permissions/authorisations. To ensure interference-free operation of radiofrequency in India, the frequency assignments to the satellite network filings whose agreements with respect to affected networks identified by the ITU have not been obtained should be assigned for use with the conditions that they should eliminate interference immediately, once occurred, and they should not claim protection from those affected networks.

Response to Question 26:

No comment.

Response to Question 27:

The Article 21 of the Radio Regulations contains necessary conditions/limitations for both terrestrial and space services sharing the same frequency bands to comply with in order to co-exist without harmful interference. Coordination between space services and terrestrial services can be conducted after the technical examination by the ITU is completed, and the coordination requirements are identified and published on the BR IFIC. Therefore, with this mechanism in place, this should ensure interference-free operation and mitigation measures should not be required.

Response to Question 28:

The polarizations of frequencies should not be considered in assigning and valuating of frequency spectrum. Otherwise, other factors having impacts on the frequency usage e.g. operating conditions, applicable service coverage and so on should also be taken into account, which unnecessarily complicate the assignment practice.

Response to Question 29:

Auctioning space spectrum according to the suggested design models for user links would create serious uncertainty to satellite service providers as they cannot ensure if they can provide services in India. For instance, if frequency spectrum for user links is obtained insufficiently or frequency spectrum for gateway links is not obtained as well, the auctioned frequency spectrum would not be operable. Worst, if there is some frequency spectrum left unsold, it would be inefficient use of frequency spectrum unnecessarily. With this, the frequency spectrum of space services should not be assigned on an exclusive basis.

Response to Question 30:

Assigning space spectrum on an exclusive basis will unavoidably cause adverse impacts to Indian satellite industry, therefore none of them should be used. The administrative assignment of frequency spectrum is most suitable for space-based communication services.

Response to Question 31:

Frequency spectrum to space services can be ultimately shared among an unidentifiable number of satellite service providers. Assigning space spectrum for user links using model 2 will unavoidably cause adverse impacts to Indian satellite industry. Thus, the administrative assignment of frequency spectrum is most suitable for space-based communication services.

Response to Question 32:

No comment.

Response to Question 33:

As the locations of gateways should be known prior to assigning frequency spectrum, the administrative assignment, which is the present process, could be implemented without issue or need of any regulatory change.

Response to Question 34:

Gateways of satellite networks are paramount important of satellite networks or systems. With this Option 2 proposed, it would drive considerable cost of constructing gateways and put unnecessary burden onto satellite service providers in finding workable gateway locations to their satellite networks. In addition to this, it would not be in line with the earlier TRAI's recommendations regarding the nationwide service area of the SESG license.

Response to Question 35:

Frequency spectrum to space services can be ultimately shared among an unidentifiable number of satellite service providers. Assigning space spectrum for gateway links using Option 2 will unavoidably cause adverse impacts to Indian satellite industry. Thus, the current administrative assignment of frequency spectrum is most suitable for space-based communication services.

Response to Question 36:

No comment.

Response to Question 37:

No comment.

Response to Question 38:

Currently, the mechanism as laid down in the Guidelines for Establishing Satellite-based Communication Networks and other relevant Orders is proper for charging the administrative assignment of frequency spectrum for user links and gateway links.

Response to Question 39:

Terrestrial frequency spectrum and space frequency spectrum are totally different even in the same frequency range. Thus, using the same approach for valuating both IMT/5G spectrum and space spectrum seems irrelevant and may not reflect its true value. Worst, the auction of space spectrum will cause adverse effect to Indian market, therefore the administrative assignment of frequency spectrum is most suitable for space-based communication services unlike terrestrial services.

Response to Question 40:

No comment.

Response to Question 41:

The administrative assignment of frequency spectrum for both user links and gateway links is most suitable for space-based communication services. Besides, the valuation of the space spectrum by relating to other bands may not reflect its true value and the auction of space spectrum will cause adverse effect to Indian market.

Response to Question 42:

The administrative assignment of frequency spectrum for both user links and gateway links is most suitable for space-based communication services. Since the valuation of space spectrum by levying spectrum fees/charges on formula/ARG basis as followed by DoT may not reflect its true value, the auction of space spectrum will cause adverse effect to Indian market.

Response to Question 43:

As the revenue surplus model used for IMT/5G spectrum auction is based on the assumption that the net present value (NPV) of the projected revenue surplus over the next 20 years, it seems not suitable to evaluate space spectrum due to significant differences. To some extent, the revenue of a satellite project is projected based on regional and/or global services of the satellite, not on a particular country, and perhaps on other timeframe such as the satellite's end of life. Since the valuation of space spectrum by revenue surplus model may not reflect its true value, the auction of space spectrum will cause adverse effect to Indian market.

Response to Question 44:

No, because the situations of valuating spectrum in each country vary and are different up to individual country's point of interests, space environment of its orbital locations and so on. As a result, they are subjective and may not be counted as applicable benchmark. More importantly, the administrative assignment of frequency spectrum is most suitable for space-based communication services. Since the valuation of the space spectrum may not reflect its true value, the auction of space spectrum will cause adverse effect to Indian market.

Response to Question 45:

No, because the administrative spectrum charges/fees in each country vary and are different up to individual country's interests. As a result, they cannot be a good basis/technique to evaluate satellite spectrum bands for India. More importantly, the administrative assignment of frequency spectrum is most suitable for space-based communication services. Since the valuation of the space spectrum may not reflect its true value, the auction of space spectrum will cause adverse effect to the Indian market.

Response to Question 46:

No comment.

Response to Question 47:

No comment.

Response to Question 48:

No, because use of spectrum for user links and for gateway links is totally different in various aspects such as purpose and technique. Even though both kinds of spectrum are in the same band, they are not necessarily comparable.

Response to Question 49:

No specific comment other than viewing that the administrative assignment of frequency spectrum is most suitable for space-based communication services.

Response to Question 50:

No specific comment other than viewing that the administrative assignment of frequency spectrum is most suitable for space-based communication services.

Response to Question 51:

No specific comment other than that the administrative assignment of frequency spectrum is most suitable for space-based communication services.

Response to Question 52:

No specific comment other than that the administrative assignment of frequency spectrum is most suitable for space-based communication services.

Response to Question 53:

No specific comment other than that the administrative assignment of frequency spectrum is most suitable for space-based communication services.

Response to Question 54:

Currently, the annual spectrum charges for administrative assignment are appropriate.